Diversification through Farming System Approach

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PREFACE

The National Development Council in its 53rd meeting adopted a resolution to launch a Food Security Mission to increase the production of rice by 10 million tonnes, wheat by 8 million tonnes and pulses by 2 million tonnes by the end of the Eleventh Plan. Accordingly, a Centrally Sponsored Scheme, 'National Food Security Mission' has been launched in 2007-08 to operationalize the resolution.

Rice and wheat production which grew after the Green Revolution has been in the range of 85-93 and 68-74 million tonnes, respectively, during the previous decade except during 2002-03 when the production reduced drastically due to unprecedented drought conditions. The production of pulses is stagnant in the range of 11-14 million tonnes while the oilseeds have touched 25 million tonnes, which are well below the domestic demand. The cost of pulses imports was Rs.3,851 crores, that of edible oils Rs.9,416 crores in 2006-07, and of wheat imports about Rs.7,500 crores during the last 2 years.

The national target of agricultural annual growth has been fixed at 4.1 per cent for 11th Plan against 2.3 per cent achieved in 10th Plan. The growth is pushing up in dairy and marine products but the food grain front is a major issue of concern.

In near future, area under plough is likely to decrease with the increasing urbanization, industrialization and expansion of infrastructural facilities. The solution now lies in the integrated farming system which is superior to that of traditional cropping system because the interest of farmers and public demand are more closely aligned. High debt requires farmers to focus on cash generation on regular basis.

Subsistence agriculture is now converting into commercialization with the concept of globalization. In the light of such circumstances there is need to diversify and utilize all the available resources in order to generate more of farm income. This bulletin documents pertinent information gathered directly from the farmers' fields to explore the possibilities and success of diversified farming through crop and subsidiary enterprises which is a need of the hour.

AUTHORS

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INTRODUCTION

India imported on an average 10 million tonnes of food grains during the sixties to meet out its requirement of food. With the introduction of semi-dwarf and fertilizers responsive varieties of rice and wheat crops in mid-sixties, India acquired food self-sufficiency in 1976. Punjab and Haryana are the major states to contribute food grains in central pool. Contribution of these states is 37 and 7 per cent in rice and 61 and 31 per cent in wheat, respectively. To fulfil the increasing demand of food, we will have to produce additional 5-6 million tonnes per annum of food grains. We had to import wheat worth Rs.7,500 crores during the previous two years. The escalating rates of wheat in the international market from $ 205 in 2006 to $ 375 per tonne in 2007 reflect about the future concern of food deficit in the country.

Food grain production of Haryana increased from 26 lakh tonnes in 1966-67 to 147 lakh tonnes in 2006-07. The contribution of rice and wheat in it was 50 per cent in 1966-67 which has increased to more than 90 per cent at present. This increase in the share of rice and wheat has created imbalance in cropping pattern which has nearly eliminated the pulses from the cropping system in irrigated agro-ecosystem.

Now the availability of pulse varieties like HC-5 of gram and SML-668 of mungbean are giving good results in irrigated agro-ecosystem if sown with bed planting method. Likewise the oilseed crops such as sunflower and variety RH-30 of mustard can find a place in the exhaustive cropping system.

Sugarcane-based cropping system is more remunerative if adopted with suitable intercrops like onion, garlic or wheat in autumn planted sugarcane. The results at farmers' field are enthusiastic and have increased the income of farmers over rice-wheat cropping system.

India is the second largest producer of vegetables and fruits with the production of 108 and 53 million tonnes, respectively. Potato, onion and tomato are the important vegetable crops being grown in the close vicinity of urban areas. Vegetable-based cropping systems which include potato, onion, tomato, pea, cucurbits, etc. are paying rich dividends to the farmers with higher benefit-cost ratio than rice-wheat sequence.

The concept of diversification remains incomplete and subdued if it is not supported by the diversified farming systems. Combination of crop production and dairy farming is very common and oldest practice in Haryana and Punjab. India has become world leader in milk production with the production of 101 million tonnes of milk. Per capita availability of milk is 246 g day^{-1} against the minimum requirement of 250 g. Haryana produces about 54 lakh tonnes of milk with per capita availability of 660 g day^{-1}. Still a large potential in milk production remains to be unexploited as the average productivity of India is less than half of the world average.

Bee-keeping has been emerging as a potent low investment enterprise in Haryana with more than 400 bee units in Kurukshetra district alone. It is an effective source of income generation particularly for the small and landless unemployed youth of society. They adopt migratory system of bee-keeping which is more economical than stationary bee-keeping system. It not only helps in boosting income of the individual bee-keeper but also helps in increasing productivity of cross-pollinated crops and generating employment for other unemployed persons.

Haryana has become a leading producer of white button mushroom with the production of 7100 tonnes and ranks first in India as far as seasonal cultivation of mushroom is concerned. Some of the factors contributing to this success are nearness of Delhi market, abundant availability of wheat and paddy straw, easy availability of quality spawn and comprehensive training programmes by Krishi Vigyan Kendras of CCS Haryana Agricultural University, Hisar. The white button mushroom alone contributes more than 95 per cent to the total production, about 78 per cent is consumed fresh and remaining is canned. Keeping in view the availability of an abundant quantity of straw, there is vast scope of increasing mushroom production in Haryana.

Besides these enterprises, on-farm studies on some other components of farming system have also been included in the present manuscript to assess the impact of multiple farming systems. The success of farming system rests with the proper combination of various enterprises and utilization of products and/ or by-products of one enterprise for other allied enterprises. Some farmers have demonstrated the success of integrated farming system at their farm. The information on these individual as well as multiple farming systems adopted by the farmers has been documented in this bulletin through success stories and group studies.

SUSTAINABILITY OF RICE-WHEAT CROPPING SYSTEM – A CAUSE OF CONCERN

Rice-wheat cropping system (RWCS) is the most important cropping system of south Asia with an area of 13.5 million ha. Immediately after the green revolution, the lead areas of RWCS witnessed higher growth rates in productivity compared to other regions in South Asia. The growth rate of these two crops and the system as a whole have declined since 1990s. However, we need to maintain the food security for 1.3 billion people by 2010 AD. In order to meet the food needs of approximately 1.3 billion people in South Asia, rice and wheat contribute nearly 70-95 per cent of calorie intake. India has 16.8 per cent of world population, 4.2 per cent world's water resources and 2.3 per cent global land (ICAR, 2006). During last few years, the farmers have started using more than recommended dose of fertilizers. Although it may not be true but extra input use may have smaller addition to the output but that has not been accounted for by scientific establishments. High minimum support price (MSP) of both rice and wheat during last two years has further encouraged farmers to use more inputs even after the addition of a small output. The total factor productivity, water productivity and fertilizer-use-efficiency are some of the important priority areas where we can spot big opportunities and grasp them rapidly. In order to stabilize productivity, the diversification within RWCS is becoming essential because other components of diversification through pulses or oilseeds have not found favour with the farmers. Similarly, diversification in favour of a farming system approach can help diversifying cropping system by indirectly encouraging farmers to grow fodder crops to replace rice.

Diversification

We should see that either crops or cropping systems that have less pressure on natural resources are introduced or technologies that help conserving natural resources are evolved. Based on such recommendations, policy makers planned to get rid off the part of rice-wheat cropping system and concentrate on diversification of this cropping system. However, the average profitability of RWCS was more than the alternate cropping system (Singh and Sidhu, 2004). The advocates of diversification need to notice that farmers, specially the small landholders, cannot take risk associated with the profitability of an alternate cropping system. Results of diversification so far are unimpressive (Rangi, 2004). The RWCS does seem to need diversification. However, farmers are not happy with the relative profit offered by diversification of this cropping system. Researchers now-a-days should know what does and what does not work. Any research output is good if it attracts farmers and is bad if it repels them. Every private enterprise including a farmer maximizes the difference between total revenue and total costs, that is profit. Rational action, however, occurs within a particular institutional context (Subroto, 1984). Which action is rational and which is not has been described in the above paragraph and in earlier reports (Malik *et al*., 2002). Efforts to diversify the RWCS in favour of crops other than RWCS seem not to have worked. So, there remains an opportunity for large scale introduction of resource conservation technologies (RCTs). The balancing effect of RCTs will allow RWCS to maintain the ecosystem without having to diversify on a large scale. Technologies such as zero-tillage may turn the lessons learnt from diversification programme to its advantage. This technology is the rational risk avoiding strategy with tremendous potential to conserve natural resources.

Decreasing fertility of soil

The visible concerns in rice-wheat system which require immediate attention are the decreasing inherent fertility of the soil, depletion of water table and increasing biotic stresses.

The data of five years (2001-02 to 2005-06) on nitrogen-use efficiency clearly reveal that the grain productivity per kg N applied increased (Fig. 1) with the subsequent cropping cycles which exhibit that the yield level decreased with the control plot due to the decline in inherent fertility of the soil. Antil *et al.*

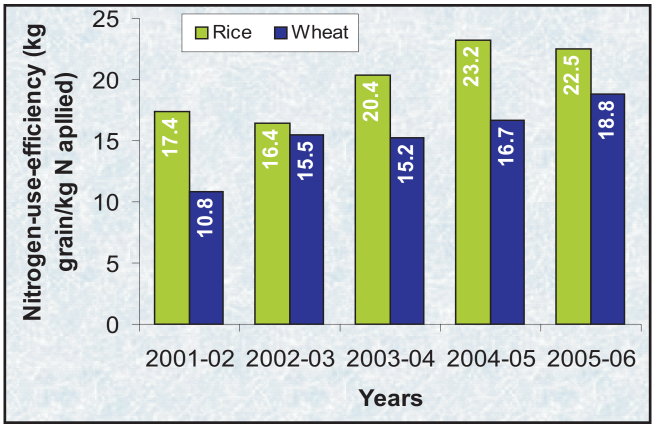

Fig. 1. N-use-efficiency (kg grain/kg N applied) from 2001-02 to 2005-06 in rice-wheat system.

(2001) and Gupta and Dahiya (2003) reported that 92.0, 70.6, 7.8, 54.0, 4.4, 21.0 and 2.6 per cent soils of Haryana were deficient in organic carbon, available P, available K, Zn, Mn, Fe and Cu, respectively. Input-use pattern reflects progressive increase in nutrient demand, more application of pesticides and also strain on water front (Garg *et al*., 2006). This implies that input use efficiency is decreasing with the simultaneous increase in the cost of production. Kumar *et al*. (1998) reported that in Haryana, the annual growth rate in total factor productivity had slowed down with time after 1985.

Heavy uptake of nutrients

There are three major cropping systems of Haryana *viz.* rice-wheat, cotton-wheat and pearl millet-wheat. Among these, rice-wheat is the most exhaustive cropping system. The study of four years from 2002-03 to 2005-06 conducted at 12 locations in eastern Haryana (Karnal and Ambala districts) on nutrient management depicts that rice-wheat system feeds 728.1 kg NPK ha^{-1} (Table 1). The same study on nutrient management conducted in districts of western Haryana (Rewari, Bhiwani, Hisar and Fatehabad) in cotton-wheat and pearl millet-wheat systems at 12 locations each reflects that cotton-wheat and pearl millet-wheat are the next heavy feeders of NPK with the total uptake of 626.2 and 562.2 kg ha^{-1} (Table 1).

The integrated results of the study on nutrient management on three cropping systems in Haryana reveal that rice-wheat system requires urgent measures for diversification within RWCS by conservation agriculture.

Table 1. Total nutrient uptake (kg ha^{-1}) in major cropping systems of Haryana (average of four years from 2002-03 to 2005-06)

Nutrient	Uptake (kg ha^{-1})				
	Control	N	NP	NK	NPK
Rice-wheat system					
N	103.8	260.1	279.5	250.9	321.7
P	18.2	40.0	47.3	42.9	54.0
K	127.0	283.3	318.0	294.2	352.4
Total	249.0	583.4	644.8	588.0	728.1
Pearl millet-wheat system					
N	63.4	136.1	187.7	148.2	216.1
P	11.4	21.9	30.5	24.2	35.3
K	96.4	214.7	274.4	223.6	310.8
Total	171.2	372.7	492.6	396.0	562.2
Cotton-wheat system					
N	82.9	163.5	209.4	187.7	239.8
P	15.7	29.1	37.8	32.7	43.7
K	157.9	258.0	313.9	267.3	342.7
Total	256.5	450.6	561.1	487.7	626.2

Depletion of ground water reservoir

Depletion of water table in five key districts (Kaithal, Kurukshetra, Karnal, Panipat and Fatehabad) of rice-wheat system is worse affected (Garg *et al*., 2006). There has been steep decline in water table over the years (Table 2). The ground water table which was 8-22 metres in 1995 in these districts lowered down to 21-30 metres in 2005. In 1995, there were 45 and 6 over exploited and dark zones in Haryana which increased to 55 and 11, respectively, in 2004. In India, there were 226 dark

Table 2. Impact on ground water table in key districts of rice-wheat cropping system

District	Water table depth (m)		
Kaithal	4 (1979)	10 (1995)	22 (2005)
Karnal	5-14 (1979)	8-18 (1995)	11-23 (2005)
Panipat	5 (1976)	13 (1995)	21 (2005)
Fatehabad	16 (1979)	22 (1995)	30 (2005)
Kurukshetra	14 (1987)	18 (1995)	25 (2005)

Figures in parentheses are the years of observation.
Source : Garg *et al.* (2006).

and 839 over exploited zones in 2004, the number of which has increased till date (Anonymous, 2006).

Increase in biotic stress

The menace of *Phalaris minor* has increased in rice-wheat cropping system and has threatened the productivity of wheat crop. Continuous use of urea-based herbicides for more than a decade has resulted in the evolution of resistant biotypes of *Phalaris minor* (Malik *et al*., 1995; Walia *et al*., 1997). Three new herbicides (sulfosulfuron, clodinafop and fenoxaprop) have been recommended for the control of isoproturon-resistant biotypes of *P. minor* in rice-wheat system. Now the cases of cross-resistance against these herbicides particularly clodinafop after its continuous use have been reported from the farmers in the rice-wheat belt.

Rice crop management system supports the survival of *P. minor* seed in rice-wheat system (Parashar and Singh, 1984, 1985; Singh *et al*., 1999). Hence, crop rotation is the best option for the control of *P. minor* (Brar, 2002). Replacement of wheat with other crops like sunflower, sugarcane, berseem, vegetables, etc. for 2-3 years reduces the intensity of *P. minor* in wheat crop (Table 3). New emerging weeds like *Sphenoclea zeylanica* in rice and *Rumex retroflexus* and *Malva parviflora* in wheat may be the likely menace of future in rice-wheat system.

Table 3. Effect of crop rotation on dry matter accumulation of *P. minor*

Treatment	Dry matter of *P. minor* (g m^{-2})
Rice-wheat (Herbicide)	20.9
Rice-wheat (control)	455.3
Rice-potato-wheat	0.0
Rice-potato-sunflower	0.0
Rice-berseem	1.3
Rice-gobhi sarson	4.0

Source : Brar *et al.* (2002).

The succulent green crop with the liberal use of nitrogenous fertilizers and constant humid micro-environment in both the crops (rice and wheat) renders susceptibility to insect-pests and diseases (Fig. 2). Generally the farmers tend to act on the advice of local dealers which adds to the complexity of the problem. Sheath blight, which was considered as a minor disease in rice, has been emerging as a major disease in both scented and non-scented varieties after 2005. Due to the increase in area under hybrids and other susceptible varieties, the incidence of false smut is on the rise. Incidence of Bakane, blast and bacterial leaf blight are other threats to the productivity of rice cultures.

Fig. 2. Incidence of bacterial leaf blight in paddy crop.

Earlier the incidence of stem borer was sporadic in nature which now is causing constant problem to rice growers not only in scented but other varieties also. Leaf folder and white backed plant hopper are the other major insects in rice crop which require special attention. Aphid in wheat is likely to be a regular pest in the years to come. Powdery mildew and rusts may be the yield limiting factors in wheat.

Economic returns

Better economic returns, availability of market infrastructure, MSP and lesser risk involved in the cultivation of rice and wheat crops are the important factors which enthuse the farmers to adopt rice-wheat system in north-western India. These factors have direct bearing on the life of farmers and their families, whereas other factors which erode the common base of natural repository of the system and environment exert indirect influence on the farmers; as these are community or government-based decisions with lesser or no accountability of individual farmer. Hence, an approach, which has community basis, can handle these common issues effectively.

Pulse and oil seeds-based

India ranks first in the world in area and production of pulses covering 43.3 per cent area and 35.5 per cent of total production of pulses. Pulses are grown in an area of 23.0 million ha, producing 14.4 million tonnes of the grain to the total food grains to the country (ICAR, 2006). Per capita availability of pulses has declined from 27.5 kg year^{-1} in 1959 to 10.05 kg year^{-1} in 2005 against the optimum requirement of 29.2 kg year^{-1} in vegetarian diet.

In oilseeds, India is the leading oilseed producing country in the world. India, in global oilseed scenario accounts for 13 per cent of area and 7 per cent of production and 10 per cent of world's edible oil consumption. Oilseeds are grown in 22.9 million ha area with the production of 20.0 million tonnes and productivity of 872 kg ha^{-1}.

Inclusion of pulses and oilseeds in rice-wheat cropping system will help to meet out the domestic requirement of the country. India has to import edible oils and pulses from other countries, thereby draining more than 13,000 crores of rupees out of the country. The share of edible oils in total agricultural imports is 71.4 per cent, whereas pulses contribute 13.7 per cent in this pool. The share of agri-imports in total merchandise imports is 4.8 per cent.

Pulses and oilseeds are the important crops for diversification in rice-wheat system. These can help in the replenishment of soil fertility and increase productivity of the system. Pulses have been reported to fix atmospheric nitrogen in the soil upto 30 kg ha^{-1}. Inclusion of oilseeds like sunflower in rice-wheat system not only helps in reducing the intensity of menacing weed *Phalaris minor* in wheat but also increases the productivity of rice through the addition of enormous amount of leafy matter in the field.

In rice-wheat system, the farmers mainly grow green gram or blackgram in the nitches available between the two crops. Mainly, farmers grow green- gram and Sesbania (*dhaincha*) crops after the harvesting of wheat crop and incorporate *in-situ* before the transplanting of rice crop (Fig. 3). Green gram is used for dual purpose i.e. for seed harvesting and green manuring. Greengram is also taken by some growers after the harvesting of potato and sugarcane crops. The area of green gram during 2007 in rice-wheat belt of eastern Haryana is given in Table 4.

The studies conducted at seven locations of farmers' field in district Kurukshetra reveal that *in-situ* incorporation of greengram after picking up of pods improved the grain yields of basmati rice by

Fig. 3. Green manure crops in rice-wheat cropping system (left : sesbania, right : green gram).

Table 4. Area under green gram in eastern Haryana

District	Area (ha)
Kurukshetra	4200
Karnal	800
Panipat	800
Kaithal	325
Ambala	1050
Yamuna Nagar	325

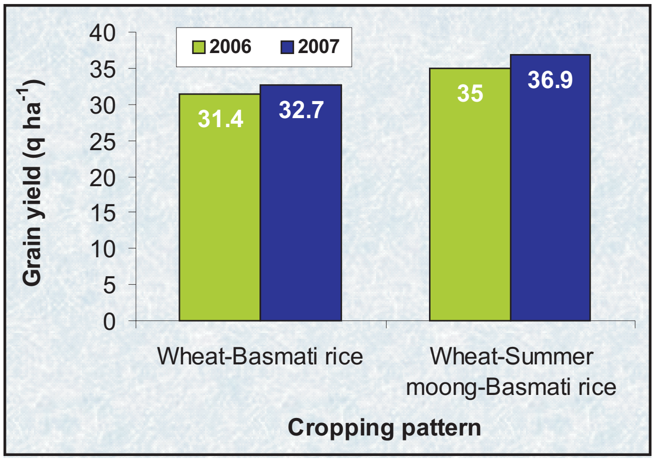

Fig. 4. Grain yield of Basmati rice in different cropping systems.

11.6 and 13.0 per cent during **kharif** 2006 and 2007, respectively (Fig. 4). This might be ascribed to the improvement in soil fertility due to the incorporation of summer greengram.

This gave an economical advantage of Rs.13,600 and Rs.14,200 ha^{-1}, respectively, to the farmers. Bhatia and Mohammad (2006a) reported that green manuring of Sesbania in rice-wheat system in 3000 ha area during 2005-06 in Ambala district gave average monitory benefit of Rs.1,200 ha^{-1}.

Fig. 5. Sunflower – A good option for diversification.

Sunflower and toria (*Brassica campestris* var. toria) are the oilseed crops which are taken by the farmers in rice-wheat system. Cultivation of toria crop before the sowing of wheat has been observed to decrease the yield of wheat by 5-12 per cent (personal observation) due to delay in wheat sowing.

Sunflower is preferred by the farmers when their fields get vacated upto mid-February in the rotations including sugarcane, potato, peas or other vegetable crops (Fig. 5). The area and productivity of sunflower over the years in Kurukshetra district in eastern Haryana are given in Fig. 6. The area was the highest (26,000 ha) in 1996-97 and lowest (2000 ha) in 2000-01. Wheat was not profitable in fields heavily

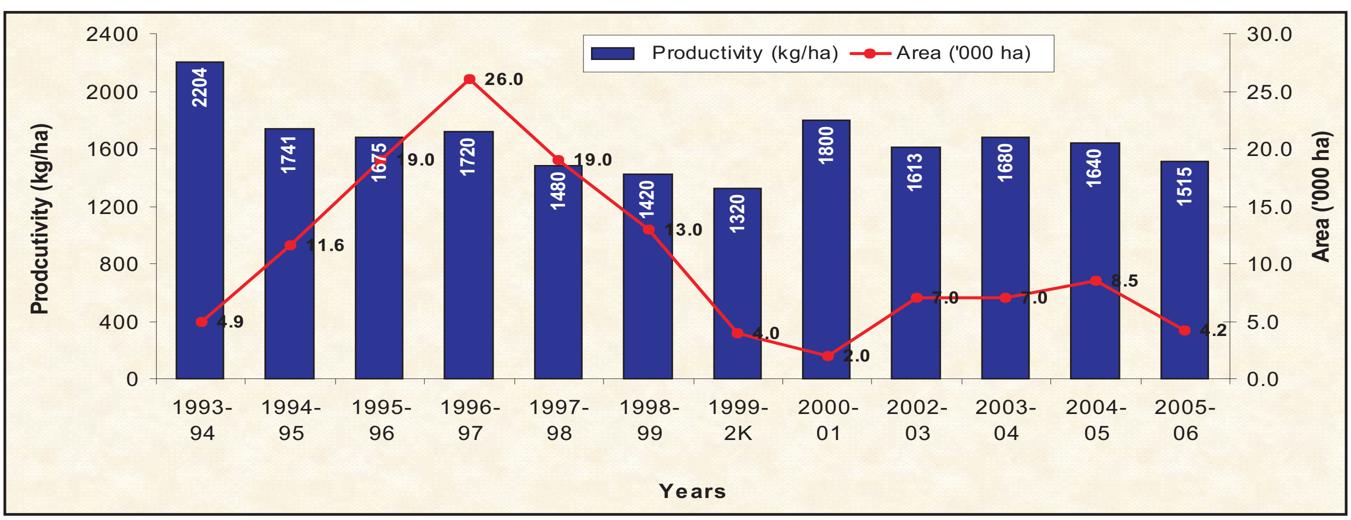

Fig. 6. Area and productivity of sunflower in district Kurukshetra in eastern Haryana.

Table 5. Productivity and economics of different rice-based cropping systems (Mean of three years from 1992-93 to 1994-95)

Crop sequence	Rice productivity (q/ha)	Wheat equivalent yield (q/ha)	System productivity (q/ha/year)	Returns over variable cost ('000 Rs. ha^{-1})	Benefit over rice-wheat (%)	Production efficiency (kg/ha/day)	Land-use efficiency (%)
Rice-wheat	68.1	43.9	112.0	21.32	–	38.04	81.1
Green manure-rice-wheat	72.5	44.9	116.4	23,38	+9.60	33.85	91.8
Rice-potato-sunflower	61.8	123.9	184.7	21.24	-1.72	59.23	95.9
Rice-toria-sunflower	61.1	56.1	117.2	18.34	-14.58	34.24	93.2
Rice (scented)-sunflower	36.1	48.2	84.3	23.47	+39.69	29.39	76.7
CD at 5%	0.31	0.40	–	1.75	–	–	–

infested with resistant *P. minor* in 1996-97. Once the *P. minor* was controlled, the economics again went in favour of wheat.

A study conducted at CCS Haryana Agricultural University Rice Research Station, Kaul revealed that total productivity, production efficiency and land-use efficiency were the highest in rice-potato-sunflower sequence, but significantly higher net returns over variable costs and benefit (40.3% higher) over the traditional rice-wheat sequence were recorded with scented rice-sunflower sequence (Table 5).

Substituting wheat crop with sunflower after rice provided 39.7 per cent higher returns over the traditional rice-wheat system. Green manuring of *dhaincha* increased rice yield by 6.5 per cent and net returns by 9.6 per cent over rice-wheat system. Slight build up in organic matter content of the soil was noticed with the green manuring-rice-wheat (0.38-0.47%) and rice-potato-sunflower (0.38-0.43%) sequence.

Sugarcane-based

Other potent crops which the farmers of eastern Haryana prefer to grow are sugarcane and potato. These crops besides sunflower are proving remunerative with respect to rice-wheat system. Field surveys during 2006 and 2007 exhibited that farmers are inclined towards the intercropping of sugarcane. The data generated from these surveys and inquisition of the farmers in district Kurukshetra are presented in Table 6. This study shows that rice-potato-sunflower sequence produced the highest wheat equivalent yield (173.2 q/ha/year) followed by rice-sugarcane (autumn planted) intercropped with garlic/onion/wheat-sugarcane (ratoon) sequences. Rice (non-scented)-wheat and rice (scented)-wheat rotations gave 101.1 and 107.6 q/ha/year wheat equivalent yield, respectively. The lowest benefit-cost ratio was registered with rice-potato-sunflower sequence (1.60).

Based on the results of the experiments (Table 7) conducted at farmers' field in district Yamunanagar (Haryana) on the intercropping in sugarcane, Kamboj and Goyal (2006) reported that the intercropping of onion with sugarcane (Fig. 7) gave maximum net returns (Rs.54,000 acre) followed by garlic (Rs.44,000), potato+cucumber (Rs.43,000), potato (Rs.36,000), ajwain (Rs.33,500) and wheat (Rs.28,000). Yield of sugarcane was in the range of 410-420 q/acre when intercropped with potato or potato+cucumber and 390 q/acre when intercropped with onion or garlic. Cane yields were lower when it was intercropped with ajwain (375 q) and wheat (350 q/acre).

Table 6. Economics of sugarcane-based intercropping systems in district Kurukshetra (Haryana)

Cropping sequence	Wheat equivalent yield (q/ha/year)	Production efficiency (kg/ha/day)	Net return (Rs./ha/year)	Benefit-cost ratio
Rice-wheat	101.1	27.70	44725	2.06
Rice (scented)-wheat	107.6	29.48	50550	2.22
Rice-potato-sunflower	173.2	47.45	55237	1.60

Table 7. Economics of sugarcane-based intercropping systems in district Yamunanagar (Haryana)

Inter cropping systems	Yield (q/acre)		Total unit expenditure (Rs.)	Gross unit income (Rs.)	Net unit income (Rs.)
	Sugarcane	Intercrop			
Sugarcane+garlic	390	22	28000	72000	44000
Sugarcane+onion	390	80	25000	79000	54000
Sugarcane+potato	410	90	28000	64000	36000
Sugarcane+potato+cucumber	420	90	33000	76000	43000
Sugarcane+ajwain	375	4	20000	53500	33500
Sugarcane+wheat	350	15	19000	47000	28000

Source : Kamboj and Goyal (2006).

Fig. 7. Intercropping of onion in sugarcane.

Prospects of other field crops

Mustard, gram (Fig. 8), maize, soybean, berseem and sorghum (fodder) are the other alternate crops which can replace rice or wheat crops in the system. Studies conducted at farmers' field in Panipat district of Haryana (Table 8) reflected that cultivation of mustard and summer moong after non-scented rice cultivar HKR 47 or Sharbati gave higher net returns and benefit-cost ratio than rice (Taraori basmati or Pusa basmati-1)- wheat cropping sequence (Garg *et al*., 2006). Rice (PB 1)-gram rotation excelled in B : C ratio over rice (Taraori Basmati or PB-1)-wheat sequence, however, the stability index of the former rotation was lower than the later. Stability index was the highest in rice (HKR-47)-mustard-summer moong sequence. Incremental gain and marginal value of RWCS have again gone up due to increas in the price of both rice and wheat.

Fig. 8. Gram variety HC 5 on beds (left) and healthy crop of mustard in RWCS (right).

Table 8. Comparative economics and stability of different cropping systems

Treatment	Wheat equivalent yield (q ha^{-1})	Net return (Rs. ha^{-1})	Benefit-cost ratio	Stability index
Rice (Taraori basmati)-wheat	113.5	43194	2.12	0.71
Rice (PB-1)-wheat	121.8	46942	2.29	0.78
Rice (PB-1)-gram	115.2	45450	2.52	0.66
Rice (HKR-47)-mustard- summer moong	132.1	54316	2.75	0.88
Rice (Sharbati)-mustard-summer moong	128.0	55040	2.83	0.87

Source : Garg *et al*. (2006).

The results of the experiments, conducted for three years (2002-03 to 2004-05) on cropping systems research through AICRP in districts Karnal and Ambala of eastern Haryana at 12 locations of farmers' field show that rice-berseem sequence gave maximum returns of Rs. 48,011 ha^{-1} and B : C ratio of 2.59 followed by rice-wheat sequence with the net returns of Rs. 36,672 ha^{-1} and B:C ratio of 2.14 (Table 9). Although the inclusion of maize and sorghum (fodder) was not found remunerative over the prevailing rice-wheat system, but the study clearly reflects that there was a positive impact of berseem (pulse) crop on the yield of following rice crop when included in the cropping system.

Table 9. Yield, net return and benefit-cost ratio of different cropping systems (mean of 3 years from 2002-03 to 2004-05)

Cropping system	Mean yield ($kg\ ha^{-1}$) Kharif	Rabi	Net return ($Rs.\ ha^{-1}$)	B : C ratio
Paddy-wheat	6379	4428	36672	2.14
Paddy-berseem	6523	103942	48011	2.59
Maize-wheat	2443	4578	22712	1.90
Sorghum (F)-wheat	29796	4307	23732	2.07

Vegetable-based

Vegetables are the important part of human diet. Vegetables provide essential nutrients and roughages required for the synthesis and maintenance of building blocks of human body. In India, vegetables were grown in an area of 70.5 lakh ha with the total production of 1082 lakh tonnes during 2005-06. Out of this acrage, potato was the main crop grown in 15.7 lakh ha with the production of 298.7 lakh tonnes. In Haryana, the area under vegetables is almost static (around 60,000 ha) after 1990-91. Vegetables (Fig. 9) are generally grown in the surroundings of urban and peri-urban areas. Haryana has the advantage of its close vicinity with the national capital. Keeping quality of vegetables is poor, hence, nearness to better facilities of market infrastructure is an important aspect.

Fig. 9. Potato (left) and chillies (right) on beds.

A study on 10 major cropping systems based on vegetable crops in the area occupied by rice-wheat system was conducted in district Kurukshetra (Haryana) in 2006-07. Five farmers on each cropping system were selected in the urban and peri-urban areas of the district. The data on different parameters were collected and cost of cultivation and net return were computed and presented in Table 10.

The data in Table 10 reveal that the highest wheat equivalent yield (233.5 q/ha/year) was obtained in rice (short duration)-potato-onion sequence closely followed by rice (short duration)-potato-bittergourd (230.6 q). The lowest wheat equivalent yield (123.6 q) was recorded with the prevailing rice-wheat system. All the rotations provided higher wheat equivalent yield than rice-wheat system. The highest net return of Rs. 63,850 per ha was recorded with

Table 10. Economics of different vegetable-based crop rotations in rice-wheat system during 2006-07

Sr. No.	Crop rotation	Wheat equivalent yield (q/ha/year)	Gross return (Rs./ha)	Total cost including rental value (Rs./ha)	Net Return (Rs./ha)	Benefit : cost ratio
1.	Rice-(HYV)-wheat	123.8	105063	72625	32438	1.45
2.	Rice (S.D.)-tomato-cucurbits	212.9	181000	117150	63850	1.55
3.	Rice (S.D.)-potato-onion	233.5	198500	134668	63812	1.47
4.	Cauliflower-wheat	144.1	122500	84750	37750	1.45
5.	Cauliflower-onion	170.6	145000	99650	45350	1.46
6.	Cauliflower-bittergourd	167.6	142500	98775	43725	1.44
7.	Rice (S.D.)-pea-cucurbits	157.6	134000	92175	41825	1.45
8.	Rice (S.D.)-pea-onion	203.2	172750	115750	57000	1.49
9.	Rice (S.D.)-cauliflower-chillies	207.1	176000	120838	55162	1.46
10.	Rice (S.D.)-potato-bittergourd	230.6	196000	133813	62187	1.46

HYV– High yielding variety, S. D. – short duration.

rice (short-duration)-tomato-cucurbits sequence followed by rice (short-duration)-potato-onion (Rs. 63,812), rice (short duration)-potato-bittergourd (Rs. 62,187), rice (short duration)-pea-onion (Rs. 57,000) and rice (short duration)-cauliflower-chillies (Rs. 55,162) sequences. Rice-wheat system proved to be the least remunerative (Rs. 32,438/ha) out of the 10 sequences evaluated.

Benefit : cost ratio in rice-wheat system was 1.45. All the cropping systems under study registered either higher or at par benefit : cost ratio with the existing rice-wheat system.

Agro-forestry-based

Long-term impact of diversification can be harvested through the plantation of *Eucalyptus* and Poplar plants. Resources of income can effectively be raised by growing nursery of these crops and intercropping in plantation crops. Kamboj *et al.* (2006) reported that Sardar Jasbir Singh, a resident of village Tigri in district Yamunanagar, adopted nursery raising of poplar on commercial scale (Fig. 10) and poplar plantation with the intercropping of sugarcane and wheat. On an average of six years, the farmer earned Rs. 88,273 ha^{-1} from the sale of Poplar nursery (Table 11). During 2003-04, returns were low (Rs. 25,000 ha^{-1}) due to poor demand of seedlings and declining market rate of Poplar wood. For intercropping in Poplar, the farmer opted sugarcane or wheat as intercrop and earned a total income of Rs. 15,000 to Rs. 56,250 ha^{-1} from the intercropping, besides the income of Rs. 9,50,000 from the sale of Poplar plants after six years of plantation (Table 12). By considering the total income of Poplar and intercropping, the farmer, on an average, earned Rs. 75,230 ha^{-1} year^{-1}.

Table 11. Economics of Poplar plants nursery at Yamunanagar (Haryana)

Year	Area under Poplar nursery (acre)	Rate per seedling (Rs.)	No. of plants sold	Total income (Rs.)
1998-99	8	10	40000	400000
1999-2K	10	10	48000	480000
2000-01	7	10	35000	350000
2001-02	7	8	34000	272000
2002-03	6	6	30000	18000
2003-04	5	5	10000	50000

Fig. 10. Nursery of poplar plants.

Table 12. Economics of Poplar plantation intercropped with sugarcane and wheat

Year	Crop	Yield of intercrop (q/acre)	Total income (Rs.)
1998-99	Poplar+ sugarcane	225	22500
1999-2000	Poplar+sugarcane+ wheat	100	10000
2000-01	Poplar+wheat	10	6000
2001-02	Poplar+Wheat	12	7300
2002-03	Poplar+wheat	10	6200
2003-04	Poplar+wheat	10	6300
2004-05	Poplar+wheat	9.5	6080
2005-06	Poplar+wheat	10	7000
	Poplar harvesting in June	950	380000

Source : Garg *et al*. (2006).

Verma *et al.* (2006) observed that wheat yield decreased by 20 per cent after two years and upto 35 per cent after the third year of plantation of Poplar. After three years of plantation, potato can be the best alternative. They further emphasized that poplar-based agro-forestry system could be sustainable on relatively larger farms. The data were generated on the farm of Sh. Yoga Singh of village Mandi Sadran in district Kaithal (Haryana).

Economic evaluation of horticultural crops – A case study

To exhibit the prospects and success of horticultural crops in the improvement of farmer's income, the success story of a farmer Sh. Chander Pal of village Bapda in district Kurukshetra, situated in the middle of rice bowl of eastern Haryana, is being given in the present chapter.

The farmer planted 2.2 ha of chiku (spota) (Fig. 11) and 0.60 ha of peach orchard in 1995-96 and 0.40 ha each of guava and plum orchards in 2003-04. The farmer, as a registered owner, grew fruit plants nursery of the seedlings of chiku, guava, plum and papaya in the orchard area itself and sold to government and private agencies/departments and farmers of surrounding area.

Fig. 11. Chiku (sapota) orchard of the selected farmer.

The farmer was provided technical expertise from Krishi Vigyan Kendra, Kurukshetra and District Horticultural Officer. The data on economics and different parameters were recorded by the farmer and scientists of KVK, Kurukshetra and analysis was done.

Economics of different orchards (Chiku, peach, pear and plum) was computed for the fruit bearing only i.e. eight years for chiku, nine years for peach and two years for guava and plum. The figures in Table 13 reveal that on long-term basis, chiku orchard was the most profitable with net income of Rs. 76,621 ha^{-1} followed by peach (Rs. 43,562 ha^{-1}), guava (Rs. 19,732 ha^{-1}) and plum (Rs. 18,850 ha^{-1}). The benefit : cost ratio of these four orchards was 7.01, 4.40, 2.99 and 2.95, respectively. The net income and benefit : cost ratio of guava and plum orchards were lower in comparison to chiku and peach orchards because guava and plum orchards are the newly established orchards, whereas the other orchards are well established. The returns from guava and plum orchards are likely to increase with the subsequent cropping years. The mean benefit-cost ratio of the farmer over the years was 2.26 which is well below than that obtained from the orchard.

Table 13. Economics (Rs. ha^{-1}) of different orchards during fruit bearing period at the selected farm

Variable	Chiku[1]	Peach[2]	Guava[3]	Plum[3]
Variable cost of production	12748	12799	9918	8150
Gross return	89373	56361	29650	24060
Net return over variable cost	76621	43562	19732	18850
B : C ratio	7.01	4.40	2.99	2.95

[1]Mean of 8 years from 1999-2K to 2006-07.
[2]Mean of 9 years from 1998-99 to 2006-07.
[3]Mean of 2 years from 2005-06 to 2006-07.

Economics of fruit plants nursery

As registered owner of fruit plants nursery (Fig. 12), the farmer earned net income of Rs.77,000 and 21,000 in 2005-06 and Rs.93,000 and 34,000 in 2006-07 from the sale of grafted seedlings of chiku and guava, respectively, just from an area of 0.025 ha each (Table 14). The benefit : cost ratio of 3.75 and 4.44 in chiku and 3.33 and 3.43 in guava in 2005-06 and 2006-07, respectively, was registered by the farmer. The farmer earned net income of Rs.15,000 and 22,000 in 2005-06 and Rs.19,500 and 27,500 in 2006-07 from the sale of plant seedlings of papaya and plum, respectively. Benefit : cost ratio was 4.00 and 4.50 in papaya and 3.75 and 4.20 in plum in 2005-06 and 2006-07, respectively.

Fig. 12. Fruit plants nursery in orchard of selected farmer.

(a) Selection and viability of intercrop in orchard

To work out the cropping pattern and income generation from vegetable crops grown with newly planted orchards, 12 farmers, who were growing mango, chiku, aonla, pear, guava and ber and cultivating intercrops, were selected in district Kurukshetra (Haryana). Data on economics of crops for first three years as intercropping were collected from selected growers and analysis was done. For establishment of the orchard, peach plants were transplanted as filler plants in mango and chiku fields, whereas papaya was used as filler plant in aonla, pear and ber orchards. No filler plant was planted in guava orchard. The cropping patterns for intercrop adopted by the farmers were bottlegourd/ spongegourd-tomato and bottlegourd/ spongegourd-pea-cucumber by 4 and 8 farmers, respectively, during the first year, spongegourd/bottlegourd-palak/ methi-cucumber and sorghum (fodder)-pea-cucumber by 5 and 7 farmers, respectively, during the second year and sorghum (fodder)-berseem and sorghum (fodder)-palak/methi by 10 and 2 farmers, respectively, during the third year of plantation of orchard (Table 15).

The expenditure incurred on the establishment of 180, 140, 180, 275, 225 and 180 plants of mango, chiku, aonla, guava, pear and ber alongwith filler plants was Rs.27,740, 28,785, 31,820, 26,050, 32,700 and 32,820 ha^{-1}, respectively. The corresponding figures on total expenditure including gap filling, hoeing, ploughing and insect management for three years were Rs. 46190, 45435, 49545, 43375, 49500 and 48095 ha^{-1}.

Table 14. Economics of fruit plants nursery

Variable	Chiku		Guava		Plum		Papaya	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Size of nursery (ha)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
No. of plants	7000	6000	3000	4000	2500	3000	10000	10000
Selling price/plant (Rs.)	15	20	10	12	12	12	2	2.5
Cost of production (Rs.)	28000	27000	9000	14000	8000	8500	5000	5500
Gross return (Rs.)	105000	120000	30000	48000	30000	36000	20000	25000
Net return (Rs.)	77000	93000	21000	34000	22000	27500	15000	19500
B : C ratio	3.75	4.44	3.33	3.43	3.75	4.20	4.00	4.50

Table 15. Cropping pattern adopted by farmers

Year	Orchard	Crops			No. of farmers
		Kharif (June-Sep.)	Rabi (Oct-Jan.)	Zaid (Feb.-May)	
1st	Mango, chiku, aonla,	Bottlegourd/Spongegourd	Tomato	-	4
	guava, ber	Bottlegourd/Spongegourd	Pea	Cucumber	8
2nd	-do-	Spongegourd/Bottlegourd	Palak/methi	Cucumber	5
		Sorghum fodder	Pea	Cucumber	7
3rd	-do-	Sorghum fodder	Berseem	-	10
		Sorghum fodder	Palak/methi	-	2

Three years' study based on 12 farmers of district Kurukshetra infers that the farmers can adopt favourable cropping patterns in newly planted orchards which are not harmful to the growing canopy and provide better returns. The most favourable cropping sequence was bottle gourd-pea-cucumber which provided net return of Rs. 57,150 ha^{-1} followed by bottle gourd-tomato (Rs. 53,775 ha^{-1}). The income from crops decreased considerably during third year after orchard plantation (Table 16).

Table 16. Net returns (Rs. ha^{-1}) from various cropping patterns in intercropping with orchard

Kharif (June-Sept.)	Rabi (Oct.-Jan.)	Zaid (Feb.-May)	Total net return
Bottlegourd	Tomato	–	–
22950	30825	–	53775
Spongegourd	Tomato	–	–
19400	30825	–	50225
Bottlegourd	Pea	Cucumber	–
22950	23075	11125	57150
Spongegourd	Pea	Cucumber	–
19400	23075	11125	53600
Sorghum fodder	Pea	Cucumber	–
4075	23075	11125	38275
Bottlegourd	Palak	Cucumber	–
22950	10450	11125	44525
Bottlegourd	Methi	Cucumber	–
22950	9888	11125	43963
Spongegourd	Palak	Cucumber	–
19400	10450	11125	40975
Spongegourd	Methi	Cucumber	–
19400	9888	11125	40413
Sorghum Fodder	Palak	–	–
4075	10450	–	14525
Sorghum (Fodder)	Methi	–	–
4075	9888	–	13963
Sorghum (Fodder)	Berseem	–	–
4075	5975	–	10050

(b) Intercrop of flower crops in orchard (group study)

A field study to work out the best intercropping option with two marigold varieties in newly planted orchards (Fig. 13) was carried out during 2004-05 and 2005-06 in district Kurukshetra (Haryana). For this purpose, eight farmers who had planted chiku, guava and aonla orchards were selected. The number of plants of chiku, guava and aonla transplanted by the farmers were 140, 275 and 180 ha^{-1}, respectively. Peach and papaya plants were used as filler plants in chiku and aonla orchards. The farmers were advised to grow two marigold varieties namely, African and Jaffri, during **kharif**, **rabi** and **zaid** seaons for intercropping for the first two years after the plantation of orchards.

Fig. 13. Intercrop of marigold in orchard.

The study revealed that the total expenditure on establishment of 140, 275 and 180 plants of chiku, guava and aonla was Rs. 28,785, 26,050 and 31,820, respectively. The corresponding figures on total expenditure including gap filling, hoeing, ploughing and insect management for two years were Rs. 39,060, 37,375 and 42,920 ha^{-1}.

From the study of two years, it was observed that Jaffri variety of marigold was more remunerative and gave an advantage of Rs. 9,900 ha^{-1} during 2004-05 and Rs. 14,700 ha^{-1} during 2005-06 over African variety when grown as intercrop in newly planted orchards of chiku, guava and aonla.

In 2001, India became the world leader in milk production with a production volume of 84.4 million tonnes which has now reached at 100.9 million tonnes (Fig. 14). The annual growth rate in milk production in India is 4-6 per cent, against the world's at 1 per cent. The steep rise in the growth pattern has been attributed to a sustained increase in domestic demand and expanding processing capacities. The per capita availability of milk is 246 g day^{-1} against the minimum requirement of 250 g day^{-1}.

India's annual milk production increased by more than four times in the last four decades, rising from 21 million tonnes in 1968. We have about 283 million population of cattle and buffaloes about four times higher than in the USA. Notwithstanding, our milk productivity is much below than the world average. Annual milk yield per dairy animal is about one-tenth of that achieved in the USA and about one-fifth of the yield of a New Zealand dairy cow. There is a tremendous scope for increasing the milk production.

Haryana with a per capita milk availability of 660 g day^{-1} ranks at number two in the country as against the national average of 246 g day^{-1}. Presently about 2600 veterinary institutions are functioning in the state and on an average every three villages have a veterinary institute besides a strong extension and research network operating through state agricultural university (CCS Haryana Agricultural University, Hisar). There is a tremendous scope for increasing the milk production.

In Haryana, more than 5.0 million tonnes of milk is produced and more than three-fourth is derived from buffalo. The growth in total milk production during the last decade has resulted from an increase in the number of crossbred cattle. About 90 per cent of farmers have less than one hectare land and one or two dairy animals (Hemme *et al*., 2003). Despite the strong growth rate of milk production from crossbred cattle, most of the milk in Haryana is still produced by buffaloes. However, the farmers are coming forward to replace their local cattle with buffaloes and crossbred animals.

The advantage in productivity of USA and European countries is due to the rearing of crossbred cows in these countries which have higher milk production capacity than the indigenous and buffalo-based dairy farming which is dominating in India. A study conducted at National Dairy Research

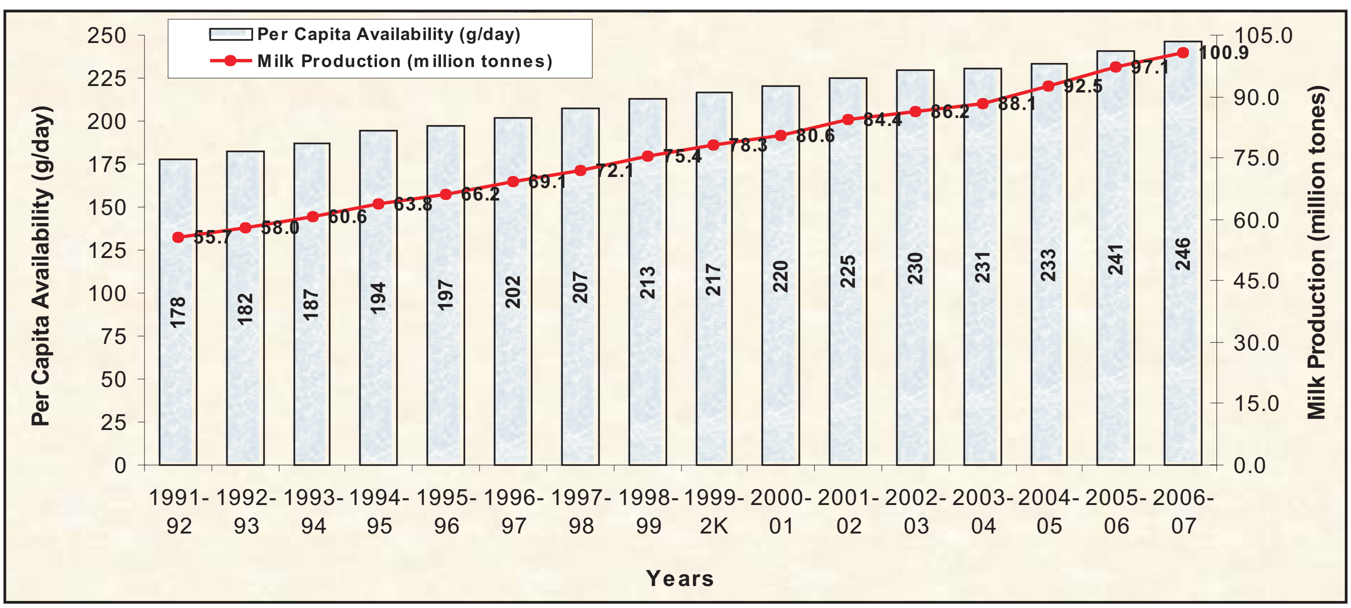

Fig. 14. Milk production and per capita availability of milk in India.

Source : Department of Animal Husbandry and Dairying and National Dairy Development Board.

Institute, Karnal (Haryana) revealed that the lifetime performance of crossbreds was much higher than indigenous breeds (Singh, 2005). The Friesian crosses had higher lifetime milk yield, longer herd and productive life and completed more number of lactations than other breed crosses. He inferred that crossbred cattle had higher milk productivity and production efficiency, hence, are more profitable than buffaloes and local cattle, however, the variability in performance of crossbreds under field conditions could be ascribed to different availability of inputs, agro-ecological conditions, type of farmer and the indigenous and exotic breeds used in cross breeding.

The cost of production is higher in or near the urbanites as compared to rural-based land-owning farms. A study of dairy farming in Haryana indicates that the cost of milk production of landless farms near urban areas is 50 per cent higher than that of the land-owning farms (http://www.fao.org/ag/againfo/projects/en/pplpi/publications.html). This is due to higher feed costs as a result of having to purchase all feed. However, the high milk price obtained in urban areas compensates for the additional costs. Landless farms near urban centres fully cover their production costs and can be economically viable in the long run.

Buffalo rearing is the backbone of livelihood in villages which provides food security and generates income and employment. Haryana has been known as the breeding tract of world-renowned Murrah breed of buffaloes and the hub of activity in buffalo trade for the entire country (Fig. 15). For increasing the income of dairy units there is a need of demonstrations on mineral mixture feeding, enrichment of poor quality roughages, induction of lactation, control of endo and octo-parasites, utility of artificial insemination over natural service, housing management of buffaloes and cattle, etc. The main risks of dairying identified by the farmers are not having an animal in milk in any one year, the death of a lactating animal, and having to pay for straw, which is the main feed source particularly for landless people in rural India. Occurrence of any of these problems can result in a decline of already low household income by upto 50 per cent which probably forces some of the families to abandon the dairy enterprise. To avoid the problems and constraints in dairy animals, some remedial measures are required to be undertaken (Table 17).

Fig. 15. Murrah buffalo–Pride of Haryana.

Table 17. Remedial measures of the problems in buffaloes

Stage of buffalo	Main problems	Management
Calf	High mortality and poor growth	Colostrum feeding within an hour after birth, deworming, feeding antibiotics, early introduction to concentrates and greens
Heifers at growing stage	Poor and stunted growth	Feeding, deworming, disease control and protection against thermal stress
Milking and adult buffaloes	Reproduction problem–mainly infertility, repeat breeding, long calving internal, low milk performance and mineral deficiency 50-90% (Ca, P, Co, Mg & Zn @ 60, 50, 80, 50 & 90, respectively)	Reproduction management – proper heat detection, artificial insemination, feeding balanced rations and mineral supplementation, protection against thermal and endo-ecto parasitic stresses

Source : Singh *et al.* (2006).

Prospects of urban and rural dairy units (Group study)

A study on milk production revealed that overall 98 per cent of the Indian milk is produced in rural areas (Hemme *et al.*, 2003), hence livestock enterprise is interwoven with agriculture. But now dairy farming in urban areas is emerging as commercial enterprise with the rapid increase in the demand of milk and milk products.

To compare the economic prospects of dairy units operating in rural and urban areas of irrigated zone of rice-wheat belt of eastern Haryana, a study was conducted in district Kurukshetra in 2006-07. The size of dairy units in urban areas generally varies from 4 to 10 animals and in rural areas from 4 to 70 animals (Fig. 16). Generally, the dairy units in urban areas are not supported with their own land holdings, whereas the units in rural areas mostly have their own land-holding farms.

Fig. 16. A modern dairy unit.

To work out the total variable cost depreciation on shed and permanent installations, interest on fixed investment, risk factor on value of animals and maintenance cost were counted. The study examines the cost and returns per year, the net returns, cost of milk production per litre and benefit : cost ratio.

The analysis of dairy units revealed that the maintenance cost per animal per annum in urban areas was worked out to be Rs. 19,375, while in rural areas it was Rs. 12,690. The variable costs in urban and rural dairy units were Rs. 30,060 and Rs. 21,066, respectively (Table 18).

To work out the gross return, market value of milk and dung and appreciation value of newly born calves and buffaloes were taken into account. Net returns per milch animal over milk and dung values were worked out to be Rs. 13,600 and Rs. 6,053 in urban and rural dairy units, respectively. Similarly, net return per animal over gross value was estimated to be Rs. 16,320 and 9,278 in urban and rural dairy units. Per litre cost of milk production was Rs. 12.52 and 9.58 of urban and rural dairy units, respectively. The benefit : cost ratio in urban and rural areas dairy units were 1.54 and 1.44, respectively. The present findings are in confirmation with those of Verma (2007), Gauraha (2007) and Chaudhary (2007).

Scientific dairy farming with crossbred cows (Case study)

Livestock as an integral part of the agricultural production system is emanating as an income-oriented enterprise in rural and peri-urban localities of India. The indigenous techniques of animal rearing coupled with the increased cost of dairy inputs and animals have become liability on the farmers. To replace the traditional dairy farming, now the crossbred cattle in all regions of the country as a whole are being preferred over indigenous cows for milk production. Hence, the present study is based on scientific dairy farming well-organized by a farmer with modernized infrastructure and improved crossbred cows at his farm.

A case study was made on investment and returns from a modernized crossbred cow unit based on the primary data collected from a single unit of Sh. Jaipal Arya S/o Sh. Ramji Lal Arya of Village Nagla Sadhan district Yamunanagar (Haryana). Shri Jaipal Arya has belief in Hindu Mythology, so he preferred rearing of cows instead of buffaloes and started crossbred cow unit with a heavy investment on construction of cattle shed in 2004 in rural area. In the beginning, the milk was sold in the nearest city Yamunanagar but it was time consuming process. Later on, contract was made with Vita and Modern Dairy milk plant for collection of whole quantity of milk from the premises itself. The data on fixed investment and operational cost for three years (2004 to 2006) were collected and arranged statistically to get the results. To workout the total

Table 18. Economics of dairy units in urban and rural areas

S. No.	Particulars	Urban Dairy Unit			Rural Dairy Unit		
		Quantity	Value (Rs.)	%age to total cost	Quantity	Value (Rs.)	%age to total cost
A.	**Fixed cost**						
	1. Investment on construction of cattle shed	450 sq.yard	400000	35.24	150 sq.yard	65000	23.59
	2. Investment on equipments and water resource		15000	1.32		3500	1.27
	3. Unit size	20	720000	63.44	6	207000	75.14
	Total fixed investment		**1135000**	**100.00**		**275500**	**100.00**
B.	**Variable cost**						
	1. Depreciation on shed & equipments @ 10%		41500	6.90		6850	5.42
	2. Interest on fixed investment @ 12% per annum		136200	22.66		33060	26.16
	3. Risk factor on value of buffalo @ 5%		36000	5.99		10350	8.19
C.	**Maintenance cost**						
	1. Expenses on feeding						
	a) Green fodder		96500	16.05		19600	15.51
	b) Dry fodder		108200	18.00		23500	18.59
	c) Concentrate		146400	24.35		25440	20.13
	Total feeding expenses		**351100**	**48.40**		**68540**	**94.00**
	2. Expenses on health aspect		4800	0.80		1600	1.27
	3. Labour charges		26000	4.32		4000	3.16
	4. Electricity charges		2600	0.43		800	0.63
	5. Miscellenous		3000	0.50		1200	0.95
	Total maintenance cost		387500	64.45		76140	60.25
	Total variable cost		601200	100		126400	100.00
	Maintenance cost per animal		19375			12690	
	Variable cost per animal		30060			21066	
	Returns						
	Milk production (litres)	48000	864000*		13200	158400**	
	Dung production (Qtls.)	960	9600		432	4320	
D.	**Return from milk and dung production**		**873600**			**162720**	
	Values of newly born calves	12	18000		6	9000	
	Appreciation in buffaloes value @ 5% per annum		36000			10350	
E.	**Appreciation in animal values**		54000			19350	
	Gross returns (D+E)		927600			182070	
	Net return over milk and dung value		272400			36320	
	Net return over gross value		326400			55670	
	Net return per milch animal over milk & dung value		13620			6053	
	Net return per animal over gross value		16320			9278	
	Cost of milk production per litre		12.52			9.58	
	Benefit : cost ratio		1.54			1.44	

*Milk price @ Rs.18 per litre. **Milk price @ Rs. 12 per litre.

cost depreciation on shed and equipments @ 10 per cent, interest on fixed investment @ 12 per cent, risk factor on value of cattle @ 5 per cent annually were also considered as operational cost.

Results

Shri Jaipal Arya has 20 acres agricultural land and started crossbred cow dairy unit from 15 cows. The initial investment on construction of cattle shed, equipments and water resources and purchase of crossbred cattle was Rs.10,00,000, 80,000 and 2,50,000, respectively (Table 19). During 2004, per cent of total cost on expenses of concentrate was highest i.e. 29.86 followed by interest on fixed investment 22.32 and expenses on green fodder were 10.72 per cent of the total cost. In the year 2005, the total cost of the crossbred farm was Rs.8,72,575, out of which 34.26 per cent was spent on concentrate followed by 19.32 per cent on interest on fixed investment.

Table 19. Economic analysis (Rs.) of crossbred cow dairy unit

Particulars	2004	% of total cost	2005	% of total cost	2006	% of total cost
A. Fixed cost (Rs.)						
Investment on construction of cattle shed	1000000					
Investment on equipments & water resources	80000					
Number of crossbred cows purchased	15		21		22	
Investment value of crossbred cattle	250000		325000		334500	
Total fixed investment (Rs.)	1330000		1405000		1414500	
B. Variable cost (Rs.)						
Depreciation on shed & equipments @ 10%	108000	15.10	108000	12.38	108000	11.67
Interest on fixed investment @ 12%	159600	22.32	168600	19.32	169700	18.33
Risk factor on value of cattle @ 5%	12500	1.75	16250	1.86	16725	1.81
Expenses on green fodder	76650	10.72	107310	12.30	112420	12.14
Expenses on dry fodder	65700	9.19	91980	10.54	96360	10.41
Expenses on concentrate	213525	29.86	298935	34.26	313170	33.83
Expenses on health aspect	6000	0.84	7500	0.86	8250	0.89
Labour charges	48000	6.71	48000	5.50	72000	7.78
Electricity charges	20000	2.80	20000	2.29	22000	2.38
Miscellaneous	5000	0.70	6000	0.69	7000	0.76
Total cost	714975		872575		925665	
Returns						
Cows in milk	15		18		20	
Milk value	810000		1009800		1188000	
Dung value	15000		17000		18000	
A. Income from milk and Dung	825000		1026800		1206000	
Newly born calves	6		8		9	
B. Value of newly born calves/heifer	50000		62000		71500	
C. Appreciation in value of cattle	25000		32500		33450	
Sale of crossbred cows	-		7		–	
Income from sale of crossbred cattle	-		85000		–	
Income from value appreciation	75000		179500		104950	
Gross farm income (A+B+C)	900000		1206300		1310950	
Net farm income	185025		333725		385285	
Net return over milk and dung value	110025		154225		280335	
Net return per milch animal	7338		8568		14016	

During 2006, the total cost was Rs. 9,25,665 and its major share was also investment on concentrate. Total income of the dairy farm from milk and dung in 2004, 2005 and 2006 was Rs. 8,25,000, 10,26,800 and 12,06,000, respectively. Appreciation value of cattle was also considered to work out the gross farm income. Net farm income from a herd of 15, 21 and 22 in the year 2004, 2005 and 2006 was worked out which was Rs. 1,85,025, 3,33,725 and 3,85,285, respectively. Net return per milch animal was to the tune of Rs. 7338, 8568 and 14016 in the respective years. One of the additional findings which was recorded in the study was that like other dairy owners, this farm also faced some problem of infertility in crossbred cows which needs to be tackled carefully and in right perspective.

Inference

Dairy farming with improved crossbred cows supported the farmer appreciably, however, it needed ample initial investment for starting the enterprise. The farmer earned Rs. 8,25,000, 10,26,800 and 12,06,000 from a herd of 15, 21 and 22 during 2004, 2005 and 2006, respectively. Net farm income from the sale of milk and dung was Rs. 1,10,025, 1,54,225 and 2,80,335 during the corresponding years.

MUSHROOM : A POTENT ENTERPRISE FOR RECYCLING FARM STRAWS

Mushroom is a nutritive food containing good percentage of protein, iron, vitamins and salts. It is an ideal food for heart and diabetic patients because of the low content of fats and carbohydrates.

The major species of mushrooms produced in the world are white-button mushroom (*Agaricus bisporus*), oyster mushroom or Dhingri (*Pleurotus* spp.), Chinese or paddy-straw mushroom (*Volvoriella volvacea*), shitake mushroom (*Lentinus edodus*) and *Auricularia* spp. The most widely cultivated species among these is white-button or European mushroom. This species alone contributes about 38 per cent of the total mushroom production. The white-button mushroom is mainly grown in USA, France and China, whereas oyster mushroom is grown in China, which produces more than 80 per cent of its production, South Korea and Italy are the other countries contributing in its production after China.

Only 45 per cent of mushrooms produced are consumed in fresh form. The rest of mushroom is utilized in processed form i.e. dehydrated (5%) and canned form (50%). Shelf life of fresh form is very short, hence, mushroom in the world is traded in processed from.

The Netherlands is the largest exporter of canned button mushroom with a market share of about 39 per cent. China is next significant exporter sharing almost 30 per cent of world trade. France has contribution of about 14 per cent of world export. Germany and USA are the largest buyer of canned mushroom with 40 and 19 per cent share, respectively, in world imports.

India produces about 85000 metric tonnes of white-button mushroom. Out of about 2000 edible mushroom species, about 280 species are produced in India. Domestic consumption of canned mushrooms is quite low. It was only after 1990 that the export of mushroom started to pick up the momentum.

The state of Haryana ranks third in mushroom production which produced 6164 tonnes of mushrooms during 2006-07 (Fig. 17). The targets for the year 2007-08 and 2008-09 have been fixed at 7000 and 7250 tonnes, respectively. District Sonipat, being in close vicinity of national capital, acquires the top position by producing 2171 tonnes of mushroom, while Panipat district stands second with 1100 tonnes of production. Though Haryana was a late starter in mushroom production, yet it has registered tremendous increase in mushroom production during the past decade. The production technology of *Agaricus bisporus*, *Agaricus bitorqis*, *Pleurotus* spp. (Dhingri) and *Volvoriella volvacea* has been worked out but all these mushrooms could not achieve commercial status except the white-button mushroom. With the increased demand of mushrooms, the growers have started to exhibit interest in Dhingri and white milky mushroom

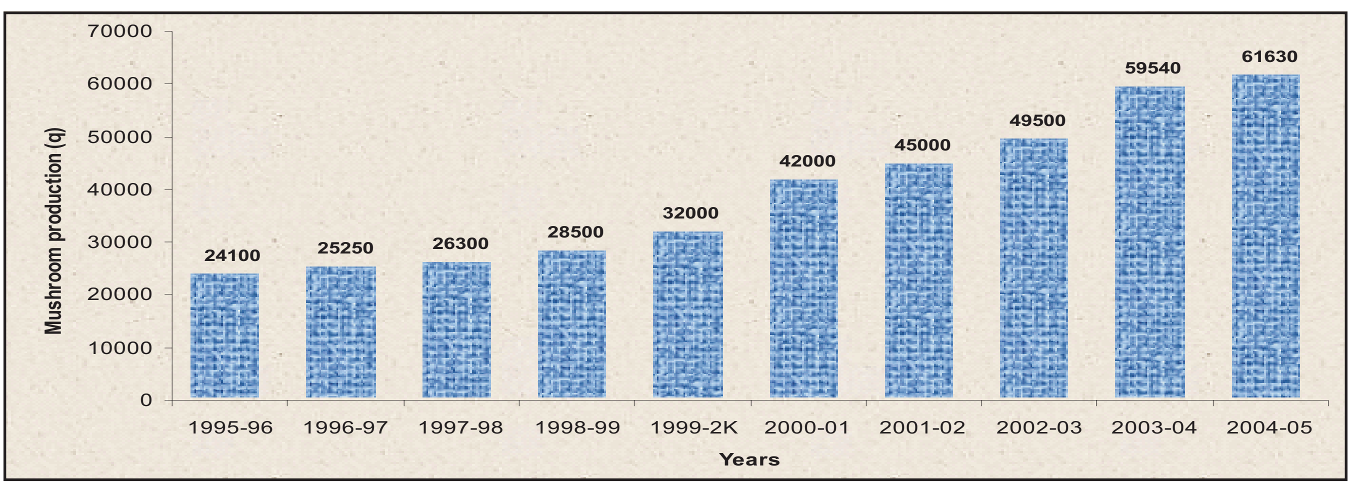

Fig. 17. Seasonal mushroom production in Haryana.

(*Calocybe indica*) cultivation. In the years to come, the production of these mushroom species is likely to increase.

Farmers like to cultivate mushrooms because this enterprise is less land dependent as it is grown indoor using vertical storey thatched structures made of locally available material like stalks of *sarkanda*, sorghum, bajra, cotton and *daincha* sticks, etc. These types of structures have been found superior to brick structure under low-cost technology. These structures are cheap and provide natural ventilation which is a requirement for mushroom houses. Small, marginal and landless farmers can easily engage themselves and earn profits/employment by adopting low-cost mushroom production technology.

Cultivation techniques for white button mushroom

Unlike plants, mushroom cannot synthesize their own food rather they need ready-made food for their growth and development. In 1921 for cultivating *Agaricus* (Fig. 18), compost based on nitrogenous fertilizers and wheat straw was patented and termed as synthetic compost. The composting process was further standardized and named as long method of composting and short method of composting.

Fig. 18. White button mushroom

Ingredients of compost

(i) Base materials : They provide the bulk and proper physical structure to the substrate. Wheat, brassica and paddy straw are used as base materials. The main function is to provide a reservoir of cellulose, hemicellulose and lignin which are used by mushroom mycelium as carbon source during its growth.

(ii) Supplement : Base materials are not rich enough in nutrients to start with decomposition process. Therefore, they are supplemented with N and carbohydrate rich materials to start the process. Generally, cattle dung has not been found suitable for compost preparation.

Growers who have pasteurization chamber facilities generally use chicken manure as supplement and harvest good yields. Carbohydrates to the composting substrate may be supplied in the form of molasses, wet brewer grain and wheat bran. They are necessary for decomposition. Nitrogen is essentially required for the microflora and is supplied through inorganic nitrogenous fertilizer. Undoubtedly N is the most important element of compost, but its excess is harmful. N should be 1.75 per cent (on dry weight basis of base material) at the start of compost. *Agaricus bisporus* also requires P and K. Gypsum is also added to provide Ca and also helps in removing greasiness of compost.

The following formula has been recommended by CCSHAU, Hisar for compost preparation.

Wheat straw	=	300 kg
Wheat bran	=	30 kg
Gypsum	=	30 kg
CAN	=	9 kg
Muriate of Potash	=	3 kg
Single super phosphate	=	3 kg
Urea	=	3.5 kg
Molasses	=	5 kg

Straw protected from rains is preferred. A large amount of water is needed for wetting the straw.

The first step in compost preparation is to clean the composting yard properly. Straw is wetted well till it attains about 75 per cent of moisture. Wetting generally takes 48 h in case of wheat straw, while it takes lesser time in wetting of paddy straw.

Decomposition of straw starts when on day-0, when fertilizers and other supplement except gypsum are mixed in wetted base material and stacked in heap with width and height of about 4-5 feet.

Soon after stacking of compost on day-0, the compost temperature starts rising after 24-48 h and reach around 70^{0}C in the central position. High temperature is necessary for correct composting. During composting, nitrogen in ammonia form is assimilated in the form of protein. This protein is further utilized by mushroom. To maintain the temperature in major portion of compost, periodic turning is given. First turning is done at 6th day and second at 10th day.

At third (13th day) or fourth (16th day) turning, gypsum is mixed and now onwards turning is given at every 4th day. At each turning, moisture of compost is maintained with water. In this way on 28th day, the compost will be ready. Compost should be dark brown and free from ammonia. Spawning (seeds) of compost is done after bringing the compost at room temperature. Generally layer spawning or through spawning is done. Rate of spawning is important for getting good yield. Generally spawn @ 0.5 per cent of compost is used. Compost layer of 6 inches is preferred on the beds. Then compost is covered with newspaper sprayed with 2 per cent formalin. The temperature during spawn run should be maintained 24±1^{0}C. Newspaper should be sprayed with water to prevent drying of compost. Relative humidity of cropping room should be 80-90 per cent. The compost is impregnated with mycelial threads of *Agaricus bisporus* completely within 15-20 days.

Compost beds are cased after spawn run is complete. Casing mixture is preferred with well rotten FYM or burnt rice husk+garden soil (1 : 1 weight basis). Casing mixture is pasteurized with 2 per cent formaldehyde. Firstly beds are exposed by removing newspaper and compost surface is levelled. Casing layer of 1-1½ inch is spread uniformly on compost surface. A week after casing, same temperature 24±1^{0}C is maintained and then it is lowered down to 16-18^{0}C. Mushroom pinheads will appear after 10 days. Buttons of 3 cm diameter are harvested after twisting the cap so that minimum disturbance is done to mycelium.

Base of mushroom fruit is cut with sharp steel knife to remove mycelium and casing mixture. Fruit bodies are washed with clean water and dried in shade. The 200 g mushroom fruit bodies are packed in a polythene bag with 2-3 holes. Mushrooms are marketed fresh as well as processed. It is the fresh mushrooms which are preferred in India.

Cultivation of Dhingri and milky mushroom

There is a vast potential of growing *Pleurotus* spp. (Dhingri) and *Calocybe indica* (milky mushroom) because these species can be cultivated at high temperature (Fig. 19). In addition to this, cumbersome composting process is not needed. So, it is easy to cultivate these species. But still they are not acceptable among the consumers due to ignorance of their food value and taste.

Fig. 19. Dhingri (left) and milky (right) mushroom.

Cultivation practices of Oyster (Dhingri) and milky mushrooms are similar except in case of milky mushroom where after spawn run casing is done. Chopped paddy straw is soaked in water for 10-12 hours. Excess water is drained. Wet straw is seeded with 2 and 5 per cent spawn in Dhingri and milky mushrooms, respectively, in polythene bags. When the spawn is complete in 15 days at 25-30^{o}C, the polythene bags are removed and blocks are sprayed with water. After a week, mushrooms emerge. But in case of milky mushroom after spawn run in bags, 1.5 inch casing mixture of sand, clay and FYM is put. After 7-10 days mushroom pins emerge. In both the cases, relative humidity above 80 per cent is maintained in growing chambers.

Impact points for the success of mushroom cultivation

A base line survey was conducted in district Kurukshetra to study the socio-economic profile and attitude of farmers. Individual and group discussion was carried out to identify the problems and needs of the farmers. It was observed that farmers are over-dependent on commission agents for day to day money needs and the problem was more serious among small and marginal farmers and landless labourers. There was also need of regular income. It was also found that there was problem of unemployment of family labour particularly in lean season. Wheat and paddy straw was available in abundant quantity. Farmers were suggested low-cost mushroom production technology keeping in view their limited resources. The following points owe the success of mushroom cultivation.

i) Complete technical know-how : Technical know-how is the first and most important step in successful cultivation of mushroom. Complete technical guidance to the farmers is required by organizing practical oriented training courses on mushroom cultivation, mushroom days and mushroom exhibitions. Farmers visit to mushroom melas, and monitoring of individual mushroom units and compost testing facilities are other related extension activities which encourage the farmers to adopt mushroom cultivation. Easy availability of a qualified mushroom expert, quite well versed with mushroom production technology certainly helps in popularization of mushroom cultivation. Farmers should be advised well in time with respect to fabrication of low-cost mushroom house, composting technique, spawn and spawning, casing, management of environmental parameters in compost and mushroom shed and management of insect-pest, diseases, competitors, mushroom disorders and post-harvest techniques. Literature in local languages (Hindi) on low-cost mushroom cultivation should be made available to each mushroom grower. Problems relating to mushroom cultivation of individual mushroom grower should be attended by the expert at his farm. Farmers of other adjoining districts should also be interacted for knowing the practical aspects and the problems to be encountered by them. Compost-testing facilities should be made available to all the mushroom growers.

ii) Methodology and material used for low-cost technology : White button mushroom cultivation is a seasonal activity taken up by farmers only from October to March. Wheat and paddy straw is available in plenty in rice-wheat growing areas. Low-cost mushroom production techniques increase the profitability of farmers (Fig. 20). Instead of fabrication of pucca mushroom house, most of the farmers erect temporary thatched houses made up of bamboos, sarkandas, eucalyptus wood, paddy straw, dry grasses or convert discarded poultry house into mushroom farm. Instead of using polythene bags and wooden trays for compost, 4-tier shelf system has been made popular. Bamboos, nylon ropes, plastic sheets, paddy straw and grasses are used in fabrication of low-cost mushroom shed. It has been scientifically proved that these temporary mushroom houses with cheap materials were good for ventilation and gave better yield than pucca mushroom houses. A standard formula which is very cheaper has been developed to use paddy straw for compost making because wheat straw has become scarce and costly. Paddy straw is generally burnt. Undecomposed FYM used in casing mixture is very harmful. A very good substitute almost free of cost and easily available local casing material comprising mixture of burnt rice husk and clay or loam soil in 1 : 1 ratio (W/W basis) has been advocated and well accepted by the farmers. Some of the farmers are using perforated plastic sheet on the bed for draining extra water and good air exchange of spawned compost. It has given very good results. Late in the season, farmers spray 300 ppm of urea solution on

Fig. 20. Low-cost technology of mushroom cultivation.

the mushroom bed, which increases the yield to a great extent.

iii) Availability of pasteurized compost and quality spawn : Quality spawn is essential input for successful mushroom cultivation. However, the quality spawn is made available from CCSHAU, Hisar, Integrated Mushroom Project, Murthal, NCMR, Solan and private laboratories including three in district Kurukshetra. Pasteurized compost (Fig. 21) is available at Murthal and Kurukshetra. Farmers can skip the tedious process of compost preparation by buying pasteurized compost.

Fig. 21. Pasteurized compost.

iv) Loans and subsidies : Banks and district rural development agency (DRDA) have been very liberal in providing loans and subsidies to mushroom growers. Lead bank officer and officers of NABARD and DRDA should be invited in each training course so that they are fully convinced with the profitability and activities of mushroom cultivation. Banks should be supplied the project report and economics of mushroom cultivation. One of the leading mushroom growers Sardar Harpal Singh Bajwa in distict Kurukshetra (Haryana) was sanctioned loan for utility Jeep for rapid transportation of mushroom to distant markets on the eve of Mushroom Day at his farm by Ambala-Kurukshetra Gramin Bank. Farmers are not facing problems in procuring bank loans for mushroom cultivation.

v) Marketing : Since white button mushroom is a highly perishable commodity, it needs daily marketing in the early morning. Surveys regarding proper marketing of mushroom were conducted by the mushroom growers alongwith the experts of KVK, Kurukshetra and it was found that marketing in Patiala, Rajpura, Ludhiana, Chandigarh and Kanpur has been found more remunerative than Delhi. It was also observed that alone Ludhiana city was having consumption of about 20 q of mushrooms daily. District Mushroom Cooperative Society has been formed with efforts of KVK and district administration and marketing of mushroom is now the subject of the society. In general, on an average, farmers are getting Rs.35-40 kg^{-1} mushroom, while cost of production is Rs.22-23 kg^{-1}. In the months of November and February, farmers get even Rs. 50-60 kg^{-1} mushroom. Some of the mushroom growers of the district are jointly marketing their produce in Patiala, Rajpura, Chandigarh, Ludhiana and are getting remunerative price.

vi) Liaison with development agencies : Mushroom cultivation has been very popular among farmers because it is employment oriented and has supplemented the income of farmers. District administration, DRDA, Nehru Yuva Kendra, Banks, Department of Horticulture are giving top priority to this activity. In district Kurukshetra, DRDA has formed self-help groups for mushroom cultivation. Sardar Harpal Singh Bajwa a leading mushroom grower of the district was felicitated on the republic day by Deputy Commissioner, Kurukshetra and he also received state level award on Kisan Mela and Mushroom Mela for his significant achievements in mushroom cultivation.

vii) Publicity : Publication of success stories of leading mushroom growers should be made in farm magazines and newspapers and broadcasted from All India Radio to attract a number of farmers towards mushroom cultivation.

Benefits harvested by mushroom growers in district Kurukshetra :

- Increase in the number of mushroom units in Kurukshetra and adjoining districts.
- Establishment of pasteurized plant to increase the quality of compost and decrease the time of compost preparation.
- Increase in net returns of farmers.

- Upliftment of socio-economic status of small, marginal farmers and landless labourers.
- Quality spawn production in Kurukshetra.
- Key communicators and better interaction through cooperative society.
- Creation of success stories of mushroom growers.
- Proper grading and marketing of mushroom by farmers.
- Formation of self-help groups of mushroom growers for production and proper marketing of produce.
- Meeting the demand of mushrooms in the market for consumers.

Constraints

- A major difficulty faced by mushroom grower is depressing/low market rates due to heavy production during the peak season and dumping of produce by a few export-oriented units in the local market. There is no system at present by which growers can be protected from the crash of prices.
- Availability of quality spawn.
- Low and variable productivity.
- Low consumption of domestic market especially in rural areas where the consumption is extremely low.
- Weak financial status of entrepreneurs/growers and limited institutional financing.
- Post-harvest losses in quality.
- Lack of industries involved in post-harvest processing/marketing value-added products.

Future outlook

- Mushroom production can be increased if assured procurement prices are there. For this formation of mushroom growers' cooperatives can go a long way.
- Mushroom being a highly perishable commodity, the establishment of processing industries is needed.
- To compete in the international market, emphasis on quality produce is required and indiscriminate use of pesticides/chemicals during cultivation should be curbed.
- Quality spawn production is another area that needs proper attention so that mushroom growers do not suffer on account of sub-standard spawn. There should be proper labeling of spawn bags indicating the name of mushroom, strain number, expiry date, etc. At present there is no regulating authority in India to monitor the quality of spawn.
- Alternative varieties like oyster, paddy straw and white milky mushrooms should be encouraged by educating growers and consumers about its vast production potential and nutritional value.
- Domestic market should be catered to by seasonal growers, while the export-oriented units should confine to exports.

Economic feasibility of mushroom enterprise in eastern Haryana (Group study)

The diversification within crops was not accepted by the farmers because of various risks associated with such diversification particularly in rice-wheat system (Goyal, 2006). Introduction of mushroom in eastern Haryana has generated enthusiasm among the farmers thereby encouraging diversification with reference to the farming system concept. In the present era, mushroom cultivation is emerging as a profitable enterprise since per unit productivity of mushroom is several folds higher than any other crop (Bhatia and Mohammad, 2006b). This enterprise also gives self-employment opportunities to the unemployed youth and rural women folk. Hence, the present study was carried out to find out the economic feasibility of mushroom cultivation in eastern Haryana.

Methodology

To extrapolate the economic returns of mushroom enterprise, a study was undertaken in district Kurukshetra during 2005-06 and 2006-07. Six farmers engaged in mushroom cultivation were selected keeping the farm size in view. The farmers

Table 20. Economic analysis of selected mushroom units in district Kurukshetra (Haryana)

Particulars	Balvinder Singh Jyotisar		Sukhdev Singh Jyotisar		Amrik Singh Jyotisar		Surender Singh Jyotisar		Vinod Kumar Ajrawar		Ranjit Singh Chajjupur	
Farmer's Name	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Mushroom unit size wheat straw (q)	200	200	100	150	100	200	100	150	60	400	300	350
Investment on mushroom shed and other equipment (Rs.)	84200	88700	58500	63900	60000	104800	48000	87900	32000	160000	165000	18500
Interest on fixed capital & depreciation (Rs.)	18524	23949	12870	17253	13200	20296	10560	23733	7040	43200	36300	49950
Material and marketing cost (Rs.)	96000	104500	44560	68840	46300	101300	47500	76250	26000	225600	130500	180875
Labour cost (Rs.)	36800	41664	16700	26650	17200	34880	17900	27620	10700	69615	52650	59200
Total cost Rs. (3+4+5)	**151324**	**170113**	**74130**	**112743**	**76700**	**164476**	**75960**	**127603**	**43740**	**338415**	**219450**	**290025**
Mushroom production (q)	54	58.5	28	44	26	57	27	43.5	17	118	89	105
Gross return (Rs.)	226800	251550	116200	191400	106600	245000	113400	191400	72250	507400	373800	456750
Net return (Rs.)	75476	81437	42070	78657	29900	80624	37440	63797	28510	168985	154350	166725
Productivity of farm (kg q^{-1} straw)	27	29.25	28	29	26	28.5	27	29	28.3	29.5	29.6	30
B : C ratio	1.50	1.48	1.56	1.70	1.39	1.49	1.49	1.50	1.65	1.50	1.70	1.57
Employment generated (man days)	657	672	282	368	278	545	289	435	170	1105	810	955
Land holding (ha)	4.0	4.0	1.2	1.2	2.0	2.0	4.8	4.8	0.4	0.4	4.0	4.0

related to marginal, small and large categories were selected for the study having variable size of mushroom unit. Economic analysis was made and is presented in Table 20.

Results

The data in Table 20 reflect that the benefit-cost ratio ranged from 1.39 to 1.70 in different mushroom units. The productivity of farm was almost consistent at all mushroom units with a range of production from 26.0 to 30.0 kg mushroom q^{-1} straw used for preparing the compost. Gross returns from the unit size of 60 to 400 q wheat straw was in the tune of Rs. 72250 to 507400 with the range of net returns from Rs. 28510 to 168985. Mushroom enterprise was quite effective in generating employment. The farmers provided 170 to 1105 mandays during the period of operation of the units. Size of the land holding could not influence comparative net returns or B/C ratio.

Mushroom enterprise has proved remunerative for the farmers of eastern Haryana. The study of two years based on six farmers clearly indicates that this enterprise helped the farmers in enhancing productivity and profitability of the farm and also helped in generating employment for the unemployed youth. The magnitude of increase was in the range of 1.39 to 1.70 in B : C ratio, Rs. 72250 to 507400 in total returns and Rs. 28510 to 168985 in net returns depending upon the size of mushroom unit. Employment generation was in the tune of 170 to 1105 mandays in different units.

BEE-KEEPING : A LOW INVESTMENT ENTERPRISE

Increased population and industrialization have excreted pressure on cultivable land. The plateauing farm production and decreasing farm size have ceased the possibilities of increase in farm income. Vertical multiplication of farm enterprises per unit land area can only pave the way for accelerating the productivity, profitability and employment generation. Obviously, the need of the hour is to provide ecologically sustainable allied agriculture enterprises to the ailing farming community. Bee-keeping has emerged as one of the low capital investment high returns enterprise. There is also a problem of employment in landless farmers, educated youths and disguised labour. To ameliorate their lot, bee-keeping is one of the enterprises which can be undertaken by them. Hence, under the prevailing conditions, a profession like bee-keeping assumes great significance. It can thus serve as an additional income-generating activity and provide round the year employment in the activities of managing hives, migrating honey bee colonies from one location to another, harnessing honey and other bee-hive products. In the present day, biofarming concept of bees is considered as an input for crop production. Hence, bees are considered good friend of mankind.

Bee-keeping refers only to rearing of domesticated honey bee species and their management. Modern bee-keeping has come a long way from the traditional clay-pots, long hives, bamboo-baskets and wooden boxes to movable frame; introduced in the beginning of this century. With the discovery of the movable frame, bee hive based on principle of bee space, honey extractor and smoker, the base of scientific bee-keeping has become established.

There are mainly four species of honey bees viz., (a) little bee, *Apis florea*, (b) rock bee, *Apis dorsata*, (c) Indian bee, *Apis cerana* and (d) Italian/ western bee, *Apis mellifera*. Out of these, the former two are wild and latter are domesticated.

Italian/Western bee, *Apis mellifera* is most widely distributed and commercially reared honey bee species in the world (Fig. 22). It is large in size than other domesticated honey bees, having wider pollinating ranges and is capable of providing more honey. There are many well recognized races and strains of *A. mellifera*, and geographical races greatly differing in appearance.

Fig. 22. Italian/Western bee (*Apis mellifera*).

Four European races, *Apis mellifera mellifera*, *Apis mellifera liqustica*, *Apis mellifera cranica* and *Apis mellifera caucasiaca* are most important in bee-keeping. *Apis mellifera ligustica* is considered to be the best and was introduced in India in 1962 and has been very successful in northern states of Himachal Pradesh, Punjab, Jammu & Kashmir and Haryana. This is a good nectar and pollen gatherer. This species has achieved a great success in north western states of India. Average honey production from this species is between 30 and 40 kg hive^{-1} annum^{-1} with foraging range extending upto 2-3 km.

Bee flora : Bee flora species are specific to different areas and have definite micro-regional habitats. Under sub-tropical climates of India, nectar and pollen sources are available for most parts of the year, but continuous succession throughout the year is lacking in some localities. There is a single surplus honey flow and in good areas two surplus flows may be available. North-west, lower and mid-hills present spring/early-summer flows and autumn flora of *Plectranthus* is also available in hills. Bees face protracted dearth period in winters and only subsistence flora is available in rainy season. Vast agricultural plains of north India and Gangetic plains offer major flora of *Brassica* from October to early February; the total area under oilseed crops being 20 million ha in India. This builds up honey flow which is followed by spring and summer surplus honey flows from *Eucalyptus*, *Dalbergia sissoo*, litchi, other fruit trees, *Mimusops*, *Pongamia* and later *Egyptian clover* are availed by bees till May. Due to adoption of sunflower crop, bees avail pollen upto May/early June. Harsh summers have no flora availability but some weeds and crops present subsistence forage in rainy season and fall.

Bee-keeping maps : Bee-keeping maps pinpoint the possibilities of bee-keeping in a particular region. Bee-keepers must have the knowledge of beekeeping maps of different regions because these help them in successful bee-keeping and deciding migratory routes and large honey harvest is possible almost throughout the year. Suitable bee-keeping areas alongwith important bee flora in different states of India are given in Table 21.

Management of colonies before and during honey flow

In the plains of north India, the bee colonies become very weak in summer and rainy season but some floral sources become available in the second half of September. Brassica species start blooming in October but in some areas it may be delayed to the end of November. The colonies grow in strength continuously but there can be some brood rearing depression during very cold spell of about a fortnight. If sufficient stores are not available then sugar feeding, 2-3 weeks before the onset of Brassica flora (early September) should be given to boost brood rearing. The bee colonies grow to yielding strength by December-January and one to two extractions are possible till the end of January or early February. After a short depression the colonies avail surplus flow from Eucalyptus and other tree flora and from Egyptian clover.

Colony examination

Frequent examination is not advisable since the interference upsets the normal working for sometime. Therefore, three-weekly examination is a common practice, though examination at shorter intervals may be required during swarming and build up period.

Colony migration

Migration between north and south Bihar and from Himachal Pradesh (Sharma, 2004) and Jammu to Punjab and Haryana is well defined. Similarly, in south also migratory routes are fairly well defined.

Bee colonies can be moved five kilometres away and during night or early morning when all the foragers are in hive. All cracks and hive entrance are sealed and movable hive parts are fastened properly. Bees are also required to be moved during hot summer months and during such period the colonies can be migrated during night when it is cooler and in hives with enough ventilation by providing screens in place of inner cover. It is also wise to sprinkle little water over the screen at intervals if it is long distance migration.

Seasonal management

Bee-keeper's calendar starts with activity in bee-colonies during spring after prolonged cold in temperate climate and during winter in tropical climates. Colony build-up and honey-flow period is from October to May in various parts of the country. There is a tendency to expand colonies with increased rate of brood production. Brood rearing starts with blooming of oilseeds and lasts upto spring honey flow.

Spring management

With blossoms in nature, honey-flow season starts during spring. It should be the earliest attempt to examine colonies on a bright sunny day to assess colony conditions, working of queen, amount of brood present and the stored pollen and nectar area.

During spring, bee-colonies go all-out to rear brood and invest all resources in increasing their strength. Queen lays more vigorously as inspired

Table 21. Suitable beekeeping areas in major states of India (Mishra and Kumar, 1998)

State	Suitable area/Districts	Important bee flora
Jammu & Kashmir	Doda, Anantnag, Kathua, Jammu, Udhampur, Rajouri, Poonch, Phulbama, Baramulaha, Srinagar and Kupwara. Rest parts are not suitable.	*Plectranthus rugosus. Robinia pseudacacia*, *Aesculus indica*, *Fagopyrum esculentum*, *Dalbergia sissoo*, *Acacia modesta*, *Sapindus* spp., *Syzygium* spp., *Toona cilata*, *Eucalyptus* spp., *Brassica* spp. and fruits trees
Himachal Pradesh	Shimla, Chamba, Kinnaur, Kangra and Kulu. Rest parts are either less suitable or not suitable.	*Plectranthus rugosus*, *Toona ciliata*, *Sipindus* Spp., *Dalbergia sissoo*, *Prunus puddum*, *Etretia acuminate*, apple and other fruit plants and forest shrubs.
Punjab & Haryana	Punjab : Gurdaspur, Hoshiarpur, Amritsar, Ludhiana, Sangrur & Patiala (most suitable). Possible in other parts also. Haryana: Yamunanagar, Ambala, Karnal, Kurukshetra & Jind (most suitable). Possible in rest part also.	*Brassica* spp., *Helianthus annus*, *Eucalyptus* spp., *Tribolium alexandrinum*, *Gossypium* spp., *Cajanus cajan* and *Dalbergia sissoo*.
Rajasthan & Gujarat	With the improvement in irrigation bee-keeping is becoming popular. Eastern belt of Rajasthan from Banswara to Sri Ganganagar. Gujarat : Kutchh.	*Brassica* spp.
Madhya Pradesh	Rajgarh, Raipur, Bastar, Kathiwada and Jhabua.	Oilseed crops especially *Brassica* spp.
Uttranchal & Uttar Pradesh	Almora, Pithoragarh, Nanital, Pillibhit, Shahjahanpur, Behraich, Gonda, Gorkhpur, Azamgarh, Banaras, Dehradun, Saharanpur, Muzaffarnagar, Meerut, Ghaiziabad, Mathura and Agra.	*Litchi chinensis*, *Brassica* spp., *Dalbergia sissoo*., *Eucalyptus* spp., *Syzygium* spp., *Moringa oleifera*, *Cajanus cajan*, *Madhuca longifolia* and *T. alexandrinum*.
Bihar	Samastipur, Muzaffarpur, east Champaran, Dharbhanga, Vaishali, Ranchi, Gumla, Palamae and Hazaribagh.	*Litchi chinesis*, *T. alexandrinum*, *Helianthus annus*, *Madhuca longifolia*, *Sesamum indicum* and *Syzygium* spp.
Tamil Nadu	Kanya Kumari, Madurai, North Arcot, Triunalveli, Salem, Dharampuri, Nilgiris, Coimbatore, Ramanatha Puram, Trichi, Thanjavur and Perriyar.	*Cocos* spp., *Hevea brasiliensis*, *Coffea arabica*., *Tamarindus indica*, *Ellaterea cardamom*, *Borassus flavelliger* (Palmirah), *Saphindus* spp. and *Feronia elephantum* (Wood apple)
Kerala	Kannur, Trivandrum, Kozhikode, Kasargod and Malappuram (very good areas), Idukki, Kottayam, Emakulam, Trichur, Quilon, Palghat and Pathanamthitta (moderately suitable).	*Hevea brasiliensis* and *Cocos nucifera*.
Karnataka	Madikeri (Kodagu), Dakshin Kannad, Hassan, Mysore (Uttar Kannad), Chikmagalar and Shimoga.	*Coffea arbica*, *Helianthus annuus*, *Carvia callosa*, *Terminalia* spp., *Eucalyptus* spp., *Anacardium occidentale* and *Cocos mucifera*.

by worker. As this is a peak breeding season, more and more combs are added and drone bees are produced. There is a tendency for ‘swarming’.

Colony division :

(1) Bee-colonies which are not very strong and can be spared from honey production are divided into 2 or 3 parts. Each divide is given a new queen. These divides grow in spring and summer and colonies produce surplus honey only during next season. (2) One or two combs with bees and brood can be removed from strong colonies without impairing their production. The bees from two colonies can be united and made into a new colony by giving a queen.

Summer and rainy season management

The spring “honey-flow” is followed by a summer dearth period. During summer flowering decreases in most places. This causes decrease in honey production and so decrease in honey-flow to hives. As a result, the queen slows down egg-laying. Brood-less colonies desert hives and enemies become active. The deserting bees behave almost in a similar fashion as swarming bees except that their bees rise very high and it is difficult to get them settled down.

The strong colony with sufficient store would continue to rear some broods and can resist enemy attack. During summer, in certain regions of India temperature goes as high as 47-50^{0}C and then gunny-bags moistened with water can be spread over top-covers. Proper cross ventilation needs to be ensured to facilitate proper aeration and to lower hive humidity. Normally hives should be placed under shade or “L”-shaped thatched cover to protect from scorching sun. The brood rearing in summer can also be boosted by feeding artificial diet/pollen substitute composed of brewers yeast, sugar, gram-powder and skimmed-milk (10 : 10 : 1 : 1). These practices would check absconding of colonies.

Rainy season follows hot and humid summer in India. In some regions, bees are confined to hives for longer intervals because of continuous rain. Large number of forager bees die in harness due to sudden storms or downpours. High humidity in hives coupled with high temperature creates an unfavourable environment for colonies. The bees become lethargic and listless. Stored pollens in combs become mouldy and unripe honey may ferment. Bee diseases and enemies also intensify and this further weakens colonies. Good management practices such as proper ventilation, ensured aeration and time-to-time artificial diet in summer are good management practices.

Winter management

Honeybees live in an environment of their own and regulate temperature between 32^0 and 35^{0}C. They form cluster when temperature falls below 10^{0}C. In some parts of India, the temperature goes below 0^{0}C. In such circumstances, the honey bee-colony should be exposed to sunlight. Bees try to regulate temperature by muscular movement and possibly consumption of honey. Strong colonies overwinter well because larger number of bees can produce heat and retain it. Bee-colony can be held to overwinter by saving their energy in raising hive temperature. Insulation of hive with doubling thickness of wooden-hive does give protection to bees against child-cold. Insulation is desirable in localities which have long spell of cold or where there is a wide range between day and night temperatures.

Bee Hive Products :

Honey

Honey is most important primary bee product in bee-keeping. It was also the first bee product used by human kind in ancient time. Honey is a natural sweet substance produced by honey bees from the floral and extra floral nectars. Honey contains about 85 per cent of total disolved solids mostly carbohydrates or sugars. It mainly consists of three sugars namely fructose, glucose and sucrose of which the first two are predominant. Besides sugars, honey has minerals, proteins, vitamins, enzymes and 181 other minor constituents. Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal are the major honey producing states. The details of bee colonies and honey production of different states of India are given in Table 22.

Table 22. Number of bee colonies (both *Apis cerana* and *A. mellifera*) and honey production in different states of India

S. No.	State/UT	No. of bee colonies	Honey production (m. tonnes)
1.	Andra Pradesh	31300	1172.0
2.	Arunachal Pradesh	720	115.0
3.	Assam	6140	985.0
4.	Bihar	125570	4850.0
5.	Goa	610	23.2
6.	Gujarat	520	104.0
7.	Haryana	105600	4077.5
8.	Himachal Pradesh	172450	4455.8
9.	Jammu & Kashmir	48720	2170.0
10.	Karnataka	59600	2166.0
11.	Kerala	92870	2682.0
12.	Madya Pradesh	49910	1287.2
13.	Maharashtra	81210	2650.5
14.	Manipur	680	105.5
15.	Meghalya	1120	103.0
16.	Mizoram	1390	98.0
17.	Nagaland	1390	105.0
18.	Orrisa	3940	1187.0
19.	Punjab	215620	7450.5
20.	Rajasthan	52260	1599.0
21.	Sikkim	530	85.0
22.	Tamil Nadu	43060	1463.8
23.	Tripura	2390	147.4
24.	Uttar Pradesh	168600	4865.8
25.	West Bengal	142600	4672.0
26.	Andaman & Nicobar	-	-
27.	Chandigarh	60	12.8
28.	Delhi	140	2.8
29.	Daman & Deu	-	-
30.	Pondicherry	80	5.8
31.	Jharkand	22640	2088.4
32.	Uttaranchal	49540	2149.3
	Total	1481260	528798.3

Source : Raina (2006).

In India, production of honey is very low as compared to China, the highest producer. In our country, honey is not taken as daily food items and per capita consumption of honey is very low. A major portion of the honey produced in the country is used in medicines and only a small quantity finds its place on the table as food. In Germany, per capita honey consumption is 1,800 g. The world average per capita honey consumption is 300 g, whereas in Asia, Japan has the highest per capita honey consumption of 600 g. The world honey production and consumption of major countries are mentioned in Table 23.

Table 23. World honey production and consumption in 2005

Country	Production ('000 metric tonnes)	Consumption ('000 metric tonnes)
Ukraine	71.46	52
Russian Federation	52.13	54
Spain	37.00	40
United States of America	79.22	163
Canada	36.11	29
Argentina	93.42	3
Mexico	50.63	31
China	299.33	238
Turkey	82.34	66
India	52.23	45
Ethiopia	41.23	40

Source : http://faostat.fao.org

Bee wax

Bee wax is natural substance secreted by worker bees to make combs in the bee hives. Wax production per colony is 350-500 g year^{-1} in case of mellifera. The demand of bee wax is very high in national and international markets. Value-wise, bee wax costs 3-4 times more than honey. Bee wax is mainly required by candle industry and bee keeping industry for preparing comb-foundation sheet. Wax is also an important constituent of cosmetics. Pharmaceuticals and perfume industries are also major users of wax. Wax is also utilized for preparing shoe-polish and varnishes.

Propolis

It is sticky resinous material gathered by honey bees from trees, buds, barks and other vegetation. In bee-colony, propolis is used by bees for sealing cracks and crevices, sticking frame and foreign material. Propolis is obtained by scrapping its frames. It is used as an adhesive and has quality of healing wounds preparing ointments, for treating cuts, wounds and many other diseases.

Royal Jelly

This is a milky-white secretion, which is produced in hypopharyngeal glands of young worker bees. It is the diet of young worker and drone larvae for first three days and that of queen larvae for the whole development period and of the adult queen. Royal jelly is considered as a miracle food and its nutritional effects may be due to combined action of various components, such as sugars, proteins, vitamin B and sterols. It has a medicinal value also.

Bee-venom

Bee-venom is synthesized by honey bees and used as a defensive agent against enemies. Strong apparatus of the worker bee is attached to a poison-sac where venom is stored. An adult bee has 0.3 mg of venom. Two-week old worker-bee can secrete maximum venom in her sac. Bee venom has been reported useful for curing many human diseases and disorder. The treatment through bee-venom is now-a-days getting popularity and it is known as apitherapy.

Pollen

Honey bees visit blossoms of entomophilus plants in search of their food, *i.e.* nectar and pollen. A single colony of *Apis mellifera* consumes 50 kg pollen annually and can collect 0.5 to 1 kg pollen daily during good pollen flow seasons. During honey harvest season, a bee keeper can extract 700-800 g of pollen from each bee colony depending upon the surrounding floral resources.

Besides having many uses in medicine and pharmaceutical industries, bee pollen is considered as a highly nutritious food and concentrated energy source for tissues/muscles.

Performance of stationary and migratory bee-keeping units

Land-owning bee-keepers generally opt for stationary units. They adopt this enterprise after making some useful manipulations in their cropping pattern for harvesting rich dividends through crops and bee-keeping. Also there are many landless youths who prefer this enterprise for earning their livelihood. They also help in generating employment for other unemployed people. Besides providing employment opportunities for themselves and other unemployed youths, these bee-keepers also help in rendering training to the associated persons who after acquiring necessary know-how and technical expertise start their own bee-keeping units which further help in the generation of employment. The landless and advanced bee-keepers adopt migratory bee-keeping. Migration of bee colonies is practised within the state or in the nearby areas of surrounding states.

The availability of flora for stationary bee keeping in eastern Haryana is given in Fig. 23.

Economic evaluation of stationary unit

A study on stationary unit operated by Sh. Jai Bhagwan of Village Adhoni in district Kurukshetra (Haryana) was conducted from 1996 to 2006. The farmer owns 2 ha of land. He started bee-keeping in 1996 with just five bee colonies (boxes) at his farm. He consistently multiplied and maintained the

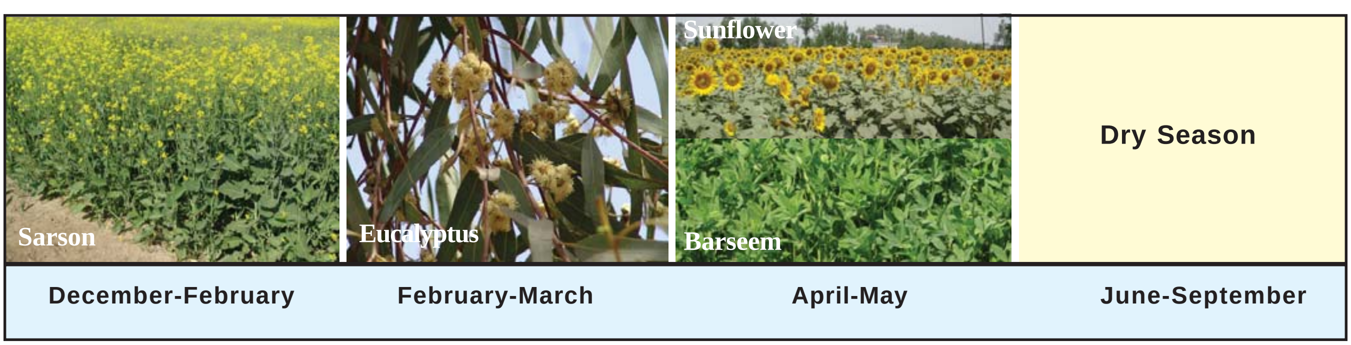

Fig. 23. Availability of flora for stationary units in eastern Haryana.

Table 24. Economic analysis of stationary bee-keeping unit of Jai Bhagwan, village Adhoni (Kurukshetra, Haryana) over the years

Year/Particular	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
No. of boxes	5	21	32	40	40	40	40	40	40	40	55
Total fixed investment (Rs.)	7870	17030	23555	28220	28620	29095	29555	30015	30575	33415	41560
Interest and depreciation on fixed investment (Rs.)	1732	3747	5137	6208	6296	6400	6502	6603	6726	7351	9143
Variable cost (Rs.)	3230	6490	8240	12185	11350	11870	11980	12380	12190	13850	17270
Total cost (Rs.)	4962	10237	13377	83393	17646	18270	18482	18983	18916	21210	26413
Total honey production (q)	1.80	7.21	10.40	12.67	9.01	12.24	12.19	11.21	11.75	9.57	12.65
Income from honey (Rs.)	4860	23100	33280	43078	29733	44064	46322	41477	37600	40200	51300
Income from wax and sale of bee colonies (Rs.)	810	3600	5720	6542	8325	15910	16650	8960	9675	15660	20810
Total income (Rs.)	5670	26700	39000	49630	38058	58974	62972	50437	47275	55860	72110
Net return (Rs.)	708	16463	25623	31237	20412	40704	44490	31454	28359	34659	45697
B : C ratio	1.14	2.60	1.91	1.70	2.15	3.22	2.40	2.65	2.50	2.63	2.73
Honey production per unit (q)	0.36	0.34	0.32	0.32	0.22	0.31	0.30	0.28	0.29	0.24	0.23
Employment generation (mandays)	53	88	99	113	108	216	106	110	108	116	145

Table 25. Economic analysis of migratory bee-keeping unit of Shankar, village Jhansa (Kurukshetra, Haryana) over the years

Year/Particular	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. of boxes/colonies	6	22	44	80	110	144	310	200	200	300	300	300	300	325
Total variable cost (Rs.)	11300	2000	7000	12000	20000	21600	50000	40000	40000	62900	66200	68400	69000	75000
Labour cost (Rs.)	1200	2700	4950	7000	9000	14430	24000	24000	15000	52900	57800	64750	72850	76000
Total cost (Rs.)	12771	6398	15448	25090	37470	51556	109600	87280	78280	155300	163500	173310	182010	204760
Total honey production (q)	1.5	7.04	14.08	22.40	37.40	51.84	117.8	78.0	50.0	84.0	102.0	126.0	138.0	159.25
Income from honey (Rs.)	4500	25344	52096	112000	194480	280000	624000	405400	370000	613000	694000	856000	276000	428650
Total wax production (q)	0.03	0.07	0.14	0.40	0.56	0.93	1.76	1.17	0.75	1.68	1.53	2.32	1.38	2.24
Income from wax (Rs.)	135	351	630	1680	2240	3500	6500	4200	3150	6384	5500	8100	5100	8000
Income from sale of bee colonies (Rs.)	-	-	-	-	-		137500	220000	-	-	173000	125000	87500	80000
Gross return (Rs.)	4635	25695	52726	113680	196720	283500	768000	629600	373150	619384	874500	989100	368600	436650
Net return (Rs.)	-8136	19261	37278	88590	159250	231944	658400	542320	294870	464084	711000	815790	186590	231890
Productivity (kg/box)	25	32	32	28	34	36	38	39	25	28	34	42	46	49
Employment generated (mandays)	30	60	110	140	160	222	395	380	230	760	830	870	915	925
B : C ratio	0.4	4.0	3.4	4.5	5.2	5.5	7.0	7.2	3.8	3.4	5.3	5.7	2.0	2.1

bee colonies upto 55 (in 2006). He generated income from the sale of honey, wax and bee colonies. Net return of the farmer varied from Rs. 708 (during first year) to Rs. 45697 per annum in 2006 (Table 24). Honey production per unit (bee colony) was 22 to 36 kg per annum. The farmer generated employment of 53 to 145 mandays per year from the unit. Range of benefit-cost ratio varied from 1.14 to 2.73 over the years.

Economic evaluation of migratory unit

A study on migratory unit adopted by a landless youth Sh. Shankar, a resident of Kurukshetra (Haryana) was conducted for 14 years from 1992 to 2005, the data on which are presented in Table 25. The farmer initially started his work with six bee colonies in 1992. He multiplied the bee colonies upto 325 (in 2005). After 4 and 6 years, the farmer operated with 110 (in 1996) and 310 (in 1998) bee colonies, thereafter he managed more than 200 bee colonies. The farmer sold honey, wax and bee colonies for income generation. The study revealed that after 1996, the farmer earned net return from Rs.1,59,250 (in 1996) to 8,15,790 (in 2003) with the productivity of 25 to 49 kg colony^{-1} year^{-1}. Benefit cost-ratio varied from 3.4 to 7.2 between 1996 to 2003 which lowered to 2.0 and 2.1 in 2004 and 2005, respectively, probably due to slump in honey rates, inclement weather conditions and incidence of pest and diseases. Besides this, the farmer helped in employment generation from 160 (in 1996) to 925 mandays (2005). Migration schedule of Sh. Shankar is given in Table 26.

Table 26. Migration schedule of a landless farmer, Sh. Shankar, a resident of Kurukshetra (Haryana)

Month	Place	Crops
2nd week of July	Pataudi	Bajra, Cotton
1st week of Sept.	Jhajjar	Arhar
2nd week of Oct.	Jhansa (Kurukshetra)	Toria
1st week of Dec.	Jhajjar	Sarson
3rd week of Feb.	Jhansa	Eucalyptus
April-May	Jhansa	Sunflower, Berseem
June-July	Jhansa	Artificial feeding

Studies show that the bee-keeping can be started with a very low investment and even the poorest farmer can adopt it with the minimum investment. The enterprise can be taken up at commercial scale by exploiting the floral resources of Haryana state to generate more profits and employment. Moreover, this enterprise fits well in farming system.

Many farmers are optionally intending to adopt various enterprises according to their access to the available resources and interest. The productivity of the adopted subsidiary enterprise sometimes becomes stagnant due to the unrecognizable constraint(s) not identified by the farmer. Under such circumstances, it becomes necessary for a technical expert to provide suitable intervention to break the impasse realized by the farmer.

i) Impact of scientific interventions (Group study)

A study on integrated farming system was undertaken during 2006-07 with the objective of enhancing the income of farmers by applying different interventions within the existing system. Six farmers in district Kurukshetra were selected who were already engaged in different enterprises of the farming system. The scientific interventions were applied in already existing farming system as mentioned in Table 27. The different components of farming system were crop production, dairy, bee-keeping, mushroom cultivation and vermi-compost unit.

Results

The data in Fig. 24 exhibit that there was considerable increase in farmers' income with the adoption of proposed intervention. The net return of different farmers from the existing unit ranged from Rs.45,620 to 68,830 annum^{-1}. This income included the income of farmer from crop production per hectare plus farming enterprise already adopted by the farmer. Net return obtained by the farmers after applying the intervention was found to have increased. The increased income was in the range of Rs.52,125 to 76,746 annum^{-1}. The magnitude of increase in net income with the application of various interventions varied from Rs.7,505 by the adoption of integrated nutrient management (inclusion of vermicompost with inorganic fertilization) to Rs.12,250 annum^{-1} through the adoption of scientific interventions in crop production and bee-keeping enterprise. The sale of vermi-compost by Karan Sikri at the rate of Rs.350 q^{-1} brought an increase of Rs.11,864 annum^{-1}. Cultivation of greengram after wheat harvesting provided an additional income of Rs.10,117. Use of alternate source of paddy straw with certain manipulations at the place of wheat straw reduced the cost of compost used for mushroom production and increased farmer's income by Rs.7,916 during the year 2006-07. From the study it can be deducted that application of different interventions in various enterprises of the farming system brought an additional income ranging from Rs.7,505 to 12,250 annum^{-1}. These interventions were applied in crop production, dairy, bee-keeping, mushroom, vermi-compost and integrated nutrient management.

ii) Impact through multi-enterprise approach (Case studies)

A few farmers are adopting a combination of multifarious enterprises on their farms on

Table 27. Details of farmer's practice and intervention applied

S. No.	Farmer's name	Village	Practice followed	Intervention applied	Unit size for intervention
1.	Gurdev Singh	Adhon	Rice (Basmati)-Wheat	Moong-Rice (Basmati)-Wheat	0.40 ha
2.	Satbir Singh	Bhaisi Majra	Rice-Wheat+Dairy	(i) Optimum plant population	0.40 ha
				(ii) Mineral mixture to milch animal	2 Buffalo
3.	Karan Sikri	Danghali	Rice-Wheat+ Vermicompost unit	(i) Levelling	0.40 ha
				(ii) Sale point for vermicompost	0.025 ha
4.	Subhash	Bhaisi Majra	Rice-Wheat+Vermicompost	Integrated nutrient management	0.40 ha
5.	Jai Bhawgan	Adhoni	Rice-Wheat+Bee-keeping	(i) Green manuring (dhaincha)	0.40 ha
				(ii) Artificial feed for bees & adoption of sanitation measures in bee hives	50 boxes
6.	Surjeet Singh	Munda Khera	Rice-wheat+Mushroom	(i) Improvement in seed quality & seed treatment	0.40 ha
				(ii) Use of paddy straw for compost	0.025 ha

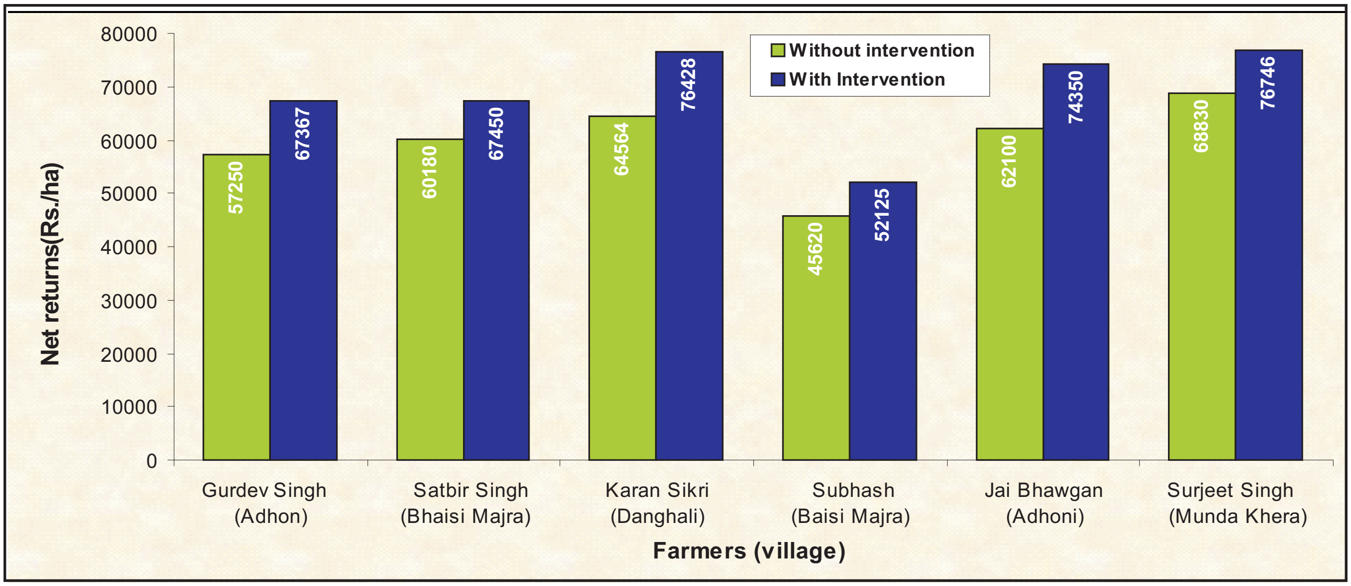

Fig 24. Economics of the farmers before and after applying intervention.

commercial basis and running successfully. Keeping above in mind, effort was made to generate information to work out the contribution of various enterprises in farm income and management of interlinked activities. The details of case studies on different farming components are given in Table 28.

Case study 1 (Sh. Harpal Singh)

A single farm unit of Sh. Harpal Singh S/o Sardar Kuldeep Singh of Village Bhorsaidan in District Kurukshetra (Haryana) was selected to study the contribution of various enterprises in farm income. Year to year data on costs and returns involved in different enterprises were registered by personal interview method and the records were maintained by the farmer himself and farm management expert of Krishi Vigyan Kendra, Kurukshetra. Technical assistance was rendered by the technical experts of the centre. The data were put to simple analysis as tables, cross tables, averages, percentages and the results are interpreted in manuscript.

Fig. 25. Intercropping of vegetables in papaya orchard.

Results

The selected farmer was engaged in traditional agriculture and doing farming as the other rural dwellers do. Sh. Harpal Singh came into the contact of Krishi Vigyan Kendra and his farm was adopted

Table 28. Details of case studies on integrated farming system

Case study	Name of farmer	Village	Farming components
1.	Harpal Singh Bajwa	Bhor Saida	Crop, Dairy, mushroom, orchard
2.	Karan Sikri	Danghali	Crop, dairy, bee-keeping, mushroom, vermicompost, floriculture
3.	Gurcharan Singh	Fatehgarh	Crop, dairy, agroforestry, vermicompost, goat-rearing, fish farming
4.	Harbir Singh	Dadlu	Crop, dairy, bee-keeping, chillies nursery

as demonstration centre by the Krishi Vigyan Kendra, Kurukshetra. He was innovative and progressive farmer hence he was advised to start other enterprises of bee-keeping and mushroom farming. He preferred to start the cultivation of papaya plants and mushroom farming. He adopted these two new enterprises in 1995-96 at small scale in the beginning and later on increased the size of enterprises on the basis of the scope and experience. On the basis of the enterprises adopted by the selected farmer, the study period was divided into three parts that is before adoption of new enterprises (Phase-I) and after adoption of new enterprises (Phase-II and III). A comparison in gross returns, costs, net returns and capital formation was made to deduct the impact of the new enterprises adopted by the farmers.

Table 29 reveals the position of various enterprises at the selected farm. In 1991-92, the total land holding with the farmer was 12 acres, out of which 0.5 acre was under cattle shed, tube well, etc. In 1995-96, two new enterprises mushroom cultivation and papaya plantation were started along with prevailing enterprises. In 1996-97, the farmer purchased 3 acres land by taking loan from bank and commission agents. Out of 15 acres land, 1 acre was put under farm buildings, cattle shed and mushroom shed and 1 acre land shifted under papaya with vegetable intercropping (Fig. 25). The area under papaya plants and vegetables intercropping increased to 2 acres in 1998-99 and again decreased to 1.5 acres in 2002-03 due to uprooting of old plantation.

Table 30 depicts the income expenditure status of the selected farm from 1991-92 to 2006-07.

In Phase-I (1991-92 to 1994-95) there were only two enterprises, *viz.* crop production (rice-wheat system) and dairy farming. In 1991-92, the farm income was Rs. 53,627 which increased to

Table 29. Land use pattern under different enterprises at selected farm

Year	Enterprises		Crop. Prod.	Orchard	Dairy farming		Mushroom farming
	Total land holding (acres)	Area under farm building (acres)	Area under crop (acres)	Area under papaya plants & vegetable crops (acres)	No. of buffaloes	No. of cows	Wheat bhusha (q)
Phase-I							
1991-92	12.00	0.50	11.50	-	5	1	-
1992-93	12.00	0.50	11.50	-	5	1	-
1993-94	12.00	0.50	11.50	-	4	1	-
1994-95	12.00	0.50	11.50	-	6	1	-
Phase-II							
1995-96	12.00	0.50	11.00	0.50	6	1	50
1996-97	15.00	1.00	13.00	1.00	5	2	50
1997-98	15.00	1.00	13.00	1.00	5	1	100
1998-99	15.00	1.00	12.00	2.00	5	1	200
1999-00	15.00	1.00	12.00	2.00	5	1	300
2000-01	15.00	1.00	12.00	2.00	5	1	300
2001-02	15.00	1.00	13.00	2.00	5	1	300
2002-03	16.00	1.00	13.50	1.50	6	1	350
2003-04	16.00	1.00	13.50	1.50	6	1	400
Phase-III							
2004-05	16.00	1.00	13.50	1.50	5	1	450
2005-06	17.00	1.00	14.50	1.50	5	1	500
2006-07	18.00	1.00	17.00	-	6	1	600

Table 30. Income-expenditure status of the selected farm from 1991-92 to 2006-07 (Amount in Rs.)

Year	Crop production			Orchard			Dairy farming			Mushroom farming			Total farm			
	Gross return	Variable cost	Return over V. C.	Gross return	Variable cost	Return over V. C.	Gross return	Variable cost	Return over V. C.	Gross return	Variable cost	Return over V. C.	Gross return	Variable cost	Farm income	B : C ratio
1991-92	94127	49750	44377 (82.75)	–	–	– –	22400	13150	9250 (17.25)	–	–	– –	116527	62900	53627	1.85
1992-93	118650	53020	65630 (80.20)	–	–	– –	31500	15300	16200 (19.80)	–	–	– –	150150	68320	81830	2.12
1993-94	141840	61340	80500 (79.78)	–	–	– –	37800	17400	20400 (20.22)	–	–	– –	179640	78740	100900	2.28
1994-95	159630	67540	92090 (76.00)	–	–	– –	60480	31400	29080 (24.00)	–	–	– –	220110	98940	121170	2.22
1995-96	188137	83250	104887 (62.04)	17000	8000	9000 (5.32)	69150	33900	35250 (20.86)	59400	39500	19900 (11.78)	333687	164650	169037	2.02
1996-97	241600	91380	150220 (62.61)	37800	20500	17300 (7.17)	75600	37200	38400 (15.90)	76700	41150	35550 (14.42)	431700	190230	241470	2.26
1997-98	253790	98640	155150 (56.68)	39400	21200	18200 (6.66)	83250	39400	43850 (16.00)	133660	77100	56560 (20.66)	510100	236340	273760	2.16
1998-99	243000	92650	150350 (41.82)	80200	39700	40500 (11.27)	81900	37650	44250 (12.31)	262400	138000	124400 (34.90)	667500	308000	359500	2.17
1999-00	272500	106300	166200 (38.54)	85300	44650	40650 (9.4)	96700	48900	47800 (11.08)	420000	243500	176500 (40.93)	874500	443350	431150	1.97
2000-01	286350	112170	174180 (36.13)	88550	46100	42450 (10.09)	107400	51350	56050 (11.62)	400200	190800	209400 (43.43)	882500	400420	482080	2.20
2001-02	298125	119950	178175 (35.12)	87870	45700	42170 (8.36)	108600	53790	54810 (10.80)	406700	174600	232100 (45.75)	901295	394940	507255	2.28
2002-03	316370	132740	183630 (34.90)	61300	30950	30350 (5.77)	127750	63490	64260 (12.21)	500175	252200	247975 (47.12)	1005595	479380	526215	2.10
2003-04	322190	134350	187840 (40.88)	60850	31200	29650 (6.45)	128800	67760	61040 (13.28)	389470	208500	180970 (39.38)	901310	441810	459500	2.04
2004-05	362100	152800	209300 (38.77)	58700	29500	29200 (5.41)	132000	66900	65908 (12.12)	497950	262560	235390 (43.61)	1051550	511760	539790	2.05
2005-06	419000	186900	232100 (40.02)	52640	27950	24690 (4.26)	147000	81400	65600 (11.31)	59800	339285	257515 (44.41)	1215440	635535	579905	1.91
2006-07	656000	316300	339700 (48.96)	–	–	– –	162700	89650	73050 (10.53)	632700	351670	281030 (40.51)	1451400	757620	693780	1.92

Figures in parentheses indicate the share of total farm income.

Rs. 1,21,170 in 1994-95. Benefit-cost ratio of the farm indicates that both the enterprises were remunerative and economically viable.

In phase-II (1995-96 to 2003-04) four enterprises were adopted on the farm. All the enterprises exhibited an increasing trend in gross and net returns during the study period. The contribution of crop production in farm income in 1995-96 was Rs. 1,04,887 which increased to Rs. 1,87,840 during 2003-04. Papaya along with vegetables intercropping contributed Rs. 9,000 in 1995-96, Rs. 42,450 in 2000-01 and Rs. 29,650 in 2003-04. Similarly, dairy farming added Rs. 35,250 in 1995-96 which increased to Rs. 61,040 in 2003-04. Mushroom farming emerged as highly paying entity on the farm (Fig. 26). Mushroom contribution to farm income in beginning was Rs. 19,900 which increased to its maximum i.e. Rs. 2,47,875 in 2002-03. The study clearly shows that the growth rate of returns from mushroom cultivation was higher than other enterprises. During Phase-II, the income generated from all the enterprises was Rs. 1,69,037 in 1995-96 which increased to Rs. 5,26,215 in 2002-03. There was a tremendous increase of 211% in farm income during this period. But in 2003-04, farm income came down to Rs. 4,59,500 from Rs. 526215 in 2002-03 which might be attributed to reduction in returns from mushroom because of low prices of mushroom in the market. Benefit-cost ratio of the farm varied from 1.97 to 2.28 during phase-II.

The farmer purchased three acres land by own investment and taking the credit from bank and commission agents and repaid the same within two years. The farmer also purchased a new tractor of higher capacity by selling the old one and constructed three mushroom sheds. A heavy investment of about Rs. 3,50,000 was also done on the purchase of Mohindra utility jeep, though the loan was taken from bank to purchase the same which was repaid in regular instalments. Again in 2002-03, farmer purchased one acre more land from farm income. The farmer is maintaining social status by keeping motor-cycle, telephones at residence and farm and a mobile phone. A remarkable enhancement of worth Rs. 22,81,000 in capital value was estimated during Phase-II (Table 31).

In Phase-III, like Phase-II, more emphasis was given on mushroom cultivation because this enterprise is more remunerative. The papaya orchard was uprooted due to continuous decline in its productivity due to the old age of orchard. The area under orchard was shifted to crops. Dairy unit remained same as in Phase- II.

It is conspicuous from the table that in Phase-I, the crop production was the major component in

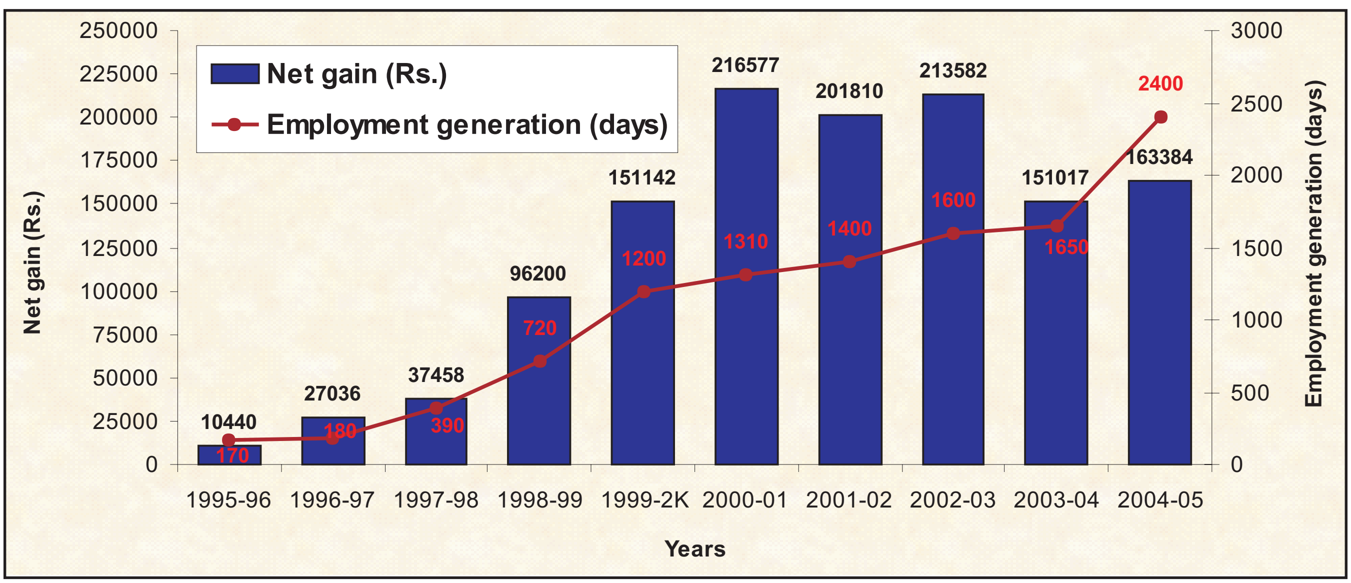

Fig. 26. Income and employment generation at Bajwa Mushroom Farm of village Bhorsaidan.

Table 31. Capital information of farm inventory on selected farm

Name of inventory	Phase I	Phase II	Change over Phase I	Estimated value (Rs.)	Phase-III	Change over Phase-II	Estimated appreciation in value
Land (acres)	12.00	12+3+1	+4.00	16,00,000	16+1+1	+2	12,00,000
Tubewell (No.)	1 (5 H.P.)	2 (5, 10 H. P.)	+1	80,000	3 (15, 20, 20 HP)	+1+HP	4,50,000
Tractor	1 (25 H.P) (Eicher)	1 (35 H. P.) (Swaraj)	+capacity	1,00,000	Sonalika (50 HP)	+ capacity	1,00,000
Farm buildings	1	2	+1	25,000	2	-	-
Live stock	5	6	+1	18,000	6	-	-
Agriculture implements	3	4	+1	15,000	Tractor Trolly	Increase in size	50,000
Zero till machine	-	1	+1	8,000	1	-	-
Mushroom shed	-	2+1	+2+1	55,000	3+1	+1	45,000
Mohindra utility jeep	-	1	+1	3,50,000	1	-	-
Motor cycle	-	1	+1	30,000	1 (replaced)	-	20,000
Telephone	-	2	+2	-	2	-	-
Mobile phone	-	1	+1	-	2	+1	2,500
Appreciation in values in period II and III			**22,81,000**			**18,67,500**	

contribution to the total farm income. The contribution of dairy farming increased from 17.25 per cent in 1991-1992 to 24 per cent in 1994-95 but after that, during phase-II the share of dairy farming in total farm income was lower than that already achieved in 1994-95 (Phase-I) probably due to the decreased cost of feed, problem of milk disposal and instability in milk price. The economy of scale and quality of animals were also affected with share of his income.

In Phase-II, after adoption of the new enterprises the contribution scenario to total farm income was completely changed. In 1995-96, the share of crop production was 62.04 per cent which has decreased to 40.88 per cent in 2003-04, though the net return from this enterprise increased with the subsequent period of study. The share of orchard in farm income showed an increasing trend. This share increased from 5.32 per cent in 1995-96 to 11.02 per cent in 2000-01 which further declined to 6.45 per cent in 2003-04, probably due to de-plantation of old plants of papaya.

In Phase-III, during 2006-07, there was tremendous increase in the net return from crop production due to appreciable increase in the prices of farm commodities. Net return from dairy unit also showed an increasing trend. Mushroom farming exhibited a constant upward trend in gross return, variable cost and net returns in Phase- III also. In 2006-07, farm income increased to Rs. 6,93,780 and B : C ratio was observed to be 1.92. In Phase- III, 2 acres of agricultural land was purchased and tube wells were renovated from shallow to deep submersible pumps and their capacity was also upgraded. Old tractor was replaced by high powered new tractor Sonalika. Tractor trolly was also renovated during this period. Thus, an appreciation in values of farm inventory was estimated to be Rs.18,67,500 in Phase-III. The loan from banks and money lenders was also drawn to purchase the farm assets. The share of crop production in 2006-07 increased to 49 per cent from 41 per cent in 2003-04, while the share of mushroom production contributed about 41 per cent. The total farm income showed an increasing trend during this period.

Mushroom farming emerged as highly paying enterprise during the study period. In the beginning, in 1995-96, the share of this enterprise to total farm income was only 11.8 per cent, which increased to 39.4 per cent in 2003-04 and rose to 44.4 per cent in 2005-06 but declined to 40.5 per cent in 2006-07. It indicates that this enterprise has very good potential in increasing the farm income.

Case study 2 (Sh. Karan Sikri)

Sh. Karan Sikri, a progressive farmer of village Danghali in district Kurkshetra (Haryana), has 9.2 ha of total land; 0.8 ha under infrastructure (house, dairy unit, vermicompost and mushroom unit and bee-keeping) and 8.4 ha under cultivation (Table 32).

Details of land holding and cropping pattern of farm of Sh. Karan Sikri

Total land holding	=	23 acres
Area under infrastructure	=	2 acres
Area under cultivation	=	21 acres

Table 32. Cropping pattern during 2006-07

Crops	Area (acres)
Kharif	
Rice	7
Sugarcane	10
Bittergourd	1
Cucumber	2
Jowar/maize fodder	1
Rabi	
Wheat	6
Sugarcane	10
Pea	3
Berseem	1
Gladiolus	1
Zaid (Summer)	
Cucumber	1
Tomato	2

Besides growing crops, the farmer started subsidiary occupations in 2003-04. After that he is continuously housing income from these enterprises. In crop production, the farmer adopts different combinations of crops such as sugarcane, vegetables, gladiolus and fodder besides rice and wheat crops alongwith 0.40 ha under organic farming for rice and wheat crops. He has developed his farm by providing underground irrigation system and sprinkler irrigation for cultivating vegetables and economizing water use. In sugarcane, different options of cultivation like pit-planting, trench plantation (single eye buds) and normal method of planting (flat sowing) are being adopted by the farmer. The farmer has expanded the work of mushroom cultivation and vermicomposting which are paying rich dividends to him. Vermicompost is used at his own farm as well as sold and sent in the states of Himachal Pradesh and Jammu and Kashmir where it is used in fruit and vegetable crops.

Methodology

For calculating total cost of production, gross and net return of different enterprises, the data on various parameters were recorded. The following points for calculation were considered.

In mushroom production

Investment on infrastructure includes the preparation of sheds, bamboos, shelf making, ropes and polythene sheets, purchase of pumps, electric motors, pipes and electricity facilities.

In bee-keeping

Investment on boxes, bee frames, honey extractor, net, etc. was considered. Material cost includes value of bee frames, wax sheets and sugar for feeding. Gross return in bee-keeping includes value of honey, wax and income from sale of bee colonies.

In vermicompost

Investment on infrastructure includes construction and shedding of beds. Material cost includes dung and waste material value and cost of worms. Labour cost occurred on mixing, watering, separation of compost and worms and packing. Marketing cost includes packing material and transportation.

Fig. 27. Compost preparation for mushroom production at Sikri farm.

Table 33. Economics of different enterprises at the farm of Sh. Karan Sikri of village Danghali (Kurukshetra, Haryana)

Parameters	Mushroom production				Bee-keeping				Vermi compost		
	2003-04	2004-05	2005-06	2006-07	2003-04	2004-05	2005-06	2006-07	2004-05	2005-06	2006-07
A. Fixed cost											
Unit size (q straw/boxes/beds)	60	150	200	200	35	35	35	35	10	15	15
Investment on infrastructure (Rs.)	20000	70000	75000	78000	14000	12600	11340	10206	18300	21470	19323
Investment on permanent equipments	2000	8000	9000	9000	6000	5400	4860	4374	3200	2880	2592
Total fixed investment	22000	78000	84000	87000	20000	18000	16200	14580	21500	24350	21915
B. Variable cost											
Interest on fixed capital and depreciation	7040	24960	26880	27840	44000	3960	3564	3210	4730	5357	4820
Material cost	27800	62840	96200	97900	51750	16000	17400	19500	11000	4500	4500
Labour cost	10540	26200	40560	41100	6000	8000	8500	10000	3000	5000	6000
Marketing cost	2800	6300	7500	7900	2000	2500	3000	3200	5500	6000	7000
Total cost	**48180**	**120300**	**171140**	**174740**	**64150**	**30460**	**32464**	**35910**	**24230**	**20857**	**22320**
Return	**63840**	**171000**	**243600**	**245100**	**30240**	**36760**	**35805**	**42600**	**36000**	**81000**	**81000**
By-product	-	-	-	-	1400	2000	1950	2300	-	-	-
Growth	-	-	-	-	26250	35000	36000	34500	4000	8000	8000
Gross return	63840	171000	243600	245100	57890	73760	73755	79400	40000	8900	89000
Net return	15660	50700	72460	70360	-6260	43300	41291	43490	15770	60143	66680
B : C ratio	1.32	1.42	1.42	1.40	0.90	2.42	2.27	2.21	0.60	4.26	3.98

Table 34. Economics of crop production at Sikri Agricultural Farm during 2006-07

S. No.	Crops	Area (acres)	Operational cost	Gross return	Crops	Area (acres)	Operational cost	Gross return	Crops	Area (acres)	Operational cost	Gross return
1.	Rice	7.00	96600	149800	Wheat	6.00						
2.	Sugarcane	10.00	-	-	Sugarcane	10.00	313950	506250	Cucumber	1.00	10200	16500
3.	Bittergourd	1.00	23260	34500	Pea	1.00	12050	18750	Tomato	2.00	3900	64000
4.	Cucumber	2.00	24600	35000	Pea	2.00	24100	37000				
5.	Jowar/maize fodder	1.00	7310	9250	Berseem	1.00	7650	11250				
					Gladiolus	1.00	28400	45000				
	Total	21.00	151770	228550		21.00	386150	618250		3.00	49200	80500

Results

Data on different enterprises exhibit that the cost of mushroom production was Rs. 48,180, 1,20,300, 1,71,140 and 1,74,740 during 2003-04, 2004-05, 2005-06 and 2006-07, respectively (Table 33). The respective figures for net return and B : C ratio were Rs. 15,660, 50,700, 72,460 and 70,360; and 1.32, 1.42, 1.42 and 1.40. Cost of production, net return and B : C ratio for bee-keeping were Rs. 64,150, 30,460, 32,464 and 35,910; Rs. (-) 6,260, 43,300, 41,291 and 43,490; and 0.90, 2.42, 2.27 and 2.21 during the respective years. Figures for these three parameters in vermicompost were Rs. 24,230, 20,857 and 22,320; Rs. 15,770, 60,143 and 66,680 and 0.60, 4.26 and 3.98 during 2004-05, 2005-06 and 2006-07, respectively. The magnitude of increase in net return was the highest in vermicompost followed by mushroom and bee-keeping enterprises. The net return in bee-keeping was almost static during the last three years (2004-05 to 2006-07). However, B : C ratio was higher in bee-keeping than mushroom occupation. The highest B : C ratio was recorded through the sale of vermicompost.

In crop production, during 2006-07, gross return was Rs. 2,28,550, 6,18,250 and 80,500 from **kharif**, **rabi** and summer season crops, respectively (Table 34). The operational cost was Rs. 1,51,770, 3,86,150 and 49,200, respectively.

By comparing the economics of different enterprises on the farm, it was observed that the share of income from various enterprises to the total income of the farm was 60.72, 12.56, 7.76, 11.90 and 7.05 from crop production, mushroom production, bee-keeping, vermicompost and dairy farming, respectively (Table 35). The respective figures for net return and B : C ratio were Rs. 3,40,180, 70,360, 43,490, 66,680 and 39,500; and 1.58, 1.40, 2.21, 3.98 and 1.45. The total cost, gross return and net return of the total farm were Rs. 9,07,590, 14,67,800 and 5,60,210 per annum, respectively.

Case study 3 (Sh. Gurcharan Singh)

To assess the contribution of allied enterprises of farming system a single unit of Sh. Gurcharan Singh S/o Sh. Surmukh Singh of Village Fatehgarh in district Yamunanagar (Haryana) was selected. He started agriculture independently in 1980 on eight acres parental land with bullocks. Crop cultivation was the traditional occupation of family of Sh. Gurcharan Singh. Alongwith farming and dairy, the farmer started agroforestry, poplar nursery raising, goat farming, fish farming and vermicompost on his farm. All the enterprises are stable and regular sources of farm income. All the enterprises are complementary to each other in the use of their main products and by-products.

Results

Starting from eight acres of parental land with a pair of bullocks, the farmer has presently acquired 23 acres of agricultural land, two tractors, four tubewells, fish pond, dairy unit and all the necessary implements needed at the farm. All the assets on the farm were accumulated/accrued within a stipulated period of his tenure from farm earnings. The figures in Table 36 reveal that the gross return from **kharif** and **rabi** crops was Rs. 2,68,960 and 6,02,450, respectively. Crop production had major share of 48.80 per cent (Table 37) followed by dairy farming (11.67%), fish farming (8.56%), poplar nursery raising (6.61%), tractor hiring (5.44%) and

Table 35. Economic status of different enterprises at Sikri Farm in 2006-07

S. No.	Enterprises/particulars	Total cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	B : C Ratio	% share in farm income
1	Crop production	5,87,120	9,27,300	3,40,180	1.58	60.72
2.	Mushroom production	1,74,740	2,45,100	70,360	1.40	12.56
3.	Bee-keeping	35,910	79,400	43,490	2.21	7.76
4.	Vermicompost	22,320	89,000	66,680	3.98	11.90
5.	Dairy farming	87,500	1,27,000	39,500	1.45	7.05
	Total farm	9,07,590	14,67,800	5,60,210		

vermi- compost (3.60%). In 2006-07, the farm income from various enterprises was computed Rs.10,81,734 including worth Rs. 1,58,000 from the harvesting of four years old poplar plantation. The increase in farm income was the result of resource utilization from different complimentary enterprises.

Case study 4 (Sh. Harbir Singh)

Sh. Harbir Singh S/o Sh. Narender Singh, Village Dadlu in district Kurukshetra (Haryana) started agriculture in 1993. He added bee-keeping enterprise at his farm in 1997 by keeping 10 bee colonies and increased upto 375 colonies in 2005. At present he is maintaining 225 colonies alongwith

Table 36. Cropping pattern of the selected farm in 2006-07
Land holdings owned: 23 acres, leased in= 4 acres, Area under fish pond= 1.5 acres, Area under crops= 25.5 acre

Crops	Kharif season			Crops	Rabi season		
	Area (acres)	Operational cost (Rs.)	Gross return (Rs.)		Area (acres)	Operational cost (Rs.)	Gross return (Rs.)
Paddy	7.00	38992	124800	Wheat	7.00	43050	135800
Sorghum+cowpea-paddy	3.00	25500	79260	Mustard	2.00	9500	26250
Sorghum fodder	2.00	6000	18000	Berseem	3.00	16380	40650
Sugarcane (R)+poplar	2.00	22900	–	Sugarcane (R) + Poplar+methi	2.00	3150	81440
Sugarcane (R)	2.00	22400	–	Sugarcane (R) + methi	2.00	3200	80830
Sugarcane (P)+poplar	2.00	39118	–	Sugarcane (P) + Poplar	2.00	-	66560
Sugarcane (P)+urd	1.50	30270	4500	Sugarcane (R) + methi	1.50	2450	60720
Sugarcane (P)+moong	1.00	20600	14500	Sugarcane (P)	2.50	–	83200
Sugarcane (P)	1.50	30450	–		–	–	–
Vegetables	1.00	14600	27900	Vegetables	1.00	14900	27000
Sub-total	23.00	250830	268960		23.00	92630	602450
Poplar nursery	1.00	47000		Poplar nursery	1.00		118500
Poplar	1.50	3300		Poplar	1.50		210000
	25.50	-	-		25.50	–	–

P – Planted, R – Ratoon.

Table 37. Economic status of different enterprises at selected farm in 2006-07

Enterprises on the farm/particulars	Operational cost (Rs)	Gross return (Rs.)	Net return (Rs.)	B : C ratio	% share in farm income
Crop production	3,43,460	8,71,410	5,27,950	2.53	48.80
Agro forestry (Poplar 4 years old)	52,000	2,10,000	1,58,000	4.00	14.61
Nursery raising (Poplar)	47,000	1,18,500	71,500	2.52	6.61
Dairy farming	1,14,500	2,40,704	1,26,204	2.10	11.67
Goat farming	1,800	9,400	7,600	5.22	00.70
Fish farming	64,800	1,57,400	92,600	2.43	08.56
Vermicompost (only labour cost)	3,000	42,000	39,000	14.00	03.60
Tractor hiring (sowing with zero drill, ploughing, threshing and transportation	21,220	80,100	58,880	3.77	05.44
Total farm	6,47,780	17,29,514	10,81,734	2.66	-

Table 38. Cropping pattern of the selected farm of Sh. Harbir Singh in 2006-07

S. No,	Crops	Kharif season			Crops	Rabi Season		
		Area (acres)	Operational cost (Rs.)	Gross return (Rs.)		Area (acres)	Operational cost (Rs.)	Gross return (Rs.)
1.	Paddy	16.00	1,15,840	3,02,400	Wheat	15.50	1,05,400	2,65,050
2.	Sugarcane (P)*	4.00	58,000	-	Sugarcane (P)	4.00	-	1,31,200
3.	Sorghum/ Maize fodder	3.00	9,600	28,500	Berseem	2.00	10,200	23,200
4.	Chillies	2.00	22,400	52,700	Mustard	3.00	15,600	44,400
					Moong (Jayad)	4.00	10,000	21,600
					Chillies nursery	0.50	2,10,000	2,60,000
	Total	25.00	2,05,840	3,83,600		25.0	3,51,200	7,45,750

P – Planted

Table 39. Economic Status of different enterprises at selected farm in 2006-07

S. No.	Particulars/Enterprise	Crop production	Dairy farming	Bee-keeping	Chillies nursery raising	Total net farm income
1.	Unit size	25 acres	Buff-5, Cow-1	225 colonies	0.5 acre	–
2.	Gross return (Rs.)	8,69,050	1,35,600	3,58,550	260000	16,23,200
3.	Operational cost (Rs.)	3,47,040	1,05,700	1,32,750	210000	7,95,490
4.	Net return (Rs.)	5,22,010	29,900	2,25,800	50000	8,27,710
5.	B : C ratio	2.50	1.28	2.70	1.24	2.04
6.	Per cent share in farm income	53.54	8.35	22.09	16.02	–

farming dairy and chillies nursery raising activities. In the present study, income from various enterprises for the year 2006-07 was worked out. The selected farmer is also growing non-traditional crops like chillies, mustard, moong and exotic vegetables like brokely, baby corn, capsicum, etc. which could be helpful in the pollen collection for the bees and, thus, the advantage could be harvested in terms of increased productivity of the crops. Chillies nursery raising occupied an area of half acre during the **rabi** season of 2006-07. Dairy unit comprised five buffaloes and one cow.

Results

The data in Table 38 indicate that the total earning of the farmer from crop production of 25 acres land was Rs. 8,69,050 for the year 2006-07 (Rs. 3,83,600 for **kharif** and Rs. 485450 for **rabi** season) plus an additional income of Rs.2,60,000 from the sale of chillies nursery. The crops grown at the farm were paddy (16 acres), sugarcane, wheat (15.5 acres), mustard and sorghum/maize and berseem as fodder crops. It is apparently clear from Table 39 that net returns from crop production, dairy farming, bee-keeping and chillies nursery raising enterprises were to the tune of Rs.5,22,010, 29,900, 2,25,800 and 50,000 with the total net farm income of Rs.8,27,710 per annum. The corresponding figures of benefit cost ratio were 2.50, 1.28, 2.70 and 1.24, respectively for different enterprises. The highest B : C ratio was from bee-keeping (2.70). Bee-keeping and crop production were more remunerative enterprises, which contributed 53.54 and 22.09 per cent in the total farm income. Similar findings on bee-keeping have also been reported by Singh and Singh (1997) and Rao (1998).

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