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Economic analysis of sustainable farming practice: A study of maize and common bean intercropping system under North-Western Himalayas of India

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Abstract
An economic analysis of maize and common bean intercropping during 2015-16 was carried out in Bhaderwah and Bhalla blocks of Doda district of J&K state which falls under North-Western Himalayas of India. A sample of 100 farmers was drawn for the present study using multistage sampling technique. Primary data were used to analyze the results which revealed that per hectare cost of cultivation of maize and common bean intercropping on overall farms was Rs. 45682.73. On marginal, small and medium farms, it showed a direct relationship with the farm size and was worked out to be Rs. 44910.16, Rs. 47434.64 and Rs. 49235.79 per hectare, respectively. On overall farms, per hectare cost-A_1, A_2, B_1, B_2, C_1, C_2 and D was worked out to be Rs. 23698.48, Rs. 24072.03, Rs. 24974.50, Rs. 36855.82, Rs. 31891.13, Rs. 43772.45 and Rs.45682.73, respectively. On an average, gross returns from maize and common bean intercropping were worked out to be Rs. 98145.26/ha with net returns of Rs. 52462.53 and benefit cost ratio of 2.15 indicating that maize and common bean intercropping is very much profitable sustainable farming practice in the study area and one rupee spent on maize and common bean intercropping would yield more than double returns of Rs. 2.15. High cost of labour, non-availability of plant protection chemicals in the market, high cost of inputs and weak research- extension farmer linkage were some major constraints associated with maize and common bean intercropping in the study area.

Keywords: Intercropping, gross returns, sustainable farming, constraints

Introduction

Agricultural sustainability is one of the greatest concerns facing the world today. Sustainable agriculture means the production of food, fiber or other plants & animal products using farming techniques which are more efficient in the use of resources for the benefit of human beings and maintains a balance with the environment. It provides food security along with increased quality and quantity considering the needs of future generations. It helps in the conservation of water, soil and natural resources, conservation of energy resources inside and outside the farm, maintains and improves farmer's profitability, maintains the vitality of rural communities and conserves the biodiversity (Eskandari, 2012) [6].

In recent years, environmentalists have focused more intensively on agricultural production methods that use available resources more efficiently and more sustainably. One of the key strategies for sustainable agriculture system is restoration of diversity to agricultural ecosystems and its effective management. Intercropping is one of the ways to increase diversity in an agricultural ecosystem which, as an example of sustainable farming practice, results in more stable yields, maintains soil fertility (Patra and Chatterjee, 1986) [8], efficient use of nutrients (Aggarwal et al., 1992) [1] and available resources (Singh et al., 1996) [9]. The main advantage of intercropping is increasing production per unit area compare to a single cultivation due to the better use of environmental factors such as light, water and nutrients in the soil. Although, intercrops reduce the yield of individual crop, the reduction is compensated by the collective yield and increased net profit to the farmers (Amanullah et al., 2007) [2]. The higher gross returns and dietary requirements have been achieved under intercropping than sole cropping. Amanullah et al., (2007) [2] reported that intercropping leads to better use of physical resources such as solar radiation, mineral nutrients and water, provides higher labour productivity than mono cropping and reduces risk as compared with mono cropping.

Intercropping of cereals with legumes has been very popular in the hilly rainfed areas (Dhima et al., 2007) [5] due to its advantages for soil conservation (Anil et al., 1998) [3], yield increment (Chen et al., 2004) [4], stability relative to sole cropping and fulfilling diversified needs of farmers. Although, intercropping may be additional intensive harvesting practice

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however it is an important and viable option within regions where the bulk of farming relies on subsistence farming. Among various cereals which can be intercropped with legumes, maize (*Zea mays* L.) is one among the foremost versatile crops having wider adaptability underneath varied agro-climatic conditions whose cultivation in India is characterized by inter-cropping i.e. along with and in pulses, vegetables and oil seeds. It is considered as the queen of the cereals and is one of the most important cereals in the world after rice and wheat. The importance of the crop lies in its wide industrial applications besides serving as human food and animal feed.

In J&K, legumes such as common bean, mung bean and black gram are used in intercropping with maize. However, intercropping of maize with common bean is extensively used and is an important component of farming system to ensure livelihood status of farmers of the state. Maize, one of the most important food, and common bean which is rich in protein, can produce a complete starch and protein food per unit area according to their physiological and morphological characteristics. These plants can be complementary in the use of environmental resources regarding maize stem. Maize has fibrous and shallow root but bean has deep and direct one. Therefore, this difference in root system can make the most use from the food in soil and its moisture. Also, common bean plants according to their lying and creeping habit, provide appropriate cover at the soil surface and reduce soil erosion, smother weeds and prevent water evaporation from the soil surface. The main districts where maize and common bean intercropping is done in J&K are Doda, Poonch, Rajouri, Udhampur, Ramban, Kathua and Reasi districts and dry temperate areas of Kishtwar district. Keeping in view the above facts, the present investigation was attempted to study the cost & returns structure and identify the major constraints in maize and common bean intercropping in the study area.

Materials and Methods
The present study was conducted purposively in Doda district of J&K state during agricultural year 2015-16 as this district is one of the major districts of the state which practice maize and common bean intercropping under North- Western Himalayan region of India. A multistage sampling technique wasadopted for the selection of ultimate sampling units. In the first stage Bhaderwah and Bhalla blocks were selected purposively as these two blocks are having maximum area and farmers under maize and common bean intercropping in the district. In the second stage, five villages from each block were selected randomly and then, from each selected village, 10 farmers were selected randomly without replacement in the third stage, so as to constitute a total sample size of 100 farmers in total. The sample farmers were further categorized into marginal (up to 1 ha), small (1.01-2 ha) and medium farmers (2.01-4 ha) based on their land holding size. Thus, the total sample of 100

farmers comprised of 78 marginal farmers, 14 small farmers and 8 medium farmers. The required information on cost & returns and resource use pattern was collected through personal interview method using well designed and pre-tested schedule. For estimating the cost of cultivation, various cost concepts like fixed cost, variable cost and concepts framed by CACP (cost A_1, A_2, B_1, B_2, C_1, C_2, D) were used which are defined below as:

Cost A_1: It includes value of casual labour, value of machine and bullock labour, value of seed (both maize and common bean), value of manures and fertilizers, value of plant protection chemicals, miscellaneous expenditure, interest on working capital, risk margin, annual depreciation and land revenue.

Cost A_2: Cost A_1 + rent paid for leased in land value
Cost B_1: Cost A_1 + interest on fixed capital
Cost B_2: Cost B_1 + rental value of owned land
Cost C_1: Cost B_1 + imputed value of family labour
Cost C_2: Cost B_2 + imputed value of family labour
Cost D: Cost C_2 + 10 per cent of Cost C_2 as management cost

To find out the returns, various income measures (gross income, net income and returns per rupee) were estimated. To measure the intensity of various constraints, mean percent score (MPS) was calculated by the following formula:
MPS = (Total score obtained for each statement/Maximum obtainable score) × 100

Results and Discussion
The quantities of various inputs directly affect the cost of cultivation and therefore, the use of different inputs like human labour, bullock labour, seeds, manures, fertilizers etc. has been studied in detail. The information on utilization of different resources for maize and common bean intercropping is presented in the Table 1 on per hectare basis.

Item-wise cost of cultivation
The results in the Table 1 indicated that at overall level per hectare cost of cultivation of maize and common bean intercropping was worked out to be Rs. 45682.73. Among different categories, it was Rs. 44910.16, Rs. 47434.64 and Rs. 49235.79 for marginal, small and medium farmers, respectively. The variable cost on marginal farms (Rs. 30286.74/ha), small farms (Rs. 31257.53/ha) and medium farms (Rs. 32228.58/ha) showed a direct relationship with the farm

Table 1: Item wise cost of cultivation of maize and common bean intercropping on sampled farms under study (Rs. /ha)

S. No.	Particulars	Marginal	Small	Medium	Overall
		A. Variable Cost			
vi	Maize seed	2552.36	2621.27	2841.36	2586.34
i	Common bean seed	4830.51	4906.87	4906.25	4867.37
ii	Casual labour	784.26	2218.83	3008.33	1163.85
iii	Family labour	7314.53	5690.08	5179.17	6916.63
iv	Machine labour	2682.81	3063.36	3164.58	2774.10
v	Bullock labour	1803.15	1590.84	1137.50	1719.55
vi	Manure	2553.26	2652.34	2836.24	2589.77
vii	Fertilizers	2198.31	2211.20	2395.83	2216.20
viii	Plant protection chemicals	539.47	755.47	913.54	598.74
ix	Miscellaneous charges	581.84	598.73	610.417	586.83
x	Interest on working capital	741.04	824.76	872.56	764.11
xi	Risk margin	1852.60	2061.89	2181.40	1910.28
xii	Managerial cost	1852.60	2061.89	2181.40	1910.28
	Total variable cost	30286.74 (67.44)	31257.53 (65.90)	32228.58 (65.46)	30604.05 (66.99)
		B. Fixed cost			
xiii	Rental value of owned land	11912.83	11766.33	11743.97	11881.32
xiv	Rent paid for leased-in land	0	1272.26	1927.08	373.55
xv	Annual Depreciation	1539.36	1851.91	1986.47	1621.34
xvi	Land Revenue	300.00	300.00	300.00	300.00
xvii	Interest on fixed capital	871.23	986.61	1049.69	902.47
	Total fixed cost	14623.42 (32.56)	16177.11 (34.10)	17007.21 (34.54)	15078.68 (33.01)
	Total cost (A+B)	44910.16	47434.64	49235.79	45682.73

size which constituted 67.44, 65.90 and 65.46 per cent of the total cost, respectively. On overall farms, variable cost (Rs. 30604.05) was 66.99 per cent to that of total cost of cultivation. Among the operational cost, at overall level, expenditure on family labour was the main component followed by expenditure on common bean seed, machine labour, manure and maize seed. In case of fixed cost, the per hectare expenditure on rental value of owned land was major cost component which was worked out to be Rs. 11912.83 on marginal farms, Rs. 11766.33 on small farms and Rs. 11743.97 on medium farms. Overall, rental value of owned land was worked out to be Rs. 11881.32/ha.

Concept-wise cost of cultivation
The cost of cultivation per hectare on the basis of different cost concepts was worked out in Table 2. It indicated that all the costs increased with increase in the size of holding as there was a direct relationship between costs and farm size. On overall cost-A_1, cost-A_2, cost-B_1, cost-B_2, cost-C_1, cost-C_2 and cost-D was worked out to be Rs. 23698.48, Rs. 24072.03, Rs. 24974.50, Rs. 36855.82, Rs. 31891.13, Rs. 43772.45 and Rs.45682.73, respectively. The total cost-D was lower on marginal farms among different categories of farms mainly due to very low expenditure on casual labour and zero amount of rent in case of leased in land as compared to small and medium farmers.

Table 2: Concept-wise cost of cultivation of maize and common bean intercropping on sampled farms under study (Rs. /ha)

Particulars / Categories	Marginal	Small	Medium	All farms
	Cost-A₁			
Casual labour	784.26	2218.83	3008.33	1163.85
Machine labour	2682.81	3063.36	3164.58	2774.10
Bullock labour	1803.15	1590.84	1137.50	1719.55
Maize seed	2552.36	2621.27	2841.36	2586.34
Common bean seed	4830.51	4906.87	4906.25	4867.37
Manure	2553.26	2652.34	2836.24	2589.77
Fertilizers	2198.31	2211.20	2395.83	2216.20
Plant protection chemicals	539.47	755.47	913.54	598.74
Miscellaneous expenditure	581.84	598.73	610.417	586.83
Interest on working capital	741.04	824.76	872.56	764.11
Risk margin	1852.60	2061.89	2181.40	1910.28
Annual depreciation	1539.36	1851.91	1986.47	1621.34
Land revenue	300.00	300.00	300.00	300.000
Total cost- A₁	22958.97	25657.47	27154.48	23698.48
	Cost-A₂			
Cost-A₁	22958.97	25657.47	27154.48	23698.48
Rent paid for leased in land	0	1272.26	1927.08	373.55
Total Cost-A₂	22958.97	26929.73	29081.56	24072.03
	Cost-B₁			
Cost-A₁	22958.97	26929.73	29081.56	24072.03
Interest on fixed capital	871.23	986.61	1049.69	902.47
Total Cost- B₁	23830.20	27916.34	30131.25	24974.50
	Cost-B₂			
Cost-B₁	23830.20	27916.34	30131.25	24974.50

Rental value of owned land	11912.83	11766.33	11743.97	11881.32
Total Cost-B$_2$	35743.03	39682.67	41875.22	36855.82
Cost-C$_1$				
Cost-B$_1$	35743.03	39682.67	41875.22	36855.82
Family Labour	7314.53	5690.08	5179.17	6916.63
Total Cost-C$_1$	31144.73	33606.42	35310.42	31891.13
Cost-C$_2$				
Cost-B$_2$	35743.03	39682.67	41875.22	36855.82
Family labour	7314.53	5690.08	5179.17	6916.63
Total Cost-C$_2$	43057.56	45372.75	47054.39	43772.45
Cost- D				
Cost-C$_2$	43057.56	45372.75	47054.39	43772.45
Managerial cost	1852.60	2061.89	2181.40	1910.28
Total Cost-D	44910.16	47434.64	49235.79	45682.73

Production and Income

The production and income from maize and common bean intercropping is presented in the Table 3 which indicated that productivity of marginal farms for both maize (17.65 q/ha) and common bean (5.21 q/ha) was higher as compared to small and medium farms. On overall farms, productivity of main product & by-product of maize was 17.64 q/ha and 15.79 q/ha and of common bean was 5.17 q/ha, 4.64 q/ha, respectively. The results also revealed that gross returns were highest on marginal farms (Rs. 98650.83) followed by small farms (Rs. 97710.80) and medium farms (Rs. 97486.66). This might be due to the reason that with increase in the farm size farmers could not manage their farm properly and not utilizing their resources efficiently. Overall, gross returns from maize and common bean intercropping were worked out to be Rs. 98145.26/ha with net returns of Rs. 52462.53 and benefit cost ratio of 2.15 (Table 4). Although, the benefit cost ratio was higher on marginal farms (2.20) as compared to small (2.06) and medium farms (1.98) but was greater than one for all categories of farms suggesting that the maize and common bean intercropping was economically very much profitable in the study area and each rupee spent would yield return of Rs. 2.20 in case of marginal farms, Rs. 2.06 in case of small farms and Rs. 1.98 in case of medium farms, respectively.

Table 3: Production and income from maize and common bean intercropping on sampled farms under study

Sr. No.	Particulars	Marginal	Small	Medium	Overall
1.	**Maize**				
i	Main product (q/ha)	17.65	17.61	17.55	17.64
ii	By- product (q/ha)	15.81	15.78	15.75	15.79
iii	Value of main product (Rs./ha)	25592.68	25534.68	25447.68	25578.18
iv	Value of by product (Rs./ha)	1581.16	1578.16	1575.16	1579.16
A.	Sub-Total (Rs./ha)	27173.83	27112.83	27022.83	27157.33
2.	**Common bean**				
vi	Main product (q/ha)	5.21	5.09	5.07	5.17
vii	By- product (q/ha)	4.73	4.56	4.54	4.64
viii	Value of main product (Rs./ha)	71240.56	70368.98	70236.75	70755.80
ix	Value of by product (Rs./ha)	236.44	227.99	227.08	232.13
B.	Sub-Total (Rs./ha)	71477.00	70597.97	70463.83	70987.93
	Gross returns(A+B)	98650.83	97710.80	97486.66	98145.26

Table 4: Cost and returns from maize and common bean intercropping on sampled farms under study

Sr. No.	Particulars	Marginal	Small	Medium	Overall
1.	**Cost**				
	Total variable cost	30286.74	31257.53	32228.58	30604.05
	Total fixed cost	14623.42	16177.11	17007.21	15078.68
	Total cost	44910.16	47434.64	49235.79	45682.73
2.	**Returns**				
	Gross returns	98650.83	97710.80	97486.66	98145.26
	Net returns	53740.67	50276.16	48250.87	52462.53
3.	Benefit-Cost Ratio	2.20	2.06	1.98	2.15

Constraints associated with maize and common bean intercropping

The results related to various constraints associated with maize and common bean intercropping in the study area are presented in Table 5 which revealed that high cost of labour, non-availability of plant protection chemicals in the market and high cost of inputs were major problem in maize and common bean intercropping as indicated by their MPS score of 68, 53 and 49, respectively. Other constraints were lack of knowledge about insect pest and diseases management, weak research- extension farmer linkage, lack of finance and credit facilities, lack of subsidy for inputs, lack of knowledge about weed management and lack of proper knowledge about seed rate, spacing and sowing date.

Table 5: Constraints associated with maize and common bean intercropping in the study area

Sr. No.	Constraints	Mean Percent Score
1.	High cost of inputs	49
2.	High cost of Labour	68
3.	Non availability of plant protection chemicals in the market	53
4.	Lack of proper knowledge about seed rate, spacing and sowing date	31
5.	Lack of knowledge about insect pest and diseases management	47
6.	Lack of knowledge about weed management	32
7.	Weak research- extension farmer linkage	43
8.	Lack of finance and credit facilities	42
9.	Lack of subsidy for inputs	39

Conclusion
Based on the results it can be inferred that in general, per hectare cost of cultivation of maize and common bean intercropping was higher in case of medium farms followed by small and marginal farms. On overall basis, total cost of cultivation was worked out to be Rs. 45682.73. Concept-wise cost of cultivation showed that all the costs increased with increase in the size of holding which indicated a direct relationship between costs and farm size. It was also found that the gross returns were higher for marginal farms followed by small and medium farms. Overall gross returns were worked out to be Rs. 98145.26 with benefit cost ratio of 2.15, indicating that maize and common bean intercropping is very much profitable farming practice in the study area and one rupee spent on maize and common bean intercropping would yield more than double returns of Rs. 2.15. However, high cost of labour, non-availability of plant protection chemicals in the market, high cost of inputs and weak research-extension farmer linkage were some major constraints associated with maize and common bean intercropping and therefore, to overcome the problems associated with maize and common bean intercropping, it is recommended that use of labour saving technology and good management practices will assist farmers to improve their production. Further, credit delivery from lending agencies is also suggested at a minimum interest rate to the farmers to encourage them to produce more and improve their productivity.

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