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Agricultural sustainability and interdependence of production systems in Jammu and Kashmir

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Abstract

Objectives: The study was conducted in four agro-ecosystems of the Kashmir Valley. The main objective of the study was to analyse the interdependence of the different agro-ecosystems of the valley.
Methods/Statistical Analysis: The ecosystem comprises of biotic and a biotic components. The study analyses many components of the four agro-ecological zones of the valley like human beings, pests, rodents etc. to quantify interdependence among the various components of agro-ecosystems, the static input-output model was used.
Findings/Results: All the components were highly interdependent and interlinked with each other. The four agro-ecosystems viz. field crop based agro-ecosystem were found to be totally interlinked with fruit crop based agro-ecosystem and livestock based ecosystem and intern the cash crop base agro-ecosystem was found interlinked with other three agro-ecosystems in the sampled area. Similarly, the cash crop and fruit crop agro-ecosystems were found more remunerative than other two agro-ecosystems, meaning there by that the value of these goods and services is very high and can provide livelihood to a huge chunk of people in almost all the four agro-ecosystems.
Application/Improvements: The study having great applicability for the betterment of poor farmers. This study can be an eye opener for the policy makers and planners, so that necessary step shall be taken to improve the living standard of the poor farmers.
***Keywords*:** Interdependence, Linkages, Agro-ecology, Betterment, Ecosystem.

1. Introduction

The valley has a distinction in terms of its diversity, which made it to provide biotic or a biotic environment to the number of agro-ecosystems [1]. An ecosystem is a natural unit of living things (animals, plants and micro-organisms) and their physical environment. Its living and non-living elements function together as an interdependent system-if one part is damaged it can have an impact on the whole system [2]. In many cases, ecosystems overlap and perform numerous functions [3]. Many of those functions are valued by humans because they deliver us ecosystem services. Agro-ecosystem is a multidisciplinary section, including multi-trophic research in agriculture, horticulture and livestock production systems, including the complex sets of inputs and outputs and the interconnections of their constituent parts [4]. The components of agro-ecosystems in the Kashmir valley can broadly be divided into four major categories, viz., field crop based, fruit crop based, livestock based, and cash crops based Agro-ecosystems.

2. Materials and Methods

A four stage random sampling method was adopted for the selection of sample respondents. In first stage of sampling, four districts of the southern part of the valley have been taken into consideration for conducting the base line survey and extensive observations for collection of necessary data and information. One district representing each ecosystem was selected purposively based upon predominant production system. The district Anantnag was purposively selected on the basis of dominant field crop production system, district Shopian was selected on the basis of dominant fruit crop production system, district Pulwama was selected on the basis of dominant livestock production system and finally district Budgam was selected on the basis of dominant of cash crop production system.

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In the second stage, two blocks from each district were randomly selected to form a total of eight blocks. In third stage, a cluster of three villages were selected from each block in order to form six villages from each district and a total of twenty four villages. In fourth and final stage of sampling, twenty five respondents were selected from each village cluster so as to make the total sample size of 50 in each district and overall total sample of 200 respondents as shown in Table 1.

Table 1. Design of the sampled districts

Ecosystem	District	Block	Village	No. of households
Field crop ecosystem(FLCES)	Anantnag	Breng	Sagam	25
			Bindoo	
			Tangpowa	
		Achabal	Bonadilgam	25
			Kamad	
			Ugian	
Fruit crop ecosystem(FRCES)	Shopian	Shopian	Malikgund	25
			Saidpora	
			Malikpora Shopian	
		Keller	Keller	25
			Mushwara	
			Mastpora	
Livestock ecosystem(LSES)	Pulwama	Pulwama	Bellow	25
			Gulshanabad	
			Chanipora	
		Kakapora	Pinglena	25
			Manduna	
			Wathar	
Cash crop ecosystem(CCES)	Budgam	Budgam	Ompora	25
			Narkoora	
			Bathar	
		Chadoora	Nagam	25
			Baidpora	
			Hafroo	
Grand total				200

Source: Field Survey (2013-2016)

2.1. Data collection

The study envisages both primary and secondary data. The primary data consisted of the Education of the sample respondents, Land holding of sample respondents, cropping pattern, area under different crops, family consumption, losses, production and net price. The secondary data consisted of the, land use, area, and production, productivity of field, fruit, livestock and cash crops. The secondary data with respect to above information were collected from various published and unpublished records of state government which include Annual reports, Digest of Statistics (Directorate of Economics & Statistics, J&K Govt.), Economic Survey (Directorate of Economics & Statistics J&K Govt) and other periodicals.

2.2. Analytical model

Inter sectoral linkage of the various components of agro-ecosystem system. To quantify interdependence among the various components of agro-ecosystems, the static input-output model was used. The input-output may be described by the following equation,

$$Si = \sum Sij + Hi \quad (i=1,2,3,\ldots\ldots,m; \quad j = 1,2,3,\ldots.,n)$$

Where Si is the output of any intermediate sector and Sij represents component flows from ith sector to the jth sector and Hi is the final output for household consumption and market.
The above equation can also be written as:

$$Si-\sum Sij = Hi \quad (i=1,2,3,\ldots\ldots,m; \quad j = 1,2,3,\ldots.,n)$$

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The relationship thus obtained can be expressed in terms of production coefficients (aij) and may be described as follows:

$$a_{ij} = \frac{S_{ij}}{S_j}$$

(i=1,2,3,……,m; j = 1,2,3,….,n)

This may also be expressed as:

Sij = aijSj

Where Sj = Total output of sector 'j'

In the above equation, 'aij' gives the value of produce of ith sector required by sector 'j' per unit value of output of sector 'j'.

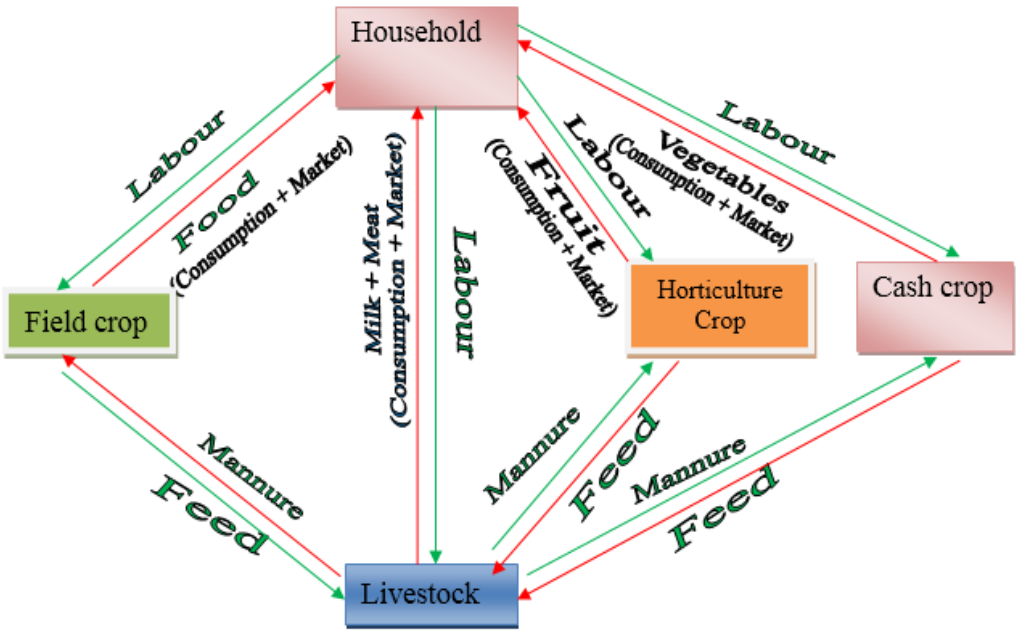
Thus the model can be also written as:

Si-∑ aijSj = Hi (i=1,2,3,……,m; j = 1,2,3,….,n)

The cost of cultivation of major crops was estimated using the cost concept defined by Commission on Agricultural Costs and Prices (CACP), GOI, which are as given below:

Inter-sectoral linkage between different agro-ecosystems. The value system embedded in the economic approach to public policy tends to lead to a certain basic way of thinking and intersectoral linkages among environmental and natural resources. The flow of resources among various system components can through illustrated by flow diagrams. At the field or plot level, the resources of interest are usually nutrients. For example, apple trees (as in fruit crop agro-systems) extract nutrients from a deeper soil layer, which are then made available through decomposition of the foliage to associated annual crops and provide the main annual income. At the farm level, the relevant resource flows include labour and cash, and how these are deployed between different possible activities within and off the farm; how the outputs of one activity (e.g. a cropping system) might act as inputs for another; and the inputs and outputs of the farm system. At the community or regional level, the resource flows include not only the marketing systems but also information and financial systems. There may also be significant material and labour flows between different types of households or farm.

Figure 1. Inter-sectorial linkages within the agricultural sectors



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The components of agro-ecosystems in the Kashmir valley can broadly be divided into four major categories, viz. field crop based, fruit crop based, livestock based, and cash crops based agro-ecosystems. Field crop based agro eco system: The field crop based ecosystem in Kashmir valley, demonstrated predominance of paddy in the area, which could be due to the best suited agro-climatic conditions of the region for the crop. Kashmir province dominates in production and consumption of rice and contributes the highest area under rice compared to other crops. Fruit crop based agro eco system: In Kashmir valley the fruit crop based ecosystem is predominant in district Shopian owing to various topographical and environmental conditions which offer comparative advantage to the production of various horticultural products. In some cases it enjoys monopoly in the production of some fresh fruits (apple) and dry fruits (walnut).

The livestock based ecosystem is prevalent in all the districts of Kashmir but the number of animals per household was more under livestock based agro ecosystem compared to cereal based ecosystems. Cash crop based agro eco system: Vegetables are also grown under the all agro-ecosystems however their cultivation remained limited to the family consumption in general except district Budgam where vegetables are grown commercially. The higher proportion of cropped area under vegetables in Budgam was due to assured irrigation facilities and favourable agro-climatic conditions as shown in Figure 1.

1. The outputs of one activity being used as inputs for another activity.
2. The use of crop straw or “residues” as animal feed. A typical consequence is the rejection by farmers of short-straw varieties of cereals such as rice due to the reduced biomass and the lower palatability to livestock of dwarf rice varieties (which have high levels of silica in the stem).
3. The use of livestock FYM as manure in crop fields (when alternative sources of fertility maintenance might be needed as grazing land decreases and/or mechanization is introduced).
4. The planting of two crops on the same plot within the same year or planting season.
5. Intercropping or mixed cropping-where two or more crops are planted at the same or similar times (e.g. maize accompanied with beans, etc. in many small holdings);
6. Relay cropping-where one crop is planted on the same plot towards the end of the life cycle of another (e.g. potato are often planted after the maize and oilseed after paddy);
7. Sequential crops-where one crop is planted after the harvest of another (oats and oilseed paddy harvest).

In such cases, the adoption of higher yielding varieties of one crop (which often involves either dense vegetation or a longer duration of the crop in the field) may adversely affect the yields of accompanying or sequential crops.

There are many such examples of interaction at the different levels of agro-ecosystems. The important point is that maximizing the output of one system (e.g. crop) may not lead to the optimum output of a higher system (e.g. the farm) of which the first system is a component.

3. Shifting matrix between different components of agro-ecosystem per household

The shifting matrix shows the linkage between different agro-ecosystem though the degree of interdependence may vary across regions. The shifting matrix between different agro-ecosystem per household in study areas presented in the Table 1 revealed that the gross returns of paddy and apple, livestock and cash crop were ₹23250, ₹321000, ₹108920 and 106915 respectively. To quantify interdependence among the various components of agro-ecosystems, the static input-output model was used to identify the linkages among various sectors. The results of these linkages are discussed under the following;

The inputs for paddy met from its own production accounted to ₹375 and ₹4400 from livestock production, while as, the contribution of crops towards livestock production was estimated at ₹9175.84 (field crop). The input-output coefficients indicated that each rupee of livestock production consumed inputs in the ratio of 0.08 from field crop. The gross returns of apple were ₹321000 and the contribution of livestock towards fruit production was estimated at ₹14560 and the input-output coefficients indicated that each rupee of fruit crop production utilized inputs in the ratio of 0.05 from livestock. The gross returns of cash crop were ₹106915 and the inputs for cash crops were estimated at ₹6688 from its own production and contribution of livestock towards cash crop production was estimated at ₹16976. The input-output coefficients indicated that each rupee of cash crop production required inputs worth 0.06 from its own production and 0.14 from livestock. The data further revealed that field crop ecosystem were found to release labour for initial stages of fruit crop ecosystem and in similar fashion livestock ecosystem produce FYM for consumption by other ecosystems.

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To quantify interdependence among the various components of agro-ecosystems, the static input-output model was used to identify the linkages among various sectors. The results of these linkages across various enterprises along with their comparison are presented in Table 2. The results indicate that input-output coefficients of different enterprises were highest in livestock for crop based farming systems in district Anantnag, Shopian and Budgam, however, the forward linkages (crop to livestock) were stronger than backward linkages (livestock to crop). The weak backward linkages suggested that there is a need to strengthen backward linkages between crops and livestock. The weak linkages could be attributed to the low use of FYM, substitution of FYM by the chemical fertilizers and the use of tractors instead of bullocks. The share of market inputs was low for the production of various enterprises, which shows a high interdependency among various enterprises of the farming systems. The data revealed that the crops consumed inputs from all the enterprises of the temperate zone, while as livestock consumed majority of inputs from crops only.

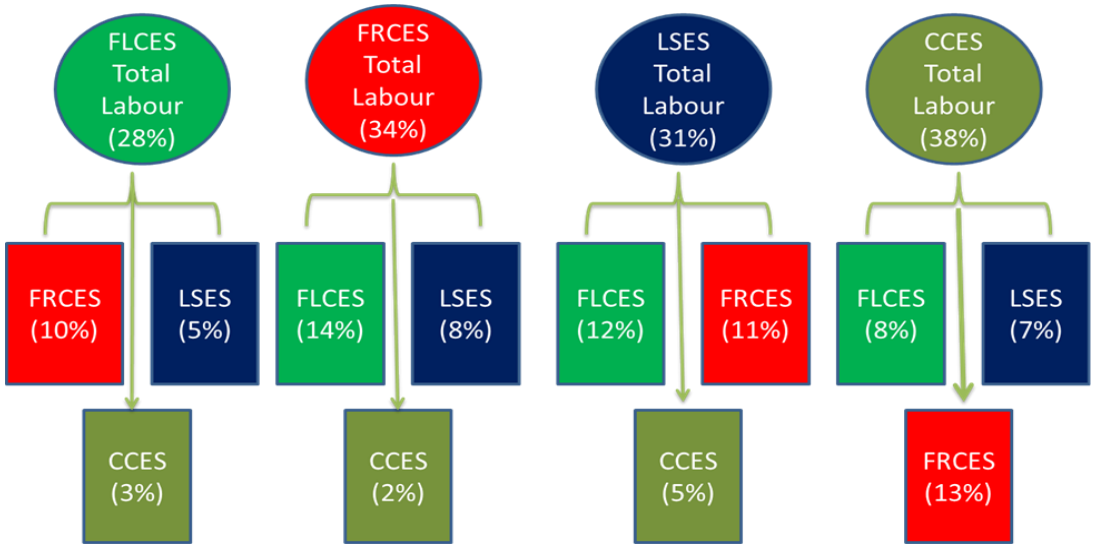
Table 2. Shifting matrix between different agro-ecosystem of Kashmir valley

Producing sectors	Consuming Sectors				Gross returns (Rs/ha)
	Field crop (paddy) (Rs)	Fruit crop (Apple) (Rs)	Livestock (Rs)	Cash crop (Rs)	
Field crop (paddy)	4500.00 (0.03)	0.00 (0.00)	5800.00 (0.04)	0.00 (0.00)	147754.00
Fruit crop (apple)	1500.00 (0.003)	500.00 (0.001)	14560.00 (0.03)	0.00 (0.00)	475556.00
Livestock	9176.00 (0.17)	4500 (0.08)	6000 (0.11)	16976.00 (0.31)	54460.00
Cash crop	1000.00 (0.003)	0.00 (0.00)	15438.00 (0.05)	6687.00 (0.02)	282092.00

Source: Calculation Based On Field Survey (2012-2014)

The input output coefficients of different enterprises were highest in family labour indicating the higher dependence of raising various enterprises on the family labour. These linkages will serve a good purpose for enhancing the production of various sub-sectors of agricultural economy. The high input-output coefficients of different enterprises and stronger forward linkages as compared to the back linkages in semi-arid parts of India [4]. In cereal based cropping system also, the forward linkages (crop to livestock as well as crop to poultry) were stronger as compared to backward linkages (livestock to crop and poultry to crops suggesting a need to strengthen backward linkages of crops with livestock as well as poultry [5].

Figure 2. Labour shift (per household)



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3.1. Labour shift

Small farmers supplying wage labour to others for harvest and plantations, leading to late planting or non-weeding on small holders own fields; farmers without livestock hiring their manual labour to ox-owners in exchange for ploughing services (which may then arrive later than the optimum planting time). The labour shift is maximum from livestock based agro-ecosystem to other agro-ecosystems i.e. out of 31% of labour 12%is shifted to FLCES, 11% to FRCES and 5% to CCES as shown in Figure 2.

4. Economics of various agro-ecosystems

The economics of different agro-ecosystems per household of Kashmir valley is presented in Table 3. The per hectare estimates of various costs revealed that in the selected districts viz. Anantnag, Shopian, Pulwama and Budgam all the cost A1, A2, B1, B2, C1, C2 and C3 were higher in fruit crop based ecosystems and lower in field crop based ecosystems. The estimates of gross returns, farm business income, farm labour income and net income per hectare were also higher in fruit crop based ecosystems and lower in field crop based ecosystems.

Table 3. The various costs, gross returns, farm business income, farm labour income, and net income and benefit cost ratio of different agro-ecosystems of Kashmir valley

	FLCES (Rs/ha)	FRCES (Rs/ha)	CCES (Rs/ha)	LSEC (Rs/HH/year)
Cost (A1)	33046	88862.4	76423.33	23481
Cost (A2)	47309.2	128492	97408	23481
Cost (B1)	41285.53	92435	78876.67	25366.5
Cost(B2)	55575.4	132078	99888	25366.5
Cost(C1)	68590.67	113291	121420.7	34846.2
Cost(C2)	82880.67	152933	142432	34846.2
Managerial cost @10 of C2	8288.067	15293.3	14243.2	3484.62
Cost (C3)	91168.67	168227	156675.3	38330.8
Gross returns	147754	475556	282098	54460.2
Farm Business Income	100444.8	347064	184690	30979.2
Family Labour Income	92178.6	343478	182210	29093.7
Net returns over cost C1	79163.33	362265	160677.3	19614
Net returns over cost C2	64873.33	322622	139666	19614
Net returns over cost C3	56585.33	307329	125422.7	16129.4
B/C ratio over C1	2.154141	3.19766	2.323311	1.562873
B/C ratio over C2	1.782732	2.10956	1.98058	1.562873
B/C ratio over C3	1.620666	1.82687	1.800526	1.420795

Source: Calculation Based o Field Survey, (2012-14))

5. Summary and Conclusion

In all districts however, the forward linkages (crop to livestock) were stronger than backward linkages (livestock to crop). The weak backward linkages suggested that there is a need to strengthen backward linkages between livestock and crops. The weak linkage is for lower use of FYM, there recommended level and its subsequent substitution by chemical fertilizers. The irrationality in use of other factors of production, has also contributed towards establishing weak linkages within the system. However, it is of great interest that despite district Anantnag identified for cereal based forming system, its investment was little less than district Pulwama which probably indicates that district Pulwama has a very strong forward and backward linkage vis-à-vis crop and livestock. The gross returns of paddy per hectare in district Anantnag registered a figure of ₹152901/- followed by the lowest ₹151785/- in district Shopian.

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These figures reveal that the field crop based agro eco system was least important in Shopian district which is evidenced by lesser area under cereal production. The Shopian district is a declared hill district owing to its topography and is famous for horticulture produce. The figures in the table reveal that Shopian district accounted for maximum average investment ₹168227/- per hectare in fruit crop (apple). One of the most important characteristics of mountain farming system is that nature has bestowed mountains with specialized advantage in respect of growing niche crops. These niche crops provide an advantage to the mountains for pushing growth in agriculture beyond the targeted growth at national level. The most prominent niche crops of the state are saffron and off season vegetables. Both these crops are commercially grown in district Budgam. The figures in the table reveal that maximum average investment ₹156675/- was made on vegetables followed by saffron ₹212227/-. It is pertinent to note here that the vegetables from this district are supplied to all the three regions of the state and are exported to the neighbouring states of Punjab and Himachal Pradesh.

The state has the largest potential for production of quality temperate horticulture crops. It has created niche production of apple, pear, cherry and dry fruits. Among temperate fruits, apple ranks first in terms of production and productivity. The annual production of apple in the state is about 9.09 lakh tons with an average yield of 10.09 tons, per hectare. However the production & productivity of apple crop has been fluctuating during last two decades, which could be due to drought or un-usual climatic changes. In spite of this apple production has increased from Just 6000 metric tons in 1950-51 to more than 18 lakh tons in 2010-11, productivity is much higher than national level of 6.86 Mt/ha and is comparable with the world average of 10.82 ton/ha or china (9.93 ton/ha) which is the world highest producer of apple.

In Jammu and Kashmir, livestock plays a significant role and contributes 13% to the State Gross Domestic Product (SGDP). The livestock products viz., Pashmina, carpet and other important handicrafts are an important source of foreign exchange earnings. As per provisional estimates of 19th livestock census 2012, total livestock population in the State has decreased from 131.25 lakh in 1992 to 125.04 in 2012, registering a decrease of 16.45%.

The increase in livestock intensity in the state was experienced due to intensification of livestock, especially higher population indicating that this region has better availability and access to resources like feed and fodder and has comparative advantage in livestock production. Increasing intensification of livestock depicted a good picture from the point of view of availability of livestock products. The sustainability issue of livestock production system, in respect of increasing livestock population, did not seem to pose a challenge, though its appropriate species-mix and enhancing productivity still remain a major challenge. However, this intensification has raised the issues of sustainability in the state in respect of decreasing holding size and pasture areas.

6. Conclusion

Field crop based agro ecosystem was interlinked with fruit crop based agro ecosystem and livestock based ecosystem and in turn the cash crop based agro-ecosystem was found interlinked with other three agro-ecosystems in the sampled area. Thus, our second objective is justified. Similarly, the cash crop and fruit crop agro eco systems were found more remunerative than the other two agro-ecosystems, it means that the value of these goods and services is very high and can provide livelihood to a huge chunk of people in almost all the four agro- ecosystems. The main conclusion drawn from study is enumerated below:

1. Rice cultivation in the agro-ecosystem has been found to be more productive with low cost of production.
2. Rice cultivation is having higher marketable surplus and engages both unskilled and semi-skilled human labour compared to other agro-ecosystem.
3. About 25 to 30 lakh people are directly or indirectly involved in horticulture sector, which contributes around 6,000 corers towards SAGDP, being highest contributor towards SAGDP the sector can be instrumental in pushing further the contribution to the state GDP by way of addressing its vertical dimensions.
4. Economic contribution of livestock is today more than that of food grain crops as such sates with higher livestock share bears lower level of poverty and vice versa.

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5. Compared to the rain-fed agriculture, livestock is less prone to climati change therefore has more acceptability as an important contributor. Despite the fact, it receives only 12% of the total public expenditure.
6. The livestock sector has turned more productive by way of its potential to push returns 36 per cent if scientific system of management is followed.
7. Vegetables are grown in all agro-ecosystems in Kashmir. However; their cultivation remains limited to family consumption in general except district Budgam where vegetables are grown on commercial lines and supplied to all the three regions of the state and are also supplied to the neighbouring states of Delhi and Haryana.
8. Higher proportion of cropped area under vegetables in Budgam was due to irrigation facilities and favourable agro-climatic conditions, therefore, all the respondents cultivated vegetables both in the kharif and rabi seasons, as such the cropping intensity was more than 200 in the vegetable growing areas.
9. Returns per rupee invested were higher from vegetables compared to other crops in the agro ecosystem, because, of better market accessibility.

7. Policy Implications

1. Well-established and effective seed sector would help farmers to access new varieties and increase rice production by putting more area under improved rice.
2. Public-private partnership and cooperatives could benefit individual members by way of providing timely inputs at fair price and help them to dispose off their surpluses.
3. Micro irrigation schemes need to be launched to reduce water stress and achieve potential benefits from improved rice technologies.
4. Land reform measures need to be implemented strictly in the state, to encourage capital formation and generate other necessary factors for improving technology adoption of input-use at the farm.
5. To enable exploitation of the opportunities and enjoy full potential of horticulture sector, major programmes, policies to educate and enable the farmers to change their production techniques and grow efficiently.
6. Assurance of stable price levels through market mechanism and supply side initiatives through better sorting and grading should be provided.
7. Better transportation, adequate cold storage facilities enables manipulation of supply to the advantage of seller.
8. Market mechanism initiative by increasing the numbers of buyers and geographic spread of buyers creating a formal market model and diversification of markets will result good revenue and remuneration to farmers producing horticulture products.
9. Market development scheme with all facilities like finance, logistics, communication, storage facilities and pack houses will induce farmers to increase production which will result in increase in productivity and profitability in horticulture.
10. A majority of our farmers still have local breed of cattle's which have poor conception rates, less lactation period, low yield and take more time to mature sexually, therefore, farmers need to be familiarized with cross bred cattle's which have high milk yields at the same time
11. Financial institutions in the agro-ecosystem should ensure 100% coverage for all the livestock owners so that credit facilities and insurance services are provided at their door steps.
12. Adoption of livestock-related technologies is poor because of absence of animal husbandry extension network; therefore the livestock extension education has to play an important role in this context to empower the farmers with appropriate technological knowledge and skills through various extension education and training programmes with special reference to Indian livestock farming situations.
13. There is a need to establish daily local regulated markets near the niche areas of vegetable production in the agro-ecosystem.
14. Timely institutional crop/marketing loan should be made available to vegetable growers at a lower cost in the agro-ecosystem.

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15. Extension facilities should be streamlined to encourage adoption of improved technologies in vegetable cultivation.
16. Soil testing laboratories need to be established at accessible distances from vegetable production centres in the agro-ecosystem.
17. Small-scale vegetable processing units need to be established at the farm and block levels in the agro-ecosystem to facilitate their processing for disposal to terminal markets.
18. Development of infrastructure, including roads and efficient transport facilities and strengthening of the co-operative marketing institutions for the vegetables may help in improving the efficiency of vegetable marketing in the state.

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