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## Dynamics of land use pattern: A time series analysis

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### Abstract

A study was undertaken to analyze the dynamic changes in land use pattern relating to growth, instability, elasticity of major crops in Jammu region. The data was collected for a period of 30 years from 1981 to 2010. The data revealed that there was an overall growth in area, production and yield of rice, 0.24 per cent, 1.61 per cent and 1.32 per cent respectively. In case of maize, growth in area was 1.40 per cent, growth in production was 0.75 per cent and growth in yield was -0.19 per cent, growth in area under wheat was 0.8 per cent, growth in production of wheat was recorded as 2.44 per cent and growth in yield was estimated to be 1.58 per cent. Pulses recorded a growth rate in area of -2.51 per cent, in production it was -7.37 and for yield it was recorded to be 2.78 per cent. The overall instability index in case of rice was 16.06 per cent, for maize it was 11.68, wheat recorded instability index of 23.87 and for pulses instability index was found to be 24.80.

**Keywords:** Growth rate, elasticity, substitution & expansion effects and instability

### Introduction

Agriculture, one of the most successful sectors' of Indian national economy in terms of productivity growth, had more than compensated for the rapid growth in demand for the past few decades. India experienced a marked upward shift in long term growth from 50.16 per cent during 1964-65 to 85.2 per cent during 2005-06 (Bhalla and Singh, 2010) [2]. The growth in production of several crops has outpaced the demand, despite the fact that India's population has more than doubled during the past four decades (from 551 million in 1971 to 1186 million in 2010) and has resulted in increase in net export of food with trade surplus of but unfortunately, production and productivity growth is also accompanied by uneven growth across crops, regions and time periods. Thus, the seriousness of this issue calls for an in-depth examination of growth in agricultural production and productivity across various crops and other related aspects of agriculture (Narayanamoorthy, 2007; Chand et.al, 2011) [4, 3].

Agriculture, being the main occupation for the people of Jammu & Kashmir provides livelihood to about 80 per cent of the population of the state. 1955-56, the area under major crops of the state such as rice, maize and wheat was 0.19 mha, 0.20 mha and 0.15 mha respectively, and it increased by 22.44 per cent in rice, 20.68 per cent in maize and 25.33 per cent in wheat in 1968-69. There was further increase in the area of these crops till 1995-96 as the area under rice increased by 13.75, maize by 24.02 per cent and wheat by 29.68 per cent. After that there was decline in the area of rice by 8.41 per cent while as maize and wheat increased by 8.66 per cent and 15.23 per cent respectively, till 2004-05 when both the crops declined, maize by 2.32 per cent and wheat by 10.02 per cent. In year 2007-08 area under rice and wheat increased by 5.28 per cent and 10.09 per cent respectively, while as maize is still showing decline by 6.69 per cent. Forest area also showed an increase from 1955-56 when it was 0.56 mha to 1968-69 and reached 0.66 mha hectares but it decreased to 0.65 mha in 1980-81 after which it remained stagnant. The average yield of the principal crops of the Jammu division i.e. rice, wheat and maize is 1.912 tones/ha, 1.794.4209 tones/ha and 4.098 tones/ha, respectively (Anonymous, 2010) [1].

### Materials and Methods

The present investigation was carried out for a period of thirty years i.e 1981-82 to 2010-11. On the basis of secondary data published by various departments and government of India. The details of the data and analytical tools undertaken have been presented below:

### Analytical technique

Compound growth rate (regression-curve estimation) and Cuddy-Della Valle Index were used to measure growth and instability in cropping system for a period of thirty years (1981-82 to 2010-11).

### Estimation of Growth

In order to study the status of cropping pattern changes, the present study made use of time-series data on different variables like area, production and yield of major crops in Jammu region. For working out the growth rates of area, production and yield of major crops, the time period had been divided into four different phases as:

1. Period I (1981-82 to 1989-90)
2. Period II (1991-92 to 1999-00)
3. Period III (2001-02 to 2010-11) and
4. Overall Period (1981-82 to 2010-11)

In order to examine the trend of above mentioned variables compound growth rate was worked out as:

$$y_t = y_0(1+g)^t \text{ or } a(1+g)^t$$

$$y_t = ab^t \quad (\text{Where } b=1+g)$$

$$\text{Or } \log y = \log a + t \log b$$

$$\text{Then, Compound growth rate (r) = (Antilog } b-1) * 100$$

Where,

y = constant

a = initial value of y or constant

t = time (years)

b = estimated regression coefficient (parameter)

The compound growth rate was estimated with the help of computing package SPSS, 16.0. version. The growth rates were tested statistically for their significance through t- test as given below:

$$t = r/S.E. (r) \sim t_{\alpha, n-2}$$

$$S.E. = b \sqrt{[\{\sum (\log y)^2 - (\sum \log y/n) \cdot \log b\}^2 / \sum x_i^2] / 0.43429(n-\alpha)}$$

$$(\sum x_i^2) \times 100$$

### Measurement of Instability

Instability in yield was measured by Cuddy-Della index which is commonly used to measure the instability in time series data (Singh and Byerlee, 1990 and Deb *et al.*, 1999). Since the simple coefficient of variation over-estimates the level of instability in time-series data characterized by long term trends, the Cuddy-Della Valle index corrects the coefficient of variation as follows:

$$CDI = (CV) (1-R^2)^{1/2}$$

Where

CD is the Cuddy-Della Valle index of instability;

CV is coefficient of variation (C.V.\*) =  $\sigma/\mu \times 100$

R<sup>2</sup> is the coefficient of multiple determinants.

### Result and Discussion

#### Changes in land utilization pattern

Growth rate analysis (Table 1) of utilization pattern revealed that, there was slight change in reported area over the years. The area under desirable ecological sector declined continuously from year to year, indicating exploitation of natural resources by human interference. As far as undesirable ecological sector was concerned it showed a positive growth of 0.24 per cent, significant at 1 per cent level of significance over the entire period due to exploitation of resources. The area under agricultural sector increased over the periods with a growth rate of 0.03 per cent. The area under non-agricultural sector declined from 271 thousand hectares to 227 thousand hectares during period II while as it further increased to 231 thousand hectares during period III. The reason for growth in area under agricultural sector as well as non-agricultural sector may be due to rapid population growth as more and

more of land is required to meet food demand and also to develop infrastructure (roads, buildings) for growing population and for industrial development. The results from the table indicated that the growth in area under agricultural as well as non-agricultural sector was due to decline in area under desirable ecological sector signifying that our natural resources are at risk. A considerable growth was observed in net sown area, gross sown area and cropping intensity due to increase in area under agricultural sector.

#### Distribution of operational holdings

Table 2 indicates operational distribution of farm size and reveals that marginal farmers dominated the agrarian structure in Jammu region. The number of marginal holding increased continuously during the entire period with the growth rate of 2.23 per cent, highly significant at 1 per cent level. The increase in number of marginal holding might be the results of combined effect of institutional, technological and demographic factors. Among these factors (i) implementation of land reforms, particularly land ceiling caused land owning joint families to split into smaller unit holding to evade land ceiling acts and to take advantage of poverty alleviation programs. (ii) regarding land tenure structure, the proportion of landless tenures might have gone up (iii) the land market might have undergone changes through sale and purchase of land (iv) with agriculture becoming more remunerative consequent on the application of technology, there might have been wrong tendency for self-cultivation through renting small piece of land and the new technologies with its high profitability might have prompted to increase the number of holdings.

The rest of operational holding showed continuous decline which in case of small farmers had negative growth rate of -0.18 per cent significant at 10 per cent level of significance. The highest percentage decline was observed in case of semi-medium holding from 14.42 per cent during 1985-86 to 9.00 per cent during 2005-06. Same was the case with medium and large holding where continuous decrease was observed year after year.

#### Irrigation development in Jammu region

Jammu region has significantly benefitted from development of canals (Table 3) as more than 80 per cent of area was irrigated through canals. However, with the increase in minor irrigation sources, area irrigated through canals had marginally declined from 88.24 per cent to 84.16 per cent from 1981-82 to 2010-11, but still is the largest source of irrigation, the reason may be that in Jammu region there are large level plains of deep fertile soil that are drained by well distributed rivers which substantially is an important condition for canal irrigation. On the other hand minor irrigation had expanded which eventually leads to crop diversification, therefore, it is important to ensure more ground water and surface water schemes to increase minor irrigation, this could be achieved through active participation of individual and cooperative efforts of the farmers with the help of institutional finance. The irrigation intensity has been found decreased over a period of years, which may be attributed to the fact that the level of groundwater table had fallen down, which was the main source of irrigation in irrigated belt of Jammu. Therefore, more of the irrigation management programmes should be implemented to improve the performance and sustainability of irrigation systems in Jammu region.

### Growth in area, production and yield

Table 4 showed that in Jammu region indicated that rice, maize and wheat crop dominated the area and these crops together occupied more than 80 per cent of gross cropped area during last three decades. The main reason behind the growing of these crops is the subsistence nature of agriculture in the region and farmers grow those crops which are required for family consumption. The results from table revealed that during period I rice, bajra, maize, wheat, oilseeds and fodder crops experienced positive and significant growth rates while as barley, millets, pulses, fruits & vegetables and condiments & spices observed negatively significant growth rates. During period II, positively significant growth rates were observed in rice, maize, wheat, barley and condiments & spices whereas negatively significant growth rates were observed in case of bajra, pulses, fruits & vegetables, oilseeds and fodder crops. Similarly during period III, rice, bajra, wheat, barley, pulses, fruits & vegetables and condiments & spices had positive and significant growth rate, whereas maize, millets, oilseeds and fodder crops had negative growth rates. The overall period recorded positively significant growth in rice, maize, wheat, barley and condiments & spices while as bajra, millets, pulses, oilseeds and fodder crops observed negative growth rate. The cropping pattern of region is the reflection of the effects of varied physical and socio-economic factors, as such wheat is the dominant crop occupying over one third of the gross cropped area followed by maize and rice. The main factors responsible for significant growth in area under major crops include higher demand for these crops due consumption pattern of local people. Also the region as a whole has experienced increase in area under spices & condiments, which is a good indication for diversification of agriculture in the region. On the other hand, area under fruits & vegetables had decline that is the matter of concern which need to be taken care so as to increase commercialization of agriculture. However, it needs to be strengthening by providing technical know-how and financial aid to the small and marginal farmer of the region.

Likewise, the growth rates computed for production and yield of major crops in Jammu region (Table 5) indicated that during period I, production of rice, maize and wheat experienced significantly positive growth rates, while as pulses had negative growth rate. During period II except for pulses (6.22 per cent), all the other crops had negative growth rate of -0.07 per cent, -0.02 per cent and -4.46 per cent in case of rice, maize and wheat, respectively. The period III recorded positively significant growth rate in all four crops. As far as the overall period was concerned, growth trend in production for rice, wheat, maize and pulses were positively significant. An important facet of progress in agriculture is its success in eradication of critical dependence on imported food grains by increasing the production. However, increased outputs could be achieved chiefly by area enhancement and adopting strategy aimed at increasing food grains production by concentrating public sector efforts and resources in Jammu regions with a high potential for quick and substantial productivity gains through increased cropping intensity and average yields. The main elements of this strategy could be: (i) expansion of irrigation coverage, (ii) increased provision and utilization of key inputs like high yielding varieties (HYVs) of crops, mainly of wheat, maize and rice, chemical fertilizers and plant protection chemicals (iii) expansion and improvement of institutional support services such as research and extension and (iv) price policies favourable to producers.

The results further revealed that in case of yield period I observed positive growth rates for rice, maize and wheat whereas negative growth rate was experienced in case of pulses (-4.04 per cent). During period II, pulses recorded positively significant growth rate and rest of the crops viz. rice, maize and wheat recorded negative growth rate under period III except for wheat which observed negative growth rate, all other crops observed positively significant growth rates. However, overall period exhibited positively significant growth rate.

### Direction of growth

The direction of growth in area, production and yield presented in Table 6 revealed that area wise rice, bajra, maize, wheat, oilseeds and fodder were having positive growth and barley, millets, pulses, fruits & vegetables, condiments and spices were having negative growth during period I. For the same period production and of rice, maize and wheat was found to be positive while as that for pulses it was negative. During period II rice, wheat, barley, millet, condiments/spices and maize were having positive growth in area while as bajra, pulses, fruits/vegetables, fodder and oilseeds were having negative growth. In case of production and yield pulses were having positive growth where as rice, wheat and maize were having negative growth.

Similarly, during period III rice, bajra, maize, wheat, barley, pulses, fruits & vegetables and condiments & spices were had positive growth and millets, oilseeds and fodder had negative growth in area. Production wise all four crops viz. rice, wheat, maize and pulses had positive growth, where as yield is concerned it was positive for rice, maize and pulses and negative for wheat. The overall period found that rice, maize, wheat, condiments & spices, barley had positive area growth while as bajra, fodder, millets, pulses, fruits & vegetables and oilseeds had negative area growth as far as production and yield was concerned it was positive for all the crops. The slow growth rate in area, production and yield of major crops is a matter of concern and efforts are needed to step up crop productivity as there is no scope for area expansion. Therefore, production and productivity gains could be achieved by using modern agronomic practices based on available technologies which indeed require state government attention.

### Elasticity, Substitution and Expansion effect on cropping pattern changes

Changes in cropping pattern in terms of expansion and substitution effect were measured by elasticity of gross cropped area i.e. by comparing growth rate of individual crop with growth rate of gross cropped area. The results of elasticity (Table 7) revealed that during period I rice and maize had elasticity less than one and greater than zero, indicating that area under these crops changed slightly with change in gross cropped area, bajra, wheat, oilseeds and fodder crops observed elasticity greater than one revealing that these crops were highly elastic with change in gross cropped area, while as barley, millets, pulses, fruits & vegetables and condiments & spices had negative elasticity indicated that with change in gross cropped area, the area under these crops did not change. During period II, crops like maize, wheat, barley, millets and condiments & spices observed elasticity greater than one whereas rice observed elasticity less than one and crops like bajra, pulses, oilseeds and fodder had negative elasticity. As far as period III was concerned, rice, bajra, wheat, pulses, fruits & vegetables and

condiments & spices observed elasticity greater than one, barley observed elasticity between zero and one whereas rest of the crops viz. maize, millet, oilseed and fodder crops observed negative elasticity. The overall period observed elasticity greater than one for maize, wheat and condiments & spices indicated that these crops were replaced with other crops when necessary. Rice and barley had elasticity between zero and one which indicated that the change in gross cropped area had less effect on rice area the reason might be food consumption patter of local people. Bajra, millets, pulses, fruits & vegetables, oilseeds and fodder crops had negative elasticity the reason may be that many of these crops have commercial value while as farmers want to increase area under subsistence crops rather than commercial crops. Therefore, indicated that the farmers in Jammu region are commercially far behind to other places which is a prime concern. Hence, policies should be made that would help farmers to improve the capacity building with regard to advancement in agriculture, financial assistance through soft interest, marketing facilities with minimum involvement of intermediates so that they get maximum price and are motivated to grow more of the commercial crops.

Table 8 revealed that during period I, expansion effect was more dominating which contributed 77.57 per cent, where as substitution effect was only 22.43 per cent during the same period. However, during period II, the substitution effect increased while as expansion effect decreased but still expansion effect was higher than substitution effect. During period III substitution effect was extensively higher than expansion effect i.e. 94.68 per cent. Indicated that the area had expanded to its limit and now, there exists substitution effect, which ultimately leads to crop diversification. This might have a profound effect on the future agricultural development strategies as more of those crops could be produced which have commercial value and will increase the income of marginal and small farmers of Jammu region.

#### Instability in yield of major crops

Fluctuations in area, production and yield of major crops shown in Table 9 indicated that as far as period I and period II was concerned, the highest instability was found in pulses. During period III instability in area was found to be highest in maize and for overall period highest instability was also observed for maize. Instability in production during period I was highest in rice and wheat. During period II instability in rice and wheat production decreased but it was still highest for wheat as compared to other crops. Period III observed that production wise instability was highest in maize and wheat where as for overall period it was highest for pulses. Yield instability during period I was observed to be highest in case of pulses, during period II for maize, during period III for rice and for overall period it was highest in pulses. Variability in area and production are interrelated as wider area gives

greater production. But the results showed that instability in area was low compared to production therefore, it is necessary to pay attention towards the factors that will reduce variability in production like improved technologies, expansion of irrigated area, development of varieties resistant to pests and insects. Also attention is required for other variability stabilising measures such as crop insurance to face consequences of production fluctuations. Yield instability was found to be the major source of variability which increased in rice, maize and wheat and decreased in pulses indicated that pulse crop had developed resilience to absorb various shocks caused by climatic and other factors, while as major cereal crops like rice, maize and wheat are still under these shocks. Thus, sustainable variety in unfavourable weather should be provided to the farmer to meet the increasing demand. If we fail to provide climate resistant and high yielding variety to the farmers, the rate of import of food grains will go on increasing.

#### Sustainability indicator

Sustainability indicators (Table 10), showed that as far as productivity was concerned, rice, wheat and pulses had positive impact on sustainability while as maize had negative impact of sustainability. The decrease in growth rate could be improved by the use of new technologies, reforming economic policies and by providing knowledge to farmers regarding new and improved varieties. The instability in rice, maize and wheat increased with negative impact on sustainability while as that of pulses decreased with positive impact on sustainability. Increase in yield instability of cereals crops had negative impact on the sustainability of agricultural system, thus, varieties that could absorb shocks should be provided to farmers so that the agricultural system may be more stable. The share of marginal farmers increased over the years with negative impact on sustainability, which may be a threat, as fragmentation of land holding causes more pressure on production system. As far as environmental resources were concerned, the percentage area of desirable ecological sector decreased having negative impact on sustainability while as undesirable ecological sector and agricultural sector increased having negative impact on sustainability, indicated that the increase in area under these two sectors was due to decrease in area under desirable ecological sector. The area under desirable ecological sector could be increased by afforestation on wasteland, barren land, uncultivable land etc. The area under non-agricultural sector decreased having positive impact on sustainability and also net irrigated area increased having positive impact on sustainability. The results further indicated that most of the parameters of sustainability were having negative impact, indicated that agriculture system in Jammu region is moving towards un-sustainability which could be reversed only by detecting and treating its causes.

**Table 1:** Changes in land utilization pattern of Jammu region

Particulars	Area (000 ha)				Compound Growth Rate (per cent)			
	1981	1991	2001	2010	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	Overall
Reported area for land utilization	1794	1794	1794	1795	-	-	0.003*	0.001*
Desirable ecological sector	918 (51.24)	918 (51.24)	888 (49.50)	878 (49.19)	-	-0.00^	-0.34***	-0.07**
Undesirable ecological sector	165 (9.25)	165 (9.25)	231 (12.87)	217 (12.20)	-	0.30***	-0.34***	0.24*
Agriculture sector	437 (24.40)	437 (24.40)	451 (25.13)	459 (25.71)	-	0.12*	1.20*	0.03*

Non- agriculture sector	271 (15.11)	271 (15.11)	227 (12.50)	231 (12.90)	-	-0.37***	1.36***	0.51*
Net area sown	359	373	376	393	-	0.40**	1.30*	0.20***
Gross area	590	636	682	714	0.91*	0.54*	1.52*	0.67*
Cropping Intensity	164	177	175	182	0.91	0.16***	2.84**	0.44*

Note: Figures in parentheses indicates percentage of respective column.

a) Desirable ecological sector includes: forest, permanent pasture and other grazing lands, land under miscellaneous trees and culturable waste.

b) Undesirable ecological sector includes: barren and uncultivable land, marshy and water logged land and land under still water.

c) Agricultural sector includes net area sown, current fallow and other fallow.

d) Non- agricultural sector includes area under roads, buildings.

\* significant at 1% los, \*\* significant at 5% los and \*\*\* Significant at 10% los.

^ Figures have values of less than 0.001

Source: *Statistical Digest*, Directorate of Economics and Statistics, Government of J&K.

**Table 2:** Distribution of operational holdings by farm size in Jammu region

Particulars	Lakh numbers			Compound Growth Rate (per cent)		
	1985	1995	2005	1985-86 to 1994-95	1995-96 to 2005-06	overall
Marginal (< 1ha)	2.898 (58.63)	3.942 (66.94)	4.314 (71.03)	2.96	0.000^	2.23**
Small (1.0- 2.0 ha)	1.126 (22.78)	1.136 (19.28)	1.086 (17.88)	0.12	0.000^	-0.18
Semi-medium (2.0- 4.0 ha)	0.713 (14.42)	0.651 (11.06)	0.546 (9.00)	-0.81	-0.001**	-1.47**
Medium (4.0-10.0 ha)	0.196 (3.97)	0.152 (2.59)	0.121 (2.00)	-2.53**	-0.001*	-2.69*
Large (> 10 ha)	0.010 (0.20)	0.007 (0.13)	0.005 (0.09)	-2.65	0.000^	-3.64**
Total	4.944 (100.00)	5.889 (100.00)	6.074 (100.00)	1.69	0.000^	1.17**

Note: Figures in parentheses indicates percentage share of total holding.

\* significant at 1% los \*\* significant at 5% los and \*\*\* significant at 10% los.

^ Figures have values of less than 0.001

Source: *Agriculture census, Statistical digest*, Directorate of Economics and Statistics, Government of J&K.

**Table 3:** Irrigation development in Jammu region

Year	Area (000 ha)				Compound Growth Rate (per cent)			
	1981	1991	2001	2010	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	Overall
Canal	75.00 (88.24)	82.86 (89.45)	83.14 (85.25)	90.20 (84.16)	1.03*	0.30	-0.06	0.19**
Tank	0.00 (0.00)	0.03 (0.03)	0.00 (0.00)	2.36 (2.20)	-	-	0.55*	0.21
Wells	2.00 (2.35)	0.54 (0.58)	0.46 (0.47)	6.60 (6.16)	-16.14*	-4.41	38.13**	-2.83
Other sources	8.00 (9.41)	9.20 (9.93)	13.93 (14.28)	8.01 (7.48)	5.96**	1.39***	18.54*	-3.31**
Net irrigated area	85.00 (100.00)	92.63 (100.00)	97.53 (100.00)	107.17 (100.00)	1.38**	0.12	0.00^	-3.16
Gross irrigated area	391.00	166.00	171.00	198.00	-8.25**	-0.06	1.26	0.47*
Percentage net irrigated area	23.68	25.80	25.01	27.26	1.38**	-0.26	1.30	0.21
Percentage gross irrigated area	66.27	26.09	25.09	29.55	-9.16**	-0.60	-0.30	-1.30
Irrigation intensity	460.00	179.21	175.33	184.75	-9.63**	-0.18	1.30**	-1.20**

Note: Figures in parentheses indicates percentage.

\* significant at 1% los \*\* significant at 5% los and \*\*\* significant at 10% los.

^ Figures have values of less than 0.001

Source: *Statistical Digest*, Directorate of Economics and Statistics, Government of J&K

**Table 4:** Area under different crops in Jammu region

Crop	Area (000ha)				Compound Growth Rate (per cent)			
	1981	1991	2001	2010	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	overall
Rice	105.23 (17.69)	108.85 (16.85)	107.78 (15.81)	112.04 (16.26)	0.35*	0.28**	1.04*	0.24*
Bajra	17.01 (2.86)	19.51 (3.02)	13.34 (1.96)	16.28 (2.36)	1.29*	-3.65	2.67*	-0.65
Maize	171.87 (28.89)	181.11 (28.04)	215.38 (31.60)	213.89 (31.03)	0.58*	1.71*	-0.15*	1.02*
Wheat	205.2 (34.49)	238.76 (36.97)	275.26 (40.38)	286.2 (41.52)	1.73*	0.74**	1.76*	0.85*

Barley	10.54 (1.77)	8.6 (1.33)	8.77 (1.29)	9.01 (1.31)	-2.48*	3.57*	0.10**	0.17*
Millet	7.01 (1.18)	4.54 (0.70)	4.31 (0.63)	2.64 (0.38)	-5.03*	2.75***	-10.32***	-2.11**
Total cereals	516.86 (86.87)	561.37 (86.92)	624.84 (91.67)	640.06 (92.86)	0.92*	0.97**	0.79**	0.74*
Total pulses	35.66 (5.99)	26.98 (4.18)	15.75 (2.31)	18.63 (2.70)	-3.34*	-4.52**	1.54*	-2.51*
Fruits & Vegetables	4.87 (0.82)	3.54 (0.55)	2.43 (0.36)	3.63 (0.53)	-2.91*	-2.21*	2.14**	-1.71*
Condiments & Spices	1.13 (0.19)	0.84 (0.13)	0.88 (0.13)	1.5 (0.22)	-2.22*	0.61*	1.61***	1.81*
Total food crops	558.52 (93.87)	592.73 (91.78)	643.9 (94.46)	663.82 (96.31)	0.65*	0.75***	0.82*	0.59*
Total oilseeds	20.02 (3.36)	25.23 (3.91)	16.9 (2.48)	14.95 (2.17)	2.99*	-2.45*	-3.24	-1.28*
Fodder crops	16.43 (2.76)	27.88 (4.32)	20.83 (3.06)	10.47 (1.52)	5.91*	-1.17	-6.19	-0.25***
Gross area	594.97 (100.00)	645.84 (100.00)	681.63 (100.00)	689.24 (100.00)	0.92*	0.58	0.57**	0.52*

Note: Figures in parentheses indicates percentage of gross cropped area.

\* significant at 1% los, \*\* significant at 5% los and \*\*\* Significant at 10% los.

Source: *Statistical Digest*, Directorate of Economics and Statistics, Government of J&K

**Table 5:** Production and yield of major crops in Jammu region

Crops		Year				Compound Growth Rate (per cent)			Overall
		1981	1991	2001	2010	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	
Rice	Production	1239	1713	1875	1912	4.08*	-0.07*	3.00*	1.61*
	Yield	11.77	15.74	17.40	17.07	3.73*	-0.34**	1.80**	1.32*
Maize	Production	2885	3931	4238	4098	4.29*	-0.02***	0.31**	0.75*
	Yield	16.79	21.71	19.68	21.05	3.71*	-1.95***	0.93*	-0.19
Wheat	Production	1976	4543	1435	4420	8.12*	-4.46***	0.28*	2.44*
	Yield	9.63	19.03	15.21	15.44	6.40*	-5.12	-1.52	1.58**
Pulses	Production	112	51	69	108	-7.37*	6.22*	5.72*	0.34
	Yield	3.14	1.89	4.38	5.80	-4.04***	11.07*	4.07**	2.78*

Note: \* significant at 1% los \*\* significant at 5% los and \*\*\* significant at 10% los.

**Table 6:** Direction of growth in area, production and yield of major crops in Jammu region

Particular	Direction	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	Overall
Area	Positive	Rice*, Bajra*, Maize*, Wheat*, Oilseeds*, Fodder*	Rice**, Wheat**, Barley*, Millet*, Condiments and Spices**, Maize*	Rice*, Bajra*, Wheat*, Barley**, Pulses*, Fruits and Vegetables***, Condiments and Spices***	Rice*, Maize*, Wheat*, Condiments & Spices*, Barley***
	Negative	Barley*, Millets*, Pulses*, Fruits and Vegetables*, Condiments and Spices*	Bajra, Pulses**, Oilseeds*, Fruits and vegetables***, Fodder	Maize**, Millets, Oilseeds, Fodder	Bajra, Fodder**, Millets**, Pulses*, Fruits and Vegetables*, Oilseeds*,
Production	Positive	Rice*, Maize*, Wheat*	Pulses**	Rice*, Maize**, Wheat*, Pulses*	Rice*, Maize*, Wheat*, Pulses**
	Negative	Pulses*	Rice, Maize**, Wheat		
Yield	Positive	Rice*, Maize*, Wheat*	Pulses*	Rice**, Maize*, Pulses**	Rice*, Wheat**, Pulses*
	Negative	Pulses***	Rice**, Maize***, Wheat	Wheat	Maize***

Note: \* significant at 1% los \*\* significant at 5% los and \*\*\* significant at 10% los.

**Table 7:** Elasticity of gross cropped area in different periods for various crops in Jammu region

Crop	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	overall
Rice	0.39	0.48	1.82	0.46
Bajra	1.40	-6.34	4.68	-1.25
Maize	0.63	2.97	-0.26	1.96
Wheat	1.88	1.28	3.09	1.63
Barley	-2.70	6.19	0.18	0.33
Millet	-5.47	4.78	-18.11	-4.06
Total cereals	1.00	1.68	1.39	1.42
Total pulses	-3.63	-7.84	2.70	-4.83
Fruits & Vegetables	-3.17	-3.83	3.75	-3.29
Condiments & Spices	-2.42	1.06	2.82	3.48
Total food crops	0.71	1.31	1.44	1.13
Total oilseeds	3.25	-4.25	-5.68	-2.46
Fodder crops	6.43	-2.03	-10.86	-0.48
Gross cropped area	1.00	1.00	1.00	1.00

**Table 8:** Substitution and expansion effect of cropping pattern changes in Jammu region ('000 ha)

Year	1981-82 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	overall
Substitution Effect	14.71 (22.43)	37.48 (54.53)	38.97 (94.68)	35.93 (32.37)
Expansion Effect	50.87 (77.57)	31.25 (45.47)	2.19 (5.32)	75.08 (67.63)
Total Effect	65.58 (100.00)	68.73 (100.00)	41.16 (100.00)	111.01 (100.00)

Note: Figures in parentheses indicates percentage of total in respective column.

**Table 9:** Instability index of major crops in Jammu region

Crop/Period	Area (%)	Production (%)	Yield (%)
<b>Rice</b>			
1981-82 to 1990-91	0.00 <sup>^</sup>	0.11	3.64
1991-92 to 2000-01	0.00 <sup>^</sup>	0.06	10.80
2001-02 to 2010-11	0.01	0.01	24.07
Overall	1.02	0.23	16.06
<b>Maize</b>			
1981-82 to 1990-91	0.00 <sup>^</sup>	0.08	6.50
1991-92 to 2000-01	0.01	0.06	8.48
2001-02 to 2010-11	0.14	0.02	11.42
Overall	1.04	0.33	11.68
<b>Wheat</b>			
1981-82 to 1990-91	0.01	0.11	12.06
1991-92 to 2000-01	0.01	0.07	24.29
2001-02 to 2010-11	0.01	0.02	17.27
Overall	1.00	0.29	23.87
<b>Pulses</b>			
1981-82 to 1990-91	0.03	0.01	14.75
1991-92 to 2000-01	0.05	0.01	17.55
2001-02 to 2010-11	0.01	0.00 <sup>^</sup>	12.70
Overall	0.98	0.45	24.80

Note: <sup>^</sup> Figures have values of less than 0.001

**Table 10:** Sustainability indicator of cropping pattern in Jammu region, 1981-82 to 2010-11

Indicator	Period I	Period II	Period III	Trend	Impact on sustainability
<b>Productivity</b>					
Rice (q/ha)	13.37	15.86	17.51	Increasing	Positive
Maize (q/ha)	20.24	20.74	18.95	Decreasing	Negative
Wheat (q/ha)	11.65	15.34	16.53	Increasing	Positive
Pulse (q/ha)	3.02	3.37	5.13	Increasing	Positive
CGR of rice	3.73	-0.34	1.80	Decreasing	Negative
CGR of maize	3.71	-1.95	0.93	Decreasing	Negative
CGR of wheat	6.40	-5.12	-1.52	Decreasing	Negative
CGR of pulse	4.04	1.07	4.07	Increasing	Positive
<b>Instability in yield (%)</b>					
Rice	3.64	10.80	24.07	Increasing	Negative
Maize	6.50	8.48	11.42	Increasing	Negative
Wheat	12.06	24.29	17.27	Increasing	Negative
Pulse	14.75	17.55	12.70	Decreasing	Positive
<b>Equity (%)</b>					
Share of marginal and small farmers in total holding	81.40	86.22	88.92	Increasing	Negative
<b>Environmental Resources (%)</b>					
Desirable ecological sector	51.17	49.50	48.92	Decreasing	Negative
Undesirable ecological sector	9.20	12.88	12.11	Increasing	Negative
Agriculture sector	24.36	25.14	25.43	Increasing	Negative
Non-agriculture sector	15.11	12.90	12.90	Decreasing	Positive
Net irrigated area	25.45	26.29	26.48	Increasing	Positive

### Conclusion and Policy Implication

This paper has worked with district-level data to describe and analyze the changes in cropping patterns in Jammu region of J&K state. It was found that growth rates in terms of area were positive for rice, maize, wheat, condiments & spice and barley, while as negative for bajra, fodder, millets, pulses, fruits & vegetables and oilseeds. Production was recorded to be positive for all major crops. Whereas yield was positive for rice, wheat and maize and negative for pulses during overall

period. Expansion effect was recorded to be greater than substitution effect for overall period.

In the light of the findings of this research the following policy recommendation are suggested:

- Policy related to technological advancement, improved varieties, extension services, fertilizer distribution, HYV seeds and production management research and increase in area irrigated may increase the productivity of food grain in Jammu region.

- b) Producer's react to price changes, as a result most of the producers increase their acreage under particular crop on the basis of its price in previous year. Therefore, price stabilization through market intervention can be effective for increasing food grain production.
1. Future works should quantify parametrically, the determinants of the productivity growth in the crops.

#### **References**

1. Anonymous. Digest of statistics, Directorate of Economics and Statistics, Govt. of Jammu and Kashmir, 2010.
2. Bhalla GS, Singh G. Final Report on Planning Commission Project Growth of Indian Agriculture: A District Level Study. Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, 2010.
3. Chand R, Kumar P, Kumar S. Total Factor Productivity and Contribution of Research Investment to Agricultural Growth in India. NCAP, Policy ICAR, NCAP, New Delhi, 2011, 25.
4. Narayanamoorthy A. Deceleration in agricultural growth: Technology or policy fatigue. Economic and Political Weekly. 2007; 42(25):2375-79.