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Research Paper

Growth and Decomposition Analysis of Food Grain Crops in India: Some Evidences from Himalayan Mountainous States

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ABSTRACT: *Agriculture's growth history in the Himalayan Mountainous States has received a lot of attention, and the Himalayan Mountainous States are typically classified separately from other Indian states. So, this research is essential for Indian state agriculture in order to understand the history and growth patterns of Himalayan Mountain states. Along with, it is important to investigate the key elements of the mountain regions for quick expansion of Food Grain Crops. In this research study, the time series data on area, production and yield of food grain crops were collected from various issues of Agricultural statistics at a glance and RBI. The data pertained to the period 1991-92 to 2016-17 i.e., 27 years. In order to find out the elements, this research employed a decomposition and compound annual growth analysis with reference to the food grain crop area, production, and yield. We have used secondary data source for to compile this study, which included all Himalayan Mountainous states. The decomposition research indicated that the major sources of agricultural production growth (rice, wheat, coarse cereals, and total food grains) rose in yield from 1991-92 to 2016-17. With the exception of wheat, average growth rates in rice, coarse cereals, pulses, and total food grain were all positive from 1991-92 to 2016-17, according to the research. Except for Arunachal Pradesh, Jammu and Kashmir, Meghalaya, and Nagaland, food grain yield growth rates in five states (Assam, Himachal Pradesh, Mizoram, Sikkim, and Tripura) improved from 1991-92/1999-00 to 2010-11/2016-17. In most Himalayan Mountainous States, the yield impact dominated rice, coarse cereals, pulses, and total food grain output; however, area and interaction impacts were small in certain mountainous states. This indicates that among a variety of crops with considerable yield differences, the majority of states have seen an increase in output.*

KEYWORDS: *Growth, Production, Productivity, Food Grain Crops, Decomposition and Mountainous States.*

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I. INTRODUCTION

Agriculture is the most important sector to play crucial role in the development of economies. It provides food security to the nation, expanding export, contribution to the capital formation and also helps to improve the economic growth with development. Agriculture is the basis of India's country because the availability of food grain is only through agriculture. Without food Grain, India cannot provide food security to its population. Therefore, agriculture is very important for the country of India. Many researchers come across that agriculture growth output is quantitatively important in elucidating growth in GDP per worker. It is a sector that still plays its role in the Gross Domestic Product shares. However, the share of GDP in agriculture sector has declined as estimated by the CSO. In 1950-51, the agriculture share was 55.1 and then declined to 17.4 percent during 2013-2014. As accounted by the CSO, this sector provides occupation directly or indirectly to 58.2 percent of the total population in India.

Presently, it still holds more importance for industries, providing raw material for industries and secure markets for industrialization. Thus, growth of the industrial sector, mainly depends on agriculture. However, researchers showed that without agriculture productivity, a traditional economy cannot overcome the fixed supply of natural resources and thus, cannot generate sustained economic growth.

After independence, Sources of agriculture growth have transformed over time; however, green revolution lifted up the growth rates of production and productivity of food grains due to new technology, high yielding varieties and increased facilities of irrigation. Technological change decelerated growth rates in 1960

from the level attained in the 1950's (Narain, Dharm, 1977). In 1970, structural transformation has seen in agriculture. However, agriculture is the engine of growth in the new settled countries of development because a high share of agriculture in economic activity and strong growth linkages with the rest of the economy. Structural transformation has been confirmed in Asian countries during the green revolution and spread rapidly throughout the regions during 1960 to 1980; especially in heavily populated and irrigated areas (Datt and Ravallion, 2002; Ravallion and Chen, 2004).

According to CSO estimation, the India's food grain production has improved from 52 to 272 million tonnes during 1951-52 to 2016-17. The production of food grain crops, namely, wheat, rice and pulses also improved in the same period. Rani *et al.* (2010) exposed that Andhra Pradesh, Karnataka, Tamil Nadu, Punjab and Haryana have largely irrigated rice and productivity on average of these states is 3.136 tonnes per hectare during 2009-10. However, Uttar Pradesh, Bihar, West Bengal, Orissa and Assam showed a mostly rain-fed system and recorded an average productivity of 1.658 tonnes per hectare during 2010. Laitonjam, N. et al (2018) examined across the states and showed the yield effect in rice production is highest in Bihar (159.98%) in sub-period I, although in sub-period II, the highest contribution in Assam (1361.83 %). The area effect was highest in Haryana (94.59%) and Punjab (1178.08%) during the sub-period I and sub-period II.

Sharma (2013) estimated positive trends in production and yield of food grains in north eastern states during 1980-81 to 2011-12. This study also showed that change in the production due to increased in the area as well as the combined effect of area and yield with interaction. Singh, Das, Roy and Tripathy (2015) examined the trend in area, production and yield with decomposition of production of growth of oil seed in the northeast states of India during 1982-83 to 2011-12. The study showed that more than half of the oilseed cultivation area suffered lower growth in production. However, Arunachal Pradesh and Nagaland estimated better growth performance in area and yield compared to the other northeast states. During this period, decomposition on yield effect was a major source of output growth.

Kumar and Prashar (2012) showed that negative trend in the area and positive trend in production in the state of Himachal Pradesh except barley and gram under all food grain during 1988-89 to 2004-05. Kumar et al (2009) examined production status, growth pattern and trend of area, yield and interaction effect in India during 1970-71 to 2006-07. The study exposed that rise in area (0.93 percent) and production (3.32 percent); production alteration due to changes in the area under the crops; however, lesser effect of the yield and interaction with the production. Kumar et al (2009) analyzed the time series data on lentil crop during 1970-71 to 2006-07. It showed that growth in area (0.934%) and production (3.32%) and change in the total production of lentil was completely due to the change in area; however, yield and interaction effects were small under this crop. Ruchi (2017) examined food grain production in India and found that total food grain production of wheat and rice improved, however decline the coarse and pulses due to shift of area towards high yielding crops during 1951-52 to 2013-14.

Decomposition of agricultural growth, productivity has remained of active interest to policy maker and researchers. Diminishing of growth in productivity, cropping pattern and area and so on; helps productivity projection with different targets and policies (Jamal and Zaman, 1992). Therefore, decomposition of agricultural growth and productivity is greater importance for estimation of its growth rates and behavior of agricultural productivity in the previous decades can provide a basis for future projection of agriculture productivity (Lakshmi and Pal, 1988). With this backdrop, the present study is to assess the contribution of area, yield and their interaction to growth in production of different food grain crops and to work out the compound annual growth rate in area, production and yield of food grain crops.

There are, however, very few studies that have analyzed the growth and decomposition of food grain in mountainous states, none of which belong to a special category states. The performance of these states in terms of growth, decomposition and also in terms of the performance of different periods, and so on have not been examined adequately in the available literature.

So, this study is trying to examine the numerous dimensions of food grain crops by studying the growth, decomposition, area, production, and productivity in the mountainous states and all India level. It further proposes to understand the area, yield and interaction effects of different food grain crops and periods in the mountainous states. The study also aims at examining whether the high level of growth rates of food grain crops transforms into gainful of food security in the mountainous states and to suggest the policy measures that need to be taken to accelerate the rate of growth of food grain crops..

II. RESEARCH METHODOLOGY

The time series data on area, production and yield of food grain crops were collected from various issues of Agricultural statistics at a glance and RBI. The data pertained to the period 1991-92 to 2016-17 *i.e.,* 27 years. The source of production growth was examined by using the decomposition model proposed by Sharma and Subramanyam (1984) redeveloped the model and several research workers (Kalamkar, 2003) used this model and studied growth performance of food grain crops in mountainous states and All India level. This

method state that if A_0, P_0 and Y_0 respectively area, production and productivity in the base year and A, P and Y are the values of the respective variable in not year item.

P0 = A0 x Y0 and Pn = An x Yn; Where A0 and An represent the area and Y0 and Yn represents the yield in the base year and n^{th} year respectively. P = A0 (Yn - Y0) + Y0 (An - A0) + ΔA ΔY

Pn - P0 = ΔP, An - A0 = ΔA, Yn – Y0 = ΔY

P0 + ΔP = (A0 + ΔA) (Y0 + ΔY)

Hence P = A0 ΔY x 100/ΔP + Y0 ΔA x 100/ΔP + ΔYΔA x 100/ΔP

Production effect = Yield effect + area effect + interaction effect

Compound Annual Growth Rate

CAGR is a short form for compound annual growth rate; it is a rate at which prearranged present value would need to earn in order to "grow" to a given future value in a certain amount of time with continuous time. The term of the growth rate is $gy = \frac{\hat{Y}}{Y} = \frac{d \log Y}{dt}$, in which $Y_t = Y_0 \exp(gy.t)$, $\log Y_t = \log Y_0 + gy.t.$ In the above, the growth rate gy is the *instantaneous* growth rate. It is used from practices of data: $\log Y_t = \log Y_0 + gy.t$

$$gy.t = \log Y_t - \log Y_0$$

$$gy = \frac{1}{t}(\log Y_t - \log_0),$$

Where t is the number of years, Y_0 is the base year and Y_t the final year level. The growth is multiplied by 100 to obtain the percentage growth rate. It is referred to as the "log difference" method of calculating the growth rate. The annual percentage growth some time is described as compound annual growth rate, $(\exp gy - 1)$ expressed as a percentage as mentioned above.

$$AGR = (\exp gy - 1).100$$

$$= \left[\exp\left(\frac{1}{t}(\log Y_t - \log Y_0) \right) - 1 \right].100.$$

We consider growth for one year; the familiar proportional rate of growth is G (multiplied by 100)

III. RESULT AND DISCUSSION

3.1 Decomposition of Growth in Production of Principal Crops in India

The study of growth an area, production and yield of food grain crops showed the general pattern of growth and direction of changes in area and yield. However, this does not evaluate the contribution of area and yield to the production growth. The growth in production of food grain was therefore allocated to the various sources of breaking the change in production into three effects, i.e, area effect, yield effect and interaction effect. The relative share of area, yield and their interaction to change in production of food grain crops is presented in table 1.

The decomposition of growth of food grain over the period under study in India exposed that growth in production of rice, coarse cereals, pulses, total cereals and total food grains was mainly on account of change in yield during 1950-51 to 2018-19. Almost 60 to 80 percent growth in principal crop and food grain output was due to yield an effect. The results presented in table 1 show that the values of the yield effect on total food grain are higher in the various periods. It indicated that the growth in total food grain production was mainly due to yield an effect. During the 1950-51 to 2018-19, the growth in production of rice, wheat, coarse cereals, total cereals, pulses and total food grains were depended on the yield effect.

During 1950-51/1959-60, 1959-60/1969-70, 1969-70/1979-80, 1979-80/1989-90, 1989-90/1999-00, 1999-2000/2009-10 and 2009-10/2018-19, the value of yield effect was highest in the growth of rice production. However, area and interaction effects were lower as compared to the yield effect in various periods as mentioned above. Area effect was highest in wheat production during the periods of 1950-51/1959-60, and 1969-70/1979-80. Yield effect was highest in coarse cereal crop production during all periods except 1989-90/1999-2000. However, in the pulses, the area effect was highest during the three periods (1950-51/1959-60, 1959-60/1969-70 and 1999-2000/2009-10.

This table also represented that the yield effect was highest in the decomposition of growth in production of principle crops; namely, rice, wheat, coarse cereals, pulses and total food grains in India during

1950-51/2018-19. The above discussion indicated that overall food grain production and some principles crops depended on the yield effect; however, lower the area and interaction effect.

3.2 Growth Rates of Food Grain Crops Area of Himalayan Mountainous states and All India

The growth performance of the food grain crop area is essential to identify the leading states and also those lagging behind. Such an analysis is essential to devise state specific policy to accelerate the rate of growth in the food grain crop area. In this section, we have taken four periods (1991-92/1999-00, 2000-01/2009-10, 2010-11/2016-17 and 1991-92/2016-17) and eleven states, namely Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Uttarakhand with all India level.

Table 2 presents the growth rates of food grain crop area across mountainous states and the all India level. At the all India level, the growth rates of rice and wheat crop area decreased from 0.68 percent per annum to -0.02 percent per annum that was negative and from 1.72 percent per annum to 1.20 percent per annum during 1991-92/1999-00 to 2000-01/2009-10. After that the rice crop area increased; however the wheat crop area was declined during 2000-01/2009-10 to 2010-11/2016-17. During 1991-92/2016-17, the growth rates of rice and the wheat crop area was estimated 0.08 percent per annum and 0.95 percent per annum.

In case of coarse cereals, the growth rates of the area were negative in various periods; however, in the case of pulses area, the negative growth rate was estimated as -6.49 percent per annum at all India level during 1991-92/1999-00. After that the growth rates of pulses area at all India level was continuously increased from 1.16 percent per annum to 1.35 percent per annum during 2000-01/2009-10 to 2010-11/2016-17. The growth rate of the food grain crop area at all India level was negative as -1.42 percent per annum during 1991-92/1999-00 and then increased to 0.29 percent per annum during 2000-01/2009-10, after that they declined but positive to 0.23 percent per annum during 2010-11/2016-17. The overall growth rate of the food grain crop area was negative as -0.31 percent per annum during 1991-92/2016-17. It indicated that the total food grain crop area was negative; however, positive in the rice and wheat during the same period.

In the case of Rice crop area in the mountainous states, the highest growth rate was observed in Nagaland (1.66 percent per annum) followed by Mizoram (1.09), Manipur (0.35), Meghalaya (0.17) and Assam (0.10) during 1991-92/1999-00. However, five states, Namely, Arunachal Pradesh (-0.12), Himachal Pradesh (-0.23), Jammu & Kashmir (-0.46), Sikkim (-1.21) and Tripura (-0.78) registered as negative growth rates of rice production areas. During 2000-01/2009-10, the four states (Arunachal Pradesh, Jammu & Kashmir, Manipur and Nagaland) registered positive growth rates of rice production area; however, other states, namely, Assam, Himachal Pradesh, Meghalaya, Mizoram, Sikkim, Tripura and Uttarakhand experienced negative growth rates during the same period.

During 2010-11/2016-17, the state of Manipur recorded higher growth rates in rice production area followed by Nagaland, Mizoram, Jammu & Kashmir, Arunachal Pradesh, Tripura and Meghalaya. During the overall period (1991-92/2016-17), the positive growth rates of rice production area were experienced in the states, namely, Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland and Tripura. However, Nagaland recorded highest growth rates in rice production area as 1.75 percent per annum. Seven states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland and Tripura) registered as an increase in the growth rates in rice production area during 1991-92/1999-00 to 2010-11/2016-17.

In the case of wheat production crop area in the mountainous states, the highest growth rate was observed in Nagaland (35.45 percent per annum) followed by Assam (0.78) during 1991-92/1999-00. However, six states, Namely, Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Sikkim and Tripura registered as negative growth rates of wheat production areas. During 2000-01/2009-10, the two states (Jammu & Kashmir and Uttarakhand) registered positive growth rates for wheat production area; however, other states experienced negative growth rates during the same period. During 2010-11/2016-17, the state of Meghalaya recorded higher growth rates in wheat production area followed by Arunachal Pradesh, Manipur and Nagaland. During the overall period (1991-92/2016-17), the positive growth rates of the wheat production area were experienced in the states, namely, Jammu & Kashmir, Manipur and Nagaland. However, Nagaland recorded highest growth rates in wheat production area as 7.60 percent per annum. Three states (Arunachal Pradesh, Jammu & Kashmir and Meghalaya) registered as an increase in the growth rates for wheat production area during 1991-92/1999-00 to 2010-11/2016-17.

In the case of Coarse Cereals production crop area in the mountainous states, the highest growth rate was observed in Nagaland (2.11 percent per annum) followed by Mizoram (0.63), Assam (0.55), Manipur (0.41) and Jammu & Kashmir (0.40) during 1991-92/1999-00. However, five states, Namely, Arunachal Pradesh, Himachal Pradesh, Meghalaya, Sikkim and Tripura registered as negative growth rates of Coarse Cereals production areas. During 2000-01/2009-10, the six states (Arunachal Pradesh, Jammu & Kashmir, Mizoram, Nagaland, Sikkim and Tripura) registered positive growth rates of Coarse Cereals production area; however, other states experienced negative growth rates during the same period. During 2010-11/2016-17, the state of

Tripura recorded higher growth rates of Coarse Cereals production area followed by Assam, Manipur, Meghalaya and Nagaland. During the overall period (1991-92/2016-17), the positive growth rates of Coarse Cereals production area were experienced in the states, namely, Arunachal Pradesh, Assam, Jammu & Kashmir, Manipur, Nagaland, Sikkim and Tripura. However, Manipur recorded highest growth rates of Coarse Cereals production area as 8.39 percent per annum. Five states (Assam, Himachal Pradesh, Manipur, Meghalaya and Tripura) registered as an increase in the growth rates of Coarse Cereals production area during 1991-92/1999-00 to 2010-11/2016-17.

In the case of Pulses production crop area in the mountainous states, the highest growth rate was observed in Meghalaya (5.14 percent per annum) followed by Nagaland (4.84), Mizoram (1.60) and Arunachal Pradesh (1.06) during 1991-92/1999-00. However, five states, Namely, Assam, Himachal Pradesh, Jammu & Kashmir, Sikkim and Tripura registered as negative growth rates of Pulses production areas during the same period. During 2000-01/2009-10, the seven states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Mizoram, Nagaland, Sikkim and Uttarakhand) registered positive growth rates of the area; however, other states experienced negative growth rates during the same period. During 2010-11/2016-17, the state of Tripura recorded higher growth rates in the Pulses production area followed by Meghalaya, Arunachal Pradesh, Assam, Manipur, Nagaland and Uttarakhand. During the overall period (1991-92/2016-17), the positive growth rates of the Pulses production area were experienced in the states, namely, Arunachal Pradesh, Manipur, Meghalaya, Nagaland and Uttarakhand. However, Manipur recorded highest growth rates in the Pulses production area as 14.66 percent per annum. Seven states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Sikkim and Tripura) registered as an increase in the growth rates in the Pulses production area during 1991-92/1999-00 to 2010-11/2016-17.

In the case of total Foodgrains area in the mountainous states, the highest growth rate was observed in Nagaland (2.19 percent per annum) followed by Mizoram,Meghalaya and Manipur during 1991-92/1999-00. However, other states registered negative growth rates of total food grain areas during the same period. During 2000-01/2009-10, the six states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Nagaland, Sikkim and Uttarakhand) registered positive growth rates in the area. During 2010-11/2016-17, the state of Manipur recorded higher growth rates in the total food grain production area followed by Tripura, Nagaland, Meghalaya and Arunachal Pradesh. During the overall period (1991-92/2016-17), the positive growth rates of the total food grain production area were experienced in the states, namely, Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland and Tripura. However, Nagaland recorded highest growth rates in the total food grain area as 2.61 percent per annum. Nine states registered as an increase in the growth rates of the total food grain area except the Himachal Pradesh and Uttarakhand during 1991-92/1999-00 to 2010-11/2016-17.

3.3 Growth Rates of Food Grain Crops Production of Himalayan Mountainous States and All India

Table 3 shows the growth rates of food grain production across mountainous states and the all India level. At the all India level, the growth rates of rice (1.47), wheat (2.04), coarse cereals (1.51), pulses (0.23) and total food grain (1.56) crop production were positive during 1991-92 to 2016-17.

During 1991-92/1999-00, the highest growth rates were observed in Mizoram (4.80) for rice, Nagaland (33.72) for wheat and Coarse Cereals (4.77), Meghalaya (5.44) for pulses and Mizoram (4.12) for total food grain production. During 2000-01/2009-10, the seven states, namely, Arunachal Pradesh (3.61), Jammu & Kashmir (3.39), Meghalaya (1.10), Nagaland (2.76), Sikkim (0.84), Tripura (1.95) and Uttarakhand (0.25) registered positive growth rates of rice production; however other states experienced negative growth rates during the same period. In case of wheat, Jammu & Kashmir observed positive growth rates (5.99 percent per annum) and followed by Uttarakhand and Himachal Pradesh during the same period. In case of coarse cereals, the highest growth experienced by Nagaland (4.50) and low growth rate observed by Mizoram during the same period. In case of pluses, the state of Manipur recorded higher growth rate (12.21) followed by Sikkim, Uttarakhand, Himachal Pardesh, Nagaland, Arunachal Pradesh, Mizoram, Jammu & Kashmir, Meghalaya and Assam during 2000-01/2009-10. During the same period, the highest growth of total food grain production observed by Nagaland (2.86) followed by Arunachal Pradesh, Jammu & Kashmir, Sikkim and Tripura.

The lowest growth rate of total food grain production experienced by Mizoram (-13.42 percent per annum) in the same period. In the period of 2010-11/2016-17, the state of Meghalaya experienced higher growth rates in food grain crop production (4.63 percent per annum) followed by Mizoram (4.37), Tripura (3.05), Himachal Pradesh (2.56) and Assam (1.29). The state of Nagaland observed highest growth rates of food grain production as 4.93 percent per annum during the 1991-92/2016-17. However, seven states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Mizoram, Sikkim and Tripura experienced as an increase in the growth rates of total food grain production during 1991-92/1999-00 to 2010-11/2016-17. The study experienced that the positive average growth rates of production in the Himalayan Mountainous states for rice (1.25), coarse cereals (2.49), Pulses (3.68) and total food grain (1.33); however, wheat experienced negative growth rates of production during 1991-92/2016-17.

3.4 Growth Rates of Food Grain Crops Productivity (yield) of Himalayan Mountainous States and All India

Table 4 presents the growth rates of food grain yield producing across mountainous states and the all India level. At the all India level, the growth rates of rice (1.38), wheat (1.09), coarse cereals (2.79), pulses (1.33) and total food grain (1.87) crop productivity were positive during 1991-92 to 2016-17.

During 1991-92/1999-00, the highest growth rates were observed in Meghalaya (3.89) for rice, Jammu & Kashmir (3.79) for wheat, Tripura (3.19) for Coarse Cereals, Himachal Pradesh (4.49) for pulses and Meghalaya (3.4) for total food grain production.

During 2000-01/2009-10, the nine states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim, Tripura and Uttarakhand) registered positive growth rates of rice productivity; however other states experienced negative growth rates during the same period. In case of wheat, Jammu & Kashmir observed positive growth rates (5.05 percent per annum) and followed by Uttarakhand and Himachal Pradesh during the same period. In case of coarse cereals, the highest growth recorded by Manipur (2.82) and lower growth rate observed by Mizoram during the same period. In case of pluses, the state of Himachal Pradesh recorded higher growth rate at 8.38 followed by Nagaland, Meghalaya, Tripura, Sikkim, Assam, Jammu & Kashmir, Uttarakhand and Arunachal Pradesh during 2000-01/2009-10. During the same period, the highest growth of total food grain productivity observed by Tripura (2.12) followed by Jammu & Kashmir, Arunachal Pradesh, Meghalaya, Sikkim, Nagaland, Assam and Uttarakhand.

In the period of 2010-11/2016-17, the state of Mizoram experienced higher growth rates in rice productivity (4.33 percent per annum) followed by Uttarakhand, Meghalaya, Himachal Pradesh, Tripura and Assam. In case of wheat, Tripura observed higher growth rates as (5.55 percent per annum) followed by Himachal Pradesh, Arunachal Pradesh, Assam, Meghalaya, Nagaland and Sikkim during the same period. In case of coarse cereals, the highest growth rate observed by Assam followed by Meghalaya and Arunachal Pradesh; however, Himachal Pradesh recorded higher growth rates in the pulses in the same period. Mizoram experienced higher growth rates of productivity in food grain followed by Meghalaya, Himachal Pradesh, Assam and Sikkim during the same period. During 1991-92/2016-17, the nine states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim, Tripura and Uttarakhand recorded positive growth rates of food grain productivity; however, Manipur and Mizoram experienced low growth rates of food grain yield. In this case, five states (Assam, Himachal Pradesh, Mizoram, Sikkim and Tripura) evidenced as an increase in the growth rates of food grain yield except the Arunachal Pradesh, Jammu & Kashmir, Meghalaya and Nagaland during1991-92/1999-00 to 2010-11/2016-17.

3.5 Decomposition and Output Growth Production of Principal Crops in Himalayan Mountainous States

This section is necessary to examine and evaluate the sources of output growth for principal crops with food grain production. It presents the change in production and separated into three modes of effects; area effect, yield effect and interaction effect. The relative contribution of area, yield and their interaction to changes in the production of principal crops in Himalayan Mountainous States is presented in Table 5.

The decomposition analysis presents at all India level that during the period from 1991-92/1999-00, the yield effect was dominating for rice, wheat and total food grain growth. However, the area effect was dominating for both coarse cereals and pulses growth in the same period. During 1999-00/2009-10, the yield effect was dominating for rice, wheat, coarse cereals, pulses and total food grain's growth. However, during 2009-10/2016-17, area effect was dominating for wheat except others, namely, rice, coarse cereals, pulses and total food grain's growth. During 1991-92/2016-17, in the all India level, the yield effect was dominating for rice, wheat, coarse cereals and total food grain growth; however, area effect dominated the Pulses growth.

IV. DECOMPOSITION OF DIFFERENT CROPS IN MOUNTAINOUS STATES

4.1 Decomposition of Rice Production in Mountanious States

The crop is grown in decidedly varied situations ranging from mountains to the coastal areas. National Rice Research Institute (2020) discovered that area under rice has increased about 1.5 times; on the other hand production has risen more than five times. The leading rice producing states were West Bengal, Uttar Pradesh, Punjab, Odisha, Andhra Pradesh, Bihar and Chhattisgarh. In this study, we have taken eleven mountainous states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Manipur, Mizoram, Tripura, Nagaland, Sikkim and Uttarakhand. During 1991-92/1999-00, we observed that the yield effect was dominating for the rice production growth in eight states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Manipur, Mizoram and Tripura. While, the area effect was controlling the rice production growth in both of Nagaland and Sikkim.

In the next sub period (1999-00/2009-10), area effect was highly dominating for the rice production growth in three states, namely, Himachal Pradesh, Manipur and Uttarakhand. However, the yield effect was influencing the rice production growth in eight states, namely, Arunachal Pradesh, Assam, Jammu & Kashmir,

Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Eight states (Arunachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Tripura and Uttarakhand) experienced that yield effect was dominating for the rice production growth during 2009-10/2016-17. However, in the same period, three states, namely, Jammu & Kashmir, Nagaland and Sikkim recorded that area effect was influencing the rice production growth. During 1991-92/2016-17, the area effect was dominating for the rice production growth in five states (Jammu & Kashmir, Manipur, Mizoram, Nagaland and Sikkim); although, six states (Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Tripura and Uttarakhand) experienced that yield effect was highly dominating for the rice production growth. As the above discussion, it indicated that mostly Himalayan Mountainous states in rice production growth influenced by the yield effect other than area and interaction effect; but the area effect was dominating rice production growth in a few states (Nagaland, Sikkim, Manipur and Jammu & Kashmir) in different periods.

4.2 Decomposition of Wheat Production in Mountanious States

India is the second largest producer of wheat, almost 101.29 million tonnes of wheat annually produce from the country. In case of area, the wheat production in India has increased from 10010 thousand hectares to 30418 thousand hectares during 1950-51 to 2015- 16 at a significant growth rate of 1.69 per cent (Anwesha, Dinesh and Rashmi, 2020). During 1991-92/1999-00, we observed that the yield effect was dominating for the wheat production growth in five states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir and Meghalaya. While, the area effect was controlling the wheat production growth in Nagaland, Tripura and Sikkim.

In the sub period of 1999-00/2009-10, area effect was highly dominating for the wheat production growth in these states, namely, Assam, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim and Tripura. However, the yield effect was influencing the wheat production growth in three states, namely, Arunachal Pradesh, Himachal Pradesh and Uttarakhand. Seven states (Assam, Jammu & Kashmir, Manipur, Nagaland, Sikkim, Tripura and Uttarakhand) experienced that area effect was dominating for the wheat production growth during 2009-10/2016-17. However, in the same period, three states, namely, Arunachal Pradesh, Himachal Pradesh and Meghalaya recorded that yield effect was influencing the wheat production growth. During 1991-92/2016-17, the area effect was dominating for the wheat production growth in seven states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Tripura and Sikkim); although, three states (Himachal Pradesh, Jammu & Kashmir and Uttarakhand) experienced that yield effect was highly dominating for the wheat production growth. As the above discussion, it indicated that mostly Himalayan Mountainous states in wheat production growth influenced by the area effect other than yield and interaction effect; however the yield effect was dominating wheat production growth in a few states (Himachal Pradesh, Jammu & Kashmir and Uttarakhand) during 1991-92/2016-17.

4.3 Decomposition of Coarse Cereals Production in Mountanious States

In the case of coarse cereals, the study recorded that the yield effect was dominating for the coarse cereal production growth in six states, namely, Arunachal Pradesh, Assam, Jammu & Kashmir, Manipur, Mizoram and Meghalaya. While, the area effect was influencing the coarse cereal production growth in these states (Himacahal Pardesh, Nagaland, Tripura and Sikkim) during 1991-92/1999-00.

During 1999-00/2009-10, the yield effect was highly dominating for the coarse cereal production growth in these mountainous states, namely, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Sikkim and Tripura. However, the area effect was influencing the coarse cereal production growth in these states, namely, Arunachal Pradesh, Assam, Nagaland and Uttarakhand.

Four states (Jammu & Kashmir, Manipur, Tripura and Uttarakhand) experienced that area effect was dominating for the coarse cereal production growth during 2009-10/2016-17. However, in the same period, seven states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Mizoram, Nagaland and Sikkim experienced that yield effect was influencing the coarse cereal production growth. During 1991-92/2016-17, the area effect was dominating for the coarse cereal production growth in these states (Manipur, Tripura and Uttarakhand); although, seven states (Arunachal Pardesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Mizoram and Sikkim) experienced that yield effect was highly dominating for the coarse cereal production growth. The state of Nagaland showed that interaction effect was dominating for the coarse cereal production growth during the same period. As the above discussion, it indicated that mostly Himalayan Mountainous states in coarse cereal production growth influenced by the yield effect other than area and interaction effect; however the area effect was dominating coarse cereal production growth in a few states during various periods. Other than, interaction effect was dominating for the coarse cereal growth during 1991-92/2016-17.

4.4 Decomposition of Pulses Production in Mountanious States

In case of pulses, the area effect was dominating for the pulses production growth in seven states, namely, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Mizoram, Nagaland, Sikim and Tripura. While, the yield effect was influencing the pulses production growth in these states (Arunachal Pradesh and Assam) during 1991-92/1999-00. During 1999-00/2009-10, the yield effect was highly dominating for the pulses production growth in these mountainous states, namely, Arunachal Pradesh, Assam, Manipur, Nagaland, Sikkim, Uttarakhand and Tripura. However, the area effect was influencing the pulses production growth in four states, namely, Himachal Pradesh, Jammu & Kashmir, Meghalaya and Mizoram.

Seven states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Sikkim and Tripura) experienced that area effect was dominating for the pulses production growth during 2009-10/2016-17. However, in the same period, four states, namely, Assam, Himachal Pradesh, Mizoram and Uttarakhand experienced that yield effect was influencing the pulses production growth. During 1991-92/2016-17, the area effect was dominating for the pulses production growth in these states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Sikkim and Uttarakhand); although, four states (Assam, Himachal Pradesh, Mizoram and Tripura) experienced that yield effect was highly dominating for the pulses production growth. As the above discussion, it is shown that mostly Himalayan Mountainous states in the pulses production growth influenced by the area effect other than yield and interaction effect; however the yield effect was dominating pulses production growth in seven states during different sub-periods.

4.5 Decomposition of Total Food Grains Production in Mountanious States

This study experienced that yield effect was dominating for the total food grain production growth in eight states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram and Tripura. While, the area effect was influencing the total food grain production growth in two states (Nagaland and Sikkim) during 1991-92/1999-00. During 1999-00/2009-10, the yield effect was highly dominating for the total food grain production growth in these mountainous states, namely, Arunachal Pradesh, Assam, Meghalaya, Mizoram, Sikkim, Uttarakhand and Tripura. However, the area effect was influencing the total food grain production growth in four states, namely, Himachal Pradesh, Jammu & Kashmir, Manipur and Nagaland.

Seven states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Mizoram and Nagaland) experienced that yield effect was dominating for the total food grain production growth during 2009-10/2016-17. However, in the same period, four states, namely, Manipur, Sikkim, Tripura and Uttarakhand experienced that area effect was influencing the total food grain production growth. During 1991-92/2016-17, the area effect was dominating for the total food grain production growth in four states (Manipur, Mizoram, Nagaland and Sikkim); although, seven states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Tripura and Uttarakhand) experienced that yield effect was highly dominating for the total food grain production growth. As the above discussion, it is shown that mostly Himalayan Mountainous states in the total food grain production growth influenced by the yield effect other than area and interaction effect; however the area effect was dominating total food grain production growth in four states during different sub-periods.

V. CONCLUSION AND POLICY IMPLICATION

From the preceding analysis, it confirms at all India level that the main sources of growth in production of crops (rice, wheat, coarse cereals and total food grains) during the period 1991-92 to 2016-17 has been the growth in yield. It looks that the agriculture price policy, especially after the independence, by ensuring the remunerative prices to the farmers, fixes the minimum support prices of agricultural products, made provision for buffer stock of food grains, state trading in foodgrains, provided necessary benefit to the farmers by providing necessary encouragement and incentives, factors such as efficient technology, financial inputs, land reforms, crop insurance and improved human resources, fertilizer at the subsidized rates has been most important elements to promote the farmers to increase the production of agriculture crops.

Production and yield of various crops (rice, wheat, coarse cereals, pulses and total food grains) experienced that positive growth rate during 1991-92 to 2016-17. In various sub periods at all India level, the study experienced that positive growth rate of all the crops as mentioned above except the wheat during 2009-10 to 2016-17. However, in case of yield, the growth rates were decreased for various crops, namely, rice, wheat, coarse cereals, pulses and total food grains during 1991-92/1999-00 to 2009-10/2016-17. The yield of total food grains, wheat and pulses were recorded that highest during the period of 1991-92/1999-00 except others sub-periods. Almost 60 to 80 percent growth in principal crop and food grain output was due to yield an effect. The study showed that the values of the yield effect on the total food grain and principal crops were higher in the various periods. It indicated that the growth in production of rice, coarse cereals, total cereals and pulses were depended on the yield effect during 1950-51 to 2018-19.

In case of mountainous states, the positive growth rates of the total food grain production area were experienced in these states, namely, Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland and Tripura. However, Nagaland recorded the highest growth rates in the total food grain area. Nine states registered as an increase in the growth rates of the total food grain area except the Himachal Pradesh and Uttarakhand during 1991-92/1999-00 to 2010-11/2016-17. In case of food grain production, Nagaland observed highest growth rates during 1991-92/2016-17. However, seven states (Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Mizoram, Sikkim and Tripura) experienced as an increase in the growth rates of total food grain production during 1991-92/1999-00 to 2010-11/2016-17. In case of productivity (yield), nine states, namely, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim, Tripura and Uttarakhand recorded positive growth rates of food grain productivity; however, Manipur and Mizoram experienced lower growth rates. Five states (Assam, Himachal Pradesh, Mizoram, Sikkim and Tripura) evidenced as an increase in the growth rates of food grain yield except the Arunachal Pradesh, Jammu & Kashmir, Meghalaya and Nagaland during 1991-92/1999-00 to 2010-11/2016-17.

During 1991-92/2016-17, the study indicated that mostly Himalayan Mountainous states in case of rice production growth influenced by the yield effect other than area and interaction effect; but the area effect was dominating rice production growth in a few states (Nagaland, Sikkim, Manipur and Jammu & Kashmir) in different periods. The study observed that mostly Himalayan Mountainous states in wheat production growth influenced by the area effect other than yield and interaction effect; however the yield effect was dominating wheat production growth in a few states (Himachal Pradesh, Jammu & Kashmir and Uttarakhand). The mostly Himalayan Mountainous states in coarse cereal production growth influenced by the yield effect other than area and interaction effect; however the area effect was dominating coarse cereal production growth in a few states during various periods. In case of pulses, the area effect was dominating for these states (Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Sikkim and Uttarakhand); although, four states (Assam, Himachal Pradesh, Mizoram and Tripura) experienced that yield effect was highly dominating. It showed that mostly Himalayan Mountainous states in the pulses production growth influenced by the area effect other than yield and interaction effect. In case of total food grain production, the area effect was dominating for four states (Manipur, Mizoram, Nagaland and Sikkim); although, seven states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Tripura and Uttarakhand) experienced that yield effect was highly dominating for the total food grain production growth. It is also shown that mostly Himalayan Mountainous states in the total food grain production growth influenced by the yield effect other than area and interaction effect.

For the simple fact that each of the growth components has a limited capacity for growth, the decomposition findings have significant policy implications. One of the factors that's land has potential, but already has been exhausted due to continuously increase the population in India. So, if the potential is exhausted than the growth of the pricncipal crops decline per hectare productivity. Because of the Indian government's goal of food security for all, there is an urgent need to improve crop output, particularly in the food grain sector. As a result, efforts must be focused on boosting the production of diverse crops. Government strategy in the future would have to be focused on creating new high-yielding varieties and innovative agricultural methods in India's hilly areas. As a result, research efforts must be stepped up to produce high-yielding crop varieties that are suited to the agro-climatic conditions of hilly and mountainous areas.

Table 1: Decomposition of Growth in Production of Principal Crops (%)

Crops	Effects	Various Period							
		1950-51 /1959-60	**1959-60 /1969-70**	**1969-70 /1979-80**	**1979-80 /1989-90**	**1989-90 /1999-00**	**1999-2000 /2009-10**	**2009-10 /2018-19**	**1950-51 /2018-19**
Rice	***Area Effect***	17.48	35.035	31.253	6.043	30.20	-14.831	-0.356	9.41
	Yield Effect	76.81	58.065	63.547	92.020	64.20	116.61	100.42	63.78
	Interaction Effect	5.70	6.901	5.20	1.937	5.598	-1.783	-0.066	26.81
Wheat	***Area Effect***	63.75	27.260	49.44	12.905	36.67	25.413	23.965	28.15
	Yield Effect	28.10	57.681	36.30	81.673	54.77	72.338	71.899	57.6
	Interaction Effect	8.14	15.059	14.259	5.423	8.56	2.249	4.137	14.25
Coarse	***Area Effect***	35.47	34.658	-140.05	-176.59	5487.69	-27.39	-94.748	-19.88

Cereals	***Yield Effect***	55.51	60.953	268.56	308.32	-6796.75	136.38	229.78	191.17
	Interaction Effect	9.01	4.390	-28.511	-31.721	1409.07	-8.989	-35.02	-71.29
Total Cereals	***Area Effect***	32.54	29.984	13.483	-5.990	-1.990	-13.36	-13.24	4.79
	Yield Effect	58.99	62.743	82.963	108.07	102.55	115.40	116.34	76.72
	Interaction Effect	8.47	7.273	3.554	-2.083	-0.559	-2.05	-3.10	18.49
Pulses	***Area Effect***	69.13	1175.05	-115.18	-14.97	-4.129	50.76	41.34	28.10
	Yield Effect	24.67	-1168.81	204.36	117.66	104.66	48.17	47.63	48.45
	Interaction Effect	6.21	93.759	10.818	-2.695	-0.525	1.078	11.03	23.45
Total Foodgrains	***Area Effect***	38.46	22.975	16.269	-6.501	-2.047	-8.291	9.57	6.43
	Yield Effect	52.84	71.679	80.151	108.67	102.59	109.44	88.53	72.64
	Interaction Effect	8.71	5.345	3.580	-2.166	-0.551	-1.147	1.897	20.93

Sources: Own Estimation and RBI Site

Table 2: Compound Annual Growth Rates of Food Grain Crops Area of Himalayan Mountainous States in India, 1991-92 to 2016-17

Himalayan Mountainous States / Periods	**Arunachal Pradesh**	**Assam**	**Himachal Pradesh**	**Jammu and Kashmir**	**Manipur**	**Meghalaya**	**Mizoram**	**Nagaland**	**Sikkim**	**Tripura**	**Uttarakhand**	**ALL INDIA**
Rice Production												
1991-92/1999-00	-0.12	0.10	-0.23	-0.46	0.35	0.17	1.09	1.66	-1.21	-0.78	NA	0.68
2000-01/2009-10	0.42	-0.93	-0.72	0.77	1.05	-0.09	-1.15	1.61	-1.24	-0.09	-0.36	-0.02
2010-11/2016-17	1.14	-0.58	-0.91	2.16	4.12	0.42	2.04	2.38	-2.45	0.63	-1.53	0.31
1991-92/2016-17	0.37	-0.09	-0.51	0.04	1.32	0.25	-2.64	1.75	-1.84	0.13	-1.27	0.08
Wheat												
1991-92/1999-00	-0.02	0.78	-0.08	-0.12	NA	-0.15	NA	35.45	-3.06	-11.91	NA	1.72
2000-01/2009-10	-2.82	-3.56	-0.17	0.90	NA	-23.30	NA	-18.83	-3.61	-5.27	0.29	1.20
2010-11/2016-17	1.92	-16.39	-0.99	-0.10	0.14	2.42	NA	0.99	-32.62	-13.23	-1.77	0.92
1991-92/2016-17	-0.79	-4.87	-0.34	0.88	0.14	-11.86	NA	7.60	-11.67	-11.22	-0.95	0.95
Coarse Cereals												
1991-92/1999-00	-0.99	0.55	-0.62	0.40	0.41	-0.92	0.63	2.11	-0.36	-3.76	NA	-2.11
2000-01/2009-10	1.47	-2.31	-0.48	0.05	-1.84	-0.05	2.79	5.84	0.35	1.03	-1.33	-0.76
2010-11/2016-17	-1.00	6.63	-0.33	-1.47	3.55	1.58	-4.08	0.22	-1.02	27.38	-3.54	-1.84
1991-92/2016-17	1.04	0.06	-0.50	0.09	8.39	-0.01	-0.26	3.83	0.07	4.40	-2.01	-1.25
Pulses												
1991-92/1999-00	1.06	-4.48	-8.10	-11.41	NA	5.14	1.60	4.84	-11.99	-10.49	NA	-6.49
2000-01/2009-10	3.56	-0.10	-0.10	1.10	12.49	-1.80	5.02	1.92	9.03	-4.71	9.60	1.16
2010-11/2016-17	7.51	3.02	-2.39	-8.51	2.34	15.32	-0.54	2.20	-9.51	20.21	1.24	1.35
1991-92/2016-17	2.95	-0.93	-2.52	-4.41	14.66	2.17	-0.43	5.72	-2.17	-1.14	4.21	-1.08
Total Foodgrains												
1991-92/1999-00	-0.34	-0.15	-0.76	-0.66	0.36	0.19	1.07	2.19	-2.47	-1.36	NA	-1.42
2000-01/2009-10	0.81	-0.97	-0.35	0.53	1.54	-0.42	-0.33	2.39	0.73	-0.25	0.04	0.29
2010-11/2016-17	0.85	-0.52	-0.76	-0.14	3.77	1.21	0.70	1.78	-2.98	2.03	-1.95	0.23
1991-92/2016-17	0.67	-0.23	-0.53	0.11	2.35	0.11	-2.16	2.61	-1.10	0.10	-1.01	-0.31

Sources: RBI and Own estimation

Table 3 : Compound Annual Growth Rates of Food grain Crops production of Himalayan Mountainous states in India During 1991-92 to 2016-17

Himalayan Mountainous States / Periods	Arunachal Pradesh	Assam	Himachal Pradesh	Jammu and Kashmir	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Uttarakhand	Average Growth in the Mountainous States	ALL INDIA
Rice Production													
1991-92/1999-00	-1.04	1.06	1.63	-1.75	2.77	4.08	4.80	0.48	-0.23	-0.24	NA	1.16	2.00
2000-01/2009-10	3.61	-0.26	-0.49	3.39	-0.30	1.10	-15.25	2.76	0.84	1.95	0.25	-0.22	1.59
2010-11/2016-17	-1.95	0.95	1.29	0.87	-4.98	3.09	6.45	-2.20	-4.14	2.51	2.14	0.37	1.39
1991-92/2016-17	3.11	1.77	0.78	0.69	0.70	3.44	-3.18	4.11	-0.61	2.52	0.46	1.25	1.47
wheat													
1991-92/1999-00	-4.22	0.00	0.77	3.66	NA	2.12	NA	33.72	-5.47	-11.84	NA	2.34	3.57
2000-01/2009-10	-2.19	-4.03	0.86	5.99	NA	-22.61	NA	-25.50	-5.57	-7.40	1.52	-6.55	1.90
2010-11/2016-17	6.15	-13.27	3.82	-0.14	0.61	6.25	NA	2.27	-32.04	-8.41	-1.82	-3.66	0.88
1991-92/2016-17	-0.41	-4.74	0.46	1.62	0.61	-10.63	NA	5.90	-13.40	-10.87	0.80	-3.07	2.04
Coarse Cereals													
1991-92/1999-00	-0.39	1.40	0.42	-0.24	3.14	1.22	1.60	4.77	-0.99	-0.70	NA	1.02	-0.01
2000-01/2009-10	1.37	-1.66	-0.56	0.42	0.93	0.24	-12.54	4.50	1.50	0.84	-0.92	-0.53	2.39
2010-11/2016-17	3.39	41.79	1.54	-0.95	7.05	10.21	-2.79	0.55	0.19	27.94	-2.27	7.88	-0.28
1991-92/2016-17	1.74	3.94	0.25	0.12	7.29	1.86	-2.44	7.21	0.95	7.40	-0.96	2.49	1.51
Pulses													
1991-92/1999-00	3.86	-1.68	-3.97	-11.94	NA	5.44	0.44	2.25	-11.81	-9.82	NA	-3.03	-4.49
2000-01/2009-10	3.56	0.04	8.27	1.11	12.21	0.27	1.35	6.14	10.06	-2.82	9.64	4.53	2.71
2010-11/2016-17	6.77	9.17	5.96	-8.82	3.50	27.94	-0.85	3.67	-8.52	23.97	0.78	5.78	2.00
1991-92/2016-17	4.07	0.49	5.24	-4.58	20.93	4.37	-2.15	7.16	-1.87	0.42	6.41	3.68	0.23
Total Food grains													
1991-92/1999-00	-0.82	0.96	0.59	0.01	2.79	3.59	4.12	1.88	-2.40	-0.49	NA	1.02	1.61
2000-01/2009-10	2.82	-0.32	-0.17	2.61	-0.12	0.69	-13.42	2.86	1.50	1.87	0.74	-0.09	1.90
2010-11/2016-17	-0.06	1.29	2.56	-0.16	-3.43	4.63	4.37	-0.99	-1.69	3.05	-0.50	0.82	0.98
1991-92/2016-17	2.65	1.66	0.46	0.66	1.49	3.04	-2.95	4.93	-0.29	2.47	0.47	1.33	1.56

Sources: RBI and Own estimation

Table 4: Compound Annual Growth Rates of Food Grain Productivity (Yield) of Himalayan Mountainous States in India During 1991-92 to 2016-17

Himalayan Mountainous States / Period	Arunachal Pradesh	Assam	Himachal Pradesh	Jammu and Kashmir	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	Uttarakhand	ALL INDIA
Rice												
1991-92/1999-00	-0.924	0.963	1.86	-1.295	2.41	3.899	3.68	-1.17	0.994	0.541	NA	1.32
2000-01/2009-10	3.17	0.68	0.24	2.595	-1.34	1.19	-14.26	1.14	2.11	2.042	1.22	1.61
2010-11/2016-17	-3.05	1.54	2.22	-1.26	-8.74	2.66	4.33	-4.47	-1.74	1.86	3.73	1.077
1991-92/2016-17	2.72	1.86	1.295	0.65	-0.618	3.18	-0.55	2.32	1.25	2.38	1.93	1.38
wheat												
1991-92/1999-00	-4.2	-0.779	0.86	3.79	NA	2.28	NA	-1.28	-2.48	0.0775	NA	1.82
2000-01/2009-10	0.65	-0.49	1.03	5.05	NA	0.902	NA	-8.21	-2.03	-2.25	1.23	0.694
2010-11/2016-17	4.15	3.74	4.86	-0.032	-0.215	3.74	NA	1.27	0.86	5.55	-0.053	-0.04
1991-92/2016-17	0.38	0.13	0.796	0.73	-0.215	1.39	NA	-1.58	-1.95	0.396	1.77	1.09
Coarse Cereals												
1991-92/1999-00	0.61	0.844	1.04	-0.64	2.72	2.153	0.96	2.598	-0.64	3.19	NA	2.14
2000-01/2009-10	-0.098	0.67	-0.08	0.38	2.82	0.283	-14.91	-1.26	1.15	-0.19	0.411	3.18

2010-11/2016-17	4.44	32.97	1.87	0.54	3.38	8.5	1.35	0.33	1.22	0.44	1.31	1.58
1991-92/2016-17	0.69	3.88	0.76	0.035	-1.017	1.88	-2.18	3.26	0.88	2.87	1.07	2.79
Pulses												
1991-92/1999-00	2.77	2.93	4.496	-0.599	NA	0.28	-1.142	-2.48	0.21	0.77	NA	2.15
2000-01/2009-10	0.003	0.15	8.38	0.0113	-0.25	2.11	-3.49	4.14	0.94	1.99	0.043	1.53
2010-11/2016-17	-0.689	5.97	8.56	-0.34	1.14	10.94	-0.312	1.43	1.096	3.13	-0.46	0.64
1991-92/2016-17	1.08	1.43	7.95	-0.175	5.47	2.15	-1.73	1.37	0.31	1.58	2.11	1.33
Total Food grains												
1991-92/1999-00	-0.48	1.11	1.36	0.68	2.43	3.401	3.02	-0.31	0.081	0.89	NA	3.07
2000-01/2009-10	1.997	0.65	0.18	2.07	-1.632	1.12	-13.13	0.46	0.76	2.122	0.696	1.61
2010-11/2016-17	-0.898	1.81	3.35	-0.017	-6.941	3.38	3.64	-2.72	1.33	0.996	1.48	0.75
1991-92/2016-17	1.96	1.89	1.001	0.55	-0.85	2.93	-0.8	2.26	0.82	2.37	1.49	1.87

Sources: RBI and Own estimation

Table 5: Decomposition of Growth in Production of Principal Crops of Himalayan Mountainous States in India during 1991-92 to 2016-17(%)

Principal Crops		Rice Production			Wheat				Coarse Cereals				
States	Effects / Periods	1991-92 / 1999-00	1999-00/ 2009-10	2009-10/ 2016-17	1991-92/ 2016-17	1991-92/ 1999-00	1999-00/ 2009-10	2009-10/ 2016-17	1991-92/ 2016-17	1991-92/ 1999-00	1999-00/ 2009-10	2009-10/ 2016-17	1991-92/ 2016-17
Arunachal Pradesh	*Area Effect*	17.01	9.24	12.45	8.95	-35.08	-1403.7	29.97	75.21	-1322.9	106.34	15.87	32.31
	Yield Effect	84.66	87.33	84.22	85.97	124.41	1697.3	60.98	22.44	1506.92	-5.28	79.76	56.61
	Interaction Effect	-1.67	3.44	3.33	5.08	10.66	-193.55	9.06	2.35	-84.01	-1.06	4.37	11.08
Assam	*Area Effect*	16.74	-30.37	6.65	-0.56	15.05	92.4	115.17	104.09	-36.17	122.18	8.79	2.87
	Yield Effect	82.31	134.87	91.56	100.87	85.52	11.56	-40.12	-16.56	139.61	-27.31	64.56	86.8
	Interaction Effect	0.95	-4.5	1.8	-0.31	-0.58	-3.96	24.95	12.47	-3.44	5.13	26.65	10.33
Himachal Pradesh	*Area Effect*	-19.74	167.54	-32.61	-52.03	-9.54	15.63	-12.17	-83.54	527.1	-211.6	-89.77	-323.9
	Yield Effect	122.73	-72.03	140.01	175.45	109.89	87.98	118.92	203.57	-454.72	329.61	194.44	489.32
	Interaction Effect	-2.99	4.49	-7.39	-23.42	-0.35	-3.61	-6.76	-20.03	27.62	-18.06	-4.67	-65.35
Jammu and Kashmir	*Area Effect*	2.48	-30.47	157.17	205.28	-0.79	243.53	83.5	40.66	33.65	26.81	67.85	-46.28
	Yield Effect	97.73	133.13	-51.64	-97.24	101.07	-124.37	15.69	49.04	64.94	70.89	34.84	150.28
	Interaction Effect	-0.21	-2.66	-5.53	-8.04	-0.28	-19.16	0.81	10.3	1.42	2.29	-2.69	-4
Manipur	*Area Effect*	6.12	199.94	-1958.1	146	NA	NA	80.78	80.78	-2439.5	-147	121.04	112.63
	Yield Effect	91.99	-95.58	1469.96	-30.79	NA	NA	18.65	18.65	3215.19	222.51	-3.19	-2.19
	Interaction Effect	1.89	-4.36	588.1	-15.21	NA	NA	0.57	0.57	-675.66	24.5	-17.85	-10.44
Meghalaya	*Area Effect*	4.9	7.33	9.16	5.45	-36.07	101.2	-133.9	106.33	-299.23	-35.52	12.31	-4.14
	Yield Effect	93.69	90.69	88.3	88.6	145.57	-11.04	251.9	-67.18	435.52	136.9	81.84	107.12
	Interaction Effect	1.89	-4.36	588.1	-15.21	NA	NA	0.57	0.57	-675.66	24.5	-17.85	-10.44
Meghalaya	*Area Effect*	4.9	7.33	9.16	5.45	-36.07	101.2	-133.9	106.33	-299.23	-35.52	12.31	-4.14
	Yield Effect	93.69	90.69	88.3	88.6	145.57	-11.04	251.9	-67.18	435.52	136.9	81.84	107.12
	Interaction Effect	1.42	1.98	2.54	5.95	-9.49	9.85	-17.99	60.85	-36.29	-1.38	5.85	-2.98
Mizoram	*Area Effect*	33.87	26.73	-39.58	751.17	NA	NA	NA	NA	46.89	-26.71	-67.66	19.18
	Yield Effect	54.66	88.7	193.4	-902.8	NA	NA	NA	NA	46.94	111.3	222.67	83.35
	Interaction Effect	11.47	-15.44	-53.82	251.67	NA	NA	NA	NA	6.16	15.4	-55.01	-2.53
Nagaland	*Area Effect*	91.47	26.51	63.14	40.12	150.69	70.99	52.83	201.12	45.02	62.57	-10.5	32.99
	Yield Effect	7.43	62.7	31.44	37.96	-5.91	60.98	23.58	-12.38	43.25	19.15	114.09	27.85
	Interaction Effect	1.1	10.79	5.42	21.92	-44.78	-31.97	23.58	-88.74	11.72	18.27	-3.6	39.15
Sikkim	*Area Effect*	110.06	-397.4	94.17	138.03	87.37	78.14	99.71	99.31	61.33	17.99	-48.6	-83.69
	Yield Effect	-11.57	578.46	7.5	-65.5	20.44	33.99	4.48	26.81	42.13	79.32	153.52	199.96
	Interaction Effect	1.51	-81.1	-1.67	27.47	-7.81	-12.13	-4.19	-26.12	-3.45	2.69	-4.92	-16.27

Tripura	*Area Effect*	-440.1	-11.68	44.34	-3.82	100.98	101.53	109.18	101.63	297.1	29.99	67.36	44.39
	Yield Effect	595.48	114.79	50.2	106.12	-2.31	-3.12	-42.23	-36.25	-242.85	63.23	7.03	13.32
	Interaction Effect	-55.42	-3.11	5.46	-2.3	1.33	1.59	33.05	34.61	45.76	6.77	25.61	42.28
Uttarakhand	*Area Effect*	NA	161.56	-209.02	-108.1	NA	31.99	226.2	-119.6	NA	83.51	223.27	139.74
	Yield Effect	NA	-68.78	345.23	232.43	NA	64.98	-145.7	242.24	NA	18.18	-150	-53.31
	Interaction Effect	NA	7.21	-36.21	-24.38	NA	3.03	19.48	-22.6	NA	-1.69	26.75	13.58
ALL INDIA	*Area Effect*	26.34	-14.83	1.46	6.38	43.29	25.44	64.1	41.04	290.84	-28.4	-114.6	-114.7
	Yield Effect	70.71	116.62	98.37	91.1	50.32	72.31	32.64	46.13	-231.72	137.81	240.61	313.72
	Interaction Effect	2.95	-1.78	0.17	2.52	6.39	2.25	3.26	12.83	40.88	-9.41	-26.02	-99.02
Principal Crops		**Pulses**				**Total Food Grains**							
States	**Effects / Periods**	**1991-92/ 1999-00**	**1999-00/ 2009-10**	**2009-10/ 2016-17**	**1991-92/ 2016-17**	**1991-92/ 1999-00**	**1999-00/ 2009-10**	**2009-10/ 2016-17**	**1991-92/ 2016-17**				
Arunachal Pradesh	*Area Effect*	26.99	76.64	94.83	56.26	33.63	27.8	19.77	21.07				
	Yield Effect	64.77	17.31	3.48	19.35	68.04	65.98	75.34	69.44				
	Interaction Effect	8.24	6.05	1.69	24.39	-1.66	6.22	4.89	9.49				
Assam	*Area Effect*	16.87	182.93	39.73	22.87	18.15	-48.62	6.88	-2.44				
	Yield Effect	78.39	-87.49	47.19	60.07	80.83	155.66	91.2	103.78				
	Interaction Effect	4.75	4.56	13.08	17.06	1.02	-7.04	1.92	-1.33				
Himachal Pradesh	*Area Effect*	173.21	-6.46	-7.91	-38.43	-504.3	53.17	-20.97	-141.02				
	Yield Effect	-148.3	113.5	115.03	318.66	647.8	49.28	126.42	284.17				
	Interaction Effect	75.08	-7.04	-7.12	-180.2	-43.54	-2.45	-5.46	-43.14				
Jammu and Kashmir	*Area Effect*	93.19	20.67	118.25	95.36	-95.73	60.13	-84.31	7.76				
	Yield Effect	16.43	81.79	-28.55	18.07	204.1	38.04	183.54	91.39				
	Interaction Effect	-9.62	-2.45	10.3	-13.42	-8.36	1.83	0.77	0.85				
Manipur	*Area Effect*	NA	110.81	37.28	39.8	4.34	337.52	327.9	132.73				
	Yield Effect	NA	-5.41	27.9	26.78	94.4	-209.8	-143.5	-17.95				
	Interaction Effect	NA	-5.41	34.82	33.42	1.32	-27.72	-84.41	-14.78				
Meghalaya	*Area Effect*	98.57	-689.58	42.83	40.22	3.97	-9.29	17.02	4.86				
	Yield Effect	0.97	890.65	29.29	23.52	95.1	111.5	78.01	90.33				
	Interaction Effect	0.45	-101.07	27.88	36.26	0.98	-2.21	4.97	4.82				
Mizoram	*Area Effect*	71.49	8.75	-70	24.6	36.4	21.63	-44.31	351.33				
	Yield Effect	25.34	94.76	193.86	79.37	53.15	90.51	196.12	-329.83				
	Interaction Effect	3.17	-3.51	-23.86	-3.97	10.42	-12.14	-51.81	78.51				
Nagaland	*Area Effect*	392.31	46.63	95.23	67.96	77.57	45.69	41.21	43.56				
	Yield Effect	-227.2	27.61	4.27	11.55	18.71	39.3	52.87	30.62				
	Interaction Effect	3.17	-3.51	-23.86	-3.97	10.42	-12.14	-51.81	78.51				
Nagaland	*Area Effect*	392.31	46.63	95.23	67.96	77.57	45.69	41.21	43.56				
	Yield Effect	-227.2	27.61	4.27	11.55	18.71	39.3	52.87	30.62				
	Interaction Effect	-65.14	25.77	0.49	20.49	3.73	15.01	5.93	25.81				
Sikkim	*Area Effect*	97.37	85.31	99.73	100.07	98.91	24.16	177.35	147.21				
	Yield Effect	9.51	7.71	0.58	-0.3	1.49	73.46	-97.35	-79.2				
	Interaction Effect	-6.88	6.98	-0.31	0.23	-0.41	2.38	20	31.99				
Tripura	*Area Effect*	104.76	1071.73	86.01	3.79	-3396.3	-15.38	64.45	-1.05				
	Yield Effect	-10.05	-1229.9	5.15	94.55	3994.7	119.54	30.21	101.65				
	Interaction Effect	5.29	258.12	8.85	1.66	-498.4	-4.15	5.34	-0.6				
Uttarakhand	*Area Effect*	NA	115.8	-1.75	85.44	NA	18.3	629.5	-921.8				
	Yield Effect	NA	-7.07	102.07	6.54	NA	81.19	-607.6	1165.39				
	Interaction Effect	NA	-8.73	-0.32	8.02	NA	0.51	78.19	-143.55				
ALL INDIA	*Area Effect*	122.37	34.56	46.12	387.87	-109.2	-8.61	16.62	-25.07				
	Yield Effect	-37.05	64	47.73	-412.9	236.7	109.82	81.5	139.85				
	Interaction Effect	14.68	1.44	6.16	125.08	-27.5	-1.21	1.88	-14.78				

Sources: RBI and Own estimation

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