

Determinants of the Changes in Cropping Pattern in India: 1970-71 to 2006-07

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Institutional and technological changes, mainly the HYV technology introduced in the 1960s, turned India into a progressive food grain producing country. Since the early-1990s, Indian agriculture has also faced competition from the global economy in the wake of globalisation. This has led to the emergence of a decelerating tendency in Indian agriculture especially in terms of growth of production of major crops and total agricultural production. In view of the above, diversification of agricultural activities is considered important for enhancing agricultural production and productivity in India. This study examines cropping pattern changes in Indian agriculture during the period 1970-71 to 2006-07. In terms of Herfindal index and substitution and expansion effects, the concentration and/or diversification reveals that the cropping pattern in India in terms of allocation of acreage is skewed towards food grains. However, few non-food grain cash crops such as cotton, sugarcane, oilseeds, and vegetables have emerged as popular crops among the farmers in recent years.

I. INTRODUCTION

The economy of India is predominantly agricultural. The contribution of agriculture to the total State Domestic Product (SDP) has been continuously decreasing from 55.11 per cent in 1950-51 to 44.26 per cent in 1970-71, further to 31.37 per cent in 1990-91 and more recently at only 17.75 per cent in 2007-08. Though the proportion of agriculture and allied activities to GDP has been decreasing over time, the majority of the population of the country earns their livelihood from the agricultural sector.

In this paper we examine the cropping pattern of India over the period of 1970-71 to 2006-07. This has been an eventful period in the history of agriculture in the country. While the decades of 1960s and 1970s were marked by successful story of Green Revolution in few selected area of the economy followed by a significant change in the 1980s, only during the decade of 1980s the Green

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Revolution was successfully implemented throughout the country including the highly densely populated eastern Indian states. The agriculture of the country faces the fears of globalisation as India adopted the policy of globalisation during the early 1990s.

Cropping pattern implies the proportion of area under different crops at a point of time. A change in cropping pattern thus implies a change in the proportion of area under different crops. The cropping pattern in an area depends largely on agro-climatic, technical and institutional factors (Vaidyanathan 1987). To be more specific, the cropping pattern is governed by the law of comparative advantage in relation to agro-climatic conditions (Vyas 1996). In India, we find that the conditions of soil and climate are mostly favourable to foodgrain production and hence foodgrain crops dominate the cropping pattern of the state (Bhalla and Singh 1997). The major foodgrain crops are rice, wheat, maize, *ragi*, millets, gram and other pulses. Among foodgrain crops, rice occupies the first position both in terms of areas under cultivation and production. Next to rice, the important cereals crop is wheat. The country also produces some important cash crops like jute, potato, vegetables, spices, tea, etc.

The change of cropping pattern is basically the results of the adoption of new crops and the intensification of cultivation through multiple cropping. More precisely, changes in cropping pattern over time are also function of changes in the extent and quality of irrigation and the relative costs of and returns to competing crops and crop combinations. The introduction of a new seed variety also alters the cropping pattern by reducing the maturity period of the crops. Moreover, with the application of technical innovation, institutional reforms of extension facilities can lead to a yield rate induced cropping pattern change (Parikh 1966). Obviously, farmers will go in favour of those crops for which the yield levels are high and have reasonable market demand for crops. Irrigation also plays a very important role in cropping pattern changes. In India, a large section of Gross Cropped Area (GCA) is still weather dependent. Out of total GCA of 190.91 million hectares, the irrigation potential of the economy utilised during 2004-05 was 79.51 million hectares (Handbook of Statistics on Indian Economy, RBI). Although the economy has experienced the green revolution, the impact was observed mainly in paddy and wheat cultivation with coverage of about 40 per cent of the total cropped area.

The paper is organised as follows. Following the introduction in section I, sections II and III deal with the statement of hypotheses and data and methodological aspects of the study respectively. The main results are presented in section IV, while conclusion and policy prescriptions are made in section V.

II. HYPOTHESES

The following hypotheses were tested in this paper:

Hypothesis 1: The cropping pattern of India has shown a tendency of change towards the non-foodgrain crops during the post-globalisation period.

Hypothesis 2: If there is any change in cropping pattern in India during the period under study, both the substitution and expansion effects contributed towards the cropping pattern changes in India.

III. DATA AND METHODOLOGY

The time series data used in this paper were collected from the various issues of Statistical Abstract of India, published by the Ministry of Statistics and Programme Implementation, Government of India, and Statistical Database of Reserve Bank of India.

The nature of crop diversification is first examined through changes in allocation of land towards the cultivation of different crops grown in different seasons over the years. The crop concentration/diversification has also been examined by using the Herfindal's index.

Average annual exponential rates of growth of area, production and yield under different crops are estimated by fitting regressions of the type $LnY = \alpha + \beta t$ (Y = value of the dependent variables area, production and yield of crops, and t is the time in years. Here α and β are the parameters of the model (Johnston 1972). The coefficient β represents the growth rate of Y . The trend equations are fitted by the OLS method (Koutsoyiannis 1977) for the period 1970-71 to 2006-07.

Once the rates of growth and the change in the rates of growth of acreage of different crops are known, then the substitution effect and expansion effect can be considered easily. For a given GCA, the substitution effect is defined as the relative decline in area under some crops and the compensating increase in area of the substitutable crops. On the other hand, the expansion effect is defined as the expansion of GCA. First of all to ensure whether the area under any crop has been changed due to the inter-crop shift of area or because of change in the total area under cultivation, a simple elasticity method is defined.

The elasticity measure defined by Venkataraman and Prahladachar (1980) is given as:

$$\begin{aligned} & \text{cropped area - gross cropped elasticity}(E) \\ & = \frac{\% \text{ change in the growth of area under crop}}{\% \text{ change in GCA}} \end{aligned}$$

The value of E under each crop is calculated to identify the crops that have a gain in area from other crops and those who lose area to the former. If E is found to be greater than unity for any crop, it can be said that the area under that crop has increased due to both substitution effect and expansion effect. On the other hand, if $E < 0$ for any crop, it can be easily asserted that the crop has lost area to crops having elasticity greater than unity. However, if the value of E is such that $0 < E < 1$, it is difficult to say whether the rise in area is due to expansion of area or due to substitution effect. In this case, it can only be said that the area of the crop has increased at a rate less than that of GCA.

IV. RESULTS

IV.1 The Aggregate Cropping Pattern and Its Changes

The cropping pattern during the study period shows no gross change in the relative area allocation under the major crop groups. However, few important changes can be noticed. First, the relative area allocation of coarse cereals crops (viz. jowar, bajra, millets, etc.) has been decreased continually during the period under study. As a result of which the percentage share of total cereals crops to gross cropped area has declined to 52.21 per cent during 2006-07 from 61.39 per cent in 1970-71 and hence, the percentage share of foodgrain crops in the gross cropped area has declined from 76 per cent in 1970-71 to 64 per cent in 2006-07. Among the non-foodgrain crops, total oilseeds and sugarcane have gained their importance in the area allocation in gross cropped area, though marginally. Jute, mesta and tobacco all have shown a declining importance in the gross area allocation during the study period.

The movement of area allocation among different crops and crop groups can also be viewed using the Herfindal's index. The Herfindal's indices were formed for various crop groups and were presented in the following figures. Four measures of the crop concentration/diversification are employed in this paper. First we measure $CRD = S_{i \in \max 2} / S_i$ which is simply the concentration ratio of the top two foodgrain crops (rice and wheat). This measures the absolute concentration into few dominant crops. In addition to this, the concentration ratio of non-foodgrain cash crops among GCA (CRNF) and the sum of rice and wheat among foodgrain crops (CRRW) are also measured. And the crop concentration of coarse cereals among GCA (CRCC) is also measured. The measure CRD shows that the share of these two crops in the GCA has been remain almost the same even after 40 years of Green Revolution in India. However, Figure 2 indicates that the relative area coverage of rice and wheat among total foodgrain area increases over the time. Among the total cropped area, the share of non-foodgrain cash crops has been sharply increasing over the period of study (Figure

3). The rapidly increasing trend of non-foodgrain cash crops has been started since 1986-87 and this trend has become more intensive during the 1990s (i.e., only after the introduction of globalisation). Among the foodgrain crops, the relative area coverage of coarse cereals has been decreasing continuously during the study period (Figure 4).

TABLE I
CROPPING PATTERN CHANGES IN INDIA DURING 1970-71 TO 2006-07
(MILLION HECTARE)

Crops	1970-71	1980-81	1990-91	2006-07
Rice	37.59 (22.67)	40.15(23.26)	42.69(22.98)	43.62(22.57)
Wheat	18.24 (11.00)	22.28 (12.91)	24.17(13.01)	28.04(14.59)
Other cereals	45.95(27.72)	41.78(24.20)	36.32(19.55)	28.71(14.86)
Total cereals	101.78 (61.39)	104.21(60.37)	103.18(55.55)	100.37(52.21)
Pulses	22.54(13.60)	22.46(13.01)	24.66(13.28)	23.11(12.02)
Foodgrain	124.32 (75.99)	126.67(73.38)	127.84(68.83)	123.48(64.23)
Groundnut	7.33 (4.42)	6.80(3.94)	8.31(4.47)	5.64(2.93)
Rape & mustard	3.32 (2.00)	4.11(2.38)	5.78(3.11)	6.60(3.43)
Total oilseeds	16.64(10.04)	17.60(10.20)	24.15(13.00)	26.05(13.55)
Sugarcane	2.62 (1.58)	2.67(1.55)	3.69(1.99)	4.86(2.53)
Cotton	7.61(4.59)	7.82(4.53)	7.44(4.01)	9.14(4.75)
Jute & Mesta	1.08(0.65)	1.30(0.75)	1.02(0.55)	0.94(0.49)
Tobacco	0.45(0.27)	0.45(0.26)	0.41(0.22)	0.37(0.19)
Tea & coffee	0.49 (0.30)	0.57(0.33)	0.64(0.34)	0.91(0.47)
Gross cropped area (GCA)	165.79 (100.00)	172.63(100.0)	185.74(100.0)	193.23(100.0)

Source: Statistical Abstracts of India, RBI Database.

Figure 1: Concentration of Rice and Wheat in Total Cropped Area

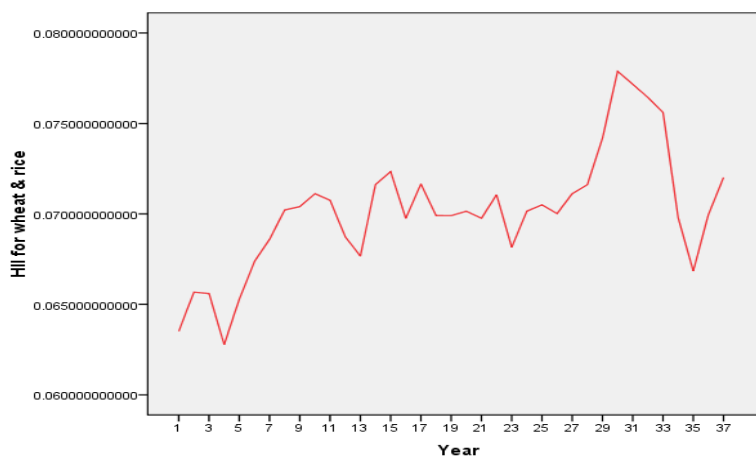


Figure 2: Concentration of Rice and Wheat in Total Foodgrain Area

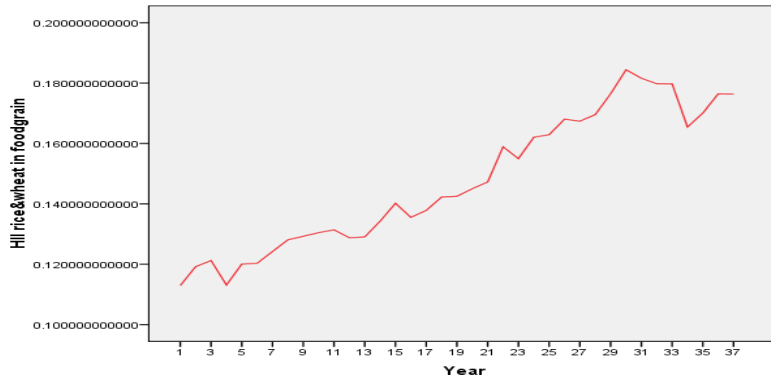


Figure 3: Share of Non-foodgrain Cash Crops in Total Cropped Area

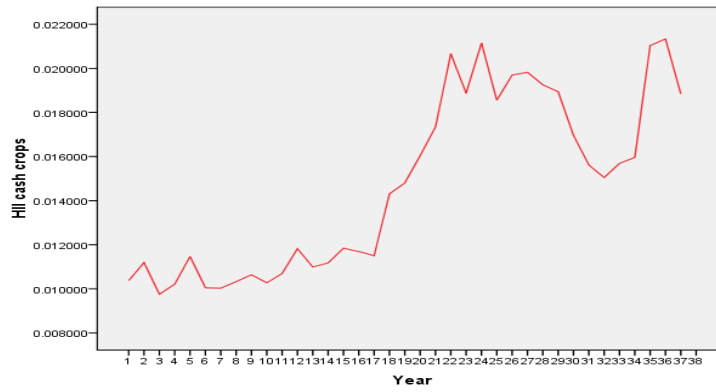
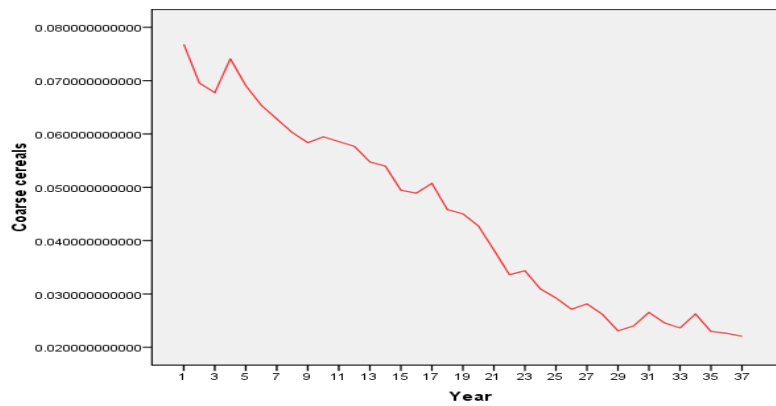


Figure 4: Concentration of Coarse Cereals among Foodgrain Crops



IV.2 The Decomposition of Production Changes: Area Effect and Yield Effect

The cropping pattern in India shows a bias towards foodgrain crops (especially rice and wheat). However, there is found to be a change trend in the cropping pattern in favour of non-foodgrain cash crops over time, though the foodgrain crops still dominate the cropping pattern of the state. Crop yield is the major component of agricultural production and acts as the main driving force behind cropping pattern. Its changes have a direct impact on the changing cropping pattern growth. In absolute terms, there has been a significant growth in yield rates of the foodgrain crops, especially after the successful introduction of HYV technology in rice and wheat cultivation and this has gathered momentum since the 1970s.

As we know that the yield rate (Y) is defined as the ratio of total production (P) and total area (A). Thus, the exponential growth rate of production would be the sum total of the exponential growth rates of area and yield. The trend rates of growth of area, production and yield show that the output rate of growth is influenced less by the rate of growth of the area and more by the rate of growth of yield in the country for most of the crops.

Table II shows the estimated growth rates of area, production and yield of different crops in India during the period under study. The result reveals that the increase in total production is largely dependent upon the increase in yields of crops, rather than on an increase in area cultivated of different crops. The total foodgrain production in the state was found to grow at an exponential rate of 2.23 per cent with more than 100 per cent contribution from the yield growth rate as the area growth rate (-0.1 % p.a.) was found to be negative. Rice registered a growth rate of 2.47 per cent with its nearly 100 per cent contribution from yield growth. In the case of total cereals, over 100 per cent of the output growth rate came from the yield growth rate due to -0.11 per cent negative growth rate. Among total foodgrain, total pulses grew only at 0.71 per cent per annum. Though the yield growth rate of total pulses was positive (0.79 per cent), a negative growth rate of area (-0.09 per cent) forced the output growth rate to be negative. Total oilseeds grew at an exponential growth rate of 3.33 per cent, of which 56 per cent output growth rate was contributed by yield growth rate and the remaining 44 per cent came from the area expansion. In the case of jute, even a moderate yield growth rate (2.05% p. a) could not able to produce high output growth rate. As a result of which output growth of jute and mesta remained at a very low level, though the crops earned a substantial amount of foreign revenue due to its high export potential. Thus, in general, we find that the yield growth rates of most of the crops was positive and higher than the area growth rates.

TABLE II
GROWTH RATES OF AREA, PRODUCTION AND
YIELD OF SOME MAJOR CROPS IN INDIA DURING 1970-71 TO 2006-07

Crops	Exponential growth rates of		
	Production	Area	Yield
Rice	2.47*** (1.87)	0.45* (10.29)	2.02* (18.53)
Wheat	3.36* (10.36)	1.05* (8.426)	2.31* (9.539)
Other cereals	0.54* (3.649)	-1.46* (-22.07)	2.00* (16.13)
Total cereals	2.36* (20.54)	-0.11** (-2.836)	2.47* (18.90)
Pulses	0.71* (4.591)	-0.09 (-1.25)	0.79* (6.760)
Food grain	2.23* (19.41)	-0.10** (-2.575)	2.32* (25.32)
Groundnut	0.66** (2.118)	-0.27 (-1.304)	0.94* (6.695)
Rape & mustard	4.48* (8.281)	2.04* (4.768)	2.44* (11.55)
Total oilseeds	3.27* (9.397)	1.39* (4.786)	1.88* (12.21)
Sugarcane	2.71* (9.474)	1.64* (9.222)	1.07* (6.36)
Cotton	3.06* (6.873)	0.45** (2.195)	2.61* (6.161)
Jute & Mesta	1.63* (9.218)	-0.42 (-1.687)	2.05* (25.40)
Tobacco	1.00* (4.3)	-0.58* (-3.156)	1.57* (9.14)
Tea	2.23* (25.01)	1.31* (7.089)	0.92* (3.939)
Coffee	3.69* (21.85)	2.51* (13.18)	1.17* (6.239)

Source: Statistical Abstracts of India, RBI Database.

Notes Figures in the parentheses are the corresponding t-values.

*, ** and *** imply significant at 1%, 5% and 10% level of significance.

Since the exponential growth rate of output is the sum total of growth rate of area and that of yield, the increase in production under different crops can be decomposed into area and yield components (Table III). During our study period (1970-71 to 2006-07), total rice production was increased by 51.1 million tons, out of which 9.318 million tons was increased because of the expansion of the area under rice cultivation and remaining 41.815 million tons due to an increase in yield growth rate. Total cereals production was increased by 106.48 million tons, which was contributed by more than 100 per cent increment came by the yield effect and area effect was found to be negative (-4.963 million tons). The same picture has been observed for the total foodgrain production. In the case of total pulses, the positive yield effect offset the negative area effect and eventually led to a marginal rise in output (2.38 million tons). The output of pulses declined mainly due to the reduction in the area under cultivation and not because of the yield effect. If we go through the table carefully, we find that the yield effects of all the crops are positive. However, the area effects of a number of important crops (coarse cereals as well as total cereals, pulses, total foodgrain, groundnut, jute and mesta, tobacco) are negative. We see that there is a movement in the cropping pattern of the country. The traditional foodgrain crops are being

substituted by the commercial cash crops. However, the cropping pattern is still found to have a bias towards the production of foodgrain crops in general and rice in particular.

The cropping pattern change can also be analysed more clearly with the help of "cropped area gross cropped area elasticity" (E) (Venkataramanan and Prohaladachar 1978). We have already defined this measure. We then categorise the crops according to the value of E. Category I includes those crops for which the value of E is greater than unity. Category II includes those crops for which the value of E lies between zero and unity. Category III includes those crops for which the value of E is found to be negative.

From Table III it is found that wheat, rape and mustard, total oilseeds, sugarcane, cotton, tea and coffee form category I. Under category II come only two crops viz. rice and total pulses. And lastly, category III includes coarse cereals (all cereals crops excluding rice and wheat), total cereals, total foodgrain, groundnut, jute and mesta and tobacco. Though the expansion of area under the crops of category II and I is observed to be higher than the decline in area under the third category of crops, there is a clear indication of crop substitution. However, only marginal crops were substituted for major crops in India during the period under study and the cropping pattern was still found to have a bias towards foodgrain crops.

TABLE III
DECOMPOSITION OF THE TOTAL INCREASE IN OUTPUT IN TERMS OF AREA
EFFECT, YIELD EFFECT AND THE CROP AREA-GROSS CROPPED AREA
ELASTICITY UNDER CROPS IN INDIA
DURING 1970-71 TO 2006-07

Crops	Area effect (million tons)	Yield effect (million tons)	Total increase in output (million tons)	Increase in area (million tons)	'E'
Rice	9.318	41.815	51.1	6.03	0<E<1
Wheat	16.243	35.736	51.98	9.80	E>1
Other cereals	-9.111	12.482	3.37	-17.24	E<0
Total cereals	-4.963	111.443	106.48	-1.41	E<0
Pulses	-0.302	2.682	2.38	0.57	0<E<1
Food grain	-4.882	113.742	108.86	-0.84	E<0
Groundnut	0.5114	-1.761	-1.25	-1.69	E<0
Rape & mustard	2.486	2.974	5.46	3.28	E>1
Total oilseeds	6.232	8.428	14.7	9.41	E>1
Sugarcane	138.673	90.476	229.15	2.24	E>1
Cotton	2.628	15.242	17.87	1.53	E>1
Jute & Mesta	-1.308	6.389	5.08	-0.14	E<0
Tobacco	-0.093	0.253	0.16	-0.08	E<0
Tea	315.398	221.501	536.9	0.22	E>1
Coffee	115.501	54.299	169.8	0.20	E>1

Source: Statistical Abstracts of India, RBI Database.

The total change in the cropping pattern is the result of both substitution and expansion effect. For a given gross cropped area, substitution effect is defined as the relative decline in the area under some crops and the compensating increase in the area of the substitutable crops. The expansion effect, on the other hand, is defined as the increase in the gross cropped area. The changing cropping pattern in India during 1970-71 to 2006-07, in terms of substitution effect and expansion effect, is examined in Table IV.

It has been observed that the area under other coarse cereals, groundnut, jute and mesta and tobacco declined by 19.15 million hectares. On the other hand, the area under rice, wheat, pulses, total oilseeds, sugarcane, cotton, tea and coffee was increased by 30 million hectares. Thus, the expansion effect alone led to an increase of area under these crops by (30 – 19.15) or 10.9 million hectares.

TABLE IV
CROPPING PATTERN CHANGES IN INDIA: SUBSTITUTION
AND EXPANSION EFFECT 1970-71 TO 2006-07

Crops	Substitution Effect (million hectares)	Crops	Substitution & Expansion Effect (million hectares)
Other cereals	-17.24	Rice	6.03
Foodgrain Items	-17.24	Wheat	9.80
Groundnut	-1.69	Pulses	0.57
Jute & Mesta	-0.14	Foodgrain Items	16.4
Tobacco	-0.08	Rape & mustard	3.28
Non-foodgrain Items	-1.91	Total oilseeds	9.41
		Sugarcane	2.24
		Cotton	1.53
		Tea	0.22
		Coffee	0.20
		Non-foodgrain Items	16.88

Source: Author's calculation from data of RBI and Statistical Abstracts of India.

Therefore, the empirical evidence suggests that both expansion effect and substitution effect were important driving forces behind the cropping pattern changes in India. The substitution effect alone could explain 63.67 per cent of the change in gross cropped area and the remaining 36.33 per cent of the gross cropped area was due to the expansion effect.

Thus, there was a tendency of change in the cropping pattern of the country. The areas under non-foodgrain crops like oilseeds, sugarcane, cotton, wheat, rice, etc. have increased significantly. There is an indication of the shift from foodgrain crops to non-foodgrain commercial cash crops. However, in spite of a decline in total pulses area, foodgrain crops occupy the first position. Among

foodgrain crops, cereals crops have occupied the first place with the largest contribution from rice. Among non-foodgrain oilseeds, sugarcane, cotton, etc. have become the major crops of the country.

V. CONCLUSION AND POLICY IMPLICATIONS

From the overall analysis of the cropping pattern changes in terms of “cropped area- gross cropped area elasticity,” it is clear that the cropping pattern in the agricultural scenario of India in terms of allocation of acreage has been skewed towards foodgrain cultivation. However, during the last fifteen to twenty years some important crops (rice, wheat, mustard and cotton) have emerged as the main crops for the farmers. The cropping pattern moved against pulses, coarse cereals, groundnut, jute and mesta. It is also found that in the cropping pattern changes, the expansion effect could explain 63.67 per cent of the gross cropped area and the remaining 36.33 per cent of the gross cropped area was due to the substitution effect. In the cropping pattern scenario of India, although the non-foodgrain crops like oilseeds, cotton, sugarcane, etc. have been gradually replacing the foodgrain crops, the cropping pattern of the country is still dominated by foodgrain.

The trends of cropping pattern in India urgently calls for the introduction of an extension and development package to exploit the untapped potential of agriculture in strengthening the diversification process of the agricultural activities in the country. Appropriate extension programmes along with the government support services in terms of minimum sale prices of the newly cultivated crops, storage facilities, technological support, and crop insurance are of utmost importance to take the advantage of globalisation and to attain a higher growth path in agriculture in the face of the emerging threats of declining trend of foodgrain productivity in Indian agriculture.

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