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Measuring Growth Performance of Selected Agricultural Crops in Bangladesh

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ABSTRACT

The study attempted to find out the relationship and estimates the growth rates of area, production, and yield of pulse, oilseeds and sugarcane in Bangladesh using secondary data covering the period from 1997-98 to 2017-18 through exponential model, correlation coefficient and simple linear regression model. Here, the whole period was divided into two sub periods such as period-I (1997-98 to 2007/08) and period-II (2008-09 to 2017-18). Results indicated that high correlation exist between area and production of pulse, and sugarcane and low correlation between area and production of oilseed. During the whole period (1997/98-2017/18), overall production on area of pulse and sugarcane have been increased except oilseeds (r=0.112). Growth rates of area which was negative but significant for pulse, oilseeds and sugarcane were 2.9, 0.04 and 3.6%, respectively. The growth rates of area of pulse, sugarcane and oilseeds were negative in period-I. But in period-II, area of pulse and oilseeds grew significantly at the rate of 6.3% and 3.1%, respectively. Growth rates of production which was significantly negative for pulse (1%) and sugarcane (3.4%) respectively and positive for oilseeds (5.4%) during the whole period. In period-I, production growth rates of pulse and sugarcane were negative but in period-II, production of pulse and sugarcane grew significantly at the rate of 8.7% and 3.8%, respectively. Growth rates of yield were significantly positive for pulse, oilseeds and sugarcane during the overall period. In period-I and period-II, pulse and oilseeds yield growth rates were found positive but yield of sugarcane grew positively in period-II than previous period. Analyzing the growth rates of area, production and yield of pulse, sugarcane and oilseed may guide the farmers allowing rational distribution of area which would enhance the production of these crops in Bangladesh.

Introduction

The economy of Bangladesh is mainly reliant on agriculture, which contributes about 14.23% to the gross domestic product (Bangladesh Economic Review, 2019). The arrangement of this sector has an excessive effect on employment generation, reduction of poverty, human resources development and food security (Wikipedia, 2019). Rice is the principal food crop of Bangladesh which covers 75 % of total cropped area and residual 25% includes other crops such as wheat, jute, sugarcane, oilseeds, pulses, vegetables, spices and condiments etc. (Khatun, 2011). Rice mainly controls the cropping system in Bangladesh. But only high volume of production of rice will not be sufficient to fulfill the demand of huge population. Production of other crops viz., sugarcane, vegetables, pulses, oilseeds and fruits are relatively inadequate. As a result, malnutrition among the population is an extreme problem now-a-days.

Pulses are vital source of vegetable protein and the second most important food for human being. Bangladesh has good climatic conditions which is favorable for growing pulse. Usually pulses are entitled as the deprived man's meat subsequently these are more inexpensive source of protein in regular nutrition. The most important pulses grown are khesari, lentil, chickpea, black gram, mung bean and cowpea, which contribute to more than 95% of total pulses production in the country. The nutritional statuses of pulses are abundant and they are also valuable foundation of energy. The energy content of most pulses has been found to be between 300 and 540 Kcal/100g (Tiwari et al., 2011). Pulses support to improve the protein intake of meals in which cereals and root tubers in combination with pulses are eaten (Kushwah et al., 2002). The per capita consumption of pulse in Bangladesh is only 15.60 gm/day which is much lower than the suggested daily consumption of 80 gm/day (Bangladesh Bureau of Statistics, 2016). Although pulses are excellent sources of proteins and energy, but they are deliberated as negligible crops and obtain little attention from farmers

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and policymakers. The area under pulse production has decreased constantly for the last few years in Bangladesh (Shahjahan, 2002). Since Bangladesh has developed significantly in rising rice and potatoes production to fulfill our essential food necessities, so now it is important to raise production of pulse for alleviating human malnutrition from the country.

Edible oils play vital roles in human nutrition by supplying calories and vitamins. Since 1999, there has been considerable change in oil consumption in Bangladesh. The per capita consumption has been increased from 5 to 6 kg per year to 10 kg from the previous figure. This increase is encouraging, as it would have a positive effect on the energy concentration of the presently insufficient diet and have progressive influence on national health (Nahar et al., 2013). At least 15% of the total calories derive from oils or fats for maintaining good health. Some oilseeds are also a source of good quality protein, vitamins, and fuel. The major oilseed crops include soybean, coconut, oil palm, sesame, rapeseed, sunflower, olive seed, etc. Majority of the oilseed meal consists of proteins and high contents of essential amino acid which are useful to human health and wellbeing. Bangladesh has to spend a huge amount of foreign exchange on imports of edible oils and oilseeds to meet the increasing demand of huge population. The value of imports is increasing year after year. The values of imported edible oils and oilseeds were USD1574 million and USD354 million in 2014-2015, respectively (Bangladesh Bank, 2016).

Botanically, sugarcane is known as *Saccharum officinarum* and belongs to *Gramineae* family. Sugarcane is one of the agro-based industrial crops in Bangladesh and sustains the economy of large number of rural people. It is the key source of sugar and gur (jaggery). Gur holds around 98% carbohydrates and approximately 97% sugar content. 10 grams gur delivers 38 calories (Singh, 2014). Almost 70% of total world's sugar is made from sugarcane and 30% from sugar beet (Iqbal and Saleem, 2015). Apart from diabetic patients, more than 99% people consume sugar/gur and sugar products on a regular basis. An annual requirement of sugar/gur is 19.97 lakh metric tons in Bangladesh. An average 7.3 million ton sugarcane is produced from 0.18 million hectares of land and average 0.15-0.20 million ton sugar and 0.35-0.40 million ton molasses is produced from the 7.3 million ton sugarcane per year (Bangladesh Sugarcane Research Institute, 2011). Deficit of sugar is met from importation. Shortage in gur cannot be met from importation, because gur is not available in the international market (KA, 1996). Thus, it is essential to increase the sugarcane area and production to meet up our national demand. But sugarcane area is declining day by day. During the period of 2015-16, 2016-17 and 2017-18, total sugarcane area was0.98 lack ha, 0.93 lack ha and 0.91 lack ha respectively (Bangladesh Bureau of Statistics, 2018).

Currently, Bangladesh has been producing around 3.64 million tons of sugarcane, 0.39 million tons of pulses, 1.026 million tons of edible oilseeds which are far away from the requirements of total consumption in the country (Bangladesh Bureau of Statistics, 2017). In addition, the country is compelled to import sugars, oils, pulses, etc. from abroad to fulfill the demand. Therefore, crop diversification is essential in order to reach the aim of nutritional food self-sufficiency, balanced supply of food. The production of pulse has to be increased to facilitate the required nutritional food consumption of the low income earning people. Increasing production of sugarcane is also important because many farm families are reliant on sugarcane cultivation for their survival. Likewise, Oilseed crops are auspicious crop with high capabilities to improve human diets, prevent malnutrition and food security in Bangladesh.

In order to explore the potentialities and possibilities of expansion in the acreage and production of the minor crops, like pulses, sugarcane and oilseed, it is essential to examine the past performance of these crops. The production structure, changing production trends of different agricultural crops and the effects of technical change of agriculture are preconditions for greater understanding of agricultural growth as well as the economic development in Bangladesh. To fulfill the increasing demand of the country, it is necessary to increase area, production and yield of pulse, oilseed and sugarcane in Bangladesh. Therefore, considering the significance of these crops in the perspective of Bangladesh economy, the present research has been undertaken to examine the relationship between area, production, and yield and growth performance of pulse, oilseed and sugarcane in Bangladesh.

Materials and Methods

The present study is aimed at estimating the area, yield and production of growth rates of pulse crops, oilseed and sugarcane over the years in the country as a whole. For better understanding of the materials and method used are discussed in each of the following aspects: selection of crops, selection of period of the study, sources of data and empirical method used in relation to the estimation of relationship and growth rates of selected major crops are presented in this section:

Selection of Crop

In this study three important agricultural crops were selected. These are pulse (leguminous crop), sugarcane (cash crop), and oilseed (vegetable oil).

Selection of period of study

For computing growth rates of major pulse crops, oilseeds and sugarcane, time series data from 1997-98 to 2017-18 have been used. For estimating the relationship and comparing the growth rate, the whole period (1997/98-2017/18) has been divided into two periods such as period -I (1997/98-2007/08) and period -II (2008/09- 2017/18).

Sources of data

The data used in the present study were compiled from various published sources, mainly from the different issues of Bangladesh Bureau of Statistics (BBS).

Processing of data

To eliminate errors and biasness, all data were carefully checked for completeness and summarization. Then it was transferred to MS excel and SPSS in a systematic way for analysis.

Analytical techniques

Different methods of analysis have been employed in the study to fulfill the objectives and to interpret the actual findings.

Correlation and regression analysis

The degree of association between area and production were measured by correlation coefficient (r). The correlation coefficient (r) was measured by following formula:

$r=n(\sum xy)-(\sum x)(\sum y)/\sqrt{[\sum x^2-(\sum x)^2][n\sum y^2 (\sum y)^2]}$.....[1]

To see the degree of relationship between area and production and to test the dependency of production on area simple linear regression function was fitted to the data. Linear model form:

$Y= a + bx$..... [2]

where, Y =Dependent variable (production/yield); x = Independent variable (area); a = intercept; andb = regression coefficient

Estimation of growth rate

For computing growth rates of area, production and yield exponential trend function was fitted to the data. Exponential model form:

$Y = \alpha e^{bt}$..... [3]

Or, $LnY = Lna + bt$

where, Y = Dependent variable (area/production/yield); b = Growth parameter to be estimated; t = Time and Ln = Natural log of the variable.

In this exponential equation 'b' is the growth rate in ratio scale and when multiplied by 100 it expresses percentage growth, i.e., annual compound growth rate.

Results and Discussion

To achieve agricultural growth especially self-sufficiency in food, the spreading of modern technologies has been placed more prominence method for agricultural development in the country. Increasing yield of a crop is deliberated as an indicator of progress and accomplishment. Estimation of relationship and analysis of growth rates of area, production and yield of pulse crops, oilseed and sugarcane are useful for policy making subsequently they support to realize the extent and way of changes that are taking place. The trend of area, production and yield of pulse, sugarcane and oilseed are shown by graphical representation.

Trends of production of the crops for the period 1997-98 to 2017-18

The trend in area, production and yield of pulse crops of Bangladesh for different years is presented in the Figure 1. In Figure 1, it has been shown that area under pulse cultivation is decreasing up to 2007/08. After that, the area of pulse has been started to increase gradually up to 2017/18. Production of pulse crop follows more or less similar trend of area of pulse. But the yield of pulse is increasing up to 2007/08 after that yield of pulse is exhibited fluctuating trend.

The trend in area, production and yield of oilseed of Bangladesh for different years is shown in the Figure 2. Area under oilseed cultivation is decreasing for certain years (1997/98 to 2003/04) then it started to increase gradually over the period (2003-04 to 2017/18). Production of oilseed also followed the same trend up to 2003/04 after that it showed increasing trend over the years. Yield of oilseed is increasing up to 2002/03 then decrease in 2003/04 after that yield of oilseed is exhibited increasing trend.

Area, production and yield of sugarcane in Bangladesh for the period 1997/98 to 2017/18 is shown in Figure 3. Area under sugarcane cultivation is more or less same but in the last few years it is slightly decreasing year by year while production follows decreasing trend over the overall period (1997/98 to 2017/18). On the other hand, yield of sugarcane is exhibited fluctuating trend during the whole period.

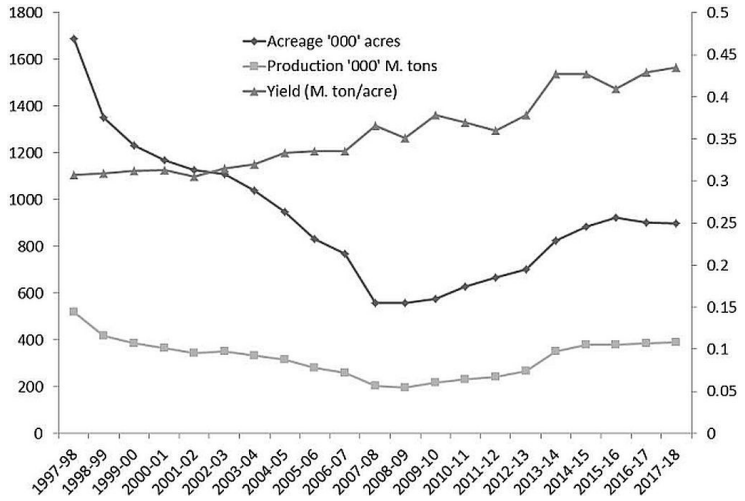

Figure 1. Area, production and yield of pulse in Bangladesh for the period 1997/98 to 2017/18

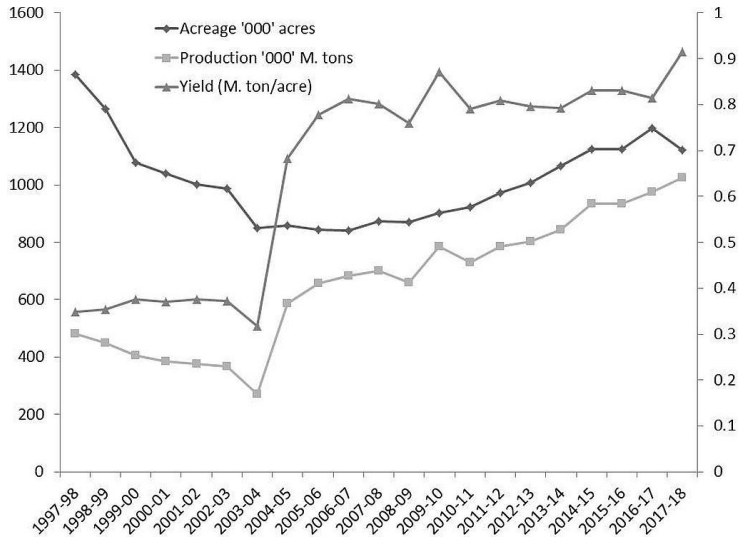

Figure 2. Area, production and yield of oilseed in Bangladesh for the period 1997/98 to 2017/18

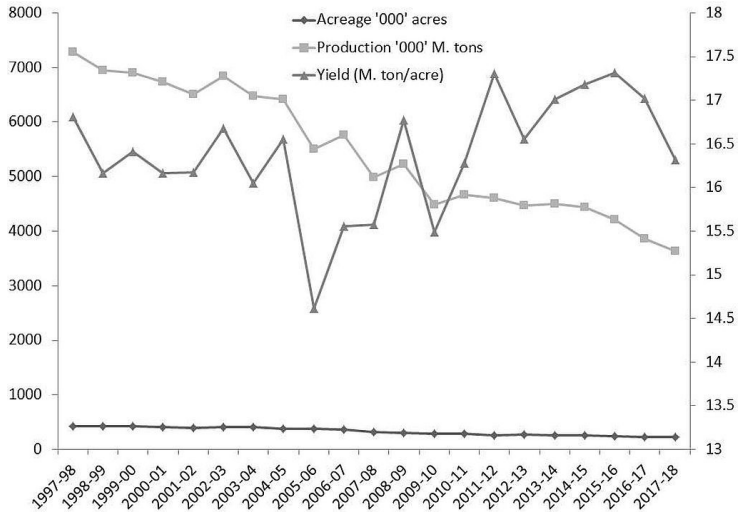

Figure 3. Area, production and yield of sugarcane in Bangladesh for the period 1997/98 to 2017/18

Relationship between area and production

It is observed that production of pulse and sugarcane is strongly and positively correlated with its area for the whole period(1997/98-2017/18)and also for period-I(1997/98-2007/08) and period-II(2008/09-2017/18) (Table 1).The values of correlation coefficient are 0.895 (pulse), 0.112 (oilseed)and 0.984 (sugarcane) for the whole period, whereas for period-I, the values are 0.99 (pulse), 0.32 (oilseed) and 0.96 (sugarcane) and for period-II, the values are 0.99 (pulse), 0.93 (oilseed) and 0.94 (sugarcane). The association between production and area of pulse and sugarcane are statistically significant which indicates that the increase of area of pulse and sugarcane strongly influences the production of pulse and sugarcane to rise for the whole study period and also for period-I as well as for Period-II. Uddin et al. (2015) reported that the production of pulse is significantly and positively correlated with area for the period (1986-2009) and the value of correlation coefficient is 0.988. On the other hand, only in period-II, area and production of oilseed is significantly correlated (r= 0.93). But for whole period, changing an area of oilseed may not cause the high change in production variability for low value of correlation coefficient and statistically insignificant as well as in period-I. Chowdhury et al. (2014) investigated oilseeds area and production variability in Bangladesh. They found that the relationship between area and production of oilseed is negative (r = 0.362) for the period (1987-2010).

Regression analysis

To see the response of production of pulse, oilseed and sugarcane on area the simple linear regression models have been used. In Table 2, it reveals that during the period-I, period-II and whole time period, due to one acre increment in area, the pulse production has increased by 0.274, 0.574 and 0.256 times respectively. According to Uddin et al. (2015), estimated coefficients of production on area of pulse are significant during the period (1986-2009). It indicates that the production of pulse has enhanced by 0.274 times during that period. From the analysis, we found that average production of oilseed has decreased by 0.261times for one acre expands in area of oilseed during the period-I but oilseed production has risen by 0.967 times in period-II and 0.168 times during the whole period. Chowdhury et al. (2014) found that the average production of oilseed has decreased by 0.227 times for a unit change in area of oilseed. However, for one acre increase in sugarcane area, the production of sugarcane also increased by 20.463, 14.752 and15.421 times during the period-I, period-II and whole period respectively (Table 2). Here, the response of production is high in a relation with area for pulse followed by sugarcane. But production of oilseed is low in a relation with area coverage.

Growth rate of area, production and yield of pulse

Growth rates in area, production and yield of pulse was computed to have a comparative measure to see the relative growth during the overall period (1997/98 to 2017/18). Table 3 shows growth rates of area, production and yield of pulse for the period-I (1997/98-2007/08), period-II (2008/09-2017/18) and overall period (1997/98-2017/18). During the period-I under study, area of pulse had decreased at the rate of 8.6% which was statistically significant. Production of pulse also decreased at the rate of 7.2% during the same period. In period-I, it was observed that yield of pulse exhibited positive growth rate which had been significant due to modern technology. In period-II, it was observed that area, production and yield of pulse grew very significantly. Growth of area under pulse had increased at higher rate of 6.3% in period-II from period-I. Production growth has been influenced by only significant area expansion. Area increase helped production increase at a very higher rate of 8.7% in period-II compared to the period-I. Yield of pulse growth has also increased significantly which only come through significant yield improvement. Yield of pulse had increased from 2.4% to 2.73 % during this period. Yield increase of pulse has been significant which tells that technological improvement has been reached. Result also revealed that area of pulse has been decreased significantly at the rate of 2.9% during the entire period. However, it is observed that total pulse production declined which was statistically significant during the whole period (Table 3). Cultivable area under pulse crop is deteriorating gradually which indicates an alarming situation for the country. This finding is also supported byUddin et al. (2015), the area and production of pulse for the whole period (1986-2009) has not been increased. Yield of pulse also had a significant positive growth rate of 1.9% over the overall period. The finding is affirmed byUddin et al. (2015) who stated that yields of pulse have been increased significantly during the period (1986-2009).High yield of pulse crop is the reflection of improvement of technology. So, in this study we observed that yield of pulse crop has been increasing though the area of pulse has been decreased.

Growth rate of area, production and yield of oilseed

In period-I (1997/98-2007/08), area of oilseed showed negative growth rate of 6.7% which was also statistically significant (Table 4). However, it is observed that yield of oilseed had positive growth rate of 4.9% in period-I (1997/98-2007/08). Production of oilseed had showed insignificant negative growth rate in Period-I (1997/98-2007/08). During the period-II (2008/09-2017/18) under the study, it was observed that area of oilseed exhibited significant positive growth rate of 3.1%. Growth of

oilseed yield grew very significantly at the rate of 0.7 % in period-II than the previous period. Increased growth rate of oilseed yield affected increased production to 3.8% significantly in period-II than the previous period. During the overall period under this study, area of oilseed was observed to have negative insignificant growth rate. Yield of oilseed exhibited positive growth rate of 5.4%during the whole period. Increased growth rate of oilseed yield affected increased production significantly. According to Chowdhury et al. (2014) who found that the growth rates of areas of oilseeds for the period (1987-2010) is negative which is highly significant at 1% level. In spite of reduction of area, the growth rates of the production and yield of oilseeds are positive during the whole period. Therefore, it is clear that the yield of oilseed has increased though the cultivable area is reduced. Similar result is obtained by Singh et al. (2015) who found that growth rate of area of oilseed declined from the period 1982/83 to 2011/12. But Reddy and Immanuel (2017) reported high growth rate in production of oilseed than the growth rate in the area from 1980/81 to 2011/12 due to increase in yield that is similar with the present study.

Growth rate of area, production and yield of sugarcane

Growth rate of area, production and yield of sugarcane is shown in Table 5. During the period-I, area of sugarcane exhibited significant negative growth rate of 2.3% followed by period-II (3.4%) and overall period (3.6%). Growth of production under sugarcane crop was also observed to have declined significantly at the growth rate of 3.1%, 3% and 3.4%during the period-I, period-II and whole period respectively. Yield of sugarcane had insignificant effect in the period-I. Growth of sugarcane yield grew positively at the rate of 0.4% in period-II than the previous period. However, significant changes were observed in growth performance of sugarcane yield in whole period due to yield improvement. According to Akhter et al. (2016), growth rate of production and yield of sugarcane crop was statistically significant but sugarcane area was statistically insignificant.

Table 1. Relationship between area and production of pulse, oilseed and sugarcane in Bangladesh for the period 1997-98 to 2017-18

Field of measurement	Pearson Correlation		
	Pulse	Oilseed	Sugarcane
Period-I (1997/98-2007/08)	0.99* (0.00)	0.32 (0.33)	0.96* (0.00)
Period-II (2007/08-2017/18)	0.99* (0.00)	0.93* (0.00)	0.94* (0.00)
Whole period (1997/98-2017/18)	0.895* (0.00)	0.112 (0.630)	0.984* (0.00)

Note: * indicates at 1% level of significance

Table 2. Testing dependency of production on area of pulse, oilseed and sugarcane

Field of measurement	Pulse	Oilseed	Sugarcane
	Period-I(1997-98 to 2007-08)		
Y=a+bx	Y=47.86+0.274x	Y=749.13-0.261x	Y=-1735.70+20.463x
Significant	0.000	0.330	0.000
R square	0.995	0.105	0.922
	Period-II(2008-09 to 2017-18)		
Y=a+bx	Y= -109.95+0.547x	Y= -149.91+0.967x	Y=515.95+14.752x
Significant	0.000	0.000	0.000
R square	0.983	0.865	0.886
	Whole period (1997-98 to 2017-18)		
Y=a+bx	Y=87.40+0.256x	Y=488.80+0.168x	Y=302.36+15.421x
Significant	0.000	0.630	0.000
R square	0.80	0.012	0.968

Table 3. Growth rate of area, production and yield of pulse

Field of measurement	Pulse	Oilseed	Sugarcane
	Period-I(1997-98 to 2007-08)		
Growth rate	-8.6*	-7.2*	1.4*
Significant	0.000	0.000	0.000
R square	0.912	0.910	0.748
	Period-II(2008-09 to 2017-18)		
Growth rate	6.3*	8.7*	2.4*
Significant	0.000	0.000	0.001
R square	0.923	0.916	0.786
	Whole period(1997-98 to 2017-18)		
Y=a+bx	-2.9*	-1.0*	1.9*
Significant	0.004	0.000	0.000
R square	0.362	0.055	0.922

Note: * indicates at 1% level of significance and *** indicates at 10% level of significance

Table 4. Growth rate of area, production and yield of oilseed

Field of measurement	Pulse	Oilseed	Sugarcane
	Period-I(1997-98 to 2007-08)		
Growth rate	-6.7*	-1.8	4.9
Significant	0.000	0.651	0.192
R square	0.930	0.036	0.285
	Period-II(2008-09 to 2017-18)		
Growth rate	3.1*	3.8*	0.7***
Significant	0.000	0.000	0.059
R square	0.944	0.933	0.286
	Whole period(1997-98 to 2017-18)		
Y=a+bx	-0.04	5.4*	5.4*
Significant	0.937	0.000	0.000
R square	0.000	0.763	0.725

Note: * indicates at 1% level of significance and *** indicates at 10% level of significance

Table 5. Growth rate of area, production and yield of sugarcane

Field of measurement	Pulse	Oilseed	Sugarcane
	Period-I(1997-98 to 2007-08)		
Growth rate	-2.3*	-3.1*	-0.8**
Significant	0.000	0.000	0.034
R square	0.797	0.804	0.408
	Period-II(2008-09 to 2017-18)		
Growth rate	-2.3*	-3.1*	-0.8**
Significant	0.000	0.000	0.034
R square	0.797	0.804	0.408
	Whole period(1997-98 to 2017-18)		
Y=a+bx	-3.6*	-3.4*	0.2*
Significant	0.000	0.000	0.000
R square	0.959	0.950	0.110

Note: * indicates at 1% level of significance and *** indicates at 10% level of significance

Conclusion

The value of coefficient is highly significant for pulse and sugarcane crops but the value is insignificant for oilseed. The dependence of production is good in association with area for pulse as well as sugarcane. On the other hand, oilseed production is not high in a relation with the area. During the overall study period for the country as a whole, growth rates of area which was negative for pulse. The areas of pulse decreased significantly at the rate of 2.9% during the period (1997/98-2017/18). The growth rate of yield was positive for pulse. In spite of increasing yield of pulse, production decreased during the whole period (1997/98-2007/08) due to declining areas of pulse crops. Oilseed production was higher than the increase of area of oilseed. The area of oilseed decreased significantly at the rate of 0.04% during the overall study period (1997/98-2017/18). The growth rate of yield was positive for oilseed. The increment of yield of oilseed is stimulated to increase production of oilseed because of technological development and adoption of new technologies. The results also revealed that area of sugarcane which decreased to 3.6% during the whole period. Production also decreased in 2017/18 which was 3.4%. The decline in sugarcane production is attributed to declining area of sugarcane. The growth rate of yield was positive for sugarcane. Moreover, growth of yield is higher from the period 1997/97 to 2017/18 due to technological advancement. For increasing production of pulse, oilseed and sugarcane crop, government should inspire the farmers to accept upgraded agronomic practices such as use of HYV seed, fertilizers, pesticide and irrigation by providing incentives. Government should also deliver efficient marketing infrastructure such as wholesale, retail and assembly markets and storage facilities so that growers get remunerative price of their produce. Potential areas should be brought under pulse, oilseed and sugarcane cultivation as soon as possible. Private sectors should be involved in pulse, oilseed and sugarcane production. Regular training programme should be conducted for farmers and extension personnel. Institutional credit facilities may be provided to farmers on a regular basis.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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