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Growth rate of cost of cultivation of soybean in Maharashtra States of India

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Abstract
In India, many states grow soybean crops but Madhya Pradesh has the first position in soybean-growing states and it is also known as soya state. Maharashtra and Rajasthan state has a second and third position in India. Three states mainly Madhya Pradesh, Maharashtra, and Rajasthan accounted for almost 90% of the area under soybean cultivation. The area of soybean in Madhya Pradesh is 5.91million hectares with a total production of 4.91million tonnes with an average yield of 831million kg/ha. Maharashtra and Rajasthan cultivate soybean in an area of 3.70 and 1.20 million hectares with a production of 2.06 and 1.00 million tonnes with an average yield of 557 and 833 million kg/ ha respectively (Agricultural statistical at a glance 2016). Twenty years of data were collected for the study. The area, production, and productivity, cost of cultivation, gross income, factors affecting the profitability of soybean by collected from secondary data. Secondary data was collected from different publications. The analytical tools used were absolute change, relative change, simple growth rate, compound growth rate and coefficient of variation. The trend and growth rates of labour cost in Maharashtra showed that more than 50 per cent of the costs were incurred in human labor followed by machine labour and bullock labour. The bullock labour constituted about 18 per cent of the total labour costs and surprisingly much of labour cost in Maharashtra was not substituted by machine labour as observed in Madhya Pradesh. Decrease in the labour units for the cultivation of one hectare of land over the study period in Maharashtra shows that the marginal productivity of labour in soybean cultivation was increasing which was desirable. Increase in the labor cost was due to the increase in the unit labor rate. The bullock labour units were also showed a decreasing trend during the study period but the unit rate was increasing. Trend and growth of major inputs indicated that seed, fertilizers and manures, plant protection chemicals and irrigation were the major inputs used in Maharashtra. The highest growth rate was observed in plant protection chemicals which further depicted the increasing use of chemicals in pests and disease management or increasing incidence of pests and disease in soybean cultivation. Followed by, growth in irrigation charges also increased indicating that more investment for irrigation was observed in the soybean farmers of Maharashtra. The quantity of seed was decreasing but fertilizers and manures used per hectare were increasing during the study period in Maharashtra. Similar to Madhya Pradesh the unit rates for the inputs were increasing resulting in the increase in the input costs. Similar to Madhya Pradesh, the increase in the cost of seed incurred can be due to use of hybrid seed. The increase in the cost of manure can be due to farmers were not having sufficient own farm manure which makes the farmer to buy it from other sources. Therefore, there is an increase demand for manure in the market. Which pushes the demand for manure in the market and thereby pushes the price of manures. Trend and growth of fixed cost incurred in cultivation of soybean in Maharashtra showed that the total fixed cost per ha was increasing at a growth rate of 9.39. All the item of fixed cost had shown increasing except for land revenue cesses and taxes. Thus, the total cost of cultivation of Soybean in Maharashtra was increasing during the study period at a growth rate of 8.91 per cent. Similarly, the cost of producing per quintal of soybean increased at a growth rate of 8.61 per cent. Thus, all the cost components like labour costs, input costs and fixed costs were increasing during the study period making the farmer to invest more in the same piece of land.

Keywords: Area, production, productivity, variability, growth

Introduction

In India soybean was important oilseed crop because of its unique quality and fulfills the vegetable oil demand of population. Soybean is a legume cum oilseed crop which belongs to legume family and is believed to be originated in China as early as 11th century. Written records of soybean farming are dated from 2200BC. The emperor Sheng-Nung named it as one of the five sacred grains. Thus, soybean has been cultivated in china for more than 4,000 years (Hymowitz, 1970) [4]. Soybean was grown in India from early 1800s.

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Black soybean was grown for ages in low Himalayan hills, in the foot hills and also some scattered regions of central India. Thus, Soybean being both legume and oilseed gained it's significance of fats and protein in Indian dietary (Bisaliah S. 1986) [5]. Attempts to explore the possibility of developing it as a commercial crop were initiated in the country in the 1960's. Most of the literature shows that the commercial cultivation of Soybean started in the country in 1970's. The expansion of soybean cultivation has happened rapidly compared to many other crops in India. Soybean crop has replaced other crops and made its important position because it give more profit to farmer as compared to other crops due to it's higher returns (Sharma *et al*. 2005) [9]. The area of soybean increased tremendously due to shift of area from cotton, groundnut, cereals, etc. (Nahatkar *et al*. 2005) [7] and in the different country of world soybean substituted other crop like sunflower in Argentina, cotton in United states and utilizing pasture land in Argentina and Brazil and expanded area of soybean (Masuda and goldsmith, 2009) [6]. Madhya Pradesh (also known as soya state), Rajasthan and Maharashtra are the major soybean growing states of India. The Soybean crop showed big change in Indian agriculture due to its increased area in these three states of India. In the year 1986-87, area of Soybean was 1209.6, 54.6, and 52 Thousand Ha in Madhya Pradesh, Maharashtra and Rajasthan respectively which increased to 4741.6, 1620.0, and 601.0 Thousand Ha respectively in 1999-20. The Production and productivity also increased similarly except for some years. The area of soybean in Madhya Pradesh is 5.91million hectares with a total production of 4.91million tonnes with an average yield of 831million kg/ha. Maharashtra and Rajasthan cultivates soybean in an area of 3.70 and 1.20 million hectares with a production of 2.06 and 1.00 million tonnes with an average yield of 557 and 833 million kg/ ha respectively (Agricultural statistical at a glance 2016). Cost of cultivation of a commodity is the total expenditure incurred on various operations and inputs that are used in the production of the commodity. Correct identification of these input and their measurements is crucial for realistic assessment of cost incurred in the production of the commodity. (Jaiswal and hugar, 2011). The operational cost of soybean cultivation had increased gradually indicated that soybean cultivation was turning capital intensive. Growth in real cost of cultivation of soybean outpaced the growth in real returns from soybean in major states. (Sharma P.2016). Due to inflation and the other economic factors, the cost of cultivation has increased but the farmer's are not getting enough returns to cover up the costs incurred.

Material and Methods

Different objective of study secondary data was used. It was mainly collected from Agriculture Statistics of India including Maharashtra with other published and unpublished records like web site of Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, Cost of Cultivation of Principal Crops in India, New Delhi Ministry of Agriculture. The states wise time series secondary data were collected for the period of 20 years from 1996-97 to 2015-16. The whole study period was broke in to three sub periods, Period I(1996-97 to 2005-06), Period II(2006-07 to 2015-16),the pooled data also used for study of entire period (1996-97 to 2015-16). To assess the percent contribution of different components in cost and gross income of soybean, the time series secondary data for the period of 1996-97 to 2015-16 has been used.

Trend

To study the trend analysis of soybean, the trend analysis was carried out using liner regression equation The liner regression equation was fitted to least square method.

$$Y = a \pm b \, x + E$$

Where
Y= Trend value of dependent variable (Area / production / yield)
a = Constant or Intercept value
b = Regression Coefficient
x = Independent variable (Time period)
E = Error term with mean zero and constant variance where Regression Coefficient (b) was worked out as follows-

$$b = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sum X^2 - \frac{(\sum X)^2}{n}}$$

The intercept value (a) was estimated as follows

$$a = \overline{Y} - b\overline{x}$$

Compound growth rate in area, production and productivity

Compound growth rates of area, production and productivity of soybean was worked out during the period 1996-97 to 2015-16. The period was further sub divided in three periods. Compound growth rate was worked out by fitting exponential function as given below:

$$X_t = ab_t$$
$$\text{Log } X_t = \text{Log } a + t \log b$$
Compound growth rate (r) = (antilog b-1) * 100

Where
X_t = Area/production/productivity of soybean in the year 't'
t = Time element which takes the value 1, 2, 3,………. N
a = Constant
b = Regression Coefficient
't' test was use to test the significance of the compound growth rate.

Multiple regression analysis

Multiple regression analysis was carried out standing the time series data for the period 1996-97 to 2015-16 to identify the important factors affecting soybean crop and affect are analyzed by using the function form.

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + \varepsilon$$

Where
Y = Gross Income (Rs /ha) (Dependent Variable)
x_1……. x_8=Independent Variables
x_1= Expenses on seed (Rs/ha)
x_2= Expenses on fertilizer (Rs/ha)
x_3= Expenses on human labor (Rs /ha)
x_4= Expenses on animal labor (Rs /ha)
x_5= Expenses on machinery(Rs/ha)
x_6= Expenses on insecticide (Rs/ha)
x_7 = Expenses on irrigation (Rs/ha)

x8 = Yield qt/ ha
b1……b8 Regression Coefficient
ε = Error term

Results and Discussion
Cost of cultivation of soybean and its growth rate
Growth rate of cost of cultivation of soybean in Maharashtra

Trend and growth of labour cost incurred in cultivation of soybean in Maharashtra during the period under study and contribution of different types of labour *viz* human labour, bullock labour and machine labour in different point of the study have been analyze and presented in table 1.It was observed from the table that the total cost of labour used in cultivation of soybean was increased at 146.06 and 548.26 per cent in the 2005-06 and 2015-16 as compared to 1996-97(Rs.3207.41/ha). The total labour cost increased at a growth rate of 8.99 per cent per year during the study period. Among the different components of total labour cost, the cost on human labour constituted 57.05 percent followed by machine labour (25.10%) and bullock labour (17.85%)in 2015-16.But in 1996-97, the cost of bullock labour constituted 27.04 per cent whereas machine labour constituted only 5.81 per cent of the total labour cost in Maharashtra. The growth rate were increasing significantly for all the components of total labour during the study period and highest growth rates were observed in machine labour compared to human labour and bullock labour. The expenditure of total human labour increased from Rs. 2,153.77 per ha in 1996-97 to Rs. 3,012.80 per ha in 2005-06 marking a per cent change of 39.88 over 10 years. But in 2015-16, the costs increased to Rs.11,860.89 per ha marking a percentage change of 450.70 over 20 years. The expenditure on total bullock labour increased from Rs.867.33 (1996-97) to 3382.69(2005-06) and 3713.34/ha in (2015-16) as compared to 1996-97.It was found to be increased with the magnitude of Rs.328.13 with the growth of 5.05 per cent year during the period of 1996-97 to 2015-16.The contribution of total bullock labour cost was found to be increased from 27.04 (1996-97)to 42.87 per cent (2005-06), while it was to be decreased to 17.85 per cent in the 2015-16.The expenditure on machine labour was found to increased to 703.47 and 2700.78 per cent in the year 2005-06 and 2015-16 respectively from the year 1996-97(Rs.186.31/ha).The expenditure on machine labour was found to be increased with the magnitude of 306.86 per ha per year with a significant growth of 12.45 per cent per year during the period of 1996-97 to 2015-16.Amongst the hired and owned machine labour the expenditure on hired and owned human labour was found to be increased with the magnitude of Rs.286.69 and 20.18 per ha per year during the period 1996-97 to 2015-16.The growth of hired machine labour (12.32%) was found to significant as compared to significant of machine labour (14.52%).The trend and growth rates of labour cost in Maharashtra showed that more than 50 per cent of the costs were incurred in human labor followed by machine labour and bullock labour. The bullock labour constituted about 18 per cent of the total labour costs and surprisingly much of labour cost in Maharashtra was not substituted by machine labour as observed in Madhya Pradesh. The trend and growth of different labour units in cultivation of soybean in Maharashtra was presented in table 2. The growth rate of labour units of both human (-0.87%) and bullock labour was (-3.14%) was negative and non–significant during the study period. In both the cases, there was increase in labour units

from 1996-97 to 2005-06 but it shows decreased at 2015-16.The unit rates of labour showed a significantly positive growth rate for human laour (10.60%) and bullock labour (8.57%).The growth rate in the cost of bullock labour and human labour even though the labour units were decreasing was due to the increasing labour units for both human and bullock labour. Decrease in the labour units for the cultivation of one hectare of land over the study period in Maharashtra shows that the marginal productivity of labour in soybean cultivation was increasing which was desirable. Increase in the labor cost was due to the increase in the unit labor rate. The bullock labour units were also showed a decreasing trend during the study period but the unit rate was increasing. The various item of input costs of Maharashtra *viz*. cost of seed, fertilizer and manures, plant protection chemicals, irrigation charges, miscellaneous expenditure and interest on working capital across points of time of the study and percentage change over the base year (1996-97) in 2005-06 and 2015-16 with trend and growth have been analyzed for the study and presented in table 3.The total input cost was Rs.2261.63 per ha in 1996-97 which increased to Rs.3310.88 per ha in 2005-06 with a percentage change of 46.39 and increased to Rs.10,855 per ha with a percentage change of 381.29. Amongst different items of input cost the maximum expenditure was found to be incurred in seed (42.59%) followed by fertilizer and manures (36.50%) and plant protection chemicals (7.59%) to total input cost (Rs.10885.1/ha) in cultivation of soybean in the year 2015-16. The percentage share of all these items of input cost found to be similar with minor variation in the 1996-97 and 2005-06.However, growth rate of expenses on plant protection chemicals (16.34%) increased at higher rate as compared to seed (8.14%) and fertilizer and manures (9.30%). Even though figures on expenses on irrigation was '0' for the year 2005-06 and 2015-16,for the overall study period it showed a positive growth rate of 13.22 per cent. Trend and growth of major inputs indicated that seed, fertilizers and manures, plant protection chemicals and irrigation were the major inputs used in Maharashtra. The highest growth rate was observed in plant protection chemicals which further depicted the increasing use of chemicals in pests and disease management or increasing incidence of pests and disease in soybean cultivation. Followed by, growth in irrigation charges also increased indicating that more investment for irrigation was observed in the soybean farmers of Maharashtra. An attempt was also made to find out the variation, trend and growth of quantity and unit rates of various inputs used by the soybean growers of Maharashtra during the period under study and the result were presented in table 4. It was observed that the quantity of seed decreased with 0.02 per cent but fertilizer and manures increased with the growth rate of 1.71 and 4.32 per cent per year with the magnitude of seed -0.01, fertilizer and manures 1.21 and 0.29kg per ha per year. The unit rates for all the inputs showed a significant and positive growth rate. The highest growth rate observed for manures (10.83%) followed by seed (8.08%) and fertilizer (5.91%) in Maharashtra. The quantity of seed was decreasing but fertilizers and manures used per hectare were increasing during the study period in Maharashtra. Similar to Madhya Pradesh the unit rates for the inputs were increasing resulting in the increase in the input costs. Similar to Madhya Pradesh, the increase in the cost of seed incurred can be due to use of hybrid seed. The increase in the cost of manure can be due to farmers were not having sufficient own farm manure which makes the farmer to buy it

from other sources. Therefore, there is an increase demand for manure in the market. Which pushes the demand for manure in the market and thereby pushes the price of manures. Trend and growth of fixed cost incurred in cultivation of soybean in Maharashtra at different point of time was presented in table 5. The total fixed cost per ha was found to be Rs.11564.08 per ha (2015-16) in cultivation of soybean which was found to be increased 48.36 and 378.21 per cent respectively as compared to 1996-97 and 2005-06 in Maharashtra. In total fixed cost the percentage share of rental value of land (47.74%) was found to be highest as compared to interest on fixed capital (46.63%) depreciation on implements and farm building (5.40%) and land revenue, cesses and taxes (0.23%) in the year 2015-16.All the item of fixed cost had shown increasing trend i.e. Rental value of land (Rs.288.45/ha/year), depreciation on implements and farm building (Rs.20.75/ha/year), interest on fixed capital (Rs.166.94/ha/year) except for land revenue cesses and taxes (Rs.-12.19/ha). The total cost of cultivation of soybean different point of time, its percentage change over the base year (1996-97) and trend and growth during the period under study along with cost of production of soybean in Maharashtra was analyzed and presented in table 6. It was

observed that soybean grower has invested Rs. 7887.22 for cultivation of soybean in hectare of land. This cost of cultivation showed a percentage change of 87.53 and 448.24b in 2005-06 and 2015-16 respectively with annual growth of 8.91 per cent during the period under study. The cost of cultivation of soybean increased at a magnitude of Rs.1939.90per ha per year during 1996-97 to 2015-16.In total cost of cultivation, the percentage share of total variable cost and fixed cost was found to be 73.26 and 26.74 per cent which was found to be increased with the magnitude of Rs.381.29 and 479.21 per ha with annual growth of 9.12 and 9.39per cent during the period under study. The percentage share of total variable cost was found to be increased from 69.34(1996-97) to 73.26 per cent (2015-16), while percentage share of total fixed cost was found to be decreased 30.66 (1996-97) to 26.74 (2015-16) in cultivation of soybean during the period under study. The cost of production of soybean was found to be 864.05 (1996-97) to 3515.76 per quintal (2015-16) with the magnitude of Rs.139.65 per q annual growth of 8.61 per cent in Maharashtra. Thus, all the cost components like labour costs, input costs and fixed costs were increasing during the study period making the farmer to invest more in the same piece of land.

Table 1: Trend and growth of labour cost incurred in cultivation of soybean in Maharashtra at different point of time. (Rs/ha)

Particulars	Point of time			Percentage change over in 1996-97		Trend (b)
	1996-97	2005-06	2015-16	2005-06	2015-16	
Human Labour						
Family	489.33 (15.26)	895.29 (11.34)	5150.35 (24.78)	82.96	952.53	205.24** /(11.41)/
Attached	67.47 (2.10)	113.38 (1.44)	402.09 (1.93)	68.04	495.95	15.04** /(7.96)/
Casual	1596.97 (49.79)	2004.13 (25.39)	6308.45 (30.34)	25.49	295.02	285.60** /(8.77)/
Sub Total	2153.77 (67.15)	3012.80 (38.17)	11860.89 (57.05)	39.88	450.70	505.89** /(9.64)/
Bullock Labour						
Hired	217.61 (6.78)	427.04 (5.42)	1045.22 (5.02)	96.24	380.31	31,79** /(5.25)/
Owned	649.72 (20.26)	2955.65 (37.45)	2668.12 (12.83)	354.91	310.65	121.90** /(5.01)/
Sub Total	867.33 (27.04)	3382.69 (42.87)	3713.34 (17.85)	290.01	328.13	153.69** /(5.05)/
Machine Labour						
Hired	185.85 (5.80)	1390.06 (17.61)	4535.80 (21.81)	647.94	2340.57	286.69** /(12.32)/
Owned	0.46 (0.01)	106.89 (1.35)	682.35 (3.29)	23136.95	148236.95	20.18** /(14.52)/
Sub Total	186.31 (5.81)	1496.95 (18.96)	5218.15 (25.10)	703.47	2700.78	306.86** /(12.45)/
Total Labour cost	3207.41 (100)	7892.44 (100)	20792.38 (100)	146.06	548.26	966.43* /(8.99)/

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability * Significant at 5% level of probability

Table 2: Trend and growth of labour units in cultivation of soybean in Maharashtra at different point of time.

Particulars	Point of time			Percentage change over in 1996-97		Trend (b)
	1996-97	2005-06	2015-16	2005-06	2015-16	
Labour unit (man Hr/ha)						
Human Labour	442.73	458.72	438.54	3.61	-0.94	-4.24 /(-0.87)/
Bullock Labour	72.14	81.09	42.55	12.40	-41.01	-2.33 /(-3.14)/
Rate per unit (Rs.)						
Human Labour	4.86	6.57		35.18	456.58	1.19**

			27.05			/(10.60)/
Bullock Labour	12.02	41.72	87.27	247.08	626.03	3.88** /(8.57)/

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability

Table 3: Trend and growth of input cost incurred in cultivation of soybean in Maharashtra at different point of time (Rs/ha)

Particulars	Point of time			Percentage change over in 1996-97		Trend (b)
	1996-97	2005-06	2015-16	2005-06	2015-16	
Seed	1431.73 (63.31)	1612.91 (48.72)	4636.33 (42.59)	12.65	223.82	187.87** /(8.14)/
Fertilizer &Manures	679.00 (30.02)	1175.10 (35.50)	3973.15 (36.50)	73.06	485.14	184.65** /(9.30)/
Plant Protection Chemicals	0	195.17 (5.89)	825.35 (7.59)	0	0	69.96** /(16.34)/
Irrigation Charges	0	15.34 (0.46)	527.88 (4.85)	0	0	13.46** /(13.22)/
Miscellaneous	0	0	118.54 (1.09)	0	0	2.03* /(25.24)/
Interest on Working Capital	150.90 (6.67)	312.36 (9.43)	803.85 (7.38)	106.99	432.70	38.09** /(8.84)/
Total Input Cost	2261.63 (100)	3310.88 (100)	10885.1 (100)	46.39	381.29	496.66** /(9.39/)

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability
* Significant at 5% level of probability

Table 4: Trend and growth of main inputs used units in cultivation of soybean in Maharashtra at different point of time.

Particulars	Point of time			Percentage change over in 1996-97		Trend (b)
	1996-97	2005-06	2015-16	2005-06	2015-16	
Quantity (Per ha)						
Seed (Kg.)	82.46	77.39	78.63	-6.14	-4.64	-0.01 /(-0.02)/
Fertilizer (Kg.)	47.60	52.12	73.16	9.49	53.69	1.21* /(1.71)/
Manures (q.)	0.61	7.01	6.27	1049.18	927.86	0.29* /(4.32)/
Rate Rs. Per unit						
Seed (/Kg.)	17.36	20.84	58.97	20.04	239.68	2.39** /(8.08)/
Fertilizer (/Kg.)	14.04	15.28	37.09	8.83	164.17	1.15** /(5.91)/
Manures (/q.)	17.88	54.05	200.98	202.29	1024.04	8.20** /(10.83)/

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability
* Significant at 5% level of probability

Table 5: Trend and growth of fixed cost incurred in cultivation of soybean in Maharashtra at different point of time. (Rs/ha)

Particulars	Point of time			Percentage change over in 1996-97		Trend (b)
	1996-97	2005-06	2015-16	2005-06	2015-16	
Rental value of owned Land	1437.43 (59.45)	2274.33 (63.39)	5520.54 (47.74)	58.22	284.05	288.45** /(7.73)/
Rent Paid for Leased -in –land	0	0	0	0	0	2.83 /(11.78)/
Land Revenue Cesses and Taxes	21.33 (0.88)	21.57 (0.60)	26.76 (0.23)	1.12	25.45	-12.19 /(-11.22)/
Dep.on Implements and Farm Builinding	248.95 (10.29)	322.43 (8.99)	623.36 (5.40)	29.51	150.39	20.75** /(5.31)/
Interest on Fixed Capital	710.47 (29.38)	969.50 (27.02)	5393.42 (46.63)	36.45	659.13	166.94 /(10.67)/
Total Fixed cost	2418.18 (100)	3587.83 (100)	11564.08 (100)	48.36	378.21	496.66** /(9.39)/

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability
* Significant at 5% level of probability

Table 6: Total cost incurred in cultivation of soybean in Maharashtra at different point of time (Rs/ha).

Particulars	Point of time			Percentage change over in 1996-97		Trend
	1996-97	2005-06	2015-16	2005-06	2015-16	(b)
Total Labour Cost	3207.41 (40.66)	7892.44 (53.35)	20792.38 (48.09)	146.06	548.26	966.43* /(8.99)/
Total Input Cost	2261.63 (28.67)	3310.88 (22.38)	10885.1 (25.17)	46.39	381.29	496.66** /(9.39)/
Total variable Cost	5469.04 (69.34)	11203.32 (75.74)	31677.48 (73.26)	104.84	479.21	1463.09 /(9.12)/
Total Fixed Cost	2418.18 (30.66)	3587.83 (24.26)	11564.08 (26.74)	48.36	378.21	496.66** /(9.39)/
Total Cost of cultivation	7887.22 (100)	14791.15 (100)	43241.56 (100)	87.53	448.24	1939.90 /(8.91)/
Cost of production (Rs./q)	864.05	1101.68	3515.76	27.50	306.89	139.65** /(8.61)/

Figure in parenthesis show percentage to total, while in slashes show growth rate.
** Significant at 1% level of probability
* Significant at 5% level of probability

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