Trends in Growth of Production, Crop Diversification, Productivity, Profitability and Cost Structure in Haryana Agriculture

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Background

Geographically, Haryana is located in north-west of the country, which makes its climate arid to semi arid. The relatively low average rainfall, 354.5 mm, and mostly concentrated in July to September months increases its dependence on irrigation. Due to dire need for irrigation, the ground water irrigation has become a significant source of irrigation in the state. At the time of formation of the state in 1966, the contribution of private investment in irrigation was very low, however, thereafter private investment in irrigation accelerated and become one of the important reasons for bringing in its cultivable area (3.7 m.ha.) under cultivation (98 %) and raising cropping intensity to 184.9%.

The state is endowed with fertile Indo Gangatic plain and accompanied with hard working farmer become harbinger for adoption of high yielding technology. This led to phenomenal increase of income in agricultural sector. The Net State Domestic Product (NSDP) of Haryana is estimated to grow at about 5% compared to about 4% for the country, whereas the growth of agriculture plus animal husbandry for the state grew at about 3% compared to 2.13% for the country during 1970-71 to 1985-86 (Sharma 1992). Haryana recorded 6.4 % average annual economic growth during 1966-67 to 2004-05, which further accelerated to 9.3 % during the period of last 7 years (2005-06 to 2011-12), even higher than the average annual growth rate of 8.5 % of Indian economy during the same period.

Since its formation, Haryana's economy has also experienced a significant structural transformation, mostly from Agriculture and Allied Sector towards Services and Industry sector.

The share of Agriculture and Allied Sector in GDP was 60.7 % in 1969-70, declined to 28.1 % in 2001-02 and further reduced to 19.0 % in 2004-05 and 14.1 % in 2011-12, whereas the share of Industry Sector increased from 17.6 % in 1969-70 to 28.6 % in 2001-02, and the share of Services Sector increased from 21.7 % in 1969-70 to 43.3 % in 2001-02 and further to 58.4 % in 2011-12. The decline in contribution of agriculture in state GDP during this transformation period is mainly on account of better performance of other sectors. Relatively low growth in agricultural sector is mainly on account of saturation in growth of Net Sown Area, low growth of irrigation and almost saturation in the yield growth due to lack of technology break. There is stagnation in NSA for the state, because most of (98 %) its cultivable area (3.7 m.ha.) is already under cultivation, while, the additional irrigation facilities in addition to the improvement in quality of irrigation in existing irrigated area has grown slowly. The cropping intensity is also showing signs of saturation. In 1966-67 only 34% of NSA could grow more than one crop, which increased to 73 % in 2000-01 and further to 82% in 2009-10. Moreover, the gap in cropping intensity across different agro climatic zone of the state is still large[1]. The factor responsible for low level of cropping intensity in the southern irrigated zone and western un-irrigated zone of the state are beyond irrigation such as the quality of land, low level of investment, input availability, etc[2].

The cropping pattern in the state has also undergone significant changes towards high productivity crops like wheat and rice from the low productivity crops like gram, barley, jowar etc. during 1960-61 to 1985-86[3]. Thereafter, the direction of change in cropping pattern has been continued.

The discussion above indicates a number of changes within agricultural sector. The sources of growth in agriculture is probably moving away from net sown area, cropping intensity to change in cropping pattern towards

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[1] The Western zone and the Central zone have the highest cropping intensity, while the Southern zone has the lowest cropping intensity of 152 % in 2010-11.

[2] One of the possible reason for variation in the irrigation facilities is groundwater conditions, canal network etc. Controlling for irrigation, one can see that even if area is irrigated Southern Zone of the state have the lowest cropping intensity. Interestingly the Western Zone which shows highest level of cropping intensity (192%) for irrigated land while shows the lowest level of cropping intensity (136%) for the un-irrigated land.

[3] Sharma, R.K. (1992).

more productive crops, increase in yield of crops and increase in total factor productivity. The focus of this paper is to examine the issues relating to changes in cropping pattern and sources of growth in Haryana during 1980-81 to 2011-12.Specifically, the relative contribution of area, yield, cropping pattern and total factor productivity in growth of agriculture is examined. The changes in profitability of selected crops and their cost structure have also been discussed. The rest of the chapter is divided into following six sections, Section-1: Trends in Production growth, Section-2: Crop Diversification, Section-3: Trends in Total Factor Productivity, Section-4: Trends in Profitability of Crops, Section-5: Structural Changes in the Cost of Cultivation and Section-6: Conclusion.

Section 1 Trends in Production Growth

Description of Data

The secondary data on area, production and yield of six crops of the state is taken from the website of Ministry of Agriculture, Government of India from 1976-77 to 2011-12. Beyond these six crops, the trends of growth of production of vegetables crop is also worked out zone-wise from 1990-91 to 2012-13. The district-wise area and production of vegetable crops is compiled from Horticultural Department of Haryana from 1990-91 to 2012-13. The input and output data for these six crops of state is also compiled from Scheme of Cost of Cultivation, Ministry of Agriculture, Government of India during this period. The prices used for deflating the input data including diesel prices are taken from Office of the Economic Adviser's website. The selection of crops is based on limitation of the data reported by different sources for other crops of the state. Ministry of Agriculture, GoI, publishes data only for selected costs and the data for rest of the crops is either not reported or reported is irregularly.

Compound Annual Growth Rate [4](CAGR)

The times series data on area, production, yield and inputs for each selected crop is tested for unit root before estimating its growth using regression. The Augmented Dickey Fuller (ADF) applied on with trends and without trends to identify the level of integration of each series. As applying regression on a non-stationary series may result in spurious regression or will increase the chances of rejection of null hypothesis when it is true. The estimated value of coefficients of ADFs is tabulated (at table-2). Comparing estimated and critical values of ADF, it is found that most of the series on area, production and yield except for area and production of sugarcane, are stationary at level without trend. While most of series have found to have non-stationary area trend except for production and yield series of wheat, area and production for mustard, and area for bajra crops.

TABLE-2: ADF Results at Level (in log transformation) 1976-77 to 2011-12

	Area		Production		Yield	
Crops	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend
Bajra	-2.201	-1.737	-1.530	-3.736	-1.189	-4.1
Gram	-1.109	-3.286	-1.91	-3.314	-2.637	-3.2
Paddy	-1.655	-3.321	-1.19	-5.138	-2.528	-4.1
Mustard	-1.834	-1.756	-2.04	-1.687	-1.939	-3.2
Sugercane	-3.947	-4.520	-2.85	-3.724	-1.179	-5.3
Wheat	-1.849	-3.722	-1.94	-2.430	-1.463	-2

Z(T) Critical Value	1%	5%	10%
Without Trends	-3.689	-2.975	-2.619
With Trends	-4.297	-3.564	-3.218

The value of Durbin-Watson (DW) in OLS estimates indicates problem of series correlation in some series. Therefore, instead of using simple OLS regression on a non-stationary series, ARIMA model is used to estimate Compound Annual Growth Rate (CAGR) as it gives better estimates than OLS in presence of serial correlation.

Trends and Pattern of Growth

The CAGR of area, production and yield of six major crops for the state is calculated and presented in the table-3 below. The production growth for the four crops *i.e.* Paddy, Bajra, Mustard and Wheat has been over three percent, while for

[4]ln Y = a + bt + U ; Where ln(Y) is log of production, yield or area of a crop. t is time. a is constant. b is the coefficient estimated. The CAGR so can be calculated as: CAGR = [*antilog b* - 1] * 100.

[5]The Augmented Dickey-Fuller test involves fitting the model $\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \ldots + \zeta_k \Delta y_{t-k} + e_t$ where k is the number of lags. δt is trend while α is constant term in the model. Testing $\beta = 0$ is equivalent to that y_t follows a unit root process. ADF Test statistics, given in table, if found higher than critical value, given below table, then we cannot reject the null hypothesis of unit root which means the series is non-stationary.

gram it has been negative and very low for Sugarcane during 1976-77 to 2011-12. The production growth of Paddy is mostly driven by its area growth, while production growth of Wheat is found receiving balanced contribution from area and yield growth. The production growth for Bajra and Mustard is *inter-alia* on account of yield growth. While the yield growth for Gram and Paddy has been very low during 1976-77 to 2011-12.

The growth pattern of various crops during 1976-77 to 2011-12 for the state shows that the area growth for Bajra, Gram and Sugarcane crops has been negative, while Mustard registered high growth of 4.4 % followed by paddy and wheat crops. The decline in the growth of area for Kharif crops such as Bajra and Sugarcane and at the same time increase in growth of area to paddy is indicating that the area has been shifting from Bajra and Sugarcane to Paddy. The minimum support price, input subsidy would possibly have favored paddy over other crops. Similarly, in Rabi season, the area growth for mustard and wheat has improved may be at the cost of gram and sugarcane. The trends in the growth of various crops show that the growth in the agricultural production is increasingly being dominated by wheat and paddy.

TABLE 3 CAGR OF MAJOR SIX CROPS IN HARYANA DURING 1976-77 TO 2011-12.

Crops	Haryana	1976-77 to 1990-91	1991-92 to 2000-01	2001-02 to 2011-12	1976-77 to 2011-12
Bajra	Area	-3.17	0.39	0.54	-1.19
	Production	0.45	4.74	4.70	3.39
	Yield	3.72	4.34	4.19	4.61
Gram	Area	-5.55	-8.11	-10.41	-7.40
	Production	-6.17	-8.12	-11.53	-6.58
	Yield	-0.73	-0.13	-1.22	0.89
Paddy	Area	3.81	3.03	6.08	3.53
	Production	4.25	3.62	4.57	4.11
	Yield	0.51	0.78	-1.49	0.61
Mustard	Area	10.02	-0.53	-4.50	4.38
	Production	16.91	1.48	-2.61	7.18
	Yield	6.31	1.80	1.34	2.87
Sugarcane	Area	-1.75	-2.21	-0.15	-1.05
	Production	-0.06	-0.79	0.40	0.74
	Yield	1.88	1.39	0.37	1.78
Wheat	Area	2.33	1.58	2.72	1.75
	Production	6.18	2.92	4.25	4.19
	Yield	3.73	1.31	1.59	2.36

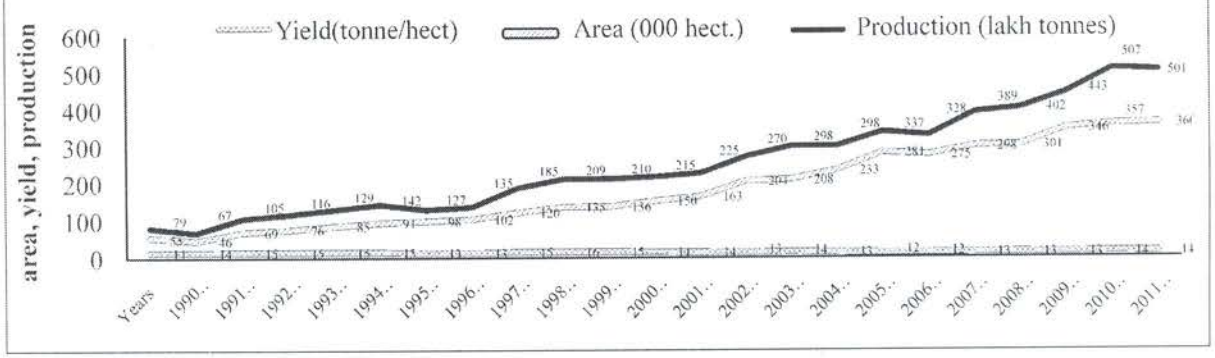
Source: Calculated using the data from Ministry of Agriculture, Government of India.

Trends in Growth of Production of Vegetable

The area under vegetables in Haryana has increased to 360 thousand hectare, in 2012-13 compared 150 thousand hectare, and 55 thousand hectare in 1990-91. The trends in area, production and yield are given in the graph-1 below.

The growth rate of area, production and yield of

Graph-1: Vegetables Area, Production and Yield in Haryana



vegetables across zones of the state is calculated for 1990-91 to 1999-00 and 2000-01 to 2012-13, which is presented in the table-4.The vegetable production in the state has grown at 8.9 % Compound Annual Growth Rate (CAGR) during 1990-91 to 2012-13, while its growth has slowed down from 11.2 % during 1990-91 to 1999-00 to 8.1% during 2000-01 to 2012-13. Main driver of vegetable production is its area growth, which grew at 9.6 % during two decade since 1990-91, but declined from 11.3 % during 1990-91 to 1999-00 to 8.7% during 2000-01 to 2012-13. The yield growth of vegetables for the state has been negative during two decades, although it was positive, but low during first decade. Decomposing[6] of the change in production of vegetables into area effect, yield effect and into joint effect shows that the increase in the vegetable production in the state is mainly on account of increase in its area, which is also true across the zones. The production growth has been over 4% for all vegetable crops except for pea and driven by high growth in their area, which is also true for vegetables across the zones of the state.

The growth of production in vegetable crops across the zone-wise shows that southern zone registered highest growth at 12.5% followed by 9.7 % in Northern and 7.3% in western zone during the period under investigation. The production growth of vegetables has moderated in second decade in all four zones compared to first decade, and the highest decline of about 5 percentage point is recorded in western and central zones of the state. The area growth for Western zone moderated by about 8 percentage points in the second decade when compared to first and it also moderated to about 3 percentage points in Northern zone and Central zones of the state. The area growth in the southern zone has increased contrary to other zones of the state during second decade. Although the growth in production of vegetables has been higher than other crops in the state, but the slowdown in the growth of production and area, and negative growth of their yield is the cause of concern.

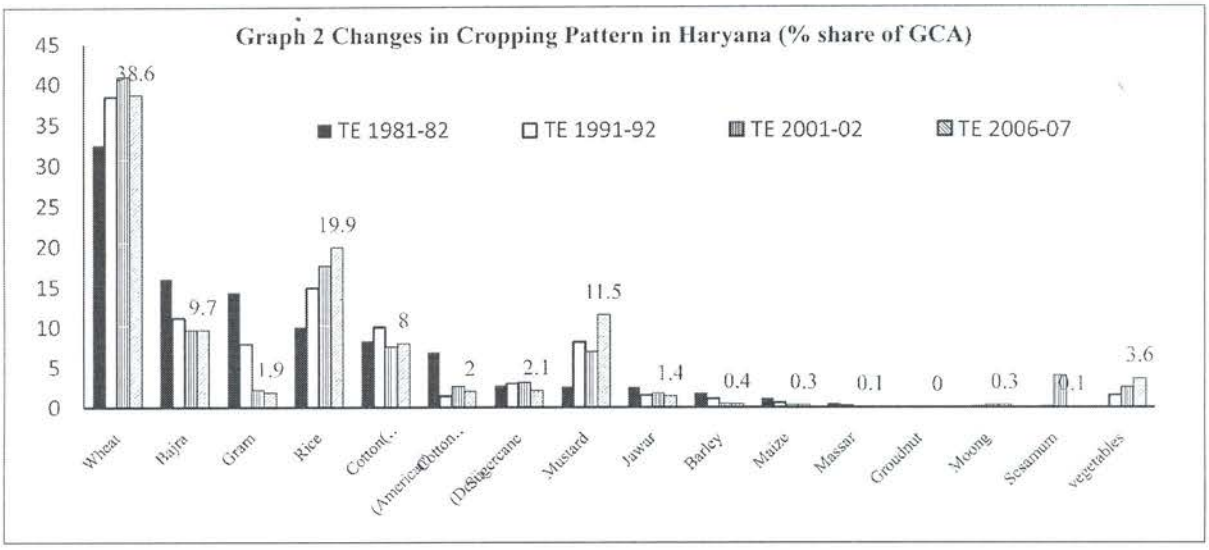
TABLE 4: COMPOUND ANNUAL GROWTH RATE (CAGR) OF AREA, PRODUCTION AND YIELD OF VEGETABLES IN STATE/ZONES.

State/ Zones	Variables	1990-91 to 1999-00	2000-01 to 2012-13	all
Haryana	Area	11.3	8.7	9.6
	Production	11.2	8.1	8.9
	Yield	0.2	-0.8	-0.6
Central	Area	9.5	6.3	7.1
	Production	10.6	4.8	6.6
	Yield	1.0	-1.3	-0.7
Northern	Area	11.3	8.5	10.0
	Production	11.5	9.0	9.7
	Yield	0.3	0.4	-0.3
Southern	Area	15.4	16.1	13.4
	Production	14.8	14.3	12.5
	Yield	-0.5	-1.7	-1.0
Western	Area	11.3	3.1	7.9
	Production	8.0	2.8	7.3
	Yield	-2.9	-0.4	-0.7

Source: Department of Horticulture, Government of Haryana.

Section 2 Crop Diversification

The skewed pattern of growth towards wheat and paddy is bringing change in the cropping pattern also. The share of area in total Gross Cropped Area (GCA) is calculated and presented in the Graph-2. The result shows that wheat-paddy dominates the cropping pattern in the state. The area share of wheat and paddy has also increased over time since 1980-81. The area under wheat is increasing at the cost of gram, while paddy is taking away area from bajra. The area under vegetables has increase from 1.5 % during TE 1991-92 to 2.5% in TE 2001-12 and 3.6 % in TE 2006-07.



[6] The growth of production is decomposed into area effect and yield effect. Decomposition is defined as in equation. $\Delta P = Ao\Delta Y + Yo\Delta A + \Delta A\,\Delta Y$; where Yield effect = $(Ao\Delta Y)$; Area effect = $(Yo\Delta A)$; and Interaction effect = $(\Delta A\,\Delta Y)$. ?P =change in production; Ao is area in the base year, ΔY is change in yield; Yo is yield in the base year; ΔA is change in area.

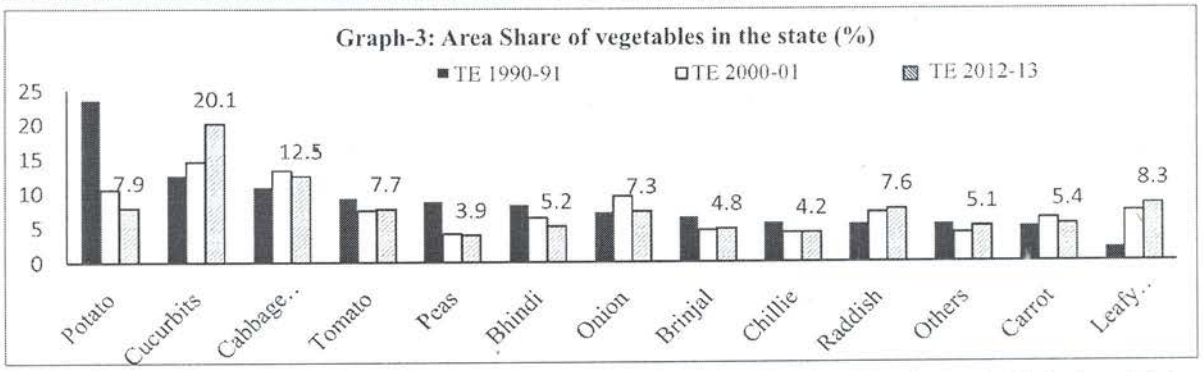
The area share of vegetable in GCA has increased from 1.5% in TE 1990-91to 3.6 % in TE 2006-07. The regional distribution[7] of area under vegetables is given in the table-5. Northern region of the state produces two fifth of total state's vegetable production, followed by Southern zone (27.2%) and Central zone (23%) in TE 2012-13. Among the zones, area share of vegetables has increased in Northern zone and Western zone in first decade, while it has increased only for Southern zone in second decade.

Among the vegetable crops, Cucurbits has grown over largest area under vegetables in the state, about 15.4 %, followed by Potato, Cabbage/Cauliflower, Tomato, Onion, Raddish, Bhindi, Others, Leafy Vegetables, Peas, Carrot, Brinjal, Chillie. Trend shows that the area share of Potato, Pea, Bhindi, and to some extent for Tomato has declined over the years, while share of Cucurbits, Cabbage/ cauliflower, raddish and leafy vegetables has increased over the years in the state.

TABLE 5. ZONAL CONTRIBUTION IN VEGETABLES AND YIELD IN HARYANA.

Years	Central	Northern	Southern	Western	Total
		Area Share (in %)			
TE 1990-91	34.6	37.5	14.0	14.0	100
TE 2000-01	29.3	39.5	12.8	18.4	100
TE 2012-13	23.1	39.3	27.2	10.3	100
		Production Share (in %)			
TE 1990-91	34.1	37.2	13.8	14.9	100
TE 2000-01	31.5	37.4	13.6	17.6	100
TE 2012-13	23.2	41.9	24.9	10.0	100
		Yield (tones/Hect.)			
TE 1990-91	14.5	14.6	14.5	15.8	14.7
TE 2000-01	15.7	13.7	15.3	13.9	14.5
TE 2012-13	13.7	14.5	12.5	13.2	13.6

Source: Calculated from the data from Department of Horticulture, Government of Haryana.



Section 3 Trends in Total Factor Productivity

The growth of production can also be decomposed into the input effect and non-input factor effect. The growth in TFP includes the efficient use of resources, accrual of scale efficiency, improvement in the quality of inputs and technology[8]. The aggregate TFP growth also includes the impact of change in cropping pattern on TFP growth. During 1980-81 to 2011-12, the TFP growth is 0.8% for all six crops. The TFP growth was 0.6% during eighties, which improved during nineties to 1.2 % but moderated during millennium decade to 0.8%. During this period, the TFP growth has been about one and half percent for Wheat and Mustard, while for Sugarcane, Paddy and Bajra, it was lower at around 0.6%. For gram TFP growth was negative. The overall TFP growth although improved during nineties compared to eighties but moderated during

[7]The Agro-Climatic Zones of the state divided based on homogeneous agroclimatic conditions are as, **Central**-Kaithal, Jind, Sonipat, Rohtak, Jhajjar; **Northern**-Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat; **Southern**-Gurgaon, Faridabad, Palwal, Rewari, Mahendragarh, Mewat; **Western**-Hisar, Bhiwani, Fatehabad, Sirsa.

[8]The non-input growth of the production is growth in total factor productivity. Tornquist-Theil TFP indices (Desai, 1994) is used for calculating TFP growth as in equation (4):ln (TFPt/TFPt-1) = ½ Σj (Rjt+Rjt-1) ln (Qjt/Qjt-1) - ½ Σi (Cit+Cit-1) ln (Xit/Xit-1)(4); Where, Rjt = Share of output 'j' in revenues in the year't'; Qjt = Output 'j' in the year't'; Cit = Share of input 'i' in total input cost in year't'; Xit = Input 'i' in period't'; Rj and Ci are in current prices, and Qj and Xi (which are in monetary values) at current prices.

last period. The growth of TFP has improved during nineties for Wheat, Sugarcane and Gram, while Mustard, Paddy and Bajra. During 2000s TFP growth has moderated for Wheat, Sugarcane, Gram and Bajra, while improved for Paddy and Mustard. There is a negative TFP growth for Sugarcane, Gram and Bajra during 2000s.

TABLE 6: Total Factor Productivity (TFP) Tornqvist-Theil Index.

Crops	TFP Growth				Input Growth				Output Growth			
	1980-81 to 1990-91	1991-92 to 1999-2000	2000-01 to 2011-12	1980-81 to 2011-12	1980-81 to 1990-91	1991-92 to 1999-2000	2000-01 to 2011-12	1980-81 to 2011-12	1980-81 to 1990-91	1991-92 to 1999-2000	2000-01 to 2011-12	1980-81 to 2011-12
Wheat	1.2	2.2	1.7	1.5	1.1	-0.1	-0.7	0.2	2.3	2.1	1.0	1.6
Sugarcane	-0.5	1.9	-0.7	0.7	1.7	-1.5	-0.5	-0.6	1.2	0.4	-1.2	0.1
Mustard	1.8	0.8	2.3	1.5	3.8	0.8	-0.6	1.3	5.6	1.5	1.7	2.8
Paddy	0.9	0.4	0.8	0.6	1.4	0.6	0.2	0.7	2.3	1.0	1.0	1.2
Gram	0.7	1.1	-0.3	-0.2	-1.1	-10.3	-1.2	-3.0	-0.3	-9.2	-1.5	-3.2
Bajra	8.3	-2.0	-0.4	0.6	-8.6	2.0	3.9	1.2	-0.2	0.0	3.5	1.8
All	0.6	1.2	0.8	0.8	1.1	0.1	-0.2	0.4	1.7	1.3	0.6	1.1

Source: Calculated using the data from Ministry of Agriculture Government of India.

Section 4 Trends in Profitability of Crops

The profitability of crop is crucial factor determining cropping pattern. Among rabi crops, the Gross Value of Output (GVO) per hectare has been highest for the Wheat followed by Mustard and Gram for all times. While among kharif crops the GVO per hectare is highest in paddy for all times than Bajra. In case of Sugarcane, the GVO per hectare is highest among all crops of rabi and kharif for all times (except for paddy in TE 1992-93). It may be mentioned that Sugarcane occupies the field for about six month in a year while other crops takes only three and half month. This shows why wheat in rabi and Paddy in kharif are most preferred crops for the farmer if condition allows.

The benefit to cost ratios is calculated for six crops. The results tabulated in the table-7 shows that among rabi crops the benefit-cost (over A2) ratio for wheat has improved from 1.9 in TE 1981-82, to 2.9 in TE 1992-93 and highest 3.5 in TE 2011-12, but moderated to 2.7 in TE 2002-03 compared to earlier years. While for Mustard, the benefit-cost ratio is highest in TE 2011-12 and improved in TE 2002-03 compared to in TE 1992-93. For Gram it has been highest in TE 1992-93 and in TE 2011-12 and lowest in TE 2002-03. For kharif crops, the profits over A2 in paddy has increased from 1.9 in TE 1981-82 to 2.6 in TE 1992-93 and further increased to 2.9 in TE 2011-12. Similar trends have also been improved in its profits over C_2 although there is some moderation in benefit cost ratio in TE 2002-03. The benefit-cost ratio for Bajra moderated has been lower highest in TE 1981-82, although improved in TE 2002-03 and TE 2011-12 compared to TE 1992-93. For sugarcane the benefit to cost over (A_2) ratio has improved in TE 2002-03 and TE 2011-12 compared to TE 1992-93.

TABLE 7 Benefit-Cost Ratios Showing Profitability for six Major Crops.

	Cost Items		TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
Paddy	yield (qtl/hec)index		106	111	112	117
	Byproduct to main product (%)		0.5	0.9	1.7	1.6
	GVO per hect (Rs/Hec)		6027	15395	29293	70237
	Benefit to cost ratios					
		A1	1.9	2.7	2.5	2.9
		A2	**1.9**	**2.6**	**2.3**	**2.9**
		B1	1.7	2.4	2.2	2.6
		B2	1.3	1.7	1.4	1.5
		C1	1.5	2.0	1.8	2.1
		C2	**1.2**	**1.5**	**1.2**	**1.4**
		C2*	1.3	1.4	1.2	1.4

TABLE 7 BENEFIT-COST RATIOS SHOWING PROFITABILITY FOR SIX MAJOR CROPS.—CONTD.

	Cost Items	TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
Wheat	yield (qtl/hec)index base:1980-81	96.5	136.4	154.2	171.7
	Byproduct to main product (%)	13.5	21.6	15.4	20.5
	GVO per hect (Rs/Hec)	4244	12627	29275	65348
	Benefit to cost ratios				
	A1	1.9	2.9	2.9	3.5
	A2	**1.9**	**2.9**	**2.7**	**3.5**
	B1	1.7	2.5	2.5	2.9
	B2	1.3	1.7	1.5	1.6
	C1	1.4	2.2	2.0	2.3
	C2	**1.1**	**1.6**	**1.3**	**1.4**
	C2*		1.5	1.3	1.4
Sugercane	yield (qtl/hec)index	87	81	150	155
	byproduct to main product (%)	6.4	3.3	3.5	5.7
	GVO per hect (Rs/Hec)	8249	14714	60359	157789
	Benefit to cost ratios				
	A1	4.2	2.1	3.6	4.4
	A2	**4.2**	**2.1**	**3.6**	**4.4**
	B1	3.6	1.8	2.9	4.0
	B2	2.3	1.3	1.5	1.8
	C1	2.5	1.4	2.3	3.4
	C2	**1.8**	**1.1**	**1.3**	**1.7**
	C2*		0.9	0.8	1.7
Mustard	yield (qtl/hec)index	121	180	650	1226
	byproduct to main product (%)	0.1	0.2	3	10
	GVO per hect (Rs/Hec)	4181	6615	19214	55909
	Benefit to cost ratios				
	A1	3.7	2.6	3.2	4.8
	A2	3.7	2.6	3.1	4.8
	B1	2.9	2.1	2.5	3.8
	B2	1.8	1.3	1.5	1.9
	C1	2.3	1.7	1.8	2.9
	C2	1.6	1.1	1.2	1.6
	C2*		1.0	1.2	1.6
Gram	yield (qtl/hec)index	124	185	93	146
	byproduct to main product (%)	10	9	8	12
	GVO per hect (Rs/Hec)	1406	4884	5744	16632
	Benefit to cost ratios				
	A1	2.4	3.5	1.6	3.3
	A2	2.3	3.3	1.5	3.3
	B1	1.8	2.8	1.2	2.4
	B2	1.2	1.6	0.7	1.4
	C1	1.4	2.2	0.9	1.5
	C2	1.0	1.3	0.6	1.0
	C2*		1.2	0.6	1.0
Bajra	yield (qtl/hec)index	99	90	170	243
	byproduct to main product (%)	49.3	34.9	35.0	28.2
	GVO per hect (Rs/Hec)	1379	2830	7382	19040
	Benefit to cost ratios				
	A1	2.8	1.8	2.1	2.4
	A2	2.7	1.8	2.0	2.4
	B1	2.0	1.4	1.8	2.0
	B2	1.3	0.8	1.1	1.2
	C1	1.4	0.9	1.0	1.2
	C2	1.0	0.7	0.7	0.8
	C2*		0.6	0.5	0.8

Source: Calculated using the data from Ministry of Agriculture Government of India.

Section 5 Structural Changes in the Cost of Cultivation

The technological progress over time may differ across crops and across regions, which some time reduces cost. It also changes the input-mix according to changes in their relative prices. While the use of inputs can also be the result of policy pushes such as use of chemical fertilizers, hybrid seeds, and mechanization promoted of during green revolution. The changes in relative share human labour, machine labour and land would have implications on income distribution, saving and investment and hence further on growth prospect of agricultural sector and economy at large (Rudra, Ashok). The changes in inputs costs and their relative shares are calculated for selected six crops of the state during 1980-81 to 2011-12.

The structure of the cost of the crops is measured as a percentage share of each inputs items to total cost over years. The changes in the shares show relative importance of the cost component in the total cost of the crop. The observation over times also shows how the structure of cost has changed over time. The changes in cost structure have implication on income distribution and resource use changes. The results on cost structure changes for six major crops of the state is computed and presented in the tables at *Annexure*.

About two third of the total cost of paddy is operational cost and rest is fixed cost in TE 1981-82. The share of fixed cost has increased from 32 % in TE 1981-82 to 41 % in TE 2011-12. The rental value of own land, a component of the fixed capital, and human labour, a component of operational cost, is one fifth in total cost in TE 1981-82, which increased to about one third in TE 2011-12. Share of fertilizer, irrigation, machine labour has moderated over times.

The cost structure of Wheat was dominated by operational cost having more than half share in total cost but its share has continuously moderated over time from 66 % in TE 1981-82 to 53 % in TE 2011-12. The rental value of own land has the highest share in total cost followed by human labour, machine labour, interest on fixed capital and irrigation charges. The share of hired machine labour, casual labour, and family labour has increased, while the share of bullock labour, seeds, fertilizer, irrigation charges has decreased since 1981-82.

The share of operational cost of Sugarcane has declined from 63 % in TE 1981-82 to 46 % in TE 2011-12. Now about half of the total cost per hectare is due to rental value of own land and increased over time. The share of cost of casual labour has increased over time and it become second largest contributor with 20 % share within operational cost. However, the share of family labour has declined over time, so the total share of human labour has been stable around 24-29 %. The share of costs fertilizer, irrigation charges also have moderated over time.

For mustard crop, about half of the total cost is operational cost which has been moderating overtime. The share of human labour, hired machine labour, irrigation charges and fertilizer has increased during two decade.

In Gram, the role of family labour is more than casual labour and increasing over the years, while the share of bullock labour has declined. The share of rental value of own land is significant and ranging between 27 to 36 % of total cost.

Contrary to other crops, the operational cost has increased overtime for Bajra. The share of human labour, machine labour, fertilizers and seeds has increased over time, while the share of interest on fixed capital has declined.

The result shows that the proportion of the fixed cost is increasing in most of the crops, primarily due to increase in rental value of land. This is a reflection of the rising pressure on land resources, declining farm size without as much of reduction in dependency of population from agriculture. Besides, the rising wages in agricultural labour appears to have led to increase in share of cost human labour in almost all crops despite the mechanization of agriculture.

Section 6 Conclusion

Using secondary data on area, production yield and input of six crops since 1980 till 2011-12, in the state, the analysis of trends in sources of growth of agriculture, crop diversification, productivity, profitability and cost structure brings up useful insights. When the net sown area in the state has stopped, their incremental contribution in agricultural production, cropping intensity, relative better growth in few crops, change in cropping pattern and productivity has become prominent for their contributing in agricultural growth of the state. Better growth in production of paddy and wheat is mostly on account of their area growth. Among rabi crops, wheat is taking away area from gram and sugarcane, while among kharif crops paddy is taking away area from Bajra and other crops.The cropping pattern of the state is dominated by wheat-rice combination. The area under these crops is increasing over the years. There is indication of concentration of area under these two crops. The assured Minimum Support Price (MSP) and consequent decline in the price risk are two crucial factor that have played significant role in the promotion of the wheat-paddy combination in the state.

Besides inputs, the contribution of non-input factors, as reflected in TFP growth for all six crops in aggregate was improved during nineties compared to eighties, but moderated in 2000s compared to nineties. TFP growth improved for wheat, sugarcane and gram during nineties compared to eighties, while during 2000s TFP growth paddy and mustard has also improved.

The profitability over A2 cost for rabi and kharif crops improved over the years as reflected in the

benefit-cost ratio of six crops. The Gross Value of Output per hectare is highest for wheat and rice among rabi and kharif crops respectively seems to be one of the reason for the more and more putting area under these crops. Within the total cost, operational cost is about two third but its share is on decline over the years for most of the crops. The rise in the share of fixed cost in total cost of cultivation is mostly on account of increasing share of 'rental value of own land', while within operational cost, the share of human labour, machine labour is important and their relative importance has increased over the years.

The vegetable production grew at 9% CAGR during 1990-2013. The vegetable production growth has moderated during 2000s to about 8% from 11% during nineties. The production growth of the vegetables has mostly been on account of area growth while the yield growth has almost been stagnant during the two decade. This is true across the zone of the state. The CAGR of area, production and yield among the vegetable crops also shows that most of the vegetables have grown at more than 4% during 1990-2013, but the growth is driven mostly by their area growth, while their growth in yield has been stagnant. The area under vegetables has increased over the years since 1990-91 to 3.6 % in 2006-07, but still low. Central zone contributes 35% and Northern zones about 38 % in the total area under vegetables of the state in 1990-91. While, the share of Southern zone is on the rise and increased from 14 % in 1990-91 to 27 5 in 2012-13. The area share of individual vegetable in the state shows that the cucurbits, cabbage/cauliflower, radish and leafy Vegetables is on the rise while the area under potato and peas is decreasing.

TABLE-1: VEGETABLES' AREA, PRODUCTION SHARE AND YIELD IN HARYANA.

Crops	TE 1990-91	TE 2000-01	TE 2012-13	All
		Share of Area (in %)		
Peas	8.8	4.1	3.9	5.7
Onion	7.2	9.5	7.3	7.6
Tomato	9.3	7.5	7.7	7.7
Raddish	5.5	7.1	7.6	6.8
Carrot	5.1	6.2	5.4	5.6
Cabbage/Cauliflower	10.9	13.3	12.5	12.3
Chillie	5.6	4.2	4.2	4.9
Bhindi	8.4	6.4	5.2	6.6
Brinjal	6.5	4.6	4.8	5.2
Cucurbits	12.7	14.6	20.1	15.4
Leafy Vegetables	2	7.2	8.3	5.9
Others	5.5	4.1	5.1	6.6
Potato	23.6	10.6	7.9	12.7
Total	**100**	**100**	**100**	**100**
		Share in Production (in %)		
Peas	7.3	2.4	1.9	4
Onion	7.8	11.2	11.3	9.7
Tomato	12.4	8.1	8.2	9.3
Raddish	7.3	7.5	8.2	8
Carrot	6.4	7.1	6.7	7
Cabbage/Cauliflower	11.8	15.1	16.6	14.9
Chillie	3	2.7	2.7	3.1
Bhindi	5.8	4.1	2.8	4.2
Brinjal	7.7	5.1	5.7	5.9
Cucurbits	8.9	11.4	14.3	11.3
Leafy Vegetables	1.1	5.8	5.4	4.3
Others	5.6	4.8	3.1	6
Potato	24.9	14.8	13.1	15.5
Total	**100**	**100**	**100**	**100**
		Yield (Tonnes/ Hect)		
Peas	12.2	8.5	6.6	9.3
Onion	16.1	16.7	21.2	17.8
Tomato	19.4	16	14.5	16.9
Raddish	19.5	15.4	14.7	16.7
Carrot	18.2	16.9	17	17.6
Cabbage/Cauliflower	15.9	16.5	18	16.8
Chillie	7.9	9.4	8.7	8.8
Bhindi	10.1	9.4	7.5	8.9
Brinjal	17.2	16.1	16.5	16
Cucurbits	10.3	11.9	9.8	10.5
Leafy Vegetables	8.2	11.5	8.8	10
Others	15.7	15.5	8.4	12.6
Potato	15.6	20.4	22.5	18.4
Total	**14.7**	**14.5**	**13.6**	**14**

Source: Department of Horticulture, Government of Haryana.

TABLE 2 SHARE OF COST COMPONENTS IN TOTAL COST OF PADDY IN HARYANA (IN %).

		Crops-Paddy	TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
1		Operational Cost	68.0	66.7	62.1	58.7
	i	Human labour				
	a	Casual	12.7	14.9	11.4	16.2
	b	Attached	3.1	2.8	1.8	2.3
	c	Family	7.2	10.3	14.4	12.2
		Total	**23.0**	**28.0**	**27.5**	**30.8**
	ii	Bullock labour				
	a	Hired	0.1	0.0	0.0	0.0
	b	Owned	2.9	2.8	0.2	0.3
		Total	3.0	2.9	0.2	0.3
	iii	Machine Labour				
	a	Hired	3.0	2.4	3.8	4.9
	b	Owned	4.8	2.7	3.5	2.1
		Total	**7.8**	**5.1**	**7.3**	**7.0**
	iv	Seed	1.7	1.8	1.6	1.7
	v	Fertilizer & Manure				
	a	Fertilizer	12.9	9.8	9.6	5.5
	b	Manure	0.4	0.2	0.3	0.0
		Total	13.3	10.0	9.9	5.5
	vi	Insecticides	3.6	4.3	3.6	3.3
	vii	Irrigation charges	13.8	13.1	10.6	8.7
	viii	Interest on W.C.	1.8	1.7	1.4	0.9
	ix	Miscellaneous				
2		Fixed Cost	32.0	33.3	37.9	41.3
	i	Rent.Value of ow.l.	22.8	23.7	28.9	35.3
	ii	R.paidL.land		0.7	3.5	0.2
	iii	Land rev.cesses T.	0.2			0.0
	iv	Dep.imp.F.bldgs.	1.2	1.4	0.5	0.3
	v	Int.on fixed Cap.	7.7	7.6	5.0	5.6
1+2		Total Cost	100	100	100	100

Source: Ministry of Agriculture, Government of India.

TABLE 3 SHARE OF COST COMPONENTS IN TOTAL COST OF WHEAT IN HARYANA (IN %).

Crop-Wheat			TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
1		Operational Cost	66.9	61.3	56.6	53.2
	i	Human labour	0.0	0.0	0.0	0.0
	a	Casual	4.9	5.6	4.9	6.3
	b	Attached	1.7	1.2	0.5	0.7
	c	Family	10.3	8.5	12.1	12.3
		Total	16.8	15.3	17.5	19.3
	ii	Bullock labour	0.0	0.0	0.0	0.0
	a	Hired	0.1	0.0	0.0	0.0
	b	Owned	7.8	3.1	1.0	0.5
		Total	7.8	3.2	1.1	0.5
	iii	Machine Labour	0.0	0.0	0.0	0.0
	a	Hired	6.6	8.1	9.4	11.0
	b	Owned	4.0	5.2	3.4	2.2
		Total	10.5	13.2	12.8	13.2
	iv	Seed	7.8	5.6	4.1	4.0
	v	Fertilizer & Manure	0.0	0.0	0.0	0.0
	a	Fertilizer	13.4	13.6	10.0	6.6

TABLE 3 SHARE OF COST COMPONENTS IN TOTAL COST OF WHEAT IN HARYANA (IN %).—*CONTD.*

Crop-Wheat			TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
	b	Manure	0.1	0.0	0.0	0.0
		Total	13.5	13.6	10.0	6.6
	vi	Insecticides	1.2	1.2	2.7	1.5
	vii	Irrigation charges	7.5	7.7	7.1	6.8
	viii	Interest on W.C.	1.7	1.6	1.4	1.2
	ix	Misc. charges	0.0	0.0	0.0	0.1
2		Fixed Cost	33.1	38.7	43.4	46.8
	i	Rent.Value of ow.l.	21.1	27.6	32.7	38.2
	ii	R.paidL.land	1.2	0.4	2.7	0.1
	iii	Land rev.cesses T.	0.3			0.0
	iv	Dep.imp.F.bldgs.	1.7	1.6	1.2	0.7
	v	Int.on fixed Cap.	8.8	9.1	6.8	7.8
1+2		Total Cost	100	100	100	100

Source: Ministry of Agriculture, Government of India.

TABLE 4 SHARE OF COST COMPONENTS IN TOTAL COST OF SUGARCANE IN HARYANA (IN %).

Crop-Sugarcane			TE 1981-82	TE 1992-93	TE 2002-03	TE 2011-12
1		Operational Cost	62.9	65.2	48.4	46.4
	i	Human labour				
	a	Casual	2.8	5.0	12.1	20.2
	b	Attached	3.9	3.2	1.5	2.0
	c	Family	22.0	16.0	12.0	7.1
		Total	28.7	24.1	25.5	29.3
	ii	Bullock labour				
	a	Hired	0.1	0.1	0.1	0.0
	b	Owned	5.9	4.6	0.5	0.0
		Total	6.0	4.7	0.6	0.1
	iii	Machine Labour				
	a	Hired	0.2	0.6	0.7	0.8
	b	Owned	1.2	1.7	3.0	1.7
		Total	1.4	2.3	3.6	2.5
	iv	Seed	5.4	16.5	5.7	5.9
	v	Fertilizer & Manure				
	a	Fertilizer	11.6	5.5	4.3	3.1
	b	Manure	1.3	0.3	0.1	0.1
		Total	12.9	5.7	4.4	3.2
	vi	Insecticides	0.2	0.3	1.7	0.7
	vii	Irrigation charges	5.9	8.6	4.7	2.3
	viii	Interest on W.C.	2.4	2.9	2.1	2.3
	ix	Misc.	0.0	0.0	0.0	0.0
2		Fixed Cost	37.1	34.8	51.6	53.6
	i	Rent.Value of ow.l.	27.7	25.9	42.0	48.9
	ii	R.paidL.land	0.2	0.0	0.0	0.0
	iii	Land rev.cesses T.	0.3	0.0	0.0	0.0
	iv	Dep.imp.F.bldgs.	1.6	1.4	1.4	0.2
	v	Int.on fixed Cap.	7.2	7.6	8.2	4.5
1+2		Total Cost	100.0	100.0	100.0	100.0

Source: Ministry of Agriculture, Government of India.