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Trends in arrivals and prices of major food crops in Haryana

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Abstract
The present study aimed to analyze the trends and growth rates in arrivals and prices of major food crops in Haryana during 2007-08 to 2017-18. The study was based on secondary data. The growth rate was computed by using CGR, trends by linear trend equations and polynomial trend equations and R^2. The results shows that the growth rate and trends of food crops prices are positive and significant in Haryana, that means food crops prices increasing over the study period, whereas wheat (4.14%), rice (5.09%) and gram (14.96%) arrivals shows positive and significant growth rate and trend. Bajra (-14.58), barley (-9.29) show negative significant growth rate. Maize shows positive non-significant growth i.e. 8.79 per cent whereas rapeseed/ mustard shows negative and non-significant i.e. -0.08 per cent. The value of R^2 in food crops prices varies from 0.69 to 0.99 and in arrivals from 0.33 to 0.84.

Keywords: Growth rate, DMI, Coefficient of multiple regression, CGR, Polynomial trend

Introduction
The price fluctuations in agricultural commodities is a common phenomenon due to their seasonal nature of production, wide ecological imbalances compared to other crops and seasonal demand for agricultural commodities. Fluctuations in market arrivals largely contribute to price instability and price fluctuations of agricultural commodities, there is need to have an understanding of the price behaviour over time. As per price theory, prices are a function of demand and supply. But demand and supply are independently related to prices. Agriculture is mostly depends on the monsoon, supplies of agricultural commodities which are uncertain and this uncertainty in supply leads to fluctuations in prices. These fluctuations in prices of agricultural commodities are greatest obstacle in the way of agricultural development. The knowledge on the interrelations between the arrivals and prices of farm product is required for assessing the extent of price fluctuations over time. The analysis of arrivals and prices over time is important for formulating a sound agricultural price policy. India is the second largest producer of food grains globally. The Crops Division has set a production target of 274.55 million tonnes of food grains during the 2017-18. Based on Wholesale Price Index (WPI) (2011-12=100), WPI of food grains, cereals, wheat and paddy increased by 1.40 percent, 5.05 percent, 8.39 percent and 4.78 percent in 2018 over 2017. India is having largest area under rice crop. Wheat is the second most important staple food crop and plays a key role in food and nutritional security of the country. Haryana has made incredible progress in the field of agriculture. In 2017-18, Haryana has total area 45 lakh hectares under food grains and production 180 lakh tonnes. More than 75 lakh tonnes of wheat has arrived in mandis compared to the total procurement of 67.5 lakh tonnes in the previous marketing season. In 2017-18, total arrivals under crops rice, bajra, barley, gram, maize, rapeseed/ mustard was 90.3 lakh tonnes, 1 lakh 14 thousand tones, 62 thousand tones, 31 thousand tonnes, 1 lakh 45 thousand tonnes and 02 lakh 43 thousand tonnes.

Methodology
Selection of crops
The major food crops i.e. wheat, rice, bajra, barley, gram, maize, rapeseed/ mustard were selected purposively for the study. The present study was primarily based on secondary data collected from Statistical Abstract of Haryana, Directorate of Marketing and Inspection (DMI), Ministry of Agriculture and Farmers Welfare Government of India (Faridabad) other published and unpublished sources. The yearly time series data on arrivals and prices of major food crops were collected for Haryana state covering period from 2007-08 to 2017-2018.

Analytical tools and techniques
Compound Growth Rate (CGR): Compound growth rate has been worked out to

examine the tendency of variable to increase, stagnant or decrease over a period of time. To examine the change in prices and arrivals of major food crops in markets of Haryana for the period 2007-08 to 2017-18, the compound growth rate was worked out using the following form of exponential function-

$$Y_t = ab^t u_t \quad \ldots. (1)$$

Where,
Y = prices or arrivals of food crops at time 't'
t = time in years
u = error term
a and b are parameters to be estimated
b = (r+1)
r = compound growth rate in per cent per annum

Thus,
$Y = a(r+1)^t u_t$ …. (2)
'r' = [Antilog of (log b) -1] x 100 …. (3)

The significance of compound growth rate (CGR) was tested by using student 't' test:

$$t = \frac{r}{SE(r)} \quad \ldots. (4)$$

The standard error of CGR is given by:

$$SE\,(r) = \frac{(100 \times b)}{\log e} SE\,(\log b) \quad \ldots. (5)$$

Where, log e = 0.4323

Trend in annual prices and arrivals
The behaviour of prices and arrivals of major food crops were studied by analysing the trend in prices and arrivals. The trend in prices and arrivals of food crops in Haryana was worked out by fitting linear, quadratic, 3rd degree polynomial and exponential trend equations.

Linear trend equation

$$Y_t = a + bt + U_t \quad \ldots. (7)$$

Where
Y_t = Annual market prices or arrivals of food crops at time 't'
t = Time in years
a and b are parameters to be estimated
U_t = Error term

Quadratic trend equation

$$Y_t = a + bt + C_t^2 \ldots. (8)$$

Where,
Y_t = Annual market prices or arrivals of Haryana at time 't' a, b and c are the constants or regression co-efficient
bt = time in years

3rd degree polynomial equation

$$Y_t = a + bt + c_t^2 + d_t^3 \ldots..(9)$$

Where,
Y_t = Annual market prices or arrivals of food crops at time 't'
a, b, c and d are the constants or regression co-efficients.
t = time in years

Exponential trend equation

$$Y = ab^t u_t \ldots.(10)$$

Where,
Y = prices or arrivals of food crops at time 't'
t = time in years
u = error term
a and b are the constants or regression co-efficients of the exponential curve

Results and Discussion
Growth in prices of food crops in Haryana
The compound annual growth rates of prices (FHPs) of major food crops over the period 2007-08 to 2017-18. The highest growth rate was registered in rice (9.41 %) and lowest in barley (4.68 %). The growth rates of prices were positive and significant in rice, bajra, gram, maize, rapeseed/ mustard, wheat and barley *i.e.* 9.41 per cent, 8.47 per cent, 7.96 per cent, 7.67 per cent, 5.78 per cent, 5.58 per cent and 4.68 per cent per annum respectively. The growth rate in prices of gram increased due to general rise in prices and failure of supply to keep pace with the increased demand due to human consumption and animal feed. Thakre *et al*., (2017) [5] reported similar results that the annual compound growth rate of prices of paddy and wheat were found positive 10.54 and 6.74 per cent.

Table 1: Compound annual growth rate of prices of food crops in Haryana for the period 2007-08 to 2017-18

Crops	Growth Rate (r) %	Standard Error of r
Cereals		
Wheat	5.58*	0.22
Rice	9.41*	1.11
Coarse Cereals		
Bajra	8.47*	0.85
Barley	4.68*	1.29
Maize	7.67*	0.81
Pulses		
Gram	7.96*	1.38
Oilseeds		
Rapeseed/ mustard	5.78*	1.19

* indicates significance at 1 per cent probability level NS – Non-significant

Growth rates of major food crops arrivals in Haryana
The compound annual growth rates of arrivals of major food crops over the period 2007-08 to 2017-18 are presented in table 2. The highest growth rate was registered in gram (14.96 %) and lowest in bajra (-14.58%). The growth rates of arrivals were positive and significant in gram, rice and wheat i.e. 14.96 per cent, 5.09 per cent and 4.14 per cent per annum respectively. Bajra and barley with negative significant growth rates of -14.58 and -9.29 per cent per annum respectively. The growth rates in maize was positive but non-significant i.e. 8.79 per cent per annum but in rape seed and mustard non significant negative growth rates in arrivals i.e -0.08 per cent per annum. Thakare *et al.* (2017) [4] examined similar observations that the annual compound growth rate of arrivals in case of paddy (65.77 %) were found positive.

Table 2: Compound annual growth rate of major food crops arrivals in Haryana for the period 2007-08 to 2017-18

Crops	Growth Rate (r) %	Standard Error of r
Cereals		
Wheat	4.14***	2.25
Rice	5.09*	0.75
Coarse Cereals		
Bajra	-14.58**	4.51
Barley	-9.29*	2.84
Maize	8.79^{NS}	5.35
Pulses		
Gram	14.96**	4.69
Oilseeds		
Rapeseed/ mustard	-0.08^{NS}	2.18

*, ** and *** indicates significance at 1, 5 & 10 per cent probability level NS – Non-significant

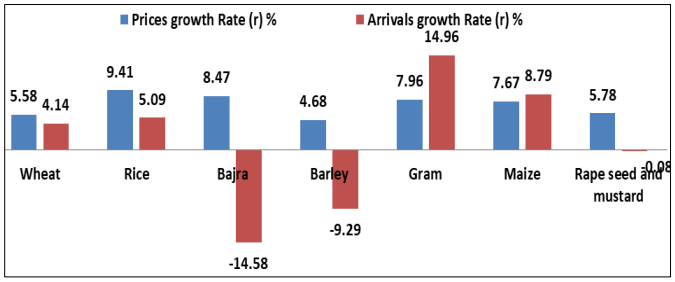

Fig 1: Commpound annual growth rate of prices and arrivals of major food crops from 2007-18

Trend in prices of major food crops in Haryana

The estimates of linear trend in prices of food crops in Haryana are shown in Table 3. In wheat the value of 'b' was positive *i.e.* 72.38. Singh (2016) [3] also observed an increasing trend in the FHPs of wheat in all the markets of Uttar Pradesh. In rice the value of 'b' was positive *i.e.* 96.46. The rise in the price of rice was due to increase in the demand of the rice in Haryana. In bajra the value of 'b' was positive *i.e.* 79.50. Decreasing trend in bajra arrivals due to increase in the area of other competitive crops like rice in Haryana. In barley the value of 'b' was positive *i.e.* 50.35. In gram the value of 'b' was positive *i.e.* 230.89. K. Divya (2015) [1] also observed that there was an increasing trend in the prices of blackgram, greengram and redgram. In maize the value of 'b' was positive *i.e.* 79.59. In rapeseed/ mustard the value of 'b' was positive *i.e.* 167.62. Increasing trend in rapeseed/ mustard was caused by increased population leading to an increase in demand for edible oils and general inflationary pressure..The positive values of 'b' and shapes of trends *i.e.* linear upward indicated that the prices of food crops had increased over the period 2007-08 to 2017-18.

Table 3: Trend in prices of major food crops in Haryana during 2007-18

Crops	Intercept(a)	Slope(b)	R^2	Trend Equation
Wheat	912.9	72.38	0.99	y = 912.9+ 72.38x
Rice	721.1	96.46	0.92	y = 721.1+ 96.46x
Bajra	638.8	79.50	0.94	y = 638.8+ 79.49x
Barley	896.9	50.35	0.69	y = 896.9+ 50.35x
Gram	2127	230.89	0.83	y = 2127+ 230.89x
Maize	759.5	79.59	0.91	y= 759.5+79.59x
Rapeseed/ Mustard	2128	167.62	0.82	y= 2128+167.62x

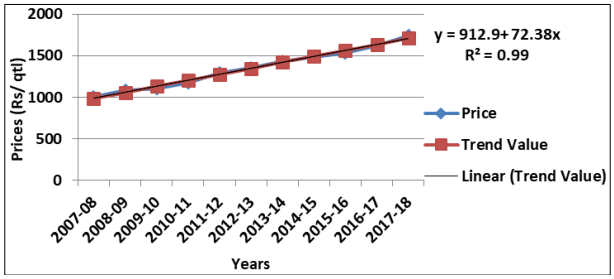

Fig 2: Trend in prices of wheat in Haryana

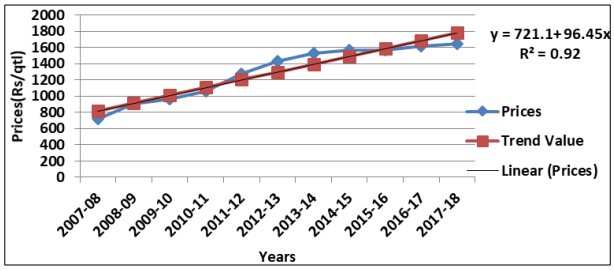

Fig 3: Trend in prices of rice in Haryana

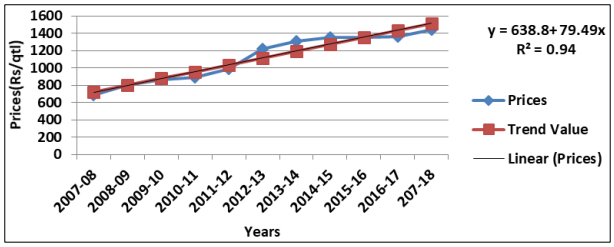

Fig 4: Trend in prices of Bajra in Haryana market

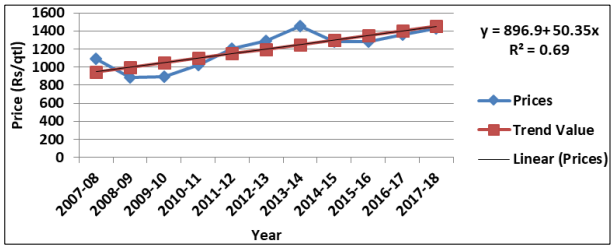

Fig 5: Trend in prices of barley in Haryana

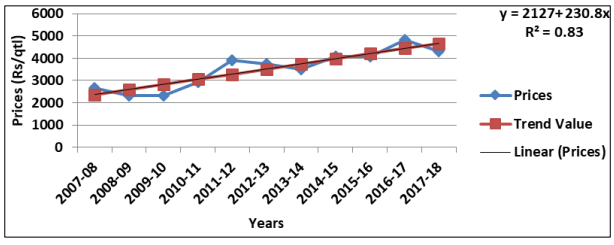

Fig 6: Trend in prices of gram in Haryana market

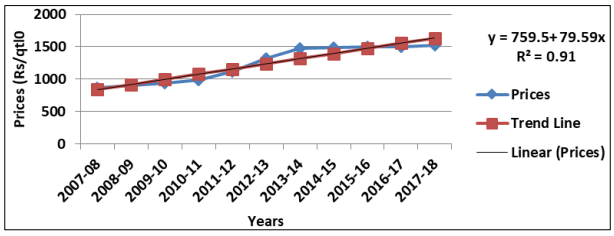

Fig 7: Trend in prices of maize in Haryana market

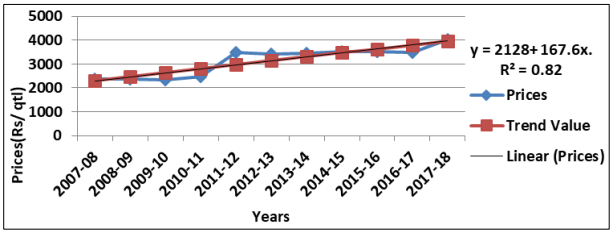

Fig 8: Trend in prices of rapeseed/ mustard in Haryana

Trend in arrivals of Food crops in Haryana

The estimates of linear and polynomial trend in arrivals of wheat, bajra, barley, gram and rapeseed/ mustard in Haryana are presented in table 4. Using the polynomial trend instead of linear trend because polynomial trend gives better results. The estimates of linear trend in rice and exponential trend in maize gives higher value of R^2. In Fatehabad, shift in cropping pattern had been observed by Kumar *et al.* (2016) [2] and concluded that cropping changed from less water intensive crops *i.e.* pearl millet to more water intensive crops like paddy. The value of 'b' was positive in wheat, rice, gram, maize and rapeseed/ mustard. The positive value of 'b' indicated that the arrivals of these crops had increased over the years. The value of 'b' was negative in bajra and barley crops. The negative value of 'b' indicated that the arrivals of these crops had decreased over the years. Meena *et al.* (2010) [5] found similar results that in Khairthal, Sri Ganganagar and Raisinghnagar markets, the trends of arrivals of rapeseed-mustard showed significant increase over a period of time.

Table 4: Trend in arrivals of food crops in Haryana during 2007-18

Crops	Intercept (a)	Slope (b)	R^2	Trend Equation
Wheat	52831	2108.16	0.31 (linear) 0.73 (Polynomial)	y = 52831+ 2108.16x (linear) $y=233.1x^3-4825x^2+30692x+11002$ (Polynomial)
Rice	41009	3689.81	0.84	y = 41009 + 3689.81x (linear)
Bajra	2728	-207.26	0.50 (linear) 0.82 (Polynomial)	y = 2728 + (-207.2)x (linear) $y= 4.84x^3 - 29.71x^2 + 460x + 3694$ (Polynomial)
Barley	1699	- 94.76	0.60 (linear) 0.72 (Polynomial)	y = 1699 + (-94.76)x (linear) $y= -15.08x^2 + 86.24x + 1307$ (Polynomial)
Gram	76.41	20.58	0.63(linear) 0.73 (Polynomial)	y = 76.41+ 20.58x (linear) $y= 0.579x^3– 13.02x^2 +103.9x -54.15$ (Polynomial)
Maize	702.2	57.98	0.14(linear) 0.33 (Exponential)	y= 702.2+57.98x (linear) $y= 568.2\ e^{0.084x}$ (Exponential)
Rapeseed/ Mustard	1459	34.82	0.09(linear) 0.62 (Polynomial)	y= 1459 +34.81x (linear) $y=9.899x^3-167.3x^2+797.3x+661.3$ (Polynomial)

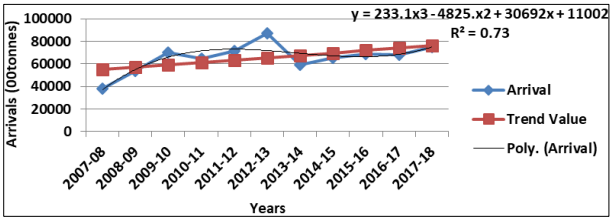

Fig 9: Trend in arrivals of wheat in Haryana

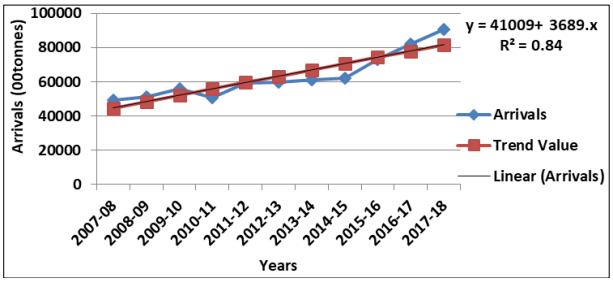

Fig 10: Trend in arrivals of rice in Haryana

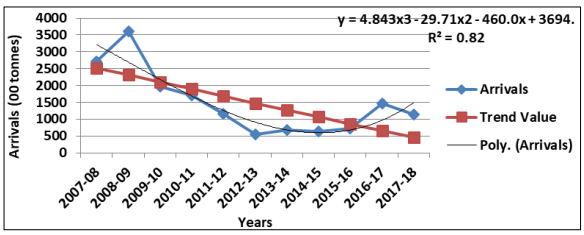

Fig 11: Trend in arrivals of bajra in Haryana

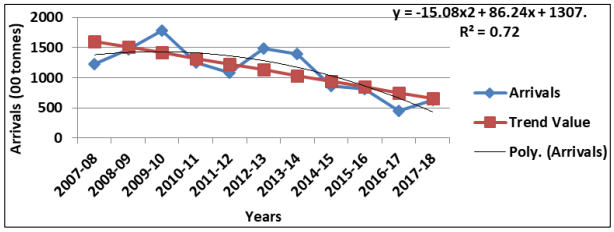

Fig 12: Trend in arrivals of barley in Haryana

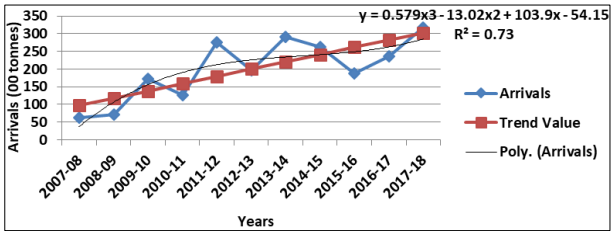

Fig 13: Trend in arrivals of gram in Haryana

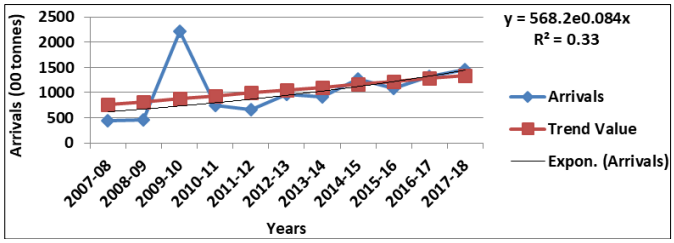

Fig 14: Trend in arrivals of maize in Haryana

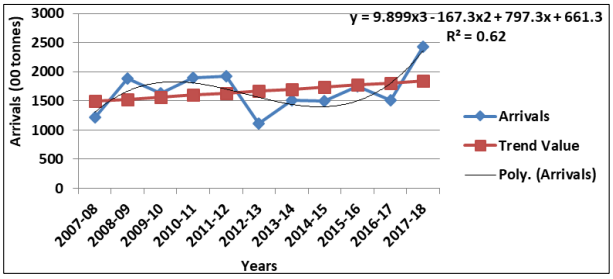

Fig 15: Trend in arrivals of rapeseed/ mustard in Haryana

Conclusion

The growth and trend values in prices were positive and significant for all the selected food crops in Haryana during the period from 2007-08 to 2017-18. Thus, there was considerable increase in food crops prices in Haryana over the study period due to demand was always greater than supply. Prices have not found itself sufficient to motivate farmers to intensify modern technology on their farms and increase the area under targeted crop. The growth and trend values in arrivals of wheat, rice, gram, maize were positive and significant. Thus, there was considerable increase in these crops arrivals over the study period due to higher prices and area under these crops in Haryana. The growth and trend values in arrivals of bajra and barley were negative and significant while in rapeseed/ mustard was negative but non-significant due to less area under these crops (more area shifted to their competing crops like rice and wheat).

Suggestions and policy implications

- In Haryana state, the crops like Bajra and barley whose area is continuously declining. In this context, concerted research efforts are needed to find out the main reasons for the devastation of these crops and also suggest appropriate remedial measures for correcting this undesired trend.
- In Haryana, procurement is effective only in rice and wheat crops. Policy should made availability of procurement machinery for all the food crops. An efficient and proper procurement mechanism from the government is needed for farmers to get the increased price benefits to their income.

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