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Research Paper

Economics of Oil Seed Exports in India: An Application of Holt-Forecasts

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ABSTRACT

This article intended to examine the export performance of oil seed crops in India from 1987 to 2019 using the Compound Annual Growth Rate (CAGR), Cuddy-Della Valle instability index, as well as forecast export quantity and value to 2025. The analysis focuses mainly on two major oil seed crops: groundnut and soyabean. The research of oil seed crop export growth trends over time revealed a positive growth rate for both export quantity and export unit value. The potential for Indian oil seed crop in the world market during the post-liberalization period were shown by the strong growth rates of soyabean goods combined with high export instability indices. When compared to soyabean, the annual growth rate of groundnut was the lowest, with instability showing a wide range across the entire period. Holt models were created in this paper to estimate oil seed export quantity and prices, with the top models chosen by comparing Akaike Information Criteria (AIC), Mean Absolute Percent Error (MAPE). Further, groundnut export quantity and price forecasts showed positive development throughout the forecast period, whereas, soyabean export price forecasts showed a 0.01 percent increase from 2021 to 2025. To improve the worldwide performance of the Indian oil seed industry, the government should make appropriate amendments to oil seed export policies and domestic supportive measures, as well as adopt appropriate value adds and market diversification strategies.

HIGHLIGHTS

- The growth rate of oil seed export quantity and export value were found high, positive and highly significant during the study period.
- This article mainly focuses the instability and forecast pattern of various oil seed crop across the India.

Keywords: Oil seed crop growth rate, Instability, CDVI, Holt and Damped Holt method forecast

Groundnut, sometimes known as peanut, is the world's fifth most important oilseed crop. Groundnut is India's leading oil seed crop, and it contributes significantly to the country's vegetable oil shortfall. India has a long history in the groundnut export trade, accounting for over a third of global export potential (Rude *et al*. 2015). Groundnut is grown in over a hundred countries worldwide, however it is mostly grown in a few Asian countries such as India and China, as well as other key growing nations such as Nigeria, Indonesia, and the United States (Beghin *et al*. 2006). These top producers together accounted for more than 75 and 60 percent of global groundnut production and area, respectively (Arul Prasad, 2019). India is the world's second-largest producer of groundnuts; with 17.39 million tonnes of groundnuts produced, China took first place, followed by India with 6.70 million tonnes. Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, Orissa, Andhra Pradesh, Tamil Nadu, Karnataka, and Uttar

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Pradesh are the major growing states. Because this crop is mostly produced in rain-fed conditions, productivity has been found to be highly variable in relation to its area (Sangeetha *et al.* 2016; Naidu *et al.* 2014). At the country and major state level, the share of groundnut area in total cultivated area and total oilseeds area has decreased (Misra, 2017).

India's agricultural exports are negatively affected by high and rising domestic demand due to a big and growing population and rising affluence (Ansari and Khan, 2015). Because domestic consumption is strong in major groundnut producing countries, groundnut export is quite limited on the global market. Only about 5 per cent of the world's groundnut production is traded abroad (Sameer *et al*. 2014).

Groundnut exports from India were found to be negatively related to domestic price and population, but increased dramatically with export price and exchange rate (Bansal *et al*. 2017). The fact that the speed of adjustment was negative and substantial indicated that exports were returning to long-run equilibrium after short-term shocks. During the 2020-21 fiscal years, the government exported 589.66 thousand tonnes of groundnuts to the world, valued at 662.74 USD Millions. Indonesia, Vietnam, the Philippines, Malaysia, and Thailand are major export destinations.

Soybean is the most popular and widely produced oilseed in the planet. It grows in a wide range of temperatures and soils that is why it is regarded as the most cost-effective crop with a high market value (Reddy and Bantilan 2012). Because of its high productivity, profitability, and critical contribution to soil fertility, soybean occupies a significant position in the world's oilseed farming situation. The crop is also the world's most important seed legume, contributing 25 per cent of worldwide vegetable oil production, nearly two-thirds of the world's protein concentrate for cattle feeding, and is a valuable element in formulated poultry and fish diets (Chand *et al*. 2004).

Soybean meal and oil are produced from about 85 per cent of the world's soybeans each year. The United States leads the world in soybean output, with Brazil, Argentina, and China following closely behind, which was accounting for 80 per cent of global supply (Bhuimali and Chakraborty, 2018). In India, soybeans are mostly grown in Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, and Karnataka, whereas, Madhya Pradesh top the list, with total soybean production of 4.981 million tonnes, or nearly 53 per cent of India's total production (Touseef Ahmad Dar and Ishfaq Ahmad Ganai, 2019).

MATERIALS AND METHODS

The growth rates were used to assess the economic variables' previous past performance. The compound annual growth model was utilized to examine the growth of oil seed exports quantity and value. CGAR predicted the size of the change in the variable under investigation per unit of time, as well as the variable's tendency to rise, decrease, or stay the same over time.

Compound Annual Growth Rate

The compound growth rate was analyzed by using exponential growth function as given below:

$$Y = ab^t \qquad \ldots(1)$$

Where,

Y = Export quantity / Export value of the animal product

t = Time variable

b = Regression coefficient

a = Intercept

Equation (1) will be converted into the natural logarithmic form in order to facilitate the use of linear regression. Taking logarithms on both sides we obtain,

$$Log\ Y = Log\ a + t\ Log\ b$$

The compound growth rates 'r' was computed by using the formula

$$CGR\ (r) = [\text{Antilog}\ (\log b) - 1] * 100$$

Where, r = Compound growth rate

Instability Index

Instability in export is expected to hamper the process of economic development. The degree of

instability in export quantity and export value of the animal products was measured by using the coefficient of variation. The standard deviation as a percentage of mean is called the coefficient of variation.

$$\text{Coefficient of variation (CV)} = \frac{\sigma}{\bar{x}} \times 100$$

Where,

σ = Standard deviation

$$\sigma = \sqrt{\frac{\Sigma (X - \underline{X})^2}{n}}$$

$\bar{x}$ = Arithmetic mean

To examine the extent of variation and risk involved in prices, the instability index is calculated using the Cuddy-Della Valle approach (Cuddy and Della Valle, 1978).

$$\text{CDVI} = \text{CV} \times \sqrt{(1 - R^2)}$$

Where, CDVI is the Cuddy-Della Valle instability index in percent, CV is the coefficient of variation in percent and adjusted R^2 is the coefficient of determination from a time-trend regression. The estimating index value is a close approximation of the average variation in annual prices which is adjusted for trend. The ranges of CDVI are given as follows (Sihmar, R. 2014).

- Low instability = 0 to 15
- Medium instability = greater than 15 and less than 30
- High instability = 30 and above

Holt's trend method

Simple exponential smoothing was expanded by Holt (1957) to allow for the forecasting of data with a trend. A forecast equation and two smoothing equations (one for the level and one for the trend) were used in this method:

$$\hat{y}_{t+h|t} = l_t + hb_t$$
$$l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1})$$
$$b_t = \beta(l_t - l_{t-1}) + (1 - \beta) b_{t-1}$$

Where, ℓ_t is an estimate of the series' level at time t, b_t is an estimate of the series' trend (slope) at time t, α is the smoothing parameter for the level, $0 \le \alpha \le 1$, β^* and is the smoothing parameter for the trend, $0 \le \beta^* \le 1$. The level equation here, as with basic exponential smoothing, indicates that ℓ_t is a weighted average of observation y_t and the one-step-ahead training projection for time t, which is given by $\ell_{t-1} + b_{t-1}$. b_t is a weighted average of the estimated trend at time t based on $\ell_t - \ell_{t-1}$ and b_{t-1}, the prior estimate of the trend, according to the trend equation.

The forecast function is now trending rather than flat. The last estimated level plus h times the last estimated trend value equals the h-step-ahead forecast. As a result, the predictions are a linear function of h.

Damped Holt trend methods

Holt's linear approach projections show a continuous trend (growing or decreasing) infinitely into the future. These methods over-predict, according to empirical evidence, especially for longer forecast horizons. Gardner and McKenzie (1985) presented a parameter that "dampens" the trend to a flat line at some point in the future, based on this discovery. When forecasts for many series are required automatically, methods that include a damped trend have proven to be quite successful. They are undoubtedly the most used individual methods.

This approach incorporates a damping parameter $0<\varphi<1$ in addition to the smoothing parameters α and β^* (with values between 0 and 1 as in Holt's method).

$$\hat{y}_{t+h|t} = l_t + \left(\phi + \phi^2 + \ldots + \phi^h\right) b_t$$
$$l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + \phi b_{t-1})$$
$$b_t = \beta(l_t - l_{t-1}) + (1 - \beta)\phi b_{t-1}$$

If the value is $\varphi = 1$, the procedure is the same as Holt's linear method. For values between 0 and 1, φ dampens the trend so that it eventually approaches a constant. In reality, for any value of $0<\varphi<1$, the estimates converge to $\ell_T + \varphi bT/(1-\varphi)$ as $h \to \infty$. Short-term forecasts are trended, whereas long-term forecasts remain steady. In practice, φ is rarely less than 0.8, as damping has a significant influence at lower values. A value of φ

around 1 indicates that a damped model cannot be discriminated from a non-damped model. As a result, we typically limit φ to a minimum of 0.8 and a maximum of 0.98.

RESULTS AND DISCUSSION

Oil seed CAGR

It is clearly seen that for export quantity, the beginning year of groundnut and soybean was 4,665 tonnes and 1726 tonnes, whereas the end of the year both registered as 664442.92 tonnes and 132314.7 tonnes (Table 1). The highest growth rate was found to be in the case of soyabean 24.91 per cent and lowest growth rate was observed in case of groundnut 14.03 per cent per annum. Results clearly depicted that for export value, the beginning year of groundnut and soybean was 3,889.07 (1000 US $) and 382 (1000 US $), whereas the end of the year both registered as 711408.15 (1000 US $) and 86070.7 (1000 US $). The growth rate was found to be significant and positive in both the crops, the highest growth rate was found to be in soybean 30.08 per cent and lowest growth rate was observed in groundnut 17.28 per cent per annum.

Table 1: Compound annual growth rate in export quantity and value under oil seed in India 1987-2019

Year	Groundnut		Soyabean	
	Export quantity (MT)	Export value (1000 US $)	Export quantity (MT)	Export value (1000 US $)
1987	4,665.00	3,889.07	1726	382
1988	22,321.00	14,459.59	3904	1067
1989	25,782.50	13,482.91	1597	375
1990	29,244.00	12,506.22	347	73
1991	3,637.00	2,997.78	108	22
1992	4,343.00	2,520.12	98.25	23.75
1993	236461	54,557.67	86.5	25.5
1994	51,123.00	32,267.68	75.75	27.25
1995	118908	68,964.78	65	29
1996	151354.86	93,406.75	1299	335
1997	245129.25	152394.94	11469	3249
1998	58,263.18	33,197.73	1327	214
1999	158109.62	85,797.06	9828	1708
2000	137065.64	69,265.11	75020	15946
2001	112812.8	53,391.19	5805	1190
2002	67,850.74	36,773.46	1716	391
2003	176109.32	120929.67	242273	62186
2004	177154.07	121913.05	2058	761
2005	190053.34	116035.16	5055	1905
2006	251428.65	177120.68	3528	1478
2007	269587.66	260523.57	7460	2911
2008	297890.37	269408.41	44838	20961
2009	340246.31	300829.74	24699	11916
2010	433753.24	477930.23	14491	7638
2011	832616.94	1094247.8	30556	18615
2012	535637.37	747390.31	46251	33250
2013	509664.85	525695.15	138609	106821
2014	708386.26	760368.75	204365	151284
2015	542726.41	620359.64	212015	144643
2016	725704.34	811585.23	149832	97587
2017	504019.2	524815.43	292483	166258
2018	489187.11	473806.42	209846	122695
2019	664442.92	711408.15	132314.7	86070.7
R^2	0.719	0.822	0.655	0.737
Growth rate	14.03***	17.28***	24.91***	30.08***

***, *indicates significant at 1 per cent level, respectively.*

Demand and supply of oil and meal determine the quantity and price of groundnut and soybean exports. In general, only a small fraction of the soyabean crop is consumed directly by people, but its products are included in a wide range of processed meals. Both oil seed crop derivatives and industrial goods can now be found in hundreds of human diets, animal feeds, and industrial products (Pyzhikova *et al*. 2020).

Oil seed Instability

The oil seed crop, soyabean recorded higher coefficient of variation (152.25%) followed by groundnut (87.45%), which shows that instability of soybean was higher than the groundnut (Table 2). The CDVI value of soyabean and groundnut was observed to be 89.33 and 46.28, which give clear signs of high range instability in the study period. In case export value of oil seed crops exists, high instability and positive correlation was observed in groundnut and soybean with coefficient of variation at 111.97 per cent and 161.93 per cent respectively. During the overall study period CDVI value of groundnut and soybean was observed to be 47.21 and 82.94 which gives clear signs of high rage instability over the study period.

Table 2: Instability analysis of export quantity and export value in oil seed (1987-2019)

	Particulars / Crops	Mean	SD	CV	CDVI	Range
	Export quantity (Metric Tonnes)					
Oil seed	Groundnut	275020.57	240511.04	87.45	46.28	High
	Soyabean	56822.58	86517.75	152.25	89.33	High
	Export value (1000 US $)					
	Groundnut	268007.26	300112.71	111.97	47.21	High
	Soyabean	32182.95	52115.11	161.93	82.94	High

Note: *SD- Standard Deviation, CV- Coefficient of Variation and CDVI- Cuddy-Della Valle instability index.*

The oil seed crop both groundnut and soyabean export quantity and value registered more instability because it depends on many market and non-market factors. Basically, this oil seed crop is grown predominantly in rainfed (85% of total area) resource poor conditions, resulting in higher yield and production volatility (Gautam and Singh, 2020). The expanding oil business, on the other hand, is putting increased demand pressure on oil seed crop production. Groundnut and soyabean prices are highly volatile, and exports fluctuate significantly during the study period (Adeleke and Babalola 2020). As a result, the country implements appropriate trade reforms, forcing domestic companies to adopt more efficient production processes and create capacity in order to withstand globalization's effects and compete with foreign players.

To fit the time series models including Holt and Damped Holt models

Present study focuses on statistical evaluation of the different Holt method forecasting models for price and quantity of oil seed commodities was done. Thirty-three-year price and quantity data for two oil seed crops was collected from the Agricultural and Processed Food Product Export Development Authority (APEDA) website from the duration 1987 to 2019.

The parameter estimates after application of Holt and Damped Holt forecast parameter for all oil seed crops category of export quantity and export value is presented in Table 3. The best fit model among the Holt and Damped Holt forecast models was chosen based on the lowest root mean square error (RMSE) and the lowest normalised Akaike Information Criteria (AIC) value. The criteria adopted for model selection for forecasting of various oil seed crops are given in Table.3. The results reveled that oil seed crop, which has a relatively low AIC and RMSE values observed from Holt method of forecasting model, which indicating that both groundnut and soyabean performed better. In case of oil seed export price, groundnut crop fitted Holt model and soyabean fitted Damped Holt of forecast was performing better although it has a very low value of AIC and RMSE of both model.

Table 3: Aggregate error measures of model fitting for export quantity and value of oil seed crop

Category			Export quantity (MT)		Export value (1000US $)	
			AIC	RMSE	AIC	RMSE
Oil seed	Groundnut	HM	892.554	111724	912.885	152030.3
		DHM	894.973	115894.5	913.919	154430.5
	Soyabean	HM	853.868	62170.71	800.606	27739.88
		DHM	855.618	63840.95	800.604	27739.32

Note: *HM- Holt Method, DHM- Damped Holt Method.*

The Table 4 shows that for forecast export quantity, the beginning year of groundnut and soybean was 652704.7 tonnes and 202558.6 tonnes, whereas the end of the year both registered as 719363.6 tonnes and 227358.6 tonnes. Whereas, the highest forecast growth percentage was found to be in the case of soyabean 15.79 per cent and lowest growth was observed in case of groundnut 13.10 per cent. In the case of both oil seed export values, the lowest forecast value was recorded, but there was a considerable and positive growth trend for the whole period (2021-2025) at 7.87 percent and 0.01 percent, respectively.

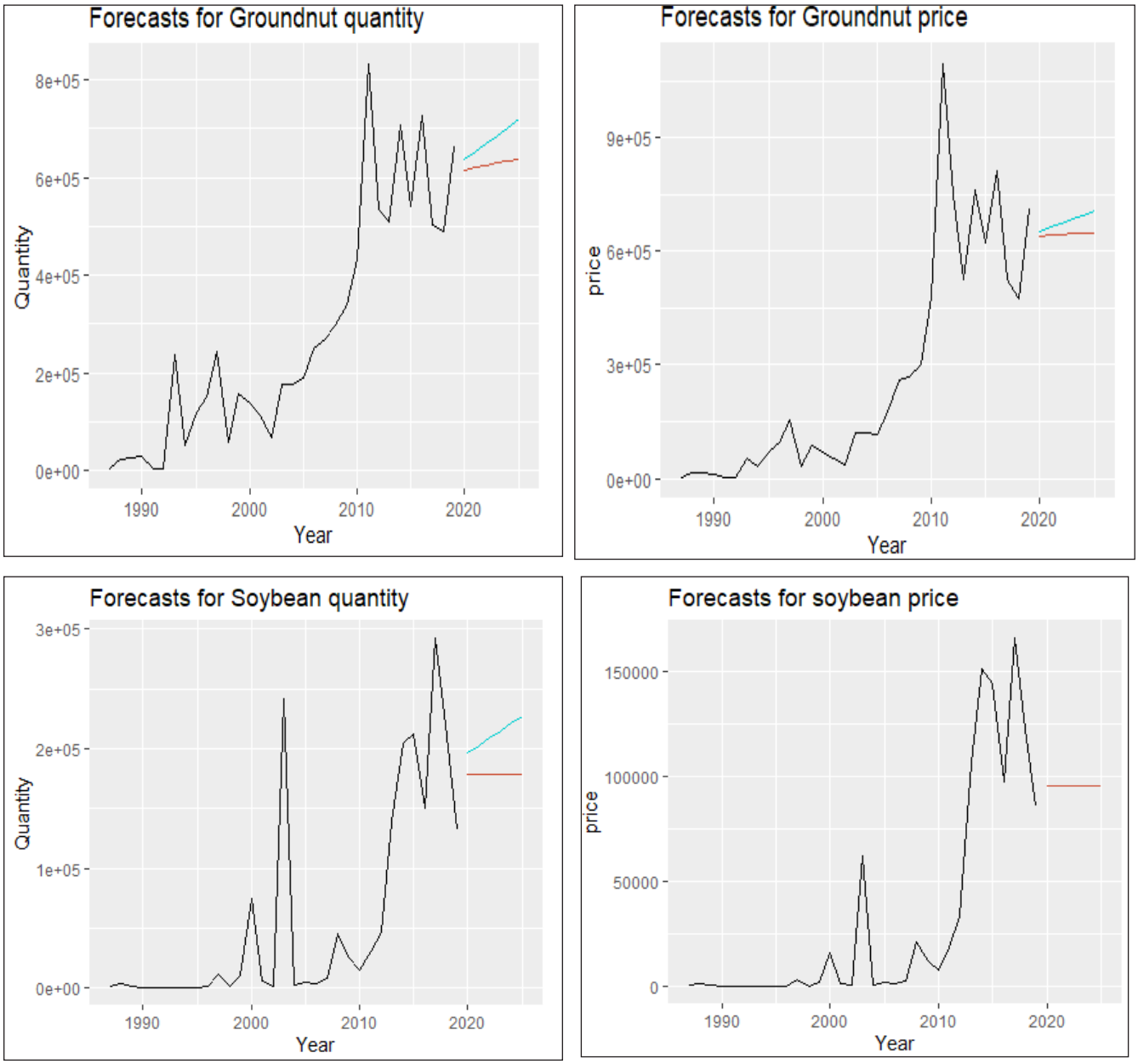
The forecast export value, the beginning year of groundnut and soybean was 663703.8 (1000 US $) and 95891.43 (1000 US $), whereas, at the end of the year both registered as 704832.0 (1000 US $) and 95900.91 (1000 US $), respectively. Currently, this oil seed crop is mostly used as a source of edible oils. The future value of export quantity and price of both oil seed crops has increased. In case of soybean export prices climbed at the smallest rate of 0.01 percent due to instability of export quantity and value. Aside from oil, its by-products contain a variety of functional substances like as proteins, fibres, polyphenols, antioxidants, vitamins, and

Table 4: Forecast of oil seed crop export quantity and export value (price) from India upto year 2025

Quantity: Metric Tonnes, Value in 1000 US$

Category/ Year			2021	2022	2023	2024	2025	Growth (%)
Oil seed	Groundnut	Qty	652704.7	669369.4	686034.1	702698.8	719363.6	13.10
		Price	663703.8	673985.8	684267.9	694550.0	704832.0	7.87
	Soyabean	Qty	202558.6	208758.6	214958.6	221158.6	227358.6	15.79
		Price	95891.43	95894.19	95896.67	95898.90	95900.91	0.01

Source: *Author Results.*



Holt's Method | Damped Holt's Method

Fig. 1: Forecast of the oil seed export quantity and prices in India

minerals that can be used as functional ingredients in a variety of processed foods (Arya *et al*. 2016).

CONCLUSION

During the study period of 1987 to 2019, the following study was conducted to investigate the compound annual growth rate, instability and forecast of oil seed crops. The growth rate of both oil seeds were positive throughout the period. The oil seed has shown a wide range of fluctuation in the case of instability, which might be due to changing production techniques and increased local oil consumption, as well as growing demand for oil seed in the global market and its execution at various periods. For both oil seed crops, the forecasted value of export quantity and price has showed a favourable trend. Soybean export prices climbed at the smallest rate of 0.01 percent due to instability of the crop. The government should make appropriate changes to oil seed export policies and domestic supportive measures to ensure higher production efficiency for their oil seed produce, as well as the adoption of appropriate value additions and market diversification strategies to improve the Indian oil seed industry's global performance.

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