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Time Series Analysis and Forecasting Techniques on the Horticulture Crops in India

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Abstract

Horticulture is a branch of agriculture that deals with the art, sciences, technology and business of plant cultivation. Horticulture has improved economic status of farmer's seasonal availability of fruits and vegetables throughout the year increased. This study was conducted to forecast the horticulture crops in India for the years from 2019 to 2021. And the study aim to find out the correctness of forecasting methods on the data collected from the source of horticulture crops in India.

Keywords: Horticulture crop, Forecasting, Fruits, Spices and Vegetables.

1. Introduction

Time series modeling and forecasting has basic importance to varied sensible domains. Hence a lot of active research works goes on during this subject throughout many years. Several necessary models are planned in literature for up the accuracy and potency of your time series modeling and forecasting.

Horticulture in India is branch of agriculture that deals with the art, sciences, technology and business of plant cultivation. Though horticulture may be a separation of an agriculture that deals with plant, plant farming, it's really totally different from agriculture. The necessity for diversification to horticulture sector was acknowledged by the govt. of India in middle eighties by focusing its attention on investment during this sector. Presently husbandry has established its credibleness in up financial gain through exaggerated productivity, generating employment and in enhancing exports. Resultantly, horticulture has moved from rural compass to business venture.

The data are secondary, Collected from the horticultural statistics at a look 2017, horticulture statistics division, Department of Agriculture, cooperation and farmers welfare, Ministry of Agriculture and Farmers welfare, Govt. of India. The info was already collected and tests had been created by a previous work. The initial experiment involved finding the most effective technique for intermittent demand. Since there was no documentation that might ensure the results, the experiments had to start out from the start by selecting the things, forecast strategies and forecast errors.[1-5]

2. Overview of Horticulture

The Department Of Agriculture, Co-Operation Of Farmers Welfare (DAC & FW) of the ministry of Agriculture and farmer's welfare is that the nodal department for over viewing horticulture development within the country. It implements totally different programs through department of

horticulture / Agriculture altogether the states and provides the leadership to coordinate activities for the promotion of horticulture.

Production: India has witnessed improved in horticulture production over the previous couple of years, important progress has been created in space enlargement leading to higher production. Over the last decade, the area beneath horticulture grew by 2.6% once a year and annual production exaggerated by 4.8%. The assembly of vegetables has exaggerated from 101.2 million tons to 184.40 million tons since 2004-5 to 2017-18 and production of fruits has exaggerated from 50.9 million tons to 97.35 million tons since 2004-05 to 2017-18.[6-10]

Fruits and vegetables account for nearly ninety percentage of total horticulture production within the country, India is currently the second largest producer of fruits and vegetables within the world and is that the leader in many horticulture crops particularly mango, Banana, Papaya, Cashew nut, Potato and Okra. But the character of horticulture crops being such it's dangerous to create assessment of their production. These crops particularly vegetables area unit grownup in tiny plots, fields or in the backyard of the homes doesn't have single harvest home in most of the cases that makes their assessment tough. Several horticulture crops have multiple pickings during a single season.[11-15]

3. Methodology

Time series modeling may be a dynamic analysis space that has attracted attentions of research worker community over previous couple of decades. The most set up of your time series modeling is to fastidiously collect and strictly study the past observations of a time series to develop an applicable model that describes the inherent structure of the series. This model is then accustomed generate future price for the series i.e., to create forecasts. Time series forecasting is termed because the act of predicting the longer term by understanding the past. It's obvious that a successful time series forecasting depends on an applicable model fitting. A Lot of efforts are done by researchers over a few years for the event of economical models to enhance the forecasting accuracy. As a result numerous necessary time series forecasting models are evolved in literature.

3.1 Some Important Mathematical Forecasting Techniques:

Quantitative forecasting methods are based on knowledge or observations that describe some issue of interest. Within the quantitative forecasting, one might try and forecast succeeding value in a time series knowledge given solely information of previous values. Within the literature variety of forecasting techniques are introduced by means that mathematical, statisticians and econometricians.

The varied applied forecasting methods generally classified into mathematical and applied mathematics forecasting models or techniques. Some necessary mathematical forecasting techniques are given by

1. Trend adjusted
2. Single moving Average forecasting model
3. Single exponential smoothing forecasting model
4. Double exponential smoothing forecasting models
5. Triple exponential smoothing forecasting models
6. Adaptive exponential smoothing forecasting models

3.2 Accuracy Measures for Forecasting Techniques:

Among a category of forecasting techniques, a specific forecasting technique for a given knowledge set is selected by using one of the criteria for model choice. In most forecasting things, accuracy is treated because the preponderant criteria for choosing forecasting techniques.

Generally, accuracy refers to 'goodness of fit', that successively visit however well the chosen forecasting model is ready to breed the info that are already renowned. In applied mathematics or time series modeling it's attainable to use a set of the renowned knowledge to forecast the remainder of the renowned knowledge, enabling one to review the accuracy of the forecasts a lot of directly. Suppose yt be the particular knowledge for fundamental quantity t; Ft be the forecast (or Fitted value) for constant fundamental quantity t; and therefore the forecast error be et= [yt-Ft]; if there are n time periods, then there'll be n error terms.Some necessary forecasting accuracy measures area unit given by

i.Mean Forecast Error (MFE) = $\sum$et/n.

ii.Mean Absolute Error (MAE) or Mean Absolute

Deviation (MAD) = ∑ | et | /n.

iii.Mean square Error (MSE) or Mean square. Deviation (MSD) = ∑ et2/n.

iv. Mean Absolute Percentage Error (MAPE) = ∑ | (et/yt)*100 | /n.

3.3 About Mini Tab

Mini tab could be a product that helps you to research the information. This is often designed primarily for the Six Sigma Professional. It provides an easy, effective way to input the applied mathematics knowledge, manipulate that knowledge, determine trends and patterns, so extrapolate answers to these problems. This is often most generally used package for the business of all sizes – little, medium and enormous. Minitab provides a fast, effective answer for the level of analysis required in most of the Six Sigma projects.

Minitab is one in all the dominant suppliers of the statistical software for quality improvement. A large range of corporations trust Minitab, thousands of colleges use Minitab package for teaching. Minitab INC. could be a company headquartered in state college, Pennsylvania, with subsidiaries within the U.K, France and Australia.

3.4 Using Mini Tab

1.Choose Stat > Time Series > Trend Analysis.

2. In Variable, enter the column containing the series.

3. If you wish, use any panel choices, and then click OK.

4. Empirical Work

4.1 India production: horticulture crops: Spices

Spice could be a dried seed, fruit, rot, bark, or vegetative substance primarily used for seasoning, coloring or protective sensible. Generally a spice is employed to cover alternative flavors. Spices are distinguished from herbs that are components of leafed inexperienced plants additionally used for seasoning or as garnish.

Several spices have antimicrobial properties, they're additional unremarkably utilized in hotter climates, wherever additional infectious diseases, are prevailing. A spice could have an additional use, typically healthful, ceremony, cosmetics or fragrance production, or as a vegetable. Asian nation is that the world's largest producer of turmeric (Curcuma longa), a perennial herb of the family ginger. The plant's underground stems or rhizomes are used as spice, dye, drugs and spiritual maker since antiquity.

To find out the correctness of forecasting methods on the information collected from the supply of horticulture crops in India throughout the year 2001 to 2018, more the study is to predict the forecast and forecast errors for 3 consecutive years from 2019 to 2021.

1: Forecast and Forecast error for the horticulture crops (Spices) using Linear Trend Model

Year	Spices	FITS1	RESI1
2001	3765	2996.62	768.38
2002	3765	3288.36	476.64
2003	5113	3580.11	1532.89
2004	4001	3871.85	129.15
2005	3705	4163.60	-458.60
2006	3953	4455.34	-502.34
2007	4357	4747.08	-390.08
2008	4145	5038.83	-893.83
2009	4016	5330.57	-1314.57
2010	5350	5622.32	-272.32
2011	5951	5914.06	36.94
2012	5744	6205.80	-461.80
2013	5908	6497.55	-589.55
2014	6108	6789.29	-681.29
2015	6988	7081.04	-93.04
2016	8122	7372.78	749.22
2017	8369	7664.52	704.48
2018	9216	7956.27	1259.73
2019		8248.01	
2020		8539.76	
2021		8831.50	

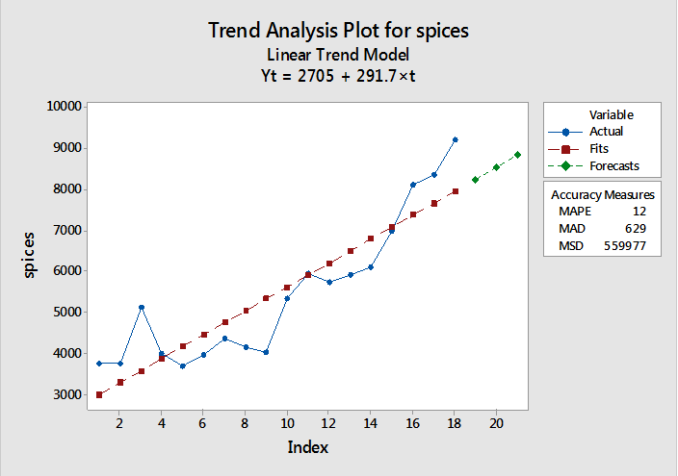

Chart 1: Linear Trend Model (spices)

Table 2: Forecast and Forecast error for the horticulture crops (Spices) using Single Exponential Method

Year	Spices	SMOO1	FITS1	RESI1
2001	3765	3993.27	4050.33	-285.33
2002	3765	3947.61	3993.27	-228.27
2003	5113	4180.69	3947.61	1165.39
2004	4001	4144.75	4180.69	-179.69
2005	3705	4056.80	4144.75	-439.75
2006	3953	4036.04	4056.80	-103.80
2007	4357	4100.23	4036.04	320.96
2008	4145	4109.19	4100.23	44.77
2009	4016	4090.55	4109.19	-93.19
2010	5350	4342.44	4090.55	1259.45
2011	5951	4664.15	4342.44	1608.56
2012	5744	4880.12	4664.15	1079.85
2013	5908	5085.70	4880.12	1027.88
2014	6108	5290.16	5085.70	1022.30
2015	6988	5629.73	5290.16	1697.84
2016	8122	6128.18	5629.73	2492.27
2017	8369	6576.34	6128.18	2240.82
2018	9216	7104.28	6576.34	2639.66
2019		7104.28		
2020		7104.28		
2021		7104.28		

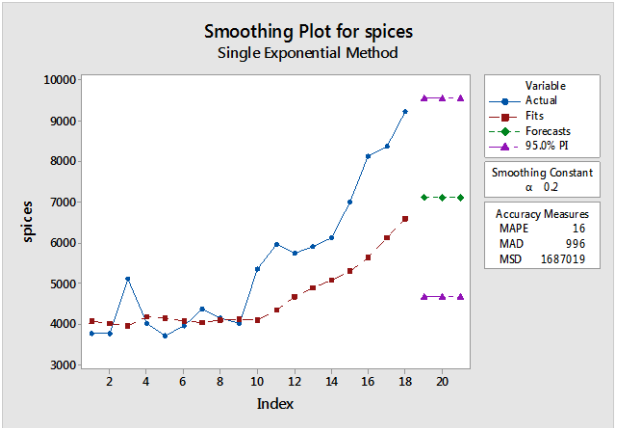

Chart 2: Single Exponential Method (spices)

Table 3: Forecast and Forecast error for the horticulture crops (Spices) using Double Exponential Method

Year	Spices	SMOO1	LEVE1	TREN1	FITS1	RESI1
2001	3765	3150.30	3150.30	322.479	2996.62	768.38
2002	3765	3531.22	3531.22	334.168	3472.78	292.22
2003	5113	4114.91	4114.91	384.073	3865.39	1247.61
2004	4001	4399.39	4399.39	364.153	4498.98	-497.98
2005	3705	4551.83	4551.83	321.812	4763.54	-1058.54
2006	3953	4689.52	4689.52	284.986	4873.64	-920.64
2007	4357	4851.00	4851.00	260.286	4974.50	-617.50
2008	4145	4918.03	4918.03	221.635	5111.29	-966.29
2009	4016	4914.93	4914.93	176.688	5139.66	-1123.66
2010	5350	5143.30	5143.30	187.023	5091.62	258.38
2011	5951	5454.45	5454.45	211.850	5330.32	620.68
2012	5744	5681.84	5681.84	214.958	5666.31	77.69
2013	5908	5899.04	5899.04	215.406	5896.80	11.20
2014	6108	6113.16	6113.16	215.148	6114.45	-6.45
2015	6988	6460.25	6460.25	241.536	6328.31	659.69
2016	8122	6985.83	6985.83	298.345	6701.78	1420.22
2017	8369	7501.14	7501.14	341.738	7284.17	1084.83
2018	9216	8117.50	8117.50	396.663	7842.87	1373.13
2019		8514.16				
2020		8910.82				
2021		9307.49				

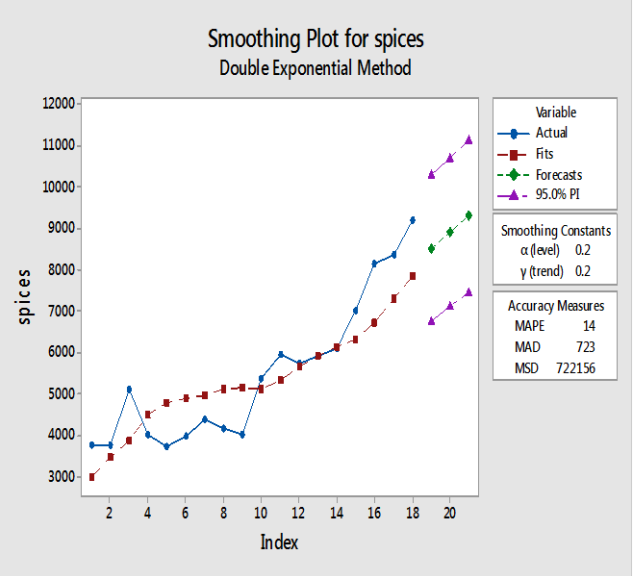

Chart 3: Double Exponential Method (spices)

After careful examination, it's apparent that the mean absolute error percentage is least i.e., MAPE = 12% in the case of the method linear trend model, thus to review and analyse the spices crop production in India and to predict for future values the linear trend model could also be adopted.

4.2 Name of the horticulture crop: Vegetables

The vegetable production in India has hyperbolic many manifolds with gradual increase in productivity and space of vegetable cultivation over the years that maintains its second ranking in world vegetable production once china. The standing and growth of vegetable production in India and its current state of affairs viz.

India is that the second largest producer of vegetables next to china within the world. In India its is fully grown in a locality of 9.575 million hectares with the productivity of 17.7% m/h that contributes 14% of the entire world population of vegetables.

Table 4: Forecast and Forecast error for the horticulture crops (Vegetables) using Linear Trend Model

Years	Vegetables	FITS1	RESI1
2001	88622	85094	3528.14
2002	84815	91396	-6581.09
2003	88334	97698	-9364.32
2004	101246	104001	-2754.56
2005	111399	110303	1096.21
2006	114993	116605	-1612.02
2007	128449	122907	5541.75
2008	129077	129209	-132.49
2009	138738	135512	3226.28
2010	146554	141814	4740.05
2011	156325	148116	8208.82
2012	162187	154418	7768.59
2013	162897	160721	2176.35
2014	169478	167023	2455.12
2015	169064	173325	-4261.11
2016	178172	179627	-1455.34
2017	179698	185930	-6231.57
2018	185883	192232	-6348.81
2019		198534	
2020		204836	
2021		211139	

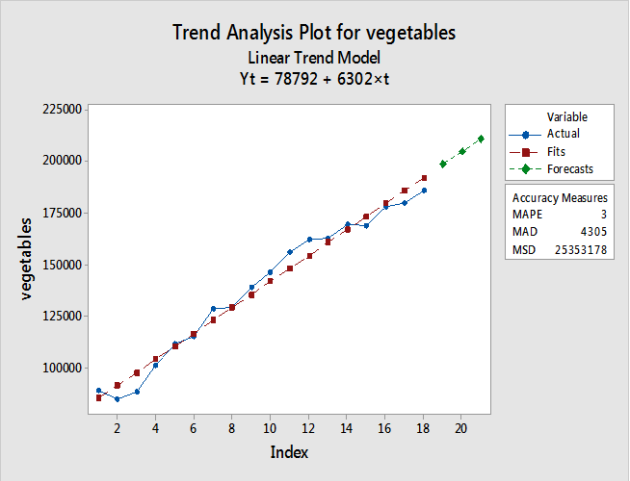

Chart 4: Linear Trend Model (vegetables)

Table 5: Forecast and Forecast error for the horticulture crops (Vegetables) using Single Exponential Method

Years	vegetables	SMOO1	FITS1	RESI1
2001	88622	96312	98235	-9612.8
2002	84815	94013	96312	-11497.3
2003	88334	92877	94013	-5678.8
2004	101246	94551	92877	8368.9
2005	111399	97920	94551	16848.2
2006	114993	101335	97920	17072.5
2007	128449	106758	101335	27114.0
2008	129077	111222	106758	22319.2
2009	138738	116725	111222	27516.4
2010	146554	122691	116725	29829.1
2011	156325	129418	122691	33634.3
2012	162187	135971	129418	32769.4
2013	162897	141357	135971	26925.5

2014	169478	146981	141357	28121.4
2015	169064	151397	146981	22083.1
2016	178172	156752	151397	26774.5
2017	179698	161342	156752	22945.6
2018	185883	166250	161342	24541.5
2019		166250		
2020		166250		
2021		166250		

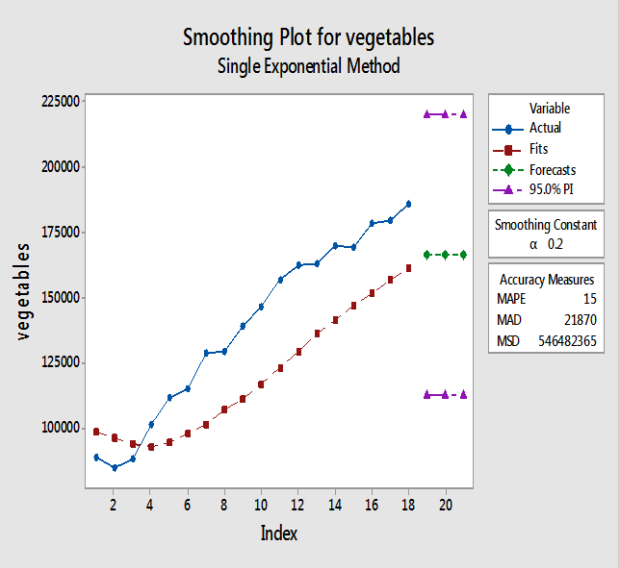

Chart 5: Single Exponential Method (Vegetables)

Table 6: Forecast and Forecast error for the horticulture crops (Vegetables) using Double Exponential Method

Years	vegetables	SMOO1	LEVE1	TREN1	FITS1	RESI1
2001	88622	85799	85799	6443.36	85094	3528.14
2002	84815	90757	90757	6146.24	92243	-7427.85
2003	88334	95190	95190	5803.46	96904	-8569.52
2004	101246	101044	101044	5813.58	100993	252.92
2005	111399	107766	107766	5995.25	106857	4541.76
2006	114993	114007	114007	6044.54	113761	1232.15
2007	128449	121731	121731	6380.42	120052	8397.19
2008	129077	128305	128305	6419.04	128112	965.33
2009	138738	135527	135527	6579.61	134724	4014.22
2010	146554	142996	142996	6757.52	142106	4447.77
2011	156325	151068	151068	7020.38	149753	6571.70
2012	162187	158908	158908	7184.34	158088	4098.98
2013	162897	165453	165453	7056.54	166092	-3195.16
2014	169478	171903	171903	6935.27	172510	-3031.67
2015	169064	176884	176884	6544.29	178839	-9774.60
2016	178172	182377	182377	6334.05	183428	-5255.97
2017	179698	186908	186908	5973.53	188711	-9012.82
2018	185883	191482	191482	5693.58	192882	-6998.79
2019		197176				
2020		202869				
2021		208563				

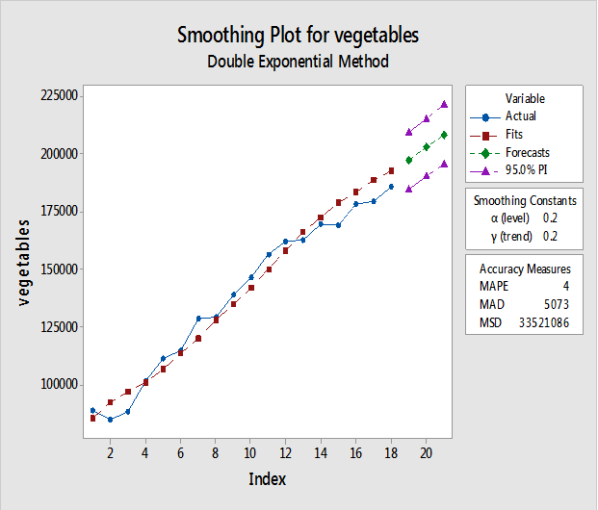

Chart 6: Double Exponential Method (vegetables)

After careful examination, it's apparent that he mean absolute error percentage is least i.e., MAPE = 3% within the case of the method linear trend model, thus to review and analyse the vegetables crop production in India and to predict for future values the linear trend model could also be adopted.

4.3 Name of the horticulture crop: Fruits

India's fruit trees had a bumper harvest last year, leading the country to become the second largest fruit producer within the world once china, in line with the ministry of horticulture as reportable by the times of India. India created 82.631 million tones of fruit in 2014 –15 whereas china flat-top the list with 154.364 million tones.

The ministry has additionally explicit that fruit production in India is quicker than vegetable, despite the later constituting a bigger section of the horticulture sector.

In fact, India is that the world's leading producer for a few fruits likes banana, mango and papaya, whereas it's the second largest producer of sugarcane and also the third largest producer of coconut. Among Indian states, Andhra Pradesh is the largest fruit manufacturing state with 13.939 tones followed by Maharashtra, Gujarat and Tamil Naidu.

Table 7: Forecast and Forecast error for the horticulture crops (Fruits) using Linear Trend Method

Year	Fruits	FITS1	RESI1
2001	43001	42339	662.29
2002	45203	45805	-601.75
2003	45942	49271	-3328.79
2004	50867	52737	-1869.83
2005	55356	56203	-846.87
2006	59563	59669	-105.91
2007	65587	63135	2452.05
2008	68466	66601	1865.00
2009	71516	70067	1448.96
2010	74878	73533	1344.92
2011	76424	76999	-575.12
2012	81285	80465	819.84
2013	88977	83931	5045.80
2014	86602	87397	-795.24
2015	90183	90863	-680.28
2016	92918	94329	-1411.32
2017	97054	97795	-741.36
2018	98579	101261	-2682.40
2019		**104727**	
2020		**108193**	
2021		**111660**	

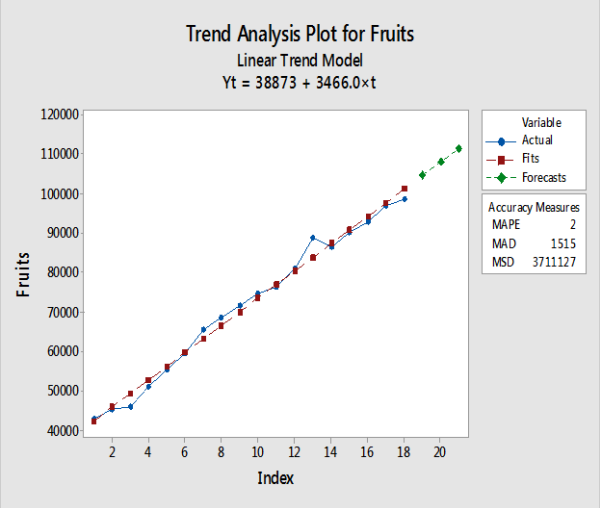

Chart 7: Linear Trend Model (Fruits)

Table 8: Forecast and Forecast error for the horticulture crops (Fruits) using Single Exponential Method

Year	Fruits	SMOO1	FITS1	RESI1
2001	43001	48591.1	49988.7	-6987.7
2002	45203	47913.5	48591.1	-3388.1
2003	45942	47519.2	47913.5	-1971.5
2004	50867	48188.8	47519.2	3347.8
2005	55356	49622.2	48188.8	7167.2
2006	59563	51610.4	49622.2	9940.8
2007	65587	54405.7	51610.4	13976.6
2008	68466	57217.8	54405.7	14060.3
2009	71516	60077.4	57217.8	14298.2
2010	74878	63037.5	60077.4	14800.6
2011	76424	65714.8	63037.5	13386.5
2012	81285	68828.9	65714.8	15570.2
2013	88977	72858.5	68828.9	20148.1
2014	86602	75607.2	72858.5	13743.5
2015	90183	78522.3	75607.2	14575.8
2016	92918	81401.5	78522.3	14395.7
2017	97054	84532.0	81401.5	15652.5
2018	98579	87341.4	84532.0	14047.0
2019		**87341.4**		
2020		**87341.4**		
2021		**87341.4**		

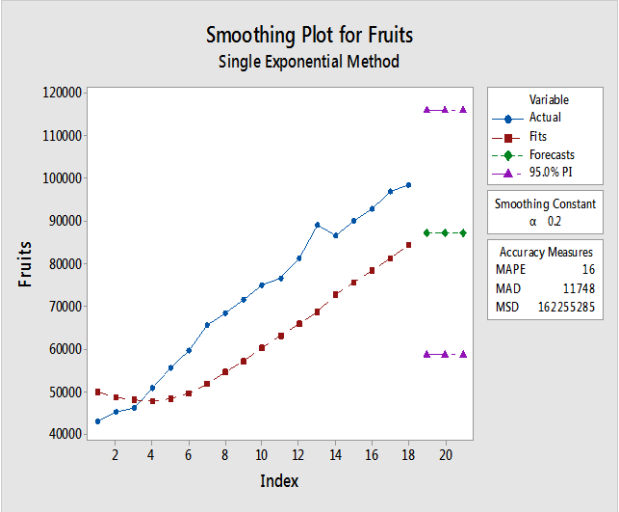

Chart 8: Single Exponential Method (Fruits)

Table 9: Forecast and Forecast error for the horticulture crops (Fruits) using Double Exponential Method

Year	Fruits	SMOO1	LEVE1	TREN1	FITS1	RESI1
2001	43001	42471	42471	3492.53	42339	662.29
2002	45203	45812	45812	3462.10	45964	-760.70
2003	45942	48607	48607	3328.84	49274	-3331.67
2004	50867	51722	51722	3286.07	51936	-1069.17
2005	55356	55078	55078	3299.97	55008	347.59
2006	59563	58615	58615	3347.38	58378	1185.10
2007	65587	62687	62687	3492.37	61962	3624.70
2008	68466	66637	66637	3583.82	66180	2286.40
2009	71516	70480	70480	3635.63	70221	1295.30
2010	74878	74268	74268	3666.14	74115	762.60
2011	76424	77632	77632	3605.74	77934	-1510.06
2012	81285	81247	81247	3607.62	81238	47.22
2013	88977	85679	85679	3772.51	84855	4122.15
2014	86602	88882	88882	3658.52	89452	-2849.79
2015	90183	92069	92069	3564.22	92540	-2357.35
2016	92918	95090	95090	3455.62	95633	-2715.11
2017	97054	98247	98247	3395.95	98546	-1491.70
2018	98579	101030	101030	3273.38	101643	-3064.32
2019		**104304**				
2020		**107577**				
2021		**110851**				

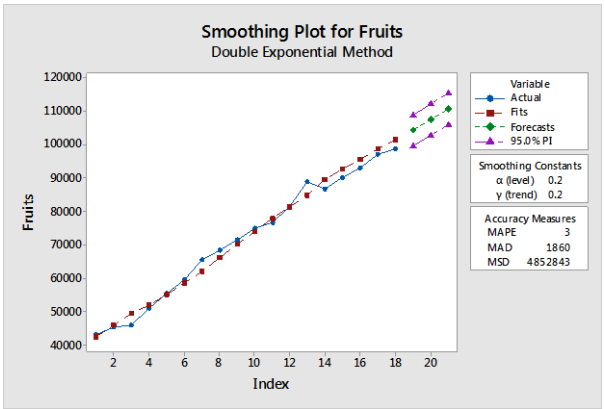

Chart 9: Double Exponential Method (Fruits)

It is quite conclusive from the higher than facts and figures that mean absolute percentage error is two percent which is minimum within the case of linear trend model, thus it's again concluded over that this methodology provides the foremost acceptable needed values and victimization this the anticipated forecast and forecast error are more closely falling to true values.

From the higher than facts and figures the MAPE values is minimum that corresponds to the linear trend model, thus this methodology provides us more the accumulation values and also the predications supported this methodology are with reference to true values.

5. CONCLUSIONS

Among the ways used for locating the forecast and forecast errors, the one and solely methodology recommended is linear trend model (Trend Analysis). This methodology is incredibly appropriate to predict the statistic values that are closely falling to true values.

it's apparently ascertained from the whole work wherever the horticulture spices, vegetables and fruits crop in India are thought-about increasing over a amount from 2001 – 2018. More it's additionally detected that there exist even associate increasing spices, vegetable and fruits crop production for the anticipated years of 2019 to 2021.

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