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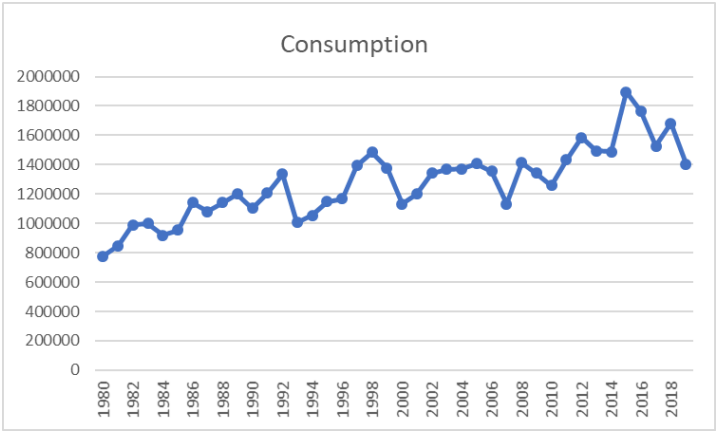
1.1 General Information

Time series provide useful information about overall economic robustness.Time series can be made using monthly and annual data.The annual data to be used is used according to the working method of the project.This data I will use has been prepared annually by the Ministry of Agriculture.The content of these data indicates the production and consumption amounts of nitrogen fertilizer. I chose it because the nitrogen fertilizer increased productivity in agriculture.

1.2 Analysis Data and Aim

Nitrogen fertilizer increases the efficiency of productivity in agricultural,so ı choose this data. I researched that nitrogen fertilizer production satisfy consumption.This data starts from 1980 and ends in 2019.As a result of the study, it was tried to estimate how many will be produced and consumed in the following years.The aim of this study is whether or not it should be taken from the outside if production is sufficient for consumption,and in order to be sufficient for consumption, it is necessary to work to improve the production.

1.3 Consumption and Production of Fertilizer Nitrogen Chart



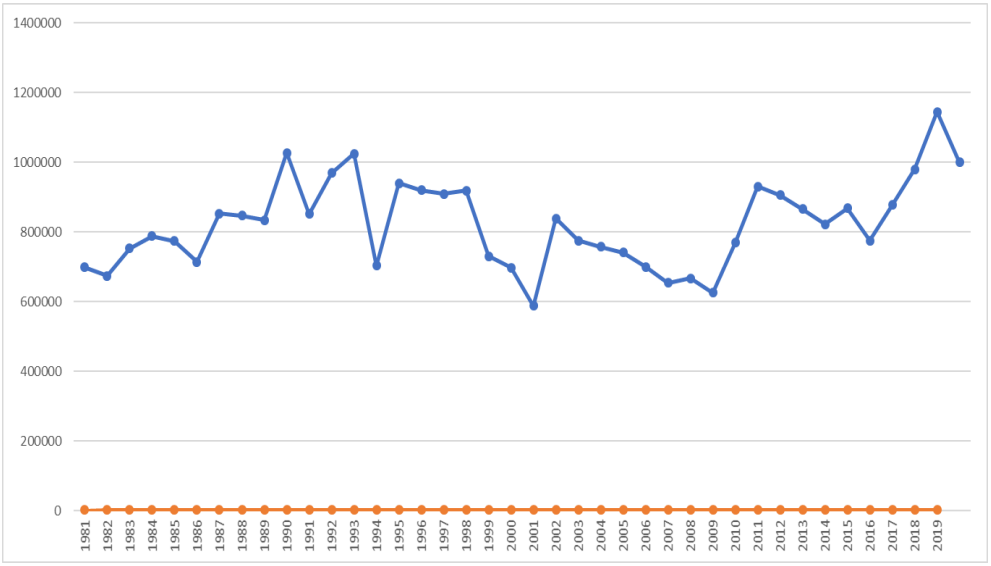


Figure:This chart is production to fertilizer nitrogen 1980 to 2019

2.Auto Correlation for Production and Consumption

2.1 Production Fertilizer Nitrogen

$$r_1 = \frac{\sum_{t=1}^{n-1}(Y_t - \bar{Y})(Y_{t-1} - \bar{Y})}{\sum_{t=1}^{n}(Y_t - \bar{Y})^2}$$

r_1= First order autocorrelation coefficient

$\bar{Y}$=mean of the values of the series

Y_t= observation at time period t

Y_{t-1} =observation one time period earlier or at time period t-1

Years	production		$Y_t - \bar{Y}$	$Y_{t-1} - \bar{Y}$	$(Y_t - \bar{Y})^2$	$(Y_t - \bar{Y})(Y_{t-k} - \bar{Y})$
1980	698788		-123551,80		15265047283	
1981	673242	698788,00	-149097,80	-123551,8	22230153965	18421301566,04
1982	752037	673242,00	-70302,80	-149097,8	4942483688	10481992813,84
1983	787970	752037,00	-34369,80	-70302,8	1181283152	2416293175,44
1984	773116	787970,00	-49223,80	-34369,8	2422982486	1691812161,24
1985	713761	773116,00	-108578,80	-49223,8	11789355809	5344661135,44
1986	852493	713761,00	30153,20	-108578,8	909215470,2	-3273998272,16
1987	846320	852493,00	23980,20	30153,2	575049992	723079766,64
1988	833030	846320,00	10690,20	23980,2	114280376	256353134,04
1989	1026159	833030,00	203819,20	10690,2	41542266289	2178868011,84
1990	851453	1026159,00	29113,20	203819,2	847578414,2	5933829133,44
1991	969078	851453,00	146738,20	29113,2	21532099339	4272018564,24
1992	1023758	969078,00	201418,20	146738,2	40569291291	29555744115,24
1993	703061	1023758,00	-119278,80	201418,2	14227432129	-24024921194,16
1994	939172	703061,00	116832,20	-119278,8	13649762957	-13935604617,36
1995	919555	939172,00	97215,20	116832,2	9450795111	11357865689,44
1996	909070	919555,00	86730,20	97215,2	7522127592	8431493739,04
1997	918457	909070,00	96117,20	86730,2	9238516136	8336263979,44
1998	729867	918457,00	-92472,80	96117,2	8551218740	-8888226612,16
1999	696913	729867,00	-125426,80	-92472,8	15731882158	11598567391,04
2000	587715	696913,00	-234624,80	-125426,8	55048796775	29428237864,64
2001	837927	587715,00	15587,20	-234624,8	242960803,8	-3657143682,56
2002	775290	837927,00	-47049,80	15587,2	2213683680	-733374642,56
2003	756668	775290,00	-65671,80	-47049,8	4312785315	3089845055,64
2004	740150	756668,00	-82189,80	-65671,8	6755163224	5397552107,64
2005	699525	740150,00	-122814,80	-82189,8	15083475099	10094123849,04
2006	653882	699525,00	-168457,80	-122814,8	28378030381	20689111015,44
2007	666459	653882,00	-155880,80	-168457,8	24298823809	26259336630,24
2008	624971	666459,00	-197368,80	-155880,8	38954443213	30766006439,04
2009	768588	624971,00	-53751,80	-197368,8	2889256003	10608928263,84
2010	929709	768588,00	107369,20	-53751,8	11528145109	-5771287764,56
2011	905086	929709,00	82746,20	107369,2	6846933614	8884393297,04
2012	865777	905086,00	43437,20	82746,2	1886790344	3594263238,64
2013	821859	865777,00	-480,80	43437,2	231168,64	-20884605,76
2014	867369	821859,00	45029,20	-480,8	2027628853	-21650039,36
2015	775025	867369,00	-47314,80	45029,2	2238690299	-2130547592,16
2016	876700	775025,00	54360,20	-47314,8	2955031344	-2572041990,96
2017	979900	876700,00	157560,20	54360,2	24825216624	8565003984,04
2018	1143688	979900,00	321348,20	157560,2	103264665643,24	50631686661,64
2019	1000004	1143688,00	177664,20	321348,2	31564567962	57092070874,44

I calculated 40 years of produciton in auto correlation and calculated to Yt-10,and find to r number.This tablo is Yt-1,and for Yt-1's r is equal 0,528417907.I showed the calculation this r value in Excel.Why did we calculate this value? Because I need to this value for correlagram.After calculation 1 to 10 we created to lags.

Lag	Autocorrelation
1	0,528417907
2	0,312318255
3	0,17494
4	0,002321487
5	0,124994583
6	0,068492782
7	0,756790763
8	-0,023076774
9	-0,208685268
10	-0,388901605

2.2 Auto Correlation for Consumption Fertilizer Nitrogen

I applied same formulas in production.I found lag 1 to 10,because ı have 40 datas and if ı did more than lag 10,ı cannot find true datas,because 40 diveded 10.

Years	Consumption of nitrogen fertilizer by years		$Y_t - \bar{Y}$	$Y_{t-1} - \bar{Y}$	$(Y_t - \bar{Y})^2$	$(Y_t - \bar{Y})(Y_{t-k} - \bar{Y})$
1980	776409		-496631,625		246642970950,14	
1981	847242	776409	-425798,63	-496631,63	181304469051,89	211465063056,52
1982	990806	847242	-282234,63	-425798,63	79656383548,89	120175115252,39
1983	998385	990806	-274655,63	-282234,63	75435712344,14	77517327326,02
1984	917423	998385	-355617,63	-274655,63	126463895210,64	97672381055,39
1985	953182	917423	-319858,63	-355617,63	102309539986,89	113747364558,27
1986	1141509	953182	-131531,63	-319858,63	17300568375,14	42071524716,52
1987	1081605	1141509	-191435,63	-131531,63	36647598519,14	25179838839,14
1988	1140446	1081605	-132594,63	-191435,63	17581334578,89	25383334908,52
1989	1199663	1140446	-73377,63	-132594,63	5384275850,64	9729478670,27
1990	1103716	1199663	-169324,63	-73377,63	28670828631,39	12424638836,52
1991	1206230	1103716	-66810,63	-169324,63	4463659612,89	11312684024,14
1992	1335253	1206230	62212,38	-66810,63	3870379603,14	-4156447656,48
1993	1006588	1335253	-266452,63	62212,38	70997001369,39	-16576650626,23
1994	1053737	1006588	-219303,63	-266452,63	48094079938,14	58434026553,27
1995	1147438	1053737	-125602,63	-219303,63	15776019406,89	27545110972,02
1996	1166966	1147438	-106074,63	-125602,63	11251826068,89	13323251345,89
1997	1394906	1166966	121865,38	-106074,63	14851169623,89	-12926823953,61
1998	1485624	1394906	212583,38	121865,38	45191691326,39	25906552713,14
1999	1378597	1485624	105556,38	212583,38	11142148303,14	22439530450,27
2000	1132555	1378597	-140485,63	105556,38	19736210831,64	-14829153314,61
2001	1199130	1132555	-73910,63	-140485,63	5462780487,89	10383380347,27
2002	1340866	1199130	67825,38	-73910,63	4600281493,89	-5013015857,11
2003	1366618	1340866	93577,38	67825,38	8756725111,89	6346920550,89
2004	1372371	1366618	99330,38	93577,38	9866523397,64	9295075750,27
2005	1406641	1372371	133600,38	99330,38	17849060200,14	13270575348,89
2006	1355755	1406641	82714,38	133600,38	6841667831,64	11050671517,89
2007	1133068	1355755	-139972,63	82714,38	19592335749,39	-11577748193,98
2008	1413793	1133068	140752,38	-139972,63	19811231068,14	-19701479403,73
2009	1343698	1413793	70657,38	140752,38	4992464641,89	9945193342,52
2010	1259352	1343698	-13688,63	70657,38	187378454,39	-967202309,86
2011	1431945	1259352	158904,38	-13688,63	25250600394,14	-2175182400,23
2012	1584237	1431945	311196,38	158904,38	96843183813,14	49450465471,64
2013	1492839	1584237	219798,38	311196,38	48311325652,64	68400457530,89
2014	1486568	1492839	213527,38	219798,38	45593939874,39	46932970043,02
2015	1896478	1486568	623437,38	213527,38	388674160546,89	133120946160,64
2016	1764637	1896478	491596,38	623437,38	241666995913,14	306479553589,52
2017	1527587	1764637	254546,38	491596,38	64793857025,64	125134075219,39
2018	1682548	1527587	409507,38	254546,38	167696290179,39	104238617842,02
2019	1405214	1682548	132173,38	409507,38	17469801058,89	54125971841,14
sum	50921625	49516411	0,00E+00	-132173,38	2357032366027,37	1754578394118,36
average	1273040,625					

This tablo show that Yt-1.You can find formulas in Excel.Also Yt-1'r is equal 0,744401,and this datas have lag 1 to 10.

Lag	Autocorrelation
1	0,744401
2	0,019886
3	0,56085
4	0,423941
5	0,305789
6	0,312086
7	0,281654
8	0,004709
9	0,1137541
10	0,182593

This lag's table show that Yts's r values.Why use correlation? Because The autocorrelation coefficient serves two purposes. It can detect non-randomness in a data set. If the values in the data set are not random, then autocorrelation can help the analyst chose an appropriate time series model.

2.3 Correlogram for Production and Consumption Fertilizer Nitrogen

How can we draw Correlogram? We can draw with r values and k values.R values come to from auto correlation,and I calculated r values in production and consumption.Also k values

calculated this formula.Formula is $0 \pm Z\ 1/\sqrt{n}$.After calculation my k value is equal to 0,309 and -0,309.

Lag	Autocorrelation	U - Critical Value	L - Critical Value
1	0,744401	0,309	-0,309
2	0,019886	0,309	-0,309
3	0,56085	0,309	-0,309
4	0,423941	0,309	-0,309
5	0,305789	0,309	-0,309
6	0,312086	0,309	-0,309
7	0,281654	0,309	-0,309
8	0,004709	0,309	-0,309
9	0,1137541	0,309	-0,309
10	0,182593	0,309	-0,309

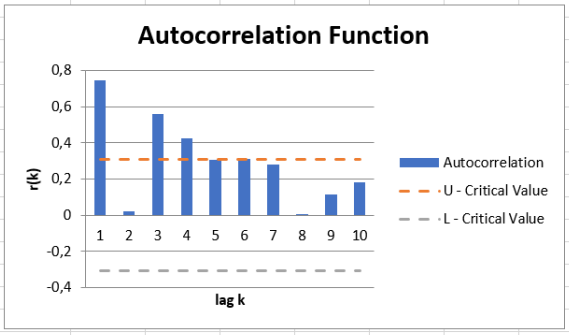


Figure: Consumption Fertilizer Nitrogen Correlogram

Number of Data Points:	40

Lag	Autocorrelation	U - Critical Value	L - Critical Value
1	0,528417907	0,309	-0,309
2	0,312318255	0,309	-0,309
3	0,17494	0,309	-0,309
4	0,002321487	0,309	-0,309
5	0,124994583	0,309	-0,309
6	0,068492782	0,309	-0,309
7	0,756790763	0,309	-0,309
8	-0,023076774	0,309	-0,309
9	-0,208685268	0,309	-0,309
10	-0,388901605	0,309	-0,309

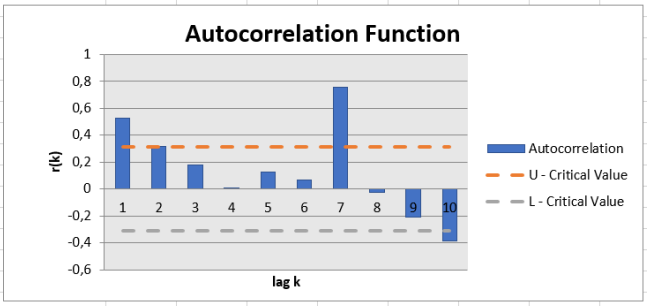


Figure:Production Fertilizer Nitrogen Correlogram

Why did we calculated correlogram? Because The **correlogram** is a commonly used tool for checking randomness in a data set. This randomness is ascertained by computing autocorrelations for data values at varying time lags. ... The **correlogram** is an excellent way of checking for such randomness.Also if you look to my correlagrom,you can see the my data type.

3. Hypothesis

   With this data, we see production and consumption by 2019. In 1980, in Turkey. Our reason for looking at these data was whether to see whether production satifies consumption, primarily. As a result of these calculations, we understand whether the production meets. If not, we will see that we have to make improvements in the development of production.

   We will use the zero and alternative hypothesis to test whether the company's autocorrelation coefficient differs significantly from productin and consumption

   H0: Does nitrogen fertilizer satify the consumption?

   $$H_0: \rho_k = 0$$

   H1:Does not nitrogen fertilizer satify the consumption?

$$H_1: \rho_k \neq 0$$

Since n=40 for this random series, test this null hypothesis at 0.05 significant level.

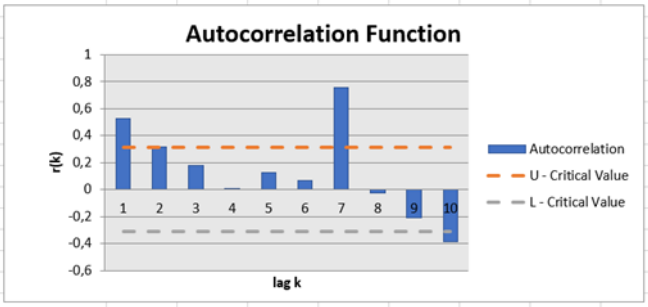
$$0 \pm Z\,\frac{1}{\sqrt{n}} = 0 \pm 1.96\,\frac{1}{\sqrt{40}} = \pm 0.309$$

The decision rule is:

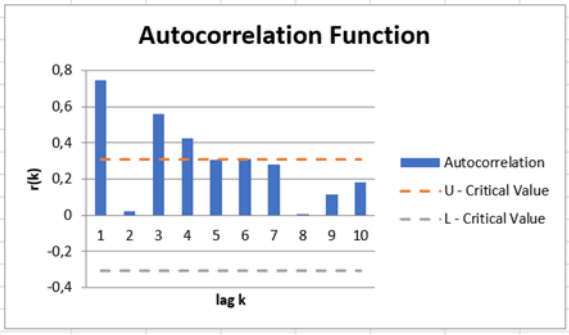
If an autocorrelation coefficient is less than 0.309 or higher than -0.309, it cannot reject the null hypothesis, otherwise it rejects the null hypothesis.

Number of Data Points:	40

Lag	Autocorrelation	U - Critical Value	L - Critical Value
1	0,528417907	0,309	-0,309
2	0,312318255	0,309	-0,309
3	0,17494	0,309	-0,309
4	0,002321487	0,309	-0,309
5	0,124994583	0,309	-0,309
6	0,068492782	0,309	-0,309
7	0,756790763	0,309	-0,309
8	-0,023076774	0,309	-0,309
9	-0,208685268	0,309	-0,309
10	-0,388901605	0,309	-0,309



Lag	Autocorrelation	U - Critical Value	L - Critical Value
1	0,744401	0,309	-0,309
2	0,019886	0,309	-0,309
3	0,56085	0,309	-0,309
4	0,423941	0,309	-0,309
5	0,305789	0,309	-0,309
6	0,312086	0,309	-0,309
7	0,281654	0,309	-0,309
8	0,004709	0,309	-0,309
9	0,1137541	0,309	-0,309
10	0,182593	0,309	-0,309



RESULT:

When we look at the correlograms of production and consumption data from 1980 to 2019, we see that production does not satify consumption,because We see that consumption is higher compared to year by year,so we can say that this hypothesis rejected because production does not satisfy the consumption of fertilizer nitrogen.

4.CENTRAL LIMIT THEOREM

In probability theory, the **central limit theorem** (**CLT**) establishes that, in some situations, when independent random variables are added, their properly normalized sum tends toward a normal distribution (informally a *bell curve*) even if the original variables themselves are

not normally distributed. The theorem is a key concept in probability theory because it implies that probabilistic and statistical methods that work for normal distributions can be applicable to many problems involving other types of distributions.

So in my Project question is Distribution of production and consumption in forty years in 80 data.Formula is $M/(\frac{\partial}{\sqrt{n}})$.M is 2 because it called that production and consumption. ∂ is 40 because 40 is years number,and n is equal all of data number that is 80.After calculation,result is equal Z:0,4472 so Z value is equal 0.17.

5.Forecasting Models

1.Naive Bayes

- Naïve methods are used to develop simple models that recent periods are the best predictors of the future

	A	B	C	D	E	F	G	H	I
1	Years	production	Naive Bayes	with trend $\hat{Y}_{t+1} = Y_t + (Y_t - Y_{t-1})$	with seasonal	error	MSE	MAD	
2	1980	698788							
3	1981	673242	698788						
4	1982	752037	673242	647696					
5	1983	787970	752037	830832	728515,333	59454,66667	3534857388,44	59454,67	
6	1984	773116	787970	823903	706533,333	66582,66667	4433251500,44	66582,67	
7	1985	713761	773116	758262	739278,333	-25517,3333	651134300,44	25517,33	
8	1986	852493	713761	654406	809477,667	43015,33333	1850318901,78	43015,33	
9	1987	846320	852493	991225	797517,333	48802,66667	2381700273,78	48802,67	
10	1988	833030	846320	840147	753517,333	79512,66667	6322264160,44	79512,67	
11	1989	1026159	833030	819740	910381,667	115777,3333	13404390913,78	115777,33	
12	1990	851453	1026159	1219288	848031	3422	11710084,00	3422,00	
13	1991	969078	851453	676747	878379,333	90698,66667	8226248135,11	90698,67	
14	1992	1023758	969078	1086703	1025358,67	-1600,66667	2562133,78	1600,67	
15	1993	703061	1023758	1078438	801989	-98928	9786749184,00	98928,00	
16	1994	939172	703061	382364	959109,333	-19937,3333	397497260,44	19937,33	
17	1995	919555	939172	1175283	989023,667	-69468,6667	4825895648,44	69468,67	
18	1996	909070	919555	899938	771730,667	137339,3333	18862092480,44	137339,33	
19	1997	918457	909070	898585	932267	-13810	190716100,00	13810,00	
20	1998	729867	918457	927844	856325,667	-126458,667	15991794375,11	126458,67	
21	1999	696913	729867	541277	838351	-141438	20004707844,00	141438,00	
22	2000	587715	696913	663959	808209,667	-220494,667	48617898028,44	220494,67	
23	2001	837927	587715	478517	765887	72040	5189761600,00	72040,00	
24	2002	775290	837927	1088139	723038,667	52251,33333	2730201835,11	52251,33	
25	2003	756668	775290	712653	644032,667	112635,3333	12686718315,11	112635,33	
26	2004	740150	756668	738046	805334,667	-65184,6667	4249040768,44	65184,67	
27	2005	699525	740150	723632	750035	-50510	2551260100,00	50510,00	
28	2006	653882	699525	658900	722406	-68524	4695538576,00	68524,00	
29	2007	666459	653882	608239	715586,333	-49127,3333	2413494880,44	49127,33	
30	2008	624971	666459	679036	674673,667	-49702,6667	2470355073,78	49702,67	
31	2009	768588	624971	583483	692117,333	76470,66667	5847762860,44	76470,67	
32	2010	929709	768588	912205	754209	175500	30800250000,00	175500,00	
33	2011	905086	929709	1090830	718342,667	186743,3333	34873072544,44	186743,33	
34	2012	865777	905086	880463	800984,333	64792,66667	4198089653,78	64792,67	
35	2013	821859	865777	826468	893759	-71900	5169610000,00	71900,00	
36	2014	867369	821859	777941	892513,667	-25144,6667	632254261,78	25144,67	
37	2015	775025	867369	912879	835526,333	-60501,3333	3660411335,11	60501,33	
38	2016	876700	775025	682681	840139,333	36560,66667	1336682347,11	36560,67	
39	2017	979900	876700	978375	904879,333	75020,66667	5628100427,11	75020,67	
40	2018	1143688	979900	1083100	897912,667	245775,3333	60405514475,11	245775,33	
41	2019	1000004	1143688	1307476	917801,333	82202,66667	6757278407,11	82202,67	
42									
43							9615978004,70	80617,46	
44									

Figure:Naive Bayes for production of fertilizer nitrogen

	A	B	C	D	E	F	G	H	I
1	Years	Consumption		With Trend	With Seasona	Error	MSE	MAD	
2	1980	776409							
3	1981	847242	776409						
4	1982	990806	847242	918075					
5	1983	998385	990806	1134370	850401	147984,00	21899264256,00	147984,00	
6	1984	917423	998385	1005964	870635,667	46787,33	2189054560,44	46787,33	
7	1985	953182	917423	836461	978264,667	-25082,67	629140167,11	25082,67	
8	1986	1141509	953182	988941	1046093	95416,00	9104213056,00	95416,00	
9	1987	1081605	1141509	1329836	972150,333	109454,67	11980324055,11	109454,67	
10	1988	1140446	1081605	1021701	1015603,33	124842,67	15585691420,44	124842,67	
11	1989	1199663	1140446	1199287	1160893,67	38769,33	1503061207,11	38769,33	
12	1990	1103716	1199663	1258880	1088975,33	14740,67	217287253,78	14740,67	
13	1991	1206230	1103716	1007769	1162374	43856,00	1923348736,00	43856,00	
14	1992	1335253	1206230	1308744	1244859,67	90393,33	8170954711,11	90393,33	
15	1993	1006588	1335253	1464276	1071340	-64752,00	4192821504,00	64752,00	
16	1994	1053737	1006588	677923	1155399	-101662,00	10335162244,00	101662,00	
17	1995	1147438	1053737	1100886	1272648	-125210,00	15677544100,00	125210,00	
18	1996	1166966	1147438	1241139	1060047,33	106918,67	11431601281,78	106918,67	
19	1997	1394906	1166966	1186494	1167460	227446,00	51731682916,00	227446,00	
20	1998	1485624	1394906	1622846	1260166,67	225457,33	50831009153,78	225457,33	
21	1999	1378597	1485624	1576342	1237509,67	141087,33	19905635627,11	141087,33	
22	2000	1132555	1378597	1271570	1307455,67	-174900,67	30590243200,44	174900,67	
23	2001	1199130	1132555	886513	1390126	-190996,00	36479472016,00	190996,00	
24	2002	1340866	1199130	1265705	1366020	-25154,00	632723716,00	25154,00	
25	2003	1366618	1340866	1482602	1210576	156042,00	24349105764,00	156042,00	
26	2004	1372371	1366618	1392370	1256877	115494,00	13338864036,00	115494,00	
27	2005	1406641	1372371	1378124	1362791	43850,00	1922822500,00	43850,00	
28	2006	1355755	1406641	1440911	1362997	-7242,00	52446564,00	7242,00	
29	2007	1133068	1355755	1304869	1292603,33	-159535,33	25451522581,78	159535,33	
30	2008	1413793	1133068	910381	1409025	4768,00	22733824,00	4768,00	
31	2009	1343698	1413793	1694518	1351736	-8038,00	64609444,00	8038,00	
32	2010	1259352	1343698	1273603	1175162,67	84189,33	7087843847,11	84189,33	
33	2011	1431945	1259352	1175006	1419843,67	12101,33	146442268,44	12101,33	
34	2012	1584237	1431945	1604538	1423877,67	160359,33	25715115787,11	160359,33	
35	2013	1492839	1584237	1736529	1337181	155658,00	24229412964,00	155658,00	
36	2014	1486568	1492839	1401441	1450152,67	36415,33	1326076501,78	36415,33	
37	2015	1896478	1486568	1480297	1688317,33	208160,67	43330863147,11	208160,67	
38	2016	1764637	1896478	2306388	1583438,33	181198,67	32832956801,78	181198,67	
39	2017	1527587	1764637	1632796	1500241	27346,00	747803716,00	27346,00	
40	2018	1682548	1527587	1290537	1825168	-142620,00	20340464400,00	142620,00	
41	2019	1405214	1682548	1837509	1644829,33	-239615,33	57415507968,44	239615,33	
42									
43							15767157494,53	104420,11	
44									
45									

Figure:Naive Bayes for consumption of fertilizer nitrogen.

2.Average Method

- Frequently, management faces the situation where forecasts need to be updated daily, weekly, or monthly for inventories containing hundreds or thousand items. Often it is not possible to develop sophisticated forecasting techniques for each item. Instead, some quick, inexpensive, very simple short term forecasting tools are needed to accomplish this task.

A	B	C	D	E
Years	Consumptio	MA3	Error MA3	MSE MA3
1980	776409			
1981	847242			
1982	990806			
1983	998385	871485,67	126899,33	126899,33
1984	917423	945477,67	-28054,67	28054,67
1985	953182	968871,33	-15689,33	15689,33
1986	1141509	956330,00	185179,00	185179,00
1987	1081605	1004038,00	77567,00	77567,00
1988	1140446	1058765,33	81680,67	81680,67
1989	1199663	1121186,67	78476,33	78476,33
1990	1103716	1140571,33	-36855,33	36855,33
1991	1206230	1147941,67	58288,33	58288,33
1992	1335253	1169869,67	165383,33	165383,33
1993	1006588	1215066,33	-208478,33	208478,33
1994	1053737	1182690,33	-128953,33	128953,33
1995	1147438	1131859,33	15578,67	15578,67
1996	1166966	1069254,33	97711,67	97711,67
1997	1394906	1122713,67	272192,33	272192,33
1998	1485624	1236436,67	249187,33	249187,33
1999	1378597	1349165,33	29431,67	29431,67
2000	1132555	1419709,00	-287154,00	287154,00
2001	1199130	1332258,67	-133128,67	133128,67
2002	1340866	1236760,67	104105,33	104105,33
2003	1366618	1224183,67	142434,33	142434,33
2004	1372371	1302204,67	70166,33	70166,33
2005	1406641	1359951,67	46689,33	46689,33
2006	1355755	1381876,67	-26121,67	26121,67
2007	1133068	1378255,67	-245187,67	245187,67
2008	1413793	1298488,00	115305,00	115305,00
2009	1343698	1300872,00	42826,00	42826,00
2010	1259352	1296853,00	-37501,00	37501,00
2011	1431945	1338947,67	92997,33	92997,33
2012	1584237	1344998,33	239238,67	239238,67
2013	1492839	1425178,00	67661,00	67661,00
2014	1486568	1503007,00	-16439,00	16439,00
2015	1896478	1521214,67	375263,33	375263,33
2016	1764637	1625295,00	139342,00	139342,00
2017	1527587	1715894,33	-188307,33	188307,33
2018	1682548	1729567,33	-47019,33	47019,33
2019	1405214	1658257,33	-253043,33	253043,33
sum	50921625	47085496,67	1221671,33	4525537,33
average	1273040,6	1272580,99	33018,14	122311,82

Figure:Average Method for consumption of fertilizer nitrogen

	A	B	C	D	E
1	Years	production	MA3	ErrorMA3	MSE MA3
2	1980	698788			
3	1981	673242			
4	1982	752037			
5	1983	787970	708022,3333	79947,66667	79947,66667
6	1984	773116	737749,6667	35366,33333	35366,33333
7	1985	713761	771041	-57280	57280
8	1986	852493	758282,3333	94210,66667	94210,66667
9	1987	846320	779790	66530	66530
10	1988	833030	804191,3333	28838,66667	28838,66667
11	1989	1026159	843947,6667	182211,3333	182211,3333
12	1990	851453	901836,3333	-50383,33333	50383,33333
13	1991	969078	903547,3333	65530,66667	65530,66667
14	1992	1023758	948896,6667	74861,33333	74861,33333
15	1993	703061	948096,3333	-245035,3333	245035,3333
16	1994	939172	898632,3333	40539,66667	40539,66667
17	1995	919555	888663,6667	30891,33333	30891,33333
18	1996	909070	853929,3333	55140,66667	55140,66667
19	1997	918457	922599	-4142	4142
20	1998	729867	915694	-185827	185827
21	1999	696913	852464,6667	-155551,6667	155551,6667
22	2000	587715	781745,6667	-194030,6667	194030,6667
23	2001	837927	671498,3333	166428,6667	166428,6667
24	2002	775290	707518,3333	67771,66667	67771,66667
25	2003	756668	733644	23024	23024
26	2004	740150	789961,6667	-49811,66667	49811,66667
27	2005	699525	757369,3333	-57844,33333	57844,33333
28	2006	653882	732114,3333	-78232,33333	78232,33333
29	2007	666459	697852,3333	-31393,33333	31393,33333
30	2008	624971	673288,6667	-48317,66667	48317,66667
31	2009	768588	648437,3333	120150,6667	120150,6667
32	2010	929709	686672,6667	243036,3333	243036,3333
33	2011	905086	774422,6667	130663,3333	130663,3333
34	2012	865777	867794,3333	-2017,333333	2017,333333
35	2013	821859	900190,6667	-78331,66667	78331,66667
36	2014	867369	864240,6667	3128,333333	3128,333333
37	2015	775025	851668,3333	-76643,33333	76643,33333
38	2016	876700	821417,6667	55282,33333	55282,33333
39	2017	979900	839698	140202	140202
40	2018	1143688	877208,3333	266479,6667	266479,6667
41	2019	1000004	1000096	-92	92
42					
43	sum	32893592	30114223,33	655301,6667	3285169
44	average	822339,8	813897,9279	17710,85586	88788,35135

Figure:Average Method for production of fertilizer nitrogen

3.Double Moving Average Method

The double moving average technique is summarized as below.

1. First, equation is used to compute the moving average.

$$\widehat{Y_{t+1}} = \frac{(Y_t + Y_{t-1} + Y_{t-2} + \cdots + Y_{t-n+1})}{n}$$

2. Let $M_t = \widehat{y_{t+1}}$. Then equation is used to compute the second moving average.

$$M'_t = \frac{(M_t + M_{t-1} + M_{t-2} + \cdots + M_{t-n+1})}{n}$$

3. Equation is used to compute the difference between the two moving average.

$$a_t = 2M_t - M'_t$$

4. Equation is an additional adjustment factor, which is similar to a slope measure that can change over the series.

$$b_t = \frac{2}{n-1}(M_t - M'_t)$$

5. Equation is used to make the forecast m periods into the future

$$\widehat{Y_{t+p}} = a_t + b_t p$$

Where
n= number of periods in the moving average
Y_t=actual series value at time period t
p= number of periods ahead to be forecast

	A	B	C	D	E	F	G	H	I	J
	Years	Consumption	Three Years Moving Average	Double moving averag	Value of a	Value of b	Forecast	Error	MSE	MAD
	1980	776409								
	1981	847242								
	1982	990806								
	1983	998385	871485,6667							
	1984	917423	945477,6667							
	1985	953182	968871,3333	928611,5556	1009131,11	40259,78	1049390,89	-96208,89	9256150301,23	96208,89
	1986	1141509	956330	956893	955767,00	-563,00	955204,00	186305,00	34709553025,00	186305,00
	1987	1081605	1004038	976413,1111	1031662,89	27624,89	1059287,78	22317,22	498058407,72	22317,22
	1988	1140446	1058765,333	1006377,778	1111152,89	52387,56	1163540,44	-23094,44	533353364,20	23094,44
	1989	1199663	1121186,667	1061330	1181043,33	59856,67	1240900,00	-41237,00	1700490169,00	41237,00
	1990	1103716	1140571,333	1106841,111	1174301,56	33730,22	1208031,78	-104315,78	10881781493,38	104315,78
	1991	1206230	1147941,667	1136566,556	1159316,78	11375,11	1170691,89	35538,11	1262957341,35	35538,11
	1992	1335253	1169869,667	1152794,222	1186945,11	17075,44	1204020,56	131232,44	17221954474,86	131232,44
	1993	1006588	1215066,333	1177625,889	1252506,78	37440,44	1289947,22	-283359,22	80292448818,38	283359,22
	1994	1053737	1182690,333	1189208,778	1176171,89	-6518,44	1169653,44	-115916,44	13436622092,64	115916,44
	1995	1147438	1131859,333	1176538,667	1087180,00	-44679,33	1042500,67	104937,33	11011843927,11	104937,33
	1996	1166966	1069254,333	1127934,667	1010574,00	-58680,33	951893,67	215072,33	46256108565,44	215072,33
	1997	1394906	1122713,667	1107942,444	1137484,89	14771,22	1152256,11	242649,89	58878968577,79	242649,89
	1998	1485624	1236436,667	1142801,556	1330071,78	93635,11	1423706,89	61917,11	3833728648,35	61917,11
	1999	1378597	1349165,333	1236105,222	1462225,44	113060,11	1575285,56	-196688,56	38686387886,53	196688,56
	2000	1132555	1419709	1335103,667	1504314,33	84605,33	1588919,67	-456364,67	208268708981,78	456364,67
	2001	1199130	1332258,667	1367044,333	1297473,00	-34785,67	1262687,33	-63557,33	4039534620,44	63557,33
	2002	1340866	1236760,667	1329576,111	1143945,22	-92815,44	1051129,78	289736,22	83947078467,60	289736,22
	2003	1366618	1224183,667	1264401	1183966,33	-40217,33	1143749,00	222869,00	49670591161,00	222869,00
	2004	1372371	1302204,667	1254383	1350026,33	47821,67	1397848,00	-25477,00	649077529,00	25477,00
	2005	1406641	1359951,667	1295446,667	1424456,67	64505,00	1488961,67	-82320,67	6776692160,44	82320,67
	2006	1355755	1381876,667	1348011	1415742,33	33865,67	1449608,00	-93853,00	8808385609,00	93853,00
	2007	1133068	1378255,667	1373361,333	1383150,00	4894,33	1388044,33	-254976,33	65012930560,11	254976,33
	2008	1413793	1298488	1352873,444	1244102,56	-54385,44	1189717,11	224075,89	50210003981,35	224075,89
	2009	1343698	1300872	1325871,889	1275872,11	-24999,89	1250872,22	92825,78	8616625020,05	92825,78
	2010	1259352	1296853	1298737,667	1294968,33	-1884,67	1293083,67	-33731,67	1137825336,11	33731,67
	2011	1431945	1338947,667	1312224,222	1365671,11	26723,44	1392394,56	39550,44	1564237655,75	39550,44
	2012	1584237	1344998,333	1326933	1363063,67	18065,33	1381129,00	203108,00	41252859664,00	203108,00
	2013	1492839	1425178	1369708	1480648,00	55470,00	1536118,00	-43279,00	1873071841,00	43279,00
	2014	1486568	1503007	1424394,444	1581619,56	78612,56	1660232,11	-173664,11	30159223488,01	173664,11
	2015	1896478	1521214,667	1483133,222	1559296,11	38081,44	1597377,56	299100,44	89461075866,86	299100,44
	2016	1764637	1625295	1549838,889	1700751,11	75456,11	1776207,22	-11570,22	133870042,27	11570,22
	2017	1527587	1715894,333	1620801,333	1810987,33	95093,00	1906080,33	-378493,33	143257203377,78	378493,33
	2018	1682548	1729567,333	1690252,222	1768882,44	39315,11	1808197,56	-125649,56	15787810811,31	125649,56
	2019	1405214	1658257,333	1701239,667	1615275,00	-42982,33	1572292,67	-167078,67	27915280855,11	167078,67
			1538449,667	1642091,444	1434807,89	-103641,78	1331166,11	-1331166,11	1772003215370,68	1331166,11
	sum	50921625								
	average	1273040,625							81639047485,91	179812,15

Figure:Double Moving Average for consumption of fertilizer nitrogen

	A	B	C	D	E	F	G	H	I	J
	Years	production	three years moving avera	double moving average	value of a	value of b	Forecast	Error	MSE	MAD
	1980	698788								
	1981	673242								
	1982	752037								
	1983	787970	708022,3333							
	1984	773116	737749,6667							
	1985	713761	771041	738937,6667	803144,3333	32103,33	835247,67	-121486,67	14759010177,78	121486,67
	1986	852493	758282,3333	755691	760873,6667	2591,33	763465,00	89028,00	7925984784,00	89028,00
	1987	846320	779790	769704,4444	789875,5556	10085,56	799961,11	46358,89	2149146579,01	46358,89
	1988	833030	804191,3333	780754,5556	827628,1111	23436,78	851064,89	-18034,89	325257217,23	18034,89
	1989	1026159	843947,6667	809309,6667	878585,6667	34638,00	913223,67	112935,33	12754389515,11	112935,33
	1990	851453	901836,3333	849991,7778	953680,8889	51844,56	1005525,44	-154072,44	23738318137,09	154072,44
	1991	969078	903547,3333	883110,4444	923984,2222	20436,89	944421,11	24656,89	607962169,68	24656,89
	1992	1023758	948896,6667	918093,4444	979699,8889	30803,22	1010503,11	13254,89	175692079,46	13254,89
	1993	703061	948096,3333	933513,4444	962679,2222	14582,89	977262,11	-274201,11	75186249334,57	274201,11
	1994	939172	898632,3333	931875,1111	865389,5556	-33242,78	832146,78	107025,22	11454398191,72	107025,22
	1995	919555	888663,6667	911797,4444	865529,8889	-23133,78	842396,11	77158,89	5953494134,57	77158,89
	1996	909070	853929,3333	880408,4444	827450,2222	-26479,11	800971,11	108098,89	11685369779,01	108098,89
	1997	918457	922599	888397,3333	956800,6667	34201,67	991002,33	-72545,33	5262825388,44	72545,33
	1998	729867	915694	897407,4444	933980,5556	18286,56	952267,11	-222400,11	49461809422,23	222400,11
	1999	696913	852464,6667	896919,2222	808010,1111	-44454,56	763555,56	-66642,56	4441230210,98	66642,56
	2000	587715	781745,6667	849968,1111	713523,2222	-68222,44	645300,78	-57585,78	3316121802,27	57585,78
	2001	837927	671498,3333	768569,5556	574427,1111	-97071,22	477355,89	360571,11	130011526167,90	360571,11
	2002	775290	707518,3333	720254,1111	694782,5556	-12735,78	682046,78	93243,22	8694298490,38	93243,22
	2003	756668	733644	704220,2222	763067,7778	29423,78	792491,56	-35823,56	1283327132,64	35823,56
	2004	740150	789961,6667	743708	836215,3333	46253,67	882469,00	-142319,00	20254697761,00	142319,00
	2005	699525	757369,3333	760325	754413,6667	-2955,67	751458,00	-51933,00	2697036489,00	51933,00
	2006	653882	732114,3333	759815,1111	704413,5556	-27700,78	676712,78	-22830,78	521244413,94	22830,78
	2007	666459	697852,3333	729112	666592,6667	-31259,67	635333,00	31126,00	968827876,00	31126,00
	2008	624971	673288,6667	701085,1111	645492,2222	-27796,44	617695,78	7275,22	52928858,38	7275,22
	2009	768588	648437,3333	673192,7778	623681,8889	-24755,44	598926,44	169661,56	28785043433,53	169661,56
	2010	929709	686672,6667	669466,2222	703879,1111	17206,44	721085,56	208623,44	43523741571,86	208623,44
	2011	905086	774422,6667	703177,5556	845667,7778	71245,11	916912,89	-11826,89	139875300,79	11826,89
	2012	865777	867794,3333	776296,5556	959292,1111	91497,78	1050789,89	-185012,89	34229769055,01	185012,89
	2013	821859	900190,6667	847469,2222	952912,1111	52721,44	1005633,56	-183774,56	33773087269,64	183774,56
	2014	867369	864240,6667	877408,5556	851072,7778	-13167,89	837904,89	29464,11	868133843,57	29464,11
	2015	775025	851668,3333	872033,2222	831303,4444	-20364,89	810938,56	-35913,56	1289783472,64	35913,56
	2016	876700	821417,6667	845775,5556	797059,7778	-24357,89	772701,89	103998,11	10815607114,68	103998,11
	2017	979900	839698	837594,6667	841801,3333	2103,33	843904,67	135995,33	18494730688,44	135995,33
	2018	1143688	877208,3333	846108	908308,6667	31100,33	939409,00	204279,00	41729909841,00	204279,00
	2019	1000004	1000096	905667,4444	1094524,556	94428,56	1188953,11	-188949,11	35701766589,68	188949,11
			1041197,333	972833,8889	1109560,778	68363,44	1177924,22			
	sum	32893592							18372359836,95	107660,18
	average	822339,8								

Figure:Double Moving Average for production of fertilizer nitrogen

4. Exponential Smoothing Methods

Exponential smoothing is a procedure for revising an estimate in the light of more recent experiences. The observations are weighted, with more weight being given to the more recent observations. The weights used are α for the most recent observations, $\alpha(1-\alpha)$ for the next most recent, $\alpha(1-\alpha)^2$ for the next, so forth. The weight α is given to the newly observed value, and weight , $(1-\alpha)$ is given to the old forecast, assuming that $0<\alpha<1$.

New forecast= α X (New observation) $+(1-\alpha)$ X (Old Forecast)

The exponential smoothing equation is

$$\widehat{Y_{t+1}} = \alpha Y_t + (1-\alpha)\,\widehat{Y_t}$$

Where
Y_{t+1}= new smoothed value or the forecast value for the next period
α= smoothed constant ($0<\alpha<1$)
Y_t= new observation or actual value of series in period t.
$\widehat{Y_t}$= old smoothed or average experience of series smoothed to period t-1

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Years	production	smoothed value for 0.	error value for 0.1	smoothed value for 0.6	error value for 0.6	smoothed value for 0.8	error value for 0.8			Years	productior	At	Tt	St	Yt	error	MSE
1980	698788	698788	0,00	698788	0,00	698788	0,00			1980	698788	698788	0	1	698788	0,00	0,00
1981	673242	698788	-25546,00	698788	-25546,00	698788,00	-25546,00			1981	673242	688570	-1021,84	0,99	698788	-10218,40	104415698,56
1982	752037	696233,4	55803,60	683460,4	68576,60	678351,20	73685,80			1982	752037	713343	1557,73	1,02	698788	14555,46	211861299,37
1983	787970	701813,76	86156,24	724606,36	63363,64	737299,84	50670,16			1983	787970	744129	4480,48	1,02	698788	45340,71	2055780106,63
1984	773116	710429,384	62686,62	762624,544	10491,46	777835,97	-4719,97			1984	773116	758412	5460,75	1,01	763872,67	-5460,75	29819838,99
1985	713761	716698,0456	-2937,05	768919,4176	-55158,42	774059,99	-60298,99			1985	713761	743828	3456,29	0,99	742293,91	1534,09	2353432,52
1986	852493	716404,341	136088,66	735824,367	116668,63	725820,80	126672,20			1986	852493	789368	7664,64	1,02	810002,32	-20634,55	425784614,42
1987	846320	730013,2069	116306,79	805825,5468	40494,45	827158,56	19161,44			1987	846320	816747	9636,14	1,01	840989,82	-24242,37	587692568,18
1988	833030	741643,8862	91386,11	830122,2187	2907,78	842487,71	-9457,71			1988	833030	829042	9902,00	1,00	843823,78	-14781,63	218496550,66
1989	1026159	750782,4976	275376,50	831866,8875	194292,11	834921,54	191237,46			1989	1026159	913830	17390,59	1,04	919928,14	-6098,05	37186269,34
1990	851453	778320,1479	73132,85	948442,155	-96989,15	987911,51	-136458,51			1990	851453	899314	14199,88	0,98	935429,41	-36115,81	1304351481,87
1991	969078	785633,4331	183444,57	890248,662	78829,34	878744,70	90333,30			1991	969078	935739	16422,46	1,01	962504,44	-26765,14	716372843,88
1992	1023758	803977,8898	219780,11	937546,2648	86211,74	951011,34	72746,66			1992	1023758	980800	19286,31	1,01	1001529,75	-20729,49	429711943,92
1993	703061	825955,9008	-122894,90	989273,3059	-286212,31	1009208,67	-306147,67			1993	703061	881276	7405,29	0,94	921452,92	-40176,58	1614157729,21
1994	939172	813666,4107	125505,59	817545,9224	121626,08	764290,53	174881,47			1994	939172	908878	9424,91	1,01	903641,33	5236,45	27420419,87
1995	919555	826216,9696	93338,03	890521,5689	29033,43	904195,71	15359,29			1995	919555	918804	9475,00	1,00	938200,48	-19396,87	376238424,85
1996	909070	835550,7727	73519,23	907941,6276	1128,37	916483,14	-7413,14			1996	909070	920595	8706,65	1,00	941512,47	-20917,31	437533785,39
1997	918457	842902,6954	75554,30	908618,651	9838,35	910552,63	7904,37			1997	918457	924964	8272,86	1,00	876619,86	48344,04	2337145824,33
1998	729867	850458,1259	-120591,13	914521,6604	-184654,66	916876,13	-187009,13			1998	729867	851889	138,07	0,96	860546,71	-8657,86	74958549,10
1999	696913	838399,0133	-141486,01	803728,8642	-106815,86	767268,83	-70355,83			1999	696913	789981	-6066,49	0,96	784107,19	5874,16	34505785,16
2000	587715	824250,412	-236535,41	739639,3457	-151924,35	710984,17	-123269,17			2000	587715	705435	-13914,48	0,95	688923,24	16511,68	272635473,57
2001	837927	800596,8708	37330,13	648484,7383	189442,26	612368,83	225558,17			2001	837927	750083	-8058,22	1,04	740458,86	9624,21	92625350,93
2002	775290	804329,8837	-29039,88	762150,0953	13139,90	792815,37	-17525,37			2002	775290	755331	-6727,61	1,01	716435,03	38895,88	1512889412,61
2003	756668	801425,8953	-44757,90	770034,0381	-13366,04	778795,07	-22127,07			2003	756668	751829	-6405,02	1,00	719078,44	32750,73	1072610565,62
2004	740150	796950,1058	-56800,11	762014,4152	-21864,42	761093,41	-20943,41			2004	740150	743314	-6615,99	1,00	699817,39	43497,11	1891998182,18
2005	699525	791270,0952	-91745,10	748895,7661	-49370,77	744338,68	-44813,68			2005	699525	721829	-8102,93	0,99	738802,00	-16972,90	288079306,01
2006	653882	782095,5857	-128213,59	719273,3064	-65391,31	708487,74	-54605,74			2006	653882	689789	-10496,70	0,98	684676,75	5111,75	26130021,20
2007	666459	769274,2271	-102815,23	680038,5226	-13579,52	664803,15	1655,85			2007	666459	674159	-11010,01	1,00	664429,09	9729,59	94664890,93
2008	624971	758992,7044	-134021,70	671890,809	-46919,81	666127,83	-41156,83			2008	624971	647878	-12537,12	0,99	634529,04	13348,56	178184089,56
2009	768588	745590,534	22997,47	643738,9236	124849,08	633202,37	135385,63			2009	768588	688639	-7207,22	1,03	675115,52	13523,97	182897886,03
2010	929709	747890,2806	181818,72	718648,3694	211060,63	741510,87	188198,13			2010	929709	780743	2723,85	1,06	771231,96	9511,01	90459257,08
2011	905086	766072,1525	139013,85	845284,7478	59801,25	892069,37	13016,63			2011	905086	832114	7588,62	1,03	836825,99	-4711,50	22198250,41
2012	865777	779973,5373	85803,46	881165,4991	-15388,50	902482,67	-36705,67			2012	865777	850133	8631,58	1,01	849655,41	477,26	227778,65
2013	821859	788553,8835	33305,12	871932,3996	-50073,40	873118,13	-51259,13			2013	821859	844002	7155,37	0,99	880802,39	-36800,24	1354257754,17
2014	867369	791884,3952	75484,60	841888,3599	25480,64	832110,83	35258,17			2014	867369	857642	7803,83	1,00	914984,15	-57342,04	3288109848,86
2015	775025	799432,8557	-24407,86	857176,7439	-82151,74	860317,37	-85292,37			2015	775025	829278	4186,99	0,98	855391,52	-26113,96	681938826,56
2016	876700	796992,0701	79707,93	807885,6976	68814,30	792083,47	84616,53			2016	876700	850759	5916,41	1,01	861404,55	-10645,83	113333591,50
2017	979900	804962,8631	174937,14	849174,279	130725,72	859776,69	120123,31			2017	979900	905965	10845,40	1,02	909594,48	-3629,40	13172543,37
2018	1143688	822456,5768	321231,42	927609,7116	216078,29	955875,34	187812,66			2018	1143688	1007561	19920,50	1,04	1030977,93	-23416,44	548329569,10
2019	1000004	854579,7191	145424,28	1057256,685	-57252,68	1106125,47	-106121,47			2019	1000004	1016491	18821,38	1,00	1014992,68	1498,11	2244340,42

Figure:Exponential Smoothing Method for production of fertilizer nitrogen

A	B	C	D	E	F	G	H
Years	Consumption of nitrogen fertilizer by yea	Smoothed value for 0.1	error for 0.1	smoothed value for 0,(	error for 0.6	smoothed value for 0.8	error for 0.8
1980	776409	776409	0,00	776409	0,00	776409	0,00
1981	847242	776409,00	70833,00	776409,00	70833,00	776409	70833,00
1982	990806	783492,30	207313,70	818908,80	171897,20	833075,4	157730,60
1983	998385	804223,67	194161,33	922047,12	76337,88	959259,88	39125,12
1984	917423	823639,80	93783,20	967849,85	-50426,85	990559,976	-73136,98
1985	953182	833018,12	120163,88	937593,74	15588,26	932050,3952	21131,60
1986	1141509	845034,51	296474,49	946946,70	194562,30	948955,679	192553,32
1987	1081605	874681,96	206923,04	1063684,08	17920,92	1102998,336	-21393,34
1988	1140446	895374,26	245071,74	1074436,63	66009,37	1085883,667	54562,33
1989	1199663	919881,44	279781,56	1114042,25	85620,75	1129533,533	70129,47
1990	1103716	947859,59	155856,41	1165414,70	-61698,70	1185637,107	-81921,11
1991	1206230	963445,23	242784,77	1128395,48	77834,52	1120100,221	86129,78
1992	1335253	987723,71	347529,29	1175096,19	160156,81	1189004,044	146248,96
1993	1006588	1022476,64	-15888,64	1271190,28	-264602,28	1306003,209	-299415,21
1994	1053737	1020887,78	32849,22	1112428,91	-58691,91	1066471,042	-12734,04
1995	1147438	1024172,70	123265,30	1077213,76	70224,24	1056283,808	91154,19
1996	1166966	1036499,23	130466,77	1119348,31	47617,69	1129207,162	37758,84
1997	1394906	1049545,91	345360,09	1147918,92	246987,08	1159414,232	235491,77
1998	1485624	1084081,91	401542,09	1296111,17	189512,83	1347807,646	137816,35
1999	1378597	1124236,12	254360,88	1409818,87	-31221,87	1458060,729	-79463,73
2000	1132555	1149672,21	-17117,21	1391085,75	-258530,75	1394489,746	-261934,75
2001	1199130	1147960,49	51169,51	1235967,30	-36837,30	1184941,949	14188,05
2002	1340866	1153077,44	187788,56	1213864,92	127001,08	1196292,39	144573,61
2003	1366618	1171856,30	194761,70	1290065,57	76552,43	1311951,278	54666,72
2004	1372371	1191332,47	181038,53	1335997,03	36373,97	1355684,656	16686,34
2005	1406641	1209436,32	197204,68	1357821,41	48819,59	1369033,731	37607,27
2006	1355755	1229156,79	126598,21	1387113,16	-31358,16	1399119,546	-43364,55
2007	1133068	1241816,61	-108748,61	1368298,27	-235230,27	1364427,909	-231359,91
2008	1413793	1230941,75	182851,25	1227160,11	186632,89	1179339,982	234453,02
2009	1343698	1249226,87	94471,13	1339139,84	4558,16	1366902,396	-23204,40
2010	1259352	1258673,99	678,01	1341874,74	-82522,74	1348338,879	-88986,88
2011	1431945	1258741,79	173203,21	1292361,09	139583,91	1277149,376	154795,62
2012	1584237	1276062,11	308174,89	1376111,44	208125,56	1400985,875	183251,12
2013	1492839	1306879,60	185959,40	1500986,78	-8147,78	1547586,775	-54747,78
2014	1486568	1325475,54	161092,46	1496098,11	-9530,11	1503788,555	-17220,56
2015	1896478	1341584,78	554893,22	1490380,04	406097,96	1490012,111	406465,89
2016	1764637	1397074,11	367562,89	1734038,82	30598,18	1815184,822	-50547,82
2017	1527587	1433830,40	93756,60	1752397,73	-224810,73	1774746,564	-247159,56
2018	1682548	1443206,06	239341,94	1617511,29	65036,71	1577018,913	105529,09
2019	1405214	1467140,25	-61926,25	1656533,32	-251319,32	1661442,183	-256228,18

Figure: Exponential Smoothing Method for consumption of fertilizer nitrogen

K	L	M	N	O	P	Q	R
Years	Consumption of nitrogen fertilizer by yea	At	Tt	St	Yt	Error	MSE
1980	776409	776409,00	0	1	776409	0,00	0,00
1981	847242	804742,20	80474,22	7,32	776409	28333,20	802770222,24
1982	990806	927452,25	157124,60	51,53	776409	151043,25	22814063974,74
1983	998385	1050100,11	230709,69	361,01	776409	273691,11	74906824744,01
1984	917423	1135455,08	298113,26	2527,28	1433568,34	-298113,26	88871516959,96
1985	953182	1241413,81	362631,99	17691,17	11734948,03	-10493534,22	110114260511165,00
1986	1141509	1419031,08	432008,70	123838,45	95386666,40	-93967635,32	8829916487734220,00
1987	1081605	1543265,87	499933,55	866869,35	7376052219,45	-736061953,59	541787199518728000,00
1988	1140446	1682098,05	568156,64	6068085,66	56870179225,23	-5685335827,18	32323043467868200000,00
1989	1199663	1830018,01	637527,12	42476599,78	436537664 45,18	-43651936427,17	1905491553841310000000,00
1990	1103716	1922013,48	702223,04	297336198,66	3249813790 18,46	-3249794570 04,99	1056116474752550000000,00
1991	1206230	2057033,91	767481,82	2081353390,81	24484861187 06,27	-2448484061672,36	5995074200363570000000,00
1992	1335253	2228810,64	836866,52	14569473735,82	18602791613335,70	-18602789384525,10	3460637728849990000000000,00
1993	1006588	2242041,50	893697,37	101986316150,88	13319552480066 7,00	-13319552255862 5,00	1774104722966530000000000000,00
1994	1053737	2302938,12	945251,71	713904213056,28	9658044151206 69,00	-9658044128177 31,00	9327781638182020000000000000000,00
1995	1147438	2407889,10	996990,27	4997329491394,11	7086757220723670,00	-7086757218315780,00	5022212787135090000000000000000,00
1996	1166966	2509714,02	1048563,62	349813064397 58,90	5184223266795 8700,00	-5184223266544 9000,00	2687617087738550000000000000000000,00
1997	1394906	2692928,99	1108143,80	24486914507 8313,00	3876574104406 49000,00	-3876574104379 57000,00	1502782678674620000000000000000000,00
1998	1485624	2874893,27	1174004,36	17140840155 48190,00	2890525078234 080000,00	-2890525078231 210000,00	8355135227883520000000000000000000000,00
1999	1378597	2980777,38	1237281,23	11998588108837300,00	2107902868065 6600000,00	-2107902868065 3600000,00	4443254501198190000000000000000000000,00
2000	1132555	2983857,17	1288210,70	83990116761861200,00	1494425151063 33000000,00	-1494425151063 30000000,00	2233306532130570000000000000000000000000,00
2001	1199130	3042892,72	1334857,83	5879308173330 29000,00	1071976034636 960000000,00	-1071976034636 960000000,00	1149132618835970000000000000000000000000,00
2002	1340866	3162996,73	1384185,94	4115515721331 200000,00	7794253127848 680000000,00	-7794253127848 680000000,00	6075038182097890000000000000000000000000,00
2003	1366618	3274956,80	1434844,43	2880861004931 8400000,00	5651096505516 0200000000,00	-5651096505516 0200000000,00	3193489171465540000000000000000000000000,00
2004	1372371	3374829,14	1485358,46	2016602703452 29000000,00	4082077238057 61000000000,00	-4082077238057 61000000000,00	1666335457746810000000000000000000000000000,00
2005	1406641	3478768,96	1536163,66	1411621892416 600000000,00	2948433434851 61000000000,00	-2948433434851 61000000000,00	8693259719750880000000000000000000000000000,00
2006	1355755	3551261,57	1584057,09	9881353246916 21000000,00	2113448467972 620000000000,00	-2113448467972 620000000000,00	4466664426775800000000000000000000000000000000,00
2007	1133068	3534418,40	1620687,51	6916947272841 3500000000,00	1485114357969 180000000000,00	-1485114357969 180000000000,00	2205564656246210000000000000000000000000000000,00
2008	1413793	3658580,74	1662408,08	4841863090988 94000000000,00	1073032045014 060000000000,00	-1073032045014 060000000000,00	1151397769627050000000000000000000000000000000000,00
2009	1343698	3730072,50	1702933,72	3389304163692 260000000000,00	7669350508036 070000000000,00	-7669350508036 070000000000,00	5881893721511310000000000000000000000000000000000,00
2010	1259352	3763544,53	1738701,42	2372512914584 580000000000,00	5436963589159 460000000000,00	-5436963589159 460000000000,00	2956057306984580000000000000000000000000000000000,00
2011	1431945	3874125,57	1778373,70	1660759042092 100000000000,00	3909803939163 360000000000,00	-3909803939163 360000000000,00	1528656684269730000000000000000000000000000000000000,00
2012	1584237	4025194,36	1825218,39	1162531328146 450000000000,00	2832689757799 090000000000,00	-2832689757799 090000000000,00	8024131265021960000000000000000000000000000000000000,00
2013	1492839	4107383,25	1870913,04	8137719297025 120000000000,00	2026226451533 220000000000,00	-2026226451533 220000000000,00	4105593632892890000000000000000000000000000000000000000,00
2014	1486568	4181604,98	1914890,93	5696403507917 580000000000,00	1446401526816 980000000000,00	-1446401526816 980000000000,00	2092077376778490000000000000000000000000000000000000000,00
2015	1896478	4416488,74	1973561,62	3987482455542 310000000000,00	1061233390424 540000000000,00	-1061233390424 540000000000,00	1126216308951970000000000000000000000000000000000000000000,00
2016	1764637	4539885,02	2032837,80	2791237718879 620000000000,00	7640996180795 140000000000,00	-7640996180795 140000000000,00	5838482263492600000000000000000000000000000000000000000000,00
2017	1527587	4554668,49	2081737,09	1953866403215 730000000000,00	5400520569488 010000000000,00	-5400520569488 010000000000,00	2916562242146310000000000000000000000000000000000000000000000,00
2018	1682548	4654862,54	2130875,92	1367706482251 010000000000,00	3865430440534 700000000000,00	-3865430440534 700000000000,00	1494155249061230000000000000000000000000000000000000000000000000,00
2019	1405214	4633528,68	2168053,61	9573945375757 080000000000,00	2712119003639 860000000000,00	-2712119003639 860000000000,00	7355589489904460000000000000000000000000000000000000000000000000000,00

Figure: Exponential Smoothing Method for consumption of fertilizer nitrogen