Assignment on Time Series Analysis & Forecasting

1. Below are the net sales in $ million for Home Depot, Inc. and its subsidiaries from 2015 to 2024.

Table 1: Net sales of different years

Year	Net Sales ($)	Year	Net Sales ($)
2015	50,600	2020	156,700
2016	67,300	2021	201,400
2017	80,800	2022	227,300
2018	98,100	2023	256,300
2019	124,400	2024	280,900

***Note:* Add last three digits of your ID with Net Sales**

i) Determine the least square equation. Based on this information, what are the estimated sales for 2030?

ii) Plot Net Sales and Trend Line

Solution:

Year	Net Sales (Y)	X	XY	XX	Yc
2015	50600025	-9	-455400036	81	32460003.97
2016	67300025	-7	-471100028	49	59553337.31
2017	80800025	-5	-404000020	25	86646670.65
2018	98100025	-3	-294300012	9	113740004
2019	124400025	-1	-124400004	1	140833337.3
2020	156700025	1	156700004	1	167926670.7
2021	201400025	3	604200012	9	195020004
2022	227300025	5	1136500020	25	222113337.4
2023	256300025	7	1794100028	49	249206670.7
2024	280900025	9	2528100036	81	276300004

Here, N=10; $\sum y$=1543800040; $\sum xy$ = 4470400000; $\sum x^2$ =330

We know,

$$a = \frac{\sum y}{N} = \frac{1543800040}{10} = \mathbf{154380004}$$

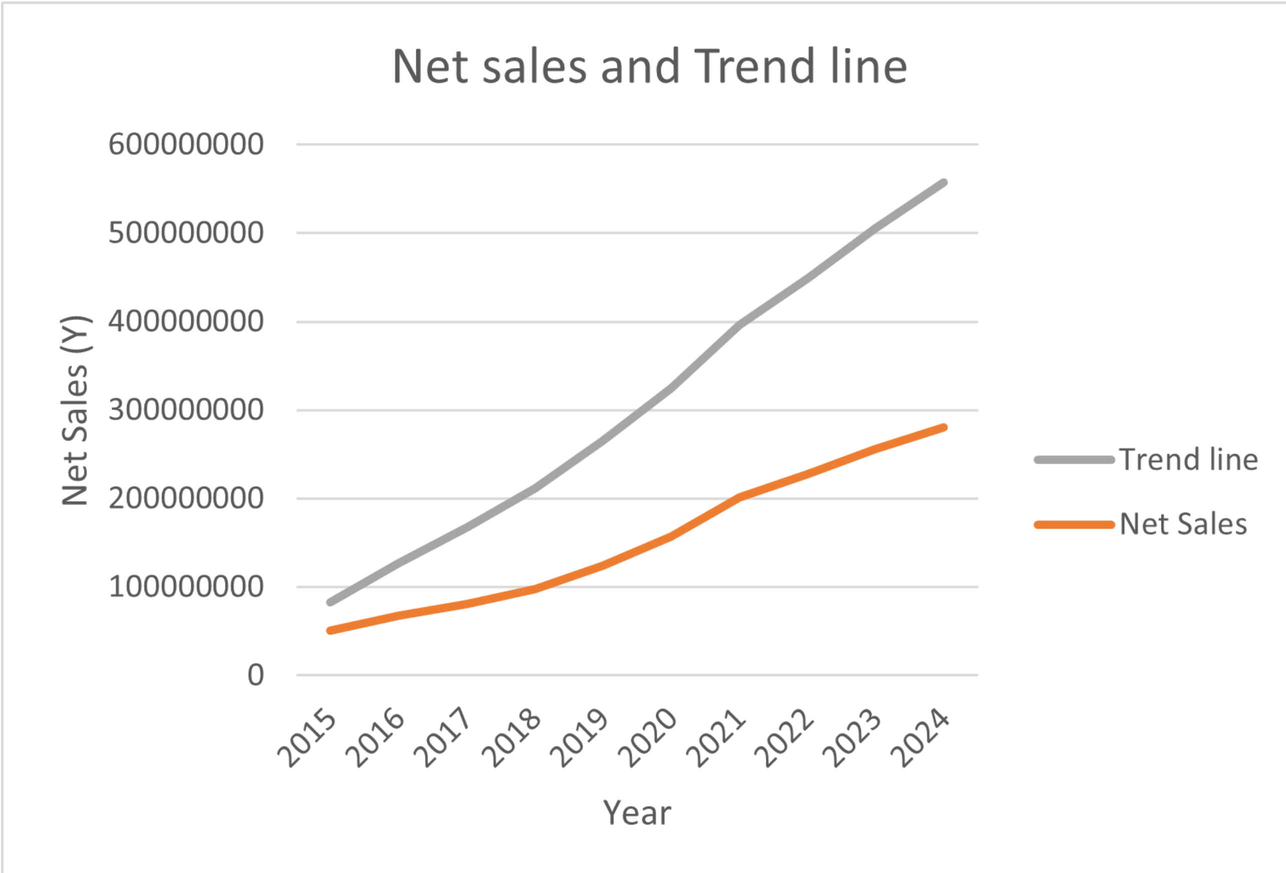
$$b = \frac{\sum xy}{\sum x^2} = \frac{4470400000}{330} = \mathbf{13546666.67}$$

Trend equation:

Yc = a + bx

For 2030, x = 21

Then Y_{2023} = 154380004 + 13546666.67 * 21 = 438860004.1



2. It appears that the imports of carbon black have been increasing by about 10 percent annually.

Table 2: Amount of Carbon Block imported in different years.

Year	Imports of Carbon Block (thousands of tons)	Year	Imports of Carbon Block (thousands of tons)
2011	124	2018	2463
2012	175	2019	3358
2013	306	2020	4181
2014	524	2021	5388
2015	714	2022	8027
2016	1052	2023	10587
2017	1638	2024	13537

Note: **Add last three digits of your ID with imports of Carbon Block**

i) Determine the logarithmic trend.
ii) Find the annual rate of increase.
iii) Estimate imports for the year 2030.

Solution:

Year	Imports of Carbon (Y)	x	xx	log(Y)	x log(y)	Log Yc	Yc
2011	124025	-13	169	5.093436	-66.2147	5.190542	155075.3
2012	175025	-11	121	5.243048	-57.6735	5.347631	222654.4
2013	306025	-9	81	5.485727	-49.3715	5.50472	319683.5
2014	524025	-7	49	5.719335	-40.0353	5.661809	458996.2
2015	714025	-5	25	5.853701	-29.2685	5.818898	659019.1
2016	1052025	-3	9	6.022017	-18.0661	5.975987	946208.5
2017	1638025	-1	1	6.214315	-6.21431	6.133076	1358550
2018	2463025	1	1	6.391465	6.391465	6.290165	1950584
2019	3358025	3	9	6.526081	19.57824	6.447253	2800615
2020	4181025	5	25	6.621281	33.1064	6.604342	4021077
2021	5388025	7	49	6.731428	47.12	6.761431	5773394
2022	8027025	9	81	6.904553	62.14098	6.91852	8289343
2023	10587025	11	121	7.024773	77.2725	7.075609	11901699
2024	13537025	13	169	7.131523	92.70979	7.232698	17088260

Here, N=14; $\sum$logy= 86.9626823; $\sum$xlogy = 71.47543718; $\sum x^2 = 910$

We know,

$Log(a) = \frac{\sum logy}{N} = \frac{86.9626823}{14} = 6.211620164$

Log(b)= $= \frac{\sum xlogy}{\sum x^2} = \frac{4470400000}{910} = 0.078544436$

Trend equation:

logY = log(a) + log(b)x

For the year 2023, x= 25

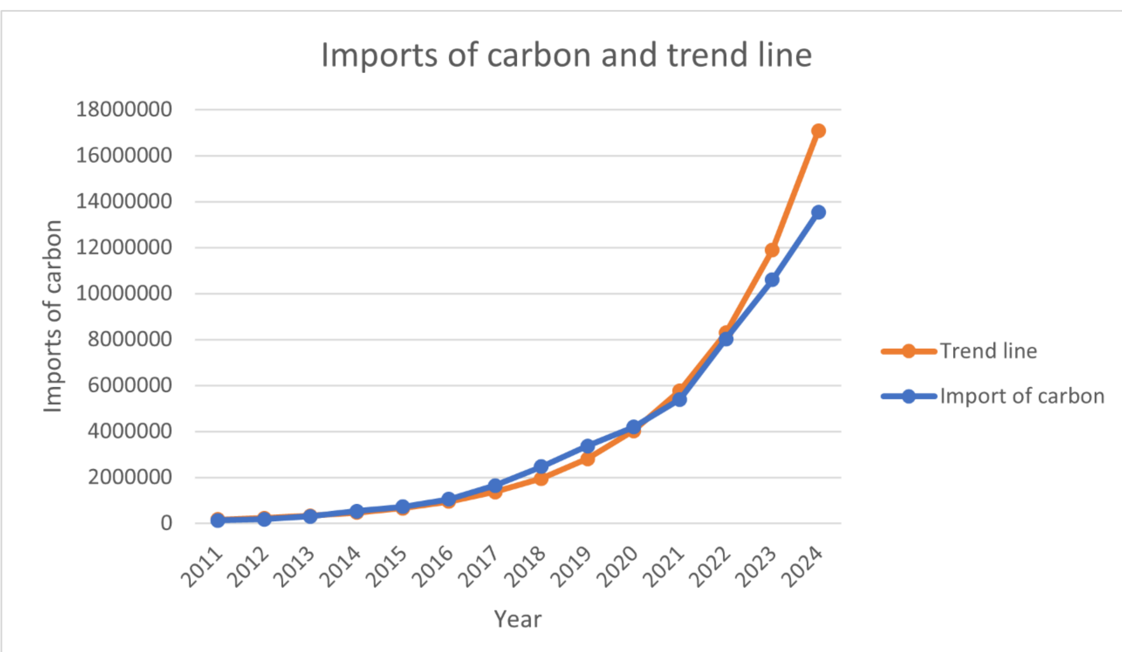
logY = = 6.211620164 + 0.078544436 * 25 = 8.175231

Y_{2030} = 149703193

Annual rate of increase = $(e^{b} -1)$ x 100%

= $(e^{0.0785} -1)$ x 100%

= 8.1663 %



3. The quarterly production of pine lumber, in millions of board feet, by Northwest lumber since 2018 is:

Table 3: Productions in different quarters of several years

Year	Quarter	Production	Year	Production	Sales	Year	Quarter	Production
2018	Winter	90	2021	Winter	201	2024	Winter	265
	Spring	85		Spring	142		Spring	185
	Summer	56		Summer	110		Summer	142
	Fall	102		Fall	274		Fall	333
2019	Winter	115	2022	Winter	251	2025	Winter	282
	Spring	89		Spring	165		Spring	175
	Summer	61		Summer	125		Summer	157
	Fall	110		Fall	305		Fall	350
2020	Winter	165	2023	Winter	241	2024	Winter	290
	Spring	110		Spring	158		Spring	201
	Summer	98		Summer	132		Summer	187
	Fall	248		Fall	299		Fall	400

Note: **Add last three digits of your ID with number of Productions**

i) Develop a seasonal index for each quarter and interpret it.
ii) Project the production for 2030 and also find the base year production.
iii) Plot the original data, deseasonalize data, and interpret.

Solution:

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)	Mean
2018	90025	85025	56025	102025	83273
2019	115025	89025	61025	110025	93773
2020	165025	110025	98025	248025	155273
2021	201025	142025	110025	274025	181773
2022	251025	165025	125025	305025	211523
2023	241025	158025	132025	299025	207523
2024	265025	185025	142025	333025	231273
2025	282025	175025	157025	350025	241023
2026	290025	201025	187025	400025	269523

Seasonal Index calculation: Divide seasonal value of each year with the mean of each year. Then we get,

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	1.081058686	1.021015215	0.67276308	1.225163018

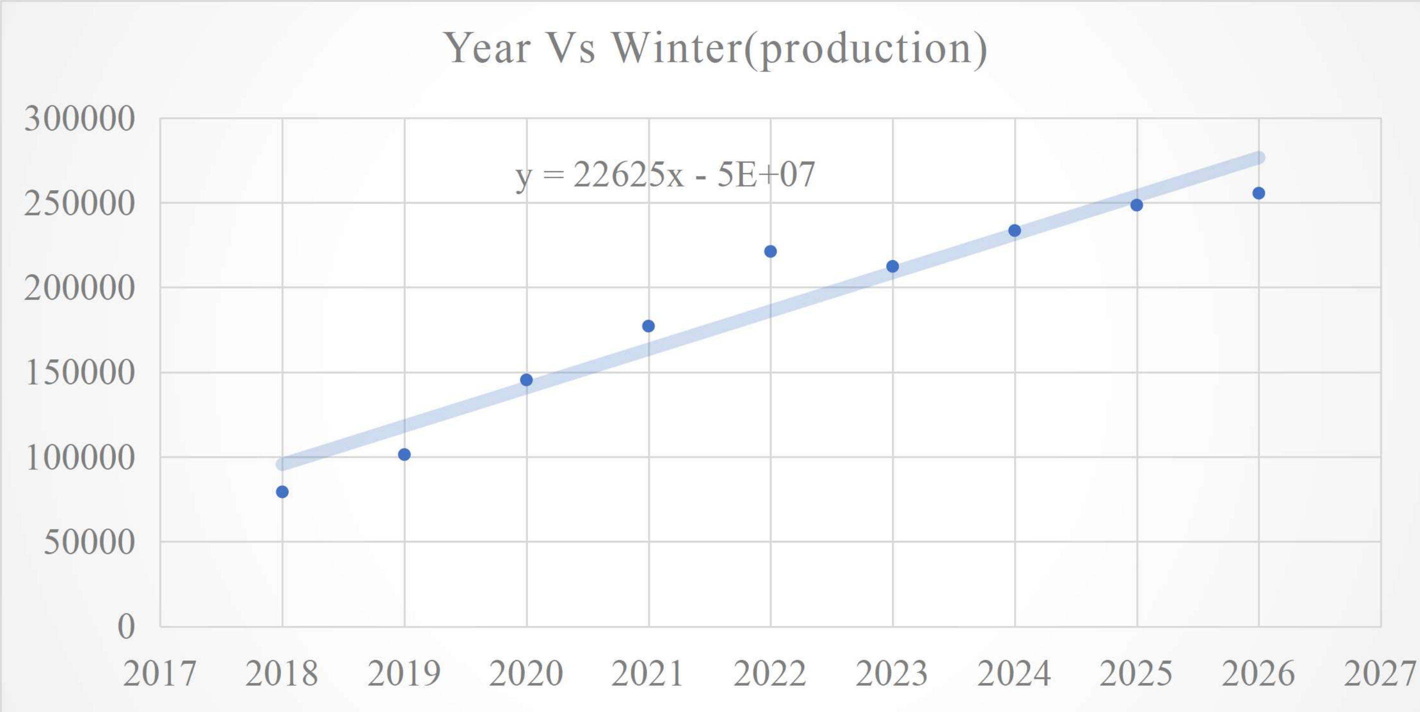
2019	1.226611071	0.949345761	0.650752349	1.173290819
2020	1.06279263	0.708577795	0.631294559	1.597335016
2021	1.105901316	0.781320658	0.605276911	1.507501114
2022	1.186740922	0.78016575	0.591061019	1.442032309
2023	1.16142789	0.761472222	0.636184905	1.440914983
2024	1.145931432	0.80001989	0.614092436	1.439956242
2025	1.170108247	0.726167212	0.651485543	1.452238998
2026	1.076060299	0.745847293	0.693903674	1.484188733

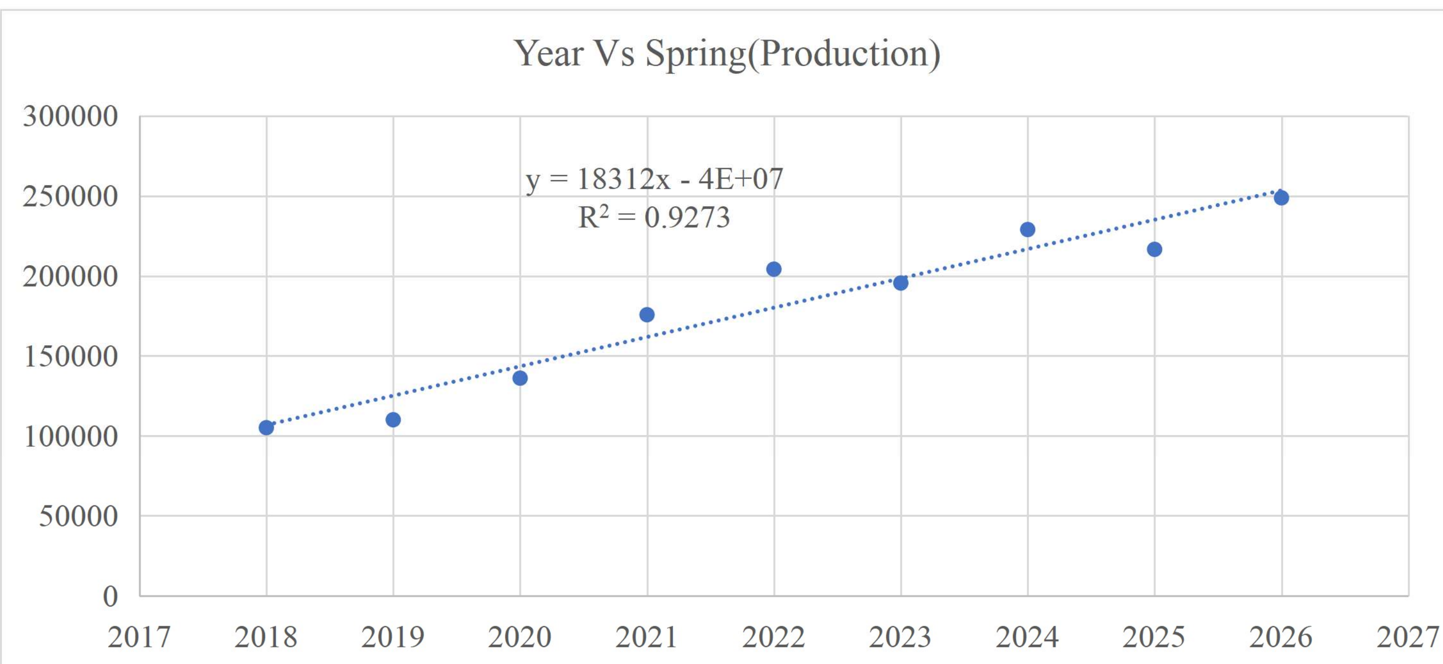
Overall Seasonal Index:

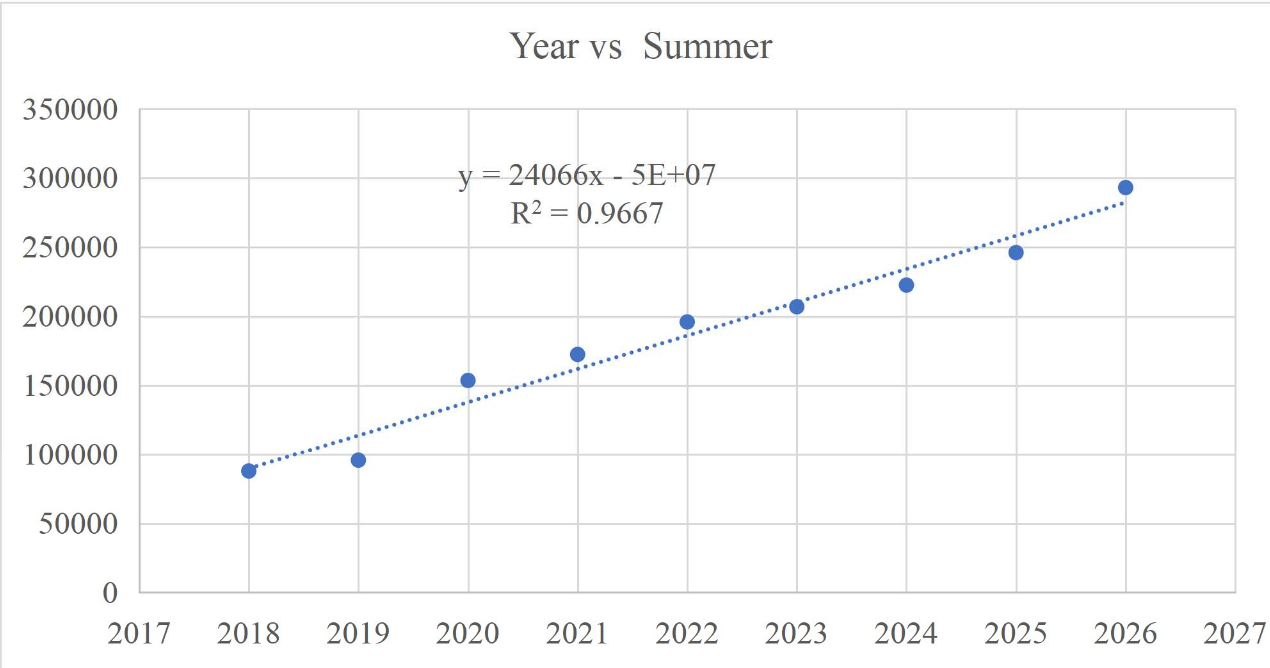
Seasonal Index	Winter	Spring	Summer	Fall
SI	1.135181388	0.808214644	0.638534942	1.418069026
Sum of SI	4			

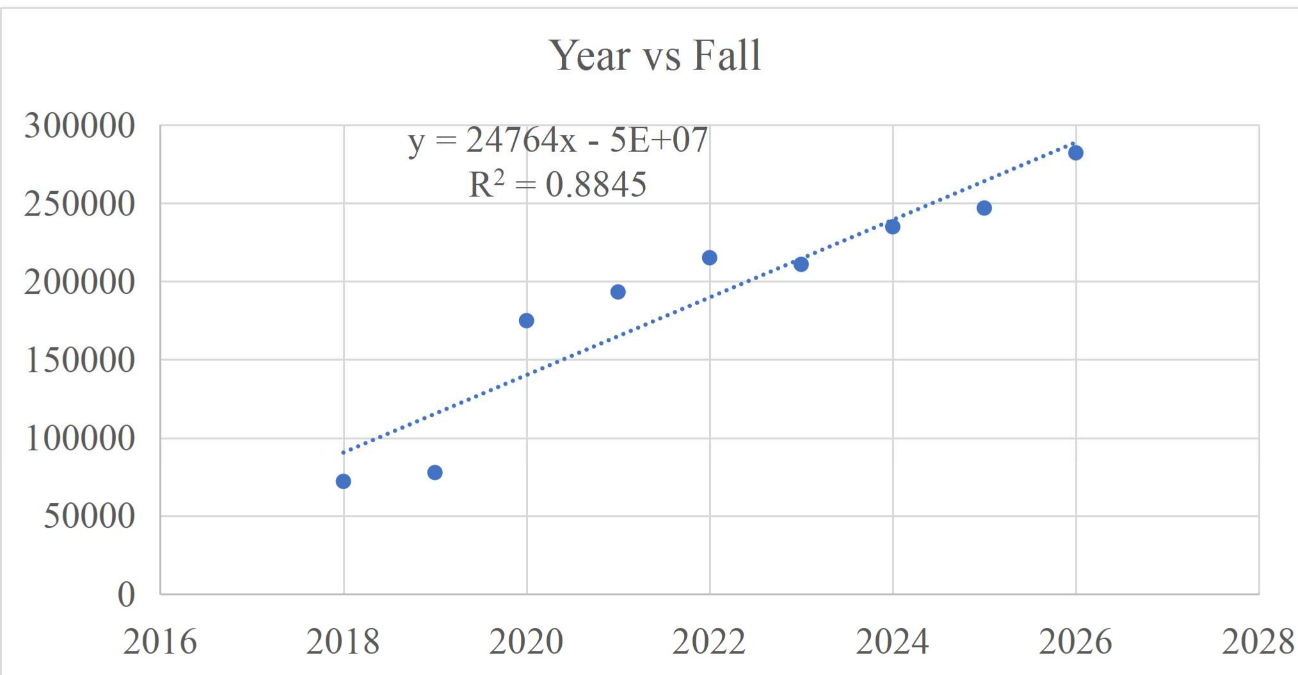
De-seasonalize data:

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	79302.74486	105198.5393	87736.78045	71945.01688
2019	101325.657	110147.7196	95567.20549	77586.4912
2020	145371.4813	136130.9162	153512.3508	174901.9233
2021	177084.4749	175724.3587	172305.3709	193236.7149
2022	221130.2992	204182.1454	195796.646	215097.4279
2023	212321.1343	195521.0799	206759.2411	210866.3221
2024	233463.13	228928.047	222420.0912	234842.588
2025	248438.7103	216555.0962	245911.3663	246830.7209
2026	255486.0422	248724.7682	292893.9166	282089.9355


Year Vs Winter(production)
y = 22625x - 5E+07
300000
250000
200000
150000
100000
50000
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027


Year Vs Spring(Production)
y = 18312x - 4E+07
R² = 0.9273
300000
250000
200000
150000
100000
50000
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027





Production in 2030:

For winter

y = 22625x – 5E+07; for x = 2030 we get production = 35,928,750

For spring,

y = 18312x-4E+07; for x = 2030 we get production =

For summer,

y = 24066x-5E+07; for x = 2030 we get production =

For fall,

y = 24764 X - 4E+07; for x=2030 we get production =