Omdena - Milan Chapter Agrifoods

AI for Sustainable agri-food systems: use of Satellite Imagery

Exploratory analysis of fruit production in Italy 2020-2022

Author: Maria Fisher

Here we have analysed the major areas and crop produced in Italy. Crop dataset used in this study was downloaded from the Italian National Institute of Statistics (Istat). The objective is to get some insights about crop production and its respective areas in Italy and how climate change have affected crop production in the last 3 years.

	ITTER107	Territory	TIPO_DATO5	Data type	AGRI_MADRE	Type of crop	TIME	Select time	Value	Flag Codes	Flags
0	ITD35	Venezia	PA_EXT	production area - hectares	KIWI	kiwi	2020	2020	33	NaN	NaN
1	ITD35	Venezia	PA_EXT	production area - hectares	KIWI	kiwi	2021	2021	35	NaN	NaN
2	ITD35	Venezia	PA_EXT	production area - hectares	KIWI	kiwi	2022	2022	37	NaN	NaN
3	ITE45	Frosinone	ART	total area - hectares	POMETES	pomegranates	2020	2020	11	NaN	NaN
4	ITE45	Frosinone	ART	total area - hectares	POMETES	pomegranates	2021	2021	12	NaN	NaN

Pre-processing dataset

	Territory	Data type	Type of crop	Select time	Value
0	Venezia	production area - hectares	kiwi	2020	33
1	Venezia	production area - hectares	kiwi	2021	35
2	Venezia	production area - hectares	kiwi	2022	37
3	Frosinone	total area - hectares	pomegranates	2020	11
4	Frosinone	total area - hectares	pomegranates	2021	12
...	...	...	...	...	...
23818	Treviso	total area - hectares	sour cherries	2022	15
23819	Padova	total area - hectares	sour cherries	2022	12
23820	Rovigo	total area - hectares	sour cherries	2022	1
23821	Pesaro e Urbino	total area - hectares	sour cherries	2022	3
23822	Ancona	total area - hectares	sour cherries	2022	6

23823 rows × 5 columns

```
DATASET SHAPE:  (23823, 5)

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FEATURE DATA TYPES:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 23823 entries, 0 to 23822
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   City       23823 non-null  object
 1   Data_type  23823 non-null  object
 2   Type_crop  23823 non-null  object
 3   Year       23823 non-null  int64 
 4   Value      23823 non-null  int64 
dtypes: int64(2), object(3)
memory usage: 930.7+ KB
None

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NUMBER OF UNIQUE VALUES PER FEATURE:

City          107
Data_type       4
Type_crop      58
Year            3
Value        3119
dtype: int64

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Data_type    0
Type_crop    0
Year         0
Value        0
dtype: int64
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Cities in Italy producing fruits

```
array(['production area - hectares ', 'total area - hectares',
       'harvested production - quintals ', 'total production - quintals '],
      dtype=object)
```

Select only values for total fruits production - quintals

	City	Data_type	Type_crop	Year	Value
23	Perugia	total production - quintals	nectarine	2020	2000
24	Perugia	total production - quintals	nectarine	2021	2000
25	Perugia	total production - quintals	nectarine	2022	600
28	Lucca	total production - quintals	plum	2020	2090
29	Lucca	total production - quintals	plum	2021	2100

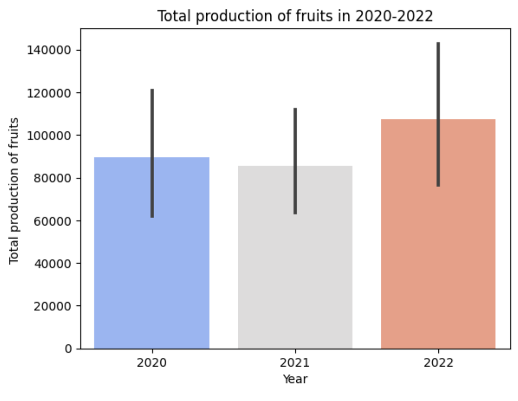
	City	Data_type	Type_crop	Year	Total_production
23	Perugia	total production - quintals	nectarine	2020	2000
24	Perugia	total production - quintals	nectarine	2021	2000
25	Perugia	total production - quintals	nectarine	2022	600
28	Lucca	total production - quintals	plum	2020	2090
29	Lucca	total production - quintals	plum	2021	2100
...	...	...	...	...	...
23783	Nuoro	total production - quintals	citrus fruit	2021	45070
23787	Cagliari	total production - quintals	citrus fruit	2021	5721
23791	Oristano	total production - quintals	citrus fruit	2021	114990
23795	Barletta-Andria-Trani	total production - quintals	citrus fruit	2021	3050
23799	Sud Sardegna	total production - quintals	citrus fruit	2021	353009

5950 rows × 5 columns

	City	Type_crop	Year	Total_production
23	Perugia	nectarine	2020	2000
24	Perugia	nectarine	2021	2000
25	Perugia	nectarine	2022	600
28	Lucca	plum	2020	2090
29	Lucca	plum	2021	2100
...	...	...	...	...
23783	Nuoro	citrus fruit	2021	45070
23787	Cagliari	citrus fruit	2021	5721
23791	Oristano	citrus fruit	2021	114990
23795	Barletta-Andria-Trani	citrus fruit	2021	3050
23799	Sud Sardegna	citrus fruit	2021	353009

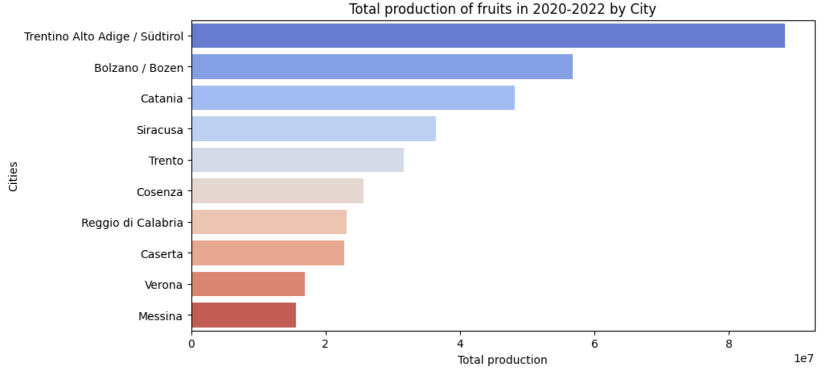
5950 rows × 4 columns

Total fruit production in 2020-2022



Fruit production by Cities

	City	Total_production
94	Trentino Alto Adige / Südtirol	88342093
14	Bolzano / Bozen	56726194
21	Catania	48114864
86	Siracusa	36396160
95	Trento	31615899
25	Cosenza	25685561
76	Reggio di Calabria	23195041
20	Caserta	22776411
103	Verona	16895734
53	Messina	15592550



Fruits produced 2020-2022

Dataset shows there are 58 different types of fruits cultivated in Italy. The top most produced crops are White oranges, Peach, Pear, Apples, Apricot, Cherry, Plum, Kiwi, Nectarine, Lemon, Orange and Raspberry.

	Year	Total_production
count	5950.000000	5.950000e+03
mean	2020.960336	9.302331e+04
std	0.779921	6.434403e+05
min	2020.000000	0.000000e+00
25%	2020.000000	4.300000e+02
50%	2021.000000	2.775000e+03
75%	2022.000000	1.770000e+04
max	2022.000000	1.513440e+07

```
<AxesSubplot: >
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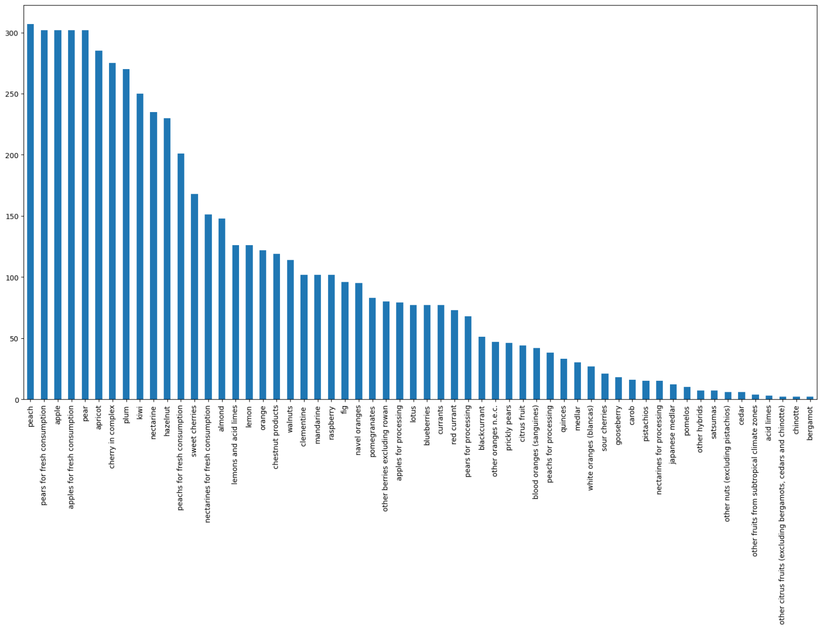
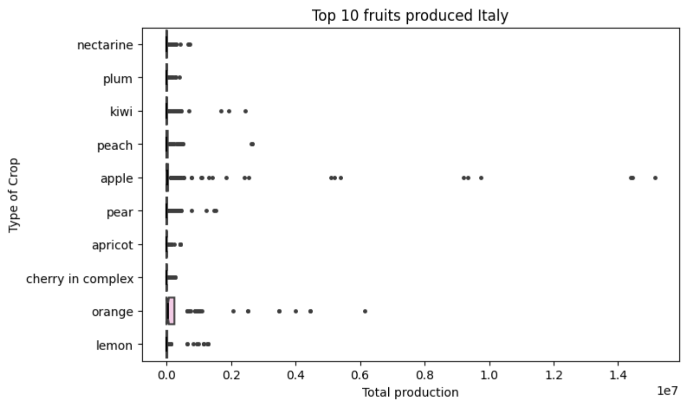


Subseting data

	City	Type_crop	Year	Total_production
23	Perugia	nectarine	2020	2000
24	Perugia	nectarine	2021	2000
25	Perugia	nectarine	2022	600
28	Lucca	plum	2020	2090
29	Lucca	plum	2021	2100

Stats

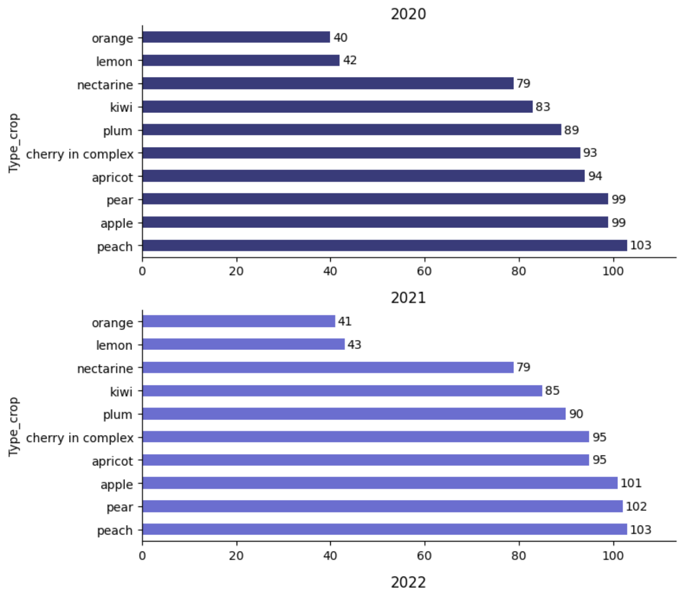
	Year	Total_production
count	2474	2474
mean	2020	105694
std	0	700401
min	2020	0
25%	2020	900
50%	2021	4760
75%	2022	23075
max	2022	15134400

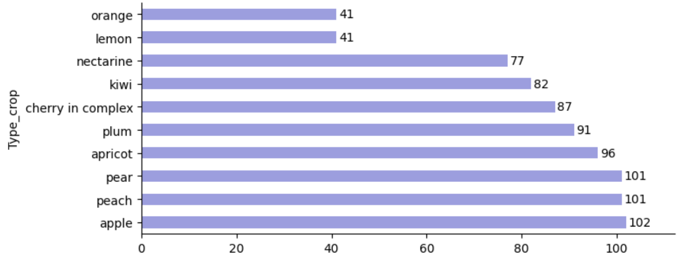


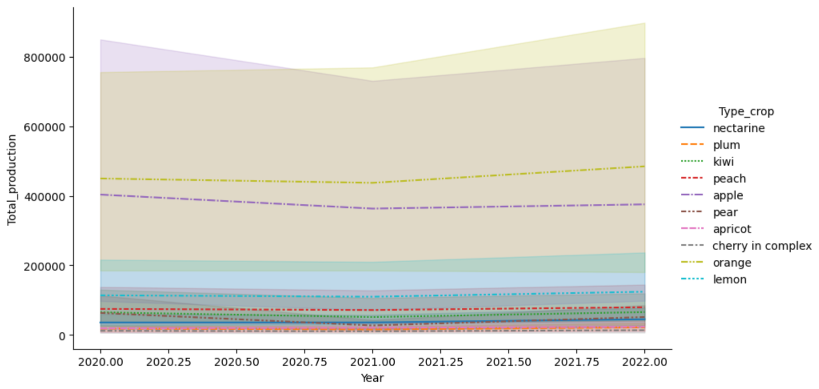
	City	Type_crop	Year	Total_production
23	Perugia	nectarine	2020	2000
24	Perugia	nectarine	2021	2000
25	Perugia	nectarine	2022	600
28	Lucca	plum	2020	2090
29	Lucca	plum	2021	2100
...	...	...	...	...
14826	Bolzano / Bozen	kiwi	2021	1000
14827	Bolzano / Bozen	kiwi	2022	960
14837	Trento	kiwi	2020	11000
14838	Trento	kiwi	2021	10000
14839	Trento	kiwi	2022	9500

2474 rows × 4 columns

Vizualization of ten type of fruits produced in Italy in the period of 2020-2022







Select fruits 2020

	City	Type_crop	Year	Total_production
23	Perugia	nectarine	2020	2000
28	Lucca	plum	2020	2090
45	Lecce	kiwi	2020	1200
63	Modena	peach	2020	18900
69	Campobasso	kiwi	2020	3150
...	...	...	...	...
14789	Trento	cherry in complex	2020	21000
14801	Bolzano / Bozen	plum	2020	715
14813	Trento	plum	2020	2700
14825	Bolzano / Bozen	kiwi	2020	1000
14837	Trento	kiwi	2020	11000

821 rows × 4 columns

Create new column for each selected crop produced

											Total_production
	Type_crop	**apple**	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**
City	**Year**										
Agrigento	**2020**	NaN	57950.0	3830.0	NaN	19758.0	19798.0	1026000.0	480750.0	NaN	6095.0
Alessandria	**2020**	24000.0	7600.0	3840.0	720.0	NaN	120.0	NaN	41600.0	17430.0	4800.0
Ancona	**2020**	5604.0	742.0	495.0	582.0	NaN	2739.0	NaN	7137.0	1880.0	5523.0
Arezzo	**2020**	165000.0	840.0	720.0	NaN	NaN	3150.0	NaN	12000.0	52500.0	11700.0
Ascoli Piceno	**2020**	13275.0	12112.0	379.0	4200.0	NaN	24164.0	NaN	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	4700.0	390.0	680.0	71100.0	NaN	1100.0	NaN	12000.0	520.0	980.0
Verona	**2020**	2408690.0	9145.0	111580.0	231850.0	NaN	69135.0	NaN	113725.0	398869.0	27190.0
Vibo Valentia	**2020**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2020**	36750.0	425.0	17760.0	2930.0	NaN	352.0	NaN	1410.0	3380.0	1500.0
Viterbo	**2020**	20500.0	1980.0	7600.0	79000.0	NaN	265.0	NaN	17900.0	420.0	1440.0

107 rows × 10 columns

	Type_crop	**apple**	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**
City	**Year**										
Agrigento	**2020**	NaN	57950.0	3830.0	NaN	19758.0	19798.0	1026000.0	480750.0	NaN	6095.0
Alessandria	**2020**	24000.0	7600.0	3840.0	720.0	NaN	120.0	NaN	41600.0	17430.0	4800.0
Ancona	**2020**	5604.0	742.0	495.0	582.0	NaN	2739.0	NaN	7137.0	1880.0	5523.0
Arezzo	**2020**	165000.0	840.0	720.0	NaN	NaN	3150.0	NaN	12000.0	52500.0	11700.0
Ascoli Piceno	**2020**	13275.0	12112.0	379.0	4200.0	NaN	24164.0	NaN	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	4700.0	390.0	680.0	71100.0	NaN	1100.0	NaN	12000.0	520.0	980.0
Verona	**2020**	2408690.0	9145.0	111580.0	231850.0	NaN	69135.0	NaN	113725.0	398869.0	27190.0
Vibo Valentia	**2020**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2020**	36750.0	425.0	17760.0	2930.0	NaN	352.0	NaN	1410.0	3380.0	1500.0
Viterbo	**2020**	20500.0	1980.0	7600.0	79000.0	NaN	265.0	NaN	17900.0	420.0	1440.0

107 rows × 10 columns

	Type_crop	**apple**	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**
City	**Year**										
Agrigento	**2020**	0.0	57950.0	3830.0	0.0	19758.0	19798.0	1026000.0	480750.0	0.0	6095.0
Alessandria	**2020**	24000.0	7600.0	3840.0	720.0	0.0	120.0	0.0	41600.0	17430.0	4800.0
Ancona	**2020**	5604.0	742.0	495.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
Arezzo	**2020**	165000.0	840.0	720.0	0.0	0.0	3150.0	0.0	12000.0	52500.0	11700.0
Ascoli Piceno	**2020**	13275.0	12112.0	379.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	4700.0	390.0	680.0	71100.0	0.0	1100.0	0.0	12000.0	520.0	980.0
Verona	**2020**	2408690.0	9145.0	111580.0	231850.0	0.0	69135.0	0.0	113725.0	398869.0	27190.0
Vibo Valentia	**2020**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2020**	36750.0	425.0	17760.0	2930.0	0.0	352.0	0.0	1410.0	3380.0	1500.0
Viterbo	**2020**	20500.0	1980.0	7600.0	79000.0	0.0	265.0	0.0	17900.0	420.0	1440.0

107 rows × 10 columns

		apple	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**
City	**Year**										
Agrigento	**2020**	0.0	57950.0	3830.0	0.0	19758.0	19798.0	1026000.0	480750.0	0.0	6095.0
Alessandria	**2020**	24000.0	7600.0	3840.0	720.0	0.0	120.0	0.0	41600.0	17430.0	4800.0
Ancona	**2020**	5604.0	742.0	495.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
Arezzo	**2020**	165000.0	840.0	720.0	0.0	0.0	3150.0	0.0	12000.0	52500.0	11700.0
Ascoli Piceno	**2020**	13275.0	12112.0	379.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	4700.0	390.0	680.0	71100.0	0.0	1100.0	0.0	12000.0	520.0	980.0
Verona	**2020**	2408690.0	9145.0	111580.0	231850.0	0.0	69135.0	0.0	113725.0	398869.0	27190.0
Vibo Valentia	**2020**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2020**	36750.0	425.0	17760.0	2930.0	0.0	352.0	0.0	1410.0	3380.0	1500.0
Viterbo	**2020**	20500.0	1980.0	7600.0	79000.0	0.0	265.0	0.0	17900.0	420.0	1440.0

107 rows × 10 columns

	City	Year	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum
0	Agrigento	2020	0.0	57950.0	3830.0	0.0	19758.0	19798.0	1026000.0	480750.0	0.0	6095.0
1	Alessandria	2020	24000.0	7600.0	3840.0	720.0	0.0	120.0	0.0	41600.0	17430.0	4800.0
2	Ancona	2020	5604.0	742.0	495.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
3	Arezzo	2020	165000.0	840.0	720.0	0.0	0.0	3150.0	0.0	12000.0	52500.0	11700.0
4	Ascoli Piceno	2020	13275.0	12112.0	379.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	...	...	...	...	...	...	...	...	...	...	...	...
102	Vercelli	2020	4700.0	390.0	680.0	71100.0	0.0	1100.0	0.0	12000.0	520.0	980.0
103	Verona	2020	2408690.0	9145.0	111580.0	231850.0	0.0	69135.0	0.0	113725.0	398869.0	27190.0
104	Vibo Valentia	2020	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
105	Vicenza	2020	36750.0	425.0	17760.0	2930.0	0.0	352.0	0.0	1410.0	3380.0	1500.0
106	Viterbo	2020	20500.0	1980.0	7600.0	79000.0	0.0	265.0	0.0	17900.0	420.0	1440.0

107 rows × 12 columns

Select fruits 2021

	City	Type_crop	Year	Total_production
24	Perugia	nectarine	2021	2000
29	Lucca	plum	2021	2100
46	Lecce	kiwi	2021	1200
64	Modena	peach	2021	18125
70	Campobasso	kiwi	2021	3150
...	...	...	...	...
14790	Trento	cherry in complex	2021	20000
14802	Bolzano / Bozen	plum	2021	600
14814	Trento	plum	2021	2200
14826	Bolzano / Bozen	kiwi	2021	1000
14838	Trento	kiwi	2021	10000

834 rows × 4 columns

Create new column for each selected crop produced

											Total_production
	Type_crop	**apple**	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**
City	**Year**										
Agrigento	**2021**	16610.0	58800.0	3930.0	NaN	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0
Alessandria	**2021**	21600.0	1520.0	632.0	360.0	NaN	110.0	NaN	38400.0	14940.0	1025.0
Ancona	**2021**	5604.0	742.0	0.0	582.0	NaN	2739.0	NaN	7137.0	1880.0	5523.0

Arezzo	**2021**	65000.0	140.0	200.0	120.0	NaN	2500.0	NaN	10050.0	21000.0	1080.0
Ascoli Piceno	**2021**	13275.0	12112.0	0.0	4200.0	NaN	24164.0	NaN	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	10100.0	60.0	200.0	75600.0	NaN	450.0	NaN	5300.0	360.0	189.0
Verona	**2021**	1413000.0	6335.0	74990.0	111520.0	NaN	15190.0	NaN	22595.0	61240.0	11420.0
Vibo Valentia	**2021**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2021**	22880.0	200.0	12560.0	1510.0	NaN	92.0	NaN	502.0	370.0	765.0
Viterbo	**2021**	20100.0	2200.0	7900.0	77000.0	NaN	190.0	NaN	14500.0	405.0	1410.0

107 rows × 10 columns

	Type_crop	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum
City	**Year**										
Agrigento	**2021**	16610.0	58800.0	3930.0	NaN	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0
Alessandria	**2021**	21600.0	1520.0	632.0	360.0	NaN	110.0	NaN	38400.0	14940.0	1025.0
Ancona	**2021**	5604.0	742.0	0.0	582.0	NaN	2739.0	NaN	7137.0	1880.0	5523.0
Arezzo	**2021**	65000.0	140.0	200.0	120.0	NaN	2500.0	NaN	10050.0	21000.0	1080.0
Ascoli Piceno	**2021**	13275.0	12112.0	0.0	4200.0	NaN	24164.0	NaN	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	10100.0	60.0	200.0	75600.0	NaN	450.0	NaN	5300.0	360.0	189.0
Verona	**2021**	1413000.0	6335.0	74990.0	111520.0	NaN	15190.0	NaN	22595.0	61240.0	11420.0
Vibo Valentia	**2021**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2021**	22880.0	200.0	12560.0	1510.0	NaN	92.0	NaN	502.0	370.0	765.0
Viterbo	**2021**	20100.0	2200.0	7900.0	77000.0	NaN	190.0	NaN	14500.0	405.0	1410.0

107 rows × 10 columns

	Type_crop	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum
City	**Year**										
Agrigento	**2021**	16610.0	58800.0	3930.0	0.0	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0
Alessandria	**2021**	21600.0	1520.0	632.0	360.0	0.0	110.0	0.0	38400.0	14940.0	1025.0
Ancona	**2021**	5604.0	742.0	0.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
Arezzo	**2021**	65000.0	140.0	200.0	120.0	0.0	2500.0	0.0	10050.0	21000.0	1080.0
Ascoli Piceno	**2021**	13275.0	12112.0	0.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	10100.0	60.0	200.0	75600.0	0.0	450.0	0.0	5300.0	360.0	189.0
Verona	**2021**	1413000.0	6335.0	74990.0	111520.0	0.0	15190.0	0.0	22595.0	61240.0	11420.0
Vibo Valentia	**2021**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2021**	22880.0	200.0	12560.0	1510.0	0.0	92.0	0.0	502.0	370.0	765.0
Viterbo	**2021**	20100.0	2200.0	7900.0	77000.0	0.0	190.0	0.0	14500.0	405.0	1410.0

107 rows × 10 columns

		apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum
City	**Year**										
Agrigento	**2021**	16610.0	58800.0	3930.0	0.0	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0
Alessandria	**2021**	21600.0	1520.0	632.0	360.0	0.0	110.0	0.0	38400.0	14940.0	1025.0
Ancona	**2021**	5604.0	742.0	0.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
Arezzo	**2021**	65000.0	140.0	200.0	120.0	0.0	2500.0	0.0	10050.0	21000.0	1080.0
Ascoli Piceno	**2021**	13275.0	12112.0	0.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	10100.0	60.0	200.0	75600.0	0.0	450.0	0.0	5300.0	360.0	189.0
Verona	**2021**	1413000.0	6335.0	74990.0	111520.0	0.0	15190.0	0.0	22595.0	61240.0	11420.0
Vibo Valentia	**2021**	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
Vicenza	**2021**	22880.0	200.0	12560.0	1510.0	0.0	92.0	0.0	502.0	370.0	765.0
Viterbo	**2021**	20100.0	2200.0	7900.0	77000.0	0.0	190.0	0.0	14500.0	405.0	1410.0

107 rows × 10 columns

	City	Year	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum
0	Agrigento	2021	16610.0	58800.0	3930.0	0.0	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0
1	Alessandria	2021	21600.0	1520.0	632.0	360.0	0.0	110.0	0.0	38400.0	14940.0	1025.0
2	Ancona	2021	5604.0	742.0	0.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0
3	Arezzo	2021	65000.0	140.0	200.0	120.0	0.0	2500.0	0.0	10050.0	21000.0	1080.0
4	Ascoli Piceno	2021	13275.0	12112.0	0.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0
...	...	...	...	...	...	...	...	...	...	...	...	...
102	Vercelli	2021	10100.0	60.0	200.0	75600.0	0.0	450.0	0.0	5300.0	360.0	189.0
103	Verona	2021	1413000.0	6335.0	74990.0	111520.0	0.0	15190.0	0.0	22595.0	61240.0	11420.0
104	Vibo Valentia	2021	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0
105	Vicenza	2021	22880.0	200.0	12560.0	1510.0	0.0	92.0	0.0	502.0	370.0	765.0
106	Viterbo	2021	20100.0	2200.0	7900.0	77000.0	0.0	190.0	0.0	14500.0	405.0	1410.0

107 rows × 12 columns

Pre-processing fertilizer dataset

	ITTER107	Territory	TIPO_DATO5	Data type	FERTILIZZANTI	Type of fertilizer	TIME	Select time	Value	Flag Codes	Flags
0	ITD59	Rimini	FERT_DISTRIB_T	fertilizers distributed - tonnes	CON_MIN_MICRO	containing micronutrients	2019	2019	11	NaN	NaN
1	ITD59	Rimini	FERT_DISTRIB_T	fertilizers distributed - tonnes	CON_MIN_MICRO	containing micronutrients	2020	2020	11	NaN	NaN
2	ITD59	Rimini	FERT_DISTRIB_T	fertilizers distributed - tonnes	CON_MIN_MICRO	containing micronutrients	2021	2021	3	NaN	NaN
3	ITD44	Trieste	FERT_DISTRIB_T	fertilizers distributed - tonnes	AMM_TORB_COMP	peaty soil amendment	2019	2019	8	NaN	NaN
4	ITD44	Trieste	FERT_DISTRIB_T	fertilizers distributed - tonnes	AMM_TORB_COMP	peaty soil amendment	2020	2020	105	NaN	NaN

	Territory	Data type	Type of fertilizer	Select time	Value
0	Rimini	fertilizers distributed - tonnes	containing micronutrients	2019	11
1	Rimini	fertilizers distributed - tonnes	containing micronutrients	2020	11
2	Rimini	fertilizers distributed - tonnes	containing micronutrients	2021	3
3	Trieste	fertilizers distributed - tonnes	peaty soil amendment	2019	8
4	Trieste	fertilizers distributed - tonnes	peaty soil amendment	2020	105
...	...	...	...	...	...
17670	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2020	422
17671	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2021	543
17672	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2019	164
17673	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2020	135
17674	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2021	193

17675 rows × 5 columns

	City	Data_type	Type_fertilizer	Year	Fertilizers_tonnes
0	Rimini	fertilizers distributed - tonnes	containing micronutrients	2019	11
1	Rimini	fertilizers distributed - tonnes	containing micronutrients	2020	11
2	Rimini	fertilizers distributed - tonnes	containing micronutrients	2021	3
3	Trieste	fertilizers distributed - tonnes	peaty soil amendment	2019	8
4	Trieste	fertilizers distributed - tonnes	peaty soil amendment	2020	105
...	...	...	...	...	...
17670	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2020	422
17671	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2021	543
17672	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2019	164
17673	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2020	135
17674	Sud Sardegna	fertilizers distributed - tonnes	specific action products -	2021	193

17675 rows × 5 columns

	City	Type_fertilizer	Year	Fertilizers_tonnes
0	Rimini	containing micronutrients	2019	11
1	Rimini	containing micronutrients	2020	11
2	Rimini	containing micronutrients	2021	3
3	Trieste	peaty soil amendment	2019	8
4	Trieste	peaty soil amendment	2020	105
...	...	...	...	...
17670	Sud Sardegna	specific action products -	2020	422
17671	Sud Sardegna	specific action products -	2021	543
17672	Sud Sardegna	specific action products -	2019	164
17673	Sud Sardegna	specific action products -	2020	135
17674	Sud Sardegna	specific action products -	2021	193

17675 rows × 4 columns

Select fertilizers 2020

	City	Type_fertilizer	Year	Fertilizers_tonnes
1	Rimini	containing micronutrients	2020	11
4	Trieste	peaty soil amendment	2020	105
7	Pisa	specific action products	2020	27
10	Pordenone	three components - nitrogen-phosphorous-phosph...	2020	8547
13	Venezia	soil correctives - sulphur for agricultural use	2020	5
...	...	...	...	...
17661	Sud Sardegna	soil correctives - other soil correctives	2020	2
17664	Sud Sardegna	crop substrates	2020	112
17667	Sud Sardegna	specific action products	2020	557
17670	Sud Sardegna	specific action products -	2020	422
17673	Sud Sardegna	specific action products -	2020	135

5892 rows × 4 columns

	City	Type_fertilizer	Year	Fertilizers_tonnes
76	Pavia	ammonium sulphate	2020	747
154	Benevento	calcium cyanamide	2020	0
166	Treviso	ammonium sulphate	2020	1423
172	Provincia Autonoma Bolzano / Bozen	nitrogen fertilizers	2020	31
235	Alessandria	organic fertilizers	2020	2251

		Fertilizers_tonnes					
	Type_fertilizer	**ammonium sulphate**	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2020**	155	12	1715	4006	142	16
Alessandria	**2020**	135	105	20968	2251	782	743
Ancona	**2020**	567	17	22511	2695	1258	33
Arezzo	**2020**	68	26	3675	2053	72	209
Ascoli Piceno	**2020**	8	158	1065	1284	22	267
...	**...**	...	...	...	...	...	...
Vercelli	**2020**	14	2570	7604	6585	0	1013
Verona	**2020**	3919	258	66460	9529	9363	6141
Vibo Valentia	**2020**	1433	0	2487	92	157	0
Vicenza	**2020**	1350	225	10182	1252	220	351
Viterbo	**2020**	176	0	14138	2673	603	10

108 rows × 6 columns

	Type_fertilizer	**ammonium sulphate**	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2020**	155	12	1715	4006	142	16
Alessandria	**2020**	135	105	20968	2251	782	743
Ancona	**2020**	567	17	22511	2695	1258	33
Arezzo	**2020**	68	26	3675	2053	72	209
Ascoli Piceno	**2020**	8	158	1065	1284	22	267
...	**...**	...	...	...	...	...	...
Vercelli	**2020**	14	2570	7604	6585	0	1013
Verona	**2020**	3919	258	66460	9529	9363	6141
Vibo Valentia	**2020**	1433	0	2487	92	157	0
Vicenza	**2020**	1350	225	10182	1252	220	351
Viterbo	**2020**	176	0	14138	2673	603	10

108 rows × 6 columns

		ammonium sulphate	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2020**	155	12	1715	4006	142	16
Alessandria	**2020**	135	105	20968	2251	782	743
Ancona	**2020**	567	17	22511	2695	1258	33
Arezzo	**2020**	68	26	3675	2053	72	209
Ascoli Piceno	**2020**	8	158	1065	1284	22	267
...	**...**	...	...	...	...	...	...
Vercelli	**2020**	14	2570	7604	6585	0	1013
Verona	**2020**	3919	258	66460	9529	9363	6141
Vibo Valentia	**2020**	1433	0	2487	92	157	0
Vicenza	**2020**	1350	225	10182	1252	220	351
Viterbo	**2020**	176	0	14138	2673	603	10

108 rows × 6 columns

	City	Year	ammonium sulphate	calcium cyanamide	nitrogen fertilizers	organic fertilizers	phosphorus fertilizers	potassium fertilizers
0	Agrigento	2020	155	12	1715	4006	142	16
1	Alessandria	2020	135	105	20968	2251	782	743
2	Ancona	2020	567	17	22511	2695	1258	33
3	Arezzo	2020	68	26	3675	2053	72	209
4	Ascoli Piceno	2020	8	158	1065	1284	22	267
...	...	...	...	...	...	...	...	...
103	Vercelli	2020	14	2570	7604	6585	0	1013
104	Verona	2020	3919	258	66460	9529	9363	6141
105	Vibo Valentia	2020	1433	0	2487	92	157	0
106	Vicenza	2020	1350	225	10182	1252	220	351
107	Viterbo	2020	176	0	14138	2673	603	10

108 rows × 8 columns

	City	Year	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum	ammonium sulphate	calcium cyanamide	nit ferti
0	Agrigento	2020	0.0	57950.0	3830.0	0.0	19758.0	19798.0	1026000.0	480750.0	0.0	6095.0	155.0	12.0	1
1	Alessandria	2020	24000.0	7600.0	3840.0	720.0	0.0	120.0	0.0	41600.0	17430.0	4800.0	135.0	105.0	20
2	Ancona	2020	5604.0	742.0	495.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0	567.0	17.0	22
3	Arezzo	2020	165000.0	840.0	720.0	0.0	0.0	3150.0	0.0	12000.0	52500.0	11700.0	68.0	26.0	3
4	Ascoli Piceno	2020	13275.0	12112.0	379.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0	8.0	158.0	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
102	Vercelli	2020	4700.0	390.0	680.0	71100.0	0.0	1100.0	0.0	12000.0	520.0	980.0	14.0	2570.0	7
103	Verona	2020	2408690.0	9145.0	111580.0	231850.0	0.0	69135.0	0.0	113725.0	398869.0	27190.0	3919.0	258.0	66
104	Vibo Valentia	2020	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0	1433.0	0.0	2
105	Vicenza	2020	36750.0	425.0	17760.0	2930.0	0.0	352.0	0.0	1410.0	3380.0	1500.0	1350.0	225.0	10
106	Viterbo	2020	20500.0	1980.0	7600.0	79000.0	0.0	265.0	0.0	17900.0	420.0	1440.0	176.0	0.0	14

107 rows × 18 columns

Select fertilizers 2021

	City	Type_fertilizer	Year	Fertilizers_tonnes
2	Rimini	containing micronutrients	2021	3
5	Trieste	peaty soil amendment	2021	0
8	Pisa	specific action products	2021	33
11	Pordenone	three components - nitrogen-phosphorous-phosph...	2021	8286
14	Venezia	soil correctives - sulphur for agricultural use	2021	95
...	...	...	...	...
17662	Sud Sardegna	soil correctives - other soil correctives	2021	4
17665	Sud Sardegna	crop substrates	2021	40
17668	Sud Sardegna	specific action products	2021	736
17671	Sud Sardegna	specific action products -	2021	543
17674	Sud Sardegna	specific action products -	2021	193

5892 rows × 4 columns

	City	Type_fertilizer	Year	Fertilizers_tonnes
77	Pavia	ammonium sulphate	2021	2504
155	Benevento	calcium cyanamide	2021	0
167	Treviso	ammonium sulphate	2021	1541
173	Provincia Autonoma Bolzano / Bozen	nitrogen fertilizers	2021	28
236	Alessandria	organic fertilizers	2021	3930

		Fertilizers_tonnes					
	Type_fertilizer	**ammonium sulphate**	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2021**	738	12	4592	3668	1075	36
Alessandria	**2021**	151	105	21951	3930	900	713

Ancona	**2021**	954	17	14630	2500	1809	43
Arezzo	**2021**	32	27	2414	2174	71	8
Ascoli Piceno	**2021**	3	158	1610	1211	8	46
...	**...**	...	...	...	...	...	...
Vercelli	**2021**	5	2571	8929	8312	225	1014
Verona	**2021**	7632	258	59389	10023	12968	10878
Vibo Valentia	**2021**	518	0	1498	61	185	0
Vicenza	**2021**	1784	226	6690	1634	1100	382
Viterbo	**2021**	152	0	11245	2199	587	11

108 rows × 6 columns

	Type_fertilizer	**ammonium sulphate**	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2021**	738	12	4592	3668	1075	36
Alessandria	**2021**	151	105	21951	3930	900	713
Ancona	**2021**	954	17	14630	2500	1809	43
Arezzo	**2021**	32	27	2414	2174	71	8
Ascoli Piceno	**2021**	3	158	1610	1211	8	46
...	**...**	...	...	...	...	...	...
Vercelli	**2021**	5	2571	8929	8312	225	1014
Verona	**2021**	7632	258	59389	10023	12968	10878
Vibo Valentia	**2021**	518	0	1498	61	185	0
Vicenza	**2021**	1784	226	6690	1634	1100	382
Viterbo	**2021**	152	0	11245	2199	587	11

108 rows × 6 columns

		ammonium sulphate	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
City	**Year**						
Agrigento	**2021**	738	12	4592	3668	1075	36
Alessandria	**2021**	151	105	21951	3930	900	713
Ancona	**2021**	954	17	14630	2500	1809	43
Arezzo	**2021**	32	27	2414	2174	71	8
Ascoli Piceno	**2021**	3	158	1610	1211	8	46
...	**...**	...	...	...	...	...	...
Vercelli	**2021**	5	2571	8929	8312	225	1014
Verona	**2021**	7632	258	59389	10023	12968	10878
Vibo Valentia	**2021**	518	0	1498	61	185	0
Vicenza	**2021**	1784	226	6690	1634	1100	382
Viterbo	**2021**	152	0	11245	2199	587	11

108 rows × 6 columns

	City	**Year**	**ammonium sulphate**	**calcium cyanamide**	**nitrogen fertilizers**	**organic fertilizers**	**phosphorus fertilizers**	**potassium fertilizers**
0	Agrigento	2021	738	12	4592	3668	1075	36
1	Alessandria	2021	151	105	21951	3930	900	713
2	Ancona	2021	954	17	14630	2500	1809	43
3	Arezzo	2021	32	27	2414	2174	71	8
4	Ascoli Piceno	2021	3	158	1610	1211	8	46
...	...	...	...	...	...	...	...	...
103	Vercelli	2021	5	2571	8929	8312	225	1014
104	Verona	2021	7632	258	59389	10023	12968	10878
105	Vibo Valentia	2021	518	0	1498	61	185	0
106	Vicenza	2021	1784	226	6690	1634	1100	382
107	Viterbo	2021	152	0	11245	2199	587	11

108 rows × 8 columns

	City	**Year**	**apple**	**apricot**	**cherry in complex**	**kiwi**	**lemon**	**nectarine**	**orange**	**peach**	**pear**	**plum**	**ammonium sulphate**	**calcium cyanamide**	**nitro fertili**
0	Agrigento	2021	16610.0	58800.0	3930.0	0.0	19610.0	17414.0	970100.0	412650.0	264300.0	5800.0	738.0	12.0	45
1	Alessandria	2021	21600.0	1520.0	632.0	360.0	0.0	110.0	0.0	38400.0	14940.0	1025.0	151.0	105.0	219
2	Ancona	2021	5604.0	742.0	0.0	582.0	0.0	2739.0	0.0	7137.0	1880.0	5523.0	954.0	17.0	146
3	Arezzo	2021	65000.0	140.0	200.0	120.0	0.0	2500.0	0.0	10050.0	21000.0	1080.0	32.0	27.0	24
4	Ascoli Piceno	2021	13275.0	12112.0	0.0	4200.0	0.0	24164.0	0.0	33034.0	4273.0	15528.0	3.0	158.0	16
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
102	Vercelli	2021	10100.0	60.0	200.0	75600.0	0.0	450.0	0.0	5300.0	360.0	189.0	5.0	2571.0	89
103	Verona	2021	1413000.0	6335.0	74990.0	111520.0	0.0	15190.0	0.0	22595.0	61240.0	11420.0	7632.0	258.0	593
104	Vibo Valentia	2021	1960.0	1200.0	5000.0	14685.0	3900.0	1440.0	211548.0	8100.0	3404.0	558.0	518.0	0.0	14
105	Vicenza	2021	22880.0	200.0	12560.0	1510.0	0.0	92.0	0.0	502.0	370.0	765.0	1784.0	226.0	66
106	Viterbo	2021	20100.0	2200.0	7900.0	77000.0	0.0	190.0	0.0	14500.0	405.0	1410.0	152.0	0.0	112

107 rows × 18 columns

Correlation 2020

```
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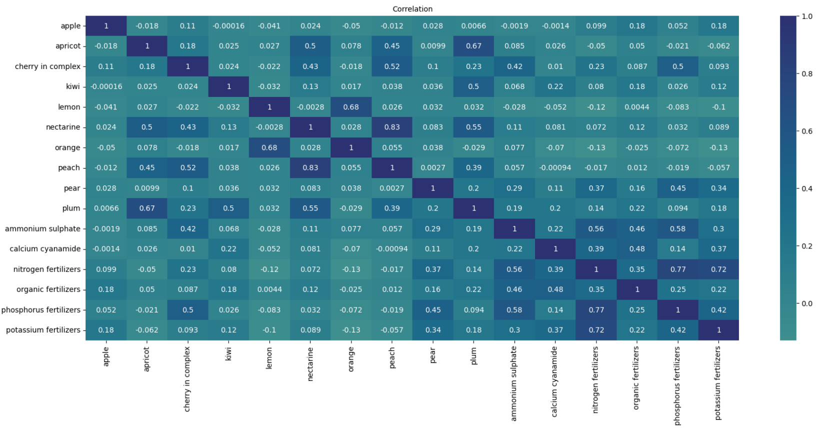

	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum	ammonium sulphate	calcium cyanamide	nitrogen fertilizers	organic fertilizers	phosphorus fertilizers	potassium fertilizers
apple	1	-0.018	0.11	-0.00016	-0.041	0.024	-0.05	-0.012	0.028	0.0066	-0.0019	-0.0014	0.099	0.18	0.052	0.18
apricot	-0.018	1	0.18	0.025	0.027	0.5	0.078	0.45	0.0099	0.67	0.085	0.026	-0.05	0.05	-0.021	-0.062
cherry in complex	0.11	0.18	1	0.024	-0.022	0.43	-0.018	0.52	0.1	0.23	0.42	0.01	0.23	0.087	0.5	0.093
kiwi	-0.00016	0.025	0.024	1	-0.032	0.13	0.017	0.038	0.036	0.5	0.068	0.22	0.08	0.18	0.026	0.12
lemon	-0.041	0.027	-0.022	-0.032	1	-0.0028	0.68	0.026	0.032	0.032	-0.028	-0.052	-0.12	0.0044	-0.083	-0.1
nectarine	0.024	0.5	0.43	0.13	-0.0028	1	0.028	0.83	0.083	0.55	0.11	0.081	0.072	0.12	0.032	0.089
orange	-0.05	0.078	-0.018	0.017	0.68	0.028	1	0.055	0.038	-0.029	0.077	-0.07	-0.13	-0.025	-0.072	-0.13
peach	-0.012	0.45	0.52	0.038	0.026	0.83	0.055	1	0.0027	0.39	0.057	-0.00094	-0.017	0.012	-0.019	-0.057
pear	0.028	0.0099	0.1	0.036	0.032	0.083	0.038	0.0027	1	0.2	0.29	0.11	0.37	0.16	0.45	0.34
plum	0.0066	0.67	0.23	0.5	0.032	0.55	-0.029	0.39	0.2	1	0.19	0.2	0.14	0.22	0.094	0.18
ammonium sulphate	-0.0019	0.085	0.42	0.068	-0.028	0.11	0.077	0.057	0.29	0.19	1	0.22	0.56	0.46	0.58	0.3
calcium cyanamide	-0.0014	0.026	0.01	0.22	-0.052	0.081	-0.07	-0.00094	0.11	0.2	0.22	1	0.39	0.48	0.14	0.37
nitrogen fertilizers	0.099	-0.05	0.23	0.08	-0.12	0.072	-0.13	-0.017	0.37	0.14	0.56	0.39	1	0.35	0.77	0.72
organic fertilizers	0.18	0.05	0.087	0.18	0.0044	0.12	-0.025	0.012	0.16	0.22	0.46	0.48	0.35	1	0.25	0.22
phosphorus fertilizers	0.052	-0.021	0.5	0.026	-0.083	0.032	-0.072	-0.019	0.45	0.094	0.58	0.14	0.77	0.25	1	0.42
potassium fertilizers	0.18	-0.062	0.093	0.12	-0.1	0.089	-0.13	-0.057	0.34	0.18	0.3	0.37	0.72	0.22	0.42	1

Correlation analysis of fruits production in Italy 2020

- Apple has low correlation with fertilizers and other crops.
- Apricot has hight correlation with Plum and Nectarine.
- Cherry has hight correlation phosphorus fertilizer and Peach.
- Kiwi has hight correlation with Plum.
- Lemon has hight correlation Orange.
- Peach has hight correlation with Nectarine.
- Pear has correlation with phosphorus and potassium fertilizers.
- There is also hight correlation between phosphorus and potassium with nitrogen fertilizer.

Correlation 2021

```
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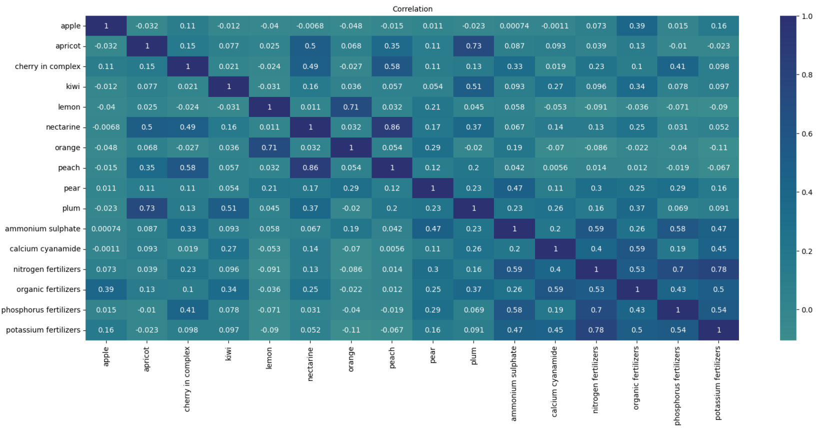

	apple	apricot	cherry in complex	kiwi	lemon	nectarine	orange	peach	pear	plum	ammonium sulphate	calcium cyanamide	nitrogen fertilizers	organic fertilizers	phosphorus fertilizers	potassium fertilizers
apple	1	-0.032	0.11	-0.012	-0.04	-0.0068	-0.048	-0.015	0.011	-0.023	0.00074	-0.0011	0.073	0.39	0.015	0.16
apricot	-0.032	1	0.15	0.077	0.025	0.5	0.068	0.35	0.11	0.73	0.087	0.093	0.039	0.13	-0.01	-0.023
cherry in complex	0.11	0.15	1	0.021	-0.024	0.49	-0.027	0.58	0.11	0.13	0.33	0.019	0.23	0.1	0.41	0.098
kiwi	-0.012	0.077	0.021	1	-0.031	0.16	0.036	0.057	0.054	0.51	0.093	0.27	0.096	0.34	0.078	0.097
lemon	-0.04	0.025	-0.024	-0.031	1	0.011	0.71	0.032	0.21	0.045	0.058	-0.053	-0.091	-0.036	-0.071	-0.09
nectarine	-0.0068	0.5	0.49	0.16	0.011	1	0.032	0.86	0.17	0.37	0.067	0.14	0.13	0.25	0.031	0.052
orange	-0.048	0.068	-0.027	0.036	0.71	0.032	1	0.054	0.29	-0.02	0.19	-0.07	-0.086	-0.022	-0.04	-0.11
peach	-0.015	0.35	0.58	0.057	0.032	0.86	0.054	1	0.12	0.2	0.042	0.0056	0.014	0.012	-0.019	-0.067
pear	0.011	0.11	0.11	0.054	0.21	0.17	0.29	0.12	1	0.23	0.47	0.11	0.3	0.25	0.29	0.16
plum	-0.023	0.73	0.13	0.51	0.045	0.37	-0.02	0.2	0.23	1	0.23	0.26	0.16	0.37	0.069	0.091
ammonium sulphate	0.00074	0.087	0.33	0.093	0.058	0.067	0.19	0.042	0.47	0.23	1	0.2	0.59	0.26	0.58	0.47
calcium cyanamide	-0.0011	0.093	0.019	0.27	-0.053	0.14	-0.07	0.0056	0.11	0.26	0.2	1	0.4	0.59	0.19	0.45
nitrogen fertilizers	0.073	0.039	0.23	0.096	-0.091	0.13	-0.086	0.014	0.3	0.16	0.59	0.4	1	0.53	0.7	0.78
organic fertilizers	0.39	0.13	0.1	0.34	-0.036	0.25	-0.022	0.012	0.25	0.37	0.26	0.59	0.53	1	0.43	0.5
phosphorus fertilizers	0.015	-0.01	0.41	0.078	-0.071	0.031	-0.04	-0.019	0.29	0.069	0.58	0.19	0.7	0.43	1	0.54
potassium fertilizers	0.16	-0.023	0.098	0.097	-0.09	0.052	-0.11	-0.067	0.16	0.091	0.47	0.45	0.78	0.5	0.54	1

Correlation analysis of fruits production in Italy 2021

- Apple has correlation with organic fertilizer.
- Apricot has hight correlation with Plum and Nectarine.
- Cherry has hight correlation with Peach and Nectarine, and correlation with phosphorus fertilizer.
- Kiwi has hight correlation with Plum.
- Lemon has hight correlation Orange.
- Peach has hight correlation with Nectarine, .
- Pear has correlation with phosphorus and potassium fertilizers.
- There is also hight correlation between phosphorus and potassium with nitrogen fertilizer.

Modelling

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