Omdena - Milan Chapter Agrifoods

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

Exploratory analysis of industrial crop 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	ITC18	Alessandria	HP_Q_EXT	harvested production - quintals	WINEES	wine grapes	2020	2020	845189	NaN	NaN
1	ITC18	Alessandria	HP_Q_EXT	harvested production - quintals	WINEES	wine grapes	2021	2021	983600	NaN	NaN
2	ITC18	Alessandria	HP_Q_EXT	harvested production - quintals	WINEES	wine grapes	2022	2022	634304	NaN	NaN
3	ITF62	Crotone	HP_Q_EXT	harvested production - quintals	WINEES	wine grapes	2020	2020	132420	NaN	NaN
4	ITF62	Crotone	HP_Q_EXT	harvested production - quintals	WINEES	wine grapes	2021	2021	105880	NaN	NaN

Pre-processing dataset

	Territory	Data type	Type of crop	Select time	Value
0	Alessandria	harvested production - quintals	wine grapes	2020	845189
1	Alessandria	harvested production - quintals	wine grapes	2021	983600
2	Alessandria	harvested production - quintals	wine grapes	2022	634304
3	Crotone	harvested production - quintals	wine grapes	2020	132420
4	Crotone	harvested production - quintals	wine grapes	2021	105880
...	...	...	...	...	...
10101	Valle d'Aosta / Vallée d'Aoste	production area - hectares	other olives	2021	1
10102	Valle d'Aosta / Vallée d'Aoste	total production - quintals	other olives	2021	40
10103	Valle d'Aosta / Vallée d'Aoste	harvested production - quintals	other olives	2021	40
10104	Milano	production area - hectares	other olives	2021	2
10105	Ferrara	total area - hectares	table olives	2021	1

10106 rows × 5 columns

```
array(['wine grapes', 'table and oil olives', 'oil olives',
       'Grapes for table use', 'olive oil', 'table olives', 'table winw',
       'wine', 'whithe wine', 'red and rosé wine',
       'registered designation of origin wine',
       'registered designation of origin white wine',
       'registered designation of origin black wine',
       'typical geographical indication wine',
       'typical geographical indication white wine',
       'typical geographical indication black wine',
       'grapes for wines with protected designation of origin (pdo)',
       'grapes for wines with protected geographical indication (pgi)',
       'grapes for other wines n.e.c. (without pdo/pgi)',
       'grapes for other purposes n.e.c.', 'grapes for raisins', 'must',
       'other olives'], dtype=object)
```

	City	Data_type	Type_crop	Year	Value
0	Alessandria	harvested production - quintals	wine grapes	2020	845189
1	Alessandria	harvested production - quintals	wine grapes	2021	983600
2	Alessandria	harvested production - quintals	wine grapes	2022	634304
3	Crotone	harvested production - quintals	wine grapes	2020	132420
4	Crotone	harvested production - quintals	wine grapes	2021	105880
...	...	...	...	...	...
10101	Valle d'Aosta / Vallée d'Aoste	production area - hectares	other olives	2021	1
10102	Valle d'Aosta / Vallée d'Aoste	total production - quintals	other olives	2021	40
10103	Valle d'Aosta / Vallée d'Aoste	harvested production - quintals	other olives	2021	40
10104	Milano	production area - hectares	other olives	2021	2
10105	Ferrara	total area - hectares	table olives	2021	1

10106 rows × 5 columns

```
array(['wine grapes', 'table olives', 'olive oil', 'Grapes for table use',
       'table winw', 'wine', 'whithe wine', 'red and rosé wine',
       'registered designation of origin wine',
       'registered designation of origin white wine',
       'registered designation of origin black wine',
       'typical geographical indication wine',
       'typical geographical indication white wine',
       'typical geographical indication black wine',
       'grapes for wines with protected designation of origin (pdo)',
       'grapes for wines with protected geographical indication (pgi)',
       'grapes for other wines n.e.c. (without pdo/pgi)',
       'grapes for other purposes n.e.c.', 'grapes for raisins', 'must',
       'other olives'], dtype=object)

DATASET SHAPE:  (10106, 5)

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FEATURE DATA TYPES:
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Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype 
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 0   City       10106 non-null  object
 1   Data_type  10106 non-null  object
 2   Type_crop  10106 non-null  object
 3   Year       10106 non-null  int64 
 4   Value      10106 non-null  int64 
dtypes: int64(2), object(3)
memory usage: 394.9+ KB
None

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NUMBER OF UNIQUE VALUES PER FEATURE:

City          106
Data_type       5
Type_crop      21
Year            3
Value        4146
dtype: int64

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NULL VALUES PER FEATURE
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Data_type    0
Type_crop    0
Year         0
Value        0
dtype: int64
```

Cities in Italy producing grapes and olives crop

Select only values for total grapes and olives crop production - quintals

	City	Data_type	Type_crop	Year	Value
6	Benevento	total production - quintals	wine grapes	2020	1017450
7	Benevento	total production - quintals	wine grapes	2021	1114000
8	Benevento	total production - quintals	wine grapes	2022	1114000
12	Vibo Valentia	total production - quintals	wine grapes	2020	12985
13	Vibo Valentia	total production - quintals	wine grapes	2021	12985

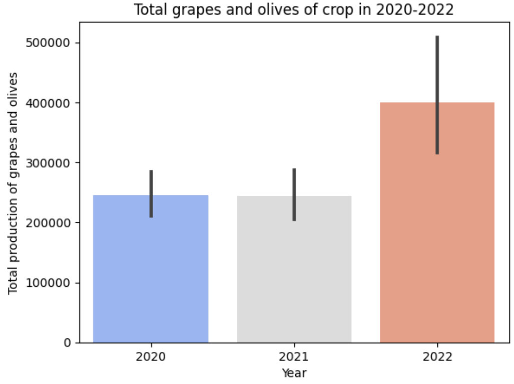
	City	Data_type	Type_crop	Year	Total_production
6	Benevento	total production - quintals	wine grapes	2020	1017450
7	Benevento	total production - quintals	wine grapes	2021	1114000
8	Benevento	total production - quintals	wine grapes	2022	1114000
12	Vibo Valentia	total production - quintals	wine grapes	2020	12985
13	Vibo Valentia	total production - quintals	wine grapes	2021	12985
...	...	...	...	...	...
10086	Trentino Alto Adige / Südtirol	total production - quintals	grapes for wines with protected geographical i...	2020	164963
10087	Trentino Alto Adige / Südtirol	total production - quintals	grapes for wines with protected geographical i...	2021	153152
10094	Trentino Alto Adige / Südtirol	total production - quintals	grapes for other wines n.e.c. (without pdo/pgi)	2020	18610
10095	Trentino Alto Adige / Südtirol	total production - quintals	grapes for other wines n.e.c. (without pdo/pgi)	2021	17865
10102	Valle d'Aosta / Vallée d'Aoste	total production - quintals	other olives	2021	40

2136 rows × 5 columns

	City	Type_crop	Year	Total_production
6	Benevento	wine grapes	2020	1017450
7	Benevento	wine grapes	2021	1114000
8	Benevento	wine grapes	2022	1114000
12	Vibo Valentia	wine grapes	2020	12985
13	Vibo Valentia	wine grapes	2021	12985
...	...	...	...	...
10086	Trentino Alto Adige / Südtirol	grapes for wines with protected geographical i...	2020	164963
10087	Trentino Alto Adige / Südtirol	grapes for wines with protected geographical i...	2021	153152
10094	Trentino Alto Adige / Südtirol	grapes for other wines n.e.c. (without pdo/pgi)	2020	18610
10095	Trentino Alto Adige / Südtirol	grapes for other wines n.e.c. (without pdo/pgi)	2021	17865
10102	Valle d'Aosta / Vallée d'Aoste	other olives	2021	40

2136 rows × 4 columns

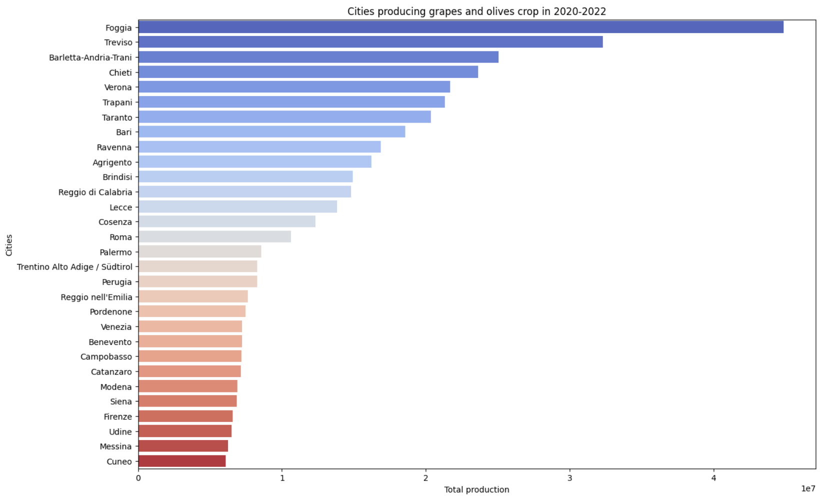
Total grapes and olives crop production in 2020-2022



Grapes and olives crop production by Cities

	City	Total_production
32	Foggia	44860760
94	Treviso	32314742
8	Barletta-Andria-Trani	25039000
22	Chieti	23620200
102	Verona	21672915
...	...	...
23	Como	10991
46	Lodi	7161
25	Cremona	6437
98	Varese	6249
55	Monza e della Brianza	582

106 rows × 2 columns



Grapes and olives production 2020-2022

```
wine grapes
table olives                                                        412
olive oil                                                           394
wine grapes                                                         318
grapes for other wines n.e.c. (without pdo/pgi)                     212
Grapes for table use                                                205
other olives                                                        199
grapes for wines with protected designation of origin (pdo)         196
grapes for wines with protected geographical indication (pgi)       186
grapes for other purposes n.e.c.                                     12
grapes for raisins                                                    2
Name: Type_crop, dtype: int64
10
```

Dataset shows there are 10 different types of grapes and olives cultivated in Italy. The top most produced crops are : Wine grapes, Table olives, Grapes for other wines, Grapes for table use ,Olive oil, Grapes for wines with protected designation of origin (pdo), Grapes for wines with protected geographical indication (pgi),Grapes for other wines n.e.c. (without pdo/pgi), Grapes for raisins, Grapes for other purposes n.e.c., Other olives,

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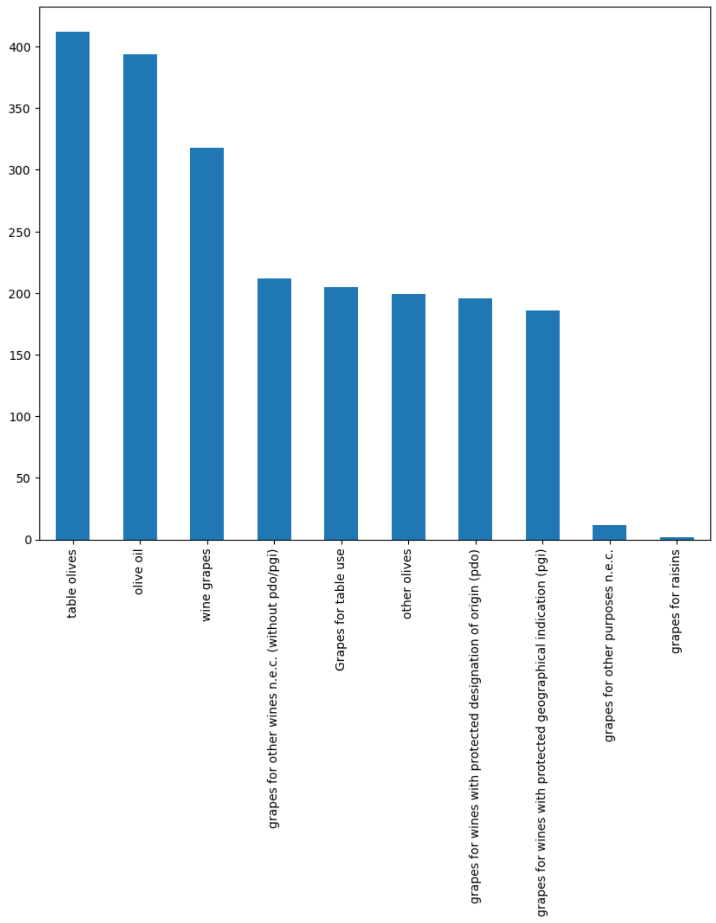
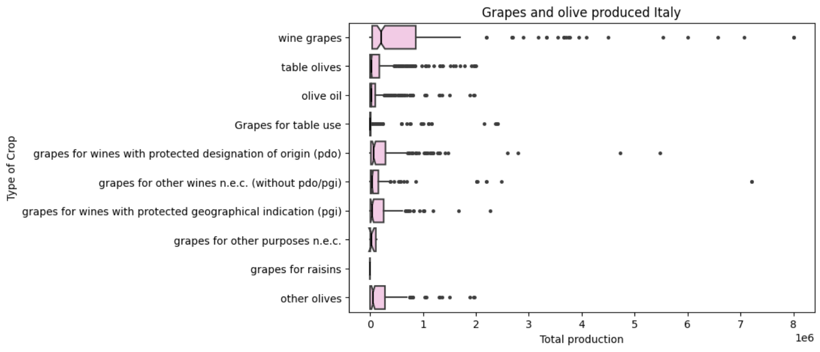


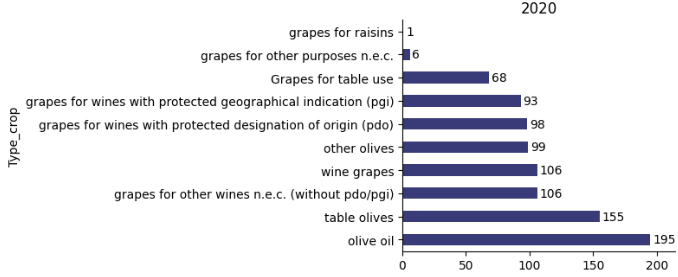
Subseting data

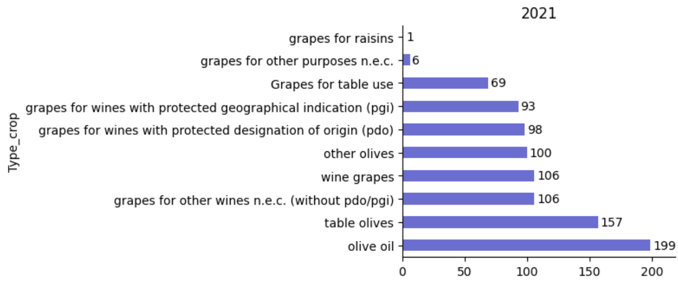
Stats

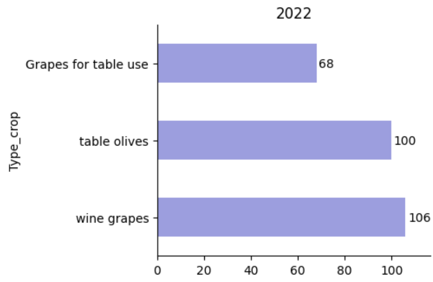
	Year	Total_production
count	2136	2136
mean	2020	264320
std	0	652511
min	2020	1
25%	2020	3200
50%	2021	39550
75%	2021	218000
max	2022	8000000

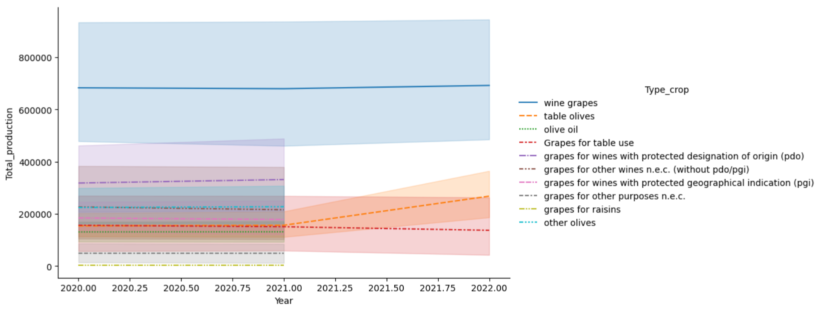


Vizualization of ten type of grapes and olives produced in Italy in the period of 2020-2022









	City	Type_crop	Year	Total_production
6	Benevento	wine grapes	2020	1017450
12	Vibo Valentia	wine grapes	2020	12985
18	Novara	wine grapes	2020	41650
30	Lecce	wine grapes	2020	643500
33	Vercelli	wine grapes	2020	15105
...	...	...	...	...
10062	Barletta-Andria-Trani	other olives	2020	1050000
10070	Sud Sardegna	other olives	2020	82202
10078	Trentino Alto Adige / Südtirol	grapes for wines with protected designation of...	2020	1480468
10086	Trentino Alto Adige / Südtirol	grapes for wines with protected geographical i...	2020	164963
10094	Trentino Alto Adige / Südtirol	grapes for other wines n.e.c. (without pdo/pgi)	2020	18610

927 rows × 4 columns

	Year	Total_production
count	927	927
mean	2020	245058
std	0	610157
min	2020	1
25%	2020	4250
50%	2020	40269
75%	2020	210278
max	2020	8000000

	City	Type_crop	Year	Total_production
7	Benevento	wine grapes	2021	1114000
13	Vibo Valentia	wine grapes	2021	12985
19	Novara	wine grapes	2021	41360
31	Lecce	wine grapes	2021	643375
34	Vercelli	wine grapes	2021	8462
...	...	...	...	...
10071	Sud Sardegna	other olives	2021	108310
10079	Trentino Alto Adige / Südtirol	grapes for wines with protected designation of...	2021	1417317
10087	Trentino Alto Adige / Südtirol	grapes for wines with protected geographical i...	2021	153152
10095	Trentino Alto Adige / Südtirol	grapes for other wines n.e.c. (without pdo/pgi)	2021	17865
10102	Valle d'Aosta / Vallée d'Aoste	other olives	2021	40

935 rows × 4 columns

	Year	Total_production
count	935	935
mean	2021	243907
std	0	625507
min	2021	1
25%	2021	2716
50%	2021	35550
75%	2021	195351
max	2021	8000000

	City	Type_crop	Year	Total_production
8	Benevento	wine grapes	2022	1114000
14	Vibo Valentia	wine grapes	2022	12985
20	Novara	wine grapes	2022	31920
32	Lecce	wine grapes	2022	750000
35	Vercelli	wine grapes	2022	9072
...	...	...	...	...
3671	Barletta-Andria-Trani	Grapes for table use	2022	1100000
3683	Sud Sardegna	Grapes for table use	2022	14146
3695	Fermo	table olives	2022	56100
3707	Barletta-Andria-Trani	table olives	2022	985000
3719	Sud Sardegna	table olives	2022	211828

274 rows × 4 columns

	Year	Total_production
count	274	274
mean	2022	399147
std	0	841087
min	2022	2
25%	2022	2962
50%	2022	47561
75%	2022	413200
max	2022	7060958

```
array(['wine grapes', 'table olives', 'Grapes for table use'],
      dtype=object)
```

Create columns for each type crop 2020

											Total_production
	Type_crop	**Grapes for table use**	**grapes for other purposes n.e.c.**	**grapes for other wines n.e.c. (without pdo/pgi)**	**grapes for raisins**	**grapes for wines with protected designation of origin (pdo)**	**grapes for wines with protected geographical indication (pgi)**	**olive oil**	**other olives**	**table olives**	**wine grapes**
City	**Year**										
Agrigento	**2020**	985000.0	120000.0	214500.0	NaN	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0
Alessandria	**2020**	950.0	NaN	41749.0	NaN	803440.0	NaN	176.0	160.0	224.0	845189.0
Ancona	**2020**	NaN	NaN	130423.0	NaN	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2020**	1440.0	NaN	35040.0	NaN	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0
Ascoli Piceno	**2020**	1041.0	NaN	287248.0	NaN	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	990.0	NaN	3330.0	NaN	11775.0	NaN	12.0	12.0	12.0	15105.0
Verona	**2020**	4500.0	NaN	871093.0	NaN	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0
Vibo Valentia	**2020**	3770.0	NaN	12446.0	NaN	NaN	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2020**	3100.0	NaN	128651.0	NaN	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0
Viterbo	**2020**	1100.0	NaN	26500.0	NaN	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0

106 rows × 10 columns

	Type_crop	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2020**	985000.0	120000.0	214500.0	NaN	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0
Alessandria	**2020**	950.0	NaN	41749.0	NaN	803440.0	NaN	176.0	160.0	224.0	845189.0
Ancona	**2020**	NaN	NaN	130423.0	NaN	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2020**	1440.0	NaN	35040.0	NaN	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0
Ascoli Piceno	**2020**	1041.0	NaN	287248.0	NaN	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	990.0	NaN	3330.0	NaN	11775.0	NaN	12.0	12.0	12.0	15105.0
Verona	**2020**	4500.0	NaN	871093.0	NaN	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0
Vibo Valentia	**2020**	3770.0	NaN	12446.0	NaN	NaN	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2020**	3100.0	NaN	128651.0	NaN	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0
Viterbo	**2020**	1100.0	NaN	26500.0	NaN	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0

106 rows × 10 columns

	Type_crop	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2020**	985000.0	120000.0	214500.0	0.0	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0
Alessandria	**2020**	950.0	0.0	41749.0	0.0	803440.0	0.0	176.0	160.0	224.0	845189.0
Ancona	**2020**	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2020**	1440.0	0.0	35040.0	0.0	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0
Ascoli Piceno	**2020**	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	990.0	0.0	3330.0	0.0	11775.0	0.0	12.0	12.0	12.0	15105.0
Verona	**2020**	4500.0	0.0	871093.0	0.0	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0
Vibo Valentia	**2020**	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2020**	3100.0	0.0	128651.0	0.0	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0
Viterbo	**2020**	1100.0	0.0	26500.0	0.0	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0

106 rows × 10 columns

		Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2020**	985000.0	120000.0	214500.0	0.0	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0
Alessandria	**2020**	950.0	0.0	41749.0	0.0	803440.0	0.0	176.0	160.0	224.0	845189.0
Ancona	**2020**	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2020**	1440.0	0.0	35040.0	0.0	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0
Ascoli Piceno	**2020**	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2020**	990.0	0.0	3330.0	0.0	11775.0	0.0	12.0	12.0	12.0	15105.0
Verona	**2020**	4500.0	0.0	871093.0	0.0	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0
Vibo Valentia	**2020**	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2020**	3100.0	0.0	128651.0	0.0	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0
Viterbo	**2020**	1100.0	0.0	26500.0	0.0	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0

106 rows × 10 columns

	City	Year	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
0	Agrigento	2020	985000.0	120000.0	214500.0	0.0	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0
1	Alessandria	2020	950.0	0.0	41749.0	0.0	803440.0	0.0	176.0	160.0	224.0	845189.0
2	Ancona	2020	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
3	Arezzo	2020	1440.0	0.0	35040.0	0.0	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0
4	Ascoli Piceno	2020	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	...	...	...	...	...	...	...	...	...	...	...	...
101	Vercelli	2020	990.0	0.0	3330.0	0.0	11775.0	0.0	12.0	12.0	12.0	15105.0
102	Verona	2020	4500.0	0.0	871093.0	0.0	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0
103	Vibo Valentia	2020	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
104	Vicenza	2020	3100.0	0.0	128651.0	0.0	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0
105	Viterbo	2020	1100.0	0.0	26500.0	0.0	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0

106 rows × 12 columns

Create columns for each type crop 2021

											Total_production
	Type_crop	**Grapes for table use**	**grapes for other purposes n.e.c.**	**grapes for other wines n.e.c. (without pdo/pgi)**	**grapes for raisins**	**grapes for wines with protected designation of origin (pdo)**	**grapes for wines with protected geographical indication (pgi)**	**olive oil**	**other olives**	**table olives**	**wine grapes**
City	**Year**										
Agrigento	**2021**	968704.0	117600.0	217070.0	NaN	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0
Alessandria	**2021**	1316.0	NaN	69300.0	NaN	914376.0	NaN	308.0	280.0	344.0	983676.0
Ancona	**2021**	NaN	NaN	130423.0	NaN	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2021**	1320.0	NaN	6069.0	NaN	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0
Ascoli Piceno	**2021**	1041.0	NaN	287248.0	NaN	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	8688.0	NaN	1062.0	NaN	7400.0	NaN	11.0	10.0	10.0	8462.0
Verona	**2021**	5250.0	NaN	328375.0	NaN	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0
Vibo Valentia	**2021**	3770.0	NaN	12446.0	NaN	NaN	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2021**	2250.0	NaN	30321.0	NaN	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0
Viterbo	**2021**	1010.0	NaN	27980.0	NaN	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0

106 rows × 10 columns

	Type_crop	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2021**	968704.0	117600.0	217070.0	NaN	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0
Alessandria	**2021**	1316.0	NaN	69300.0	NaN	914376.0	NaN	308.0	280.0	344.0	983676.0
Ancona	**2021**	NaN	NaN	130423.0	NaN	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2021**	1320.0	NaN	6069.0	NaN	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0
Ascoli Piceno	**2021**	1041.0	NaN	287248.0	NaN	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	8688.0	NaN	1062.0	NaN	7400.0	NaN	11.0	10.0	10.0	8462.0
Verona	**2021**	5250.0	NaN	328375.0	NaN	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0
Vibo Valentia	**2021**	3770.0	NaN	12446.0	NaN	NaN	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2021**	2250.0	NaN	30321.0	NaN	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0
Viterbo	**2021**	1010.0	NaN	27980.0	NaN	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0

106 rows × 10 columns

	Type_crop	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2021**	968704.0	117600.0	217070.0	0.0	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0
Alessandria	**2021**	1316.0	0.0	69300.0	0.0	914376.0	0.0	308.0	280.0	344.0	983676.0
Ancona	**2021**	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2021**	1320.0	0.0	6069.0	0.0	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0
Ascoli Piceno	**2021**	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	8688.0	0.0	1062.0	0.0	7400.0	0.0	11.0	10.0	10.0	8462.0
Verona	**2021**	5250.0	0.0	328375.0	0.0	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0
Vibo Valentia	**2021**	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2021**	2250.0	0.0	30321.0	0.0	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0
Viterbo	**2021**	1010.0	0.0	27980.0	0.0	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0

106 rows × 10 columns

		Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
City	**Year**										
Agrigento	**2021**	968704.0	117600.0	217070.0	0.0	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0
Alessandria	**2021**	1316.0	0.0	69300.0	0.0	914376.0	0.0	308.0	280.0	344.0	983676.0
Ancona	**2021**	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
Arezzo	**2021**	1320.0	0.0	6069.0	0.0	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0
Ascoli Piceno	**2021**	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	**...**	...	...	...	...	...	...	...	...	...	...
Vercelli	**2021**	8688.0	0.0	1062.0	0.0	7400.0	0.0	11.0	10.0	10.0	8462.0
Verona	**2021**	5250.0	0.0	328375.0	0.0	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0
Vibo Valentia	**2021**	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
Vicenza	**2021**	2250.0	0.0	30321.0	0.0	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0
Viterbo	**2021**	1010.0	0.0	27980.0	0.0	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0

106 rows × 10 columns

	City	Year	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes
0	Agrigento	2021	968704.0	117600.0	217070.0	0.0	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0
1	Alessandria	2021	1316.0	0.0	69300.0	0.0	914376.0	0.0	308.0	280.0	344.0	983676.0
2	Ancona	2021	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0
3	Arezzo	2021	1320.0	0.0	6069.0	0.0	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0
4	Ascoli Piceno	2021	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0
...	...	...	...	...	...	...	...	...	...	...	...	...
101	Vercelli	2021	8688.0	0.0	1062.0	0.0	7400.0	0.0	11.0	10.0	10.0	8462.0
102	Verona	2021	5250.0	0.0	328375.0	0.0	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0
103	Vibo Valentia	2021	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0
104	Vicenza	2021	2250.0	0.0	30321.0	0.0	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0
105	Viterbo	2021	1010.0	0.0	27980.0	0.0	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0

106 rows × 12 columns

Pre-process fertilizers 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

	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	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes	ammonium sulphate	calciu cyanami
0	Agrigento	2020	985000.0	120000.0	214500.0	0.0	1300000.0	685000.0	354500.0	308000.0	423060.0	2199500.0	155	
1	Alessandria	2020	950.0	0.0	41749.0	0.0	803440.0	0.0	176.0	160.0	224.0	845189.0	135	1
2	Ancona	2020	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0	567	
3	Arezzo	2020	1440.0	0.0	35040.0	0.0	211420.0	92800.0	202300.0	178500.0	178500.0	339260.0	68	
4	Ascoli Piceno	2020	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0	8	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
101	Vercelli	2020	990.0	0.0	3330.0	0.0	11775.0	0.0	12.0	12.0	12.0	15105.0	14	25
102	Verona	2020	4500.0	0.0	871093.0	0.0	2600705.0	1025273.0	203562.0	182190.0	182606.0	4497071.0	3919	2
103	Vibo Valentia	2020	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0	1433	
104	Vicenza	2020	3100.0	0.0	128651.0	0.0	624698.0	412571.0	32164.0	29174.0	29384.0	1165920.0	1350	2
105	Viterbo	2020	1100.0	0.0	26500.0	0.0	75000.0	105600.0	245650.0	221000.0	221000.0	207100.0	176	

106 rows × 18 columns

Analysis 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
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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	Grapes for table use	grapes for other purposes n.e.c.	grapes for other wines n.e.c. (without pdo/pgi)	grapes for raisins	grapes for wines with protected designation of origin (pdo)	grapes for wines with protected geographical indication (pgi)	olive oil	other olives	table olives	wine grapes	ammonium sulphate	calciu cyanami
0	Agrigento	2021	968704.0	117600.0	217070.0	0.0	1321980.0	661710.0	353321.0	305939.0	420339.0	2200760.0	738	
1	Alessandria	2021	1316.0	0.0	69300.0	0.0	914376.0	0.0	308.0	280.0	344.0	983676.0	151	1
2	Ancona	2021	0.0	0.0	130423.0	0.0	260321.0	27201.0	44088.0	39550.0	40988.0	417945.0	954	
3	Arezzo	2021	1320.0	0.0	6069.0	0.0	148686.0	77779.0	74340.0	63000.0	63000.0	232534.0	32	
4	Ascoli Piceno	2021	1041.0	0.0	287248.0	0.0	131785.0	164392.0	94794.0	85852.0	98452.0	583425.0	3	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
101	Vercelli	2021	8688.0	0.0	1062.0	0.0	7400.0	0.0	11.0	10.0	10.0	8462.0	5	25
102	Verona	2021	5250.0	0.0	328375.0	0.0	2800148.0	816675.0	20550.0	18220.0	18250.0	3945198.0	7632	2
103	Vibo Valentia	2021	3770.0	0.0	12446.0	0.0	0.0	539.0	861065.0	764730.0	765690.0	12985.0	518	
104	Vicenza	2021	2250.0	0.0	30321.0	0.0	683218.0	264409.0	3305.0	2930.0	2950.0	977948.0	1784	2
105	Viterbo	2021	1010.0	0.0	27980.0	0.0	78800.0	115000.0	241900.0	218000.0	218000.0	221780.0	152	

106 rows × 18 columns

Correlation 2020

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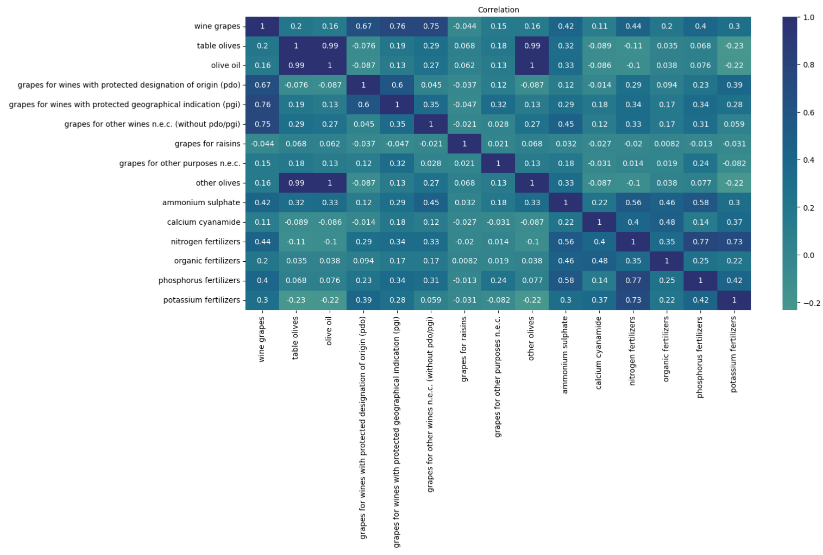

Correlation analysis of grapes and olives production in Italy 2020:

- Wine grapes has correlation nitrogen, phosphorus and ammonium sulphate fertilizers.
- Table olive has correlation with ammonium sulphate fertilizer.
- Olive oil ammonium sulphate fertilizer.
- Grapes for wine has correlation with potassium, phosphorus and nitrogen fertilizers.
- There is no high correlation between Grapes for raisins and other purposes, and fertilizers.
- There is also hight correlation between phosphorus and potassium with nitrogen fertilizer.

Correlation 2021

```
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```

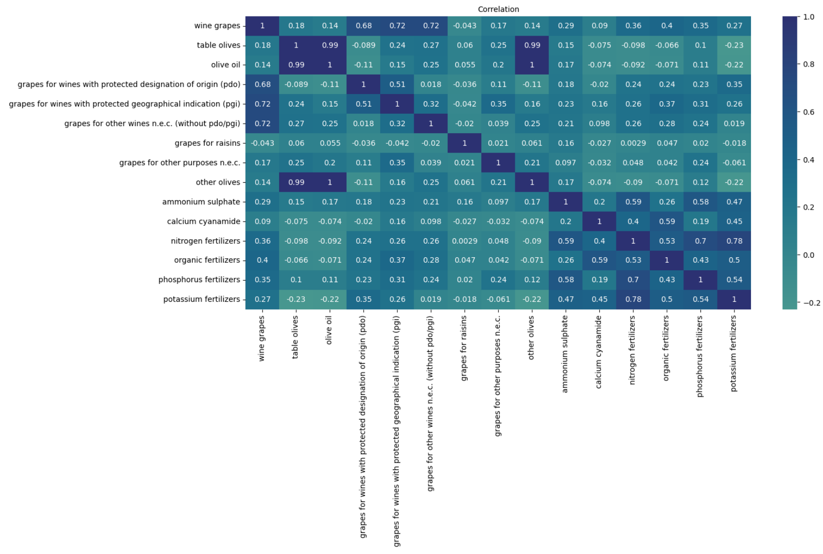

Correlation analysis of grapes and olives production in Italy 2021:

- Wine grapes has correlation organic, nitrogen, and phosphorus fertilizers.
- Table olive has low correlation with ammonium sulphate fertilizer, and negative correlation with calcium,potassium, organic and nitrogen.
- Olive oil has low correlation with ammonium sulphate and phosphorus fertilizers.
- Grapes for wine has correlation with potassium, organic, phosphorus and nitrogen fertilizers.
- Grapes for raisins and other purposes has low correlation with fertilizers.
- There is also hight correlation between phosphorus and potassium with nitrogen fertilizer.

Modelling

References

http://dati.istat.it

https://maps.princeton.edu/catalog/stanford-mn871sp9778

https://www.crea.gov.it/documents/68457/0/ITACONTA+2020_ENG+DEF+xweb+%281%29.pdf/95c6b30a-1e18-8e94-d4ac-ce884aef76e8?t=1619527317576

https://seaborn.pydata.org/generated/seaborn.relplot.html