

# Omdena - Milan Chapter Agrifoods

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

### Exploratory analysis of industrial crop production in Italy 2020-2022

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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.

ITER107	Territory	TIPO_DATOS	Data type	AGRI_MADRE	Type of crop	TIME	Select time	Value	Flag Codes	Flags
0	ITC16	Cuneo	TP_QUIN_EXT	total production - quintals	parsley in greenhouses	2020	2020	350	NaN	NaN
1	ITC16	Cuneo	HP_Q_EXT	harvested production - quintals	parsley in greenhouses	2020	2020	350	NaN	NaN
2	ITC16	Cuneo	ART_ARE	total area - ares	parsley in greenhouses	2020	2020	155	NaN	NaN
3	ITC31	Imperia	TP_QUIN_EXT	total production - quintals	parsley in greenhouses	2021	2021	125	NaN	NaN
4	ITC31	Imperia	HP_Q_EXT	harvested production - quintals	parsley in greenhouses	2021	2021	110	NaN	NaN
...	...	...	...	...	...	...	...	...	...	...
3315	Trentino Alto Adige	Südtirol	harvested production - quintals		hops	2021	2021	60		
3316	Grosseto		total area - hectares	other oilseed crops (excluding sesame)	hops	2021	2021	72		
3317	Udine		total area - hectares		hops	2021	2021	1		
3318	Arezzo		total area - hectares		other textile crops	2021	2021	4		
3319	Grosseto		total area - hectares		other textile crops	2021	2021	12		

3320 rows × 5 columns

## Pre-processing dataset

	Territory	Data type	Type of crop	Select time	Value
0	Cuneo	total production - quintals	parsley in greenhouses	2020	350
1	Cuneo	harvested production - quintals	parsley in greenhouses	2020	350
2	Cuneo	total area - ares	parsley in greenhouses	2020	155
3	Imperia	total production - quintals	parsley in greenhouses	2021	125
4	Imperia	harvested production - quintals	parsley in greenhouses	2021	110
...	...	...	...	...	...
3315	Trentino Alto Adige / Südtirol	harvested production - quintals	hops	2021	60
3316	Grosseto	total area - hectares	other oilseed crops (excluding sesame)	2021	72
3317	Udine	total area - hectares	hops	2021	1
3318	Arezzo	total area - hectares	other textile crops	2021	4
3319	Grosseto	total area - hectares	other textile crops	2021	12

3320 rows × 5 columns

DATASET SHAPE: (3320, 5)

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FEATURE DATA TYPES:  
<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 3320 entries, 0 to 3319  
Data columns (total 5 columns):  
# Column Non-Null Count Dtype  
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0 City 3320 non-null object  
1 Data\_type 3320 non-null object  
2 Type\_crop 3320 non-null object  
3 Year 3320 non-null int64  
4 Value 3320 non-null int64  
dtypes: int64(2), object(3)  
memory usage: 129.8+ KB  
None

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NUMBER OF UNIQUE VALUES PER FEATURE:  
City 98  
Data\_type 4  
Type\_crop 17  
Year 3  
Value 1174  
dtype: int64

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NULL VALUES PER FEATURE  
City 0  
Data\_type 0  
Type\_crop 0  
Year 0  
Value 0  
dtype: int64

## Cities in Italy producing industrial crop

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

## Select only Values for total industrial crop production - quintals

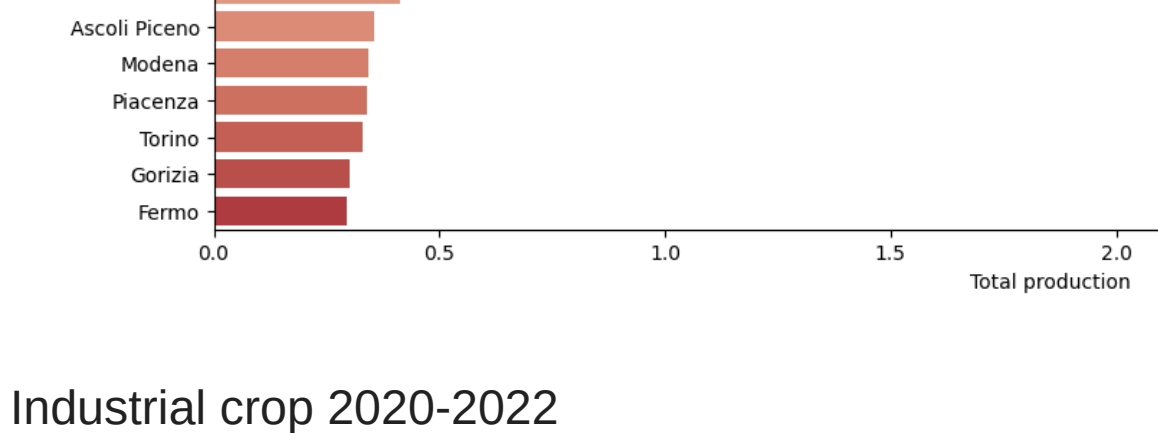
City	Data_type	Type_crop	Year	Value
0	Cuneo	total production - quintals	parsley in greenhouses	2020 350
3	Imperia	total production - quintals	parsley in greenhouses	2021 125
6	Varese	total production - quintals	parsley in greenhouses	2020 5
9	Lecco	total production - quintals	parsley in greenhouses	2020 300
12	Milano	total production - quintals	parsley in greenhouses	2020 580
...	...	...	...	...
3270	Campobasso	total production - quintals	other aromatic, medicinal and culinary plants	2021 150
3276	Reggio di Calabria	total production - quintals	other aromatic, medicinal and culinary plants	2021 95
3277	Caserta	total production - quintals	other aromatic, medicinal and culinary plants	2021 33520
3312	Trentino Alto Adige / Südtirol	total production - quintals	hops	2020 50
3313	Trentino Alto Adige / Südtirol	total production - quintals	hops	2021 60

1107 rows × 5 columns

	City	Type_crop	Year	Total_production
0	Cuneo	parsley in greenhouses	2020	350
3	Imperia	parsley in greenhouses	2021	125
6	Varese	parsley in greenhouses	2020	5
9	Lecco	parsley in greenhouses	2020	300
12	Milano	parsley in greenhouses	2020	580
...	...	...	...	...
3270	Campobasso	other aromatic, medicinal and culinary plants	2021	150
3276	Reggio di Calabria	other aromatic, medicinal and culinary plants	2021	95
3277	Caserta	other aromatic, medicinal and culinary plants	2021	33520
3312	Trentino Alto Adige / Südtirol	hops	2020	50
3313	Trentino Alto Adige / Südtirol	hops	2021	60

1107 rows × 4 columns

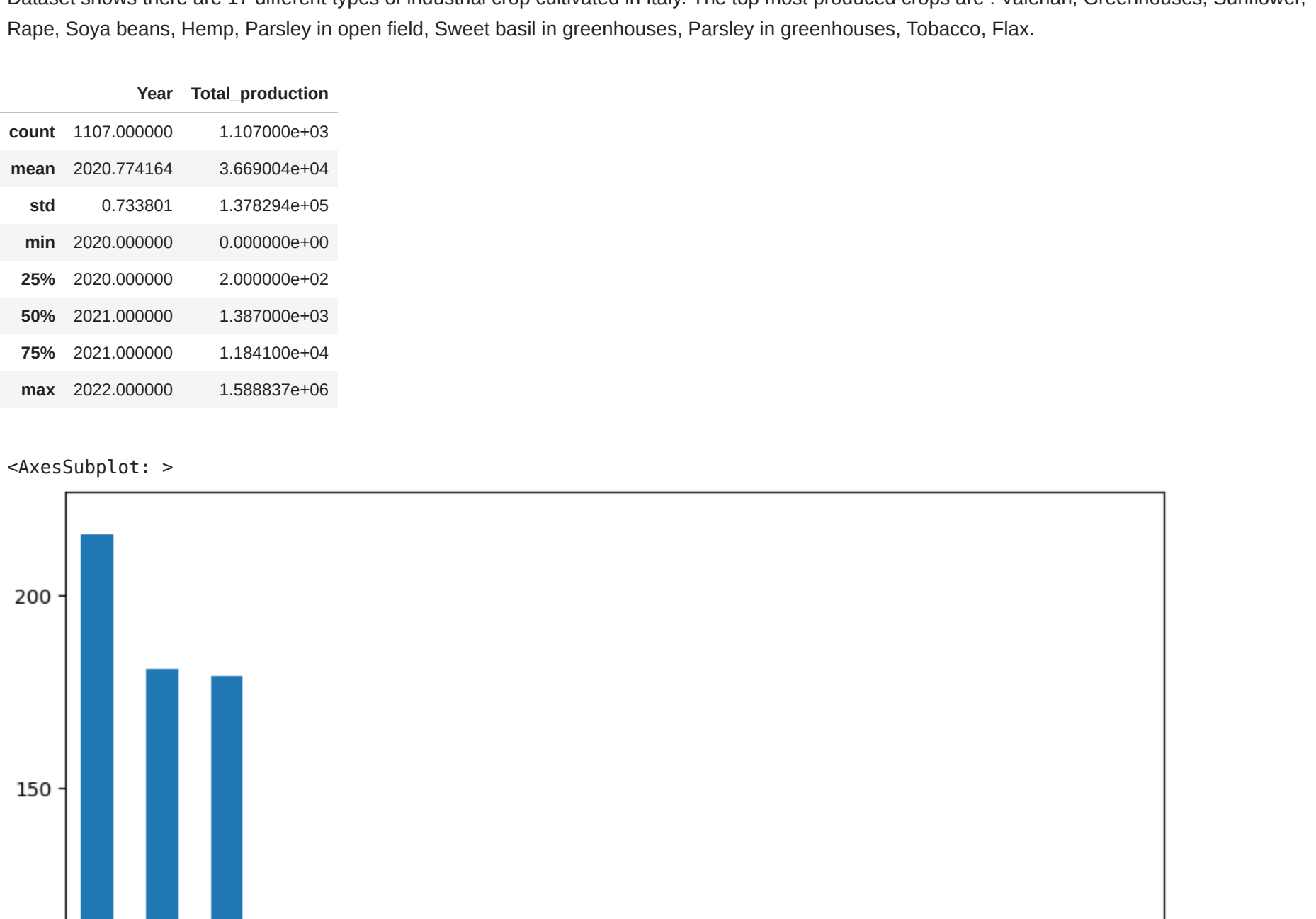
## Total industrial crop production in 2020-2022



## Industrial crop production by Cities

	City	Total_production
92	Venezia	3531099
28	Ferrara	3500002
56	Padova	3221039
75	Rovigo	3148194
89	Udine	3094739
...	...	...
85	Trapani	240
77	Sassari	182
57	Palermo	180
16	Cagliari	122
90	Valle d'Aosta / Vallée d'Aoste	42

98 rows × 2 columns



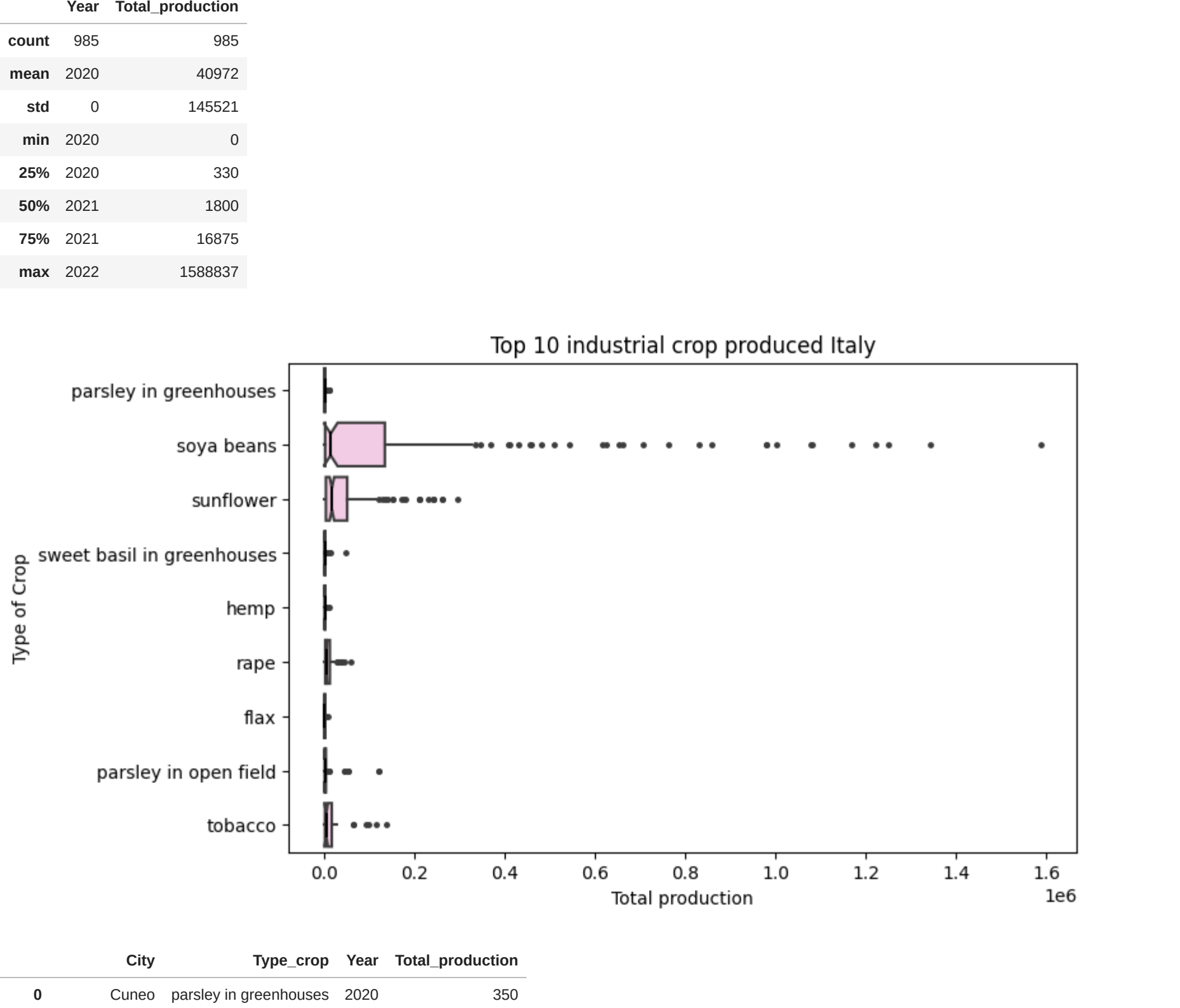
## Industrial crop 2020-2022

valerian in greenhouses	216
sunflower	161
rape	179
soya beans	93
hemp	86
parsley in open field	80
sweet basil in greenhouses	79
parsley in greenhouses	44
tobacco	36
flax	22
hops	35
valerian in greenhouses	32
groundnut	22
turnip rape	29
other aromatic, medicinal and culinary plants	8
sesame	2
other textile crops	2
other oilseed crops (excluding sesame)	1
Name: Type_crop, dtype: int64	

Dataset shows there are 17 different types of industrial crop cultivated in Italy. The top most produced crops are : Valerian, Greenhouses, Sunflower, Rape, Soya beans, Hemp, Parsley in open field, Sweet basil in greenhouses, Parsley in greenhouses, Tobacco, Flax.

	Year	Total_production
count	1107.000000	1.107000e+03
mean	2020.774164	3.669004e+04
std	0.738801	1.378294e+05
min	2020.000000	0.000000e+00
25%	2020.000000	2.000000e+02
50%	2021.000000	1.387000e+03
75%	2021.000000	1.184100e+04
max	2022.000000	1.588837e+06

<AxesSubplot: >

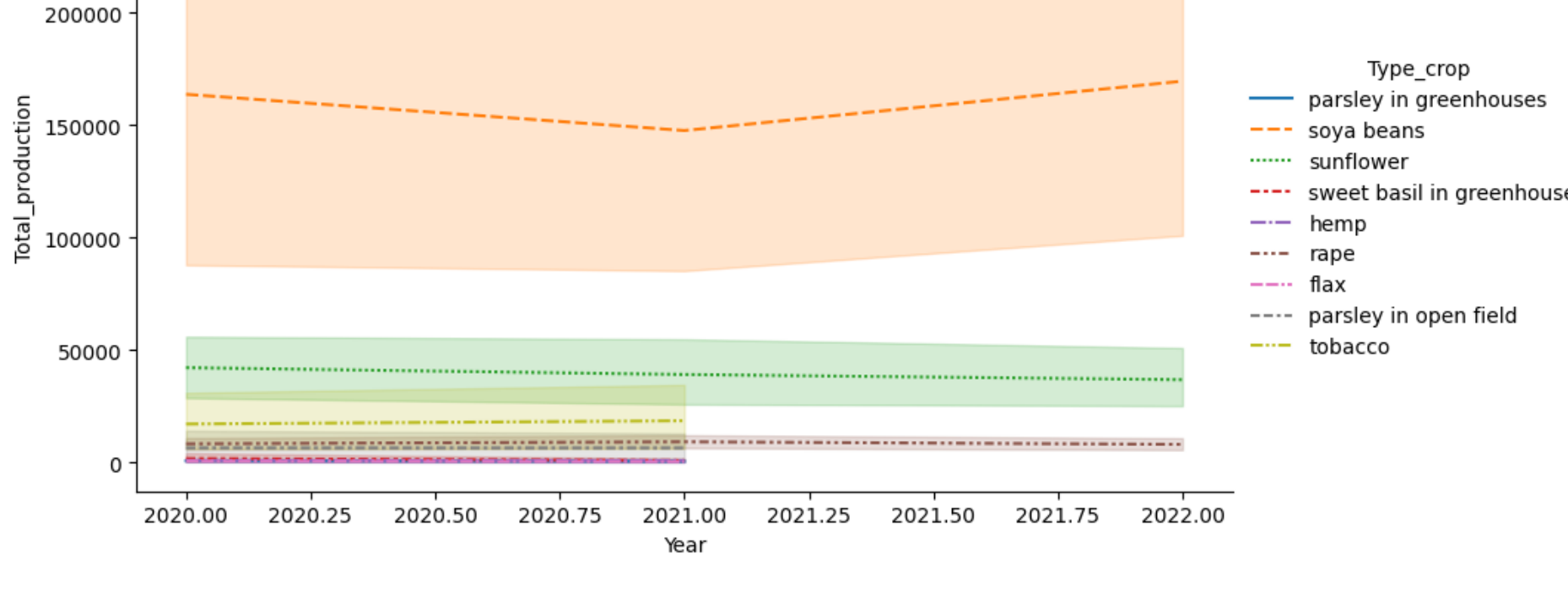
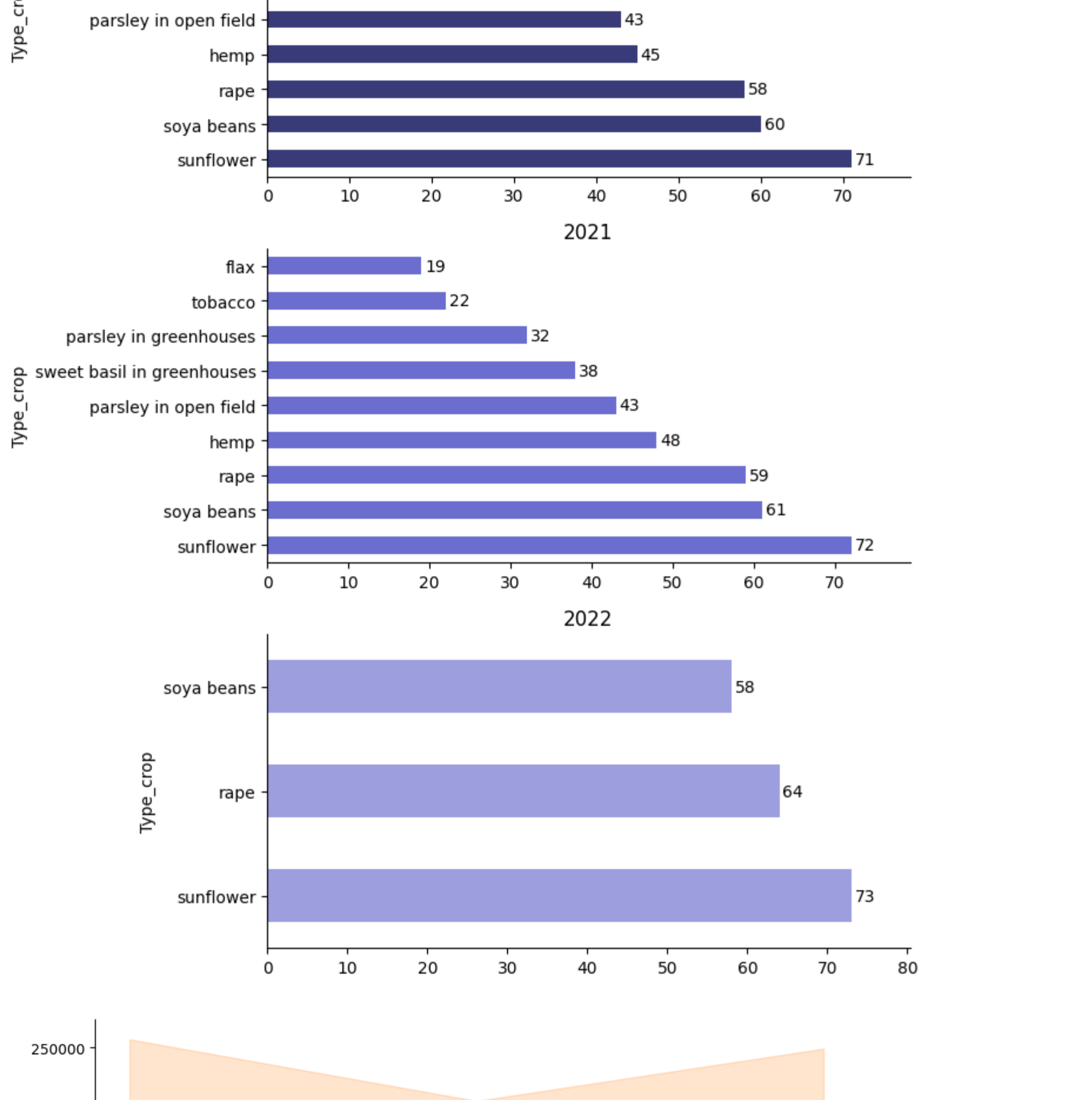


## Subsetting data

	City	Type_crop	Year	Total_production
0	Cuneo	parsley in greenhouses	2020	350
3	Imperia	parsley in greenhouses	2021	125
6	Varese	parsley in greenhouses	2020	5
9	Lecco	parsley in greenhouses	2020	300
12	Milano	parsley in greenhouses	2020	580
...	...	...	...	...
3171	Trento	hemp	2020	50
3172	Trento	hemp	2021	60
3175	Sud Sardegna	parsley in greenhouses	2020	1461
3176	Sud Sardegna	parsley in greenhouses	2021	1461
3248	Rieti	tobacco	2021	3

985 rows × 4 columns

## Vizualization of ten type of industrial crop produced in Italy in the period of 2020-2022



	City	Type_crop	Year	Total_production
0	Cuneo	parsley in greenhouses	2020	350
6	Varese	parsley in greenhouses	2020	5
9	Lecco	parsley in greenhouses	2020	300
12	Milano	parsley in greenhouses	2020	580
...	...	...	...	...
3171	Trento	hemp	2020	50
3172	Trento	hemp	2021	60
3175	Sud Sardegna	parsley in greenhouses	2020	1461
3176	Sud Sardegna	parsley in greenhouses	2021	1461
3248	Rieti	tobacco	2021	3

985 rows × 4 columns

## Create columns for each type crop

	Type_crop	flax	hemp	parsley in greenhouses	parsley in open field	rape	soya beans	sunflower	sweet basil in greenhouses	tobacco
	City	Year								
	Agirgento	2020	NaN	NaN	NaN	155.0	NaN	NaN	NaN	NaN
	Alessandria	2020	1320.0	1040.0	NaN	6120.0	28975.0	119245.0	177300.0	NaN
	Ancona	2020	NaN	2300.0	2.0	NaN	2070.0	4736.0	240435.0	15.0
	Arezzo	2020	40.0	6650.0	12.0	140.0	10530.0	1250.0	119700.0	30.0
	Ascoli Piceno	2020	NaN	NaN	7.0	400.0	NaN	776.0	150659.0	2.0
	...	...	...	...	...	...	...	...	...	...
	Verbanio-Cusio-Ossola	2020	NaN	75.0	NaN	NaN	NaN	450.0	NaN	NaN
	Vercelli	2020	NaN	NaN	NaN	NaN	4163.0	70992.0	1107.0	NaN
	Verona	2020	NaN	5160.0	9515.0	1080.0	21515.0	480160.0	85830.0	45309.0
	Vicenza	2020	40.0	600.0	NaN	NaN	10590.0	368080.0	14650.0	NaN
	Viterbo	2020	1150.0	215.0	NaN	NaN	550.0	NaN	16900.0	NaN

98 rows × 9 columns											
	Type_crop	flax	hemp	parsley in greenhouses	parsley in open field	rape	soya beans	sunflower	sweet basil in greenhouses	tobacco	
	City	Year									
	Agrigento	2020	NaN	NaN	NaN	155.0	NaN	NaN	NaN	NaN	NaN
	Alessandria	2020	1320.0	1040.0	NaN	6120.0	28975.0	119245.0	177300.0	NaN	NaN
	Ancona	2020	NaN	2300.0	2.0	NaN	2070.0	4736.0	240435.0	15.0	NaN
	Arezzo	2020	40.0	6650.0	12.0	140.0	10530.0	1250.0	119700.0	30.0	22164.0
	Ascoli Piceno	2020	NaN	NaN	7.0	400.0	NaN	776.0	150659.0	2.0	NaN
	...	...	...	...	...	...	...	...	...	...	...
	Verbanio-Cusio-Ossola	2020	NaN	75.0	NaN	NaN	NaN	450.0	NaN	NaN	NaN
	Vercelli	2020	NaN	NaN	NaN	NaN	4163.0	70992.0	1107.0	NaN	NaN
	Verona	2020	NaN	5160.0	9515.0	1080.0	21515.0	480160.0	85830.0	45309.0	98106.0

	Viterbo	2020	1150.0	215.0	NaN	NaN	550.0	NaN	16900.0	NaN	2699.0	
98 rows × 9 columns												
		Type	crop	flax	hemp	parsley in greenhouses	parsley in open field	rape	soya beans	sunflower	sweet basil in greenhouses	tobacco
	City	Year										
	Agripento	2020	0.0	0.0		0.0	155.0	0.0	0.0	0.0	0.0	0.0
	Alessandria	2020	1320.0	1040.0		0.0	6120.0	28975.0	119245.0	177300.0	0.0	0.0
	Ancona	2020	0.0	2300.0		2.0	0.0	2070.0	4736.0	240435.0	15.0	0.0
	Arezzo	2020	40.0	6650.0		12.0	140.0	10530.0	1250.0	119700.0	30.0	22164.0
	Ascoli Piceno	2020	0.0	0.0		7.0	400.0	0.0	776.0	150659.0	2.0	0.0
	...	...	...	...		...	...	...	...	...	...	...
	Verbano-Cusio-Ossola	2020	0.0	75.0		0.0	0.0	0.0	450.0	0.0	0.0	0.0
	Vercelli	2020	0.0	0.0		0.0	4163.0	70992.0	1107.0	0.0	0.0	0.0
	Verona	2020	0.0	5160.0		9515.0	1080.0	2151				



Type_fertilizer		ammonium sulphate	calcium cyanamide	nitrogen fertilizers	organic fertilizers	phosphorus fertilizers	potassium fertilizers
City	Year						
Agrigento	2020	155	12	1715	4006	142	16
	2020	135	105	20968	2251	782	743
Alessandria	2020	567	17	22511	2695	1258	33
Ancona	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

95	Verona	2020	0.0	5160.0		9515.0	1080.0	21515.0	480160.0	85830.0	45309.0	98106.0	3919.0	258.0	66460.0
96	Vercelli	2020	40.0	600.0		0.0	0.0	10590.0	369800.0	14650.0	0.0	7559.0	1350.0	225.0	10182.0
97	Viterbo	2020	1150.0	215.0		0.0	0.0	550.0	0.0	16900.0	0.0	2699.0	176.0	0.0	14138.0

98 rows x 17 columns

### Correlation

<AxesSubplot: title='center': 'Correlation'>

	ammonium sulphate	ammonium cyanamide	ammonium nitrate	calcium cyanamide	calcium nitrate	calcium phosphate	calcium sulphate	calcium superphosphate	calcium urea	calcium urea phosphate	calcium urea sulphate	calcium urea superphosphate	calcium urea superphosphate	calcium urea superphosphate	calcium urea superphosphate
ammonium sulphate	1	0.28	0.081	0.28	-0.045	0.069	0.0087	0.27	0.18	-0.012	0.0074	0.34	0.022	0.24	0.078
ammonium cyanamide	0.28	1	0.74	0.31	-0.066	0.18	0.12	0.12	0.1	0.067	0.14	0.58	0.099	0.44	0.57
ammonium nitrate	0.081	0.74	1	0.24	-0.049	0.13	0.13	0.089	0.23	0.043	0.04	0.4	0.11	0.37	0.33
calcium cyanamide	0.28	0.31	0.24	1	-0.076	0.39	0.27	0.27	0.12	0.12	0.24	0.63	0.24	0.38	0.21
calcium nitrate	-0.045	-0.066	-0.069	-0.076	1	-0.011	-0.0036	-0.007	-0.0074	0.46	0.023	0.2	0.066	0.48	0.052
calcium phosphate	0.069	0.18	0.13	0.39	-0.011	1	0.82	0.35	0.05	0.05	0.29	0.68	0.36	0.24	0.48
calcium sulphate	0.0087	0.12	0.13	0.27	-0.0036	0.82	1	0.38	-0.037	0.38	0.18	0.29	0.63	0.38	0.22
calcium superphosphate	0.27	0.12	0.089	0.27	-0.007	0.38	0.38	1	-0.053	0.12	0.29	0.3	0.63	0.38	0.13
calcium urea	0.18	0.1	0.23	0.12	0.0074	0.05	0.05	0.05	1	-0.1	0.15	0.50	0.05	0.002	0.12
calcium urea phosphate	-0.012	0.067	0.043	0.24	0.46	0.29	0.38	0.2	-0.1	1	0.21	0.55	0.48	0.37	0.28
calcium urea sulphate	0.022	0.34	0.022	0.038	0.023	0.68	0.29	0.36	0.29	0.21	1	0.38	0.48	0.37	0.38
calcium urea superphosphate	0.24	0.38	0.37	0.21	0.052	0.36	0.38	0.13	0.002	0.37	0.38	1	0.37	0.37	0.37

108 rows × 8 columns

City	Year	flax	hemp	parsley in greenhouses	parsley in open field	rape	soya beans	sunflower	sweet basil in greenhouses	tobacco	ammonium sulphate	calcium cyanamide	nitrogen fertilizers
0	Agrigento	2020	0.0	0.0	0.0	155.0	0.0	0.0	0.0	0.0	155.0	12.0	1715.0
1	Alessandria	2020	1320.0	1040.0	0.0	6120.0	28975.0	119245.0	177300.0	0.0	135.0	105.0	20968.0
2	Ancona	2020	0.0	2300.0	2.0	0.0	2070.0	4736.0	240435.0	15.0	0.0	567.0	17.0
3	Arezzo	2020	40.0	6650.0	12.0	140.0	10530.0	1250.0	139700.0	30.0	22164.0	68.0	26.0
4	Ascoli Piceno	2020	0.0	0.0	7.0	400.0	0.0	776.0	150659.0	2.0	0.0	8.0	158.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
93	Verbania-Cusio-Ossola	2020	0.0	75.0	0.0	0.0	0.0	450.0	0.0	0.0	0.0	0.0	0.0
94	Vercelli	2020	0.0	0.0	0.0	0.0	4163.0	70992.0	1107.0	0.0	0.0	14.0	2570.0
95	Verona	2020	0.0	5160.0	9515.0	1080.0	21515.0	480160.0	85830.0	45309.0	98106.0	3919.0	258.0
96	Vicenza	2020	40.0	600.0	0.0	0.0	105990.0	368080.0	14650.0	0.0	7559.0	1390.0	225.0
97	Viterbo	2020	1150.0	215.0	0.0	0.0	550.0	0.0	16900.0	0.0	2699.0	176.0	0.0

98 rows × 17 columns

## Correlation

<AxesSubplot: title='center': 'Correlation'>



Correlation analysis of industrial crop production in Italy with high correlation with fertilizers:

- Sunflower has correlation nitrogen fertilizer, and low correlation with phosphorus fertilizer.
- Rape has high correlation with potassium, nitrogen and phosphorus fertilizers.
- Soya been has correlation with nitrogen, phosphorus and potassium fertilizers.
- Hemp has low correlation with fertilizers.
- Parsley in the field has high correlation with ammonium sulphate and phosphorus fertilizers.
- Parsley in greenhouses has high correlation with organic and low correlation with ammonium fertilizers.
- Tobacco and Flax have low correlation with fertilizers.
- There is also high correlation 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+web+%281%29.pdf/95c6b30a-1e18-8e94-d4ac-ce884ae76e8?t=1619527317576](https://www.crea.gov.it/documents/68457/0/ITACONTA+2020_ENG+DEF+web+%281%29.pdf/95c6b30a-1e18-8e94-d4ac-ce884ae76e8?t=1619527317576)
- <https://seaborn.pydata.org/generated/seaborn.relplot.html>