Omdena - Milan Chapter Agrifoods

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

Exploratory analysis of fresh vegetables 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	ITC16	Cuneo	TP_QUIN_EXT	total production - quintals	RADIINGRE	chicory and radicchio in greenhouses	2020	2020	850	NaN	NaN
1	ITC16	Cuneo	HP_Q_EXT	harvested production - quintals	RADIINGRE	chicory and radicchio in greenhouses	2020	2020	850	NaN	NaN
2	ITC16	Cuneo	ART_ARE	total area - ares	RADIINGRE	chicory and radicchio in greenhouses	2020	2020	360	NaN	NaN
3	ITC17	Asti	TP_QUIN_EXT	total production - quintals	RADIINGRE	chicory and radicchio in greenhouses	2020	2020	870	NaN	NaN
4	ITC17	Asti	HP_Q_EXT	harvested production - quintals	RADIINGRE	chicory and radicchio in greenhouses	2020	2020	870	NaN	NaN

Pre-processing dataset

	Territory	Data type	Type of crop	Select time	Value
0	Cuneo	total production - quintals	chicory and radicchio in greenhouses	2020	850
1	Cuneo	harvested production - quintals	chicory and radicchio in greenhouses	2020	850
2	Cuneo	total area - ares	chicory and radicchio in greenhouses	2020	360
3	Asti	total production - quintals	chicory and radicchio in greenhouses	2020	870
4	Asti	harvested production - quintals	chicory and radicchio in greenhouses	2020	870
...	...	...	...	...	...
25228	Rimini	harvested production - quintals	other fresh legumes	2022	1360
25229	Perugia	total area - hectares	other fresh legumes	2022	5
25230	Perugia	total production - quintals	other fresh legumes	2022	400
25231	Perugia	harvested production - quintals	other fresh legumes	2022	400
25232	Imperia	total area - hectares	other fresh vegetables n.e.c. (excluding broad...	2022	1

25233 rows × 5 columns

```
DATASET SHAPE:  (25233, 5)

--------------------------------------------------
FEATURE DATA TYPES:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25233 entries, 0 to 25232
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   City       25233 non-null  object
 1   Data_type  25233 non-null  object
 2   Type_crop  25233 non-null  object
 3   Year       25233 non-null  int64 
 4   Value      25233 non-null  int64 
dtypes: int64(2), object(3)
memory usage: 985.8+ KB
None

 --------------------------------------------------
NUMBER OF UNIQUE VALUES PER FEATURE:

City          105
Data_type       5
Type_crop      64
Year            3
Value        3903
dtype: int64

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

Cities in Italy producing fresh vegetables

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

Select only values for total fresh vegetables production - quintals

	City	Data_type	Type_crop	Year	Value
0	Cuneo	total production - quintals	chicory and radicchio in greenhouses	2020	850
3	Asti	total production - quintals	chicory and radicchio in greenhouses	2020	870
6	La Spezia	total production - quintals	chicory and radicchio in greenhouses	2020	600
7	La Spezia	total production - quintals	chicory and radicchio in greenhouses	2021	600
12	Varese	total production - quintals	chicory and radicchio in greenhouses	2020	30

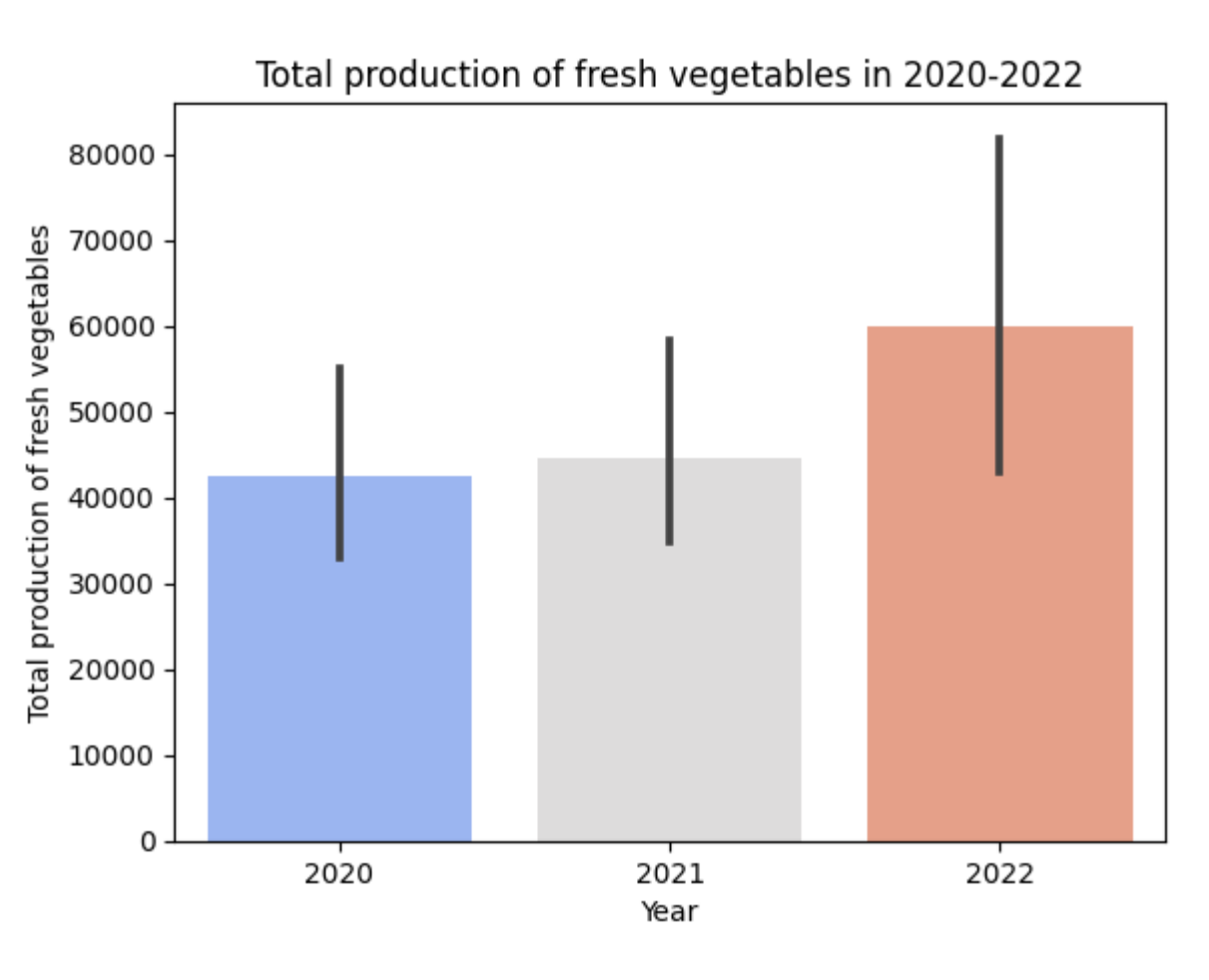
	City	Data_type	Type_crop	Year	Total_production
0	Cuneo	total production - quintals	chicory and radicchio in greenhouses	2020	850
3	Asti	total production - quintals	chicory and radicchio in greenhouses	2020	870
6	La Spezia	total production - quintals	chicory and radicchio in greenhouses	2020	600
7	La Spezia	total production - quintals	chicory and radicchio in greenhouses	2021	600
12	Varese	total production - quintals	chicory and radicchio in greenhouses	2020	30
...	...	...	...	...	...
25211	Salerno	total production - quintals	tomato for process in greenhouse	2021	25000
25214	Lecce	total production - quintals	tomato for process in greenhouse	2021	22000
25224	Imperia	total production - quintals	other fresh legumes	2022	70
25227	Rimini	total production - quintals	other fresh legumes	2022	1360
25230	Perugia	total production - quintals	other fresh legumes	2022	400

8321 rows × 5 columns

	City	Type_crop	Year	Total_production
0	Cuneo	chicory and radicchio in greenhouses	2020	850
3	Asti	chicory and radicchio in greenhouses	2020	870
6	La Spezia	chicory and radicchio in greenhouses	2020	600
7	La Spezia	chicory and radicchio in greenhouses	2021	600
12	Varese	chicory and radicchio in greenhouses	2020	30
...	...	...	...	...
25211	Salerno	tomato for process in greenhouse	2021	25000
25214	Lecce	tomato for process in greenhouse	2021	22000
25224	Imperia	other fresh legumes	2022	70
25227	Rimini	other fresh legumes	2022	1360
25230	Perugia	other fresh legumes	2022	400

8321 rows × 4 columns

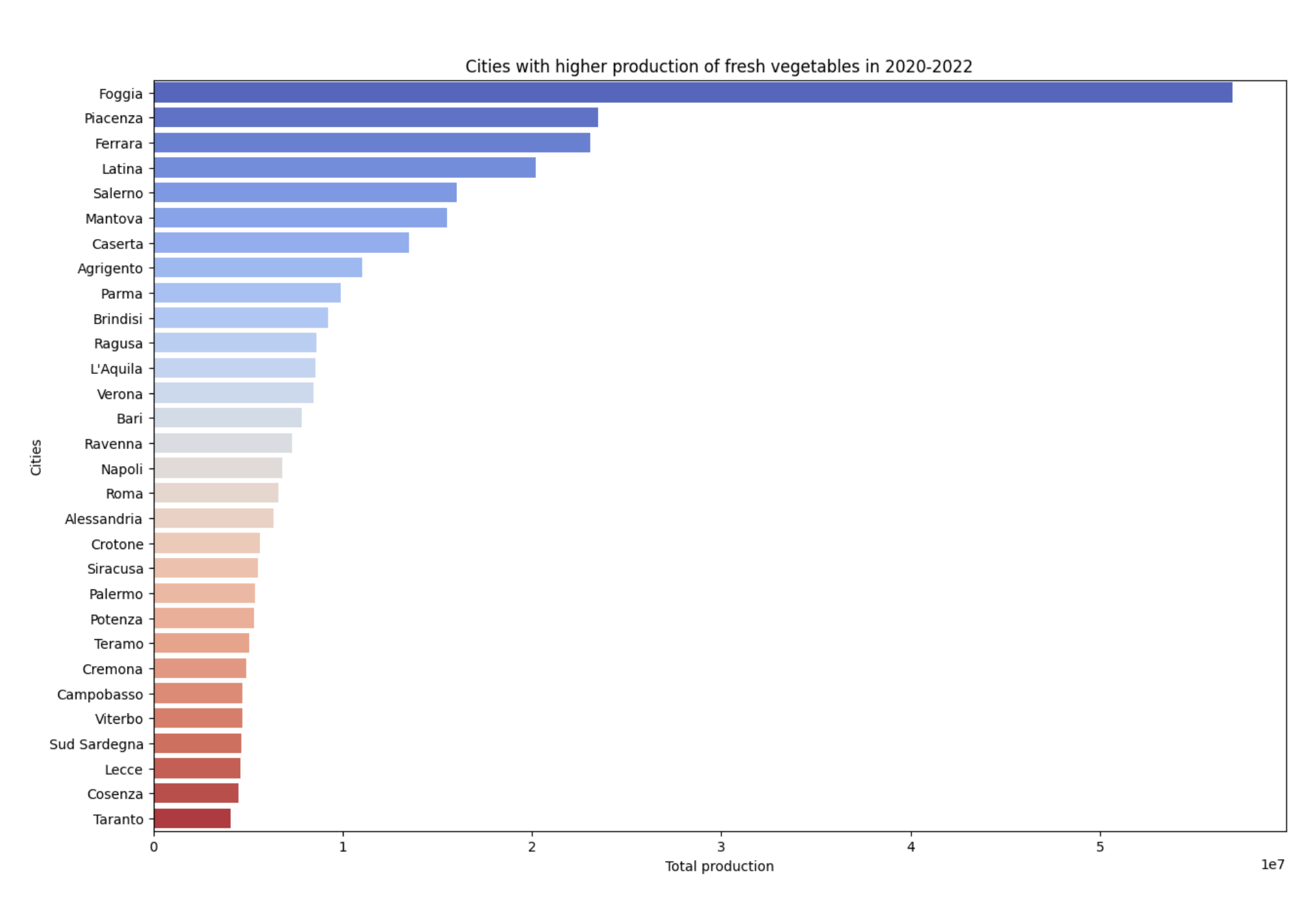
Fresh vegetables production in 2020-2022



Fresh vegetables production by Cities

	City	Total_production
32	Foggia	56993500
67	Piacenza	23479479
30	Ferrara	23074507
42	Latina	20229419
81	Salerno	16043370
...	...	...
12	Biella	9650
96	Valle d'Aosta / Vallée d'Aoste	6872
23	Como	5700
99	Verbano-Cusio-Ossola	4280
86	Sondrio	2469

105 rows × 2 columns



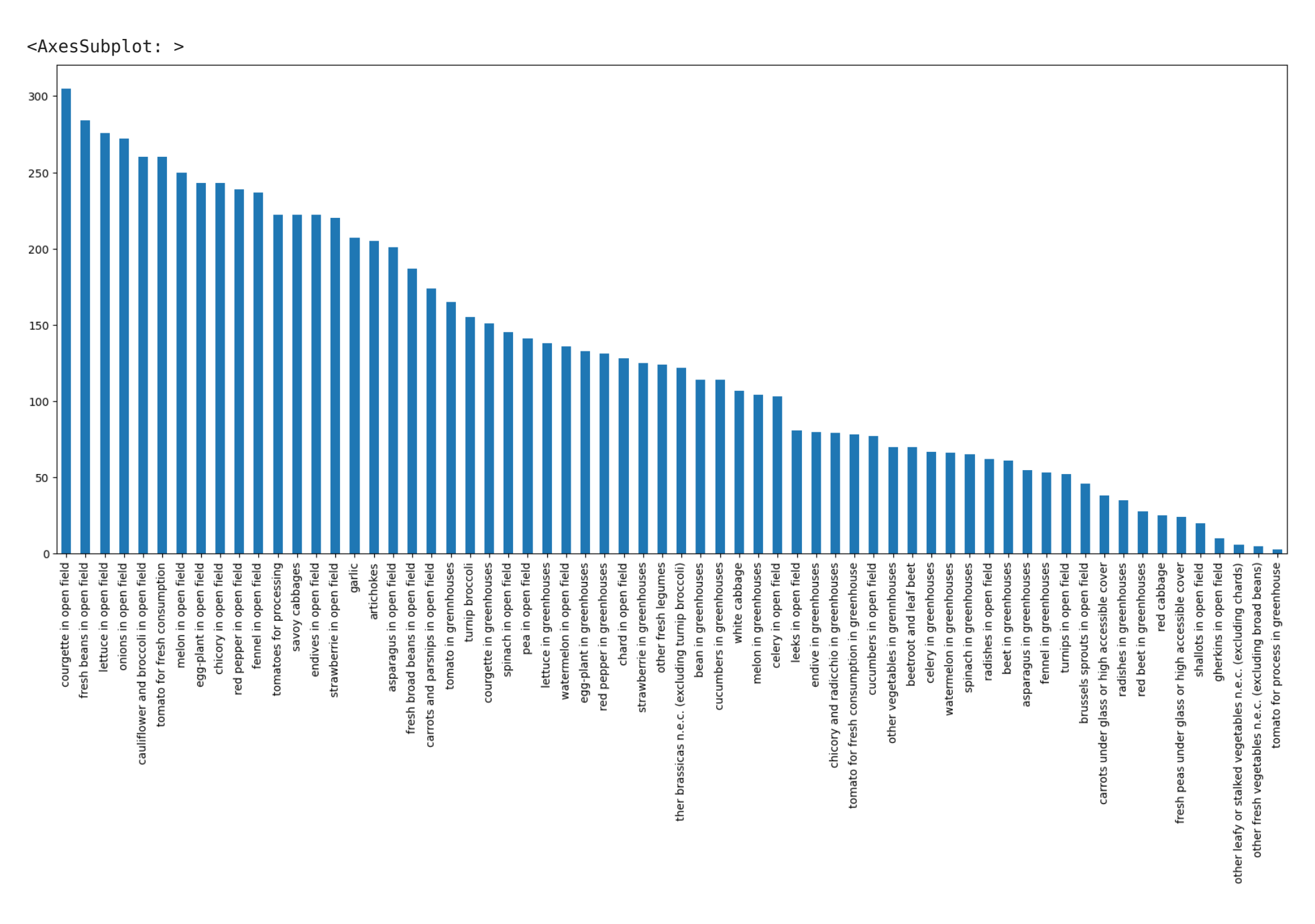
Fresh vegetables 2020-2022

```
white cabbage
courgette in open field                                        305
fresh beans in open field                                      284
lettuce in open field                                          276
onions in open field                                           272
cauliflower and broccoli in open field                         260
                                                              ... 
shallots in open field                                          20
gherkins in open field                                          10
other leafy or stalked vegetables n.e.c. (excluding chards)      6
other fresh vegetables n.e.c. (excluding broad beans)            5
tomato for process in greenhouse                                 3
Name: Type_crop, Length: 64, dtype: int64
64
```

Dataset shows there are 64 different types of industrial crop cultivated in Italy. The top most produced crops are : Courgette in open field, Fresh beans in open field, Lettuce in open field, Onions in open field, Cauliflower and Broccoli in open field.

	Year	Total_production
count	8321.000000	8.321000e+03
mean	2020.825742	4.701730e+04
std	0.756171	3.557369e+05
min	2020.000000	0.000000e+00
25%	2020.000000	5.850000e+02
50%	2021.000000	2.910000e+03
75%	2021.000000	1.746500e+04
max	2022.000000	1.425000e+07

```
<AxesSubplot: >
```

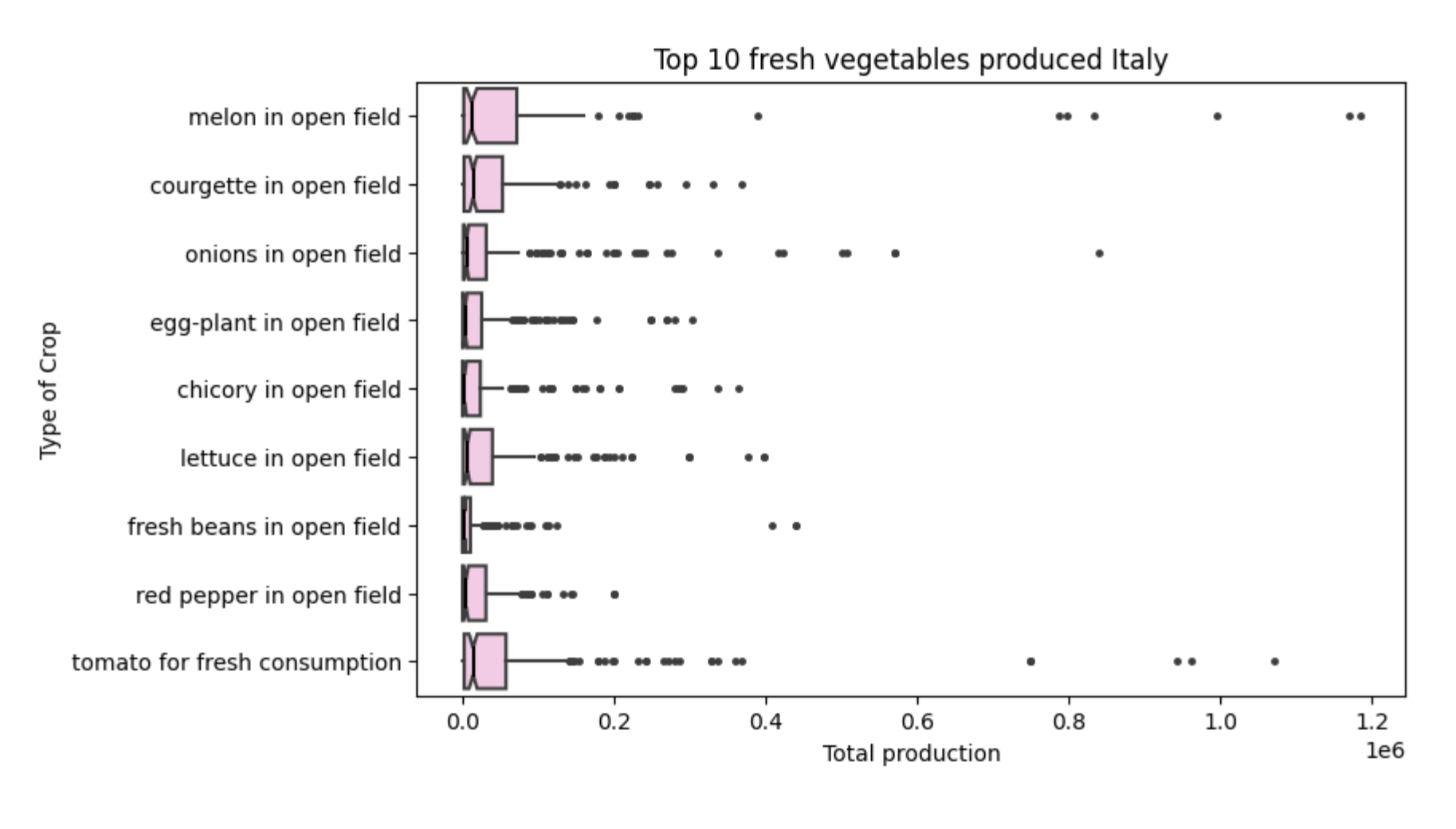


Subseting data

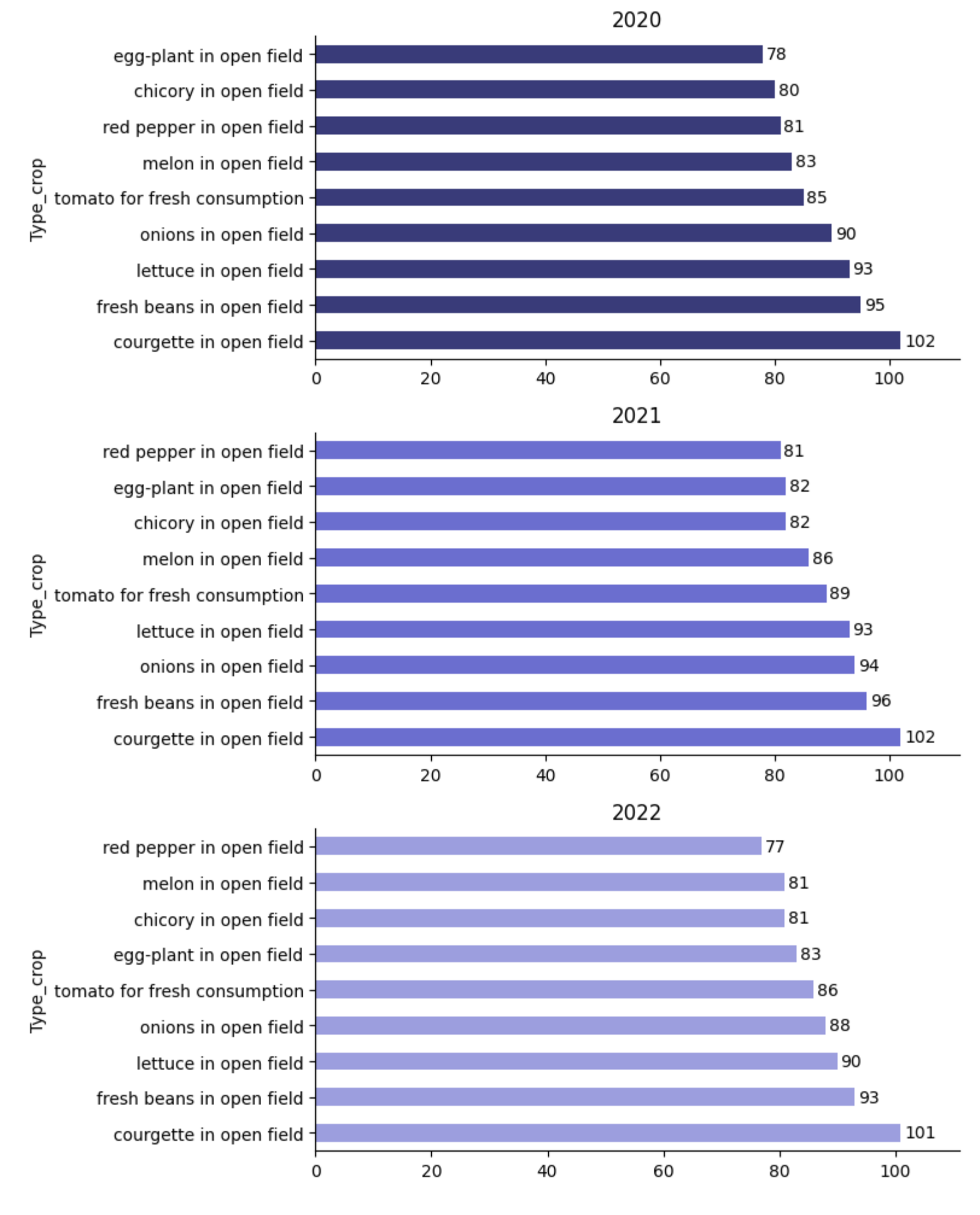
	City	Type_crop	Year	Total_production
2201	Torino	melon in open field	2020	1050
2202	Torino	melon in open field	2021	1320
2203	Torino	melon in open field	2022	800
2209	Biella	melon in open field	2020	80
2210	Biella	melon in open field	2021	0

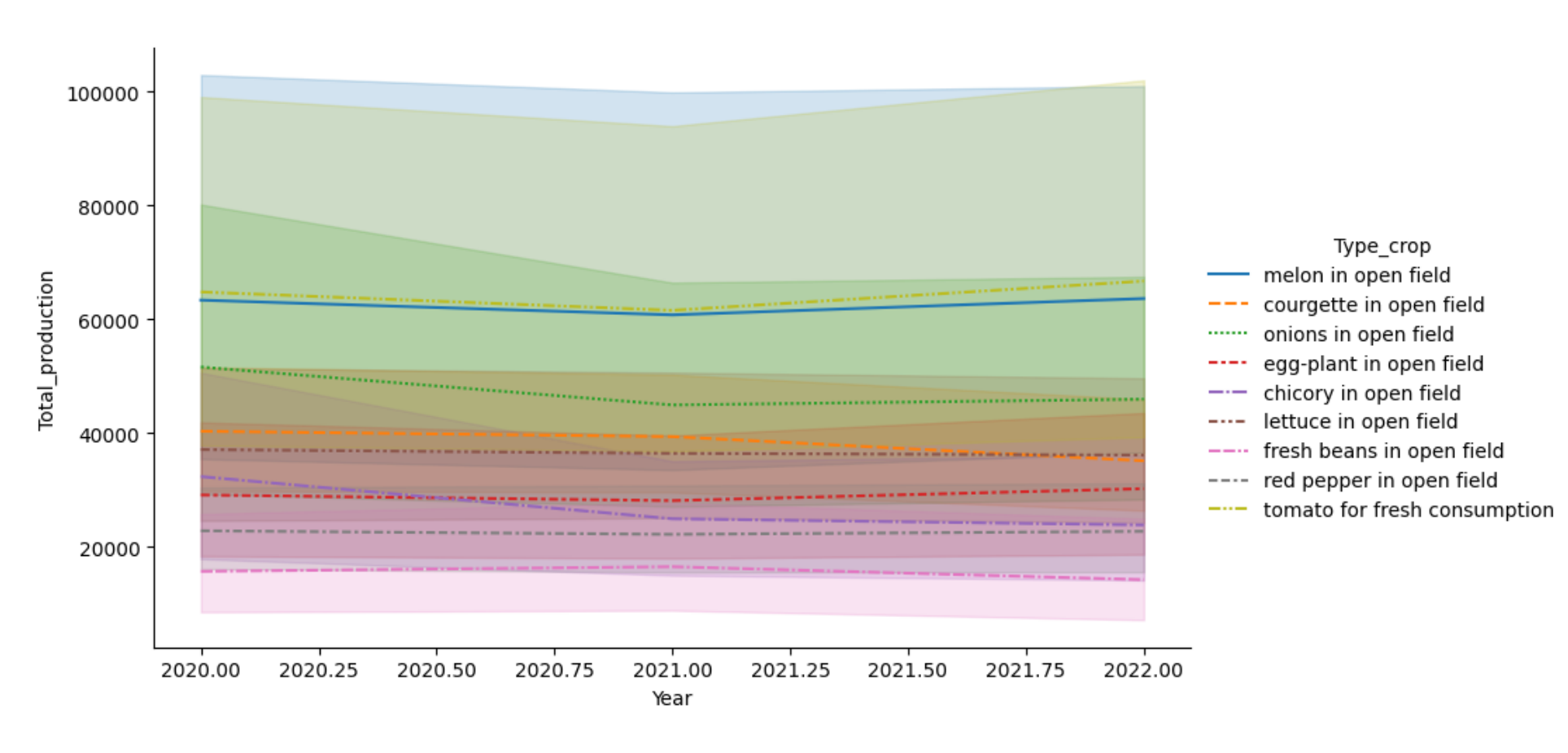
Stats

	Year	Total_production
count	2372	2372
mean	2020	38156
std	0	90989
min	2020	0
25%	2020	1590
50%	2021	7317
75%	2022	35000
max	2022	1185600



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





	City	Type_crop	Year	Total_production
2201	Torino	melon in open field	2020	1050
2209	Biella	melon in open field	2020	80
2222	Cuneo	melon in open field	2020	1540
2231	Asti	melon in open field	2020	1000
2240	Alessandria	melon in open field	2020	12750
...	...	...	...	...
23667	Cosenza	tomato for fresh consumption	2020	188105
23688	Trapani	tomato for fresh consumption	2020	33000
23704	Taranto	tomato for fresh consumption	2020	20000
23713	Ragusa	tomato for fresh consumption	2020	180000
24951	Trentino Alto Adige / Südtirol	tomato for fresh consumption	2020	1300

787 rows × 4 columns

Create columns for each type crop 2020

		Total_production								
	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2020	NaN	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0
Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0
Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0
Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2020	NaN	54000.0	440.0	3225.0	150.0	NaN	NaN	NaN	660.0
Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0
Vibo Valentia	2020	NaN	83635.0	13500.0	18000.0	11520.0	NaN	164400.0	57170.0	58240.0
Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	NaN
Viterbo	2020	NaN	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0

103 rows × 9 columns

	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2020	NaN	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0
Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0
Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0
Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2020	NaN	54000.0	440.0	3225.0	150.0	NaN	NaN	NaN	660.0
Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0
Vibo Valentia	2020	NaN	83635.0	13500.0	18000.0	11520.0	NaN	164400.0	57170.0	58240.0
Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	NaN
Viterbo	2020	NaN	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0

103 rows × 9 columns

	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2020	0.0	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0
Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0
Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0
Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2020	0.0	54000.0	440.0	3225.0	150.0	0.0	0.0	0.0	660.0
Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0
Vibo Valentia	2020	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	0.0
Viterbo	2020	0.0	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0

103 rows × 9 columns

		chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2020	0.0	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0
Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0
Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0
Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2020	0.0	54000.0	440.0	3225.0	150.0	0.0	0.0	0.0	660.0
Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0
Vibo Valentia	2020	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	0.0
Viterbo	2020	0.0	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0

103 rows × 9 columns

	City	Year	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
0	Agrigento	2020	0.0	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0
1	Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0
2	Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
3	Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0
4	Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...	...
98	Vercelli	2020	0.0	54000.0	440.0	3225.0	150.0	0.0	0.0	0.0	660.0
99	Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0
100	Vibo Valentia	2020	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
101	Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	0.0
102	Viterbo	2020	0.0	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0

103 rows × 11 columns

Create columns for each type crop 2021

	City	Type_crop	Year	Total_production
2202	Torino	melon in open field	2021	1320
2210	Biella	melon in open field	2021	0
2214	Verbano-Cusio-Ossola	melon in open field	2021	200
2217	Novara	melon in open field	2021	250
2223	Cuneo	melon in open field	2021	1260
...	...	...	...	...
23668	Cosenza	tomato for fresh consumption	2021	199320
23689	Trapani	tomato for fresh consumption	2021	33000
23705	Taranto	tomato for fresh consumption	2021	20000
23714	Ragusa	tomato for fresh consumption	2021	180000
24952	Trentino Alto Adige / Südtirol	tomato for fresh consumption	2021	1300

805 rows × 4 columns

Create columns for each type crop

		Total_production								
	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2021	NaN	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0
Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0
Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0
Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	NaN	295.0	NaN	600.0
Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0
Vibo Valentia	2021	NaN	83635.0	13500.0	18000.0	11520.0	NaN	164400.0	57170.0	58240.0
Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	NaN
Viterbo	2021	NaN	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0

104 rows × 9 columns

	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2021	NaN	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0
Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0
Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0
Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	NaN	295.0	NaN	600.0
Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0
Vibo Valentia	2021	NaN	83635.0	13500.0	18000.0	11520.0	NaN	164400.0	57170.0	58240.0
Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	NaN
Viterbo	2021	NaN	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0

104 rows × 9 columns

	Type_crop	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2021	0.0	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0
Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0
Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0
Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	0.0	295.0	0.0	600.0
Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0
Vibo Valentia	2021	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	0.0
Viterbo	2021	0.0	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0

104 rows × 9 columns

		chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
City	Year									
Agrigento	2021	0.0	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0
Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0
Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0
Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...
Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	0.0	295.0	0.0	600.0
Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0
Vibo Valentia	2021	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	0.0
Viterbo	2021	0.0	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0

104 rows × 9 columns

	City	Year	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption
0	Agrigento	2021	0.0	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0
1	Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0
2	Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0
3	Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0
4	Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0
...	...	...	...	...	...	...	...	...	...	...	...
99	Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	0.0	295.0	0.0	600.0
100	Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0
101	Vibo Valentia	2021	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0
102	Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	0.0
103	Viterbo	2021	0.0	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0

104 rows × 11 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

Select ferlizers 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	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption	ammonium sulphate	calcium cyanamide	nitrogen fertilizers
0	Agrigento	2020	0.0	39600.0	79950.0	4160.0	104500.0	1185600.0	129850.0	53940.0	943000.0	155	12	1715
1	Alessandria	2020	7200.0	30060.0	3640.0	6160.0	10320.0	12750.0	275550.0	3920.0	36750.0	135	105	20968
2	Ancona	2020	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0	567	17	22511
3	Arezzo	2020	4800.0	13050.0	560.0	560.0	660.0	9920.0	6000.0	7800.0	8500.0	68	26	3675
4	Ascoli Piceno	2020	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0	8	158	1065
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
98	Vercelli	2020	0.0	54000.0	440.0	3225.0	150.0	0.0	0.0	0.0	660.0	14	2570	7604
99	Verona	2020	290750.0	247310.0	47410.0	40400.0	20060.0	79640.0	237235.0	3920.0	4590.0	3919	258	66460
100	Vibo Valentia	2020	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0	1433	0	2487
101	Vicenza	2020	32750.0	27880.0	480.0	2725.0	1050.0	315.0	49600.0	830.0	0.0	1350	225	10182
102	Viterbo	2020	0.0	14220.0	1590.0	5540.0	320.0	82000.0	2880.0	5600.0	31900.0	176	0	14138

103 rows × 17 columns

Select ferlizers 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

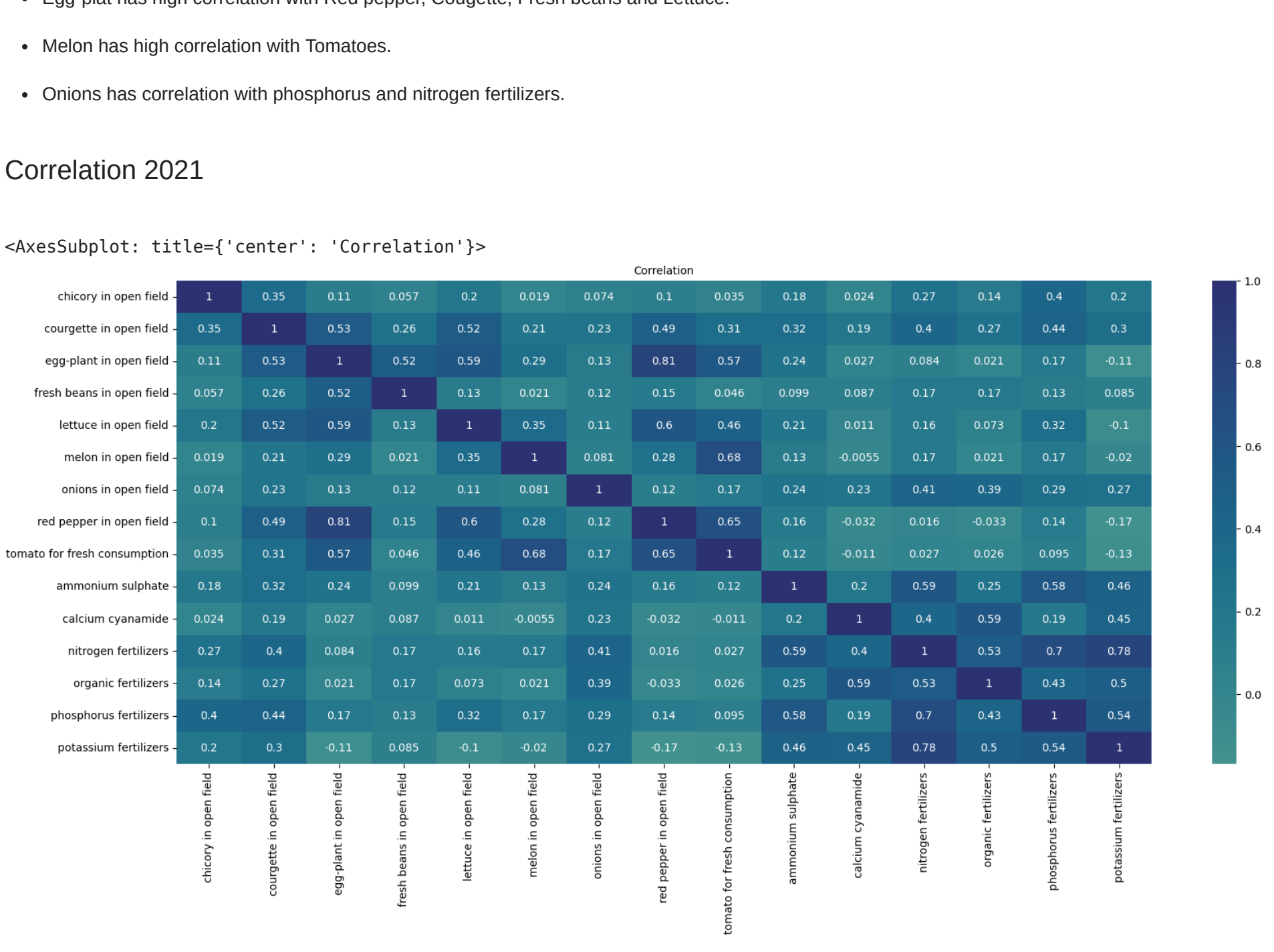
108 rows × 8 columns

	City	Year	chicory in open field	courgette in open field	egg-plant in open field	fresh beans in open field	lettuce in open field	melon in open field	onions in open field	red pepper in open field	tomato for fresh consumption	ammonium sulphate	calcium cyanamide	nitrogen fertilizers
0	Agrigento	2021	0.0	39000.0	78155.0	4266.0	93500.0	1169550.0	132300.0	52450.0	962000.0	738	12	4592
1	Alessandria	2021	5520.0	72900.0	3080.0	6160.0	14400.0	11000.0	269500.0	3640.0	29400.0	151	105	21951
2	Ancona	2021	1807.0	3714.0	1655.0	16015.0	3197.0	3117.0	1474.0	2368.0	13594.0	954	17	14630
3	Arezzo	2021	3200.0	12180.0	560.0	3150.0	660.0	12000.0	6240.0	7800.0	3500.0	32	27	2414
4	Ascoli Piceno	2021	24743.0	8186.0	4362.0	4670.0	37435.0	8074.0	2342.0	6823.0	38759.0	3	158	1610
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
99	Vercelli	2021	160.0	60800.0	230.0	2380.0	600.0	0.0	295.0	0.0	600.0	5	2571	8929
100	Verona	2021	181200.0	256990.0	41920.0	40040.0	14605.0	67385.0	240590.0	3650.0	3510.0	7632	258	59389
101	Vibo Valentia	2021	0.0	83635.0	13500.0	18000.0	11520.0	0.0	164400.0	57170.0	58240.0	518	0	1498
102	Vicenza	2021	25550.0	14670.0	495.0	3240.0	1200.0	300.0	36870.0	850.0	0.0	1784	226	6690
103	Viterbo	2021	0.0	14200.0	1590.0	5520.0	410.0	81000.0	2085.0	5500.0	29800.0	152	0	11245

104 rows × 17 columns

Correlation 2020

```
<AxesSubplot: title={'center': 'Correlation'}>
```

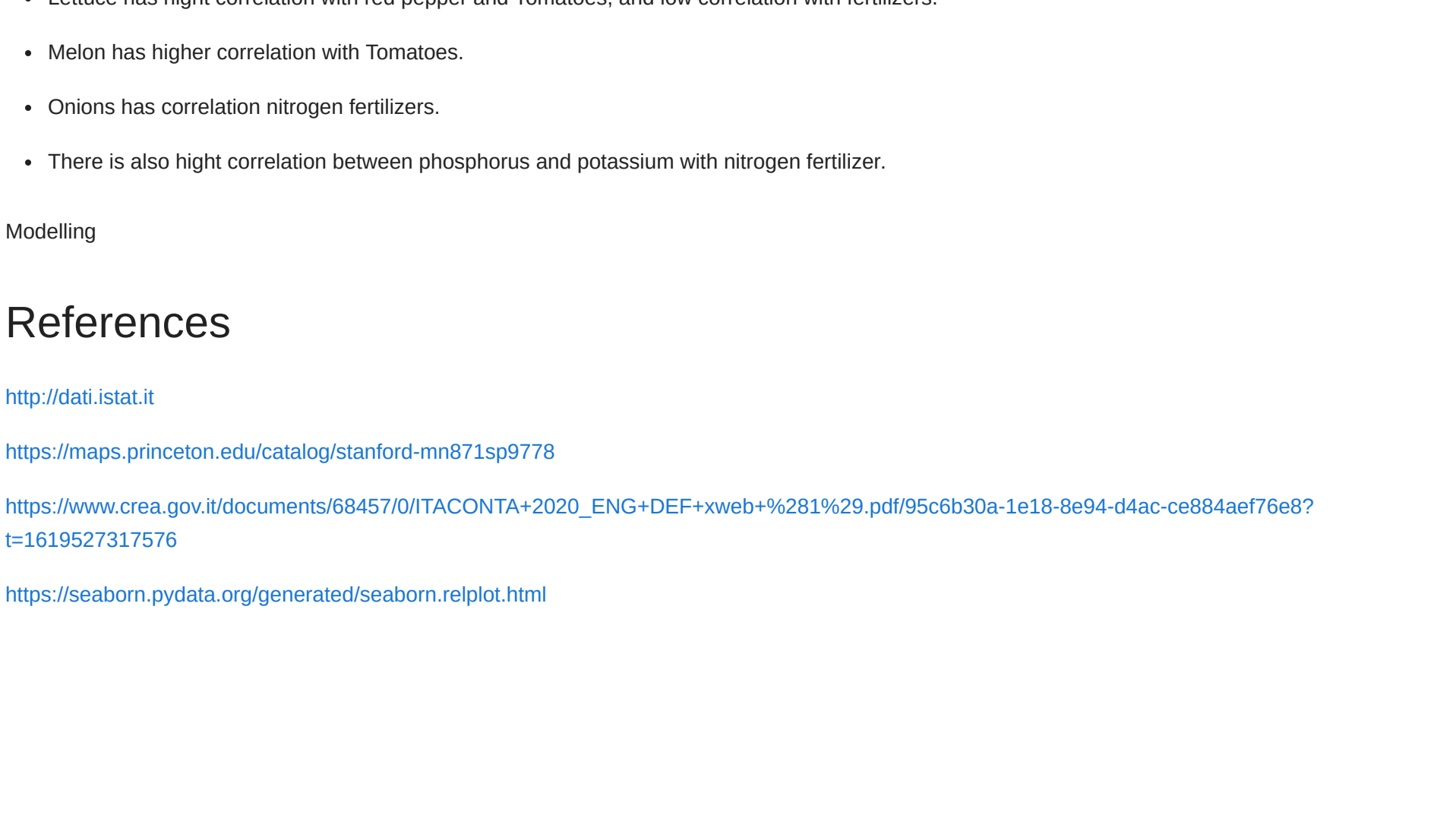


Correlation analysis of fresh vegetables production in Italy - 2020:

- Chicory has correlation with Courgette and phosphorus fertilizer.
- Cougette has high correlation with Lettuce potassium, Egg-plat, Red pepper, and phosphorus fertilizer.
- Egg-plat has high correlation with Red pepper, Cougette, Fresh beans and Lettuce.
- Melon has high correlation with Tomatoes.
- Onions has correlation with phosphorus and nitrogen fertilizers.

Correlation 2021

```
<AxesSubplot: title={'center': 'Correlation'}>
```



Correlation analysis of fresh vegetables production and fertilizers in Italy - 2021:

- Chicory has correlation with phosphorus fertilizer, and hight correlation with Beans.
- Cougette has correlation with phosphorus and nitrogen fertilizers, and hight correlation with Egg-plant.
- Egg-plant has hight correlation with Red pepper , low correlation with fertilizers.
- Lettuce has hight correlation with red pepper and Tomatoes, and low correlation with fertilizers.
- Melon has higher correlation with Tomatoes.
- Onions has correlation nitrogen 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