In [1]:
```
from matplotlib import pyplot as plt
import numpy as np
```

General conversions

Conversions

Sunflower Seeds, sunflower seed kernels, dried 584kcal/100g https://fdc.nal.usda.gov/fdc-app.html#/food-details/170562/nutrients FDC ID: 170562 USDA Unit LB/acre

Potatoes, flesh and skin, raw https://fdc.nal.usda.gov/fdc-app.html#/food-details/170026/nutrients 77kcal/100g FDC ID: 170026 USDA Unit CWT/acre 1 CWT = 100lbs

Wheat, hard red winter FDC ID: 168890 327kcal/100g https://fdc.nal.usda.gov/fdc-app.html#/food-details/168890/nutrients USDA Unit BU/acre 60lb / BU https://www.plainsgrains.org/wp-content/uploads/2018/10/2017-HRWW-Report__HiRes-FINAL.pdf

Corn grain, yellow 365kcal/100g https://fdc.nal.usda.gov/fdc-app.html#/food-details/170288/nutrients FDC ID: 170288 USDA Unit BU/acre Shelled, 56lbs/BU

Soybeans, mature seeds, raw 446kcal/100g https://fdc.nal.usda.gov/fdc-app.html#/food-details/174270/nutrients FDC ID: 174270 USDA Unit BU/acre 60LB/BU https://soybeanresearchinfo.com/research-highlight/exploring-the-impact-of-genetics-on-soybean-test-weight

Corn

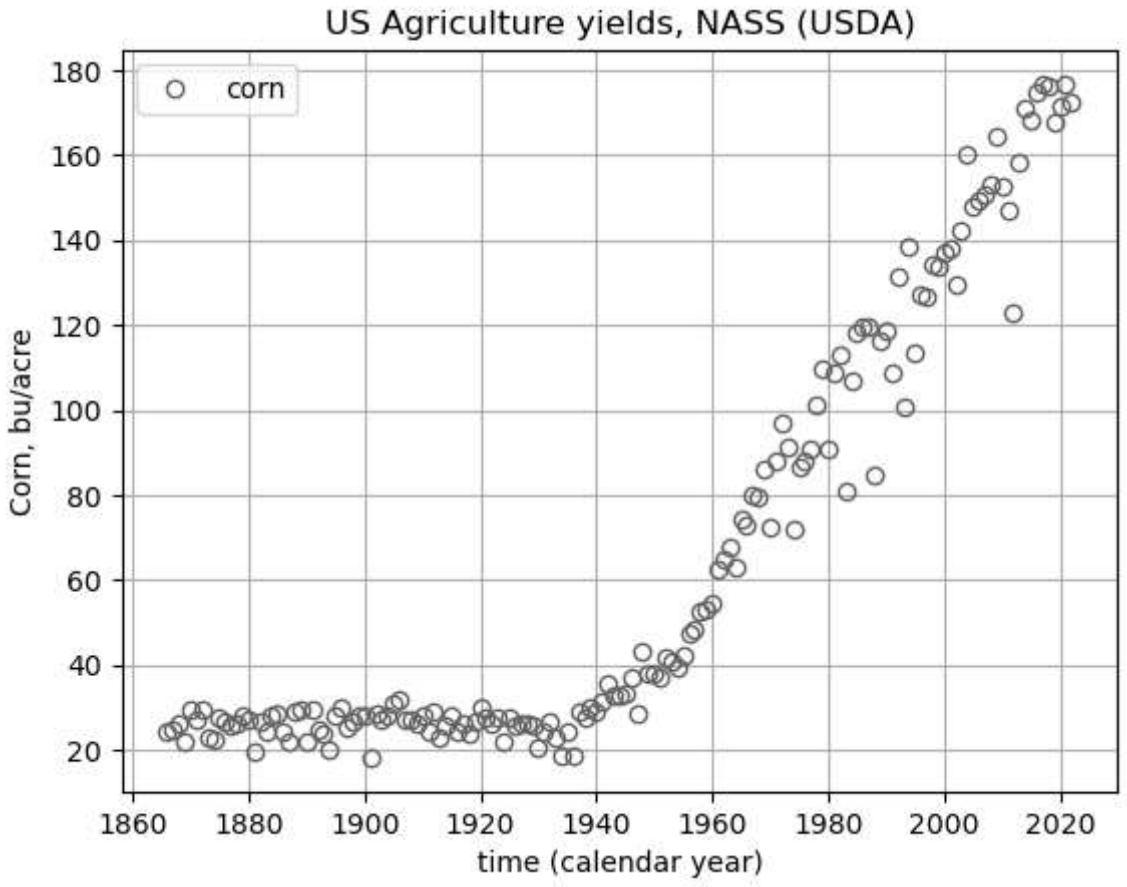
In [2]:
```
csv=np.genfromtxt ('./data/corn.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[2]:
```
array([[   nan, 2022. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,  172.3,    nan],
       [   nan, 2021. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,  176.7,    nan],
       [   nan, 2020. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,  171.4,    nan]])
```

In [3]:
```
corn_year=csv[:,1]
corn_bu_per_acre=csv[:,-2]

grams_per_lbs=453.592
corn_lbs_per_bu=(56.0/1.0)
```

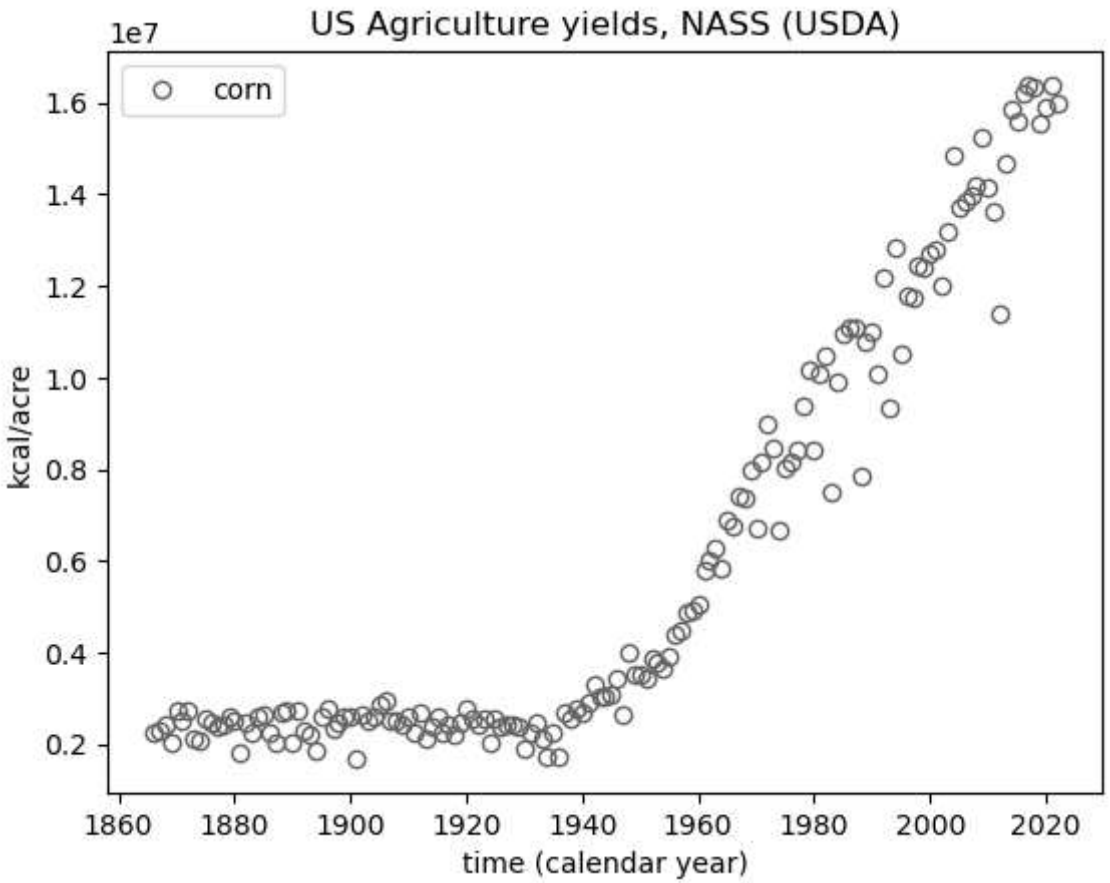
```
corn_kcal_per_gram=(365/100)
corn_kcal_per_acre = corn_bu_per_acre*corn_lbs_per_bu*grams_per_lbs*corn_kcal_per_gram
```

In [32]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="corn")
plt.xlabel("time (calendar year)")
plt.ylabel("Corn, bu/acre")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.grid()

#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



In [5]:
```
plt.plot(corn_year,corn_kcal_per_acre,"o",markerfacecolor="none",label="corn")
plt.xlabel("time (calendar year)")
plt.ylabel("kcal/acre")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()

#plt.show()
#plt.savefig("bear-quadratic.pdf")
```

Out[5]:
```
<matplotlib.legend.Legend at 0x255cc993610>
```



Wheat

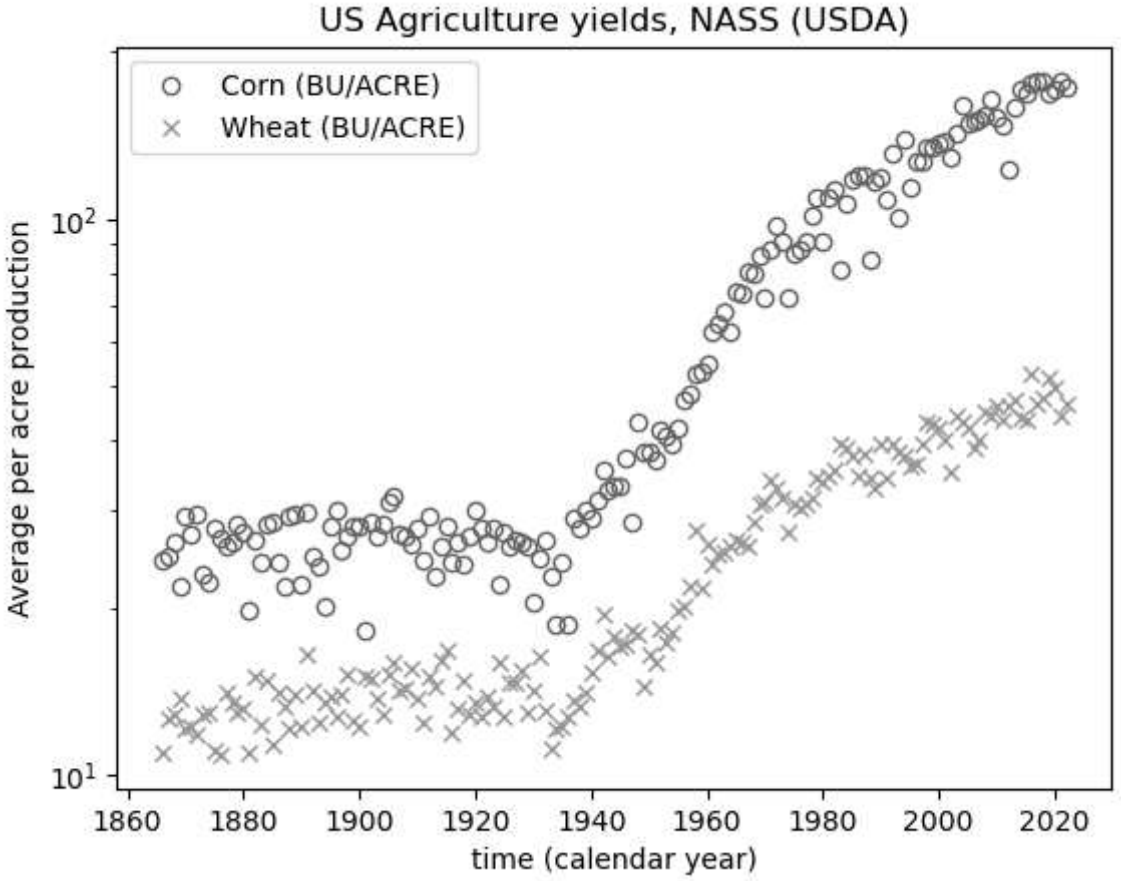
In [6]:
```
csv=np.genfromtxt ('./data/wheat.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[6]:
```
array([[   nan, 2022. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   46.5,    nan],
       [   nan, 2021. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   44.3,    nan],
       [   nan, 2020. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   49.7,    nan]])
```

In [7]:
```
wheat_year=csv[:,1]
wheat_bu_per_acre=csv[:,-2]

wheat_lbs_per_bu=60
#grams_per_lbs
wheat_kcal_per_gram=327.0/100.0

wheat_kcal_per_acre=wheat_bu_per_acre*wheat_lbs_per_bu*grams_per_lbs*wheat_kcal_per_gr
```

In [8]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
```

```
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.yscale("log")
#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



Potatoes

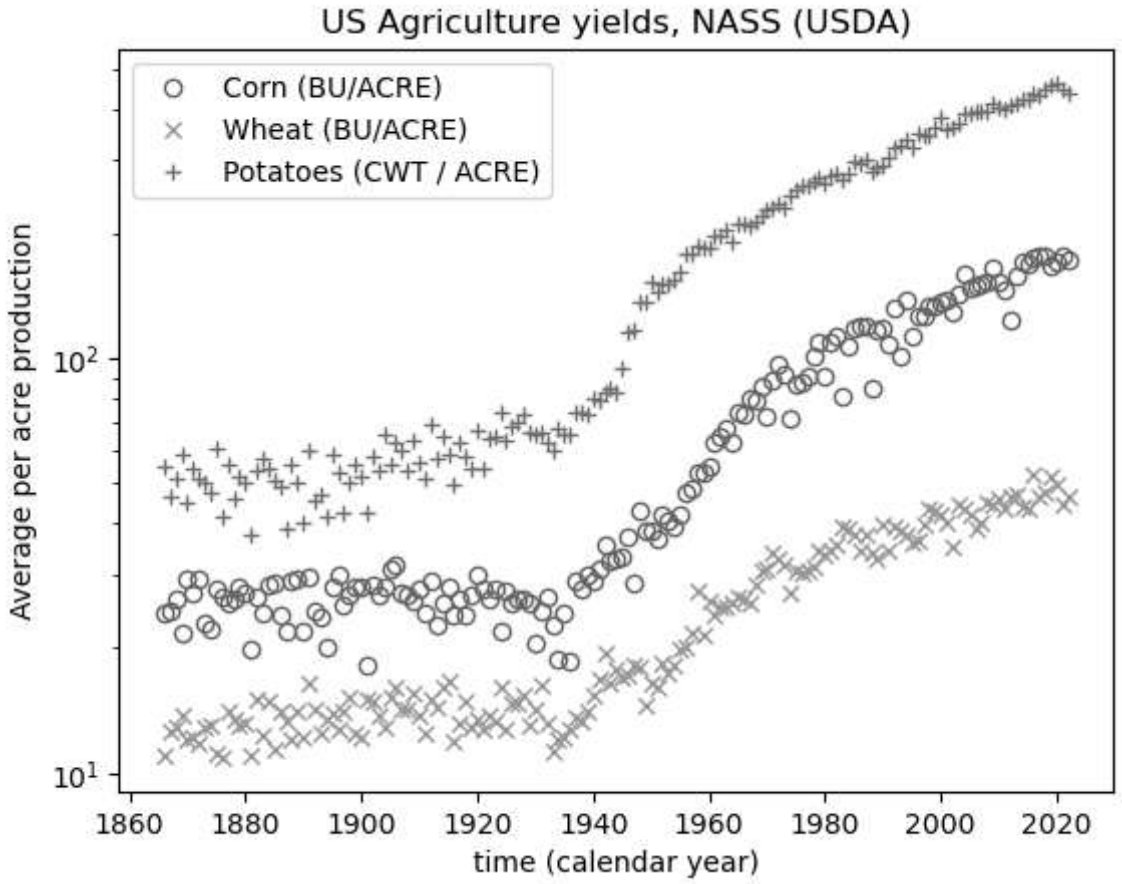
In [9]:
```
csv=np.genfromtxt ('./data/potatoes.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[9]:
```
array([[  nan, 2022.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
        438.,   nan],
       [  nan, 2021.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
        444.,   nan],
       [  nan, 2020.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
        461.,   nan]])
```

In [10]:
```
potatoes_year=csv[:,1]
potatoes_cwt_per_acre=csv[:,-2]

lbs_per_cwt=100
```

```
#grams_per_lbs
potatoes_kcal_per_gram=77.0/100.0
potatoes_kcal_per_acre=potatoes_cwt_per_acre*lbs_per_cwt*grams_per_lbs*potatoes_kcal_p
```

In [11]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
plt.plot(potatoes_year,potatoes_cwt_per_acre,"+",label="Potatoes (CWT / ACRE)")
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.yscale("log")
#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



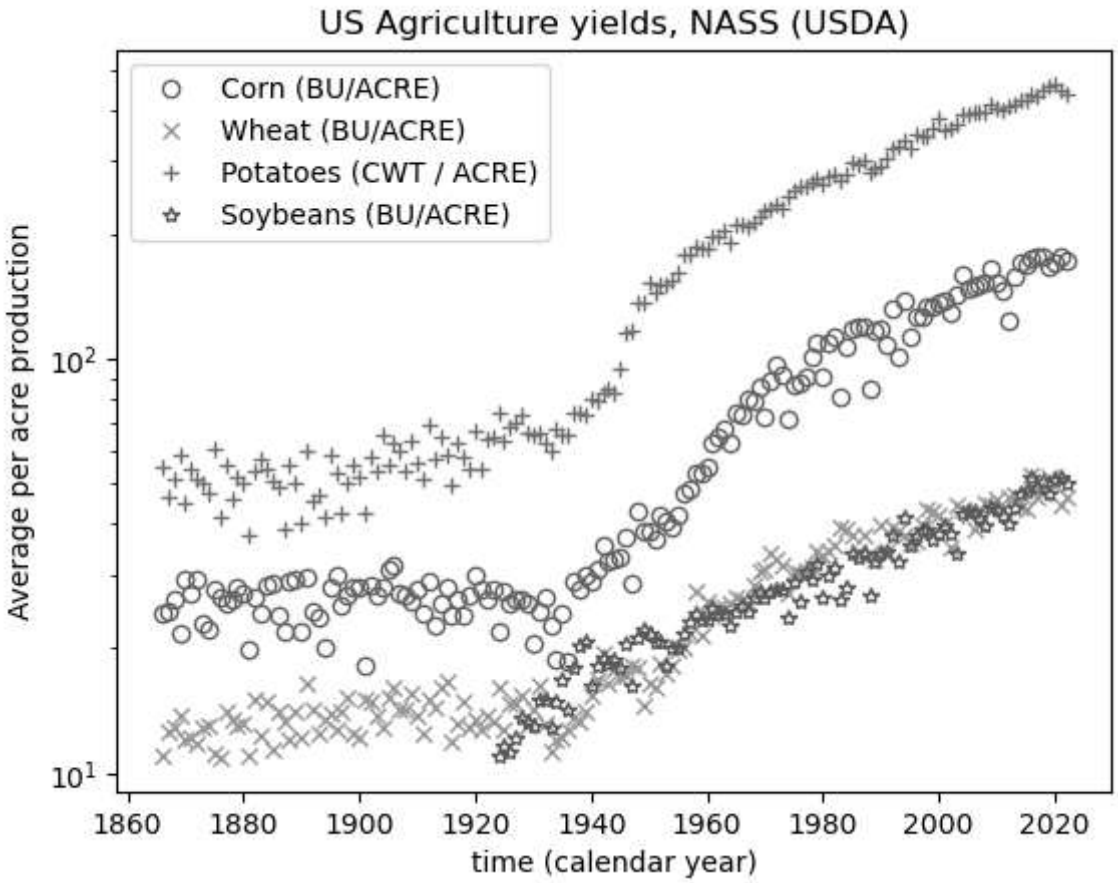
Soybeans

In [12]:
```
csv=np.genfromtxt ('./data/soybeans.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[12]:
```
array([[   nan, 2022. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   50.2,    nan],
       [   nan, 2021. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   51.7,    nan],
       [   nan, 2020. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   51. ,    nan]])
```

In [13]:
```
soybeans_year=csv[:,1]
soybeans_bu_per_acre=csv[:,-2]

soybeans_lbs_per_bu=60
#grams_per_lbs
soybeans_kcal_per_gram=446.0/100.0
soybeans_kcal_per_acre=soybeans_bu_per_acre*soybeans_lbs_per_bu*grams_per_lbs*soybeans
```

In [14]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
plt.plot(potatoes_year,potatoes_cwt_per_acre,"+",label="Potatoes (CWT / ACRE)")
plt.plot(soybeans_year,soybeans_bu_per_acre,"*",markerfacecolor="none",label="Soybeans
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.yscale("log")
#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



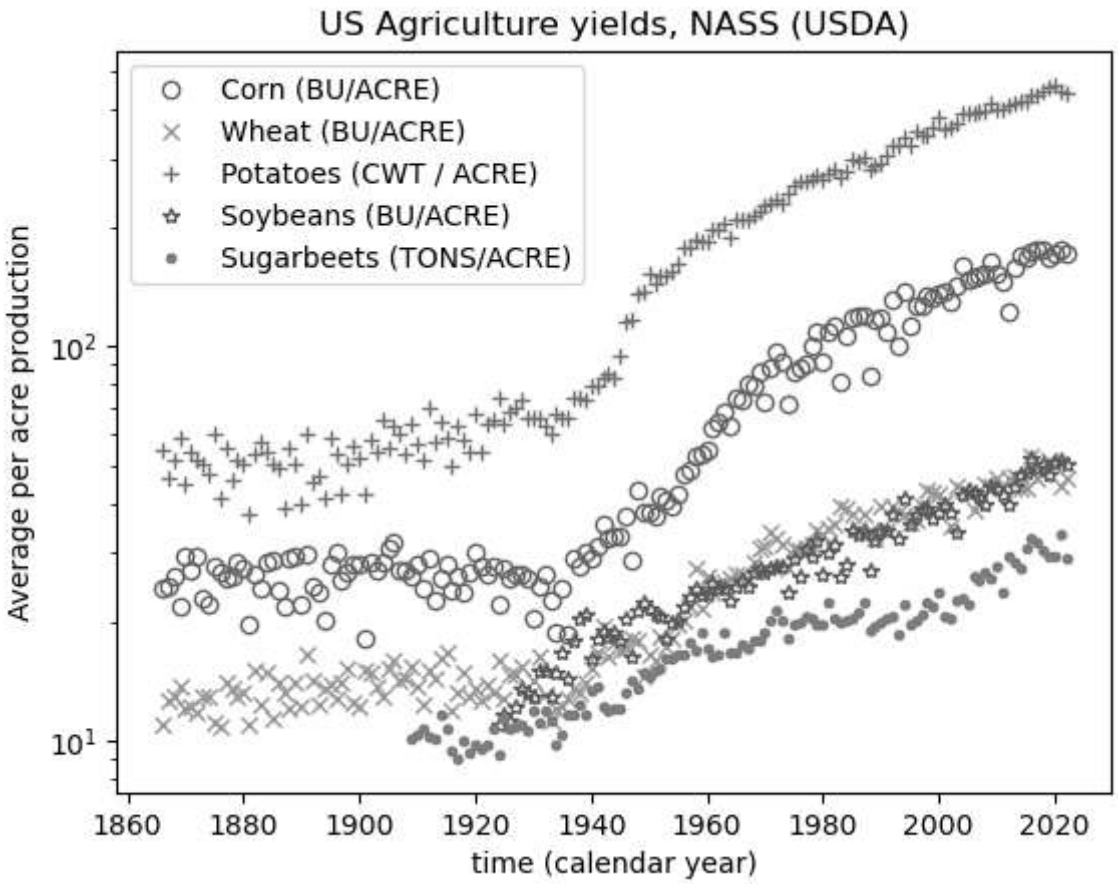
Sugarbeets

In [15]:
```
csv=np.genfromtxt ('./data/sugarbeets.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[15]:
```
array([[   nan, 2022. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   29.1,    nan],
       [   nan, 2021. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   33.2,    nan],
       [   nan, 2020. ,    nan,    nan,    nan,    nan,    nan,    nan,
           nan,    nan,    nan,    nan,    nan,    0. ,    nan,    nan,
           nan,    nan,   29.4,    nan]])
```

In [16]:
```
sugarbeets_year=csv[:,1]
sugarbeets_tons_per_acre=csv[:,-2]
```

In [17]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
plt.plot(potatoes_year,potatoes_cwt_per_acre,"+",label="Potatoes (CWT / ACRE)")
plt.plot(soybeans_year,soybeans_bu_per_acre,"*",markerfacecolor="none",label="Soybeans
plt.plot(sugarbeets_year,sugarbeets_tons_per_acre,".",label="Sugarbeets (TONS/ACRE)")
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.yscale("log")
#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



Sunflowers

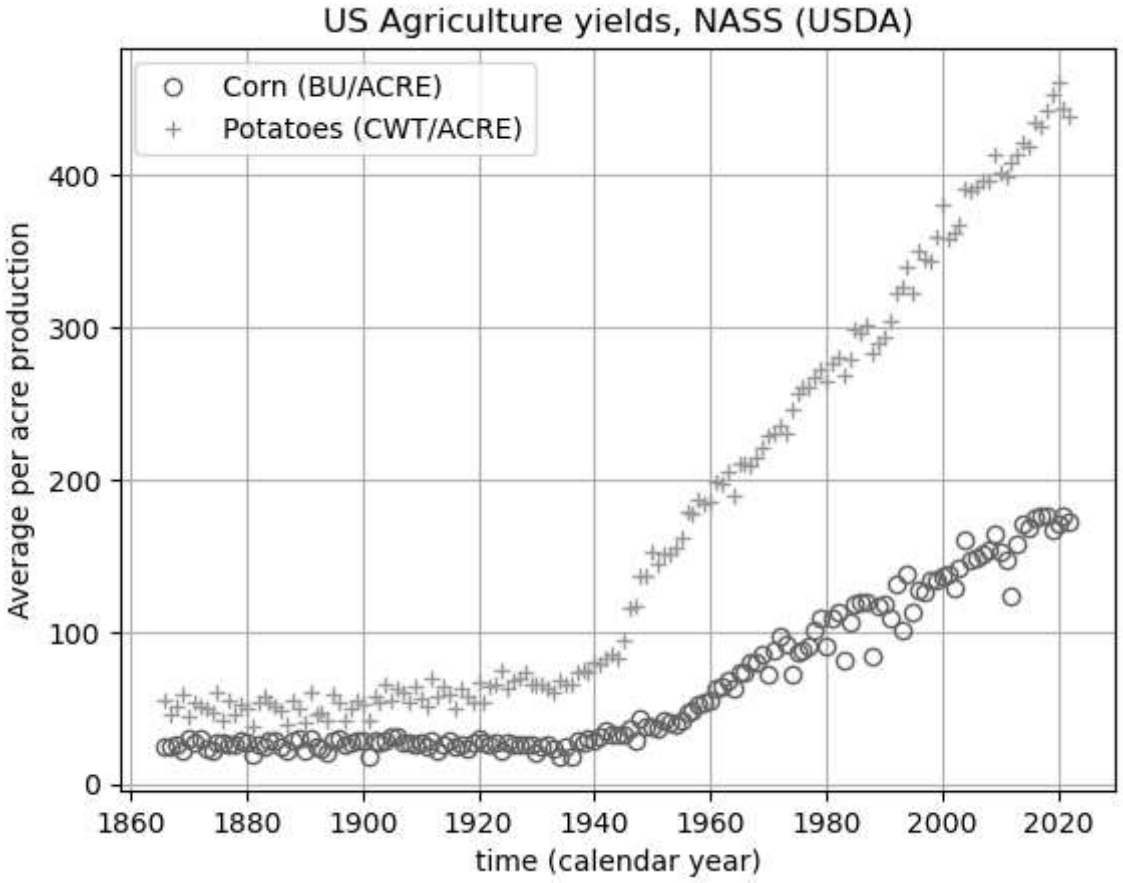
In [18]:
```
csv=np.genfromtxt ('./data/sunflowers.csv',
                   skip_header=1,
                   delimiter=",")
csv[0:3]
#csv[0:3].astype(float)
```

Out[18]:
```
array([[  nan, 2022.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
       1782.,   nan],
       [  nan, 2021.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
       1529.,   nan],
       [  nan, 2020.,   nan,   nan,   nan,   nan,   nan,   nan,   nan,
          nan,   nan,   nan,   nan,    0.,   nan,   nan,   nan,   nan,
       1790.,   nan]])
```

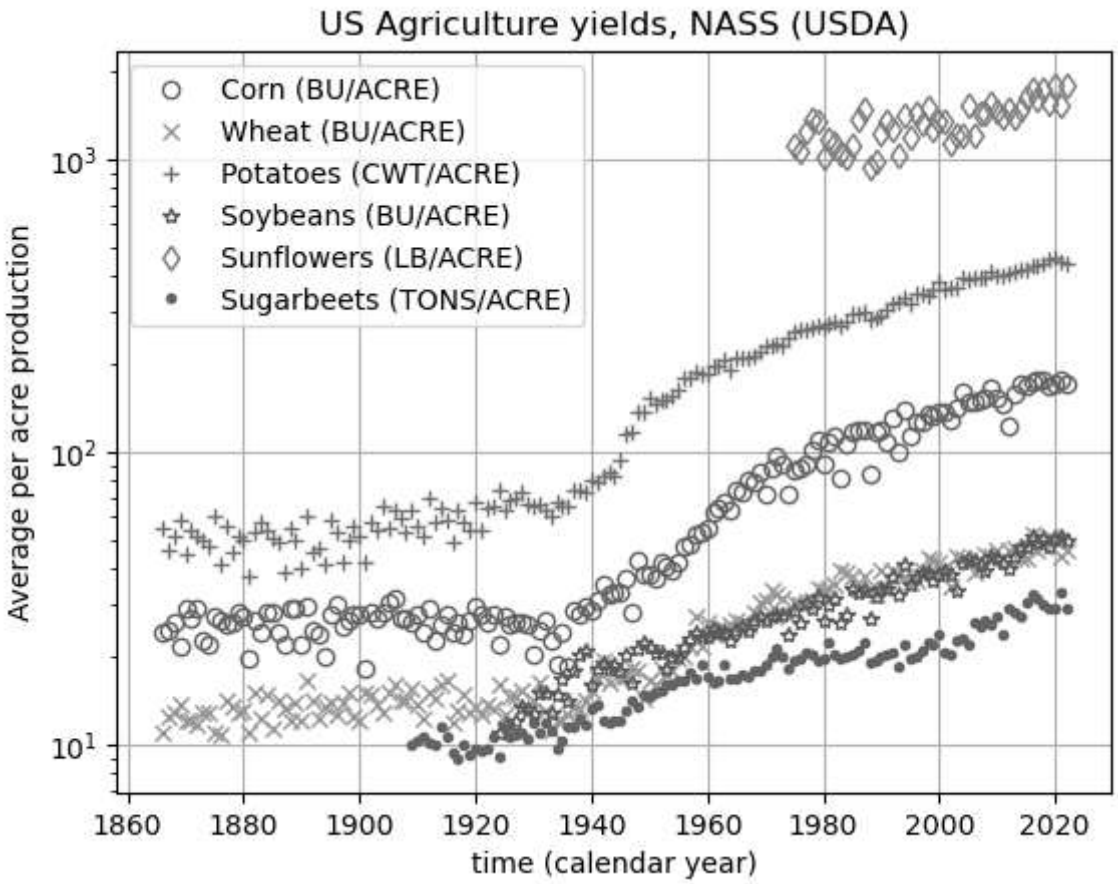
In [19]:
```
sunflowers_year=csv[:,1]
sunflowers_lbs_per_acre=csv[:,-2]

#grams_per_lbs
sunflowers_kcal_per_gram=584.0/100.0
sunflowers_kcal_per_acre=sunflowers_lbs_per_acre*grams_per_lbs*sunflowers_kcal_per_gra
```

In [34]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
#plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
plt.plot(potatoes_year,potatoes_cwt_per_acre,"+",label="Potatoes (CWT/ACRE)")
#plt.plot(soybeans_year,soybeans_bu_per_acre,"*",markerfacecolor="none",label="Soybear
```

```
#plt.plot(sunflowers_year,sunflowers_lbs_per_acre,"d",markerfacecolor="none",label="Su
#plt.plot(sugarbeets_year,sugarbeets_tons_per_acre,".",label="Sugarbeets (TONS/ACRE)")
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
#plt.yscale("log")
plt.grid()
#plt.show()
plt.savefig("corn_potatoes_raw_production_per_acre.pdf")
```



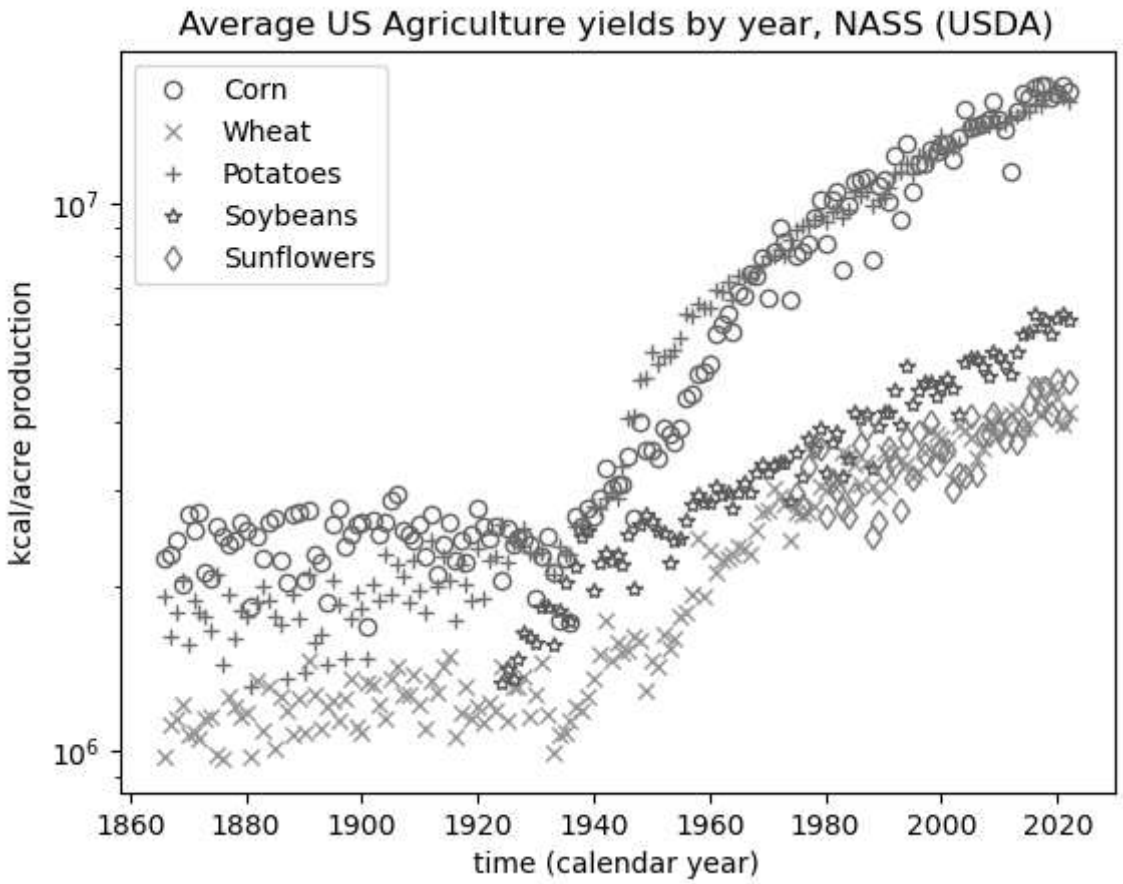
In [31]:
```
plt.plot(corn_year,corn_bu_per_acre,"o",markerfacecolor="none",label="Corn (BU/ACRE)")
plt.plot(wheat_year,wheat_bu_per_acre,"x",label="Wheat (BU/ACRE)")
plt.plot(potatoes_year,potatoes_cwt_per_acre,"+",label="Potatoes (CWT/ACRE)")
plt.plot(soybeans_year,soybeans_bu_per_acre,"*",markerfacecolor="none",label="Soybeans
plt.plot(sunflowers_year,sunflowers_lbs_per_acre,"d",markerfacecolor="none",label="Sun
plt.plot(sugarbeets_year,sugarbeets_tons_per_acre,".",label="Sugarbeets (TONS/ACRE)")
plt.xlabel("time (calendar year)")
plt.ylabel("Average per acre production")
plt.title("US Agriculture yields, NASS (USDA)")
plt.legend()
plt.yscale("log")
plt.grid()
#plt.show()
plt.savefig("raw_production_per_acre.pdf")
```



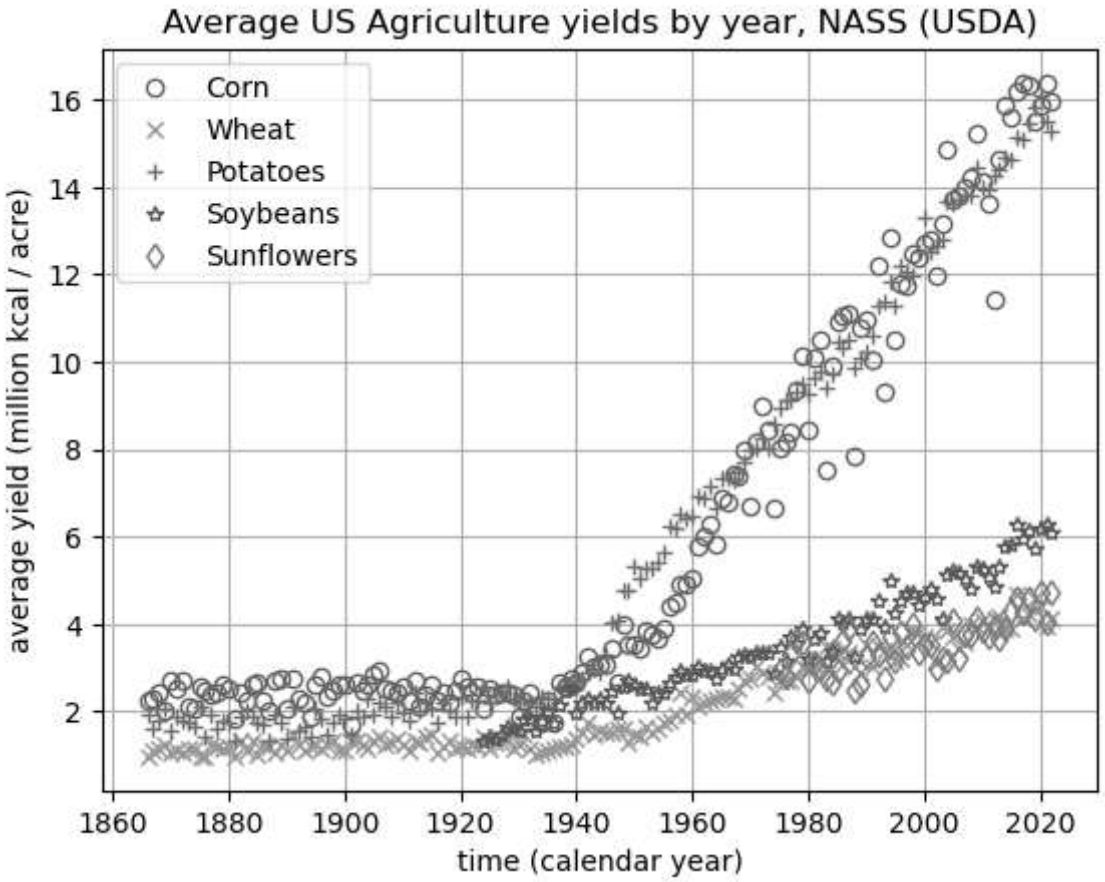
All together, kcal/acre

In [ ]:

In [21]:
```
plt.plot(corn_year,corn_kcal_per_acre,"o",markerfacecolor="none",label="Corn")
plt.plot(wheat_year,wheat_kcal_per_acre,"x",label="Wheat")
plt.plot(potatoes_year,potatoes_kcal_per_acre,"+",label="Potatoes")
plt.plot(soybeans_year,soybeans_kcal_per_acre,"*",markerfacecolor="none",label="Soybea
#plt.plot(sugarbeets_year,sugarbeets_kcal_per_acre,".",label="Sugarbeets")
plt.plot(sunflowers_year,sunflowers_kcal_per_acre,"d",markerfacecolor="none",label="Su
plt.xlabel("time (calendar year)")
plt.ylabel("kcal/acre production")
plt.title("Average US Agriculture yields by year, NASS (USDA)")
plt.legend()
plt.yscale("log")
#plt.show()
#plt.savefig("bear-quadratic.pdf")
```



In [29]:
```
plt.plot(corn_year,corn_kcal_per_acre/1.0e6,"o",markerfacecolor="none",label="Corn")
plt.plot(wheat_year,wheat_kcal_per_acre/1.0e6,"x",label="Wheat")
plt.plot(potatoes_year,potatoes_kcal_per_acre/1.0e6,"+",label="Potatoes")
plt.plot(soybeans_year,soybeans_kcal_per_acre/1.0e6,"*",markerfacecolor="none",label='
#plt.plot(sugarbeets_year,sugarbeets_kcal_per_acre,".",label="Sugarbeets")
plt.plot(sunflowers_year,sunflowers_kcal_per_acre/1.0e6,"d",markerfacecolor="none",lab
plt.xlabel("time (calendar year)")
plt.ylabel("average yield (million kcal / acre)")
plt.title("Average US Agriculture yields by year, NASS (USDA)")
plt.legend()
plt.grid()
#plt.yscale("log")
#plt.show()
plt.savefig("kcal_per_acre_yields.pdf")
```


Average US Agriculture yields by year, NASS (USDA)
Corn
Wheat
Potatoes
Soybeans
Sunflowers
average yield (million kcal / acre)
time (calendar year)
2
4
6
8
10
12
14
16
1860
1880
1900
1920
1940
1960
1980
2000
2020

In [ ]: