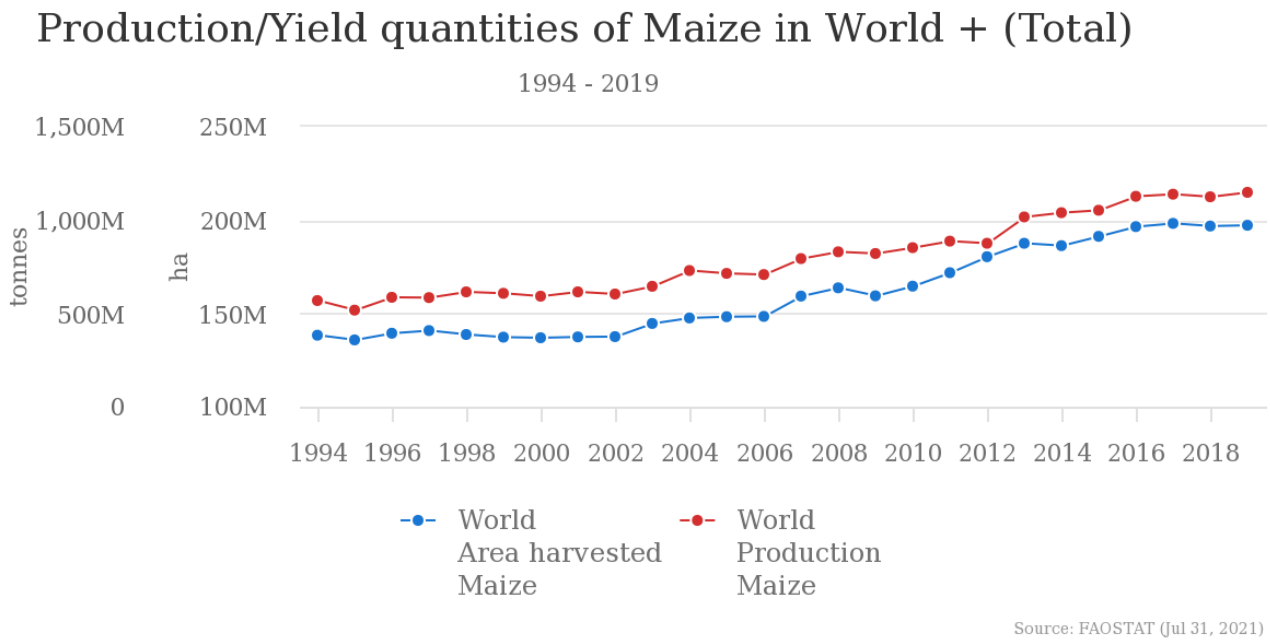
基于光利用效率模型对Illinois州玉米产量进行估算

报告人：符珊　　指导老师：袁文平教授

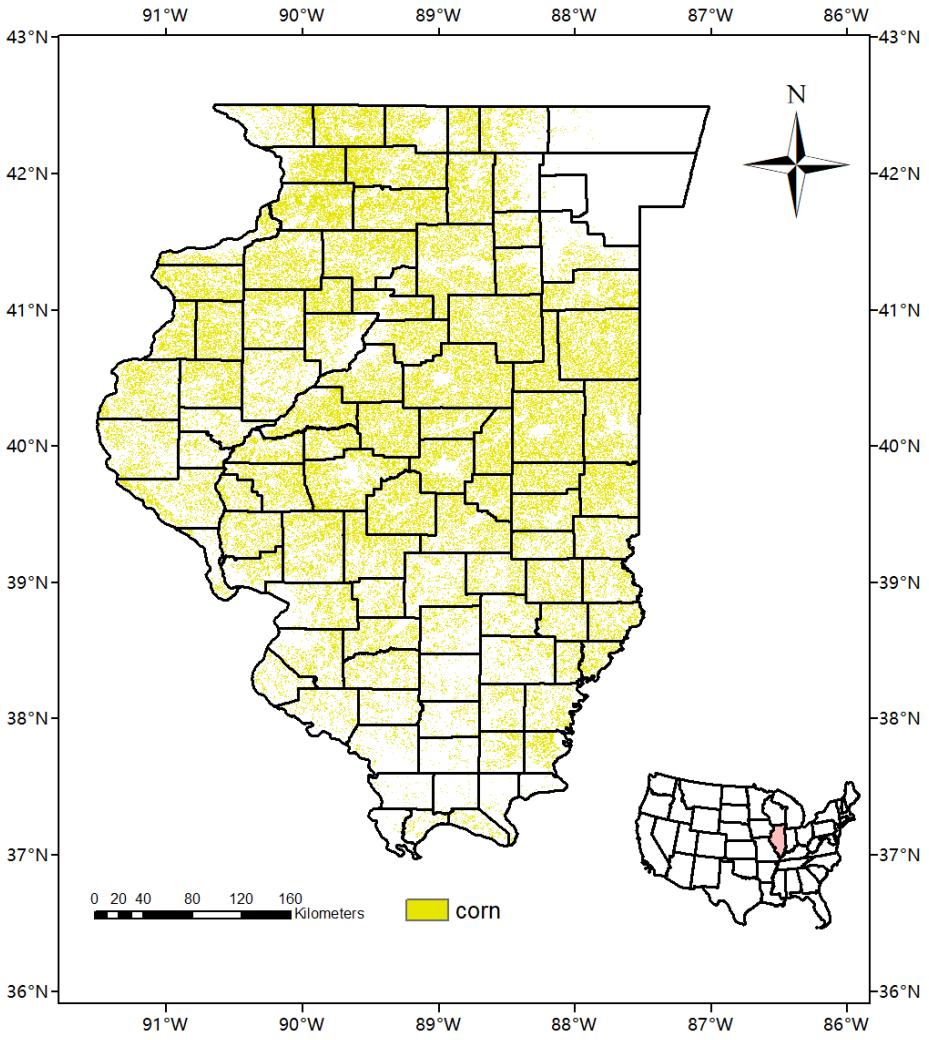
2021.7.31

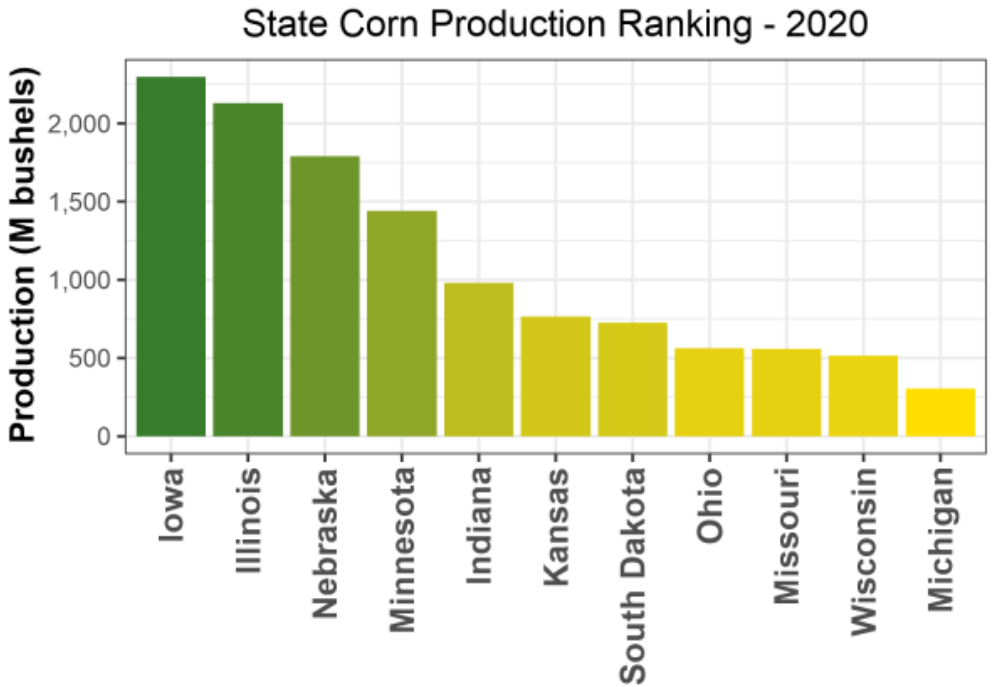
研究背景



- 2019年世界总产量10.4亿吨
- 全球第一大粮食作物

研究地点





- 2019年，75%的总面积用于农业生产
- 美国第二大玉米生产州，2019年玉米产量占美国15%
- 研究时间2009年-2019年

研究方法

$$GPP = PAR * fPAR * \varepsilon_{max} * \min(T_s, W_s)$$

$$fPAR = 1.24 * NDVI - 0.168$$

$$T_S = \frac{(T - T_{min}) \times (T - T_{max})}{(T - T_{min}) \times (T - T_{max}) - (T - T_{opt})^2}$$

$$W_S = \frac{VPD_{max} - VPD}{VPD_{max} - VPD_{min}}$$

$$VPD = \begin{cases} VPD_a = e_{sat}(T_a) - e_a \\ VPD_l = e_{sat}(T_{leaf}) - e_a \end{cases}$$

$$Yield = GPP * AR * \frac{1}{1+RS} * \frac{1}{1-MC} * HI$$

$Yield$:县级统计单产

AR :除去自养呼吸后剩下的部分

RS :根冠比

MC ： 收获谷物含水量

HI： 收获指数

$Yield$偏差校正

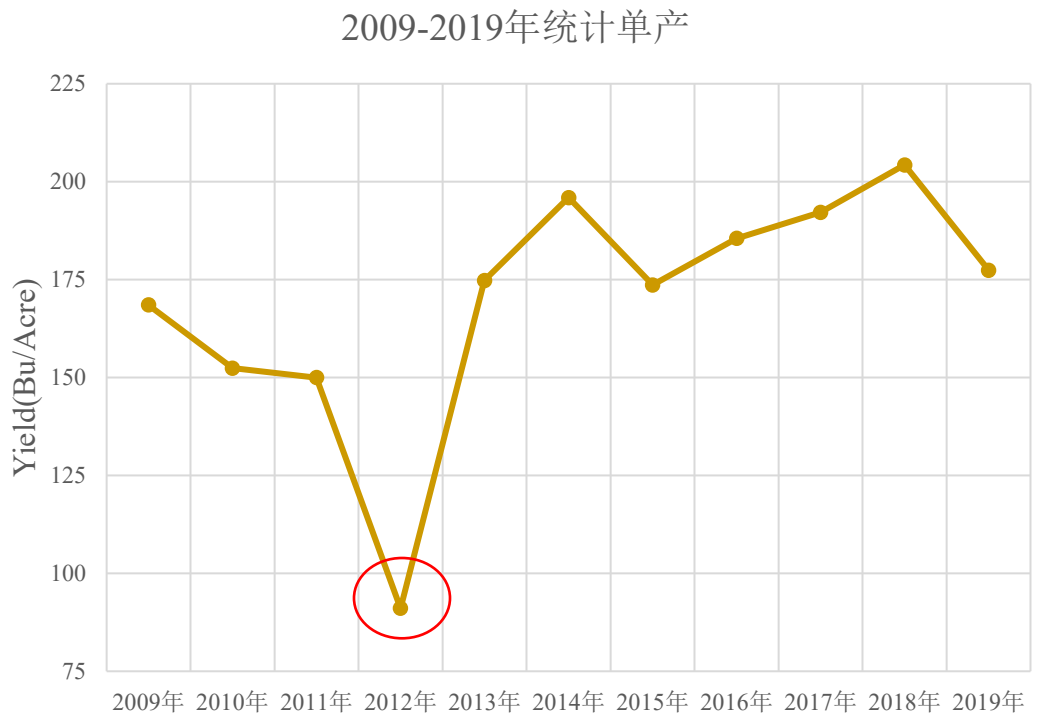
$$Yield = GPP * AR * \frac{1}{1+RS} * HI * \frac{1}{1-MC} + c(n)$$

$$c(n) = \frac{1}{4} \sum_{i=n-4}^{n-1} y(i) - e(i)$$

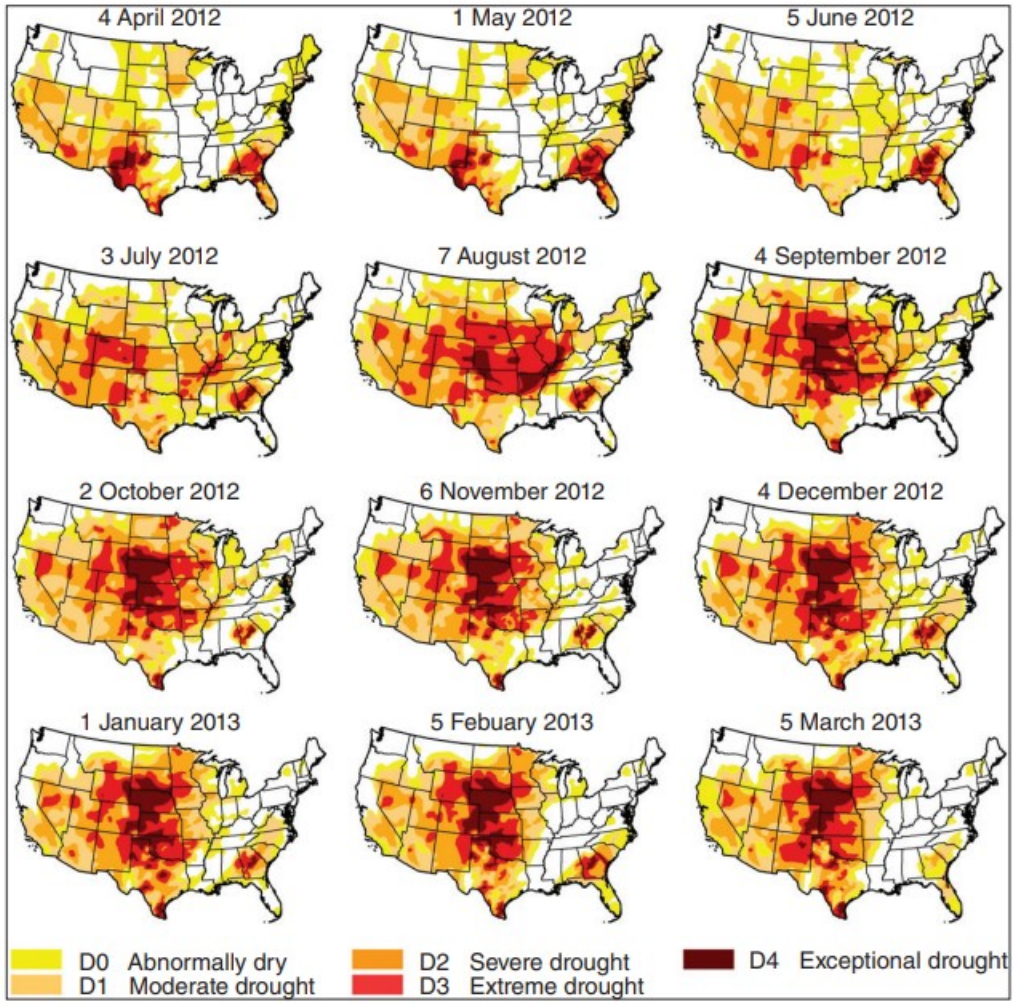
研究数据

- MERRA-2： photosynthetically active radiation (PAR), air temperature (T_a), dew point temperature(T_d)
- Landsat 5,7,8: Normalized Difference Vegetation Index(NDVI)
- MODIS：land surface temperature (LST)
- 时间分辨率：16d

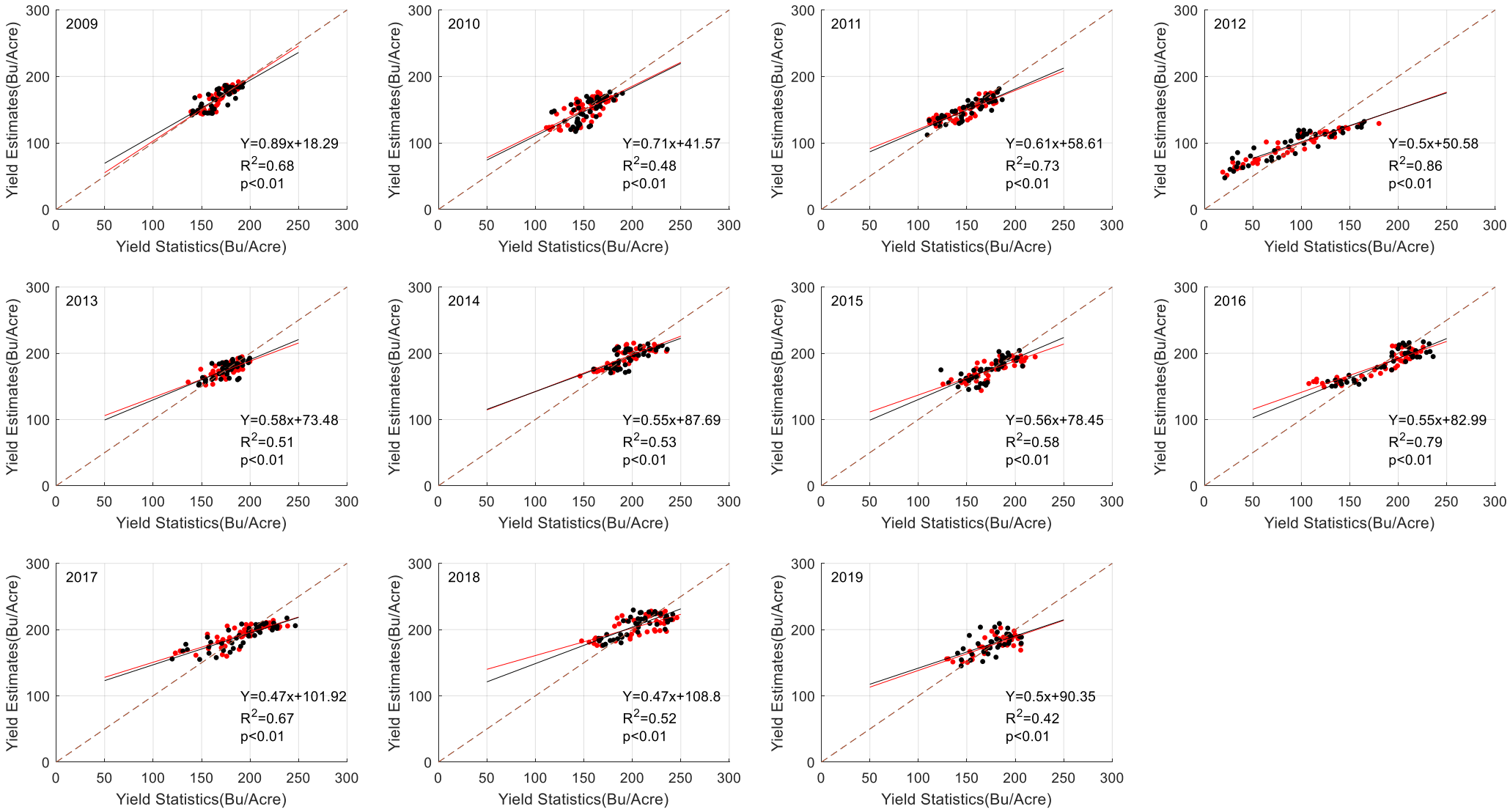
结果



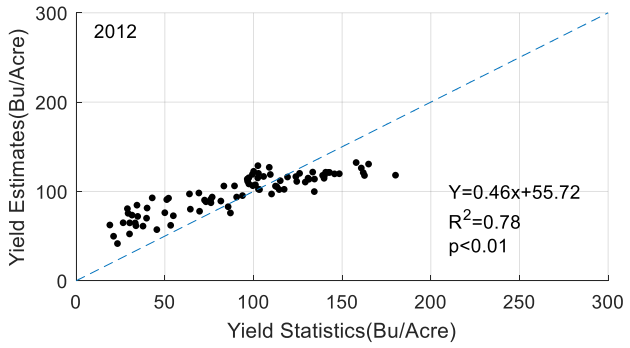
- 2012年极端干旱导致产量下降至正常年份50%左右

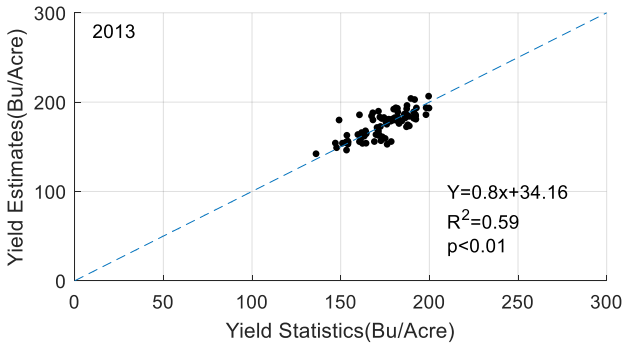


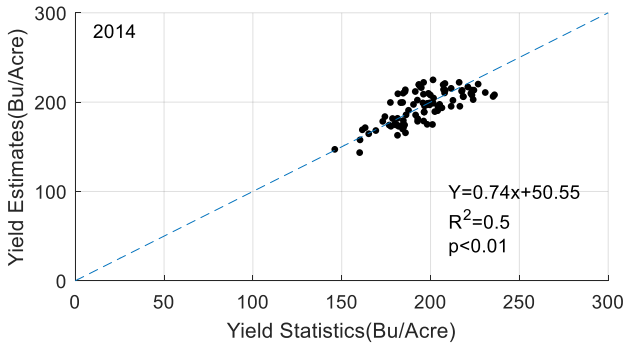
未校正结果-VPD_a

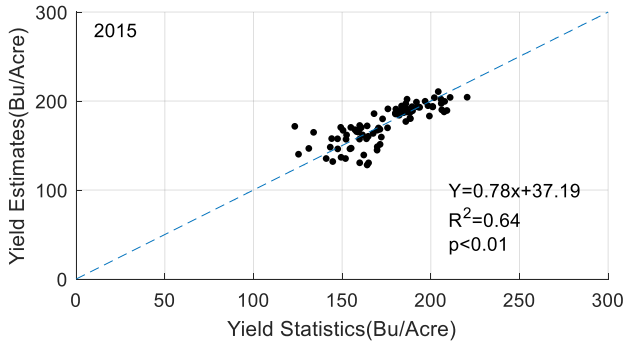

2009
Y=0.89x+18.29
R2=0.68
p<0.01
2010
Y=0.71x+41.57
R2=0.48
p<0.01
2011
Y=0.61x+58.61
R2=0.73
p<0.01
2012
Y=0.5x+50.58
R2=0.86
p<0.01
2013
Y=0.58x+73.48
R2=0.51
p<0.01
2014
Y=0.55x+87.69
R2=0.53
p<0.01
2015
Y=0.56x+78.45
R2=0.58
p<0.01
2016
Y=0.55x+82.99
R2=0.79
p<0.01
2017
Y=0.47x+101.92
R2=0.67
p<0.01
2018
Y=0.47x+108.8
R2=0.52
p<0.01
2019
Y=0.5x+90.35
R2=0.42
p<0.01
Yield Estimates(Bu/Acre)
Yield Statistics(Bu/Acre)
0
50
100
150
200
250
300

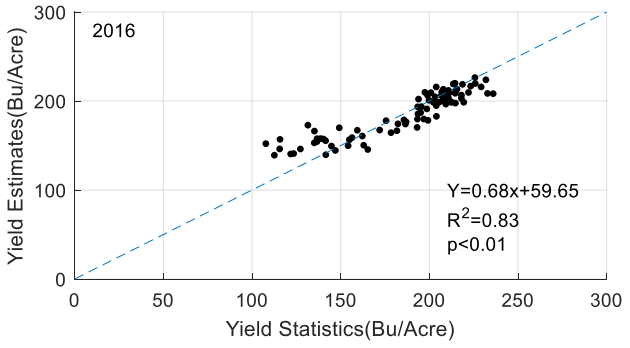
偏差校正后结果, VPD_a

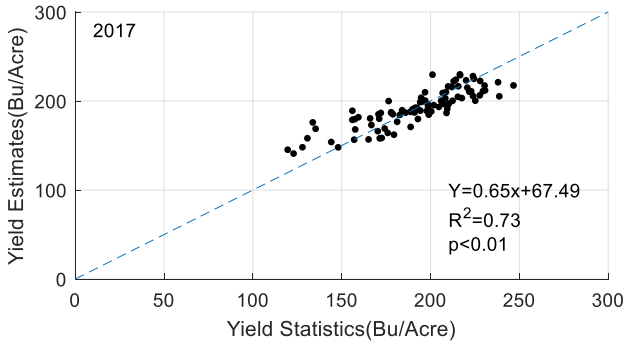


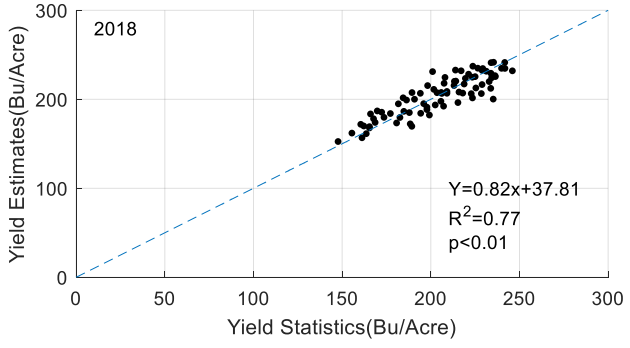


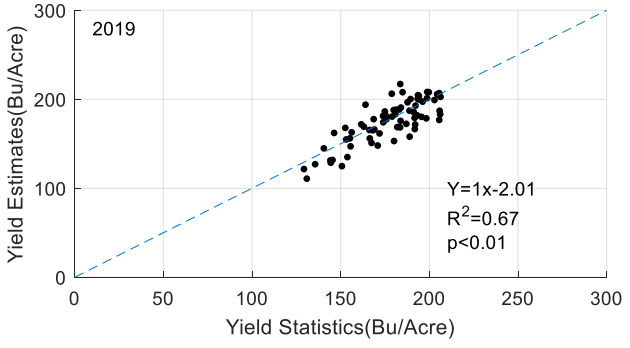




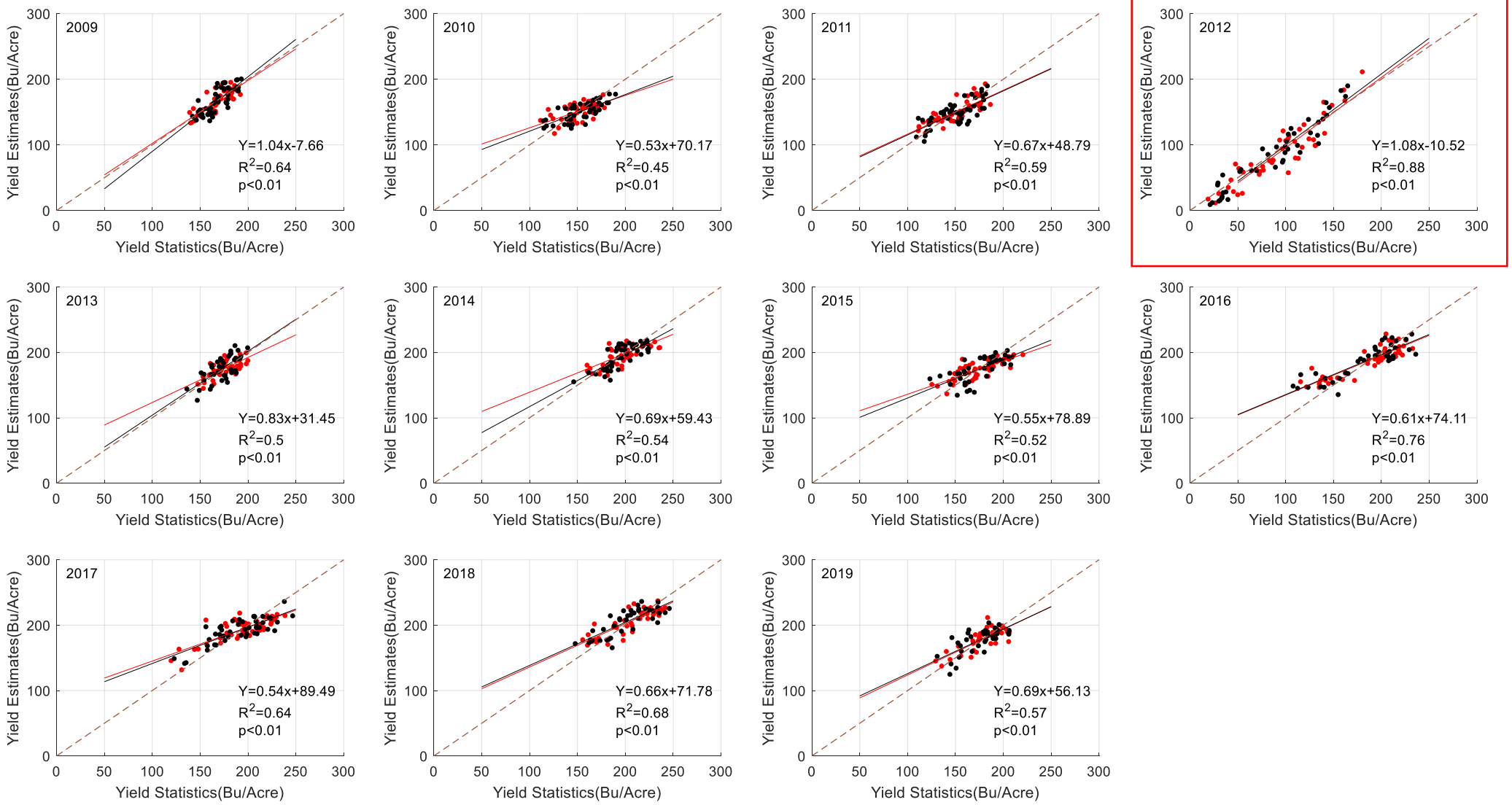




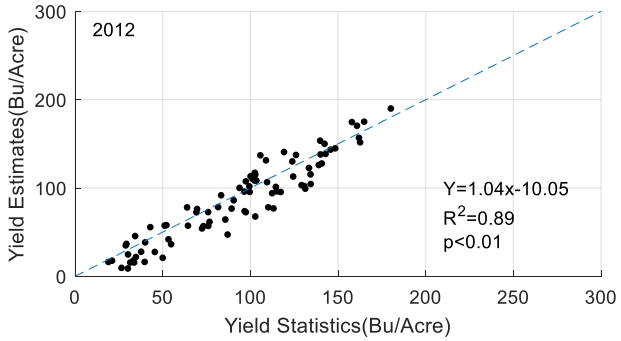


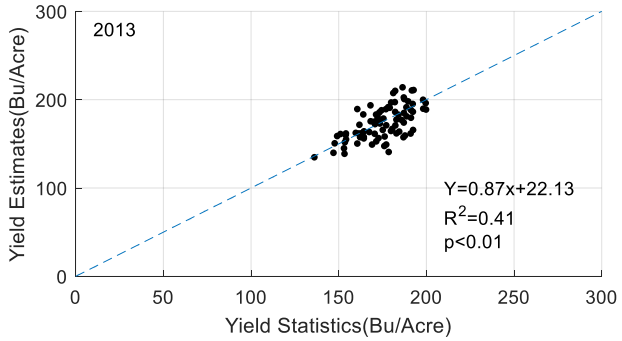


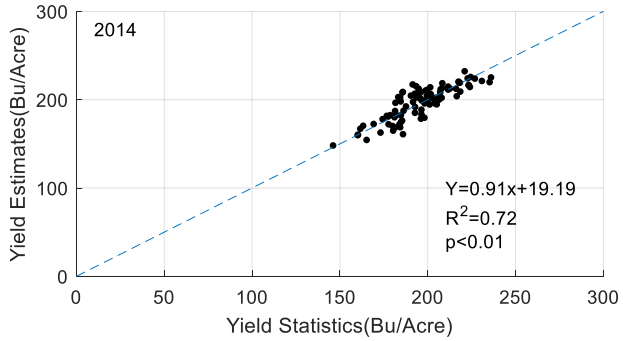
未校正结果 – VPD_l

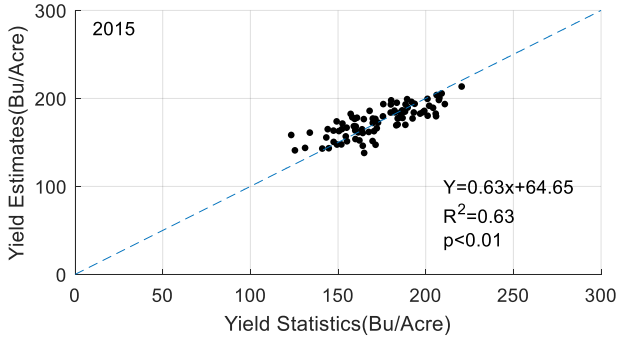

2009
Y=1.04x-7.66
R2=0.64
p<0.01
2010
Y=0.53x+70.17
R2=0.45
p<0.01
2011
Y=0.67x+48.79
R2=0.59
p<0.01
2012
Y=1.08x-10.52
R2=0.88
p<0.01
2013
Y=0.83x+31.45
R2=0.5
p<0.01
2014
Y=0.69x+59.43
R2=0.54
p<0.01
2015
Y=0.55x+78.89
R2=0.52
p<0.01
2016
Y=0.61x+74.11
R2=0.76
p<0.01
2017
Y=0.54x+89.49
R2=0.64
p<0.01
2018
Y=0.66x+71.78
R2=0.68
p<0.01
2019
Y=0.69x+56.13
R2=0.57
p<0.01
Yield Estimates(Bu/Acre)
Yield Statistics(Bu/Acre)
0
50
100
150
200
250
300

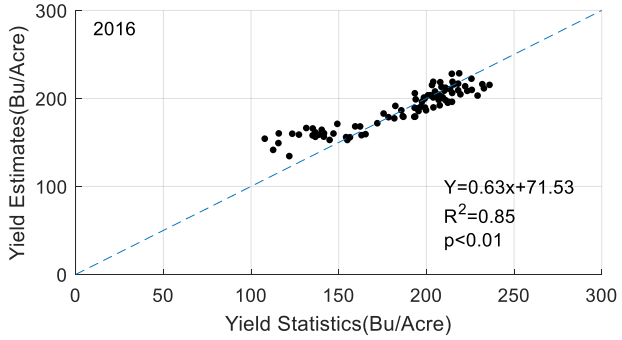
偏差校正后结果,VPD_l

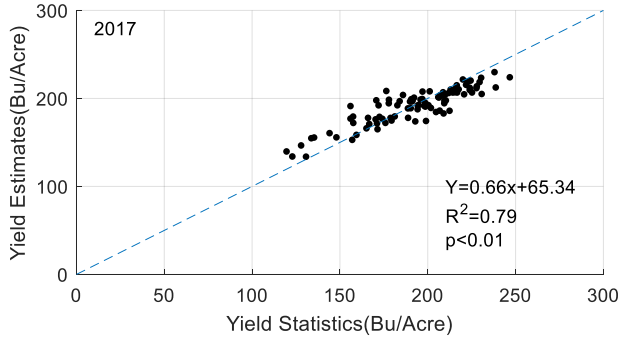


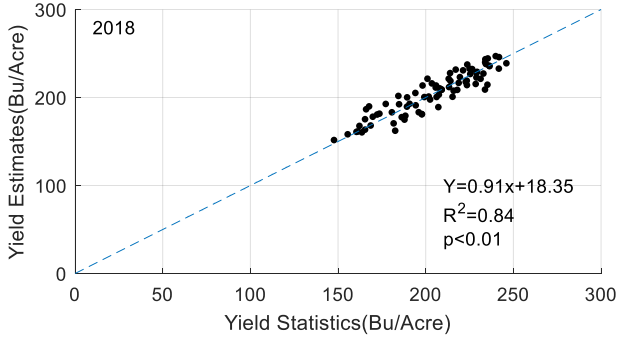


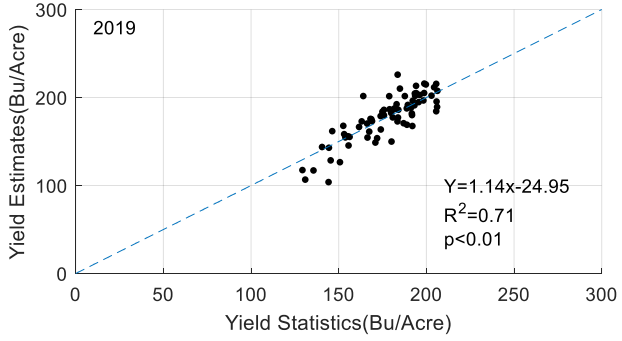




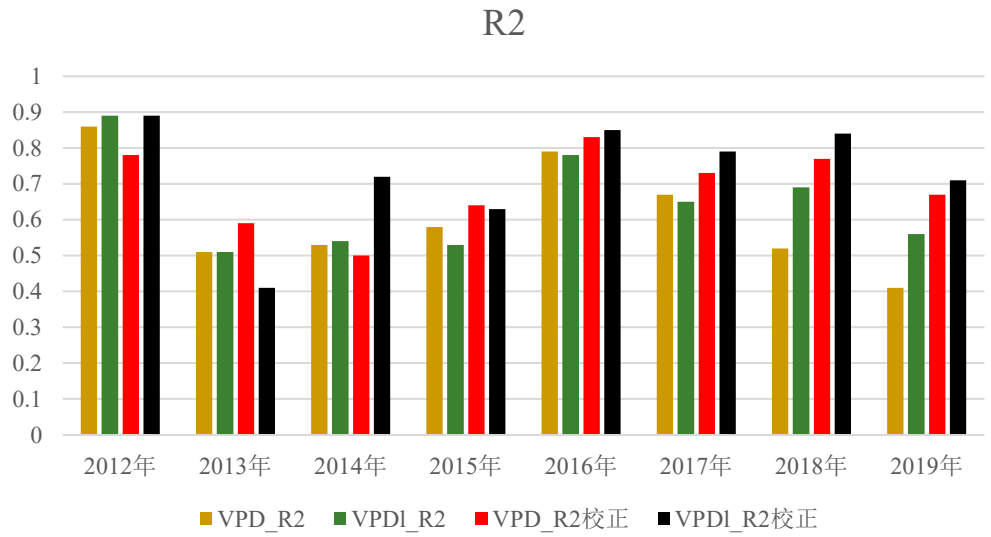


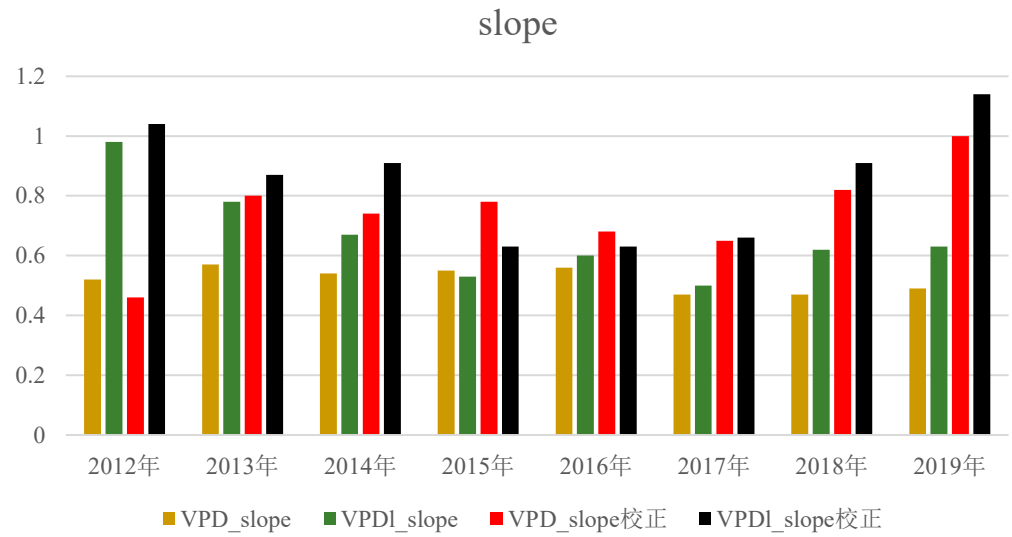


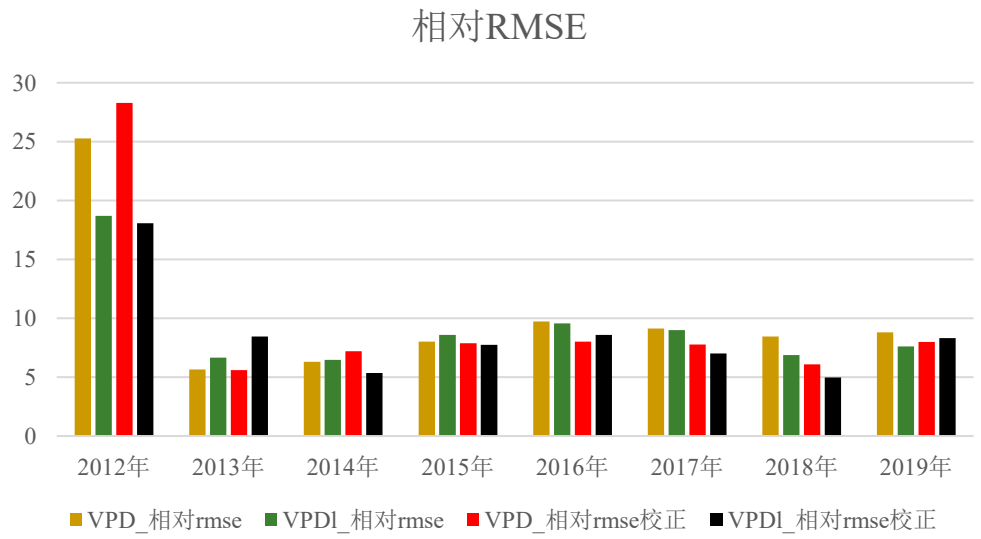




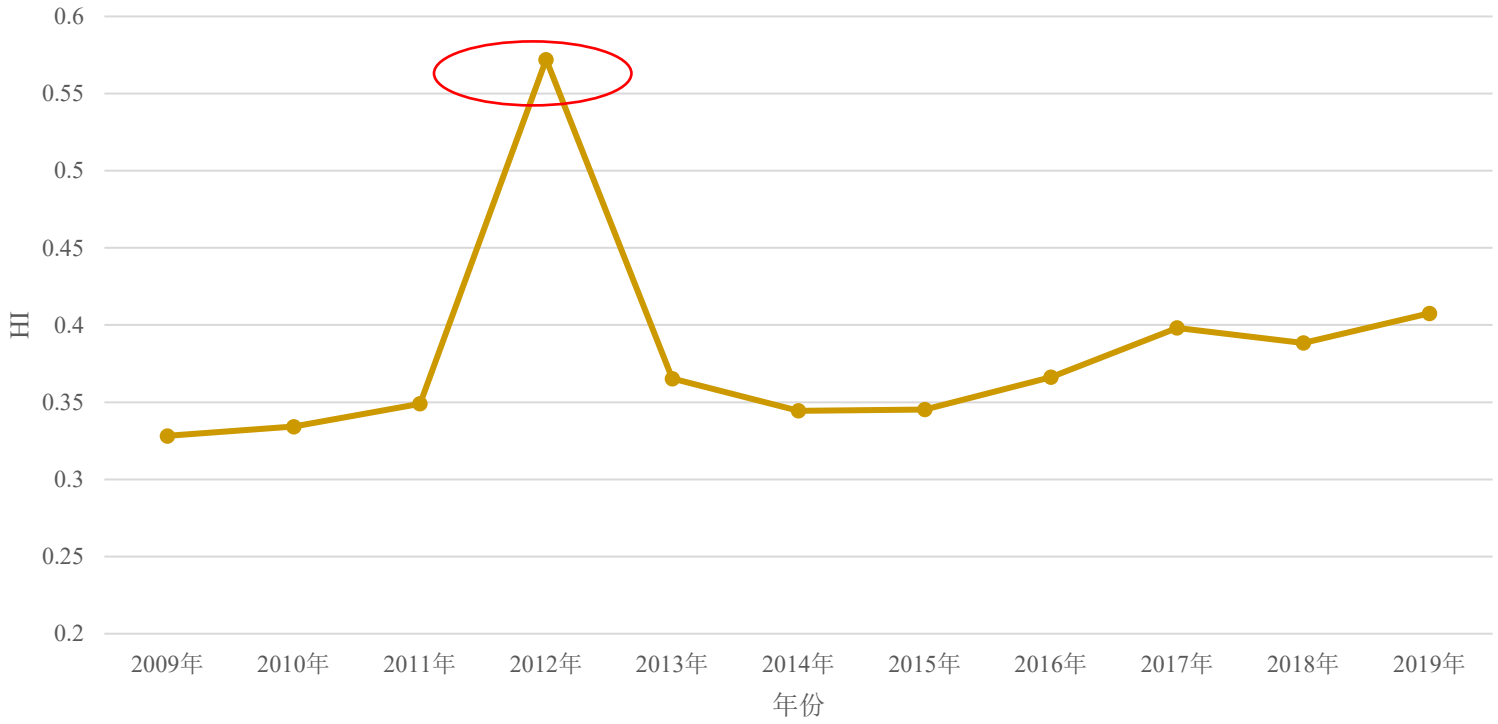
四种情况R2、slope、相对RMSE对比





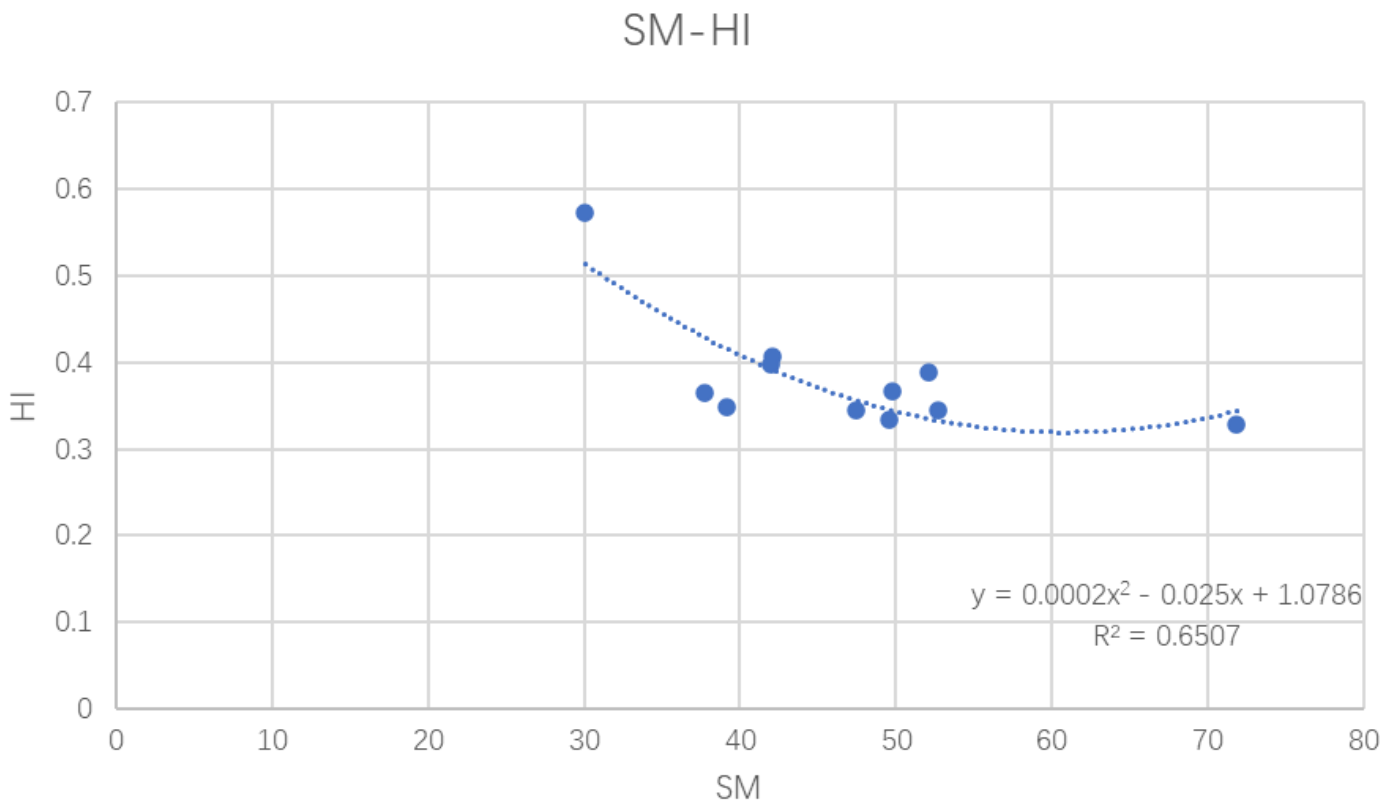


HI年际波动- VPD_l



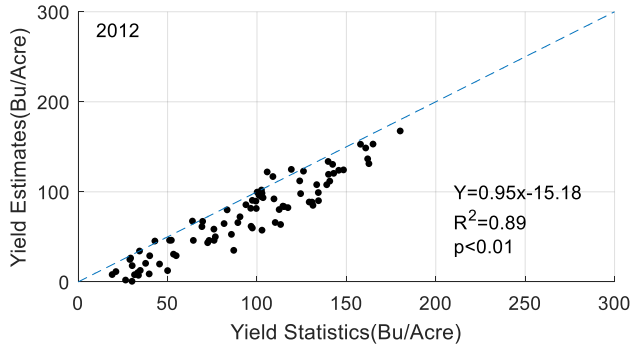
HI存在年际波动，如何做预测？

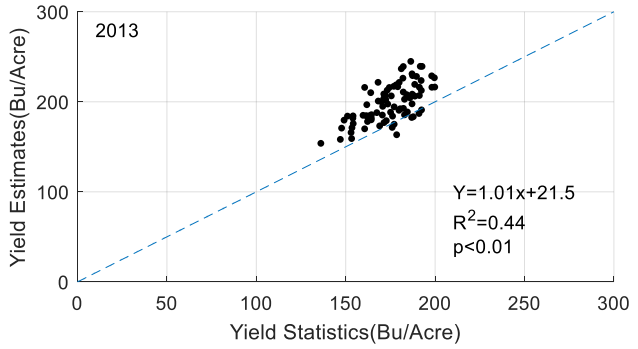
SM与HI（VPD_l）存在良好的关系

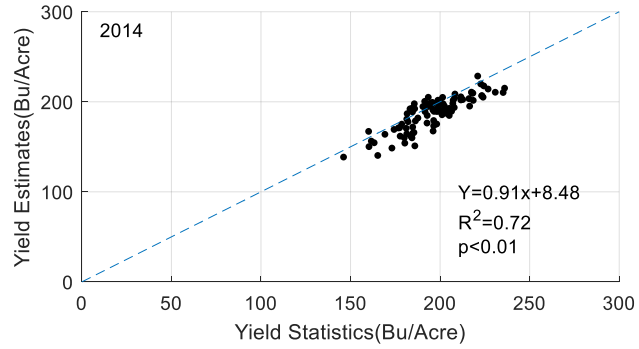


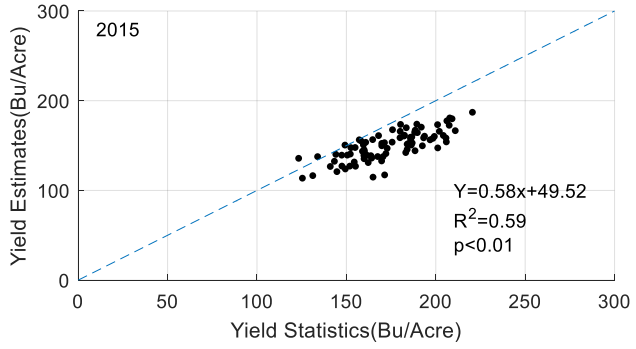
实现利用关系反推HI

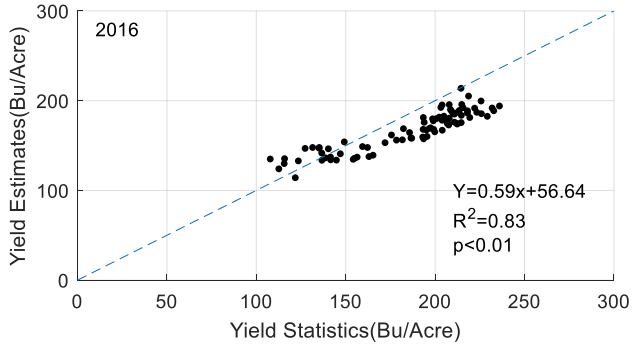
带入反推的HI计算产量，并修正

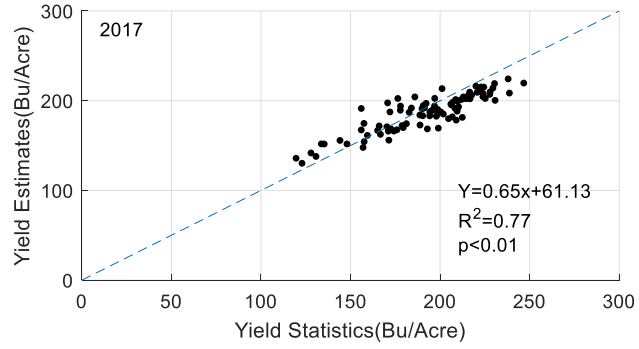


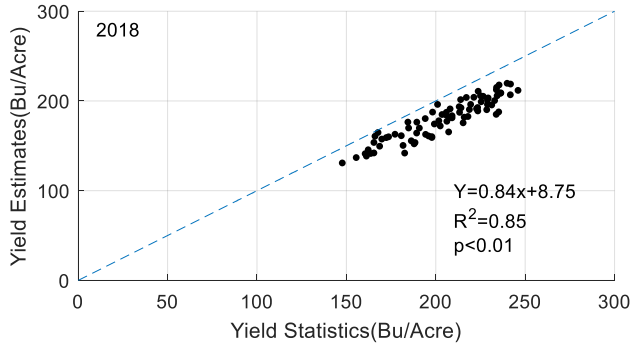


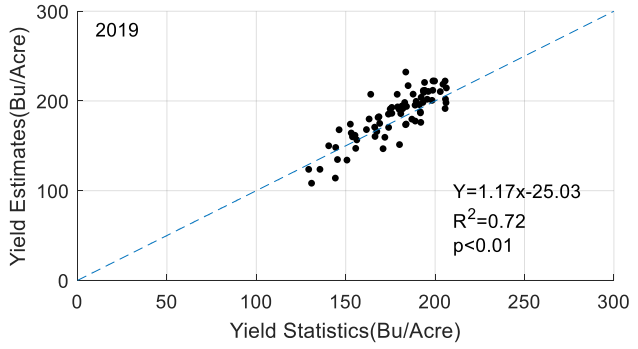






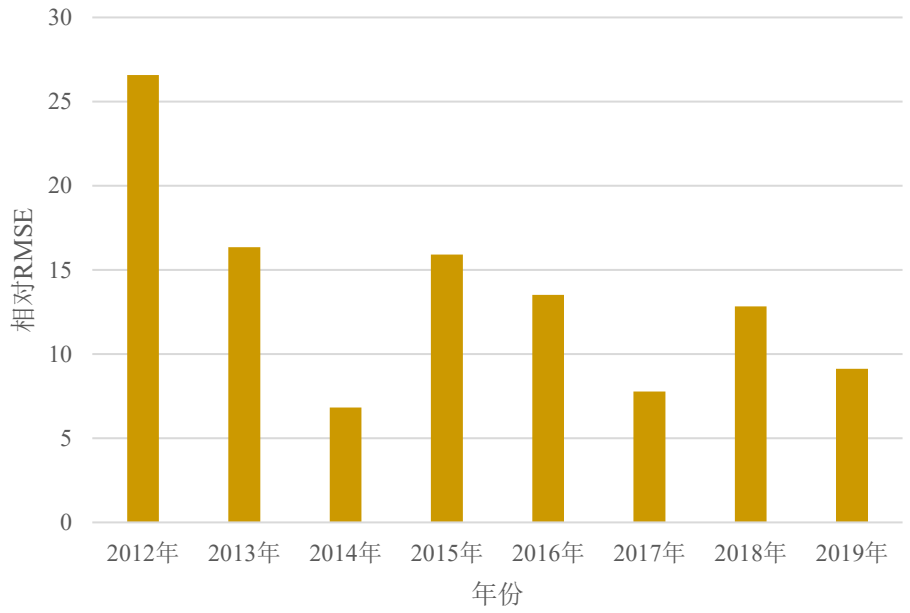




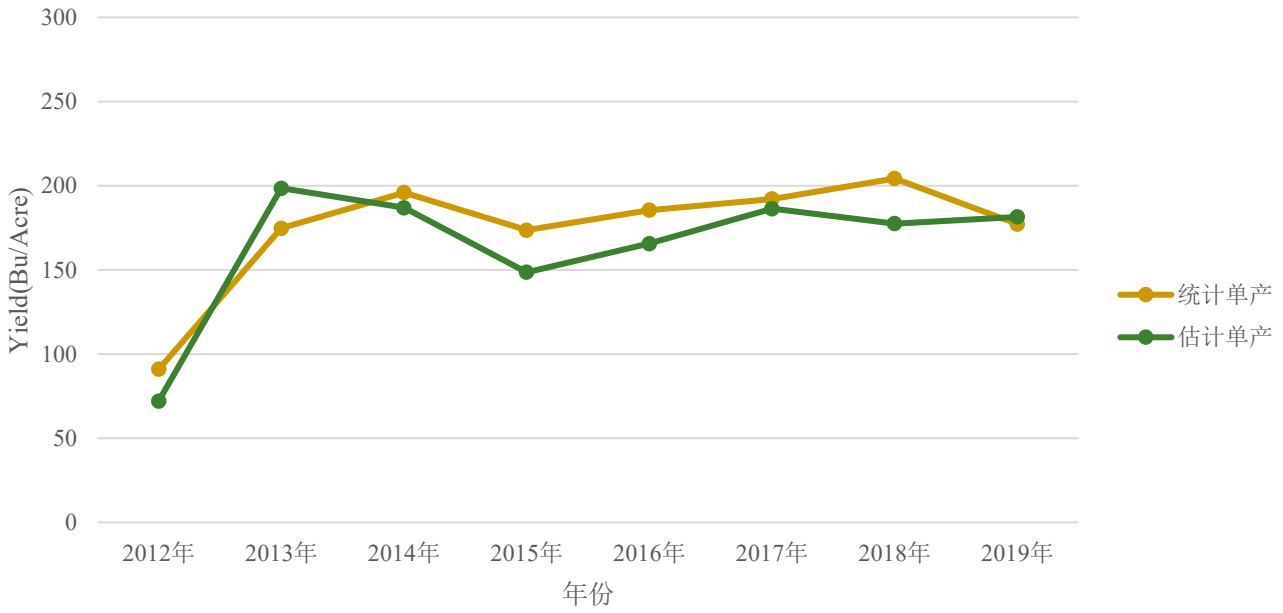


带入预测HI计算的产量误差分析

相对RMSE



州级均产



Thank you!