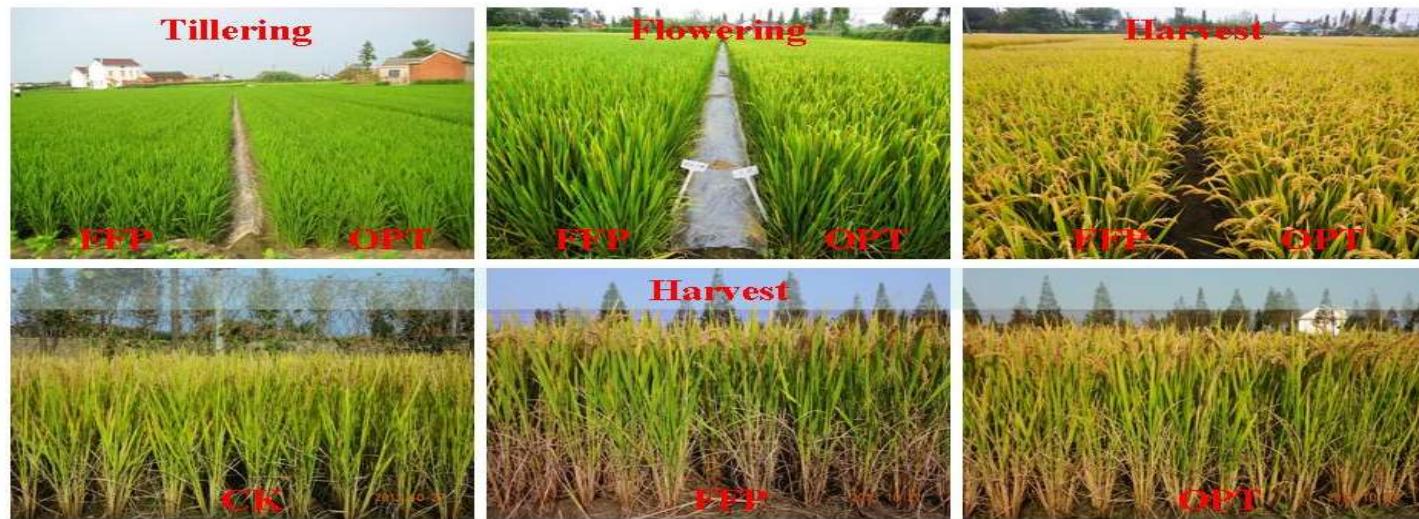


## 13th IPI-CAU-ISSAS International Symposium

# The effects of K fertilizer and straw returning on crop yield and soil K status

Dr. Shiwei Guo, Kailiu Xie, Junjie Guo and Min Wang

Nanjing Agricultural University

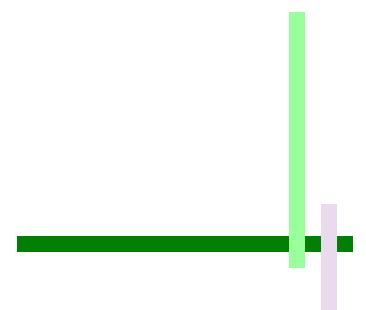
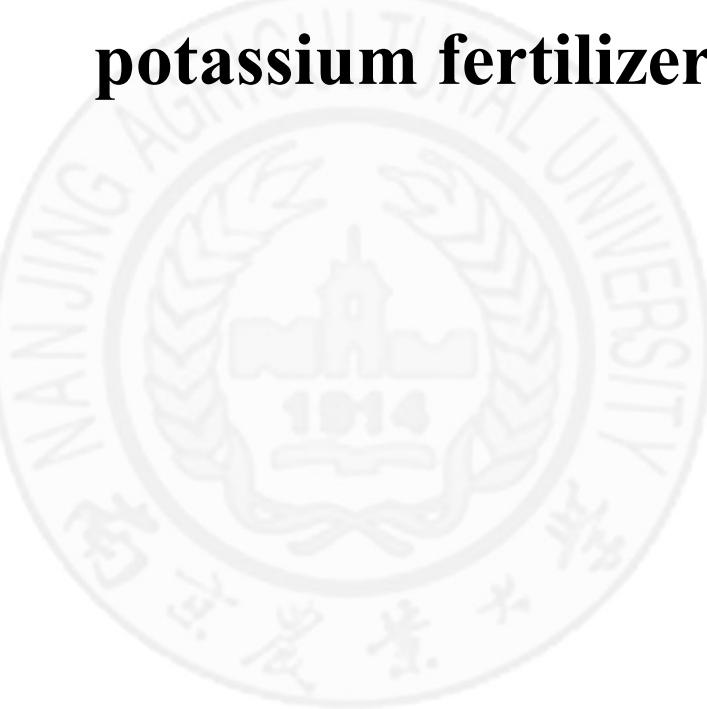




## Content

---

- The status in crop production of China
- The efficient utilization and alternative technology of potassium fertilizer -- case study in Jiangsu, China

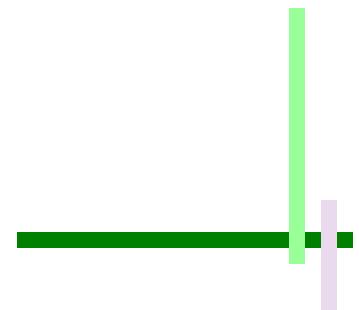


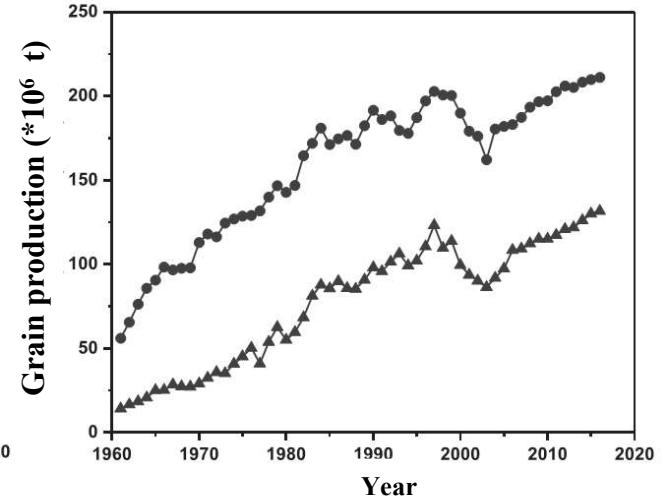
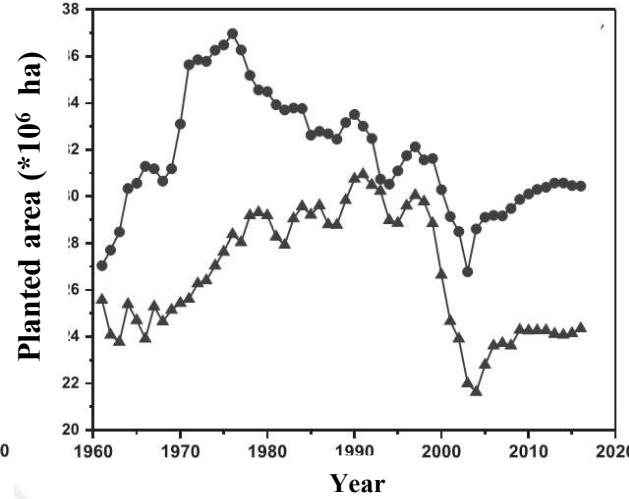
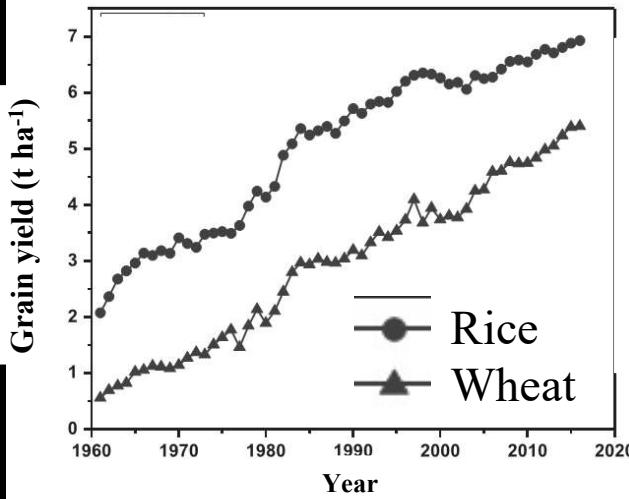


# The status and problem of crop production

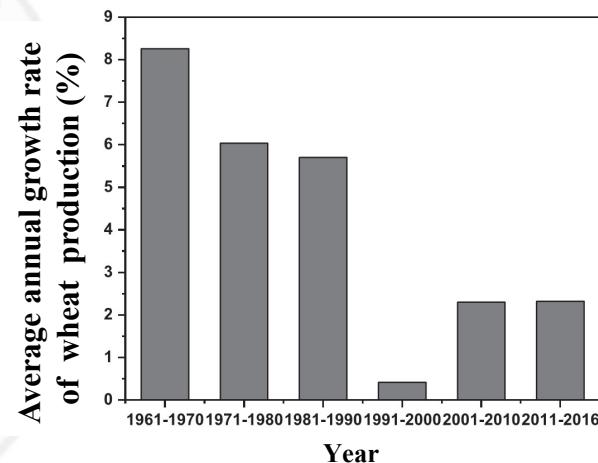
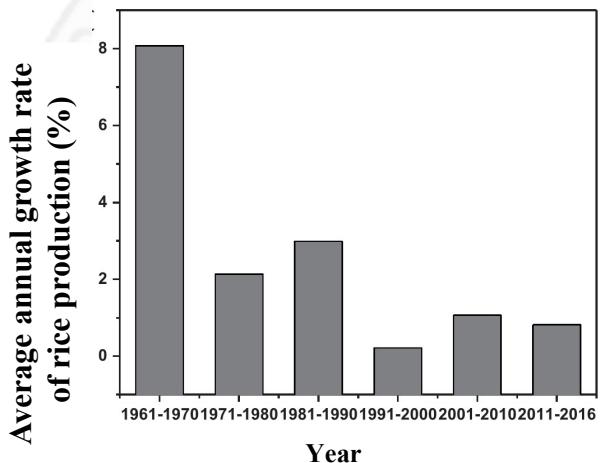
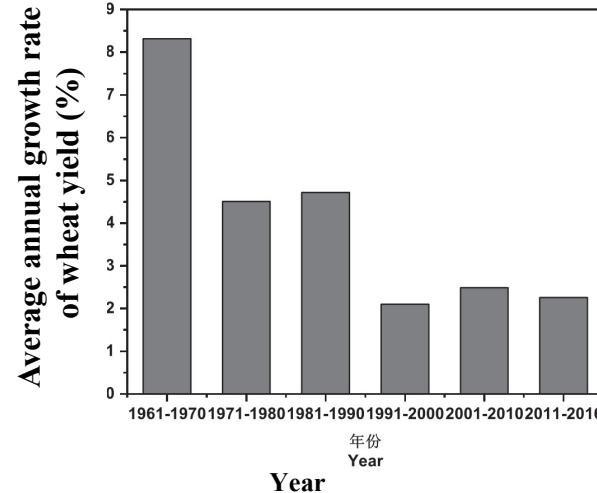
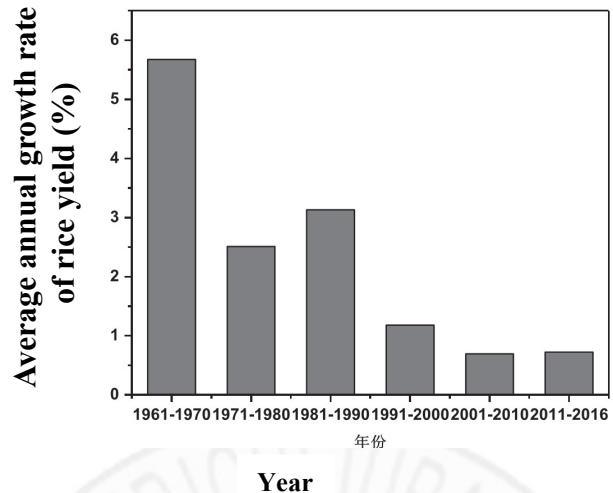
---

- ✓ Crop production and area
  
- ✓ The status of fertilizer application and soil nutrient supply

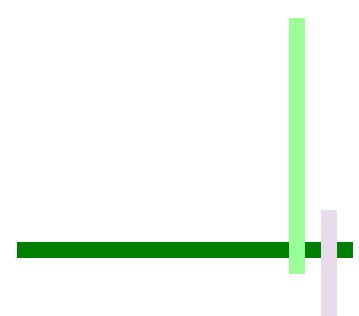




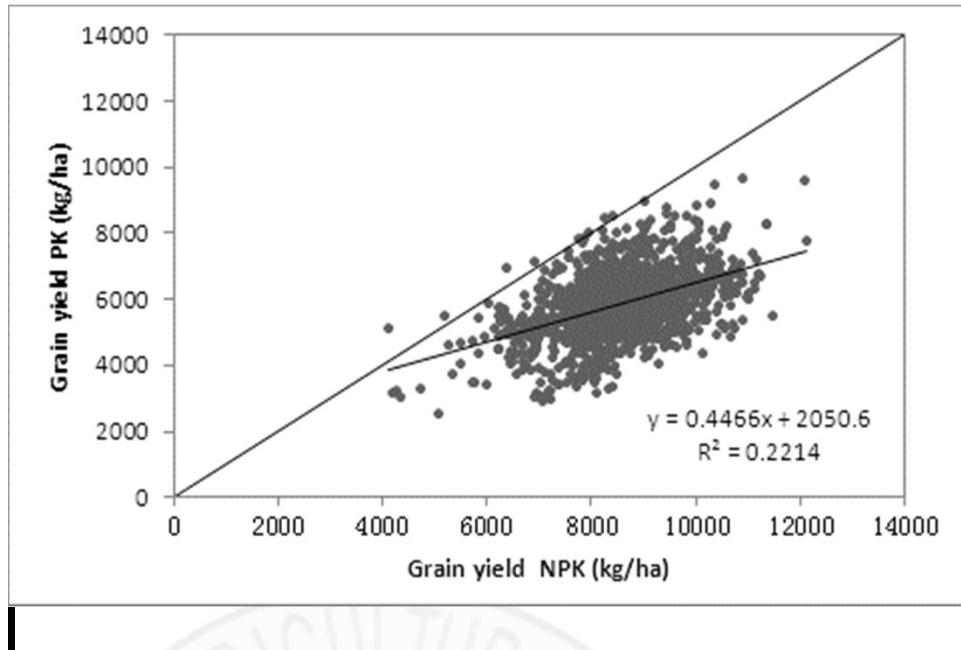
The annual growth rate of rice and wheat yield are decreased.



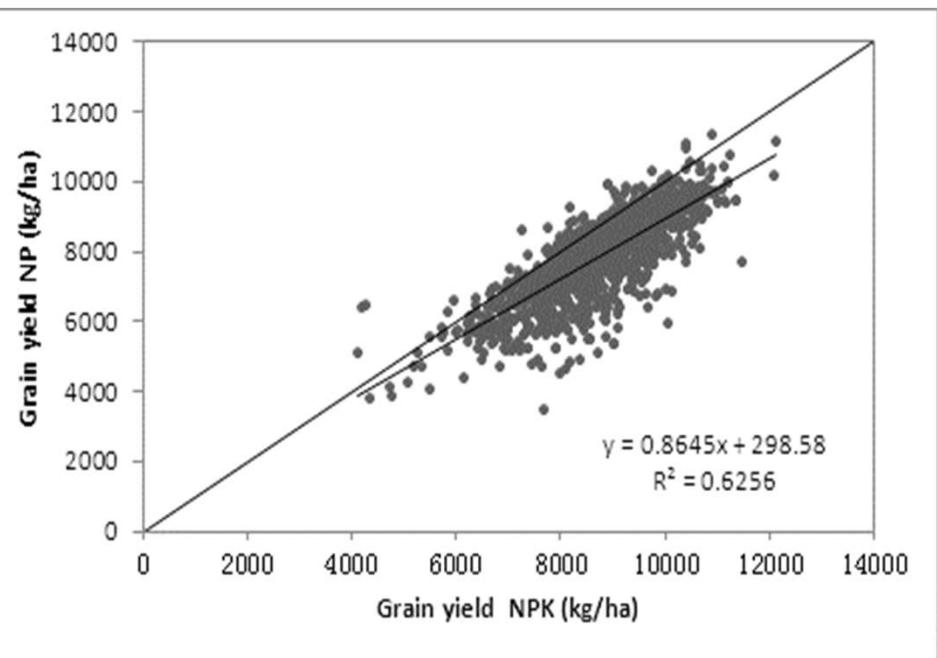
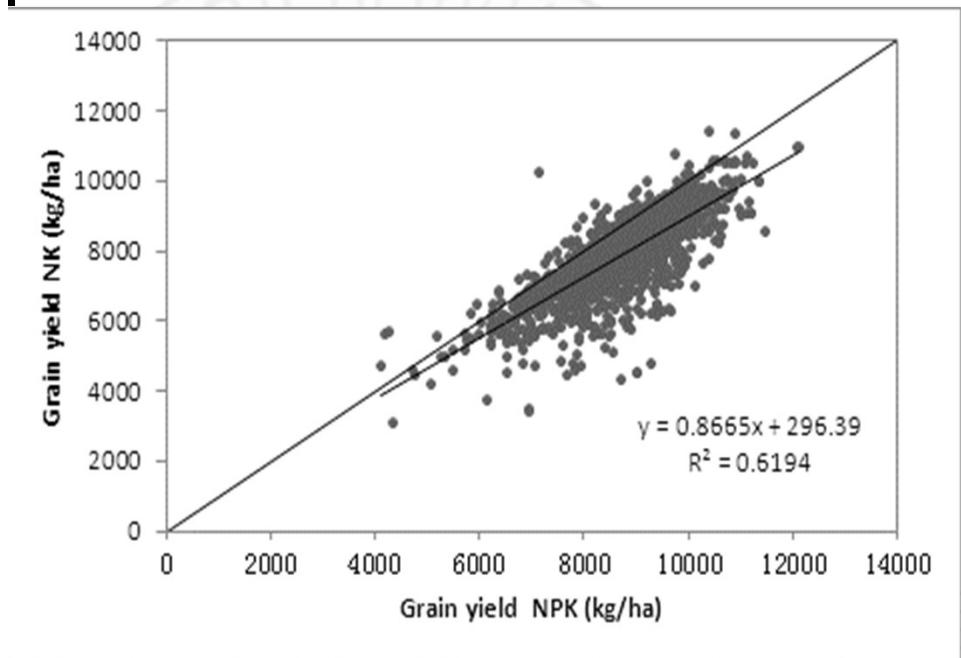
Crop production are stagnant.

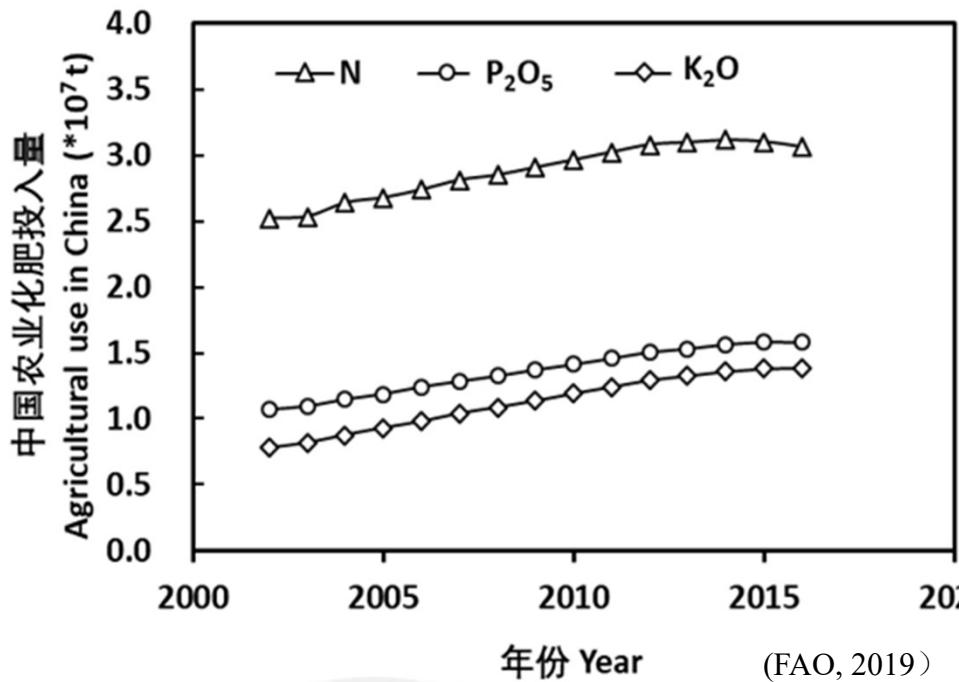


# The status of fertilization and yield

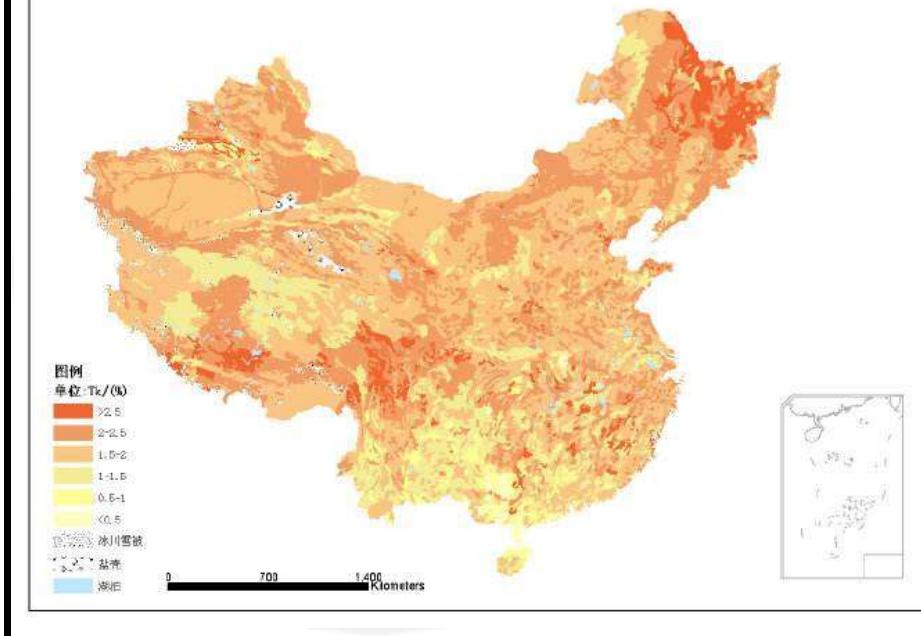


**N is the most affecting factor on crop yield formation.**  
**Crop yield (P and K free) is positive correlated to NPK, to obtain a higher crop yield, P and K are need.**





Distribution of soil total potassium content



Over nitrogen fertilization and shortage of potassium fertilization.

Lodging



Disease



Result

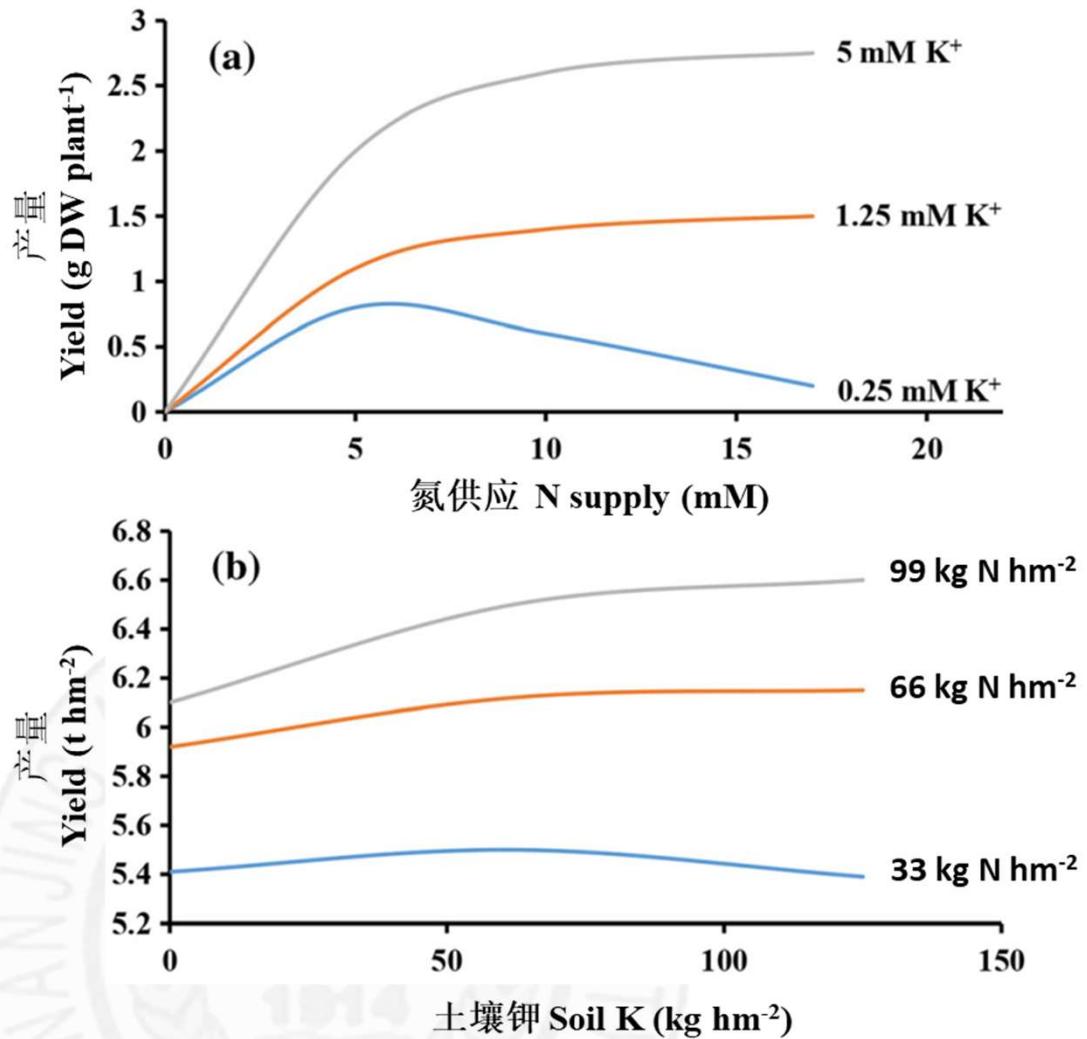
The capacity of soil potassium supply is different in different areas.

Low fertilizer use efficiency



Potassium deficiency





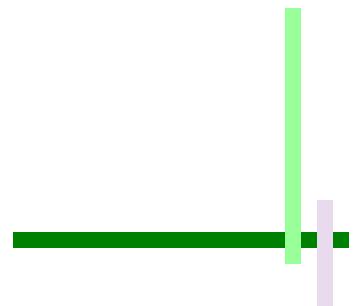
The reasonable application rate and ratio of N and K fertilizer are beneficial to improve yield and nutrient efficiency of crop.

(Coskun et al., 2016, *Plant Cell Environ.*)



# The efficient utilization and alternative technology of potassium fertilizer -- case study in Jiangsu, China

- ✓ Introduction
- ✓ Field experiment
- ✓ Results----Crop yield and K application effect curve
  - Crop K accumulation and allocation
  - Crop K spatial distribution and K flow
  - Soil K balance





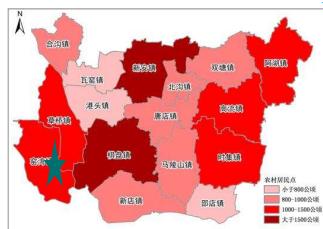
## Introduction -- Location situation



Location	Soil type	OM (g/kg)	Total N (g/kg)	Olsen-P (mg/kg)	<b>NH<sub>4</sub>OA<sub>C</sub>-K (mg/kg)</b>	pH
Xinyi	Paddy soil	15.6	0.88	7.4	<b>56</b>	6.81



# Introduction -- Xinyi Science and Technology Backyard



Rice-wheat  
rotation



Farm  
survey



## Introduction -- Farm survey results

Farmers fertilizer input and crop yield

Crop	N rate kg/ha	P <sub>2</sub> O <sub>5</sub> rate kg/ha	K <sub>2</sub> O rate kg/ha	Yield kg/ha	PFP <sub>N</sub> kg/kg	N:P:K
Rice	407.4	94.0	79.3	7645	18.8	1:0.23:0.19
Wheat	388.4	100.0	75.3	7237	18.6	1:0.26:0.19

Farmers fertilizer application frequency and yield

Crop		One	Two	Three
Rice	Percent (%)	30.3	57.6	12.1
	Yield (kg/ha)	7313	7757	7450
Wheat	Percent (%)	Zero	One	Two
	Yield (kg/ha)	5.1	86.9	8.1

1. The ratio of N:P:K was not balance;
2. The fertilizer management method should been improved;



## Field experiment -- Materials and methods

### ✓ Treatments:

**Major plots:** Six K fertilisation rates,  
**0, 45, 90, 135, 225, 400 kg K<sub>2</sub>O /ha ;**

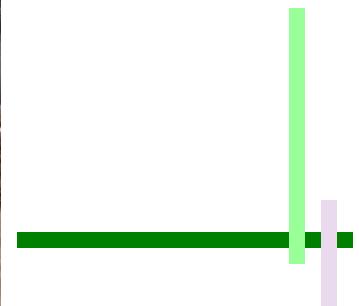
**Subplots:** Two types of straw utilization,  
**half straw return (HSR), no straw return (NSR);**

### ✓ Fertilizer management:

**Nitrogen:** rice (240 kg N /ha), basal : tiller : boot : spike = 4:2:2:2;  
wheat (225 kg N /ha), basal : tiller : boot = 4:3:3;

**Phosphorus:** 90 kg P<sub>2</sub>O<sub>5</sub> /ha, basal;

**Potassium:** basal : boot = 5:5.





## Field experiment VS Farmer practice





农民习惯施肥区

配方肥区



# 不合理施肥导致不能按时灌浆成熟，穗小，无效穗多

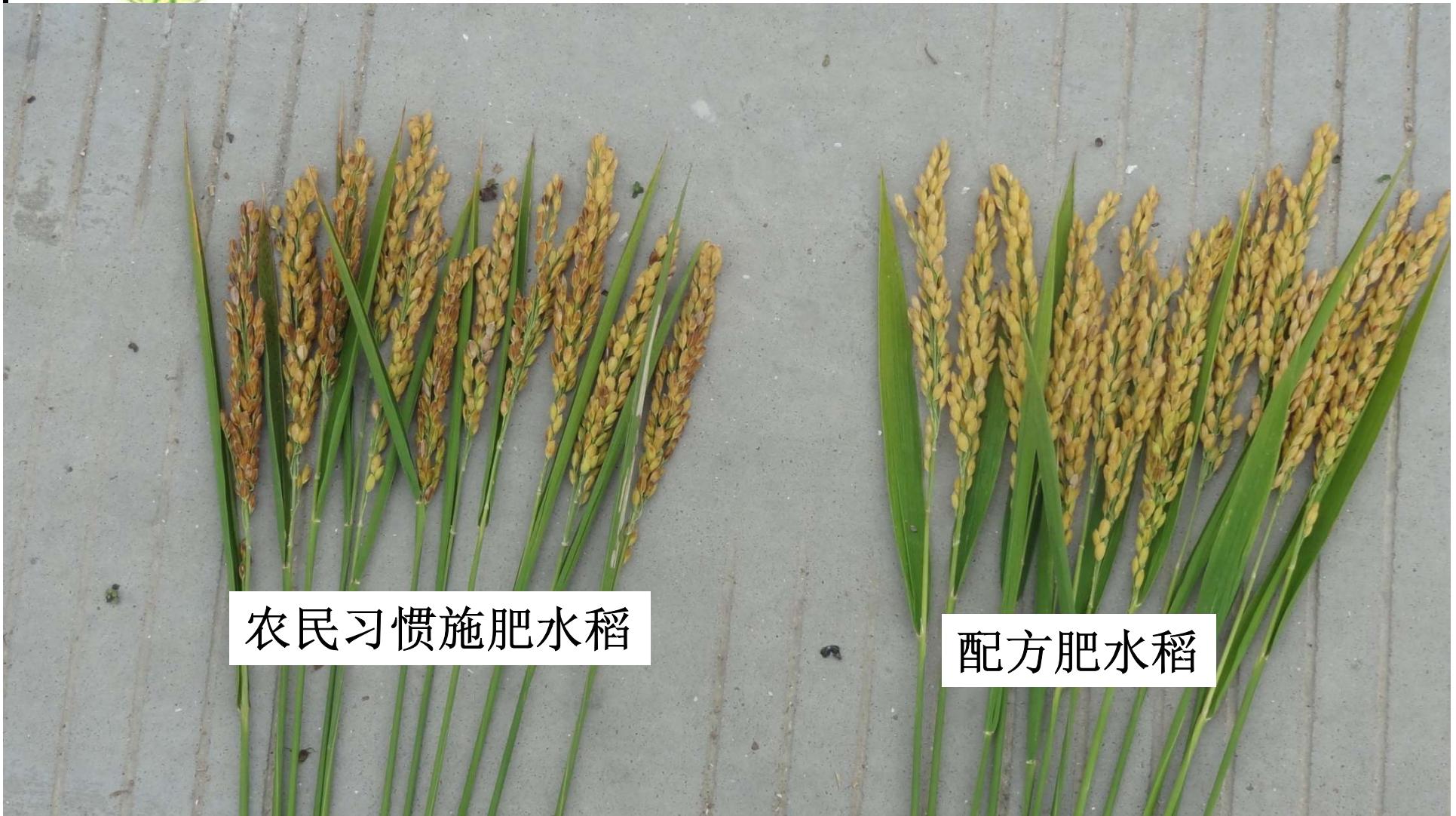


农民习惯施肥水稻

配方肥水稻

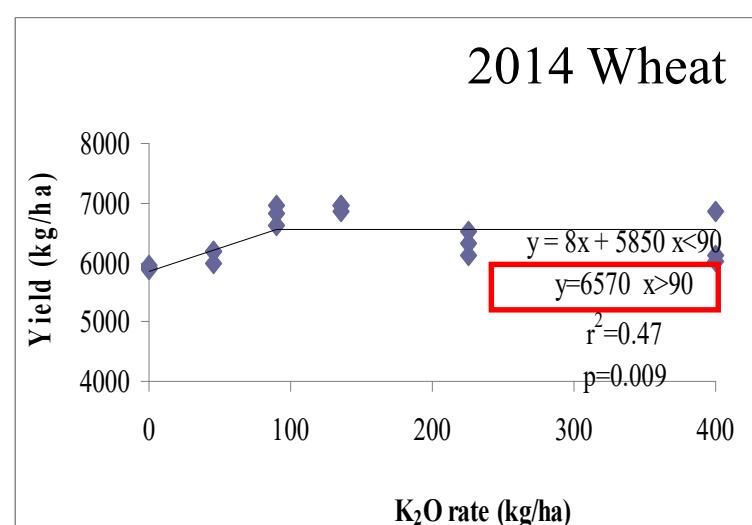
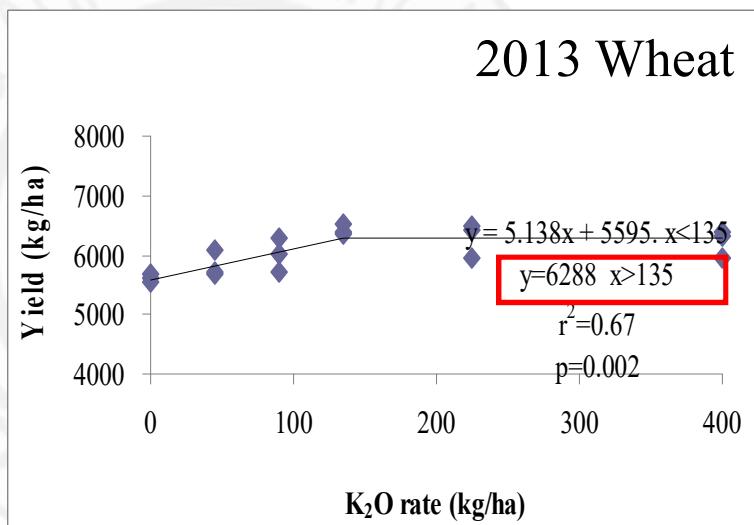
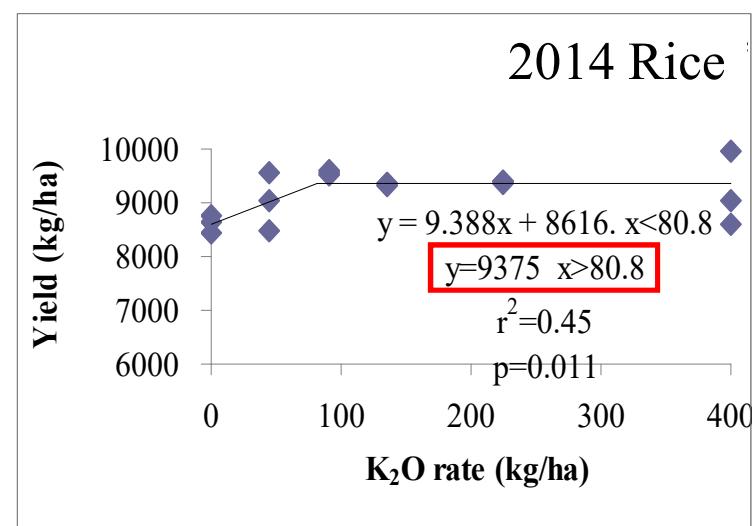
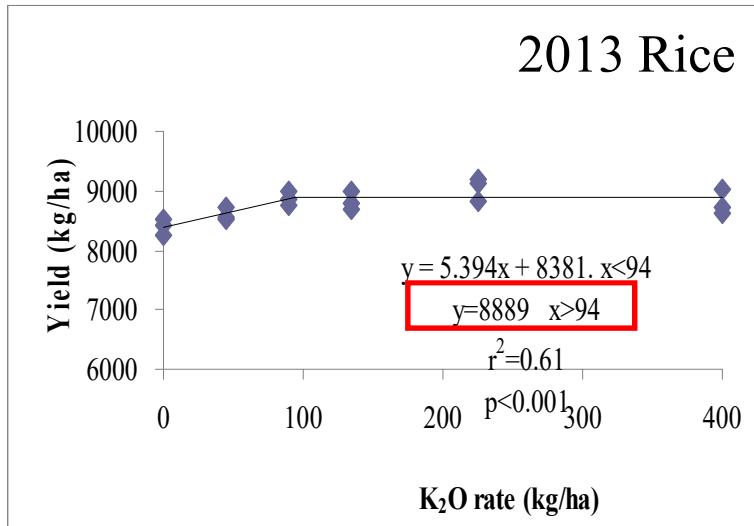


# 不合理施肥导致水稻病害严重





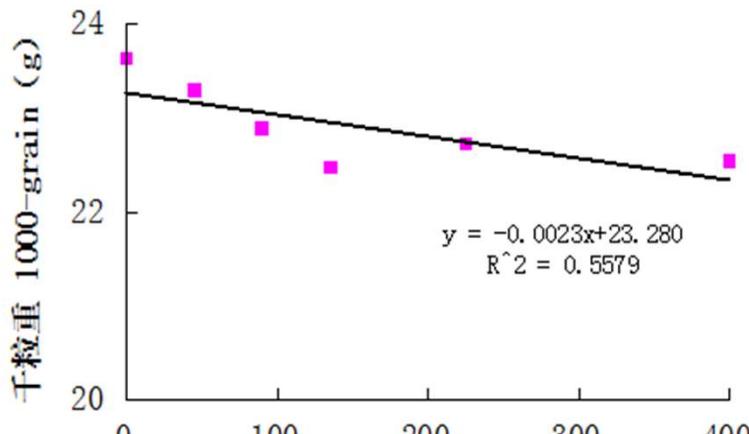
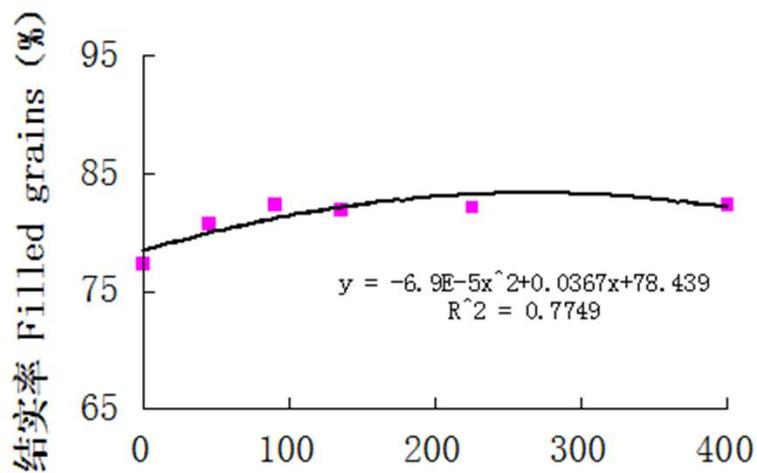
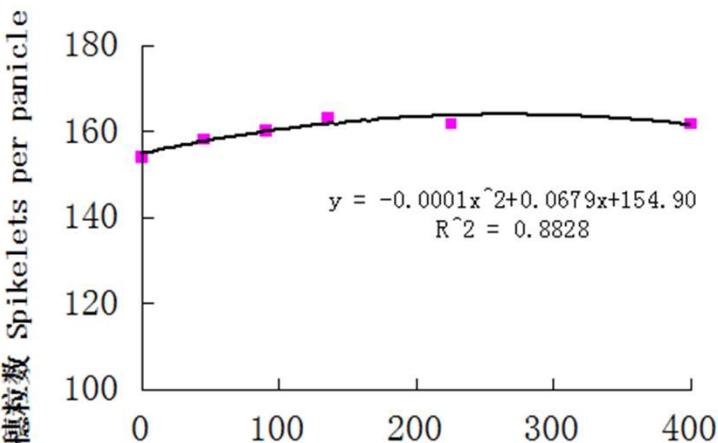
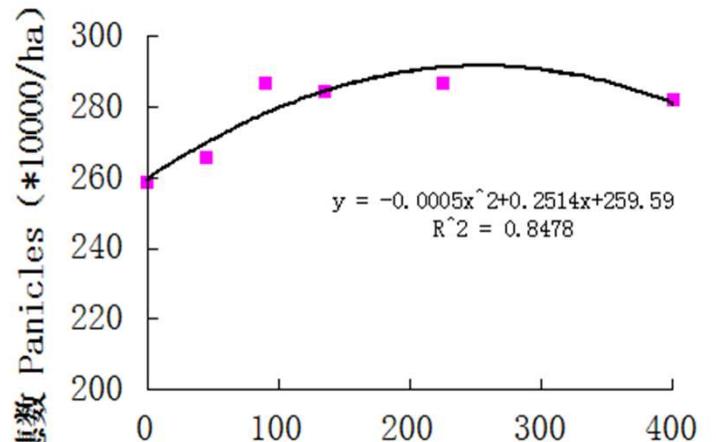
## Results -- Crop yield





## Results -- K application effect curve

Rice yield components and K application



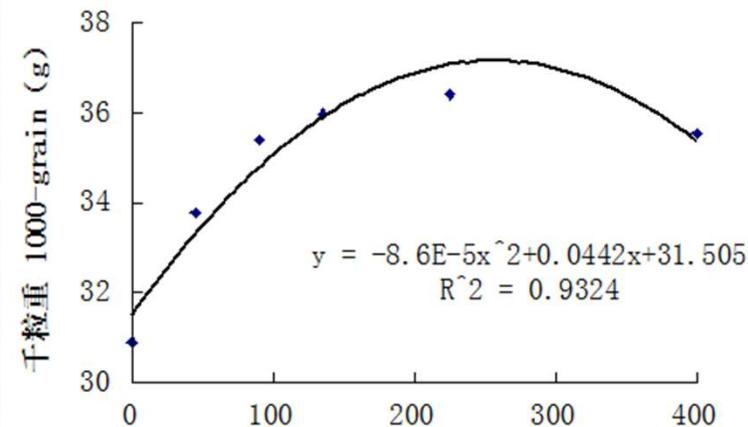
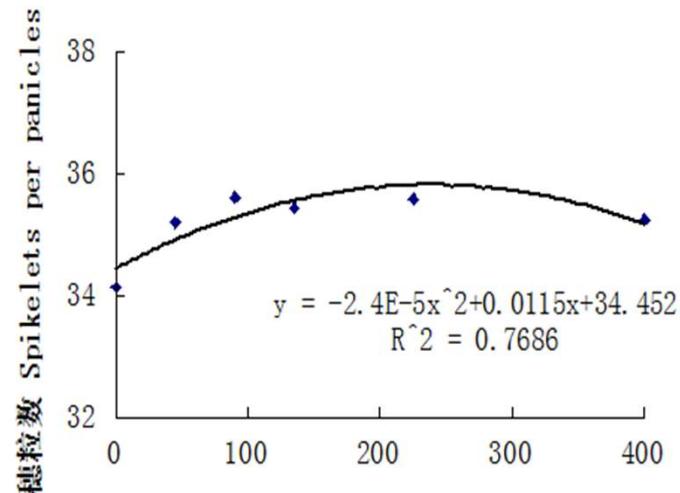
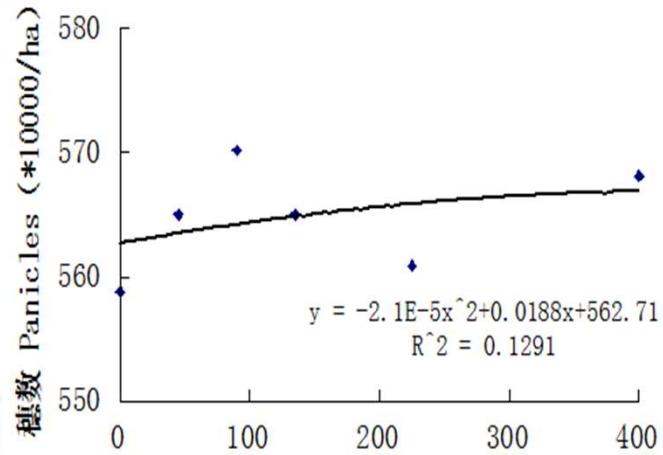
(eg. 2013 Rice)

K application rate (kg/ha)



## Results -- K application effect curve

### Wheat yield components and K application

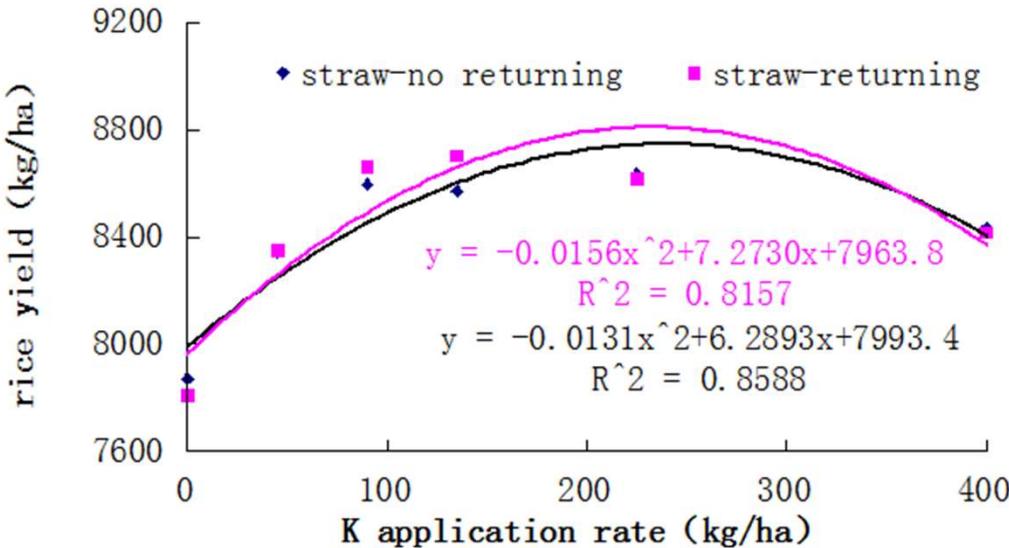


K application rate (kg/ha)

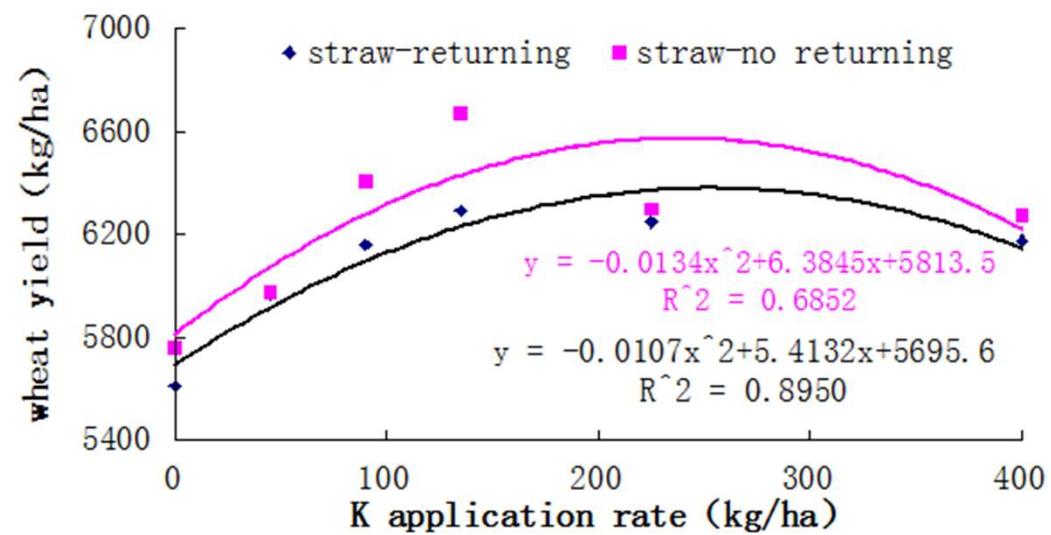
(eg. 2013 wheat)



## Results -- K effect curve

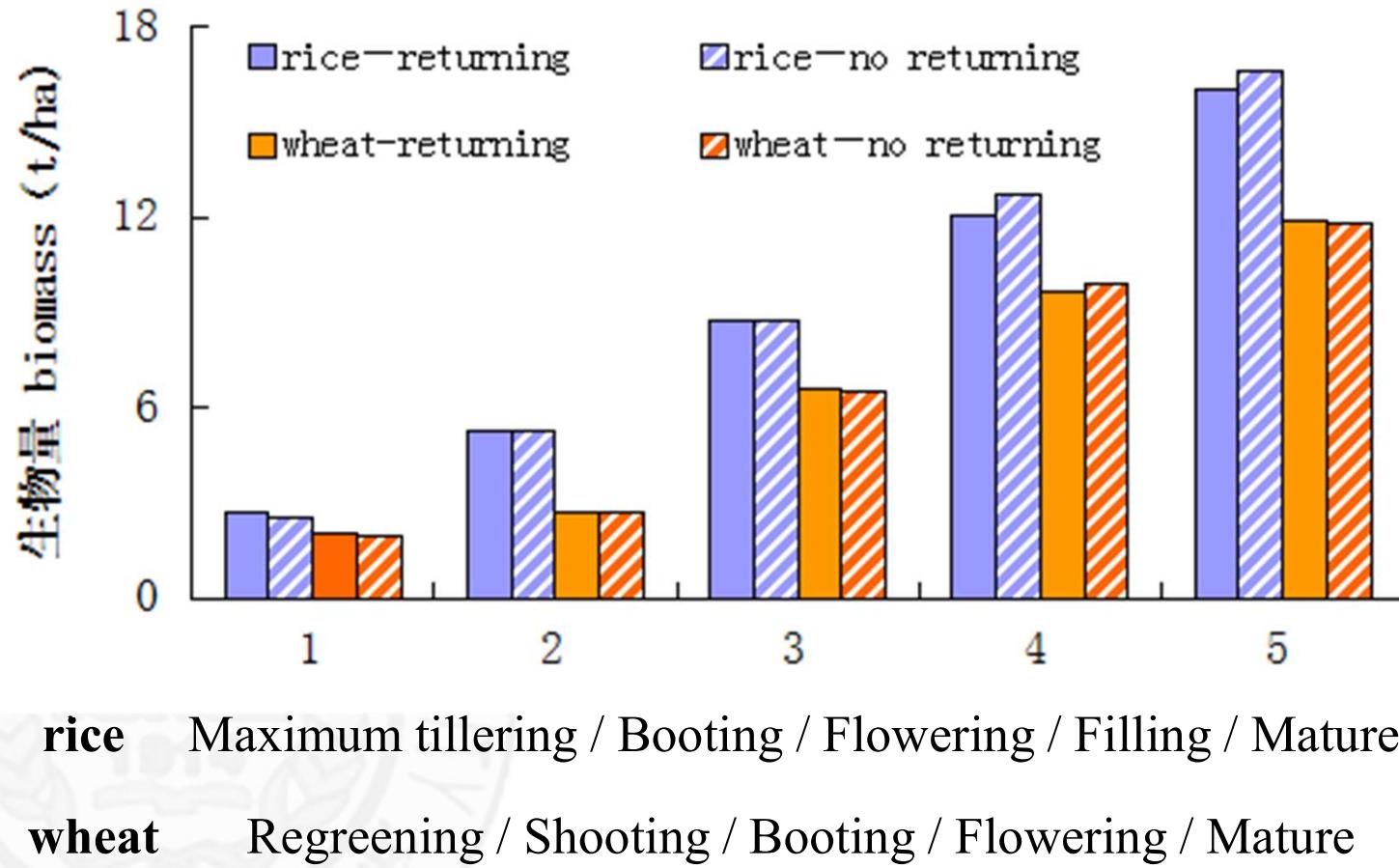


The yield of rice/wheat  
and  
K rate under NSR/HSR



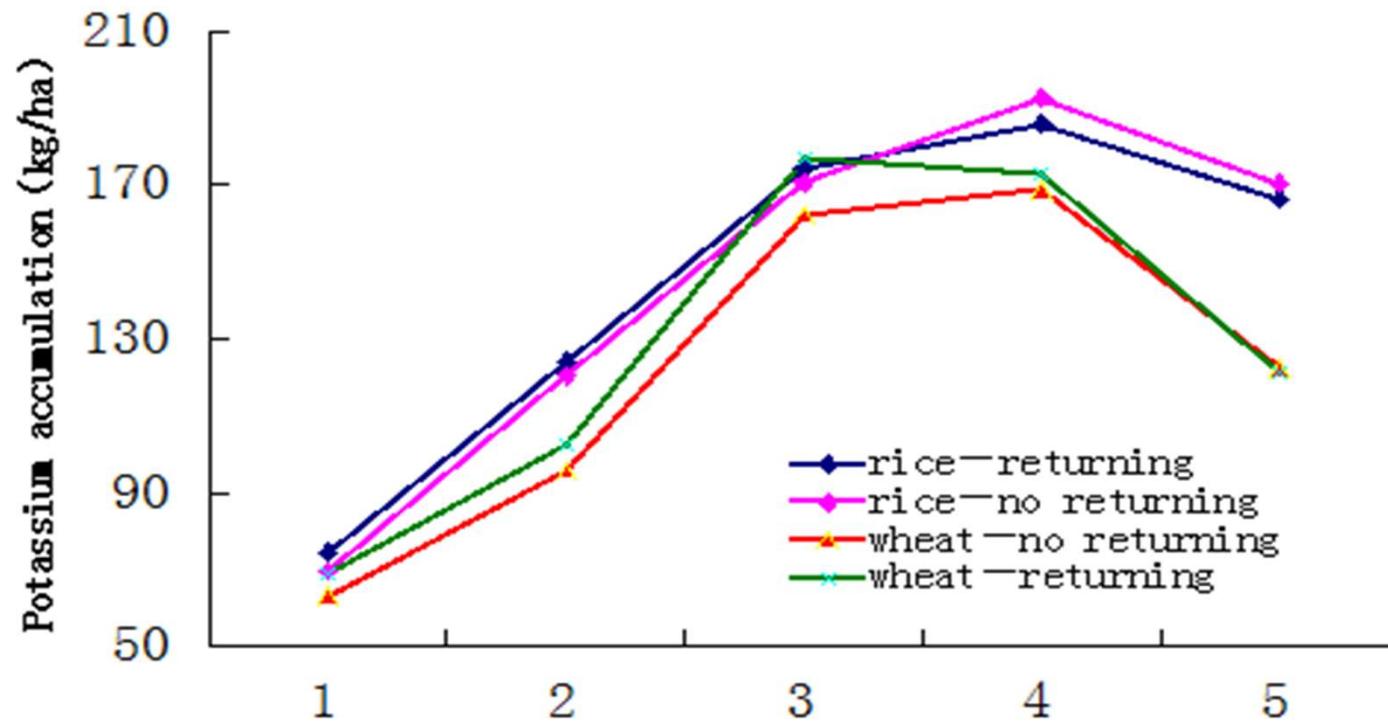


## Results -- Biomass accumulation





## Results -- K accumulation

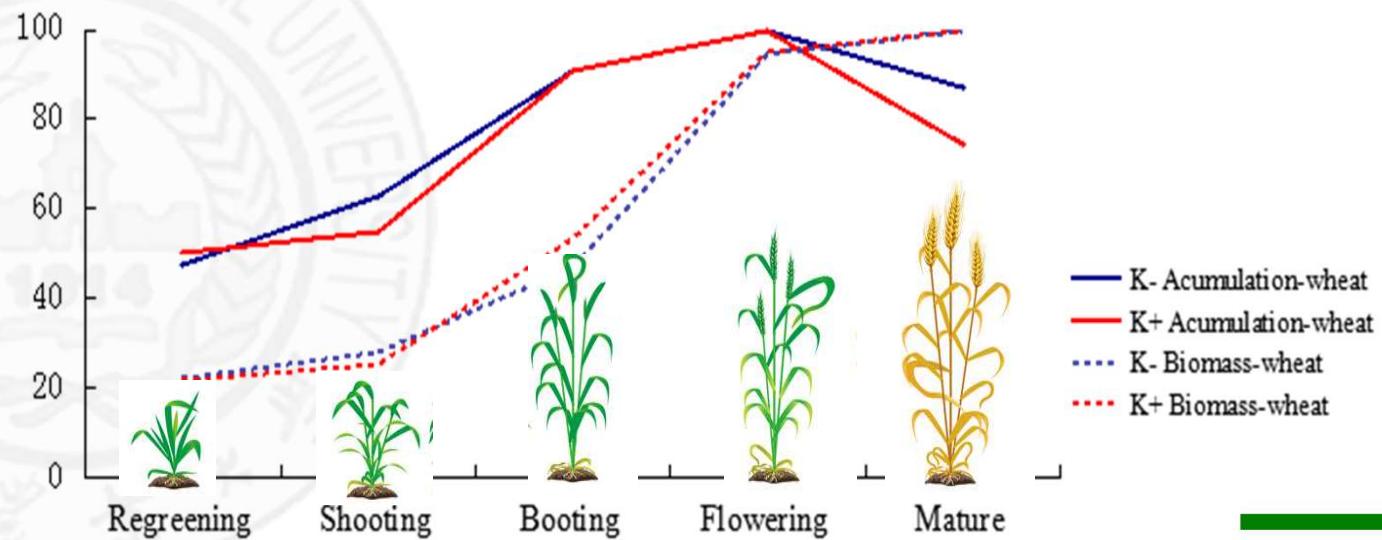
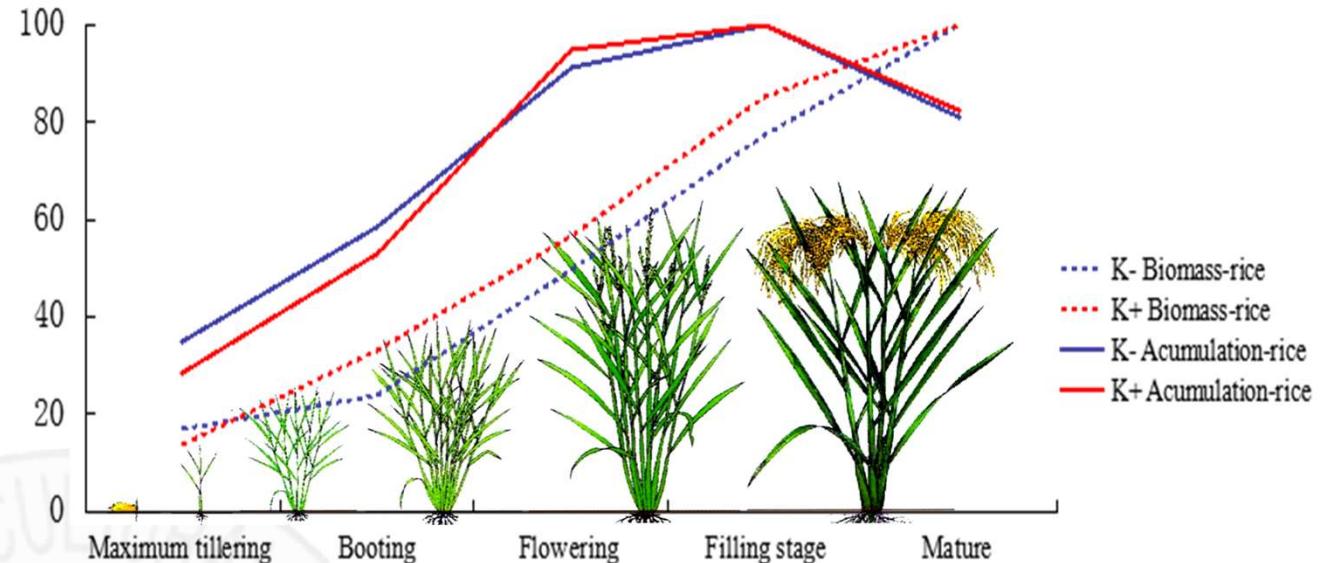


**rice** Maximum tillering / Booting / Flowering / Filling / Mature

**wheat** Regreening / Shooting / Booting / Flowering / Mature

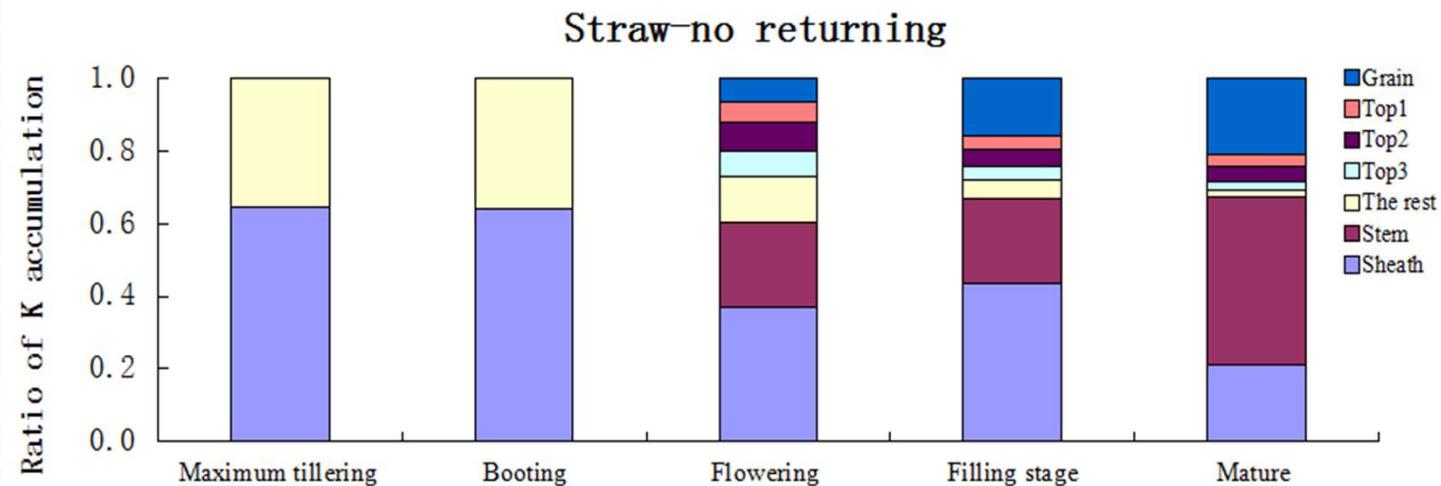
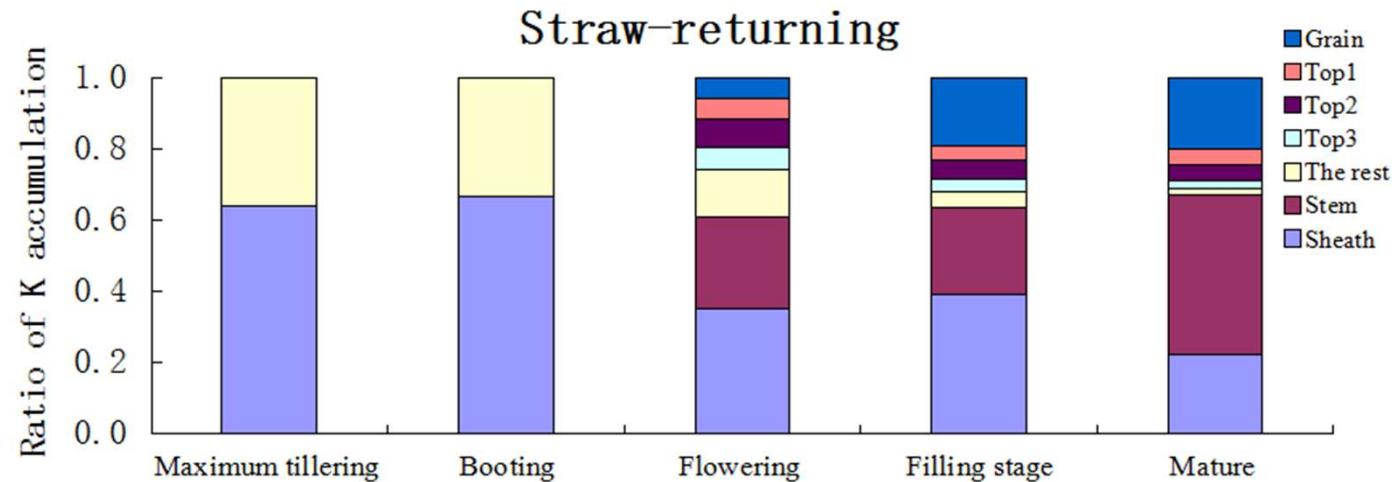


## Results -- Model of biomass and K accumulation



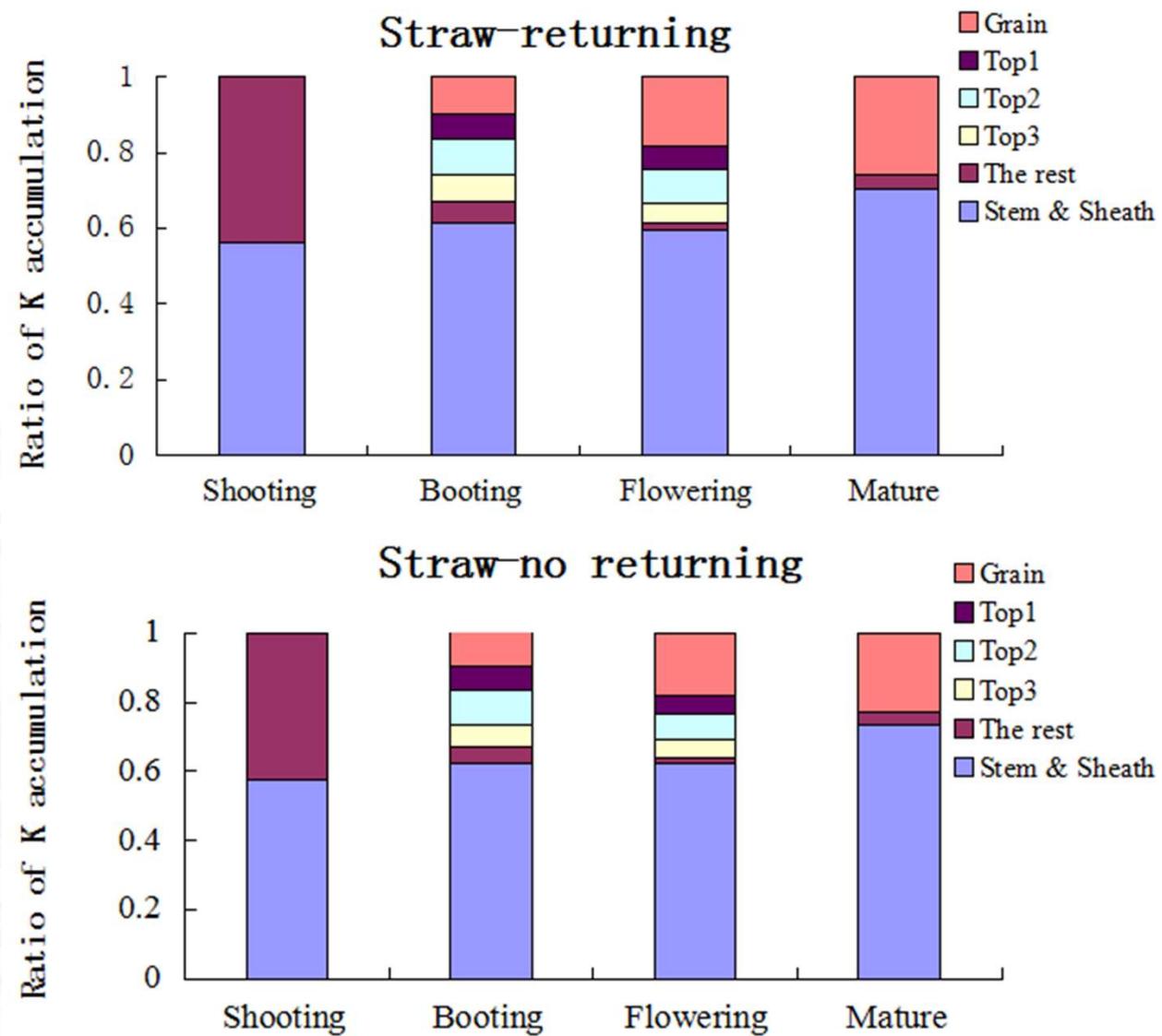


## Results -- Allocation proportion of K in rice organs



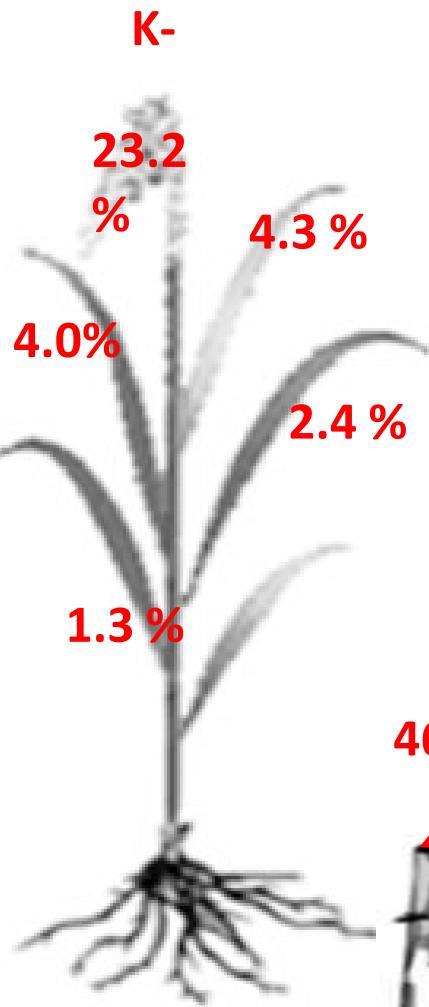


## Results -- Allocation proportion of K in wheat organs



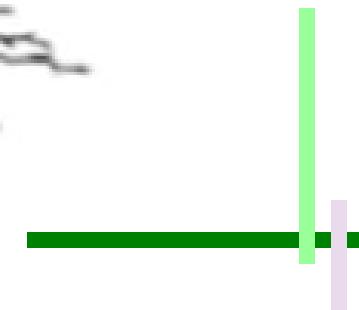
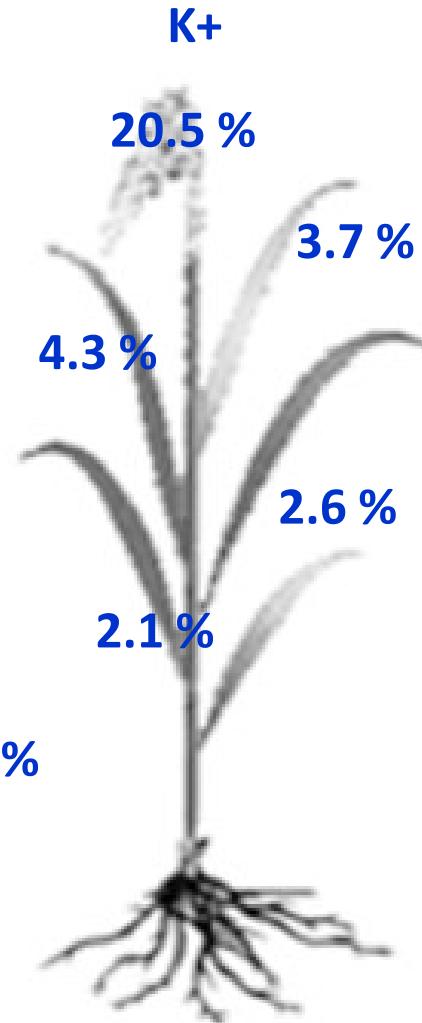


## Results -- Model of K allocation proportion of rice in different K supply status



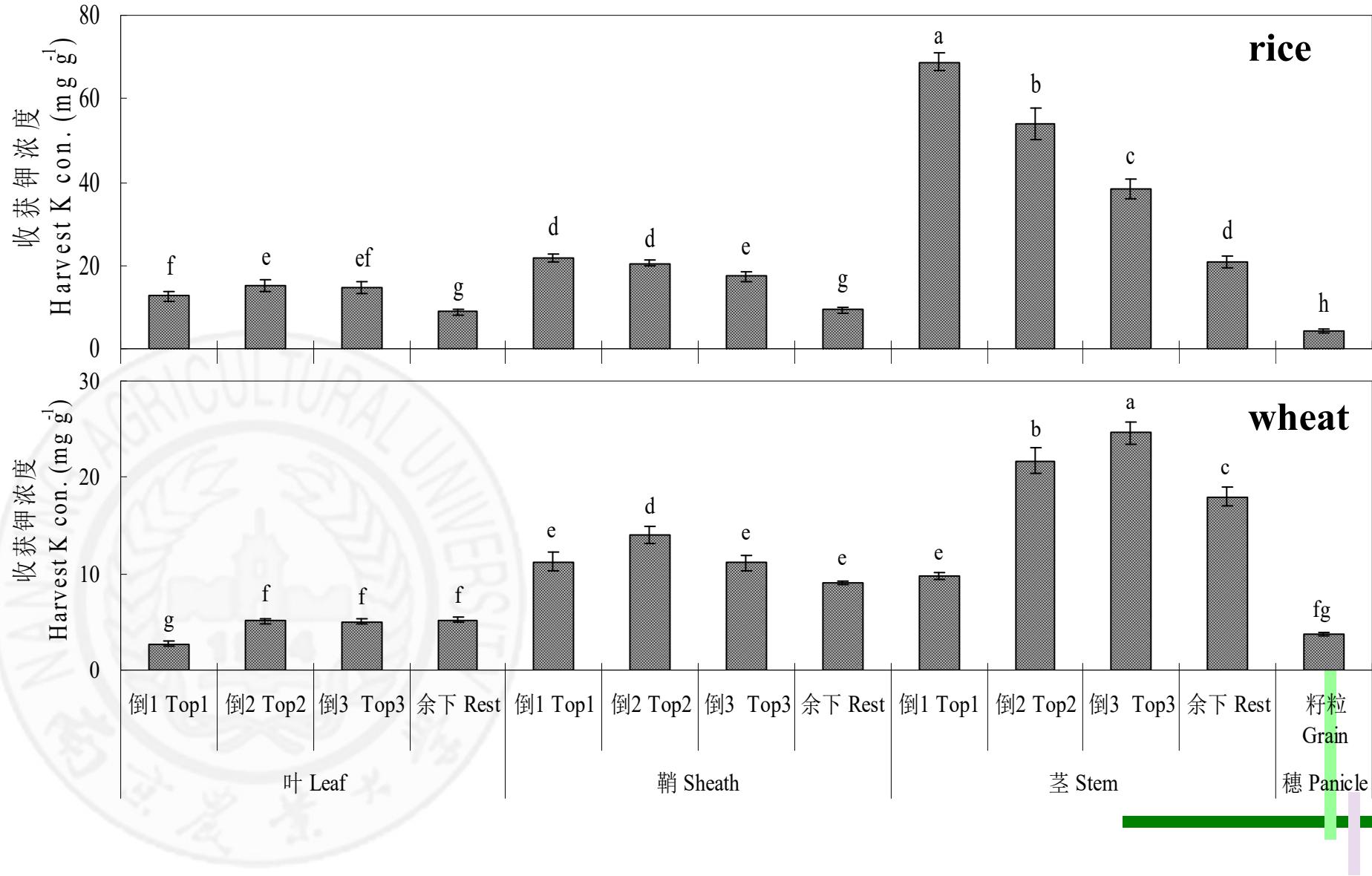
Grain  
Top1 leaf  
Top2 leaf  
Top3 leaf  
The rest leaf

Stem  
Sheath  
18.5 % 22.7 %



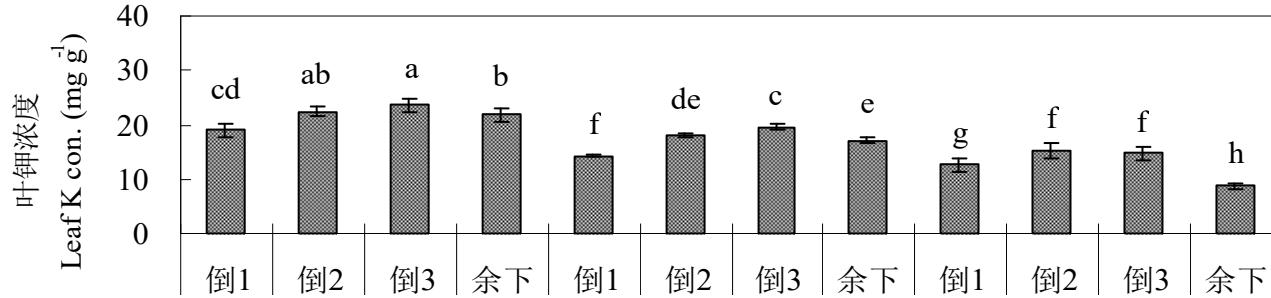


# Results -- K nutrition distribution

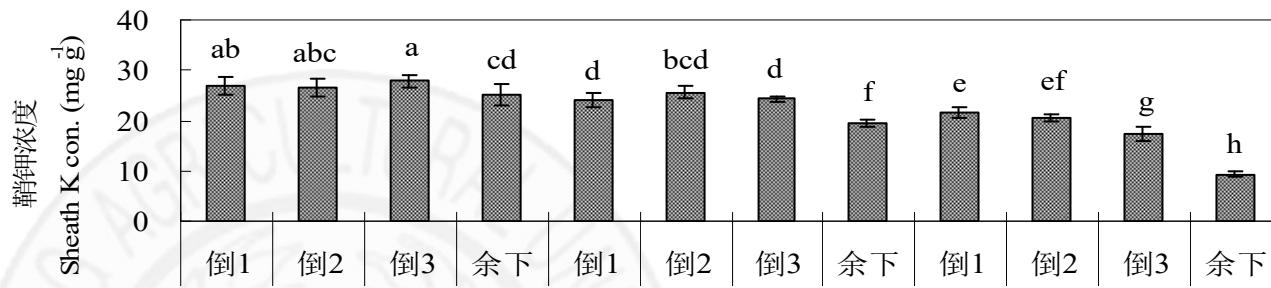




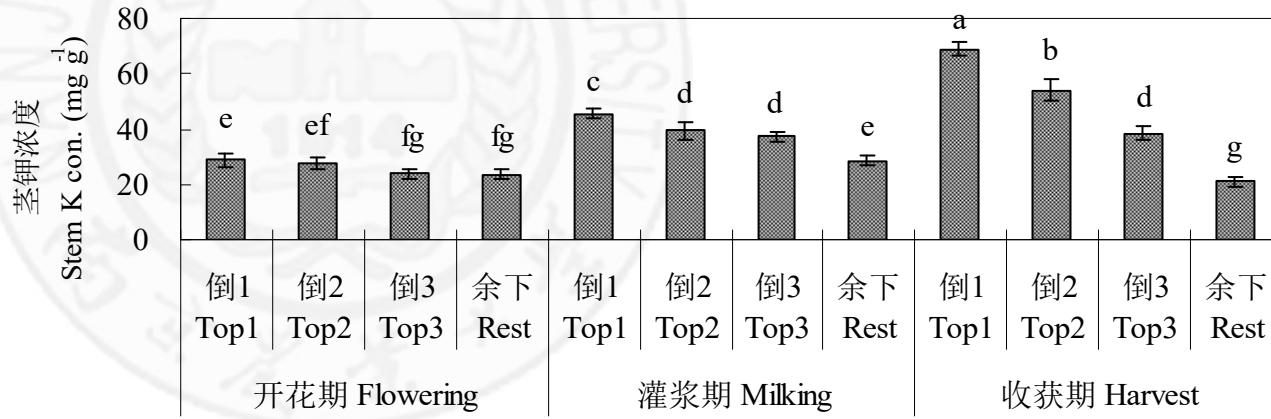
# Results -- The K flow in the process of rice yield formation



Flower Milk Harvest  
21.7 17.3 12.9  
-20.4% -40.8%



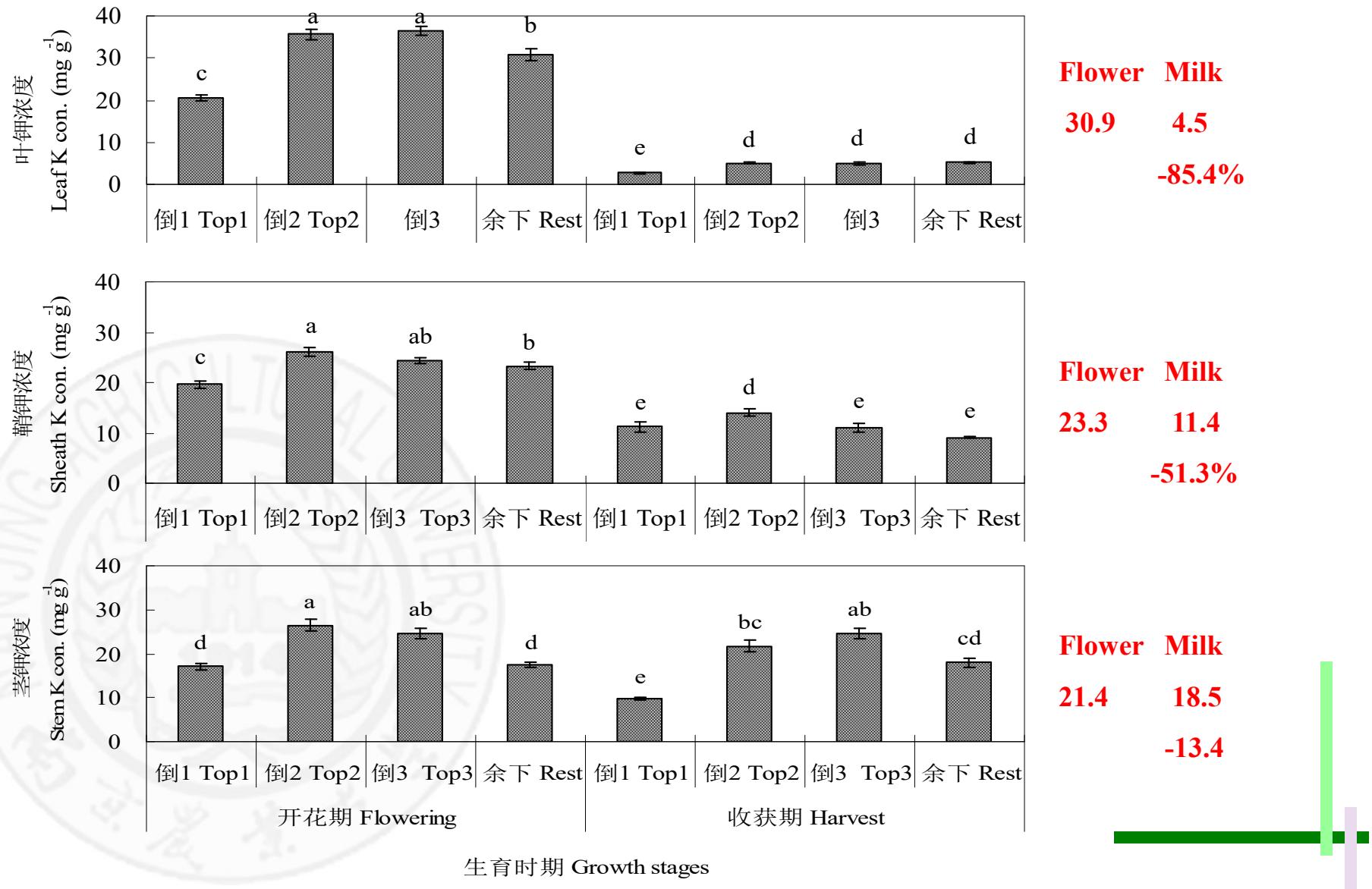
Flower Milk Harvest  
26.6 23.3 17.2  
-12.1% -35.1%



Flower Milk Harvest  
25.9 37.7 45.5  
+45.5% +75.6%

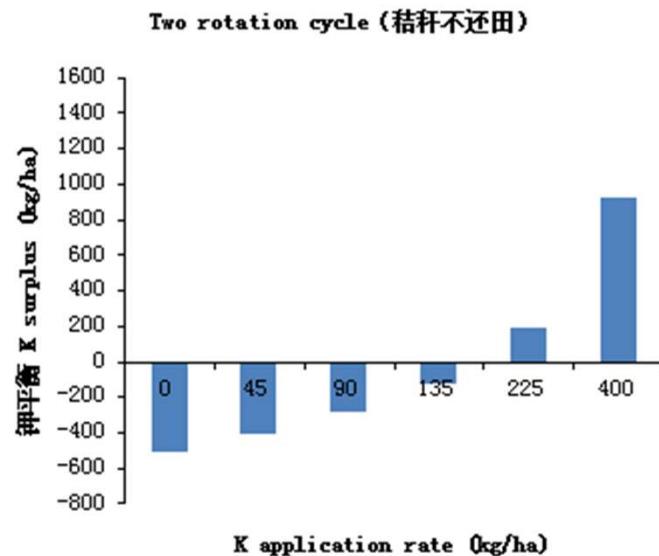
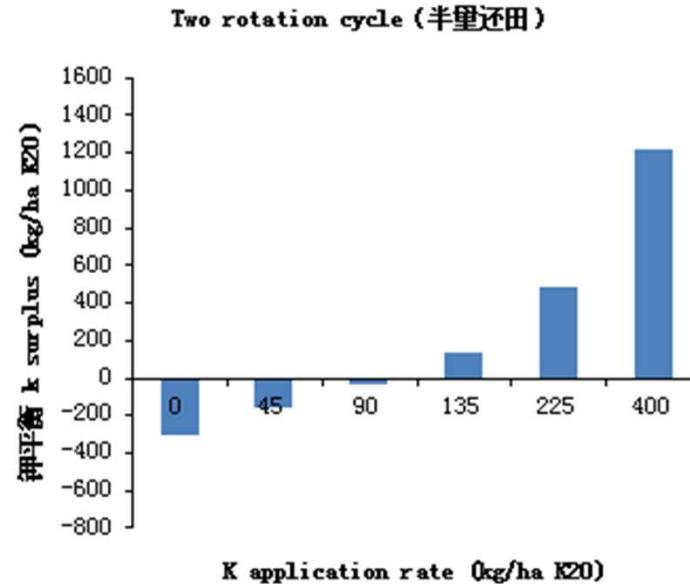
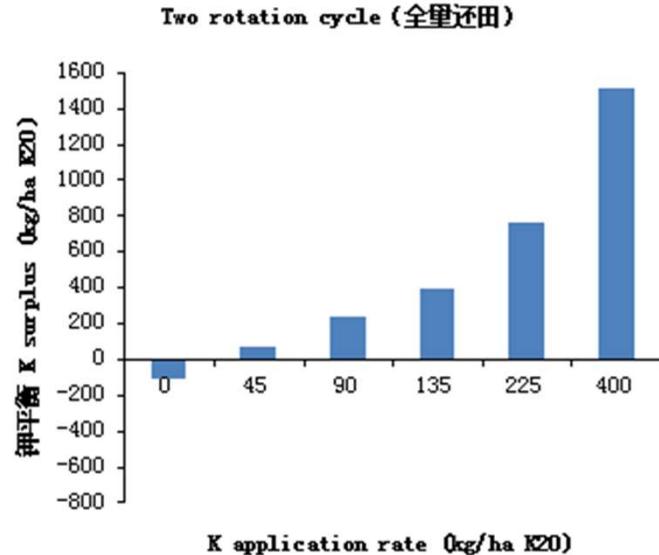


# Results -- The K flow in the process of wheat yield formation





# Results – Soil K balance



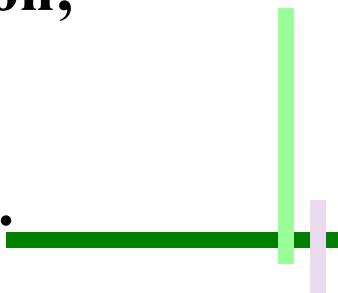
Surplus of K = Total potassium input  
(kg/hm<sup>2</sup>) — Total potassium output(kg/hm<sup>2</sup>)

钾素表观盈亏量 = 钾素投入总量(kg/hm<sup>2</sup>) —  
作物带出走钾素总量 (kg/hm<sup>2</sup>)



## Conclusion

---

- ✓ Potash fertilizer obviously increase the yield, biomass and K accumulation (luxury) of rice and wheat crops;
  - ✓ Distribution of potassium in the straw in Wheat is 75% and Rice is 80% (Stem>Sheath>Leaf) , and the Potassium lactation period in wheat is before the rice;
  - ✓ Straw returning or not was not significant, the effect of rice straw returning on yield is greater than the influence of wheat straw returning;
  - ✓ There significantly exists spatial distribution and flow of potassium in the process of wheat-rice yield formation;
  - ✓ Two cycle rotation with straw returning (half or full mount)significantly increased soil potassium balance.
- 



# Thanks for your attention!





# Thanks for your attention !

