



Maize/peanut intercropping and its application

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1. Introduction of intercropping



Concept



Millet / peanut intercropping



Wheat / maize intercropping

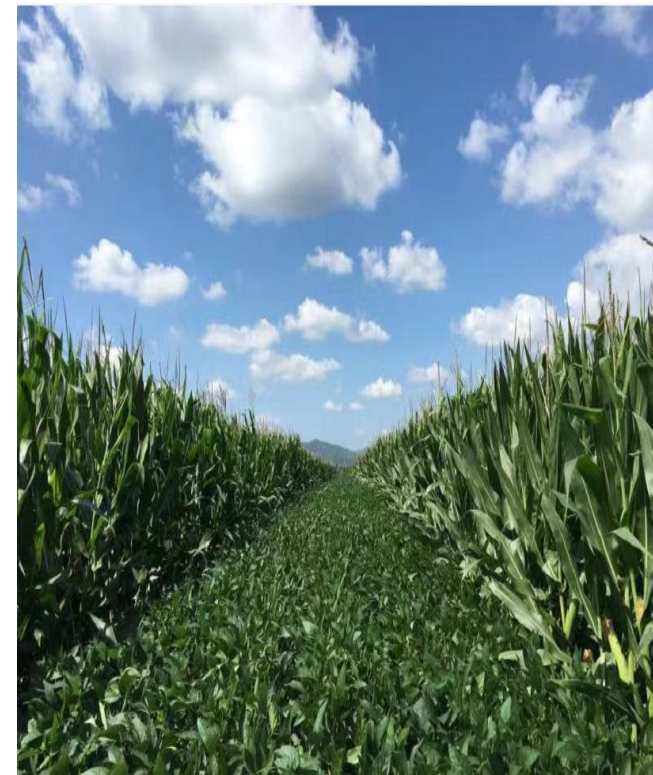
Intercropping

- Intercropping is defined as the cultivation of two or more crop species in the same field for the whole or part of their growing period (Willey, 1990; Hauggaard-Nielsen et al., 2008).



Why intercropping

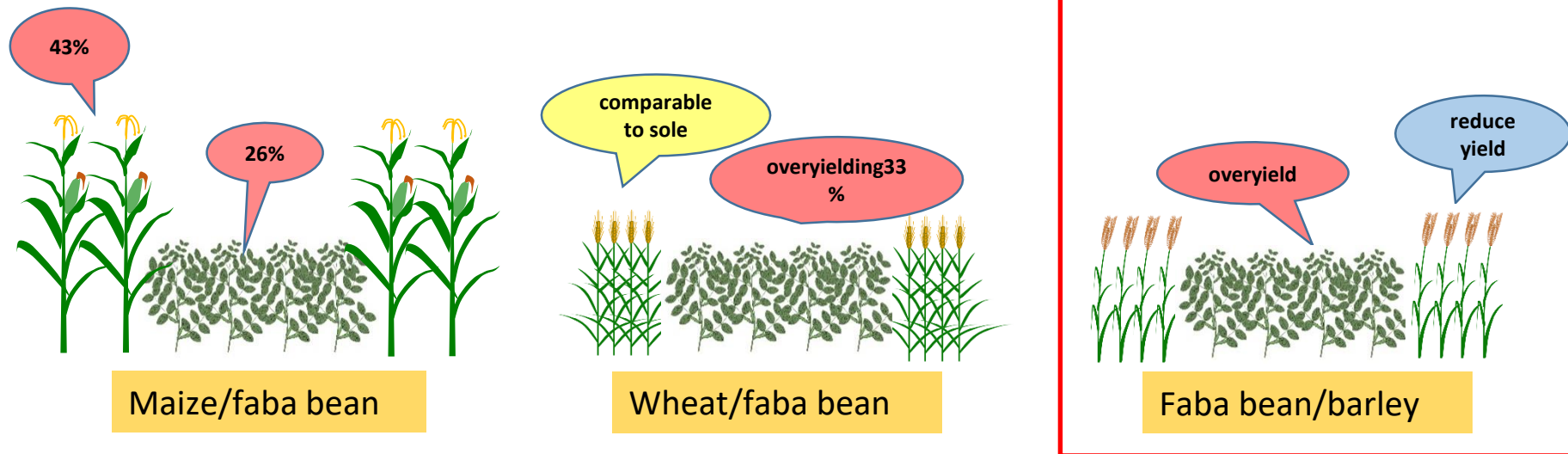
- Intercropping provides an alternative way to ensure food security and develop sustainable agriculture.





Advantages of intercropping

1. Overyielding



2. Increase the biodiversity and stability of agroecosystem.



Advantages of intercropping

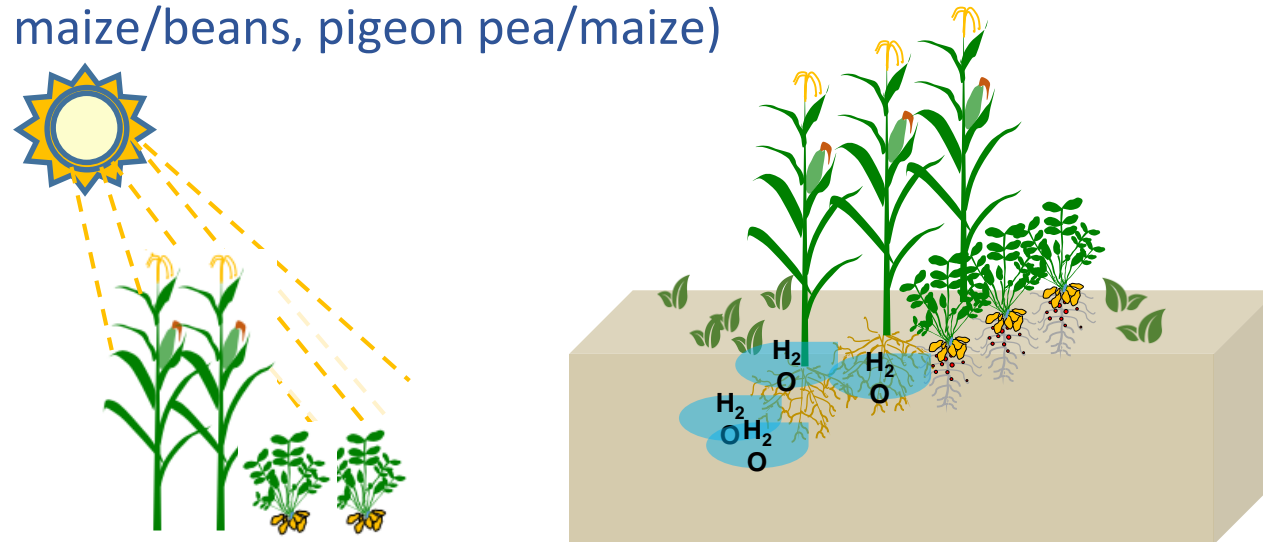
3. Increase the light interception (LI) and light use efficiency (LUE)

4. Complementarity in root spatial and temporal distribution

- Deeper--shallower roots, Change the rooting pattern
- Interspecific facilitation of intermingling roots

5. Increase water capture, enhance “hydraulic lift”

(Wheat/maize, maize/beans, pigeon pea/maize)

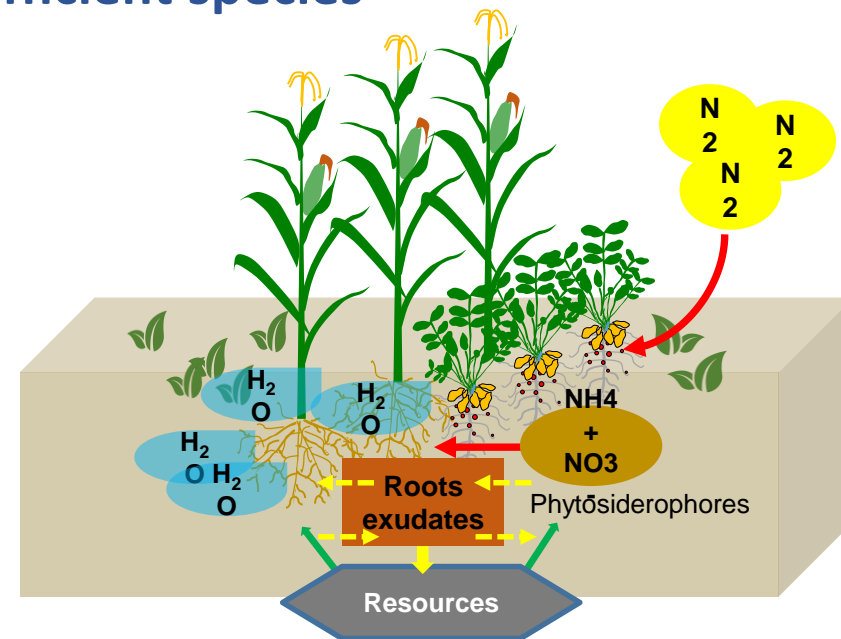




Advantages of intercropping

6. Increase nutrient uptake

- **Nitrogen complementary utilization in legume-based crop mixtures**
(Cereal acquire more N, Legume fix N_2 , N transfer)
- **Phosphorus facilitation between P-efficient species and P-inefficient species**
(Chickpea/wheat Faba bean/maize)
- **Fe/Zn improvement**
(Peanut/maize)

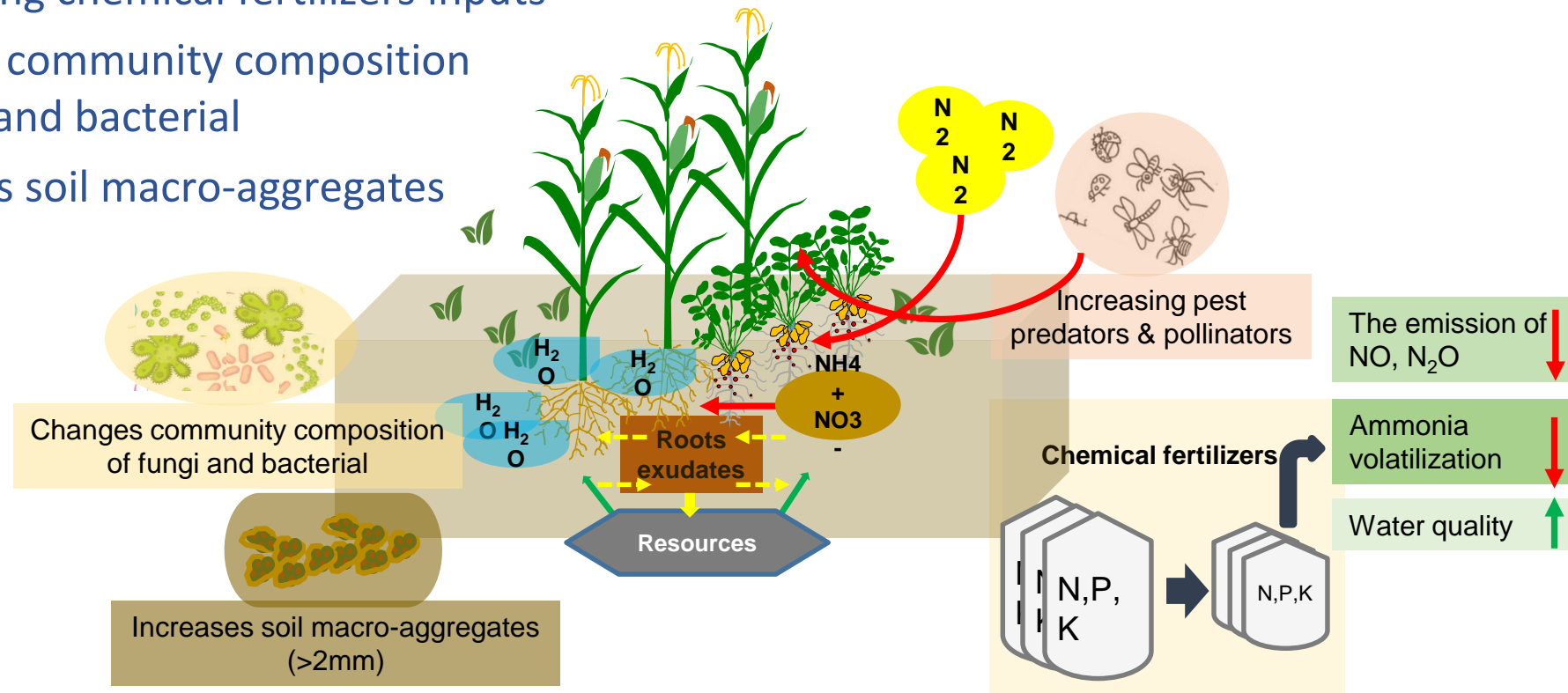




Advantages of intercropping

7. Other ecological functions

- Reduces crop pests, weeds and diseases
- Decreasing chemical fertilizers inputs
- Changes community composition of fungi and bacterial
- Increases soil macro-aggregates



2. Maize/peanut intercropping in Liaoning





Maize/Peanut Intercropping

Background

- Liaoning province (4.2 million ha farmland)
- Northwest semi-arid region (2.7 million ha farmland)
- Maize and peanut are the major crops



Maize field



Peanut field



Maize/Peanut Intercropping

Problems

Maize



- **Drought**
(limit maize yield)
- **Continuous cropping**
(Declining soil fertility)
- **Excessive fertilizer applying**
(serious environmental impacts)

Rainfall
400~500mm

Fuxin, 2019



Maize/Peanut Intercropping

Problems

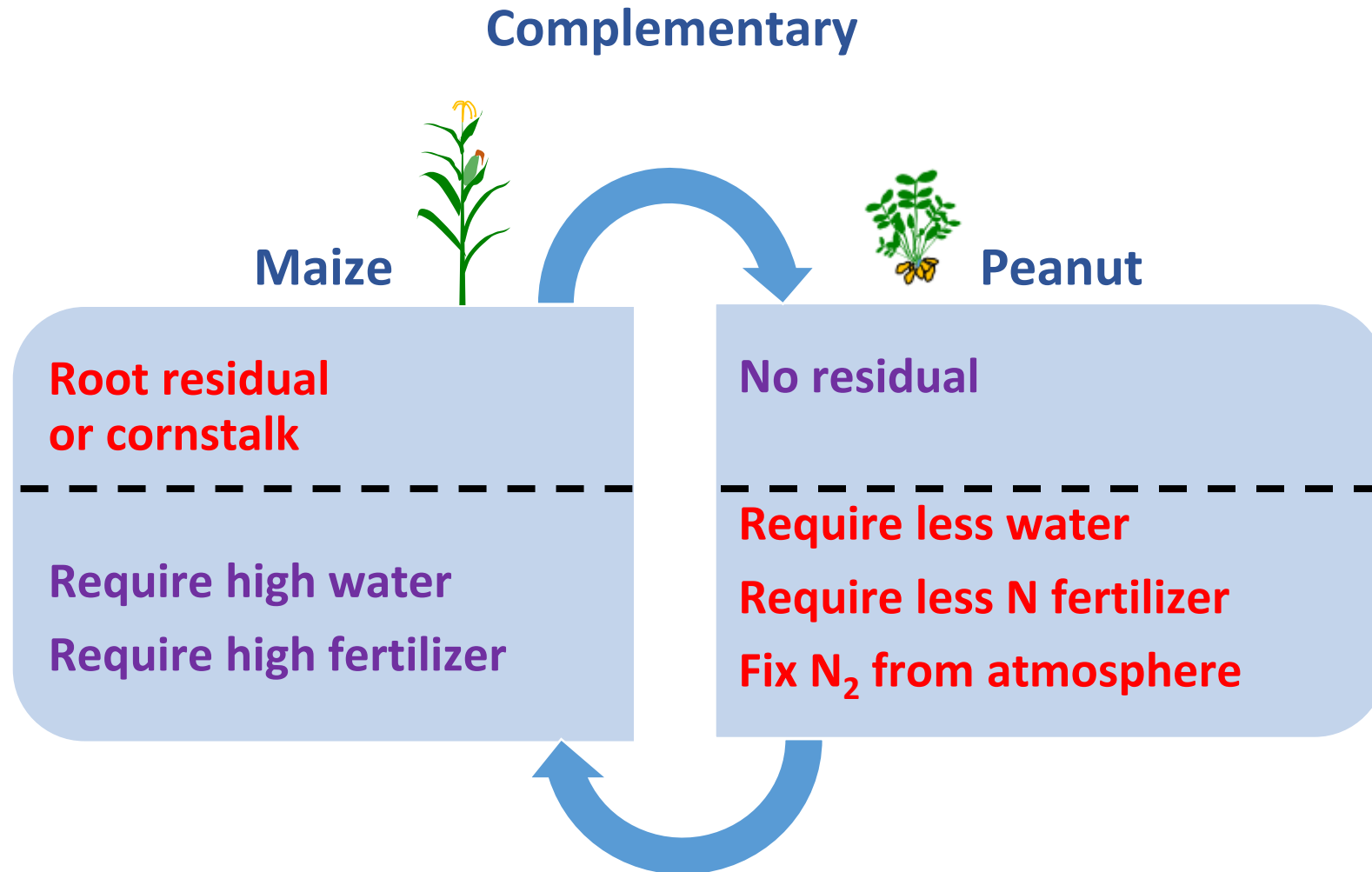
Peanut



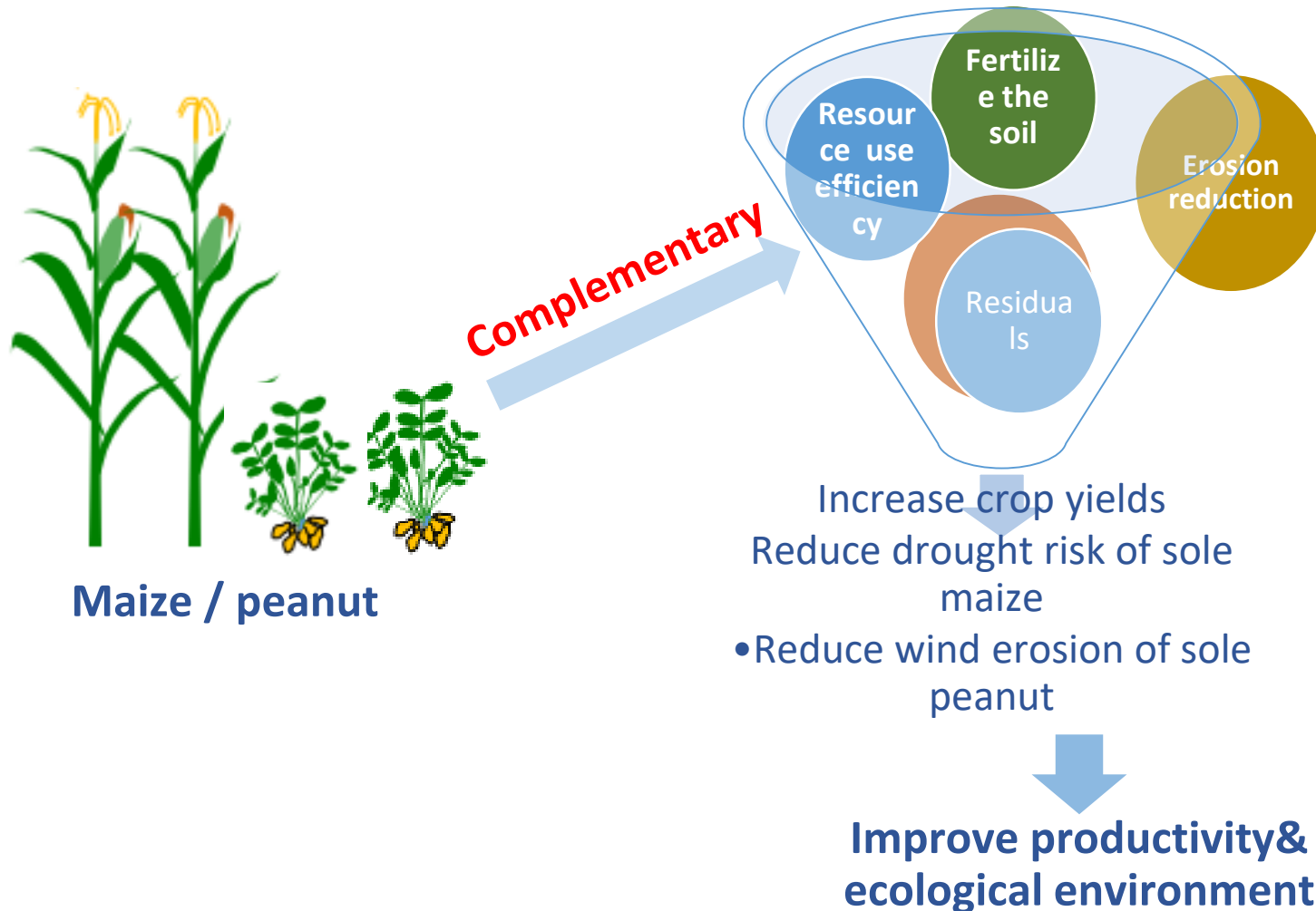
- **Continuous cropping**
(Continuous cropping obstacle)
- **No residues after harvesting**
(Serious wind erosion)

Fuxin, 2021

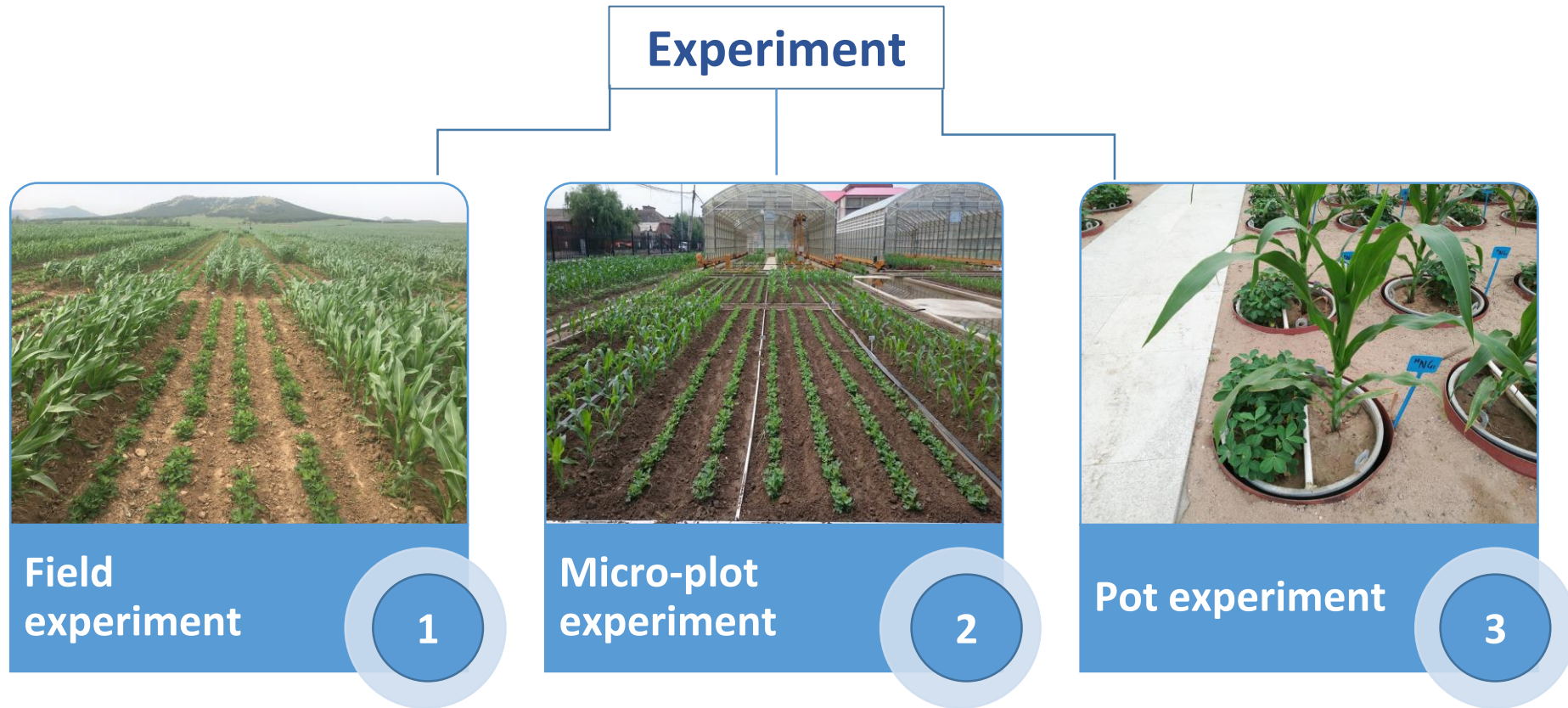
Maize/Peanut Intercropping



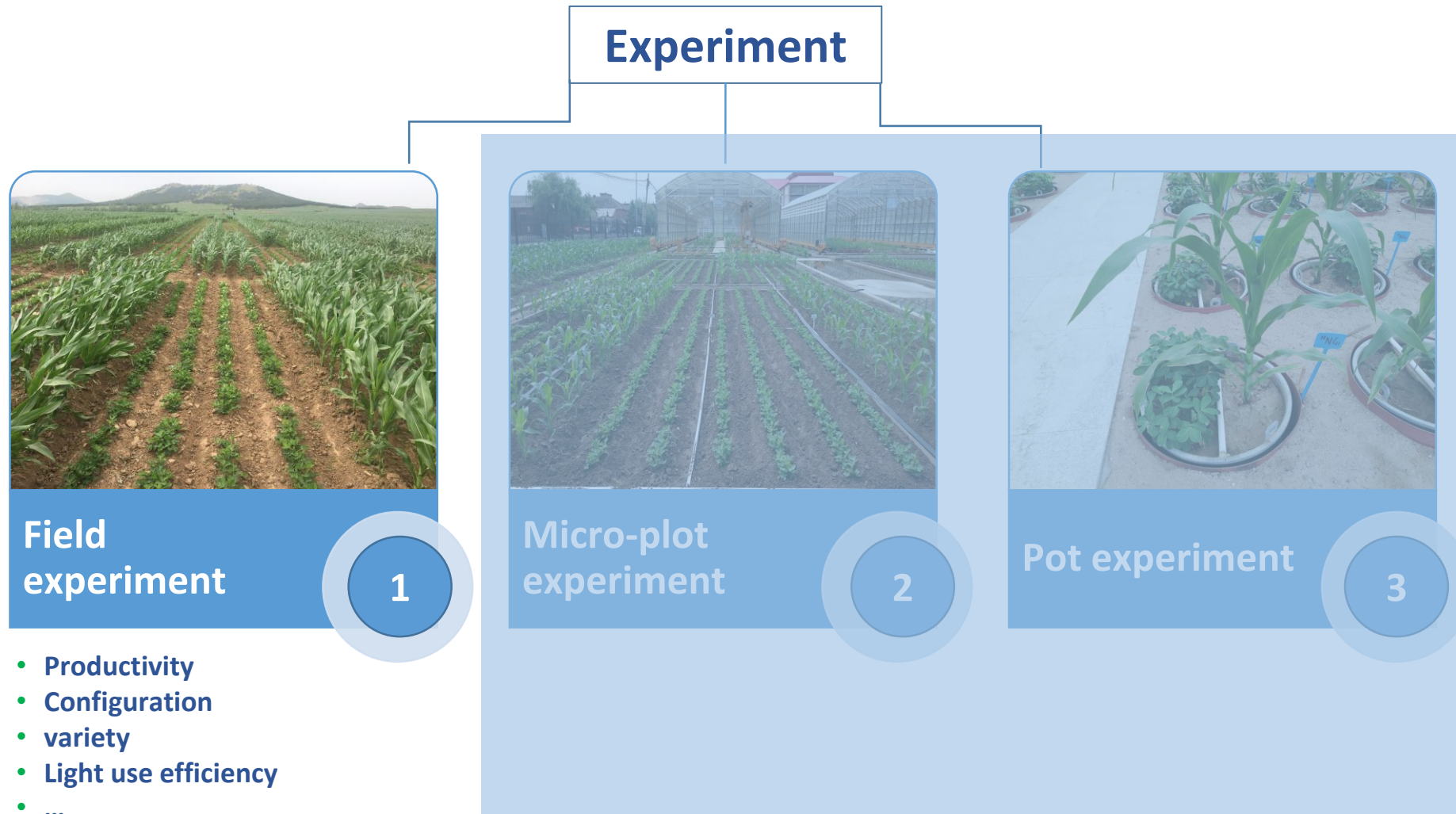
Maize/Peanut Intercropping



Maize/Peanut Intercropping



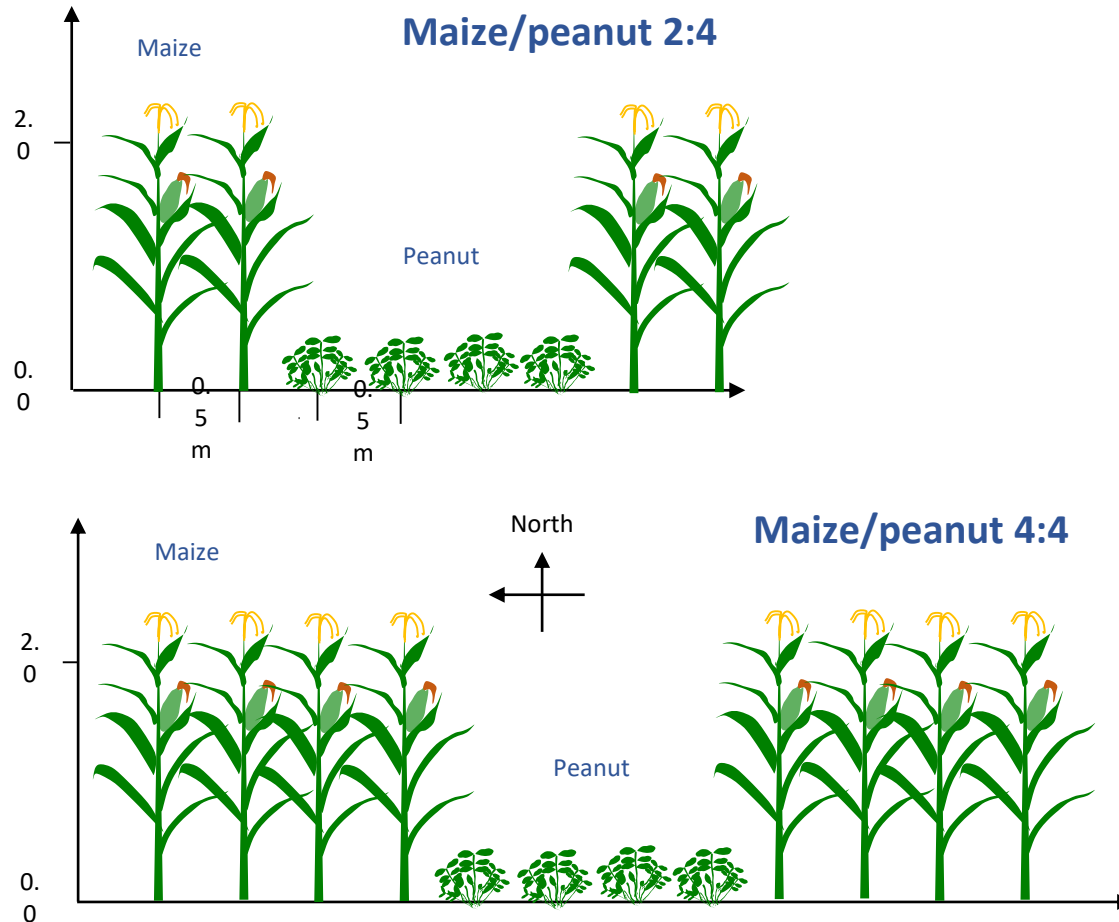
Maize/Peanut Intercropping



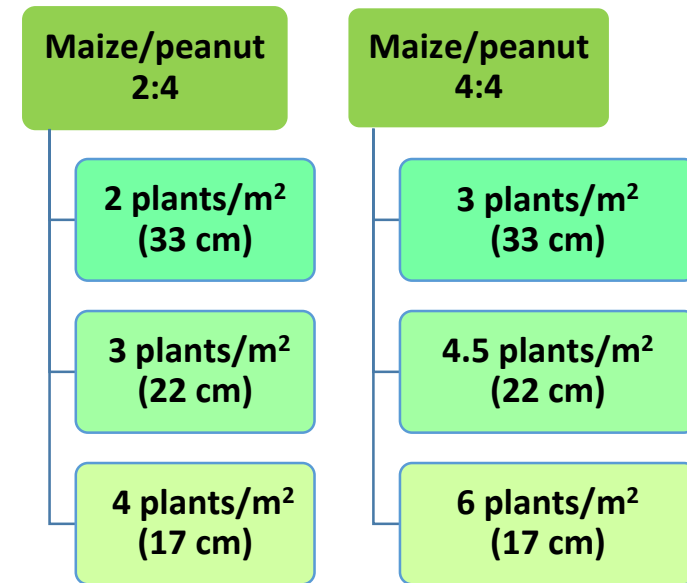


Maize/Peanut Intercropping

Field experiment



Maize density





Maize/Peanut Intercropping

Field experiment-Configuration





Maize/Peanut Intercropping

Field experiment-Variety



P1

P2

P3

P4

P5



M/P1

M/P2

M/P3

M/P4

M/P5



Maize/Peanut Intercropping

Experiment



Field
experiment

1



Micro-plot
experiment

2

- N application
- Water allocation
- ...



Pot experiment

3

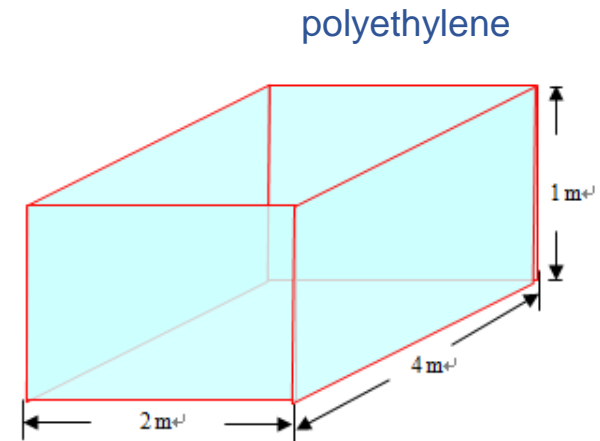
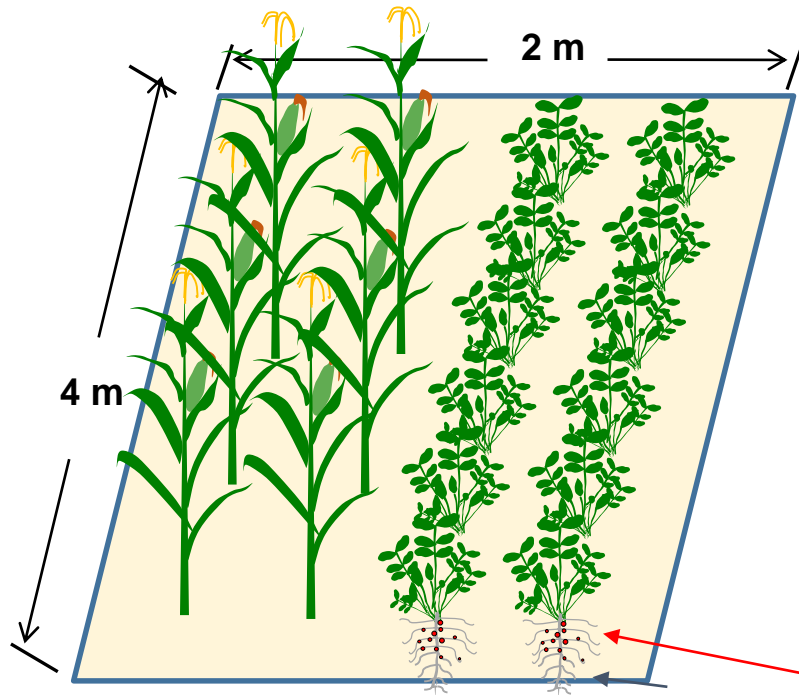


Maize/Peanut Intercropping

Micro-plot experiment



Nitrogen amount (0, 100, 200 kg/ha)



- Nodulation Characteristics
- Nitrogen uptake and use efficiency

Maize/Peanut Intercropping



Micro-plot experiment



Maize/Peanut Intercropping



Micro-plot experiment



Maize/Peanut Intercropping



Experiment



Field
experiment

1



Micro-plot
experiment

2



Pot experiment

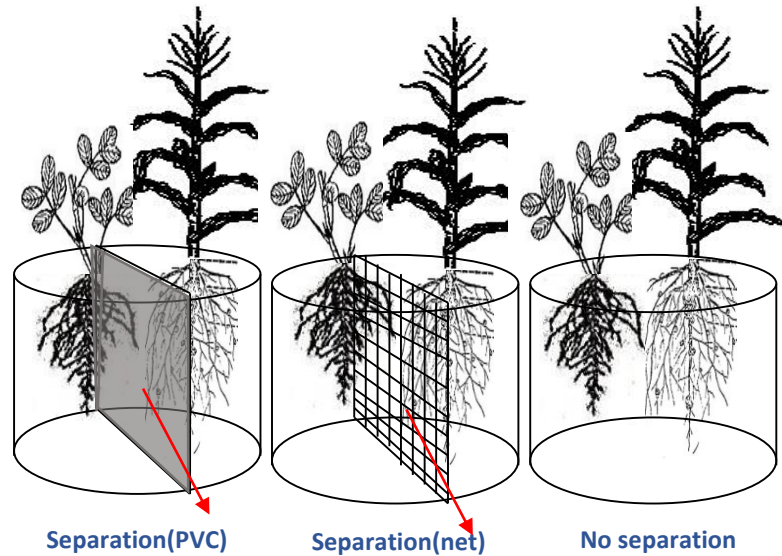
3

- Root interaction
- N₂ fixation
- ...

Maize/Peanut Intercropping



Pot experiment



- Root interaction
- Nitrogen transformation and transfer

Maize/Peanut Intercropping



Pot experiment



Maize/Peanut Intercropping



Results

Land equivalent ratio(LER)

- LER was 0.98~1.20>1, indicating the maize/peanut intercropping system effectively utilize the land resources.
- LERs of M4P4 and M2P4 are higher than that of others.
- The LER of high-density treatment in system is higher than that of low-density treatment, which means increase the density properly improve the land productivity of this system.

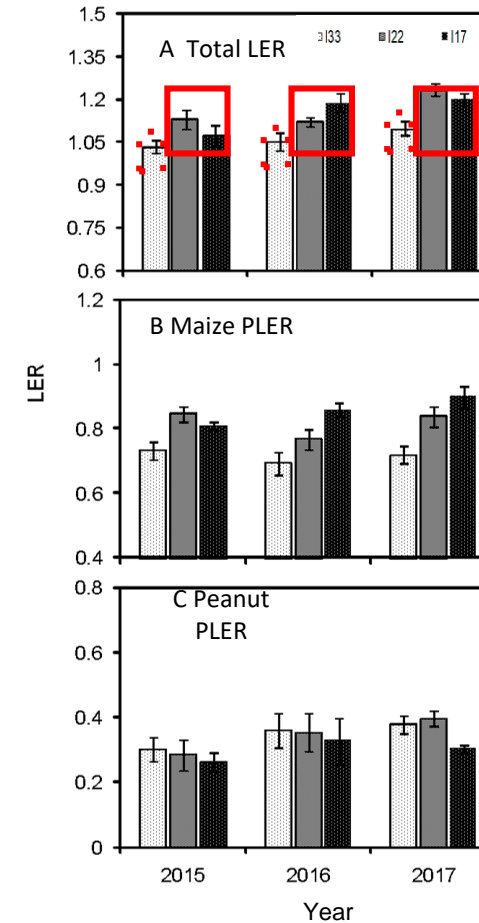
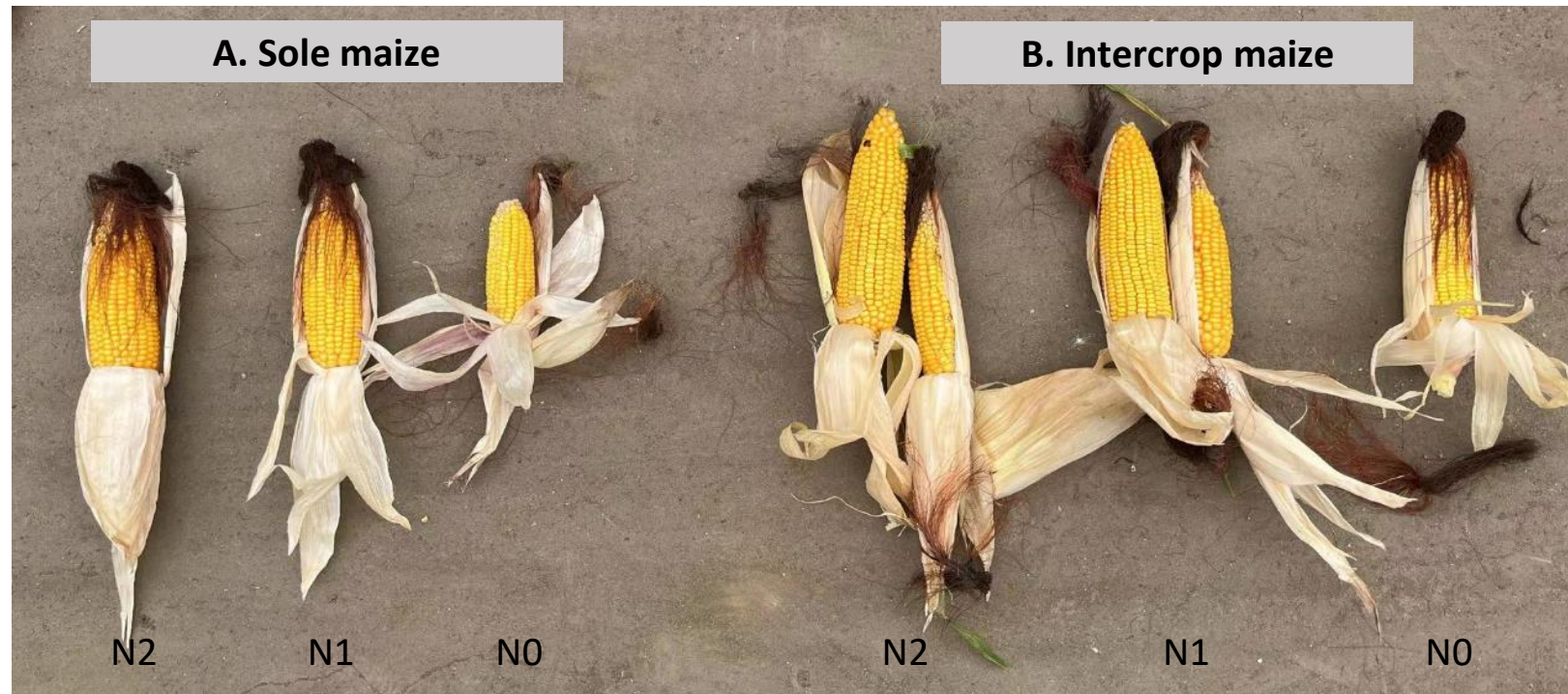


Fig.5 The LER of different treatments

Maize/Peanut Intercropping



Results



- Maize contribute more to the yield advantage of maize/peanut intercropping



Maize/Peanut Intercropping

Light

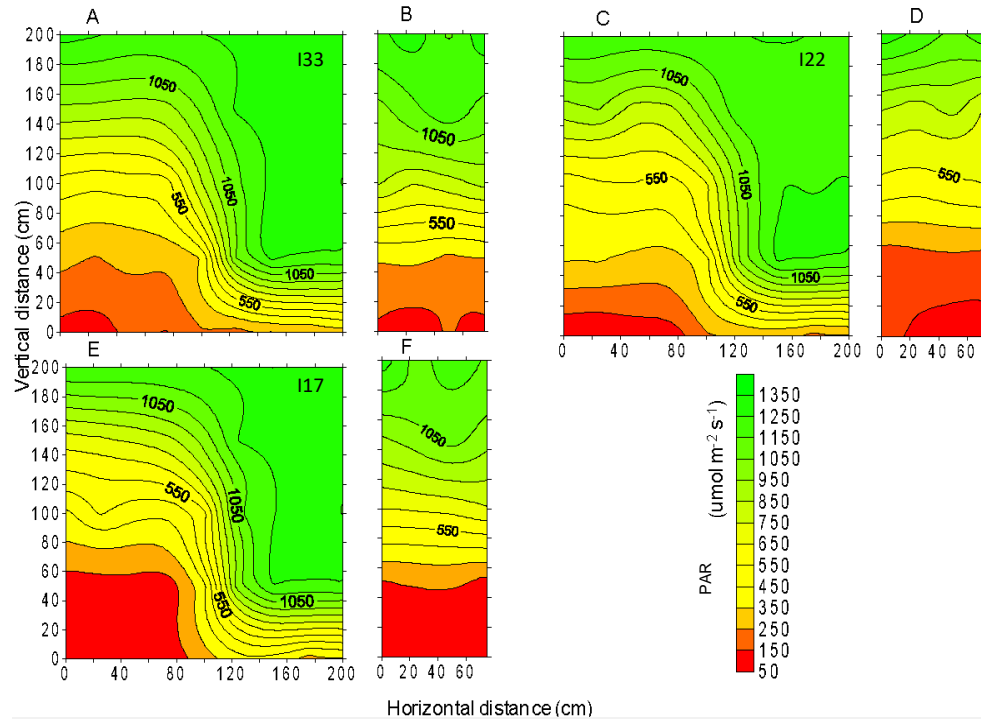


Fig.6 The distribution of PAR in different treatments.



- The light distribution was more uniform in intercropping than in monoculture. The light interception of maize in intercropping system is more than that of sole maize. LUER was 1.04~1.11



Maize/Peanut Intercropping

Water

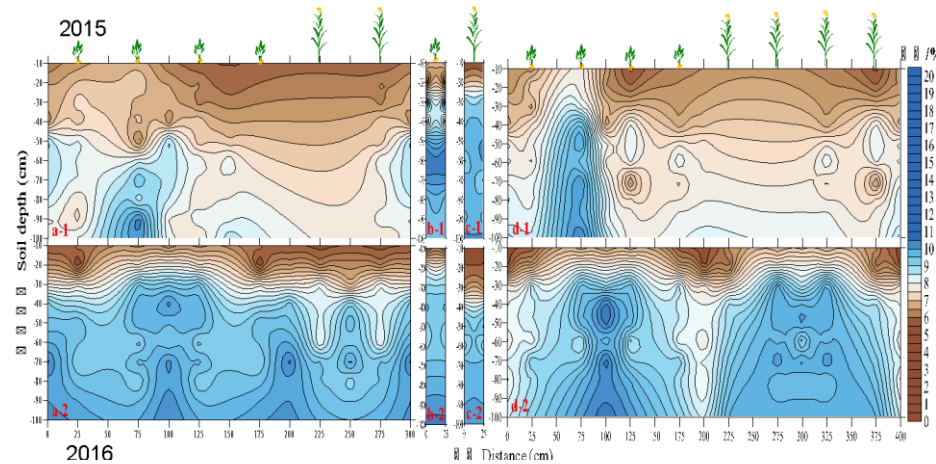


Fig.7 The distribution of soil water in different treatments (2015-2016)

Table 2 The WUE and WER in different systems

Years	System	WUE/(g·(m ² ·mm) ⁻¹)		WER		
		WUE _M	WUE _P	WER _M	WER _P	WER
2015	M2P4	1.99c	0.36b	0.65b	0.58a	1.23a
	M4P4	2.21b	0.28c	0.72a	0.45b	1.17b
	Sole	3.07a	0.63a			
2016	SE	0.16	0.05	0.02	0.03	0.02
	M2P4	1.55c	0.34b	0.62b	0.51a	1.12b
	M4P4	1.80b	0.29c	0.72a	0.44b	1.16a
	SE	0.14	0.06	0.02	0.02	0.01



- The soil water content in maize strips is lower than that in peanut strips in maize/peanut. The soil water content of maize (peanut) strip in intercropping is much higher than that of sole maize (peanut).
- The WER was ranged from 1.12 to 1.23. Therefore, maize/peanut intercropping system improve the water use efficiency.



Maize/Peanut Intercropping

Nodulation

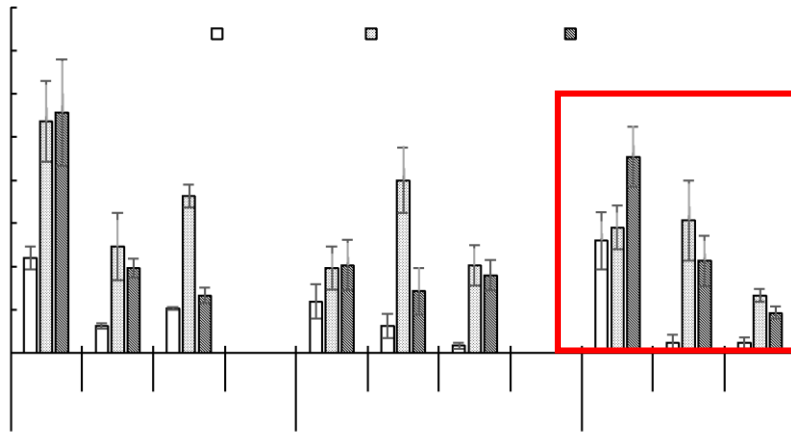
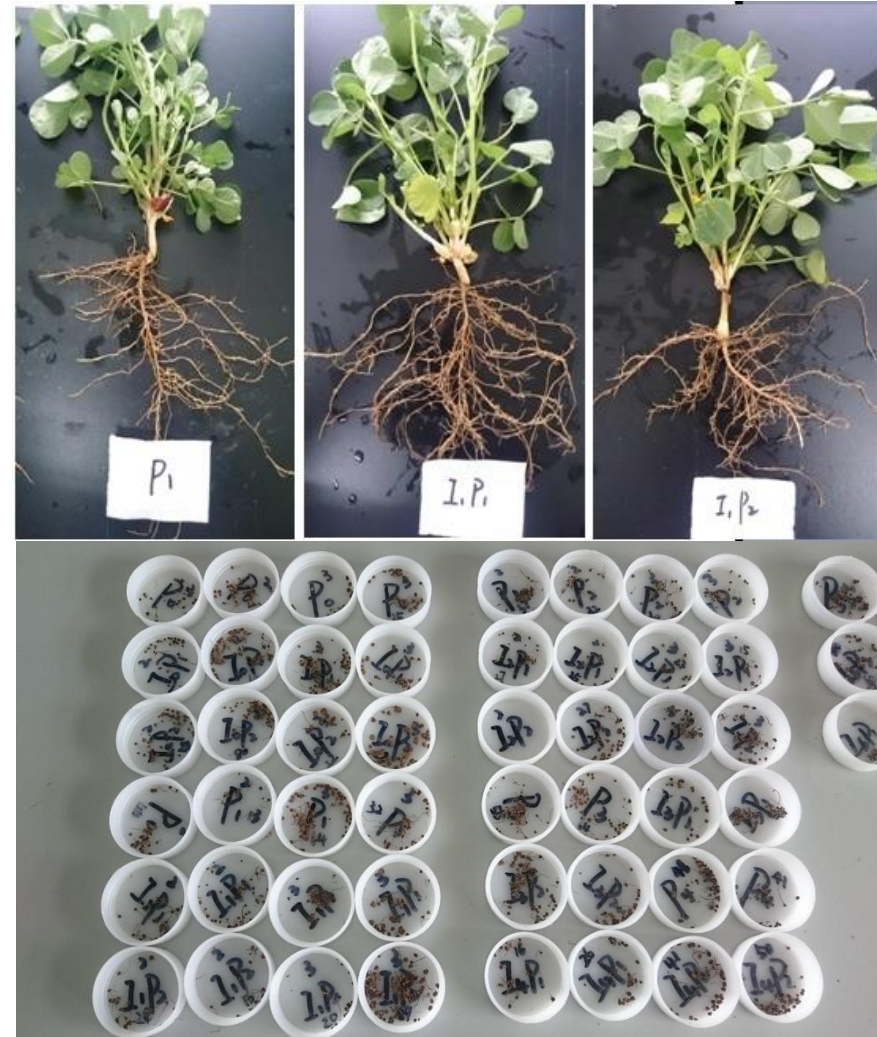


Fig.8 Effects of intercropping and N fertilization on nodule number of peanut

- Application of N fertilizer decrease the nodule number of peanut in intercropping and monoculture.
- But the nodule number of intercropping is more than that of monoculture, even the amount of N is up to 200 kg/ha.





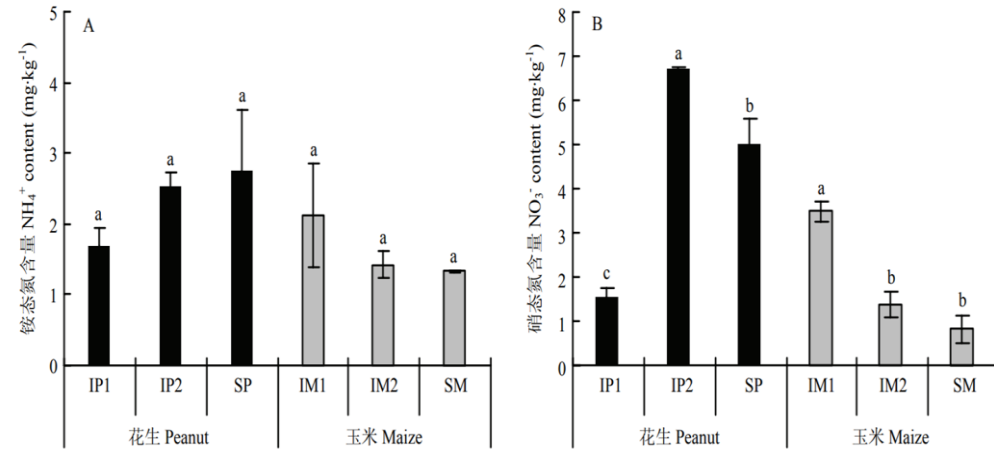
Maize/Peanut Intercropping

NUER

Table 2 Nitrogen yield and equivalent ratio of nitrogen absorption of maize and peanut under different intercropping configurations (2015-2016)

年份 Year	间作配置 Configuration	玉米氮产量 N yield of maize (kg·hm ⁻²)		花生氮产量 N yield of peanut (kg·hm ⁻²)		氮吸收当量比 NER		
		间作 Intercropping	单作 Sole	间作 Intercropping	单作 Sole	ρNER_m	ρNER_p	NER
2015-2016	M2P4-4	102.7	156.1	66.9	199.2	0.66	0.34	1.00
	M2P4-6	115.3	170.2	66.9		0.68	0.34	1.02
	M2P4-8	121.6	170.4	68.3		0.71	0.35	1.06
	M4P4-4	98.7	156.1	85.4		0.63	0.43	1.06
	M4P4-6	117.6	170.2	85.5		0.69	0.43	1.12
	M4P4-8	136.3	170.4	82.2		0.80	0.42	1.22
	SE	5.84	4.64	3.34	8.92	0.024	0.026	0.042
P 值	行比 Row proportion (R)	0.3715	1.0000	0.0000	—	0.2336	0.0003	0.0031
P value	密度 Density (D)	0.0001	0.0055	0.9483	—	0.0002	0.9926	0.0446
	行比×密度 (R×D)	0.2813	1.0000	0.7175	—	0.0747	0.8467	0.5915

M2P4-4、M2P4-6、M2P4-8 分别代表 M2P4 行比下 3 种玉米密度处理；M4P4-4、M4P4-6、M4P4-8 分别代表 M4P4 行比下 3 种玉米密度处理。下同 M2P4-4、M2P4-6、和 M2P4-8 represent three different densities of maize in intercropping row configuration M2P4; M4P4-4、M4P4-6、和 M4P4-8 represent three different densities of maize in intercropping row configuration M4P4. The same as below



- There was no significant difference between intercropped maize (peanut) and sole maize (peanut) in N concentration.
- The NUER of maize/peanut intercropping is 1.0~1.22, there is N uptake advantages in maize/peanut intercropping system.

Maize/Peanut Intercropping

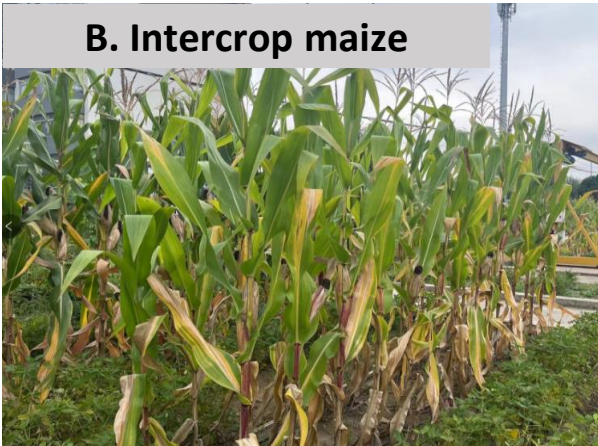


NUER

A. Sole maize



B. Intercrop maize





Maize/Peanut Intercropping

Technical parameters



- **Configuration**

Row proportion: M2P4, M4P4, M8P8

- **Spacing(row):**

maize 50~60 cm,

peanut 50 cm

- **Spacing(plant):**

maize 25~33 cm

peanut 12~14 cm (double plants in one hole)/ 6-7 cm (single plant)



Maize/Peanut Intercropping

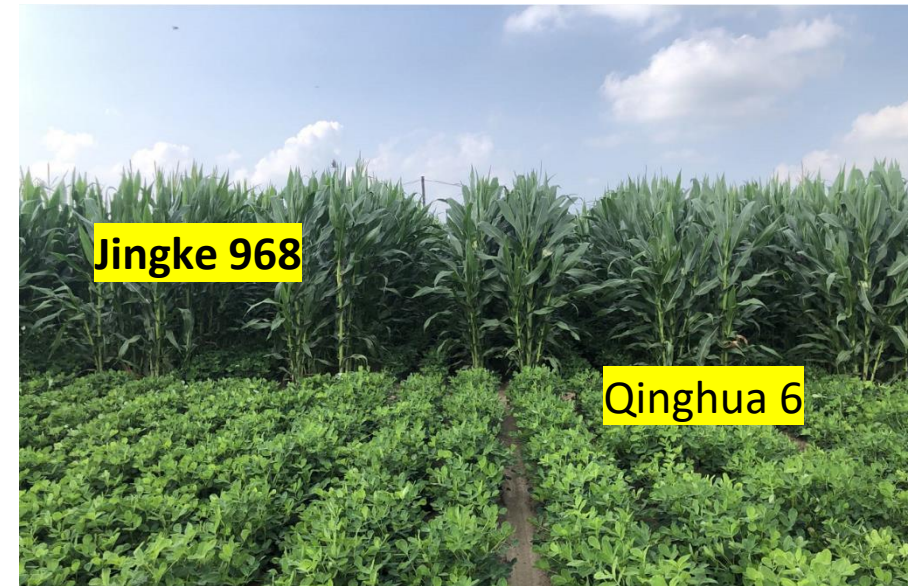
Technical parameters



- **Varieties (maize):**

Density-tolerant, stress-resistant, compact/semi-compact (maize), e.g. Zhengdan 958, Jingke 968, etc.

National /provincial standard, suitable for the local climate and soil condition



- **Varieties(peanut):**

Shade-tolerant, disease-resistant, pest-resistant (peanut), e.g. Baisha1016, Qinghua 6, Fuhua 30, Jihua 18, etc.



Maize/Peanut Intercropping

Technical parameters



- **Sowing date**

Late April to early May

Soil temperature(5~10 cm soil layer) $\geq 12^{\circ}\text{C}$

- **Sowing depth:**

maize 5~7 cm, peanut 4~6 cm

- **Sowing method:**

Hand sowing

Mechanical sowing



Maize/Peanut Intercropping

Technical parameters



- **Ordinary fertilizer**

Maize: 180~240 kg N/ha (4g/plant)

Peanut: 60~80 kg N/ha

- **Control-released compound fertilizer**

Maize (26-11-11) 40~45 kg/mu, 150 kg N/ha

Peanut (13-17-15) 30~40 kg/mu, 50 kg N/ha

- **Harvesting**

Hand harvesting

Mechanical harvesting





Maize/Peanut Intercropping



- **Other technology**

Closed weeding (pre-emergence)/special herbicide (after emergence)

Plastic film mulching / Drip/sprinkling irrigation

Residual: leaving high stubble / leaving whole plants / straw mulching

Strip rotation



Maize/Peanut Intercropping

Regional suitable intercropping pattern

Pattern

- Maize/peanut intercropping

Core technology

- Crop configuration
- Water and fertilizer management
- Reduce wind erosion by residual
- Integration of agricultural machinery and agronomy

Supporting technology

- Selection of variety
- Tillage
- Rotation
- Control of diseases, pests and weeds
- ...



Applied in Liaoning



- **Increase resource use efficiency**

Water 10~20%↑, Light 8~20%↑, N 6~16%↑

- **Reduce wind erosion, maintain soil fertility**

Farmland wind erosion 43%↓, water-stable aggregates 25%↑

- **Improve productivity and yield stability**

Yield (system) 10~20%



National Agricultural Experimental Station for Agricultural Environment, Fuxin







Field experiment,
2023









Field experiment,
2023





Thank you!