Alfalfa to get back into planetary boundaries

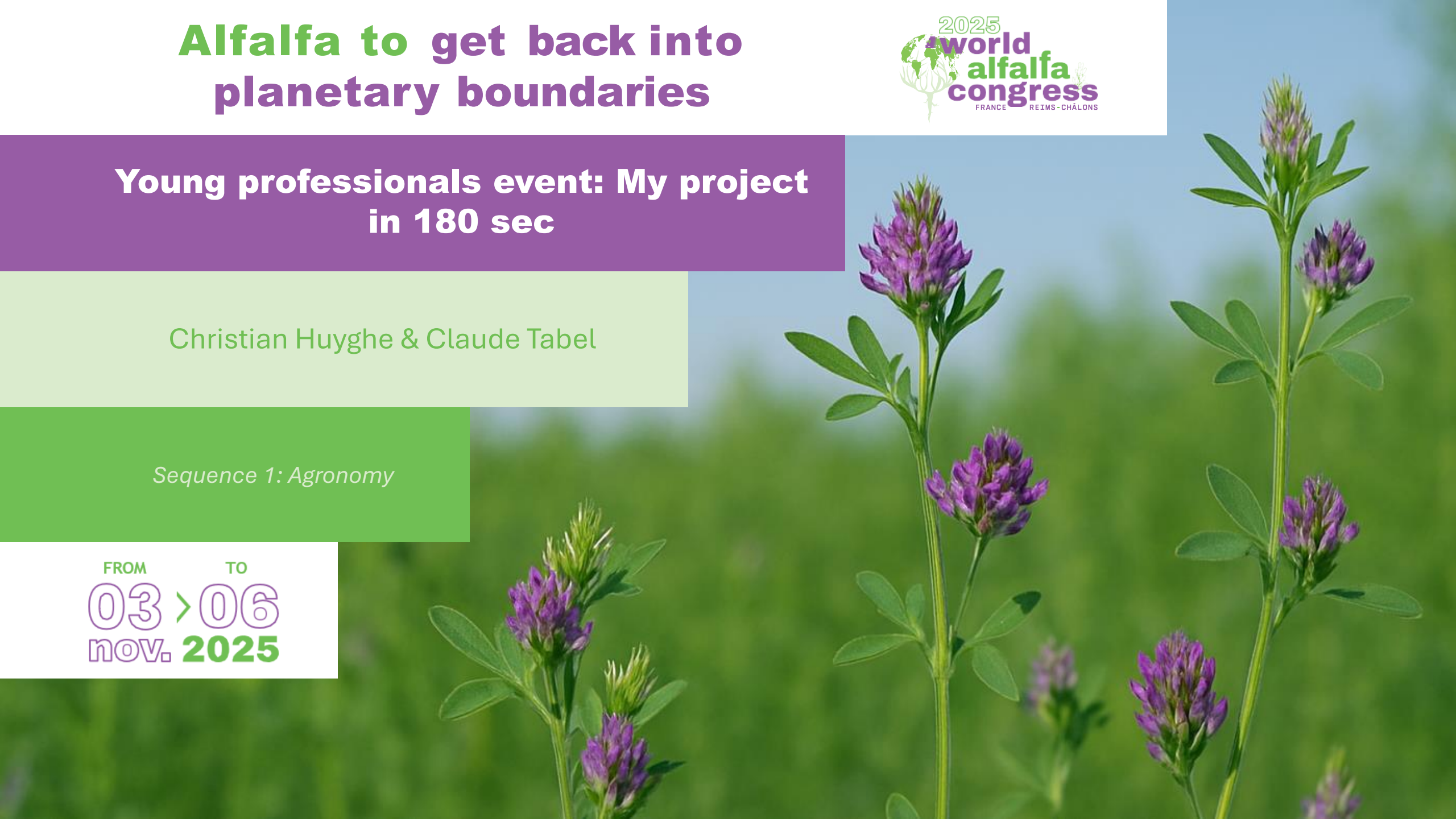
2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

Young professionals event: My project in 180 sec

Christian Huyghe & Claude Tabel

Sequence 1: Agronomy

FROM 03 TO 06 nov. 2025



Alfalfa to get back into planetary boundaries

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Research and practice on alfalfa-maize intercropping in China

Ruixuan Xu Yingjun Zhang



FROM 03 TO 06 nov. 2025

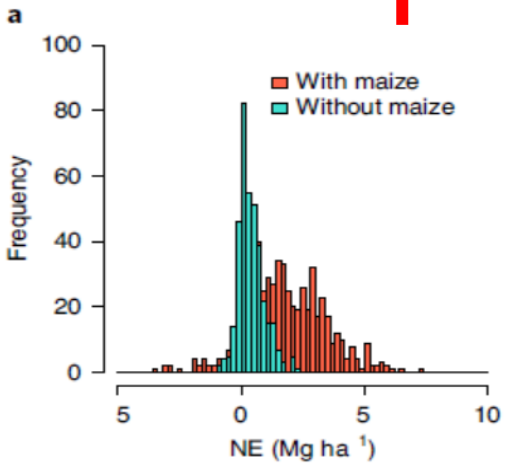
Why we are trying to intercrop alfalfa and maize

- Shortage of forages
- Limited arable land

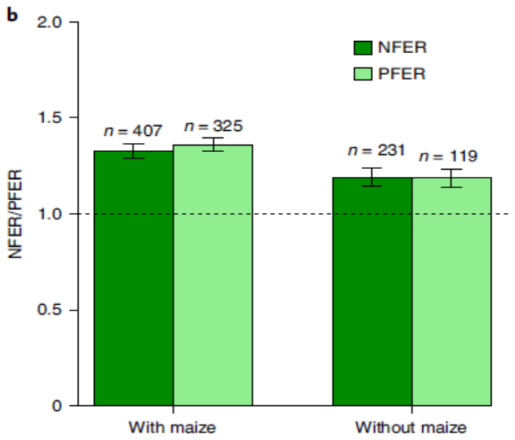
Alfalfa // Maize
Legume // Cereal
C3 // C4

- Intercropping can increase yield and efficiency, and improve soil quality

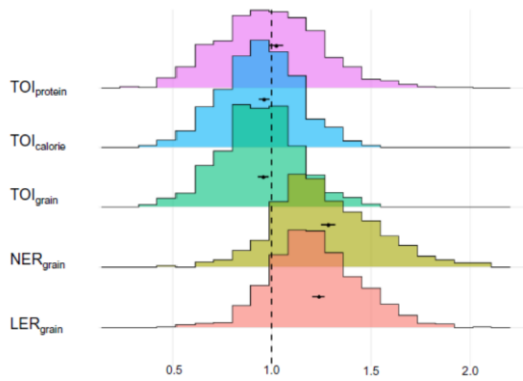
Grain yield: 1.5 t/ha ↑



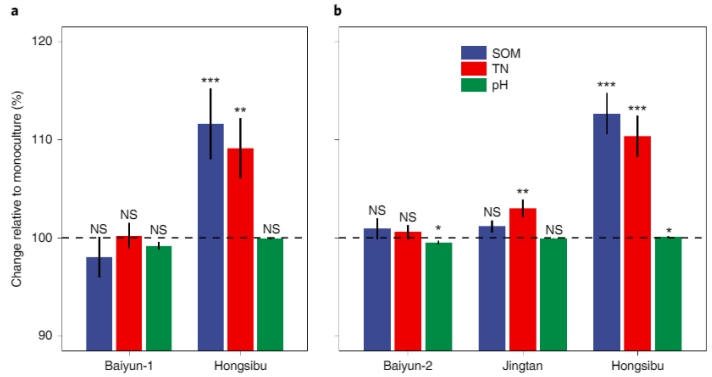
Efficiency: 28%（fertilizer input） ↓



Protein yield: 47% of intercropping system ↑



Soil organic matter: 9%-12% ↑

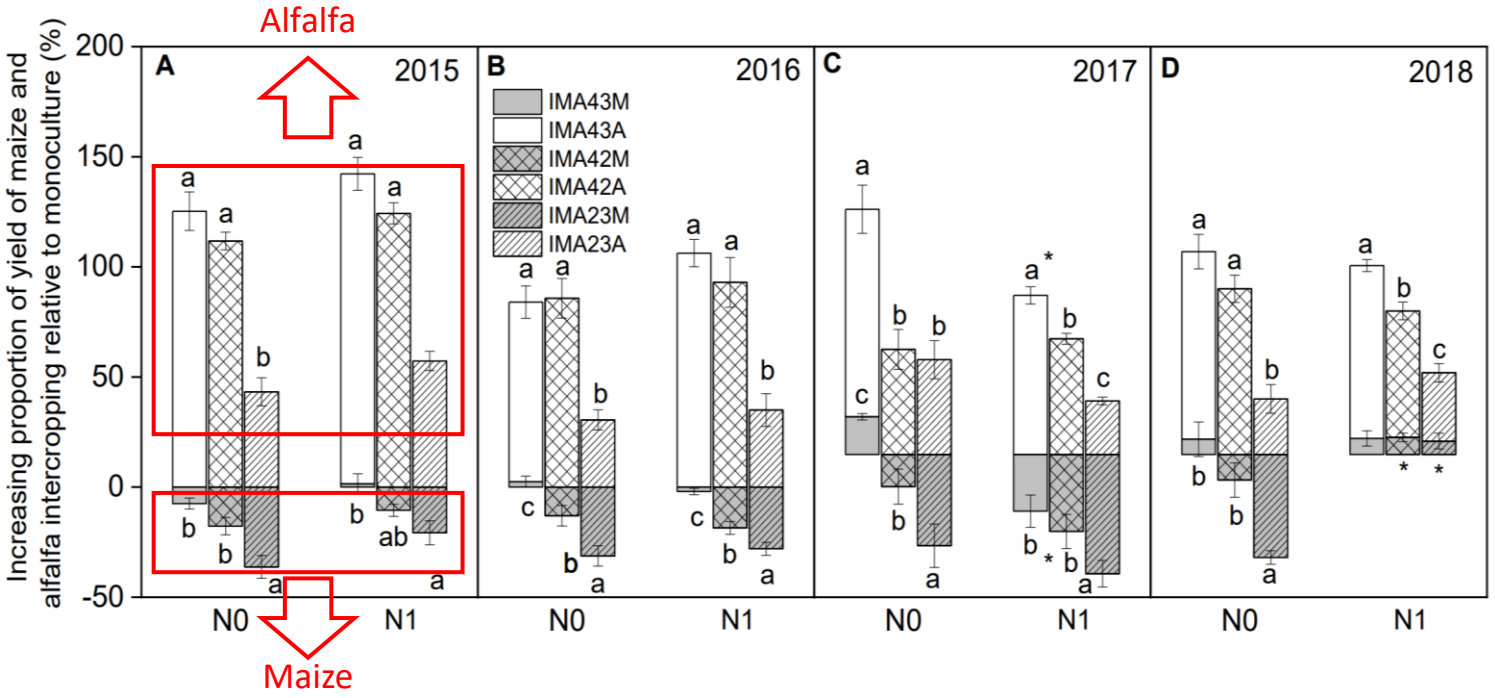


Li et al, 2020 *Nature Plant*; Li et al, 2021 *Nature sustainability*; Li et al, 2022 *PNAS*

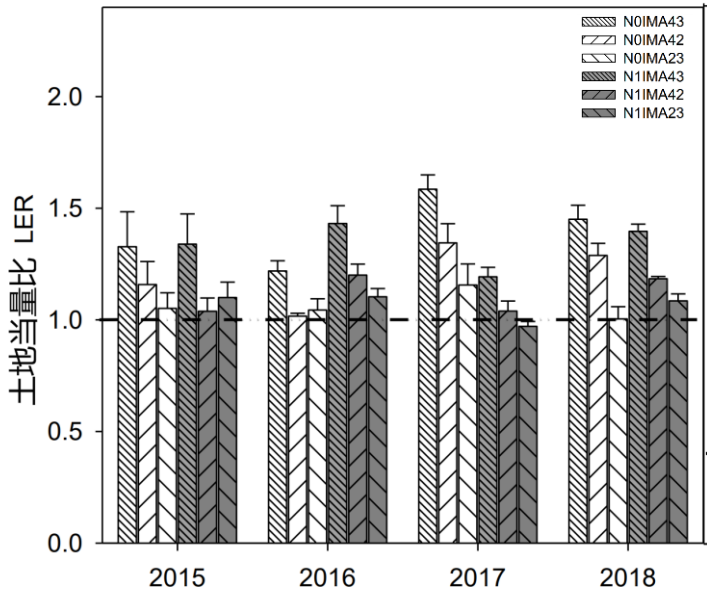
Alfalfa-maize intercropping system---higher productivity

- Higher system yield: maize ↓ alfalfa ↑
- LER 1.0~1.6

Increasing proportion of yield of intercropped maize and alfalfa relative to monoculture



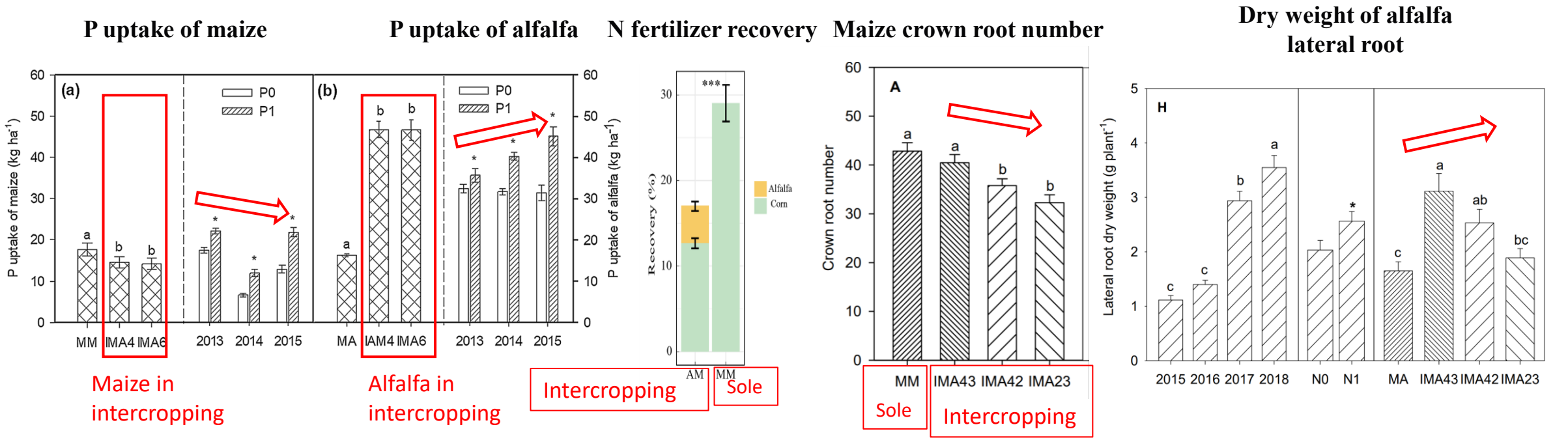
Land equivalent ratio



Zhang et al, 2011 *Field Crops Research*; Sun et al, 2019,2020 *Plant soil*

Alfalfa-maize intercropping system---higher nutrient uptake

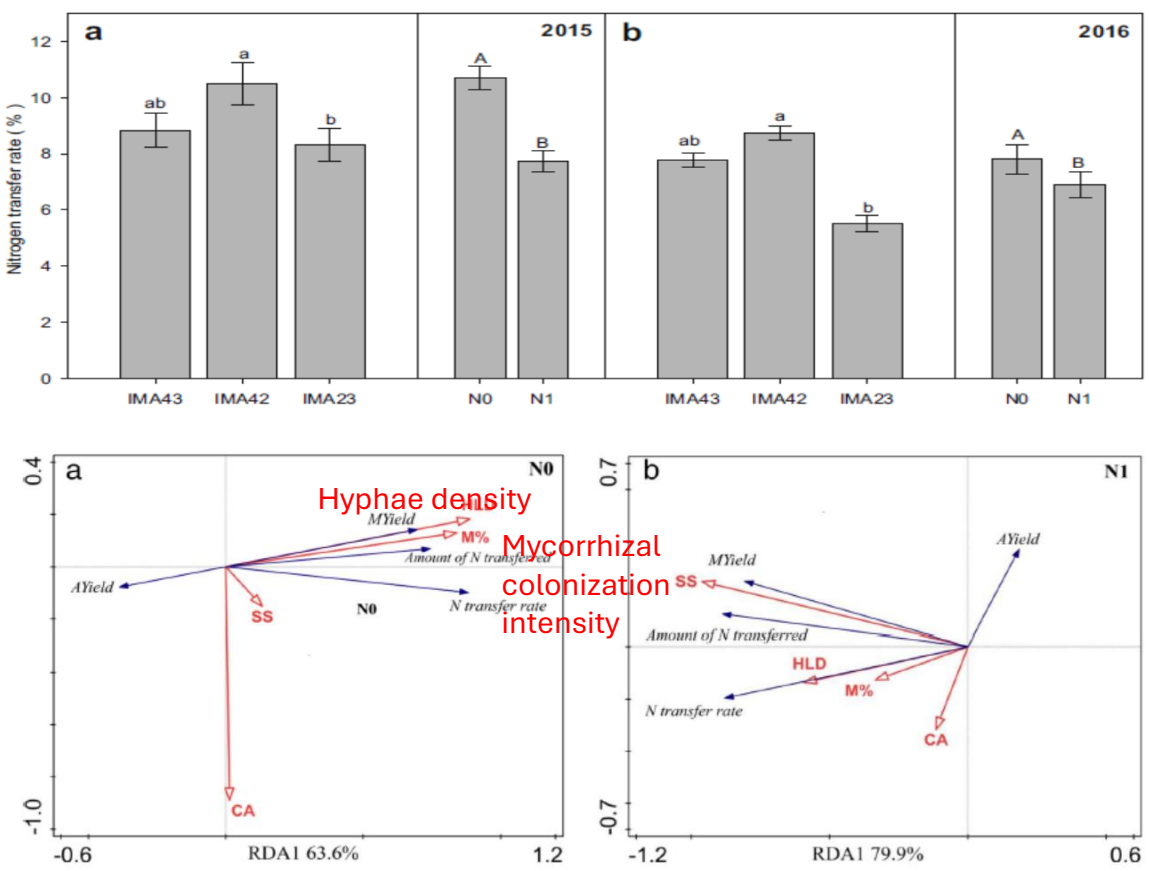
- Higher system N and P uptake: maize ↓ alfalfa ↑
- Alfalfa is a stronger competitor for soil nutrients in intercropping system: luxury absorption
- Stronger alfalfa root (taproot and lateral root); smaller maize root (crown roots)



Zhang et al, 2011 *Field Crops Research*; Sun et al, 2019,2020 *Plant soil*

N transfer between alfalfa and maize

- Alfalfa to maize: 5.52%-10.49% (7-10 mg N/plant)
- AMF is the main pathway
- Bi-direction N transfer
- The amount of N transfer from alfalfa is low



Zhang et al, 2020 Plant soil

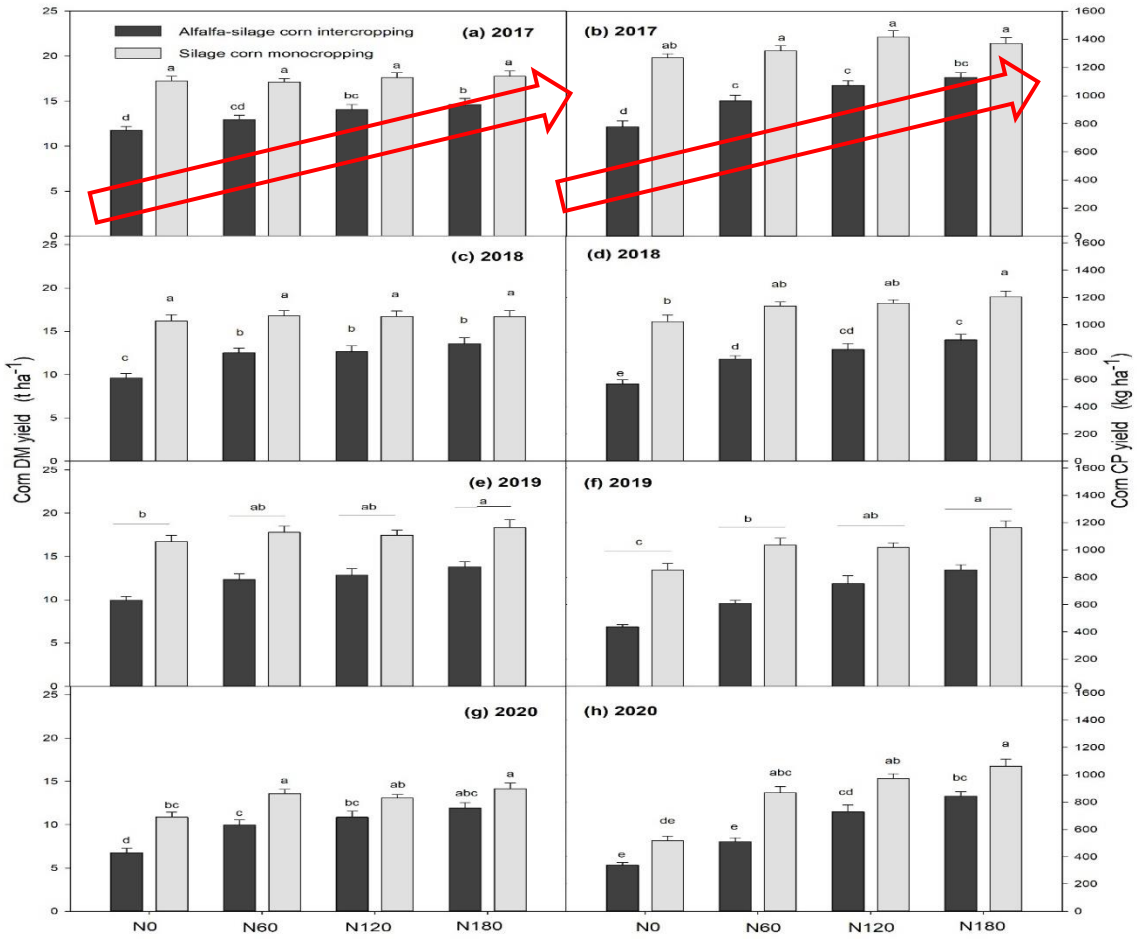
氮处理 N treatment	苜蓿向玉米转移 Alfalfa → Silage corn 氮素转移比例 %Ndft (%)	氮转移量 Nt (mg)	氮转移量占接收植物氮的比例 Nreceiver (%)	玉米向苜蓿转移 Silage corn → Alfalfa 氮素转移比例 %Ndft (%)	氮转移量 Nt (mg)	氮转移量占接收植物氮的比例 Nreceiver (%)
地上部分 Shoots						
N0	1.5 ± 0.2	9.3 ± 1.4	0.7 ± 0.1	0.2 ± 0.02 B	2.1 ± 0.2 B	0.3 ± 0.01 B
N1	2.1 ± 0.2	8.6 ± 0.4	0.5 ± 0.0	0.2 ± 0.02 B	3.2 ± 0.3 B	0.6 ± 0.1 B
N2	2.1 ± 0.3	10.6 ± 0.2	0.6 ± 0.1	0.6 ± 0.02 A	11.6 ± 1.3 A	2.5 ± 0.3 A
P value	ns	ns	ns	<0.001	<0.001	<0.001
地下部分 Roots						
N0	3.0 ± 0.6	8.1 ± 2.0	3.7 ± 0.4 A	0.6 ± 0.2 B	1.0 ± 0.3 B	0.4 ± 0.1 B
N1	2.7 ± 0.4	4.5 ± 0.9	1.7 ± 0.3 B	1.9 ± 0.5 AB	3.8 ± 0.6 AB	1.8 ± 0.3 AB
N2	3.9 ± 0.9	6.0 ± 1.4	2.0 ± 0.3 B	2.3 ± 0.4 A	5.9 ± 1.6 A	2.7 ± 0.4 A
P value	ns	ns	0.010	0.035	0.020	0.001
全株 Total						
N0		17.4 ± 3.22	1.1 ± 0.2		3.1 ± 0.2 B	0.3 ± 0.04 B
N1		13.1 ± 0.9	0.7 ± 0.1		7.0 ± 0.7 B	1.0 ± 0.1 B
N2		16.6 ± 1.5	0.8 ± 0.1		17.5 ± 1.7 A	2.6 ± 0.3 A
P value		ns	ns		<0.001	<0.001

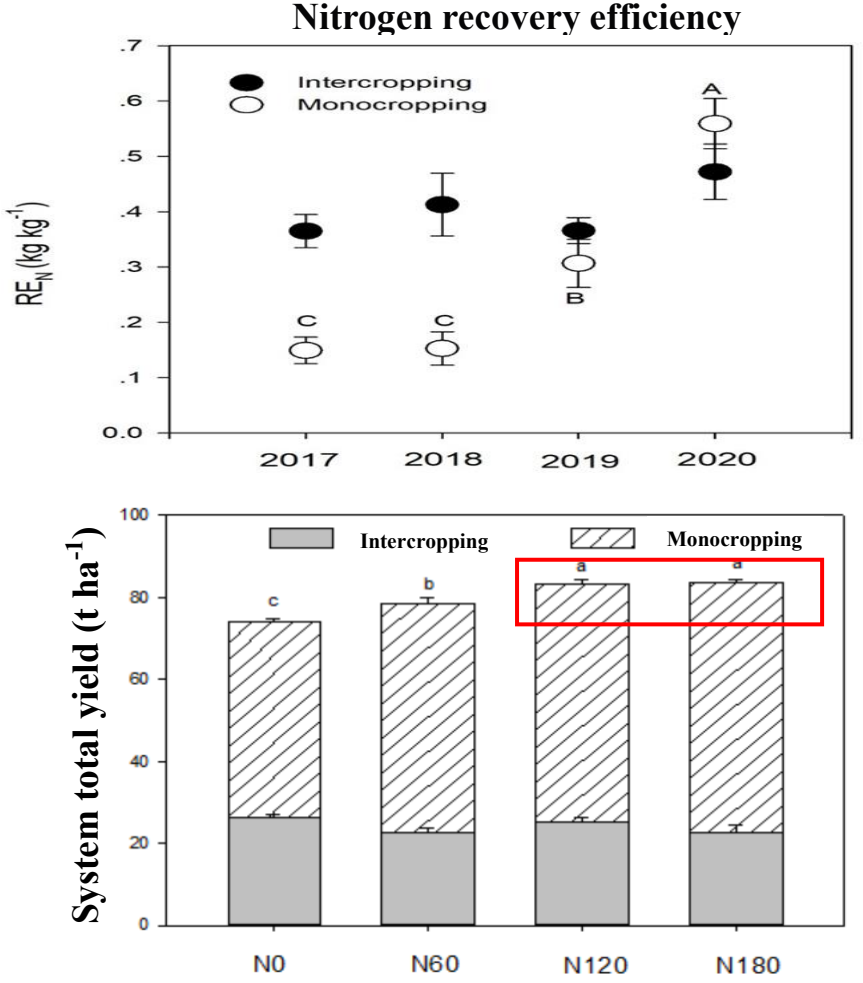
Amount of nitrogen transfer

Xu et al, In prepararion

Fertilizer use in alfalfa-maize intercropping

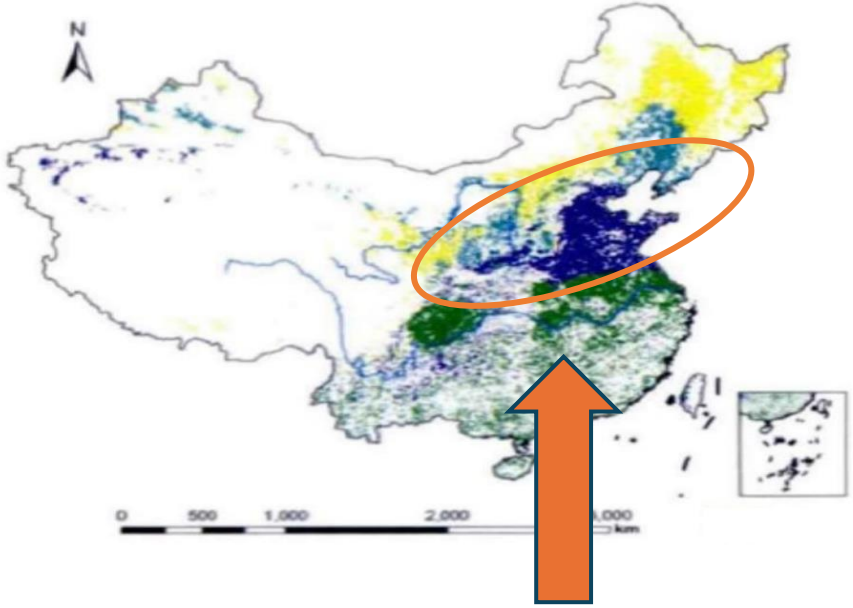
- N application can effectively enhance the nitrogen status of maize
- The intercropping system requires an appropriate fertilizer management





Xu et al, 2021, *Field Crops Research*

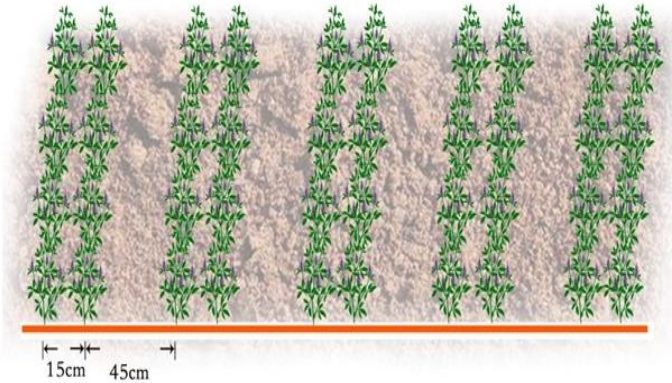
Alfalfa-maize relay intercropping in the North China Plain



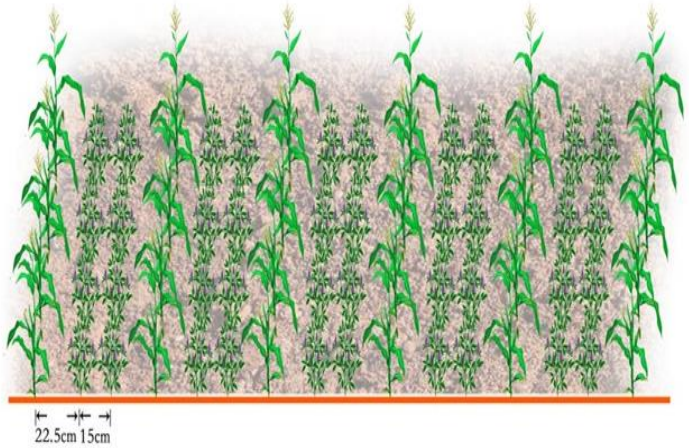
The North China Plain(NCP)

2-3 crops a year

Spring—dry season



Summer —rainy season



- Alfalfa production
- Maize production

- **Autumn:** mixed harvesting and ensiling

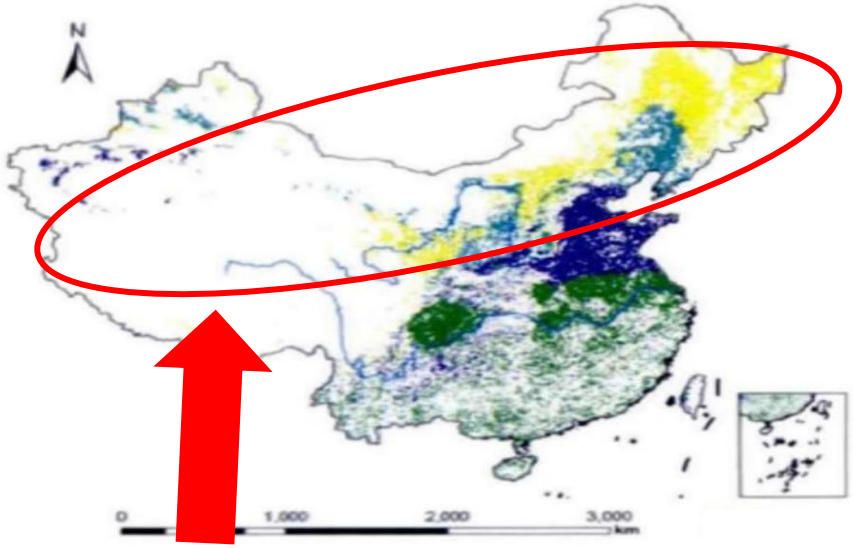
Alfalfa-maize relay intercropping in the North China Plain

No-till maize planting into alfalfa

Co-growth period

Harvesting

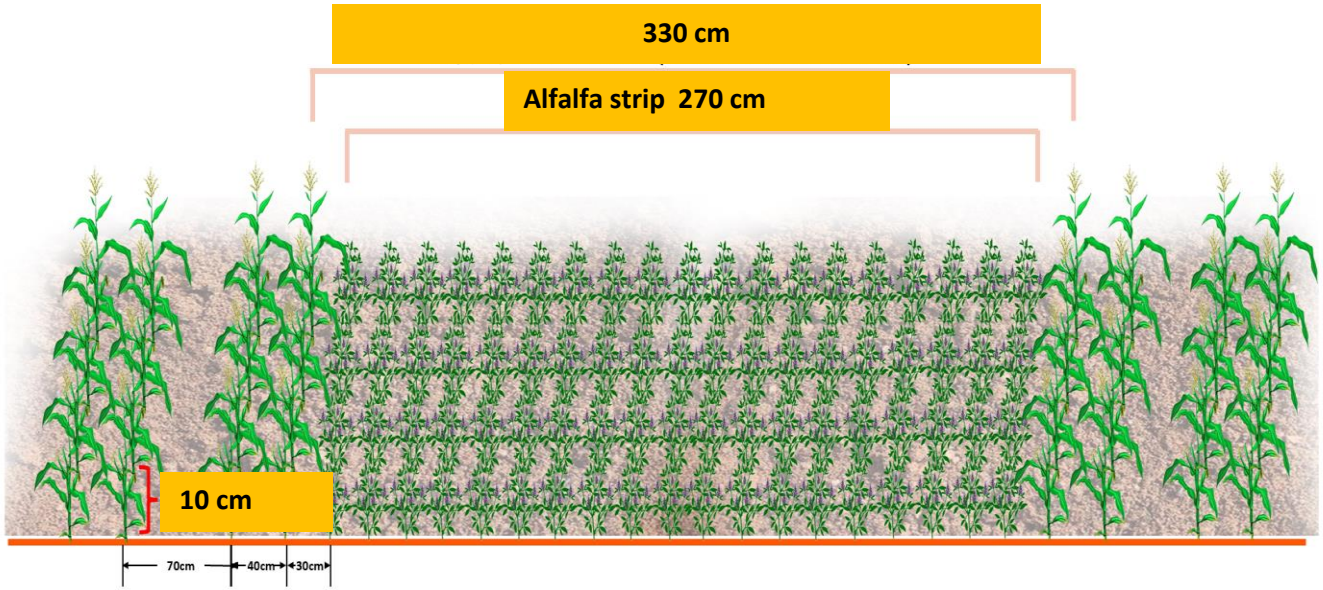
Alfalfa-maize strip intercropping in Northern China



Northern China

1 crop a year

Actual Land Proportion	**alfalfa: 60%**	**maize: 40%**
Relative Land Proportion	**alfalfa: 34%**	**maize: 66%**



- High productivity: high-density maize in maize stripe
- Alfalfa and maize are harvesting and processing separately

Alfalfa-maize strip intercropping in Northern China


Laying drip tapes while maize sowing


No-till maize planting into alfalfa


Co-growth period


Harvesting

Conclusion and outlook

- Maximize the production potential of the two forages
- Improve the efficiency of land and other resources

Thanks for your attention

- 60000/60000=1
- 52/1000=0.52
- 0.52/（1+0.52）=34%