Ecological intensification by intercropping requires novel fine-scale mechanization

Wopke van der Werf, Centre for Crop Systems Analysis
Wageningen University & Research

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Intercropping (Dutch: mengteelt)

- Cultivation of more than one crop in one field at the same time
- Produces on average 20% more yield per unit area
- Has on average 30% less pest and disease severity
- Has higher root mass and thereby increases soil organic matter content

- Important agronomic advantages!

Intercropping and crop/tree mixture along the Yellow River in Gansu, China (photo: Li Long)


There is an incredible diversity of systems
Wheat - maize
Photo: Zhang Fusuo

There is an incredible diversity of systems

There is an incredible diversity of systems
















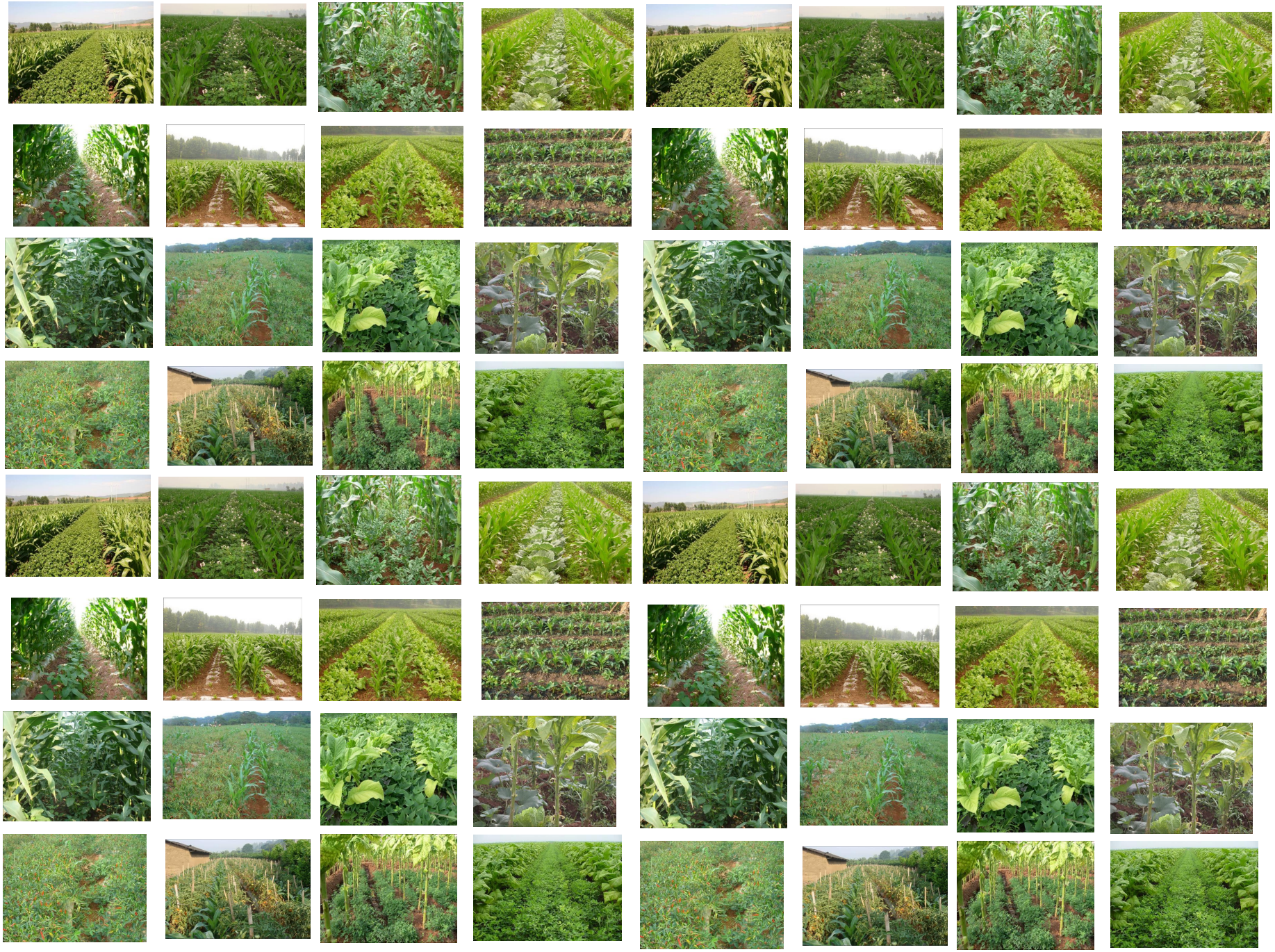

Intercropping

- Is still widespread in developing countries, but almost absent in modern western agriculture (but coming back)
- Is under pressure in developing countries due to rising cost of labour and higher labour income in cities
- Traditional intercropping as a practice needs modernization
- Provides inspiration for ways to make Western agriculture more productive and sustainable
- Enhanced ecosystem services: food provision, pest & disease control, soil quality
- Intercropping makes better use of the land and other growth resources (light, water, nutrients) due to more complete uptake (and lower losses)


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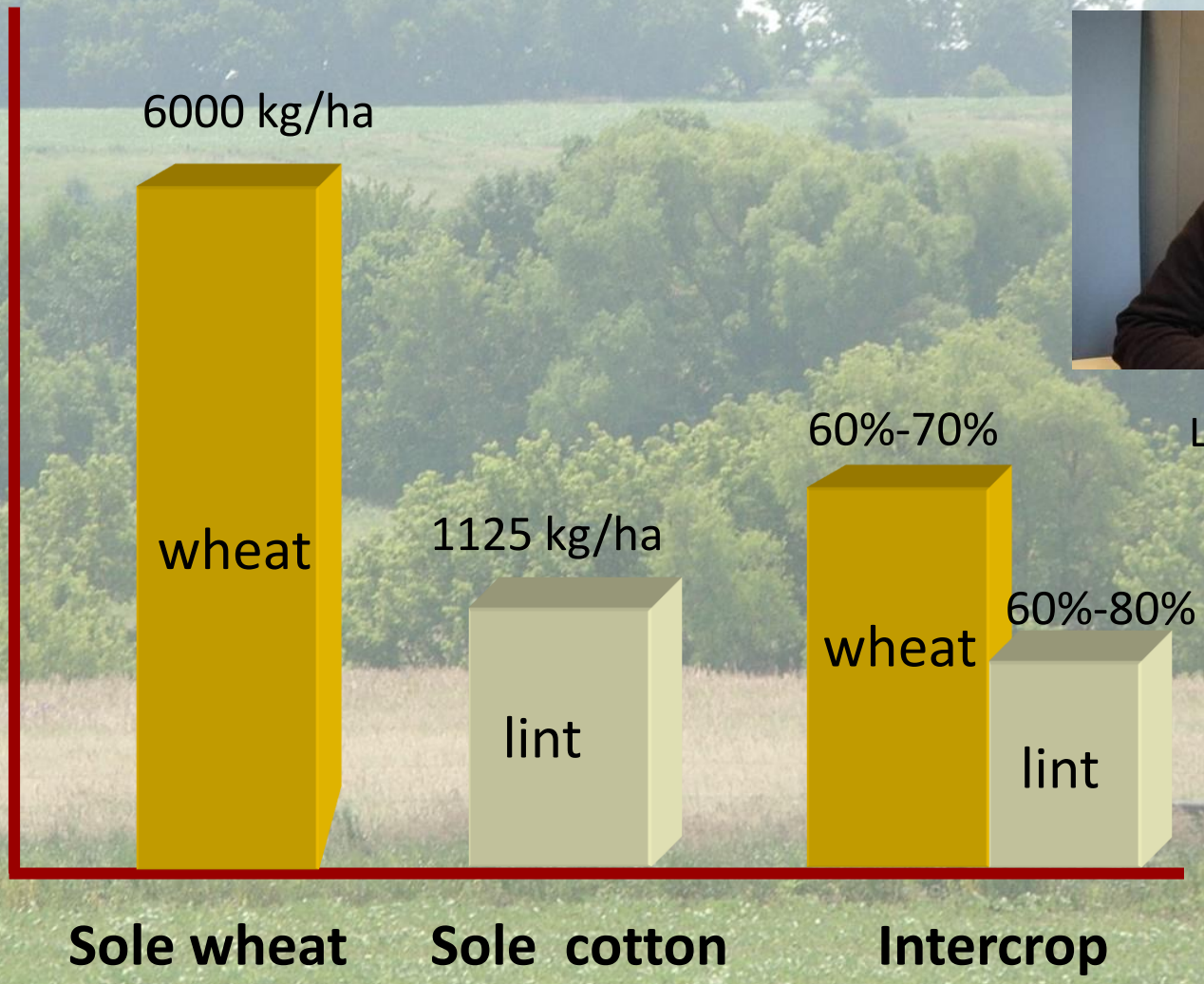
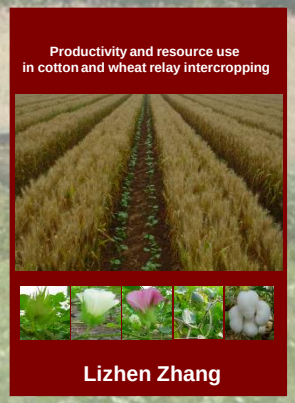
Productivity of cotton-wheat intercropping



Lizhen Zhang



Reduced need for land!

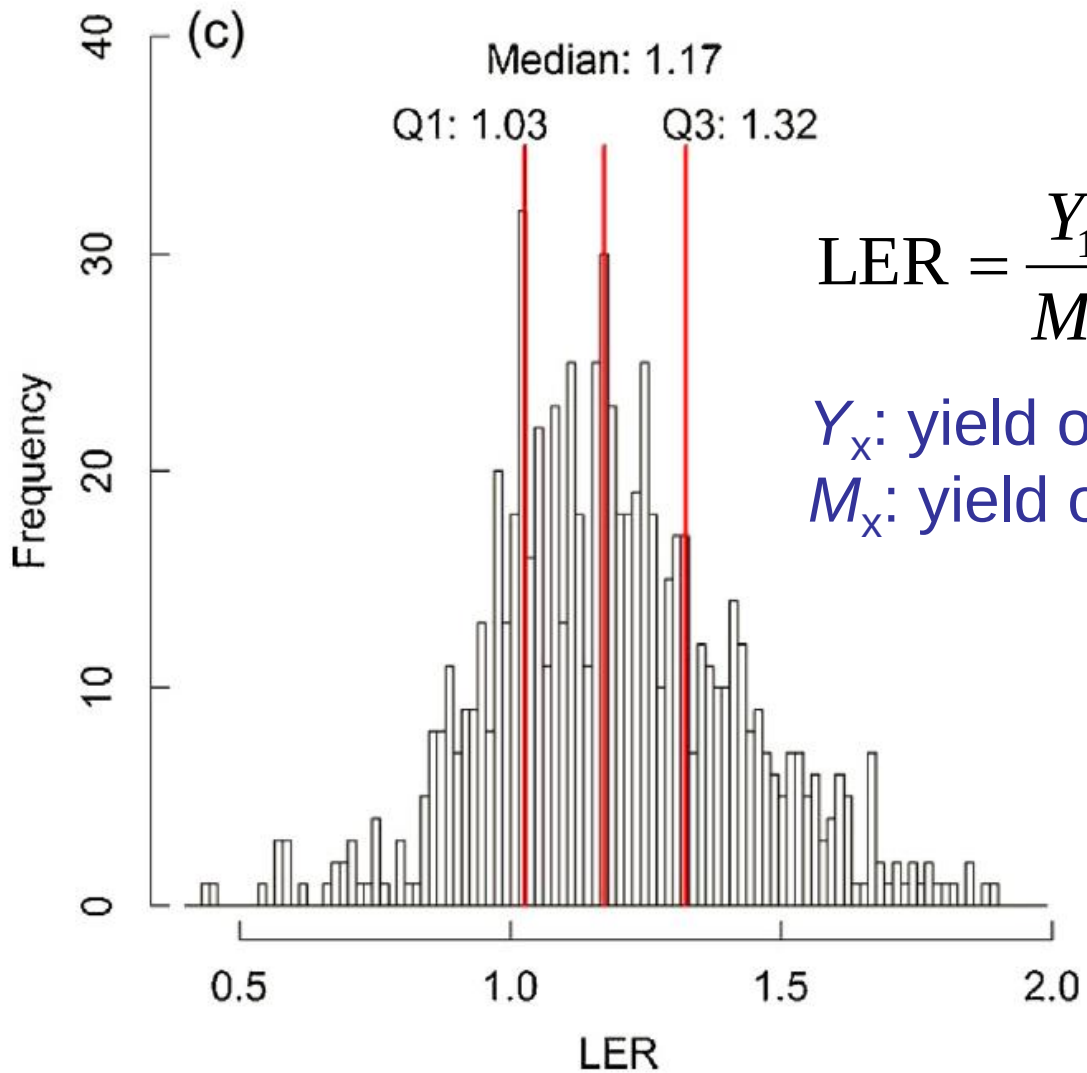
1 ha of wheat-cotton Intercrop

=

~ 0.7 ha of sole wheat

~ 0.7 ha of sole cotton

Average land equivalent ratio (LER) is 1.22



$$\mathrm{LER} = \frac{Y_1}{M_1} + \frac{Y_2}{M_2}$$

Y_x: yield of crop *x* in intercrop

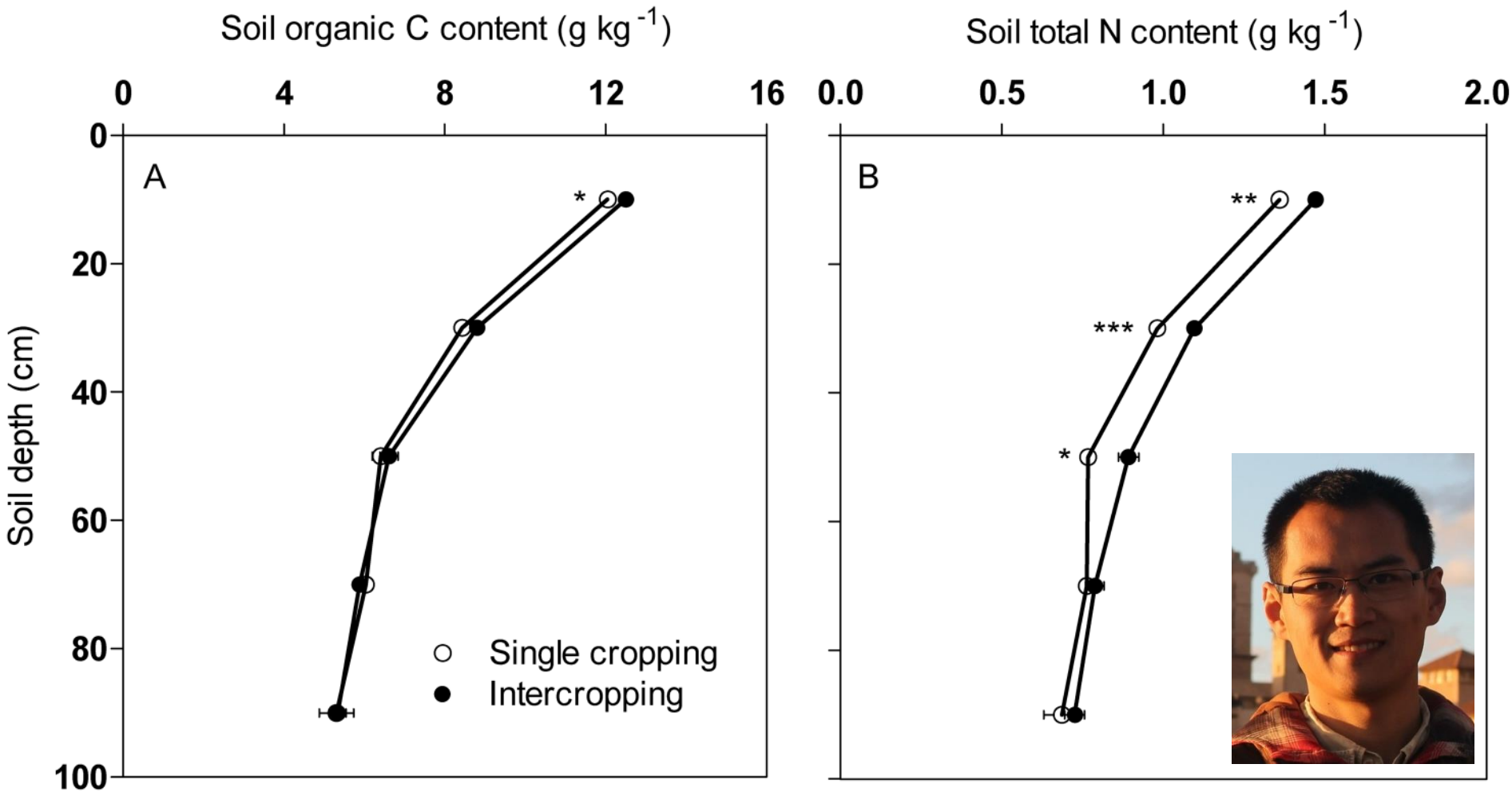
M_x: yield of crop *x* in sole crop

Rows 3 & 4

Rows 2 & 5

Border rows (1 & 6)

Intercropping increases soil organic C and N



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Global Change Biology, 2015

Crop strength through diversity

Martin S. Wolfe

In conventional farming, single varieties of crop plants are grown alone. But mixing varieties may be a better option: several rice strains, planted together on a large scale, are more resistant to a major fungal disease.

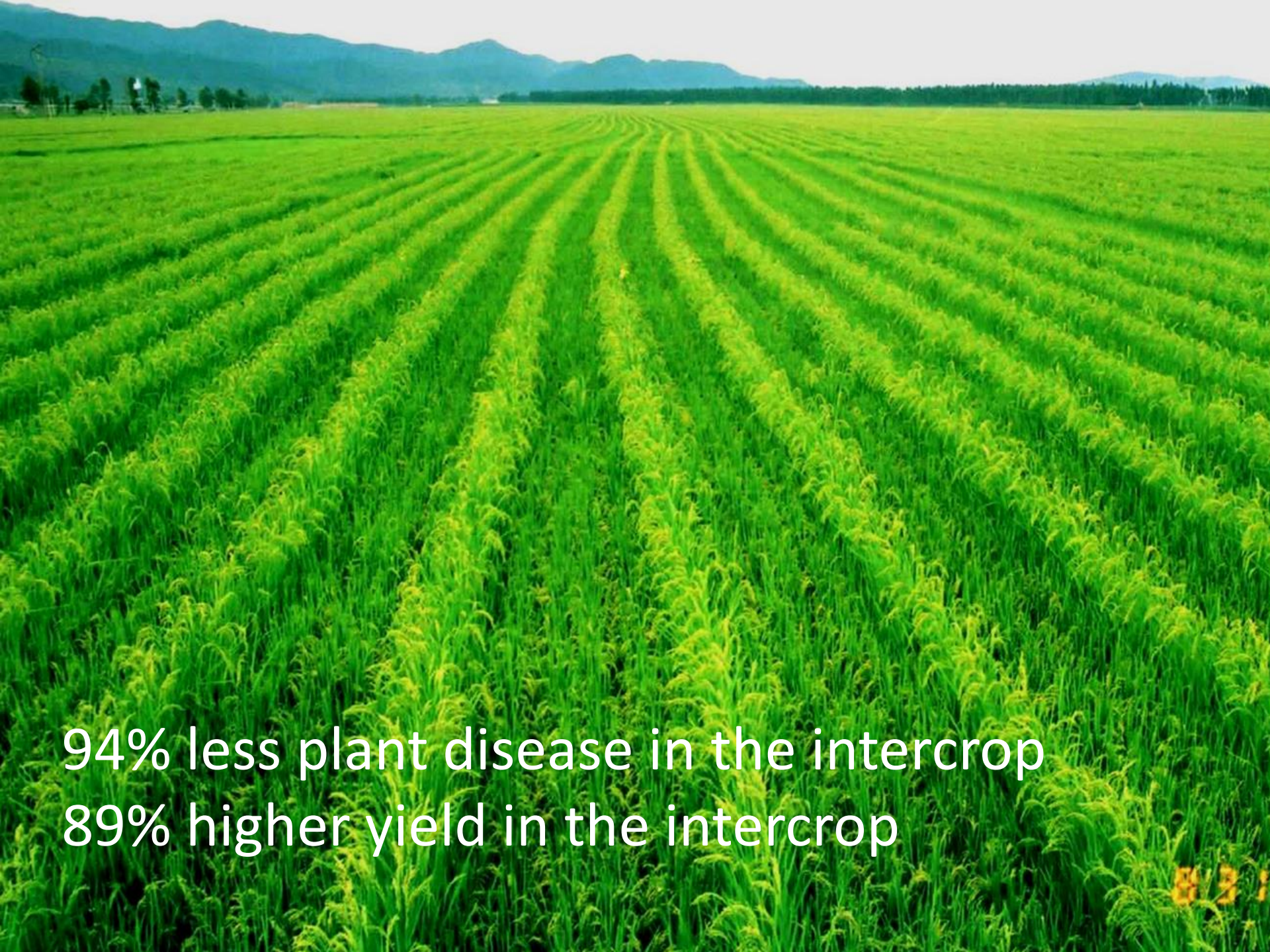
MICHAEL S. YAMASHITA/CORBIS

HOLT STUDIOS

Attempted solutions to the problems caused by modern agriculture, such as

Figure 1 The main disease of rice (rice blast, pictured inset) spreads more slowly in

1. Title: Genetic diversity and disease control in rice
Author(s): Zhu YY, Chen HR, Fan JH, et al.
Source: NATURE Volume: 406 Issue: 6797 Pages: 718-722 Published: AUG 17 2000
Times Cited: 185
Get it!


94% less plant disease in the intercrop
89% higher yield in the intercrop

Effect of intercropping on plant diseases

	% disease reduction
Airborne	38
Soilborne	47

	% disease reduction
Bacterial diseases	73
Fungal diseases	32
Virus diseases	35

Strokenteelt (Nederland) onderdukt ziekten

slide credit: Dirk van Apeldoorn (WUR)

Fine scale of mixing makes a difference

	Intercropping (1 m)	Strokenteelt (3 m)
Yield advantage	± 20%	Probably small
Disease suppression	> 30%	Substantial
Soil improvement	Relevant increase	Unknown

A future for intercropping?

- Produces more yield per unit area
- Can help suppress diseases, pests and weeds
- Helps to improve soil
- Can help meet modern needs for productive and sustainable agriculture in developed countries
- Poses many questions on the biological mechanisms
- Enabling socio-economic context?
- **Needs mechanization to become feasible in the west and remain feasible elsewhere**
- Smaller equipment conserves soil quality

谢谢

(thank you)