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INSTITUTE

Small-Holder Agriculture… Current Challenges and Future Opportunities

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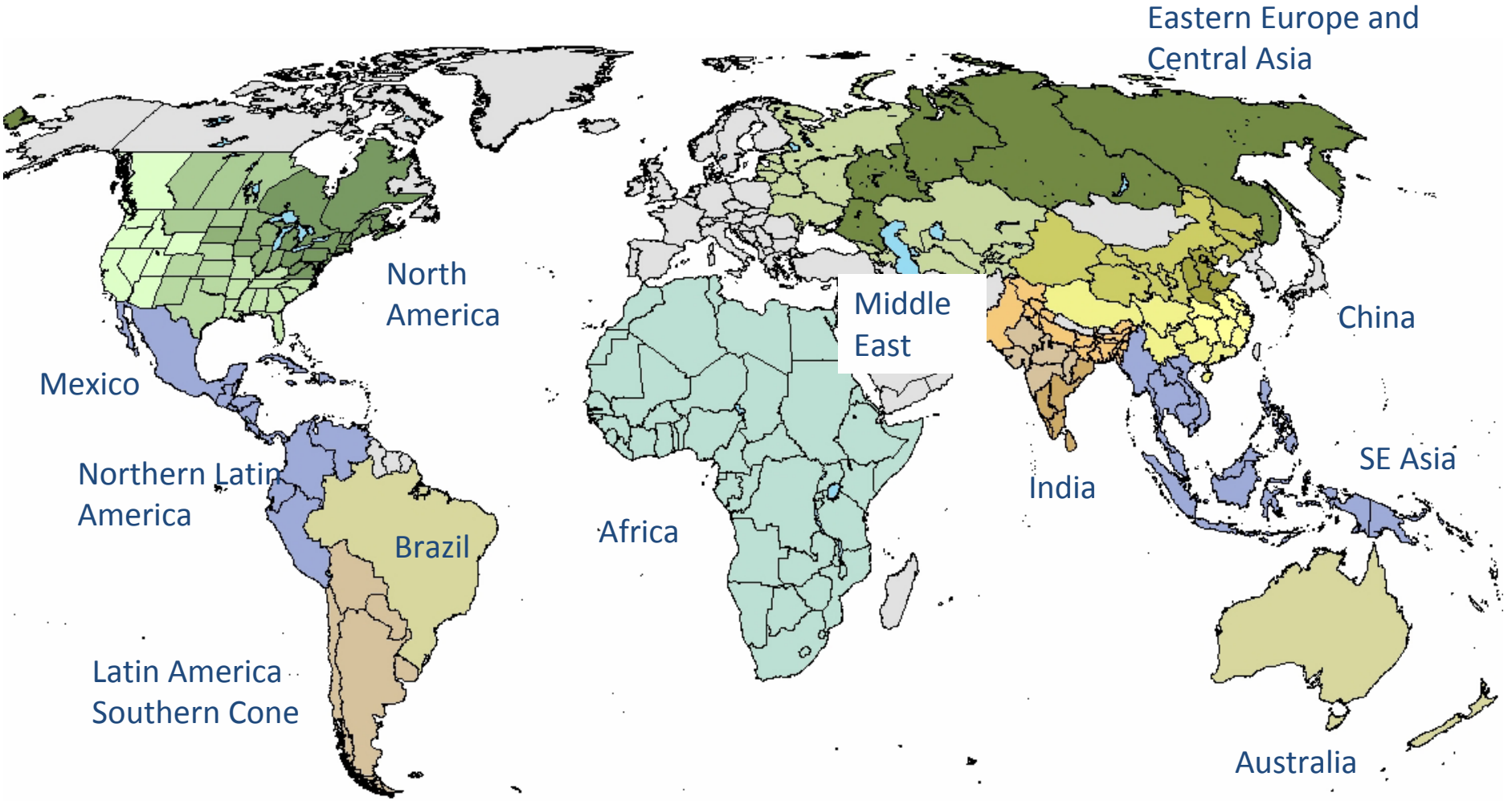
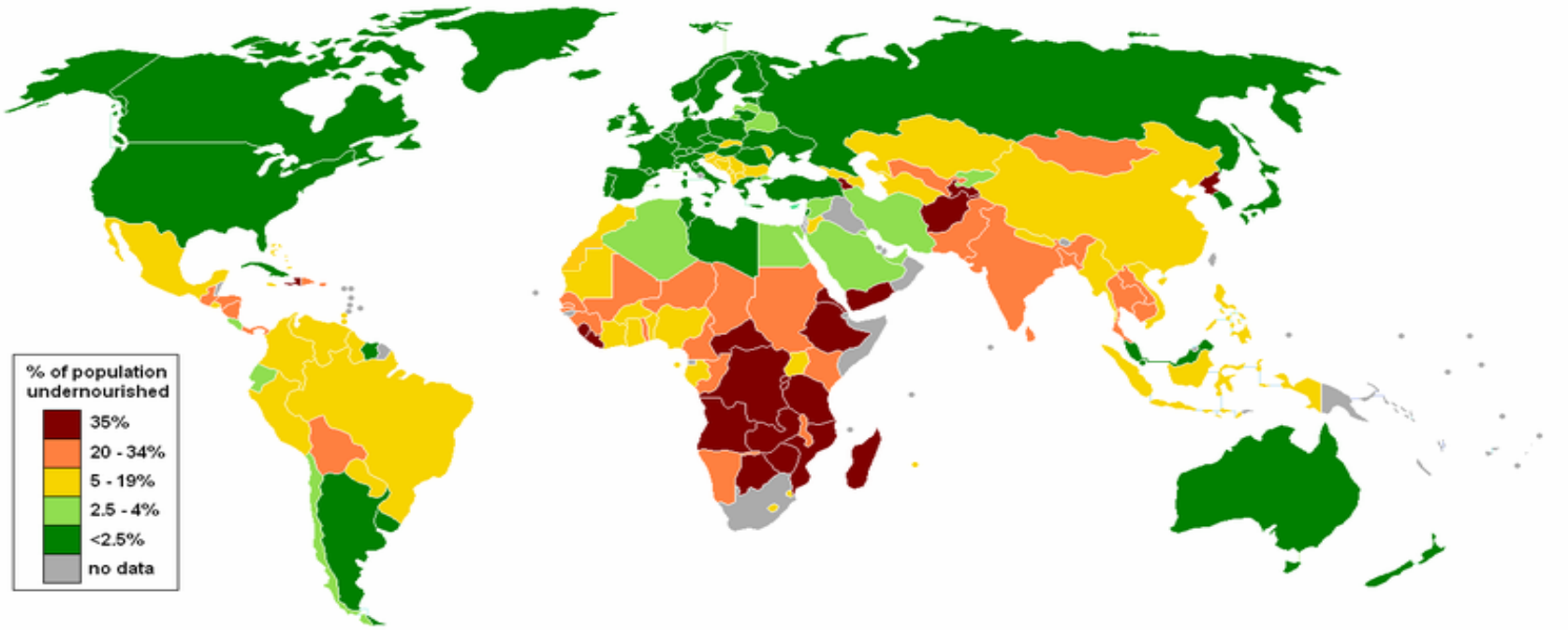
- Vale Fertilizantes S.A.
- Anda - Associação Nacional para Difusão de Adubos
- Arab Fertilizer Association (AFA)
- Canadian Fertilizer Institute (CFI)
- The Fertiliser Association of India
- International Fertilizer Industry Association (IFA)
- International Potash Institute (IPI)
- The Fertilizer Institute (TFI)

IPNI Current Programs



- 30 Ph.D. scientists in 10 program areas
- 140 R&D projects in 2010, 75% dealing with increasing yields

Global Population and Food Security



- Population increases are placing greater pressure on the food security of certain regions of the world
- Question is, who is going to face food security problems, and at what cost?

Food Security

- “Food security is a global challenge, played out on a local scale”.
- “Challenges of this scale (food security) have been met in the past – between 1961 and 2008, agriculture output increased by 179 percent globally. In many parts of the world, these production increases were achieved by intensification”.

Brian Keating and Peter Carberry, CSIRO, Australia

World Population – Projected Changes

Values shown are %

Year	World	Asia	Africa	Europe	L.A.	N.A.	Oceania
2000	6,115	60.5	13.4	11.9	8.5	5.2	0.5
2005	6,512	60.5	14.1	11.2	8.6	5.1	0.5
2010	6,909	60.3	15.0	10.6	8.5	5.1	0.5
2015	7,302	60.1	15.8	10.1	8.5	5.0	0.5
2020	7,675	59.9	16.6	9.6	8.4	5.0	0.5
2025	8,012	59.6	17.5	9.1	8.4	5.0	0.5
2030	8,309	59.2	18.3	8.7	8.3	4.9	0.5
2035	8,571	58.7	19.2	8.4	8.2	4.9	0.5
2040	8,801	58.2	20.1	8.0	8.2	4.9	0.5
2045	8,996	57.7	21.0	7.8	8.1	4.9	0.6
2050	9,150	58.2	21.8	7.6	8.0	4.9	0.6
				World Population database, FAO, 2008			

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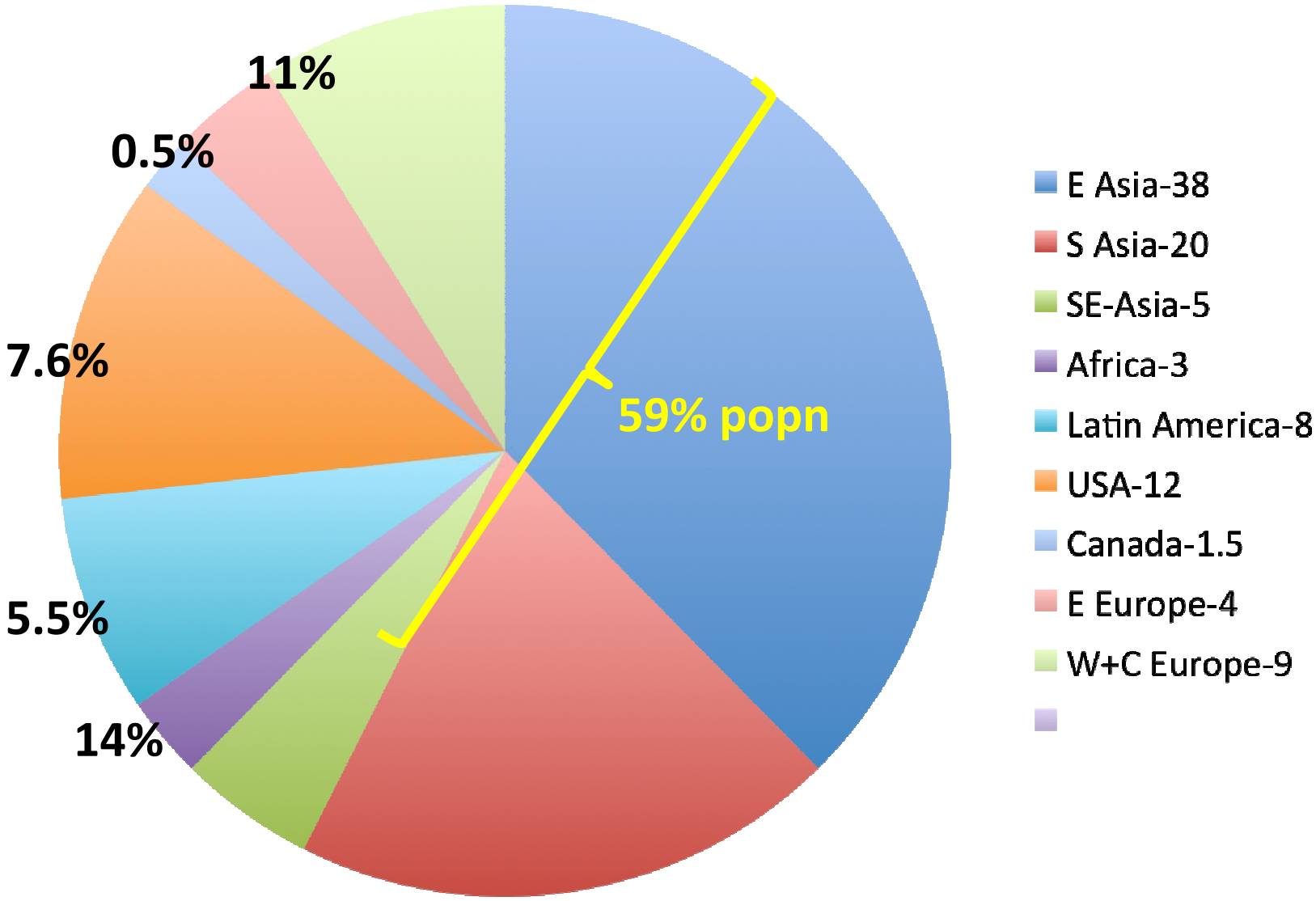
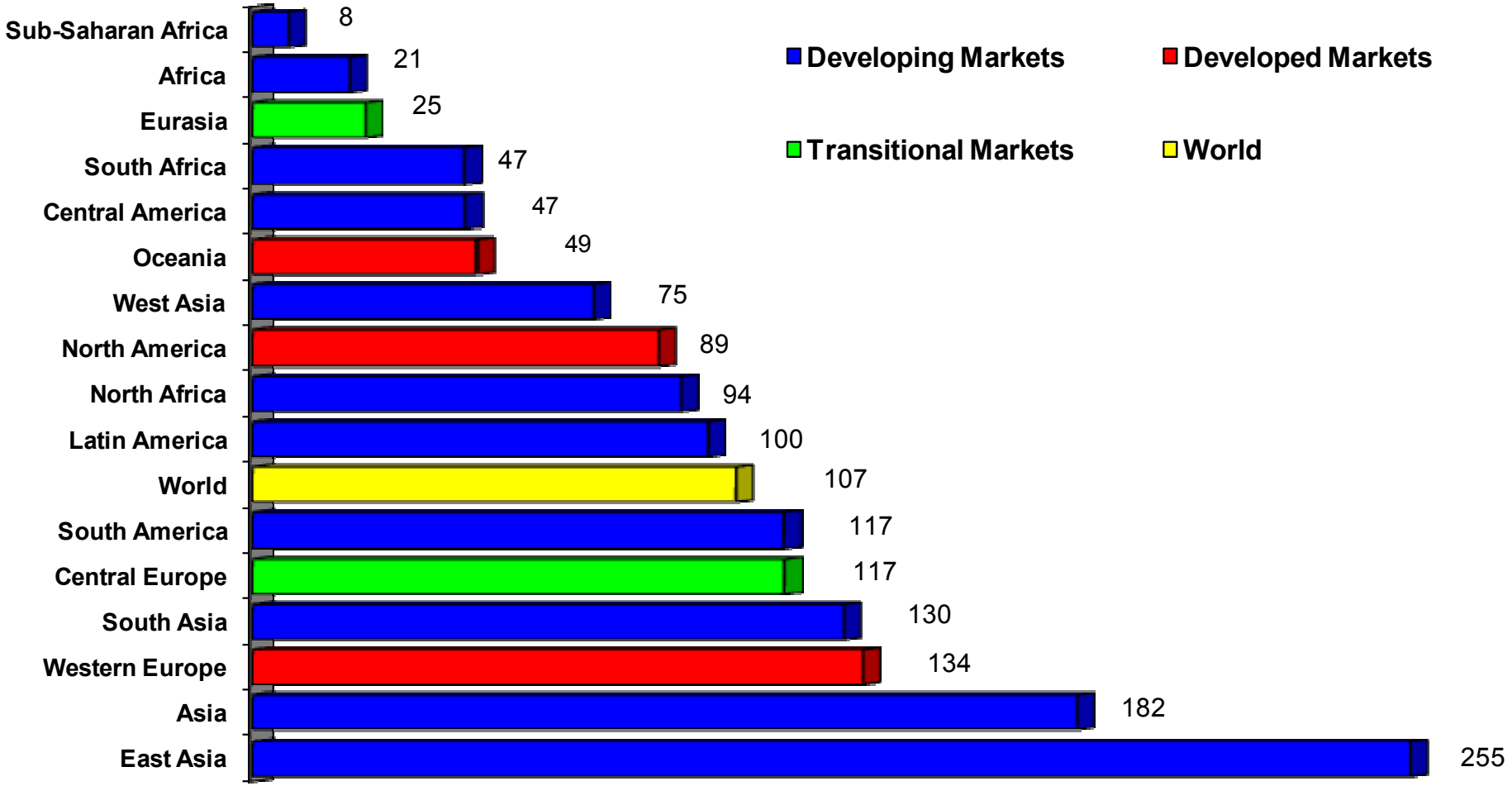
Fertilizer Consumption - 2009



Fertilizer use

Average per hectare fertilizer use rates as kilograms of nutrients (NPK) by fertilizer markets in 2008/09



Source: IFDC; derived from FAO data

Smallholder Farmers…
Who are they?

- Smallholders represent 2.5 billion of the current 7.0 billion people living in the world today.
- Their land holdings are small…based on population pressure, but usually less than 2.0 ha (5 ac). In populated areas they often have less than 0.5 ha (1.0 ac).
- Hand labor (planting, weeding, fertilizing, harvesting), with some animal support.
- Family based…man, woman and children.

Smallholder Farmers…
Who are they?

- Often very dependent on cheap local labor to support their farming activities…a growing challenge.
- Smallholders often eat a significant portion of their production, leaving little to sell and generate income.
- When asked what they would do with more cash, they rarely indicate that they would use it for more production. School fees, fix the house, buy livestock, buy some meat, are often the responses.

Reality check - India

- A good farmer in Eastern India, with 0.5 ha, produces about 8 t/ha/year of rice
  - His operational cost is $700 for the two rice crops
  - For a 5 member family, his own consumption is 1 t rice/year
  - For 7 t rice his income is about $980
  - After deducting the operational cost, he is left with $280 ($0.77/day)

- Lets assume that his 3rd crop is mustard with yield potential of about 1.4 t/ha
  - His income from this crop is $476
  - Assume cost of cultivation is $200
  - Earning is $276

- He is left with US$556/year or US$46/month ($1.52/day)…and there are 400 million in the same position in India.

Who is minding the farm in China?

Reality Check - China

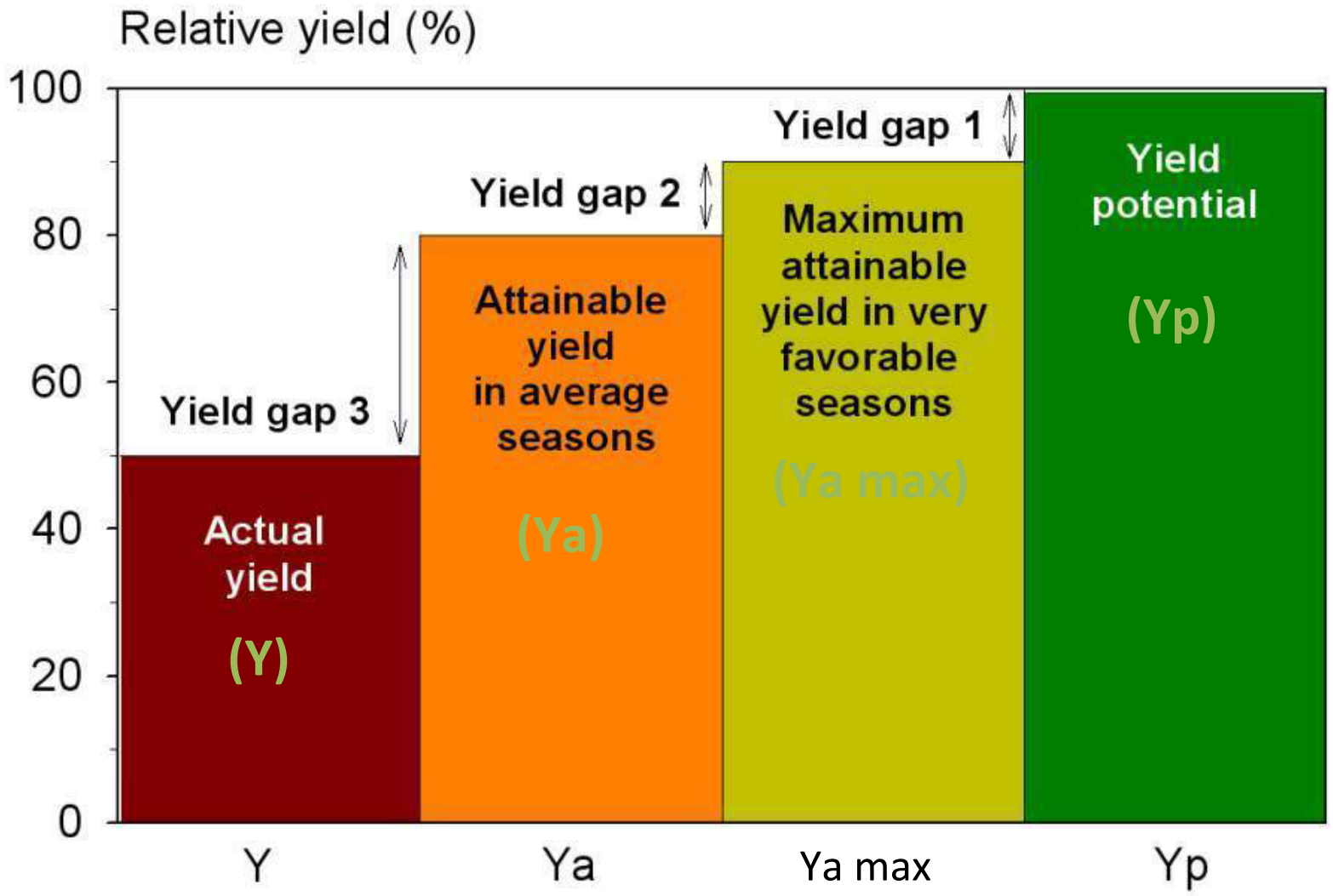
- A good farmer in wheat and maize rotation area, with 0.3 ha, produces about 15 t/ha/year of wheat and maize :
  - His operational cost is $231 for two crops, family consumption is $770.
  - For the wheat and maize from 0.3 ha he sells his income is about $1,523.
  - After deducting the operational cost and personal use, he is left with $523.
- A good farmer in vegetable growing area, with 0.3 ha (2 greenhouses) and 2 crops/year, earns $7,077 (net).

- Therefore he left with US$523 (grain crops), or US$7,077 (vegetables) as a yearly income, or $1.43/day or $19.39/day.

Future of Smallholders…?

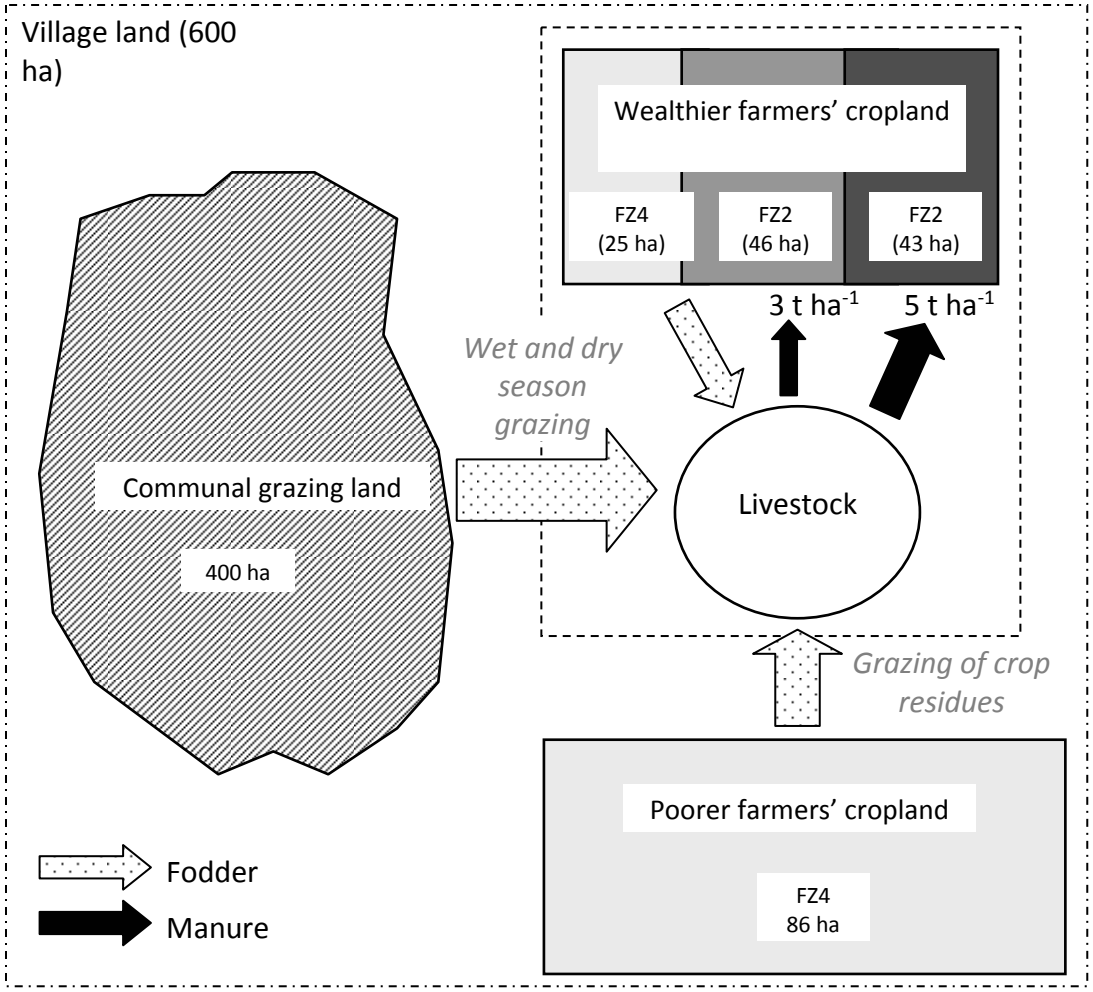
- Children being encouraged to leave to escape the poverty
- Land rental becoming more common
- Sad, but a reality in the evolution of agriculture production, globally
- Impacts on decisions by agencies focused on global agriculture development

Analyzing farmers' practice: Yield gaps

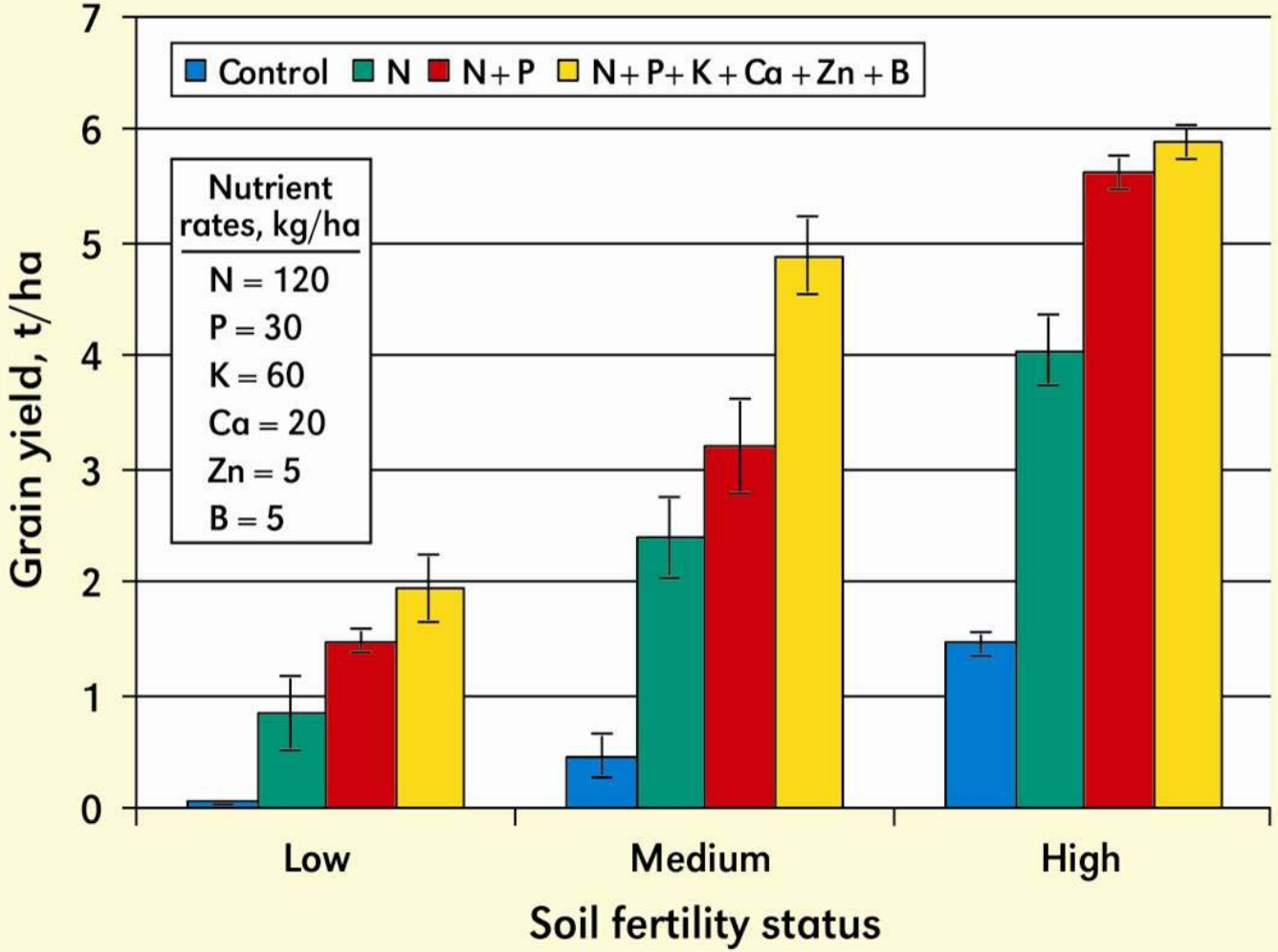


Sub-Saharan Africa

The context of smallholder farming systems

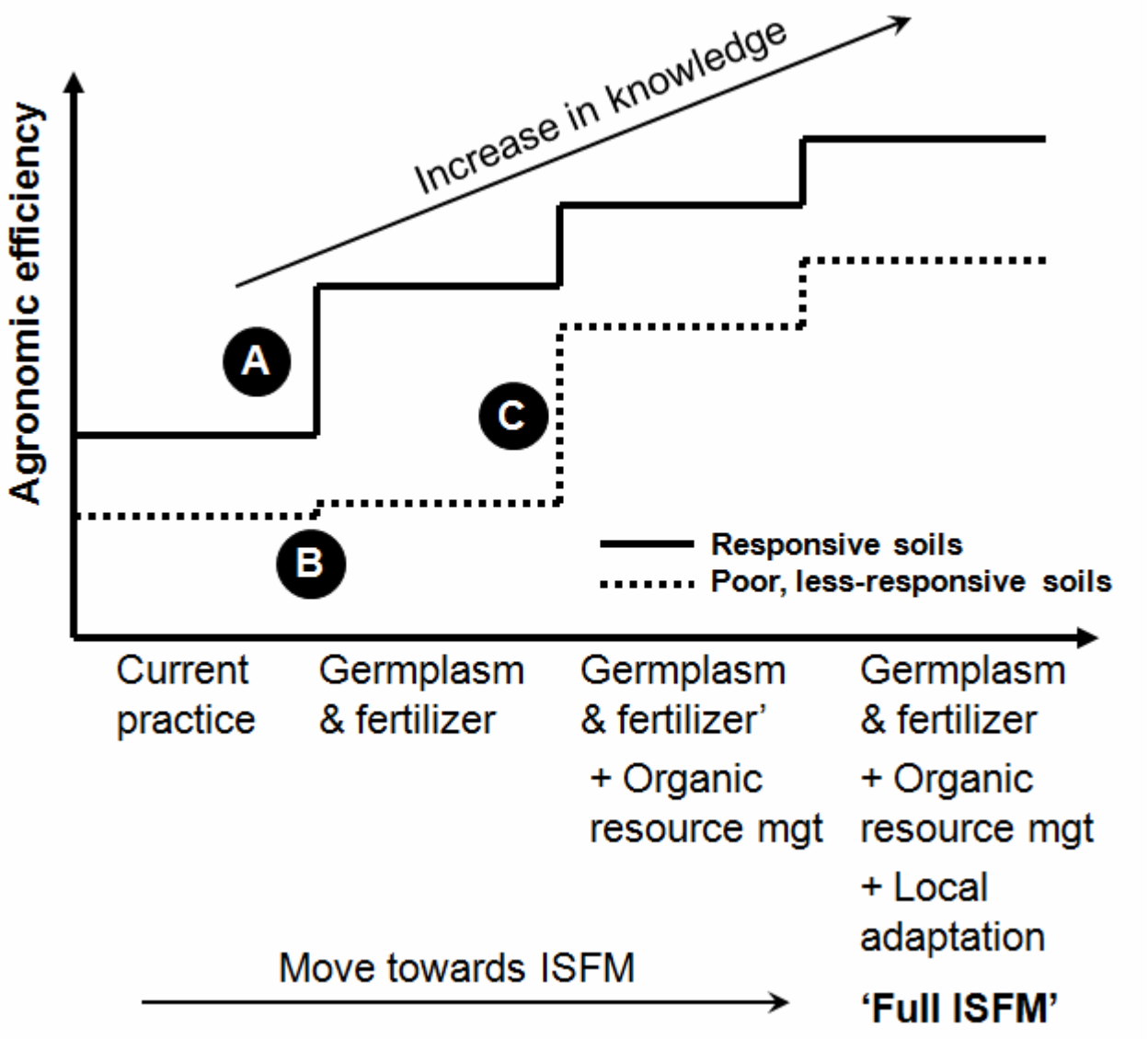


Impact of Soil Quality on Nutrient Response



Malawi data, Zingore et al. (2009)

Fertilizer use an important factor



Vanlauwe et al. 2010

Obstacles Farmers Face

Low Yields
Need good seed and fertilizer on time

Lack of Financing
Seasonal income at a low point during planting

Lack of Knowledge
Little access to extension services

Lack of Markets
Need more market and storage options

Development program goals:

100% increase in farm income

Before

After

Donor Agency Approaches to Africa

Low Yields Need good seed and fertilizer on time	**1) Inputs** Fertilizer & certified seed delivery to village
Lack of Financing Seasonal income at a low point during planting	**2) Credit** Group lending makes farmer credit possible
Lack of Knowledge Little access to extension services	**3) Education** Training in farmer fields and weekly follow-up
Lack of Markets Need more market and storage options	**4) Markets** Harvest buyback and storage training

Field Innovations - Fertilizer

- Fertilizer Scoop –
  - micro-dosing
  - Precision placement
- Fertilizer Blending –

  DAP/Granulated lime blend

  - micro-targeting: move towards customized blends.

* Fertilizer Adoption and Behavior Change
* Fertilizer and new products, e.g. bananas

Fertilizer Blending

Dry Blending Plant

Compounding Plant

ARM Mining and Fertilizers, Nairobi

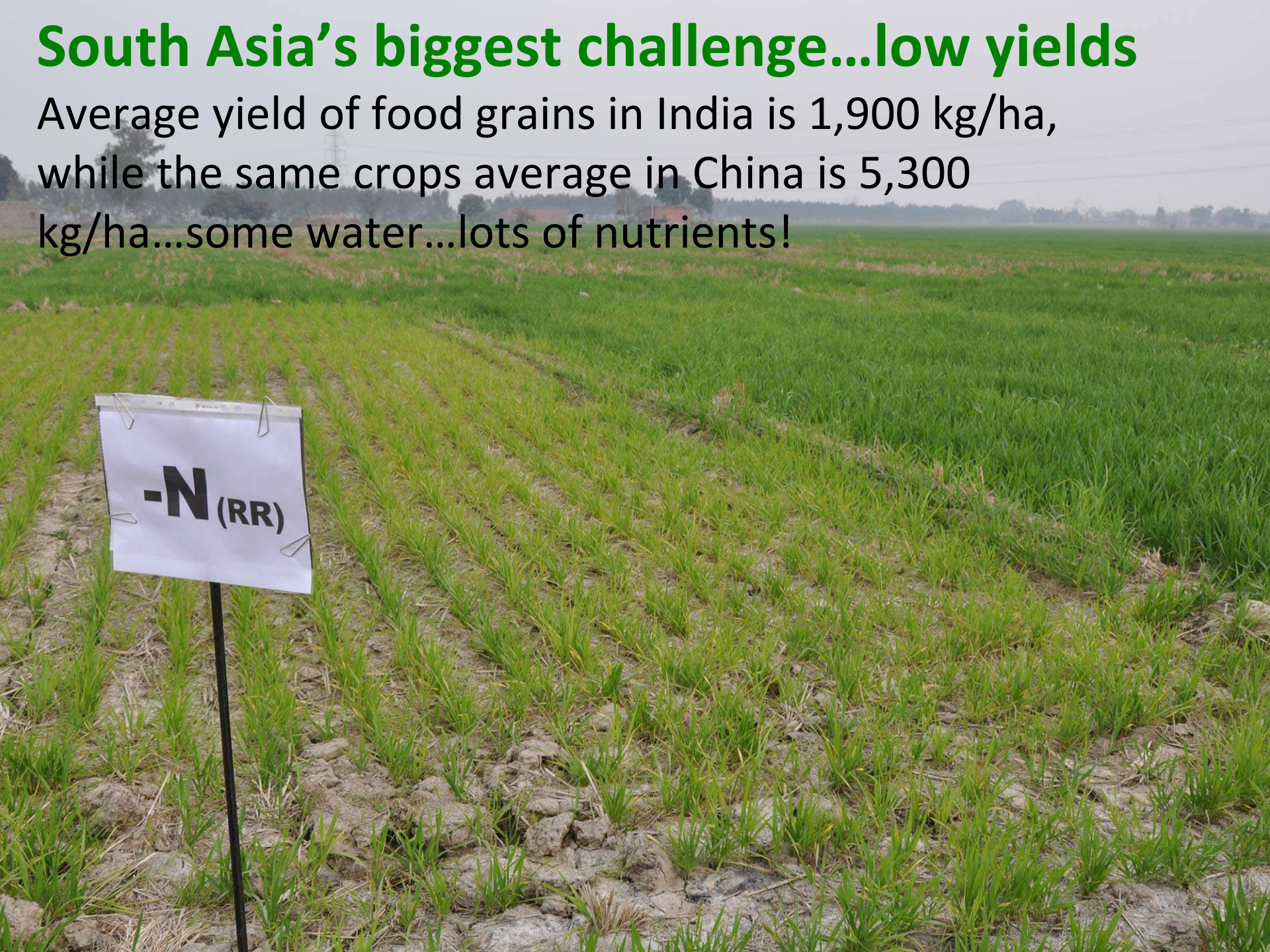
Africa and Food Security

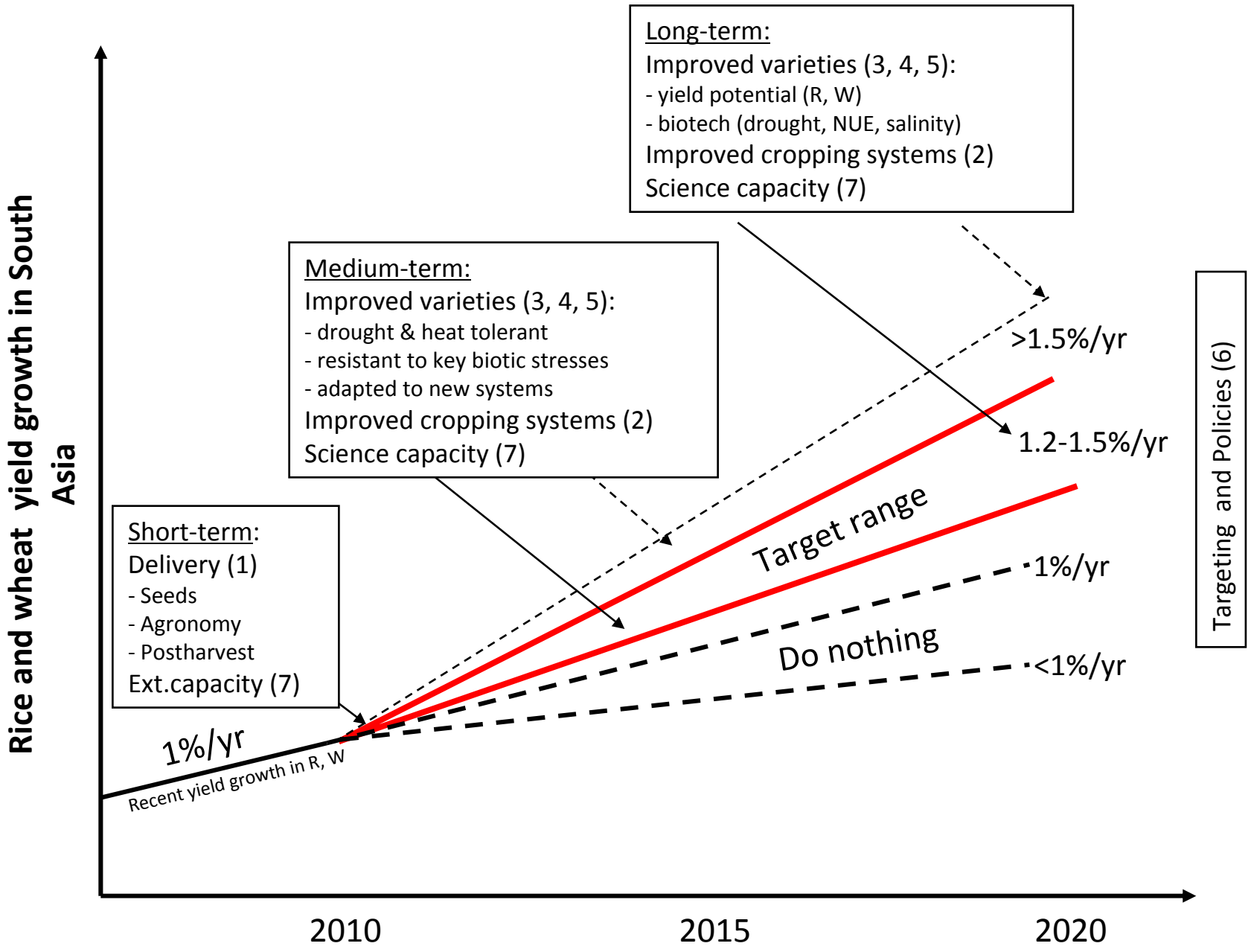
- Africa annually imports $50 Billion USD of food materials
- Has become very reliant on food aid from donors…resulting in “donor fatigue”
- CG report states “..Africa could become a net exporter of both rice and maize using current technology.”

South Asia

South Asia's biggest challenge…low yields

Average yield of food grains in India is 1,900 kg/ha, while the same crops average in China is 5,300 kg/ha…some water…lots of nutrients!




Rice and wheat yield growth in South Asia
Long-term:
Improved varieties (3, 4, 5):
- yield potential (R, W)
- biotech (drought, NUE, salinity)
Improved cropping systems (2)
Science capacity (7)
Medium-term:
Improved varieties (3, 4, 5):
- drought & heat tolerant
- resistant to key biotic stresses
- adapted to new systems
Improved cropping systems (2)
Science capacity (7)
Short-term:
Delivery (1)
- Seeds
- Agronomy
- Postharvest
Ext.capacity (7)
1%/yr
Recent yield growth in R, W
>1.5%/yr
1.2-1.5%/yr
Target range
1%/yr
Do nothing
<1%/yr
Targeting and Policies (6)
2010
2015
2020

Making fertilizer recommendations in S.Asia

IPNI Research Trials

Nutrient deficiency status in SSNM experiment (high yield target) under rice-wheat system

Centers	Nutrient deficient							
	P	K	S	Zn	Fe	Mn	Cu	B
PDCSR, Modipuram	-	√	√	√	-	√	√	√
GBPUA&T, Pantnagar	√	√	-	√	-	√	-	√
CSAUA&T, Kanpur	√	√	√	√	-	-	-	-
NDUA&T, Faizabad	√	√	√	√	-	√	-	√
BHU, Varanasi	√	√	√	√	-	√	√	√
RAU, Sabour	√	√	√	-	-	-	-	-
BAU, Ranchi	√	√	√	√	-	-	-	√
HPKV, Palampur	√	√	√	√	-	-	-	√
PAU, Ludhiana	√	√	√	√	√	√	√	√
R S Pura	√	√	√	√	-	√	√	-

IPNI, 2006

Nutrient Use Efficiency in Asia

Manure Management

Effect of P deficiency in Corn
IPNI funded SSNM research in Comilla, Bangladesh

K Omission plot (left) vs. full NPK plot (right) at Comilla, Bangladesh

Effect of SSNM practices on productivity (t/ha) of wheat under RWCS

Site	FP	SR	SSNM	% increase over SR	% increase over FP
Ranchi	2.56	4.06	4.15	-	58.5
Modipuram	4.77	4.90	6.43	31.0	46.5
Kanpur	4.72	5.45	6.00	10.1	27.1
Ludhiana	5.45	6.28	6.55	4.3	20.1
Sabour	3.92	4.97	5.82	17.1	48.7
Pantnagar	3.87	5.10	6.39	25.3	66.0
Palampur	2.64	3.76	3.87	-	46.5

SR= State recommendation, FP= Farmer,s practice

Tiwari et al., 2006

South Asia and Food Security

- Region has annual imports $1.5 Billion USD of food aid, the bulk of which goes to Pakistan
- Most countries are self sufficient at this time
- Very large unused productivity potential…easy to double yields in region with available technology.
- Government subsidies have a major impact on future success in the region

China

China in 2012

• China food grain production continues to rise each year, especially corn and rice.

•However, land continues to disappear to industrial development and cities.

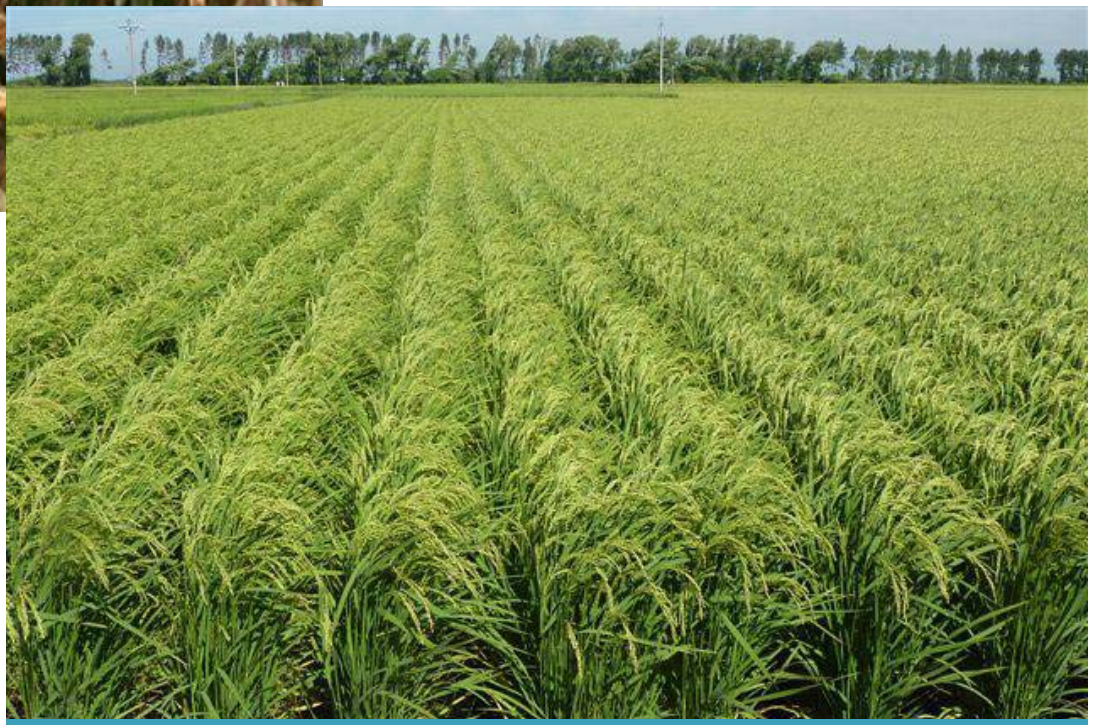
•The labor challenge in China is serious, with all able bodied men and women leaving for work in construction.

•Mechanization is rapidly taking hold in the country…labor issue.

•Over-use of N and P very common.

•Food security is a major concern, reflected in the movement of China to support development in Africa.

Maize field in Henan Province, 2009



Rice field in Heilongjiang, 2010

Maize-Winter Wheat System

Fruits and Vegetables

Making fertilizer recommendations in China

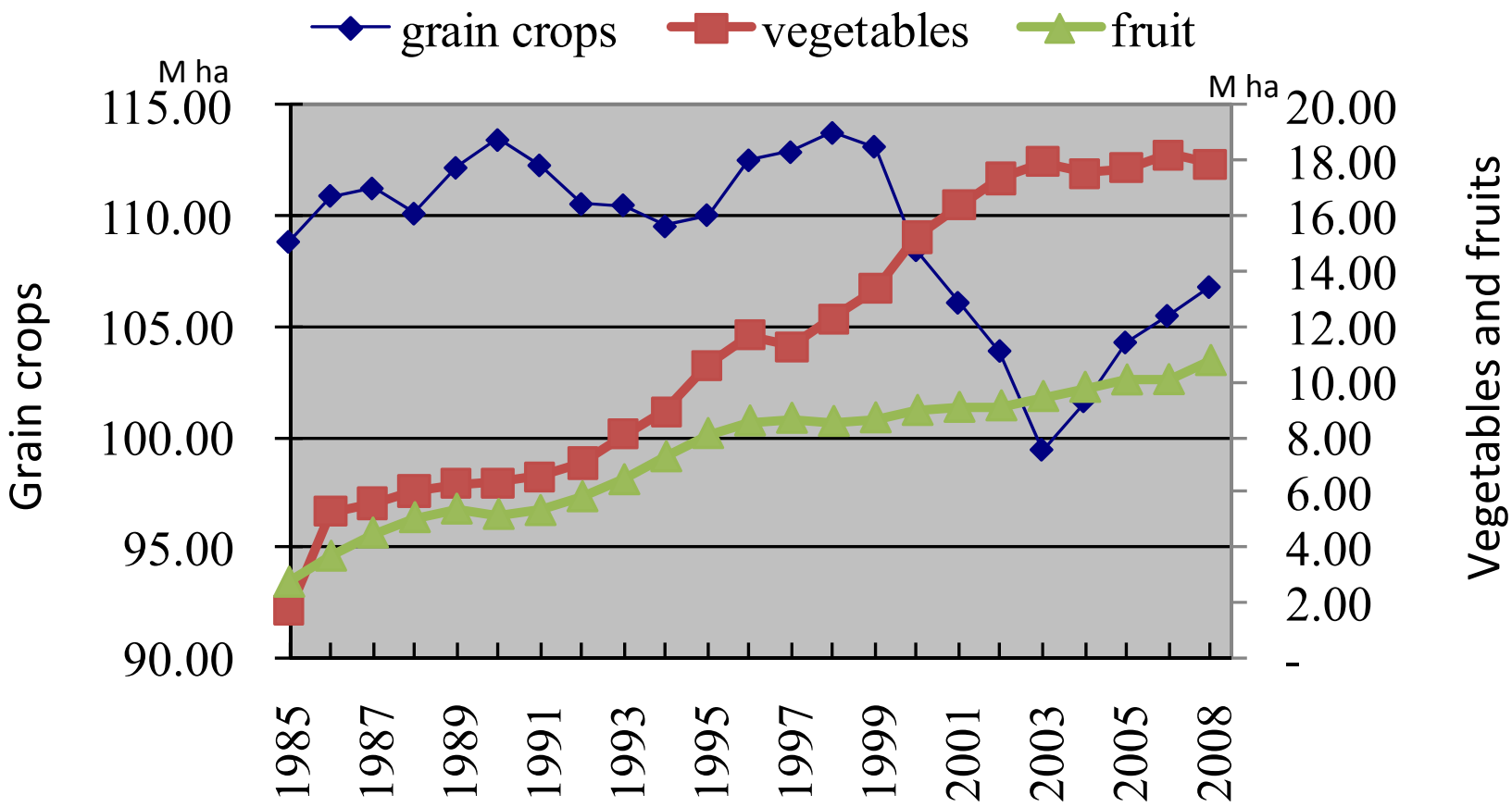
Fertilizer use in China…Future Prospects

- Chinese crop production increases are impressive:
  - >75% increase in food grains in the past 20 years,
  - >250% increase in fertilizer use,
  - However, they have shown a -54% change in PFP?
- Estimates are that there is a 30-60% overuse of N fertilizer in China, mainly driven by the pressure to meet food security targets.
  - Amounts to 12 mmt of fertilizer N = 50-60 kg N/ha in all of SSA…?
- This raises the question of how "eco-efficient" some production systems are, when others are so degrading.

Brian Keating and Peter Carberry, CSIRO, Australia
CIALCA conference, Kigali, Rwanda – October, 2011

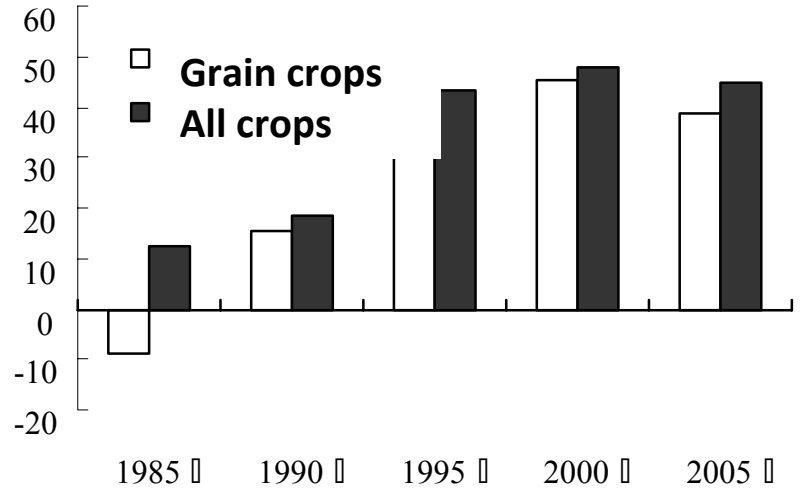
Fertigation Systems and Plastic Mulch

Changes of crop structure

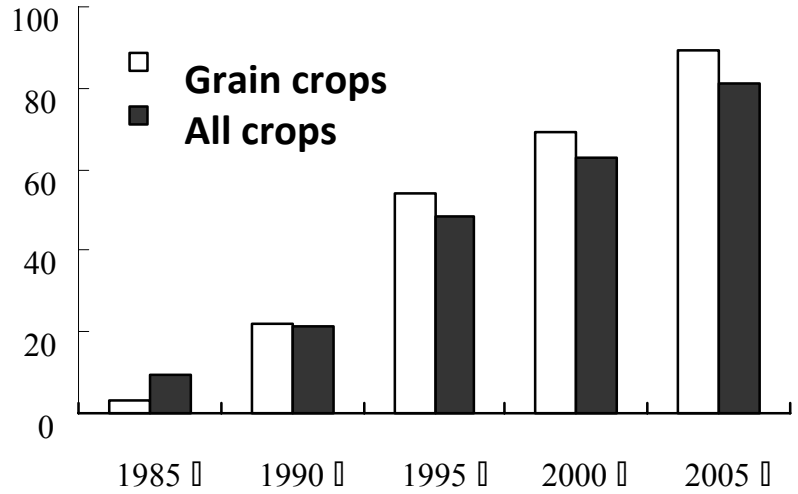


Nutrient balance in farmland in China

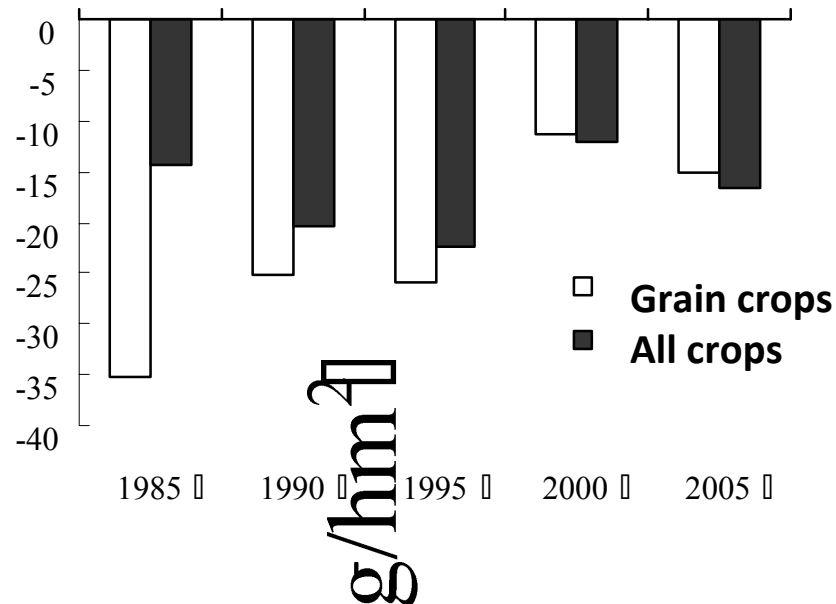
N surplus (kg/ha)



P_2O_5 surplus (kg/ha)



K_2O surplus (kg/ha)



Liu, Xiaoyan, 2008

Burning straw in the fields

Mechanization is developing and more straw is returned to crop land

The Focus is on Everyone Growing Their Own Food

Thank You