Farm Level Sustainable Intensification; Growing More With Less

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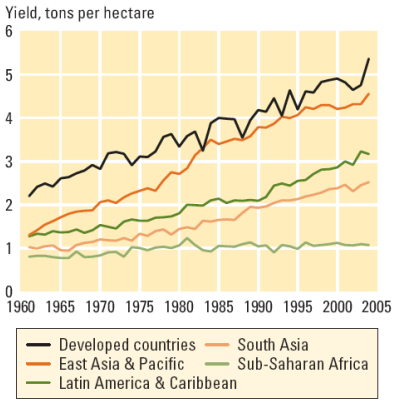
NAS Washington May 2011

Classification: PUBLIC

Growing More From Less

- The world must grow more crops on the currently available land to meet the increasing demand for food, feed and fuel
  - Climate Change
  - Sustainability
- 4 Technologies have raised yields since 50‘s
    - Doubled or tripled everywhere except SS Africa
  - Mechanisation, Fertilisers
  - Better crop varieties, CP Chemicals



Source: http://faostat.fao.org, accessed June 2007.

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Sustainable Intensification....

- All commentators agree that food production will have to increase substantially this century. But there are very different views about how this should best be achieved
- Agriculture can negatively affect the environment through overuse of natural resources as inputs or as a sink for pollution
- Sustainable agricultural intensification is defined as producing more output from the same area of land while reducing the negative environmental impacts ...
- ...both agricultural and environmental outcomes are pre-eminent under sustainable intensification
- Can't define by the acceptability *[or rejection]* of any particular technology or practices, there are no blueprints

- Jules Pretty. Editorial: Sustainable intensification: Increasing productivity jn African food and agricultural systems, February 2011

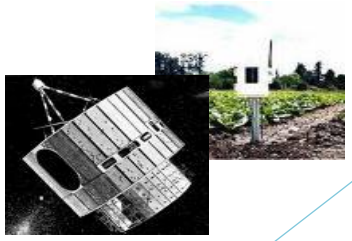
Sustainable Intensification

- We must get beyond pointless arguments based on entrenched beliefs or narrow debates about individual technologies

- Focus on desired outcomes
- Practical matter not an academic exercise
- There is no magic solution
- Sustainability is a journey, not the destination
- Solutions must work locally for individual farmers and communities

- Yield Gap? Best yields are typically 2-3x higher than low yields
  - Sometimes on adjacent farms
  - Technology, Knowhow

“No Silver Bullet”, complexity leads to partnerships



Computing, sensing and measuring

Energy

Ag Practices

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CP, Seeds

Agronomy

Water

Services

Insurances
Derivatives

Consulting

Financing

Barter Trade
Commodity Hedgin

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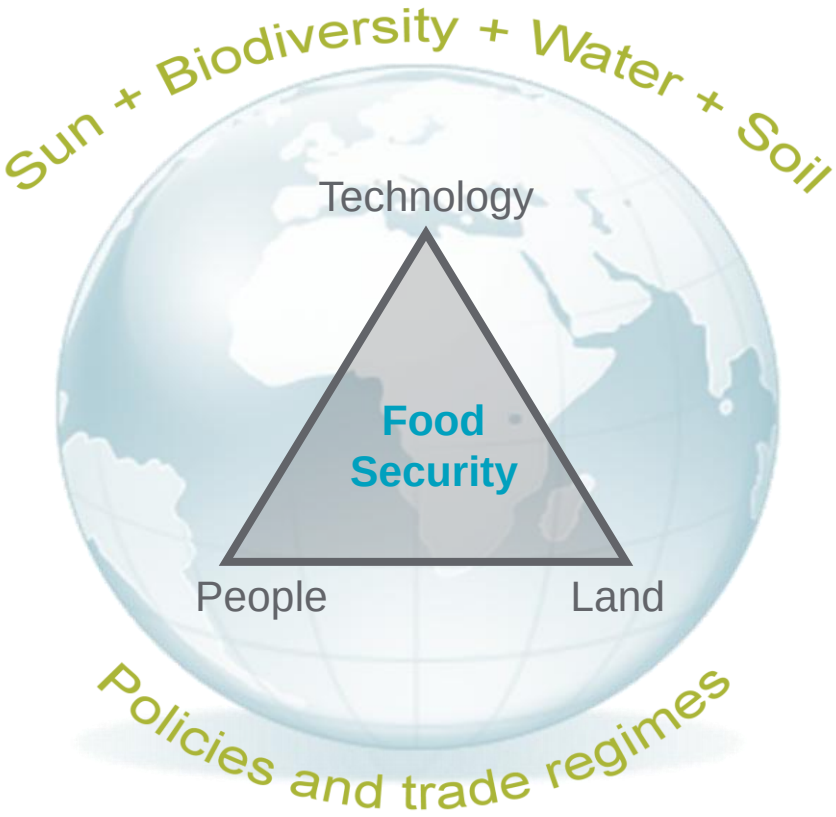
Sustainable Intensification reduces pressure for land use change

Food security: better food systems using fewer resources



- Sustainable production system
  - recognizes connections between technology, land and people
- Limitation: availability of natural resources
- Improved access and distribution through enabling policies

Grow More With Less

- We can meet the challenge of sustainably feeding 9 billion people using less natural resource and improve the economic resilience of smallholders
- Approaches that work for farmers in their local situation
- Technology is just one of the critical components of solutions
- Governments, international agencies, NGO's, Universities, Research institutes, Private sector companies and Farmers
- Joined up thinking needs partnerships – everyone playing their part
- Be assured that Syngenta will play our part in developing great technology solutions that offer practical benefits to famers worldwide

Translating Scientific Information into Knowledge

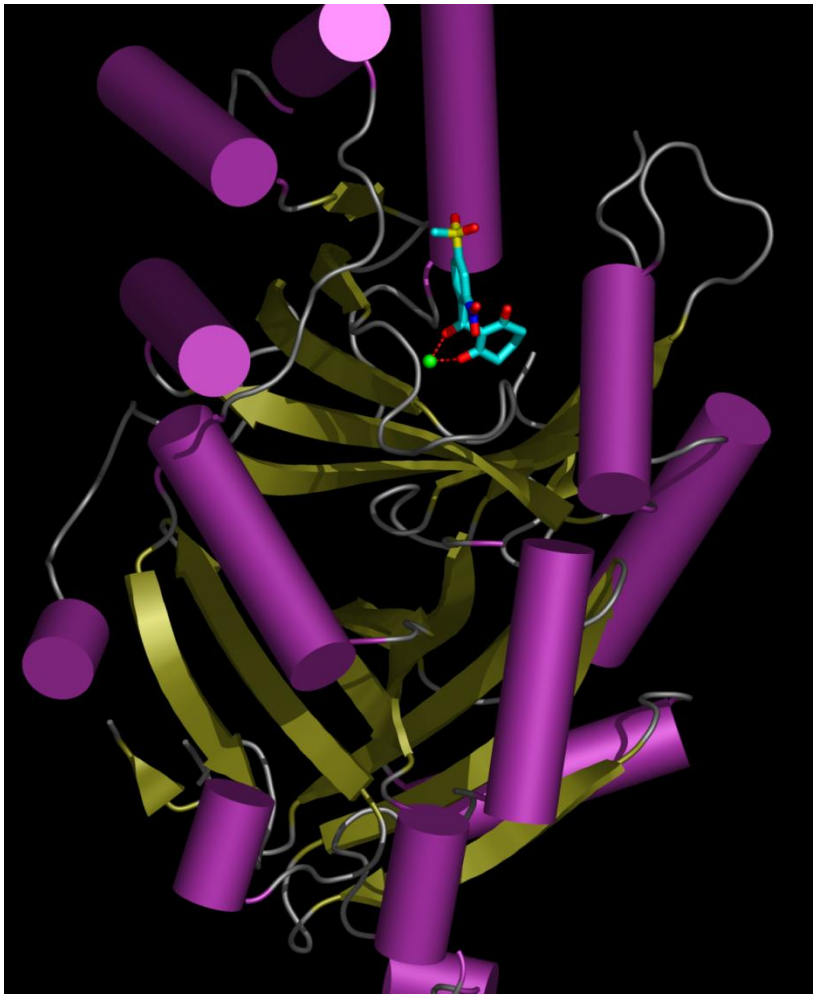
From gene data across technologies and crops….

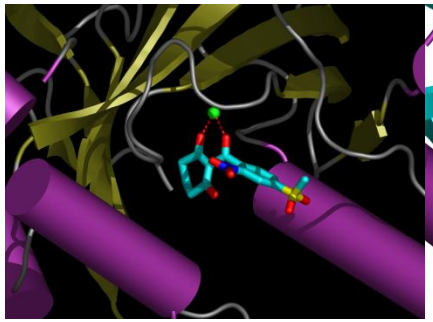
- Corn
- Wheat
- Sorghum
- Soybean
- Tomato
- Pepper
- Cassava
- Poplar
- Melon

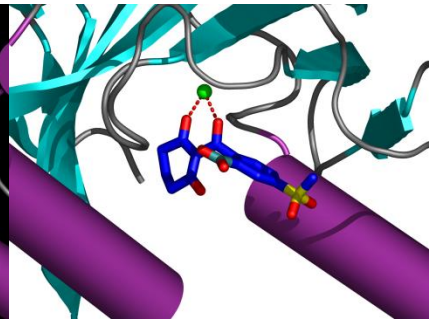
- Stress Tolerance
- Yield
- Flowering
- Fruit and petal color
- Taste
- Disease resistance
- Nutrient efficiency
- Insect Resistance

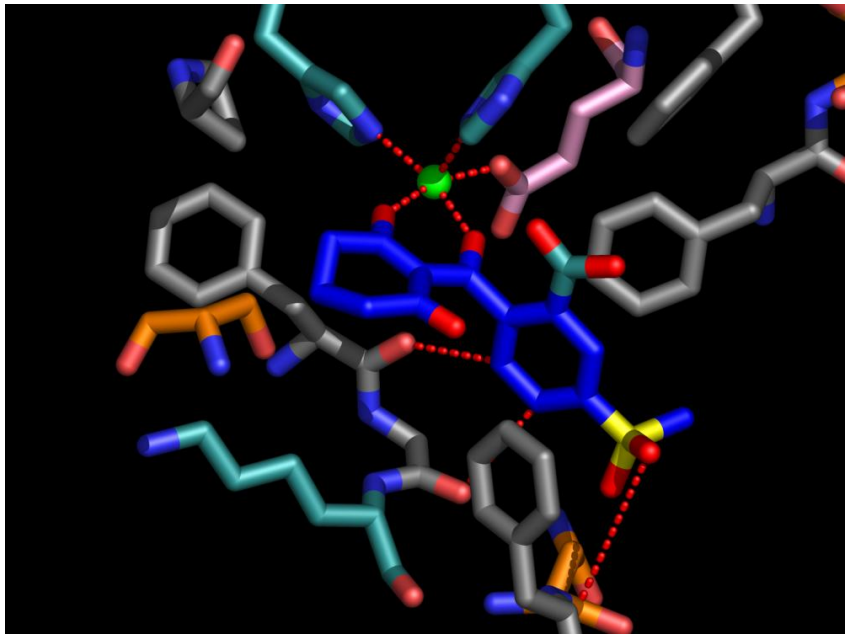
….to trait and marker knowledge within crops

Modern approaches to design









- Protein X-ray crystallography and modelling

IZM 0.75 + Proline 0.4 fb IZM 0.75 + Proline 0.4

Safety all around

Toxicology

Food

People

Protection of employees

Operator safety

Environment

Environment

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Integrating technologies for customer benefit

Innovative crop protection chemistry and Seed Care

Agronomic expertise

Precision breeding and plant genomics

Development of integrated solutions

Increasing level of integration and risk mitigation

Pest (IPM)

Threshold Concepts

Beneficials Management

Traps, Pheromones

Resistance Management

Crop (ICM)

Programs

Altenative Solutions

Residue Minimization

Seed Care

Product Stewardship

Forecast Models

Alert Systems

Field / Farm

Field Margins

Pollinator Habitat

Application Technology

Farm Stewardship

C / N Footprint

Landscape

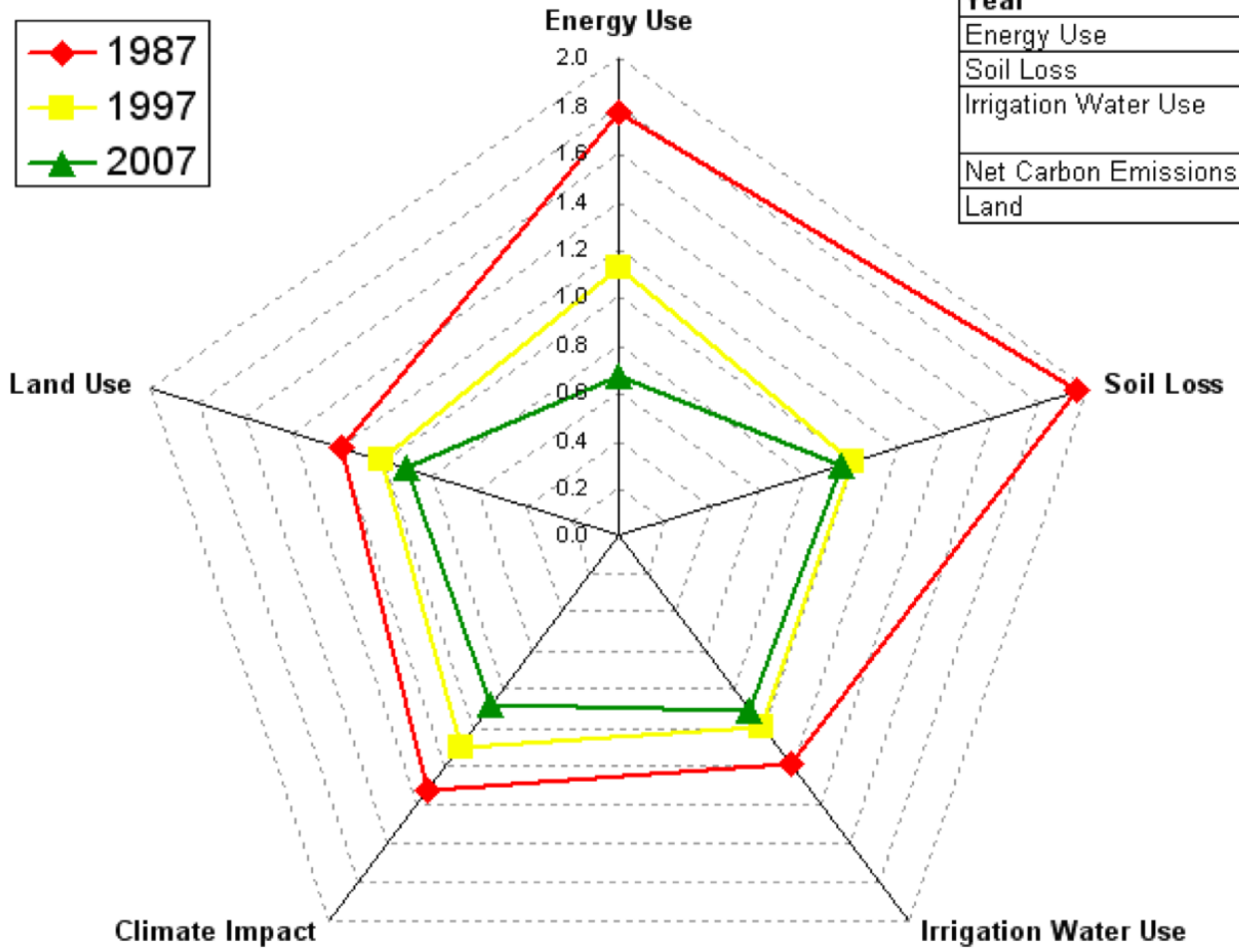
Refuge Management

Biodiversity Concepts

Water Protection

Land Use Concepts

Soybean Efficiency Indicators (Per Unit of Output, Index 2000 = 1)



Year	2000	Unit
Energy Use	0.044	Million Btu/bushel
Soil Loss	101.0	Pounds soil/bushel
Irrigation Water Use	19.4	Thousand gallons/Incremental bushel due to irrigation
Net Carbon Emissions	2.2	Pounds Carbon/bushel
Land	0.026	Acres/bushel

(Values are expressed as 5-year centered averages.)

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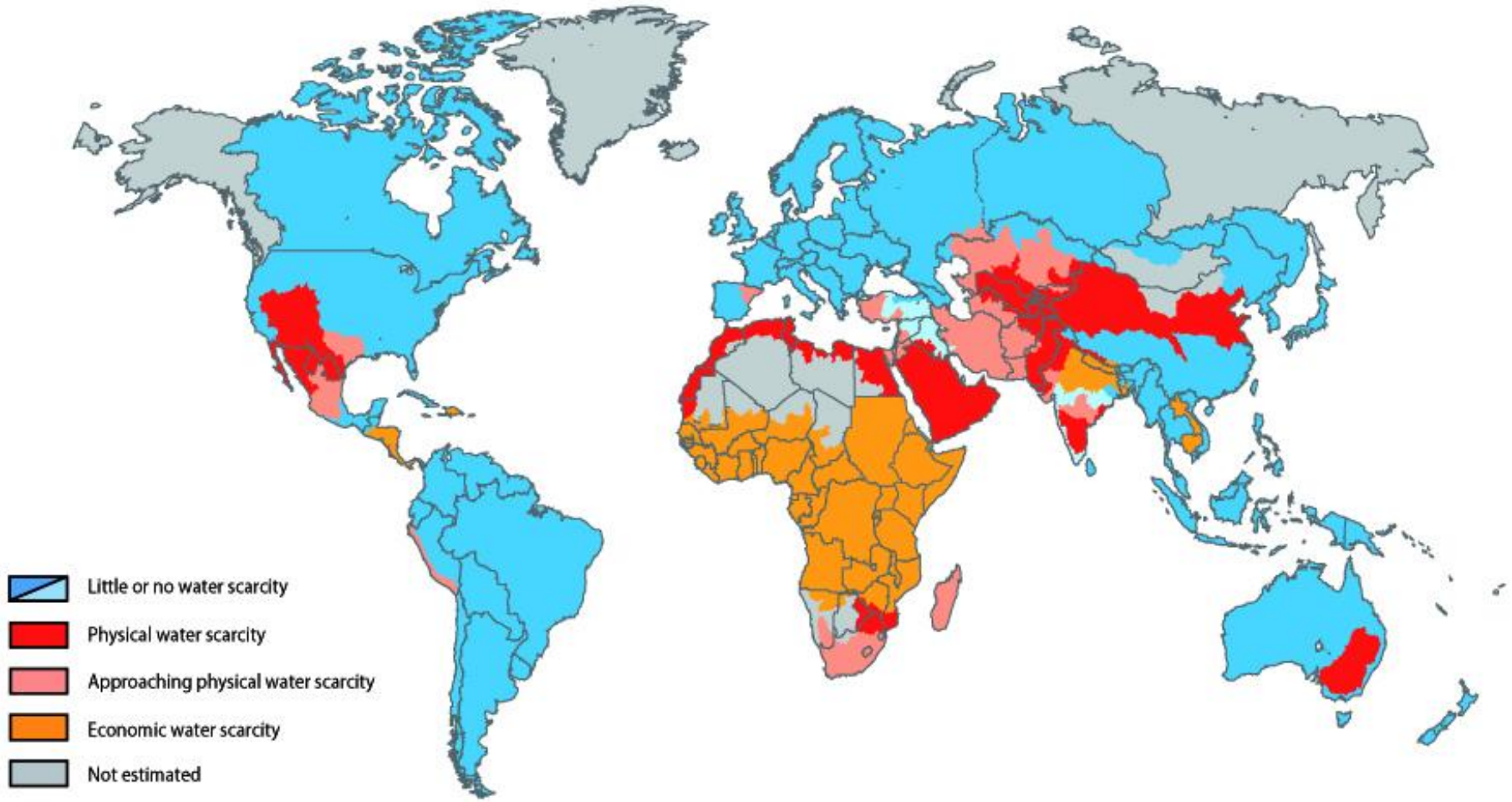
Integrated Solutions: Brief case studies

- Water stress
- Water Quality
- Farm management through spatial planning
- Biodiversity on farm
- Sugar Cane productivity
- Rice yield and quality

Areas of physical and economic water scarcity



Source: IMWI report, Insights from the Comprehensive Assessment of Water Management in Agriculture, 2006 / p8

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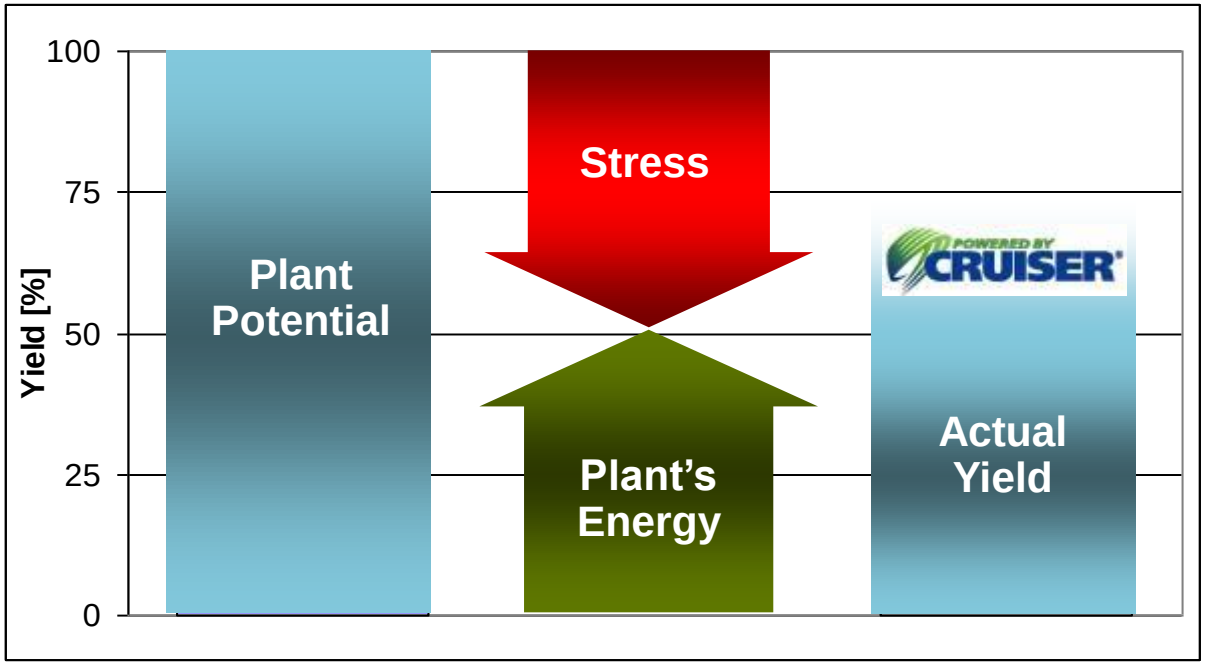
Crop Enhancement Chemicals for Water Efficiency

- Programme containing Growth regulator “Moddus” in Wheat
- Yield +15-25%; Reduced irrigation - Water savings 15%
- “Crop per Drop” improvement ca 35%

Seed Treatment – Chemicals Complementing Genetics

Abiotic stresses are responsible for more than 50% yield reduction.
Thiamethoxam shown to activate proteins that protect against stress.



Stress: drought, heat, salinity, UV light, nutrient deficiency etc.

Water optimization : Combining GM and non-GM technology

- Drought during pollination leads to poor kernel set
- New technology can protect during drought conditions
- Multiple complementary approaches to new seed varieties: native trait and functional genomics, transgenics
- New trait constructs are currently under evaluation in field trials
- 1st Launch drought tolerant corn, Agrisure Artesian™ US 2011

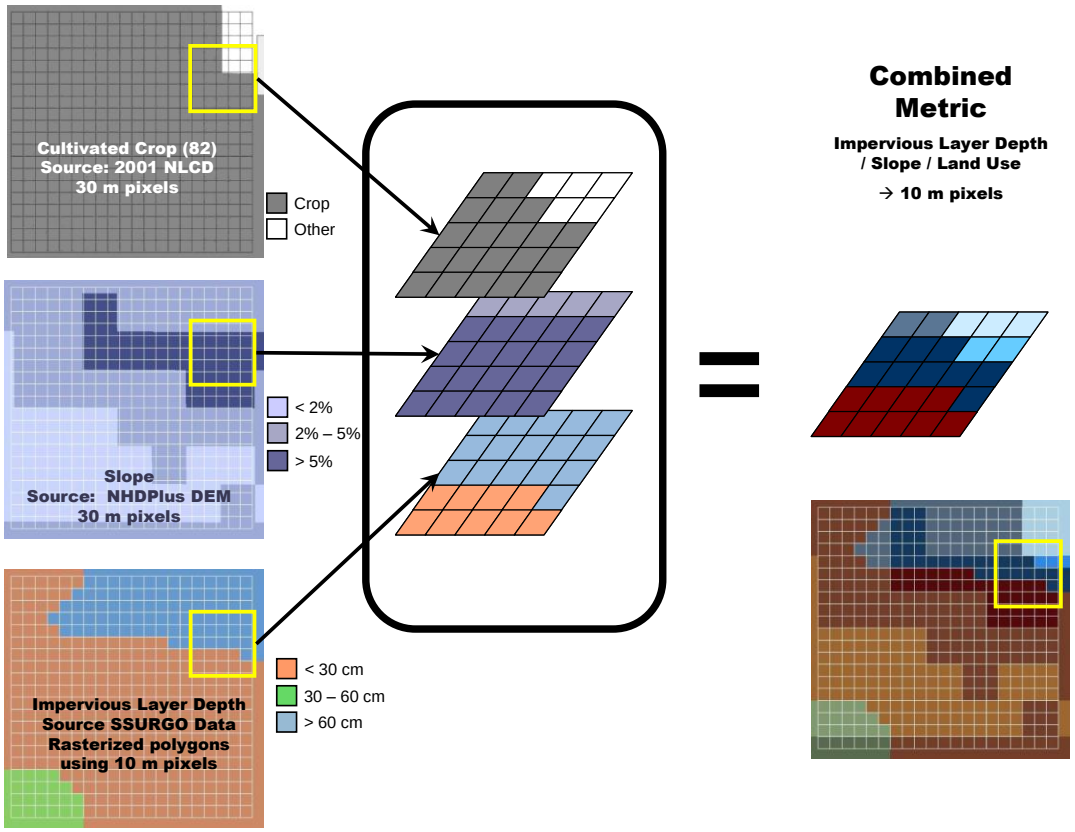
Agronomic practices for Water Conservation

- Useful in water dependent crops like rice...
  - Drip Irrigation
- Pani-Pipe project Bangladesh (50,000 units)
- 46% reduction in water use; 23% cost reduction
- 4-5% yield gain; 27% farmer profit increase

Using High Resolution GIS for identifying Regional and within field scale potential runoff vulnerability

Characterizing Co-Occurrence of Shallow Impervious Soils with Other Factors across USA

- Best Available Data for
  - Soil, Slope, and Crop
- SSURGO (USDA)
  - Depth to impervious layer
- 30m DEM (from NHDPlus)
  - 10 m grid processing
- Landuse (USDA)
  - Best available reclassed from CDL or NLCD
- Selecting Criteria
  - ≥ 2% slope - Practical hydrology
  - ≤ 30 cm depth to impervious layer (K_{sat} <1.25 micron/s)



77.8 Billion 10m grid points examined nationwide!

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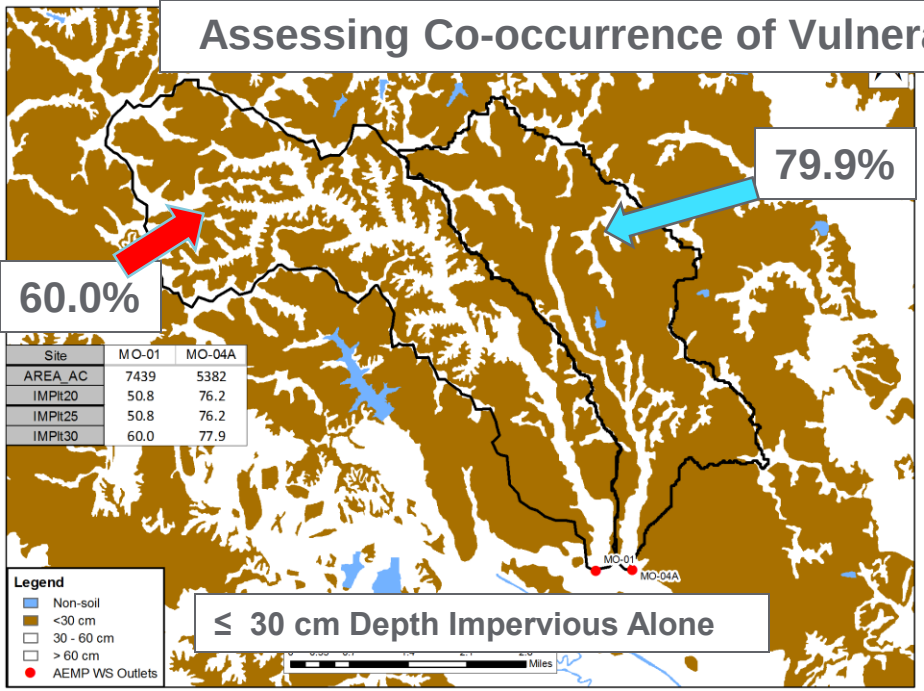
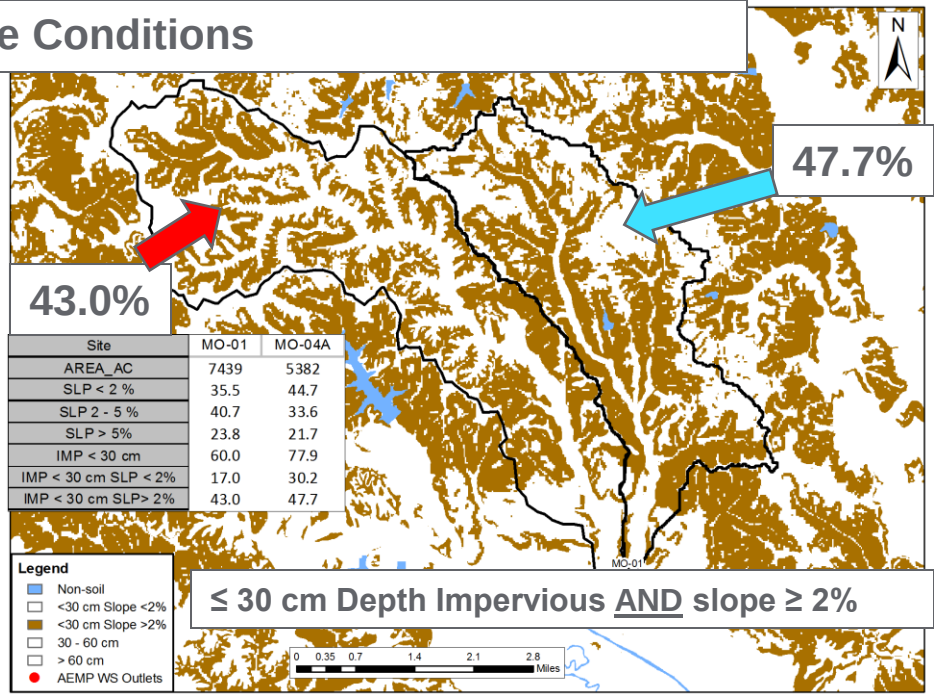
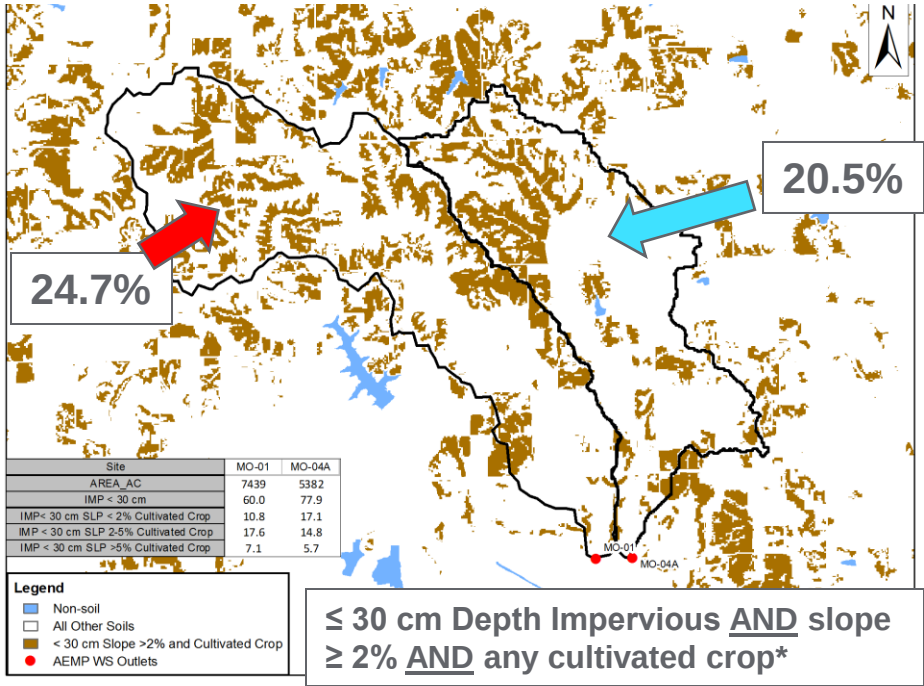
Assessing Co-occurrence of Vulnerable Conditions



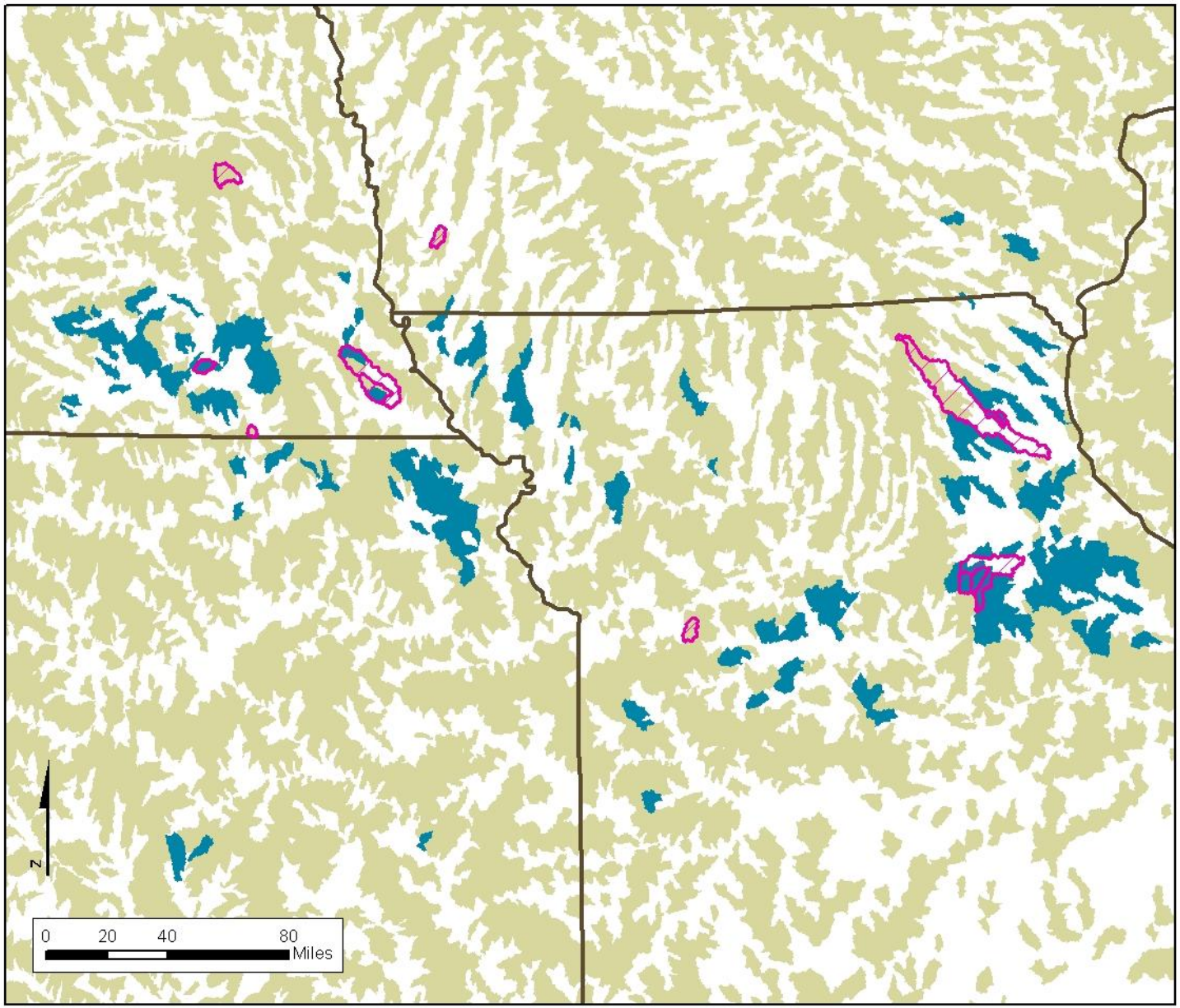




Spatial imaging and modelling - Remarkable potential resource for effective land use planning and management?

"Any cultivated crop" includes soybeans, wheat, cotton, vegetables plus corn and sorghum

Identifying watersheds which have relatively high co-occurrence of these conditions

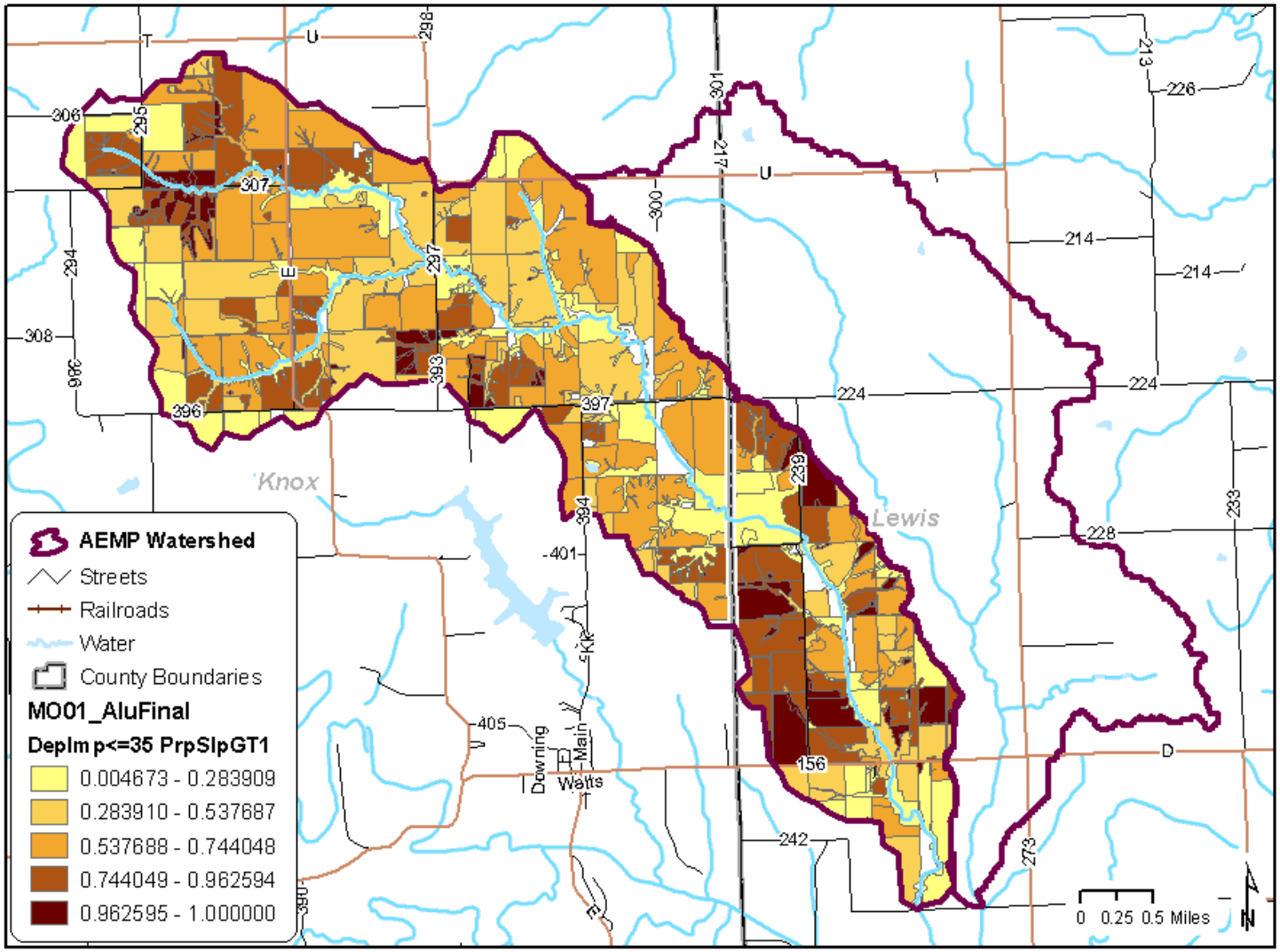


AEMP Watersheds

Meet Refined Criteria

>= 10% Percent corn-sorghum
>= 6% <30 cm, >2% slope, cult.crop
>= 0.0065 PRZM flx_30_90

Fields Ranked by Potential for Extreme Runoff



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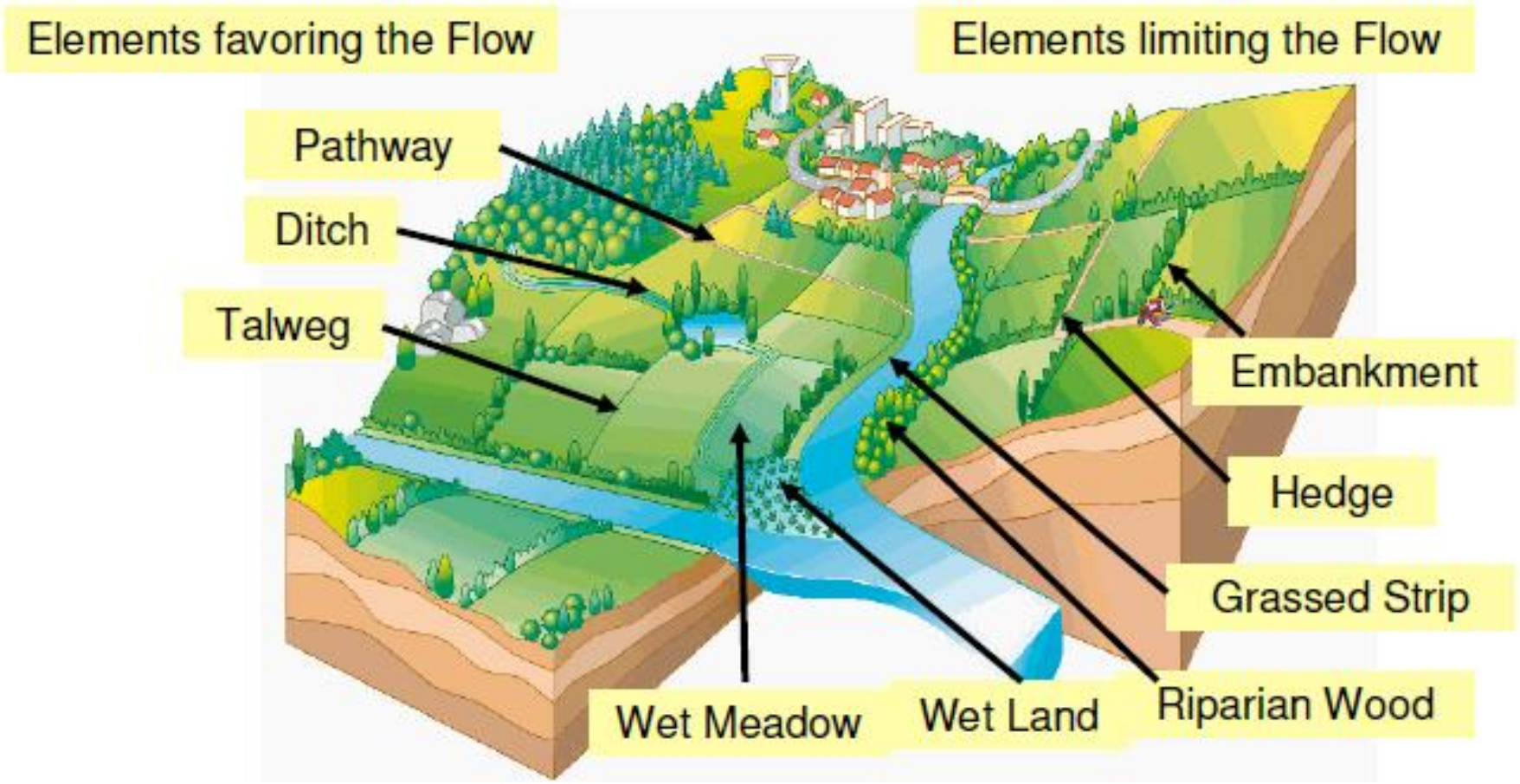
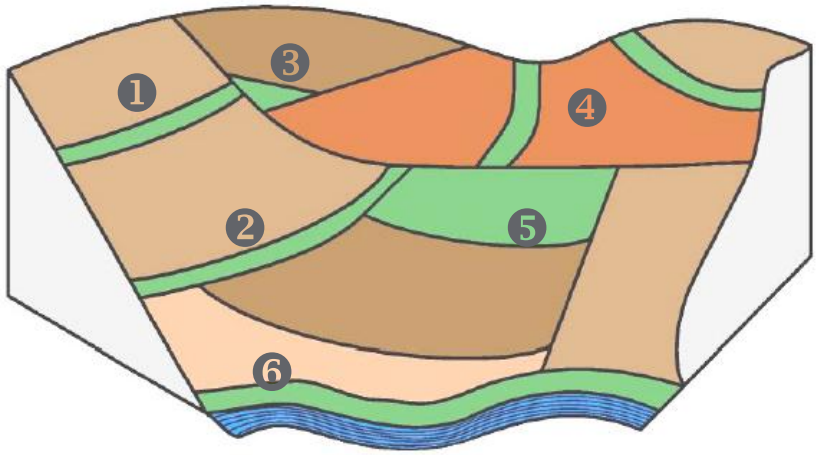
Water Quality – Best Management Practices



Describing the correct positioning of vegetative buffer strips...



1. buffer strip inside field
2. buffer zone at the edge of a field This could be a non treated area, and a grassed strip between the field and a road
3. grassed corner of field, where water concentrates before flowing down the catchment
4. grassed pathway to reduce water flow where it concentrates
5. grassed field positioned to intercept concentrated runoff
6. grassed strip along river, to intercept diffuse runoff

Operation Pollinator:
Creating farmland habitats for high biodiversity

Limited value plants & invertebrates

Simple structure & composition

Crop

Very visual
Attractive to the widest range of invertebrates & butterflies (8X)

Wildflower Mix

Good for invertebrates (4X bugs & spiders) & small mammals

Tussocky Grass

Best for Bumblebees & butterflies (13x)
Pollen & nectar abundant

Pollen & Nectar Mix

A win-win-win Situation for our customers + agriculture:

Fulfil environmental obligations + increase of biodiversity + enable efficient farming

What we do

- Cultivating pollen + nectar margins around fields
- Innovative pesticide use
- Develop targeted seed mix
- Best managmt Practice
- Train farmers + experts
- Educate society

What we achieve in short term

- Increase of Crop yield
- Simplify field management
- Environmental payment
- Increase habitat for Pollinators
- Increase Pollinator numbers

What we achieve in long term

- Increase overall biodiverstity
- Create habitat for mammals and farmland birds
- Create a more sustainable farming system
- Knowledge on Pollination + Environment
- Grow more food from less land

Tailoring systems: Plene™ in sugar cane

Tailoring crops and systems

Evolution in sugar cane planting

- Integrated solution which simplifies cane planting, offers buds treated against diseases and insects delivering a healthy crop, varietal purity and traceability

Advantages

Economic	• Reduces planting costs of 15% per ha
	• Increases production of 5 -15 ton/ha with faster renovation and productivity gain
Environmental	• Sustainable agriculture–min. cultivation and lower compaction
	• Better *carbon footprint*–less machinery operations
Social	• Better work conditions – less physically stressing

Commercial launch at the end of 2010

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Eplene: transforming sugar cane planting in Brazil

SYNGENTA INNOVATION

- Crop Protection active ingredients and formulations
- Coating protectors
- Vigor technology
- Cutting and treatment equipment
- “Integrated Planting System”

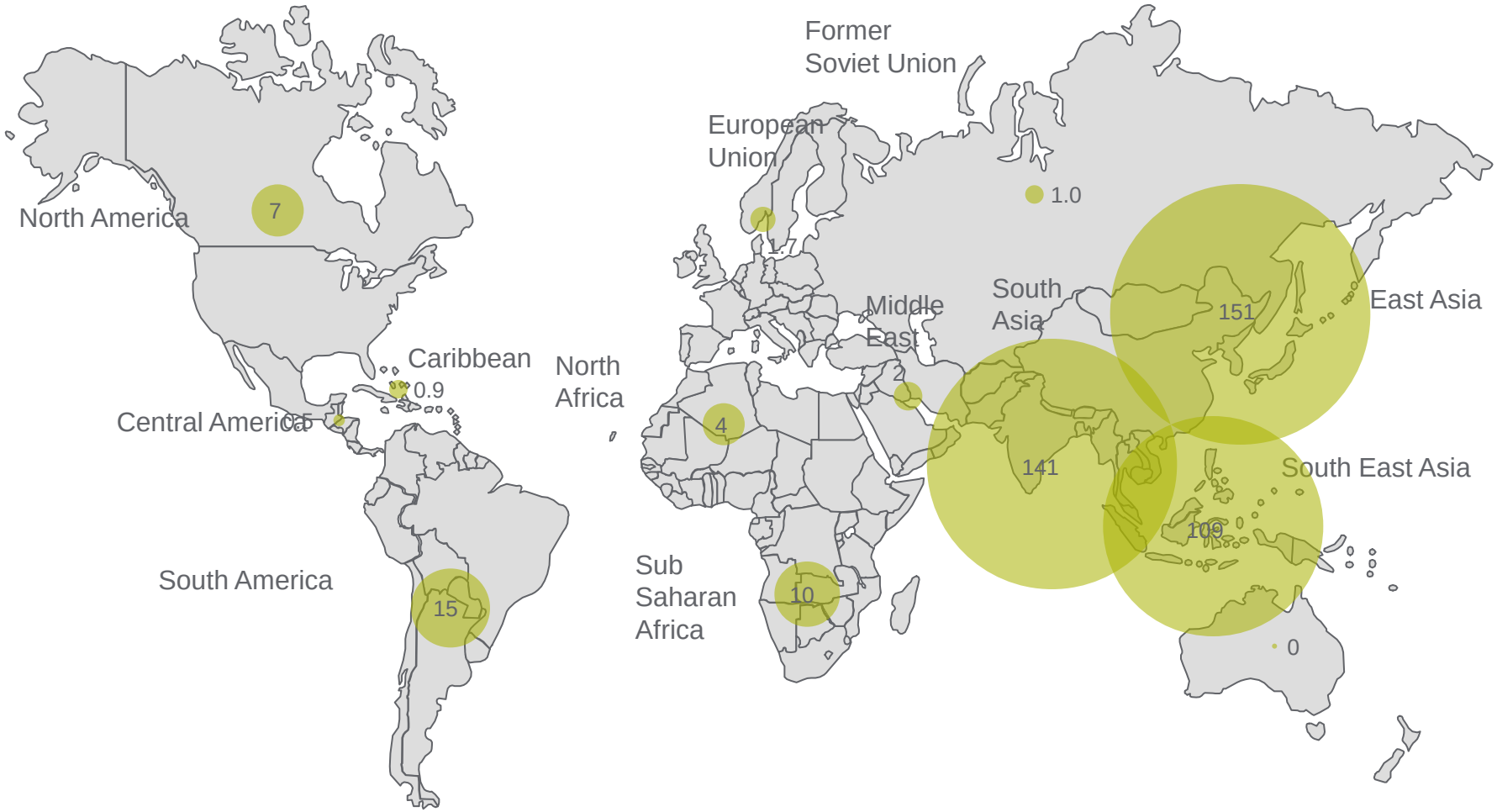
TECHNOLOGY DEVELOPMENT

- Planting Equipments
- Treating Equipments

GERMPLASM

90% of rice is grown in APAC

2008 Rice Production = 444mmt



Source: USDA (May 2009)

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Rice Integrated Solutions

- There cannot be a single solution
- Tailored approaches to meet local farmer needs and preferences
  - Rainfed, secure/erratic
  - Irrigated, depleting groundwater, water rich areas
  - Transplanted rice, Direct seeded
  - Farmer saved seed, certified seed, hybrids
- Importance of Agricultural extension services for Knowledge transfer

Hainan China November 2008

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10 t/ha yield integrated solution: Chennai March 2011

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Transplanting

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Tanzania Irrigated rice; April 2011

Tanzania Rainfed rice; April 2011

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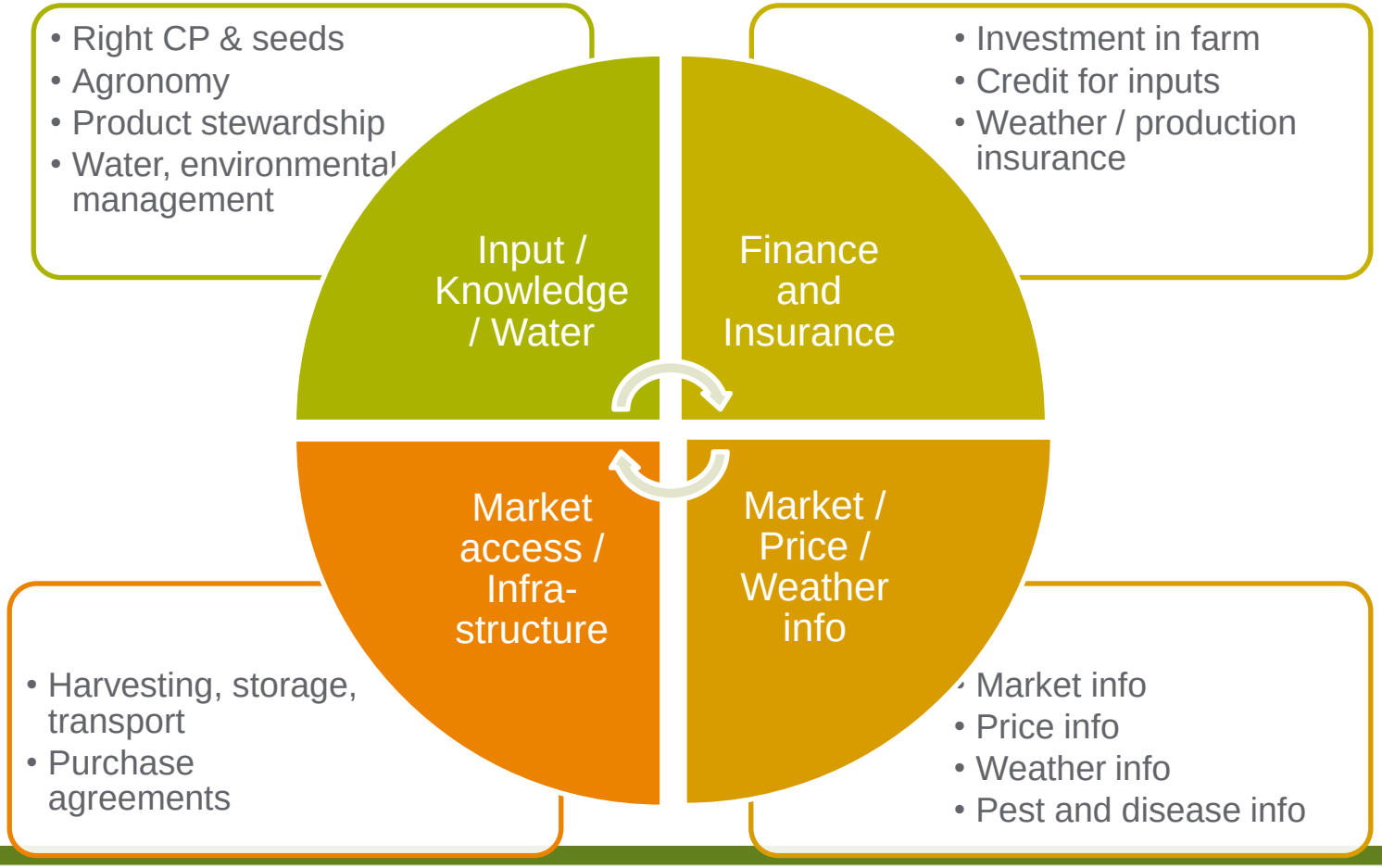
Limitations for smallholders are not just lack of technology



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Kilimo Salama: Insurance scheme (Syngenta Foundation for Sustainable Agriculture)

Grow more from less

Sustainable Intensification of Agriculture

Metrics for desired Outcomes
Focus on productivity and environmental aspects
Yield, Quality, Soil, Water, Biodiversity, Waste
Efficient use of Natural Resources

Responsible use of technology

Proportionate Regulation; risk based

Practical help for growers: Knowledge transfer

Grower training and demonstrations
Sustainable and safe farm management practices
Improving capability in local University and Extension services

Infrastructure investments and Policy

Economic and Social benefits

Integrated solutions for farmer benefit

Innovative crop protection chemistry and Seed Care

Agronomy

Local Knowledge

Machinery

Fertiliser

Services

Finance

Biotechnology expertise

Precision breeding and plant genomics

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