Assessing prospects for food and water security using scenario analysis

TIAS WEBINAR: ADVANCING THE WATER-FOOD NEXUS APPROACHES AND METHODS

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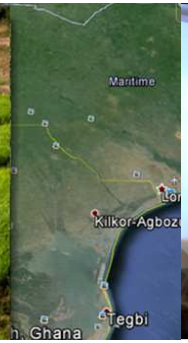
Key Messages

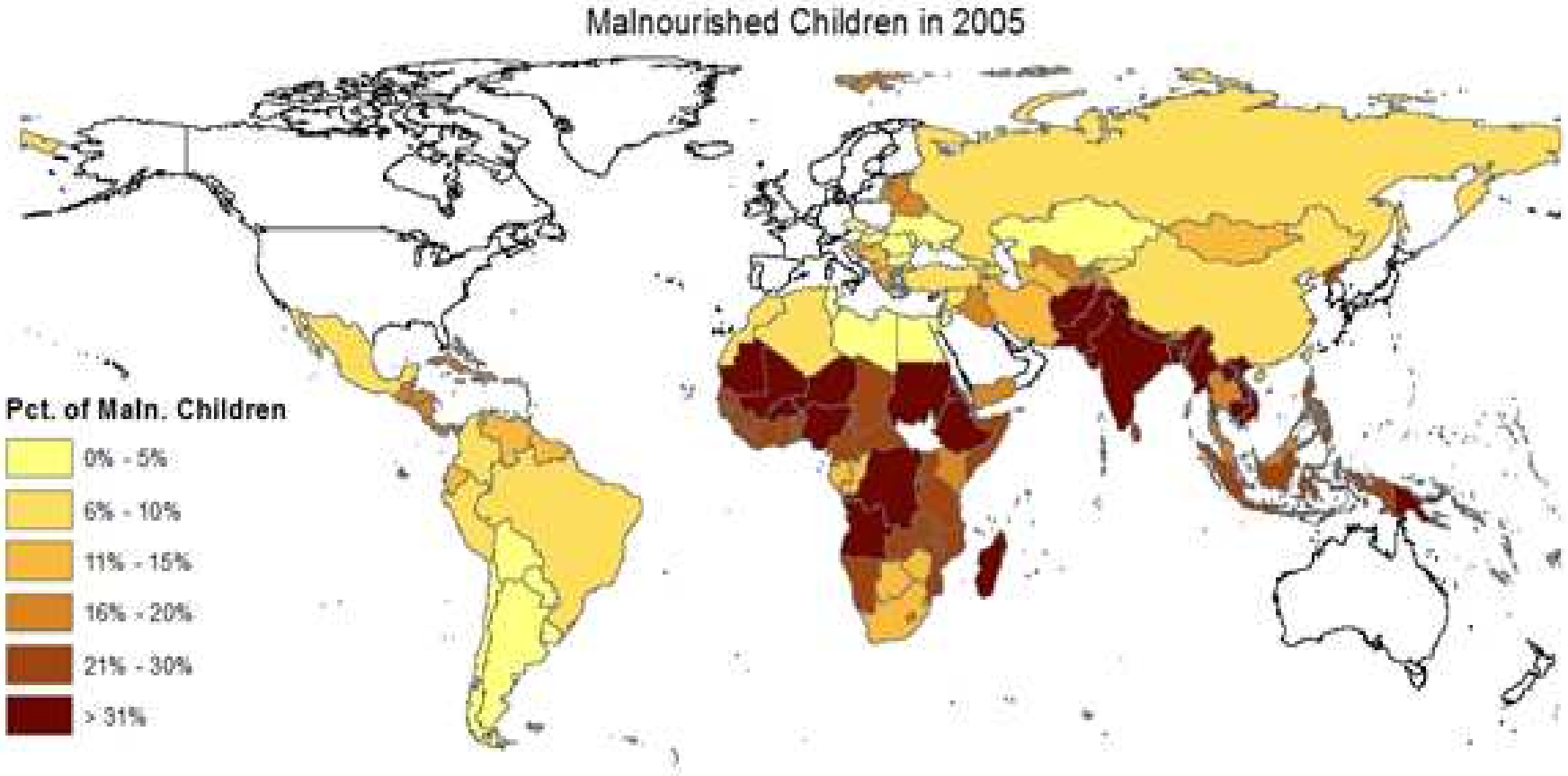
1. Global hunger and malnutrition persist
2. A scenario approach can be used to assess linkages of food with other sectors
3. Water (and energy) scarcity threaten food security
4. Water quality is a key component of the nexus
5. Sustainable intensification is essential to meet agriculture and food requirements
6. A nexus approach should be adopted to achieve sustainable food security

Global hunger and malnutrition persist



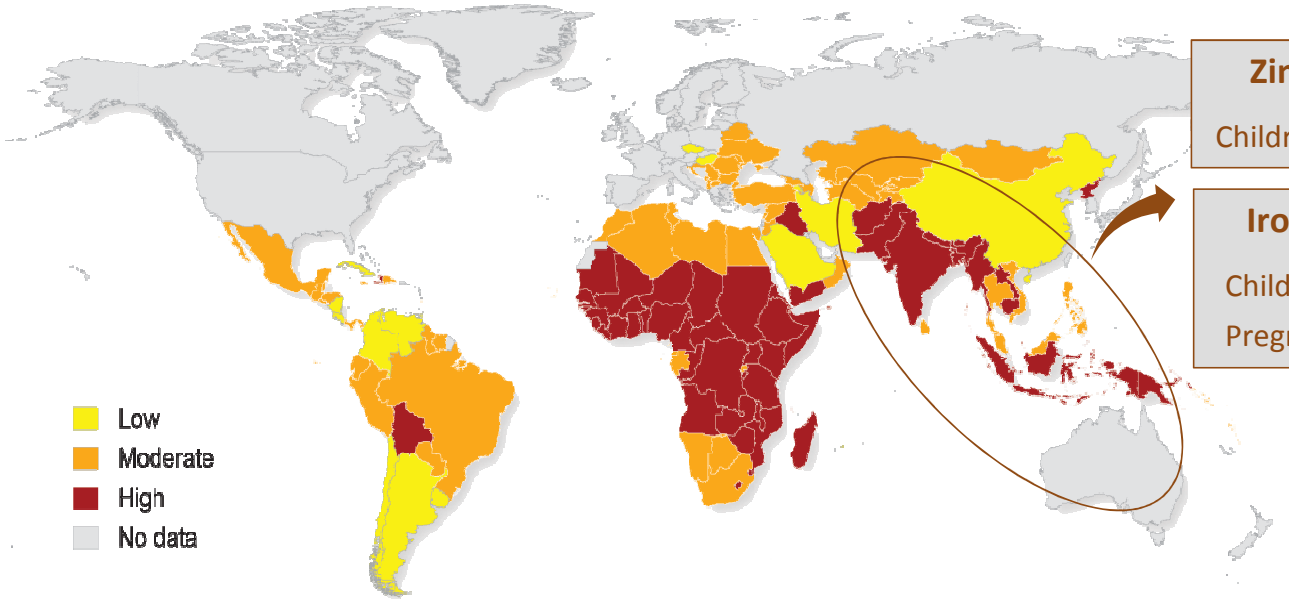
Today, about 870 million, or 1 in 8 people worldwide, still suffer from hunger, including 150 million children



Source: IFPRI (2013)

Micronutrient deficiencies are pervasive

Prevalence of micronutrient deficiencies



Zinc deficiency, S. Asia

Children <5: **79%**

Iron deficiency, SE Asia

Children <5: **66%**

Pregnant women: **48%**

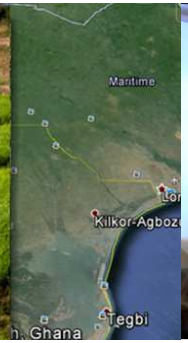
Economic cost of undernutrition = **$1.4 - 2.1 trillion** or

2 - 3% of global GDP per year

(FAO 2013)

A scenario approach can be used to assess linkages of food with other sectors



Major drivers of the nexus

- Increasing population and urbanization
- Rising incomes and demand / dietary changes
- **Rising energy prices / biofuel expansion;** increasing volatility of food prices
- **Growing land and water constraints**
- Climate change and higher frequency / intensity of extreme weather events

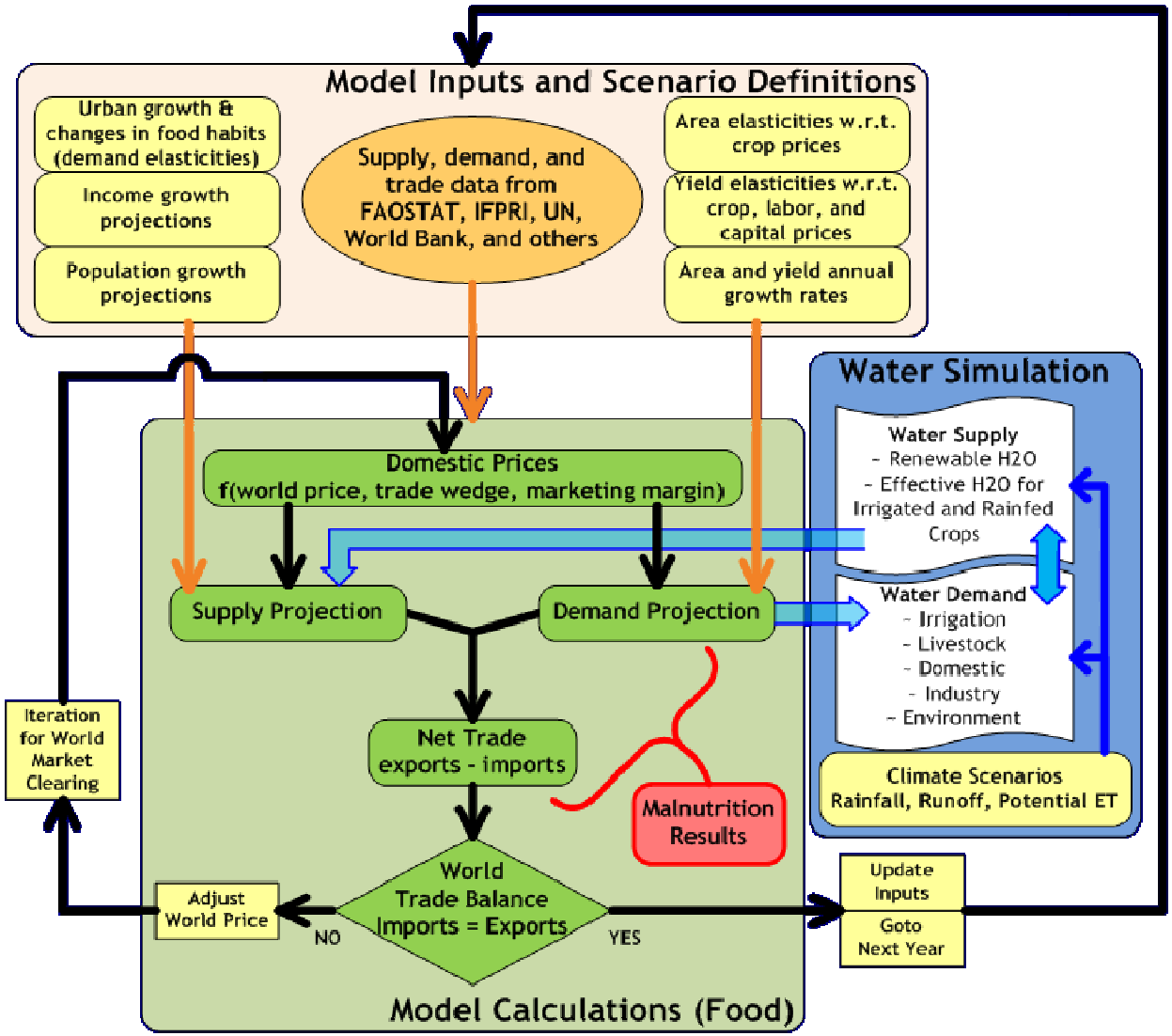
Scenario

- Internally consistent verbal picture of a phenomenon, sequence of events, or situation, based on certain assumptions and factors (variables) chosen by its creator. Scenarios are used in estimating the probable effects of one or more variables, and are an integral part of situation analysis and long-range planning (businessdictionary.com)

- Qualitative and quantitative scenarios

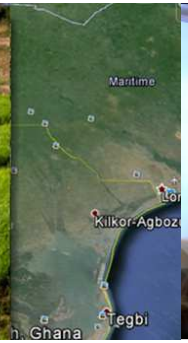
- Quantitative should combine socioeconomic with biophysical approaches

Flow Chart of IMPACT Model



Water and energy scarcity increasingly threaten food security and nutrition



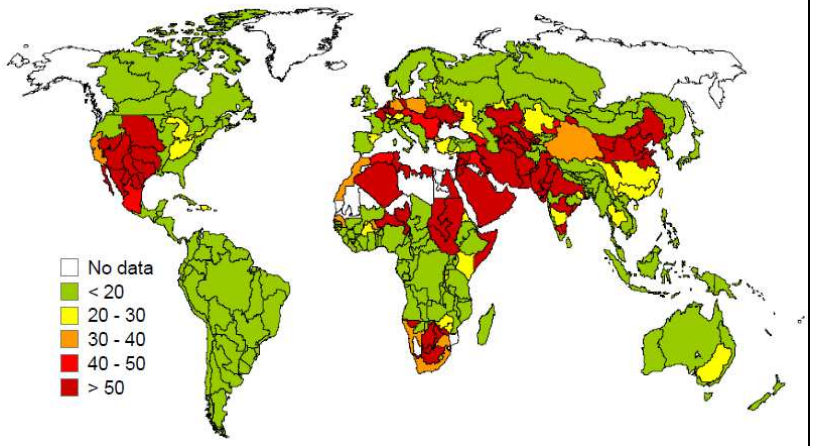
Water

- Irrigation is key for securing future food supply
  - accounting for less than 20% of global cropland; contributing ~40% of global cereals production
- Irrigation is the largest water user, accounting for
  - 70% global water withdrawals; 90% global water consumption
- Usually seen as the major driver of water scarcity
- Improvement of agricultural water use efficiency is usually a slow and difficult process
- Shifting diets toward increasing water use intensity (livestock products, vegetables, sugars, aquaculture)

Agriculture is both vulnerable to and a contributor to water scarcity

Water stress is rising

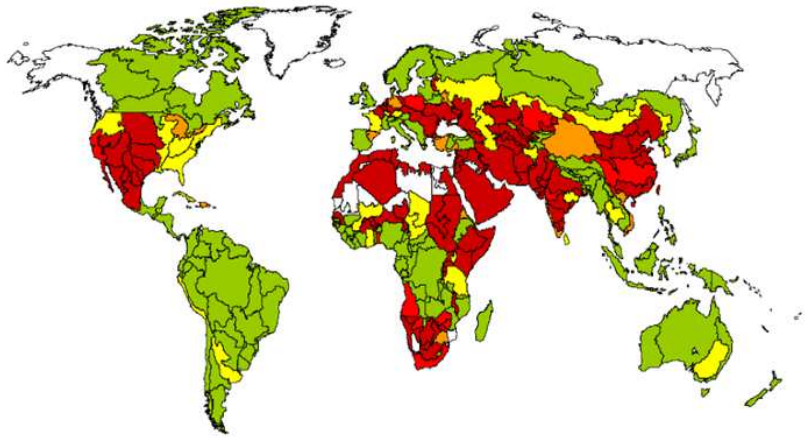
Water stress, total renewable water withdrawn 2010 (%)



Water-scarce regions account for:

- **36% of global population**
- **22% of global GDP**
- **39% of global grain production**

Water stress for total renewable water withdrawn, BAU, 2050 (%)

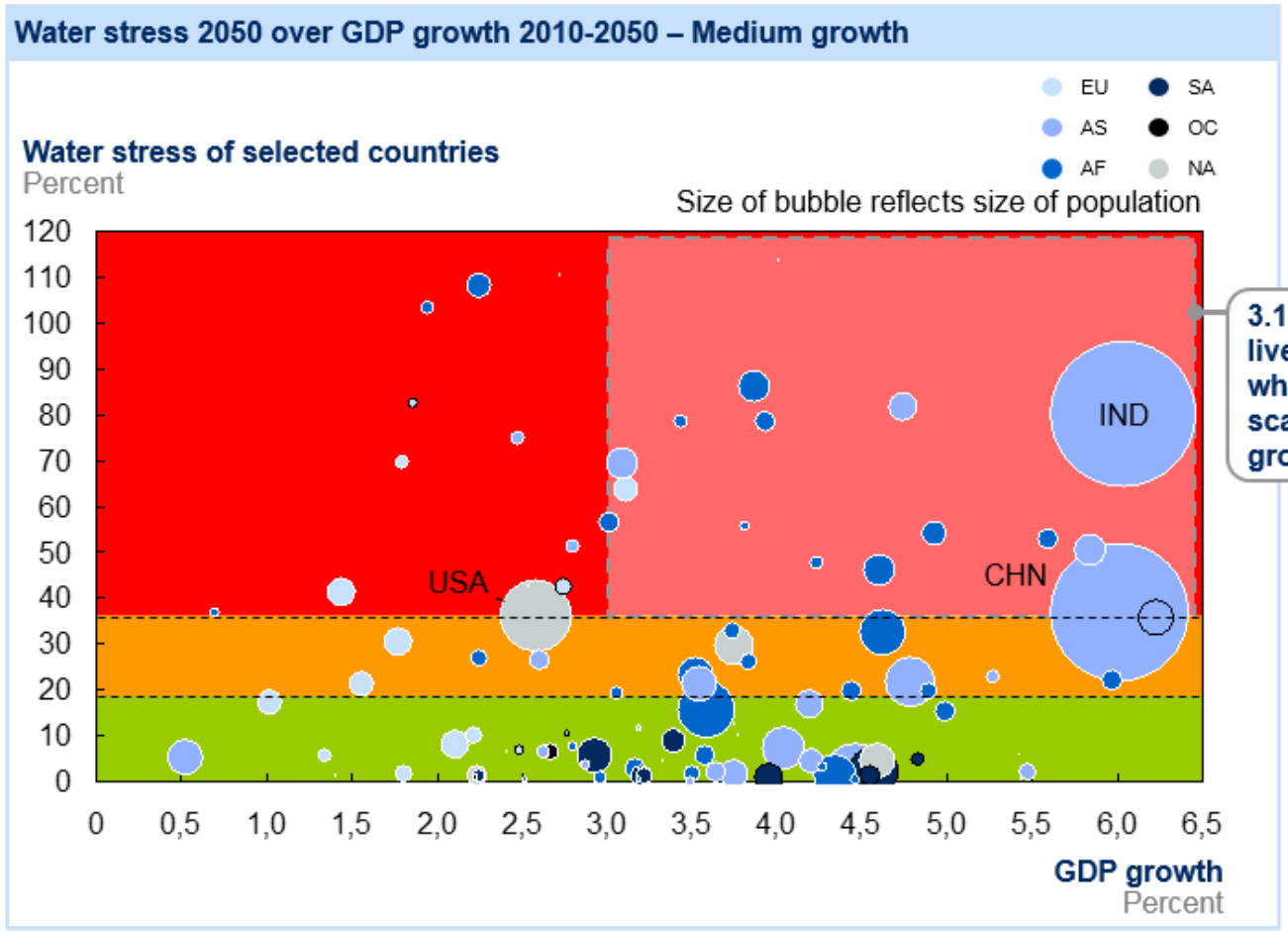


Under BAU, at risk from water stress are:

- **52% of global population**
- **45% of global GDP**
- **49% of global grain production**

Source: IFPRI / Veolia Water 2010

For China and India and many other rapidly-developing countries, water stress will pose a risk to growth



Source: IFPRI / Veolia Water 2010

Energy

- Energy demand to increase by **30%** from 2011-35 (IEA 2013)
- Rising energy prices affect agriculture
  - Make biofuels more profitable, promoting food-fuel competition
    - Biofuel production to increase by **50%** by 2020 (OECD-FAO 2013)
  - Increase costs of agricultural production
    - Planting and harvesting increasingly dependent on energy
    - Many inputs also depend on energy e.g. fertilizer and water
- *Energy prices will affect water use, e.g.*
  - More expensive to extract and convey irrigation water (Von Grebmer et al. 2012)
  - Large dam construction can be costly and have implications for agriculture; must be site/size specific (Ansar 2014)

Scenarios Compared to Baseline

- Scenario 1 – Yield Increase
  - Higher crop productivity growth rate resulting in higher crop yields
  - Increase the productivity growth rate for each crop such that the projected crop prices in 2050 in real terms are the same as crop prices in 2010 in real terms
- Scenario 2 – Energy Shock
  - Doubling of oil prices in 2050 compared to baseline
  - Higher fertilizer price (fertilizer price growth rate increased by 75%)

Changes in World Prices of Crops Relative to Baseline, 2050

Commodity/Scenario	Yield Increase	Energy Shock
Rice	-20.2%	9.8%
Wheat	-26.3%	10.1%
Maize	-36.3%	13.4%
Other Grains	-12.0%	6.4%
Soybeans	-19.2%	8.2%
Sorghum	-17.7%	6.5%

Source: IFPRI IMPACT Model, September 2011 simulations

Changes in World Prices Relative to Baseline, 2050

Commodity/Scenario	Yield Increase	Energy Shock
Beef	-4.9%	2.2%
Pork	-5.8%	2.2%
Poultry	-8.8%	2.5%
Soybean Oil	-15.3%	26.3%
Rapeseed Oil	-22.8%	50.5%
Milk	-3.4%	1.1%

Source: IFPRI IMPACT Model, September 2011 simulations

Changes in World Yield of Crops Relative to Baseline, 2050

Commodity/Scenario	Yield Increase	Energy Shock
Rice	11.8%	-4.7%
Wheat	27.8%	-3.7%
Maize	45.6%	-2.5%
Other Grains	5.3%	-2.8%
Soybeans	12.5%	-3.0%
Sorghum	12.0%	-2.6%

Source: IFPRI IMPACT Model, September 2011 simulations

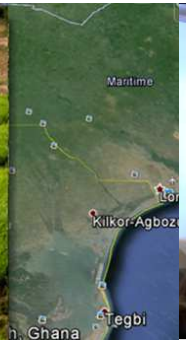
Impact on Population at Risk of Hunger Relative to Baseline, 2050

Commodity/Scenario	Yield Increase	Energy Shock
East Asia and Pacific	-11%	6%
Europe and Central Asia	-4%	2%
Latin America and Caribbean	-19%	17%
Middle East and North Africa	-16%	8%
South Asia	-32%	19%
Sub-Saharan Africa	-32%	15%
Developed	-1%	4%
Developing	-26%	14%
World	-24%	14%

Source: IFPRI IMPACT Model, September 2011 simulations

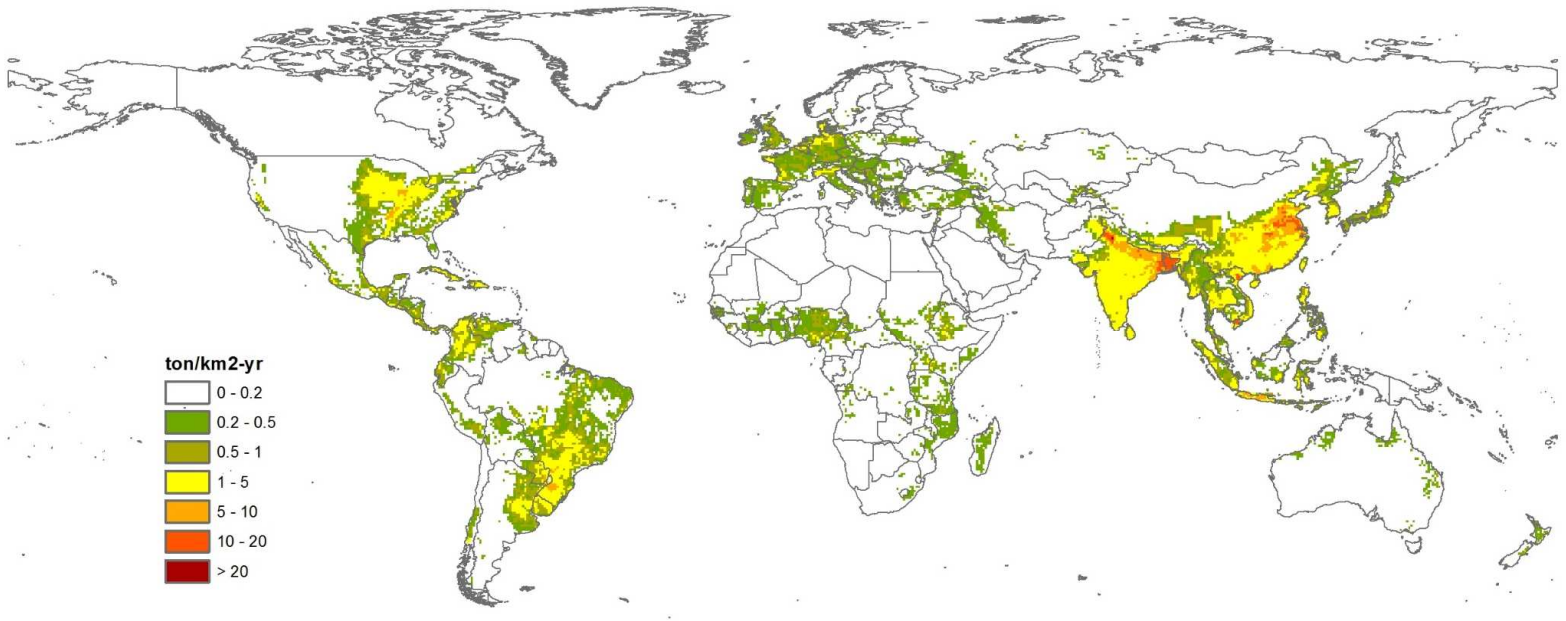
Water Quality is a key component of the nexus



- Water quantity and water quality- two sides of one coin
- Global water quality assessment – an emerging research field
- Non-point source agricultural pollution

Nitrogen emissions from agriculture-base period

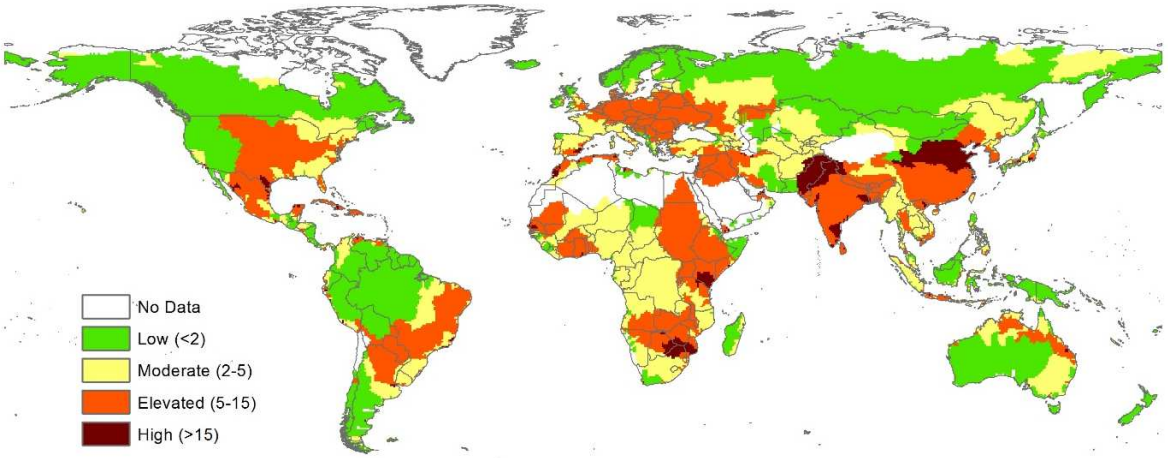


46 million tons/yr

Source: IFPRI / Veolia Water 2014

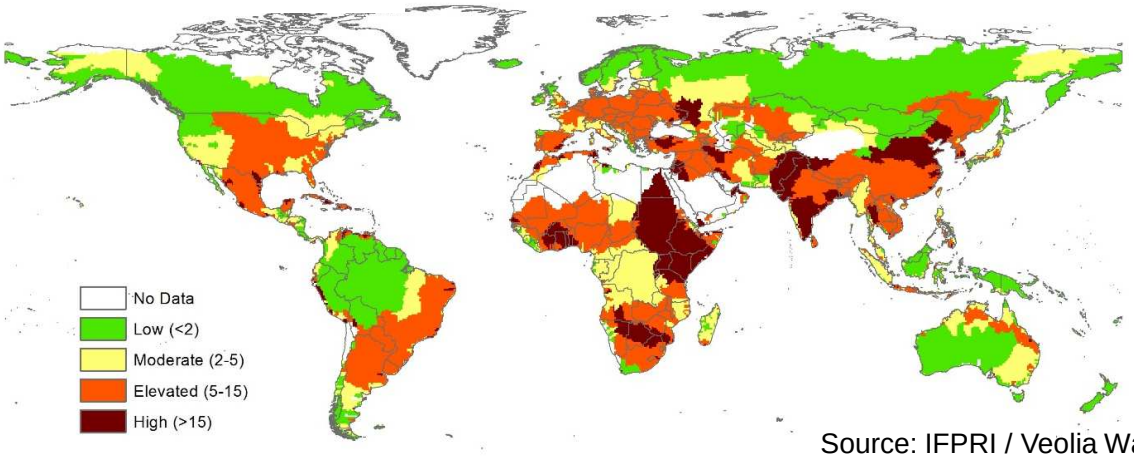
Nitrogen (agriculture and domestic)—2000/5-2050

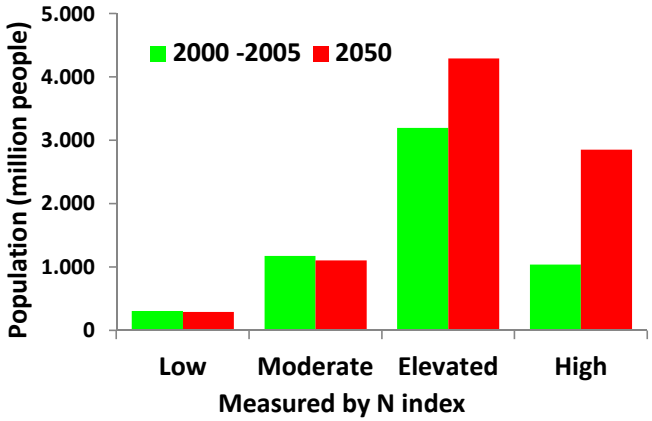
N Index (2000-2005)



Index:
N loadings / renewable water resources

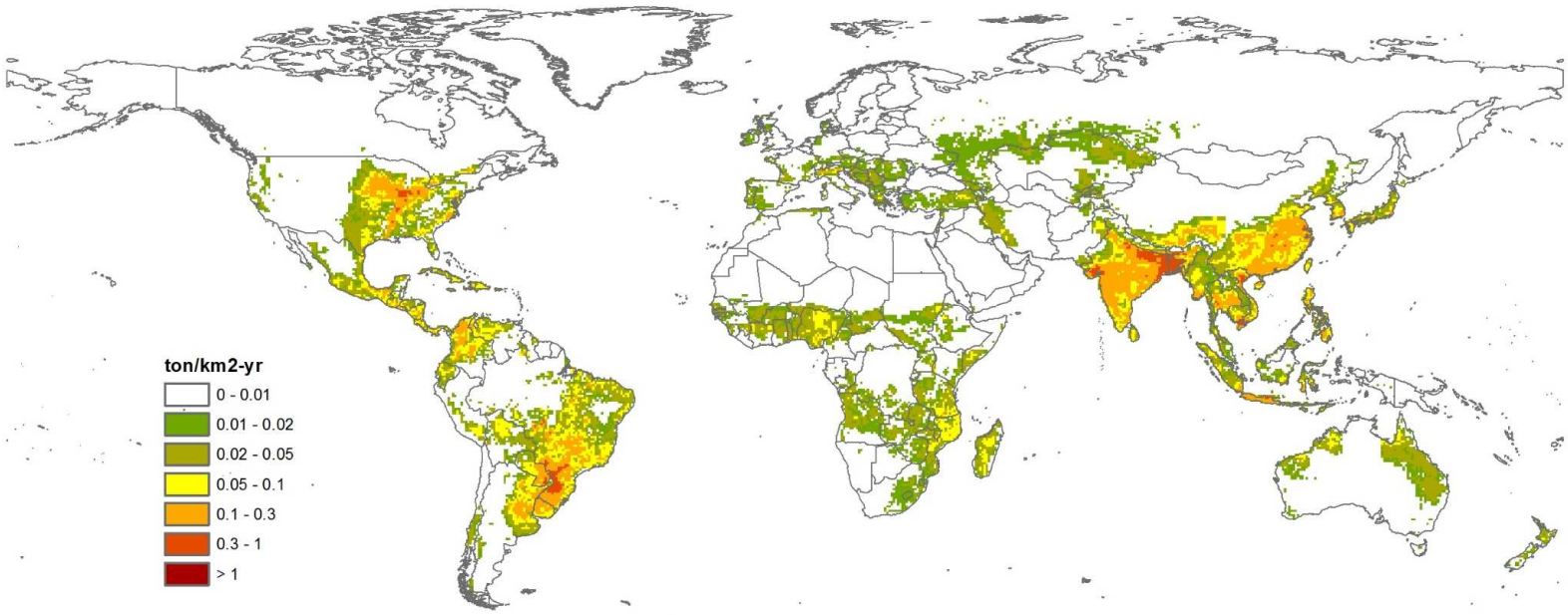
N Index (2050)





Source: IFPRI / Veolia Water 2014

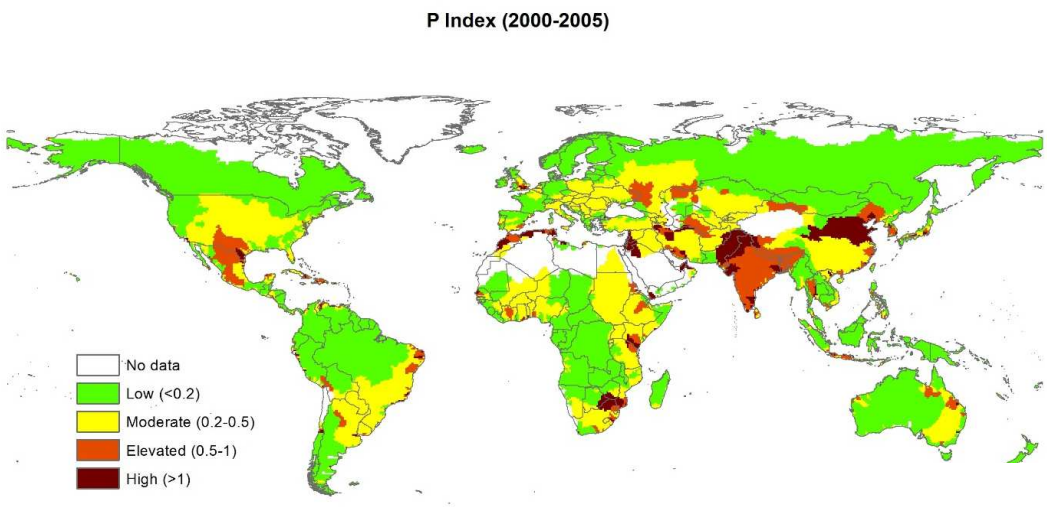
Phosphorous emissions from agriculture, base period



2.7 million tons/yr

Source: IFPRI / Veolia Water 2014

Phosphorus-(agriculture and domestic)—2000/5- 2050



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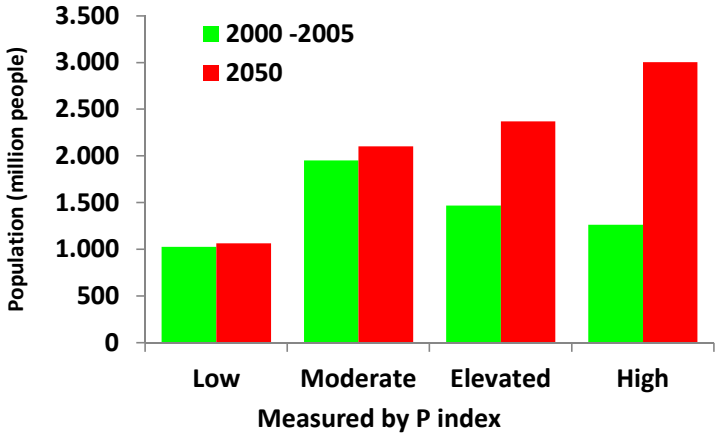
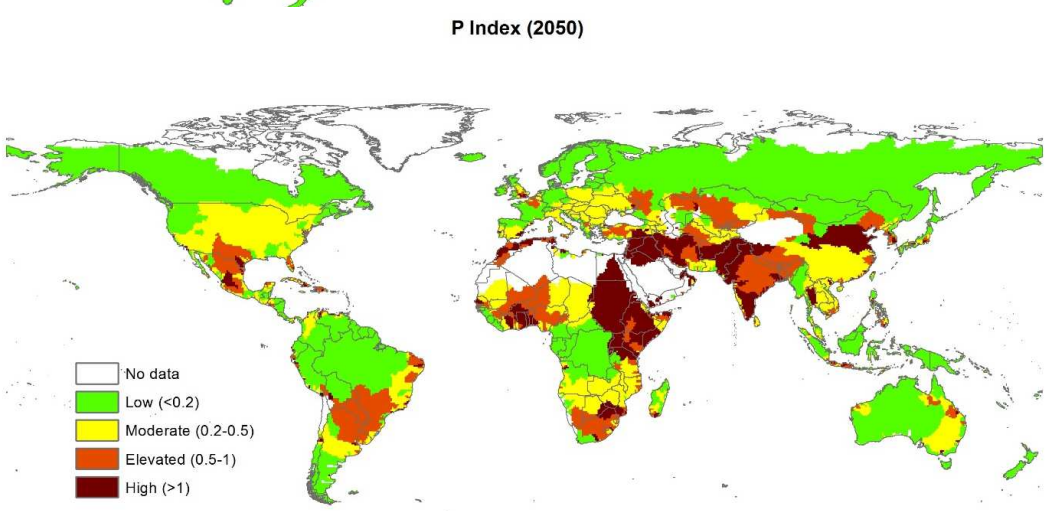
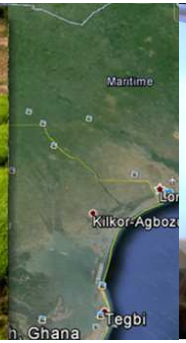




Source: IFPRI / Veolia Water 2014

Sustainable intensification is essential to meet agriculture and food requirements



Technology Assessment Scope

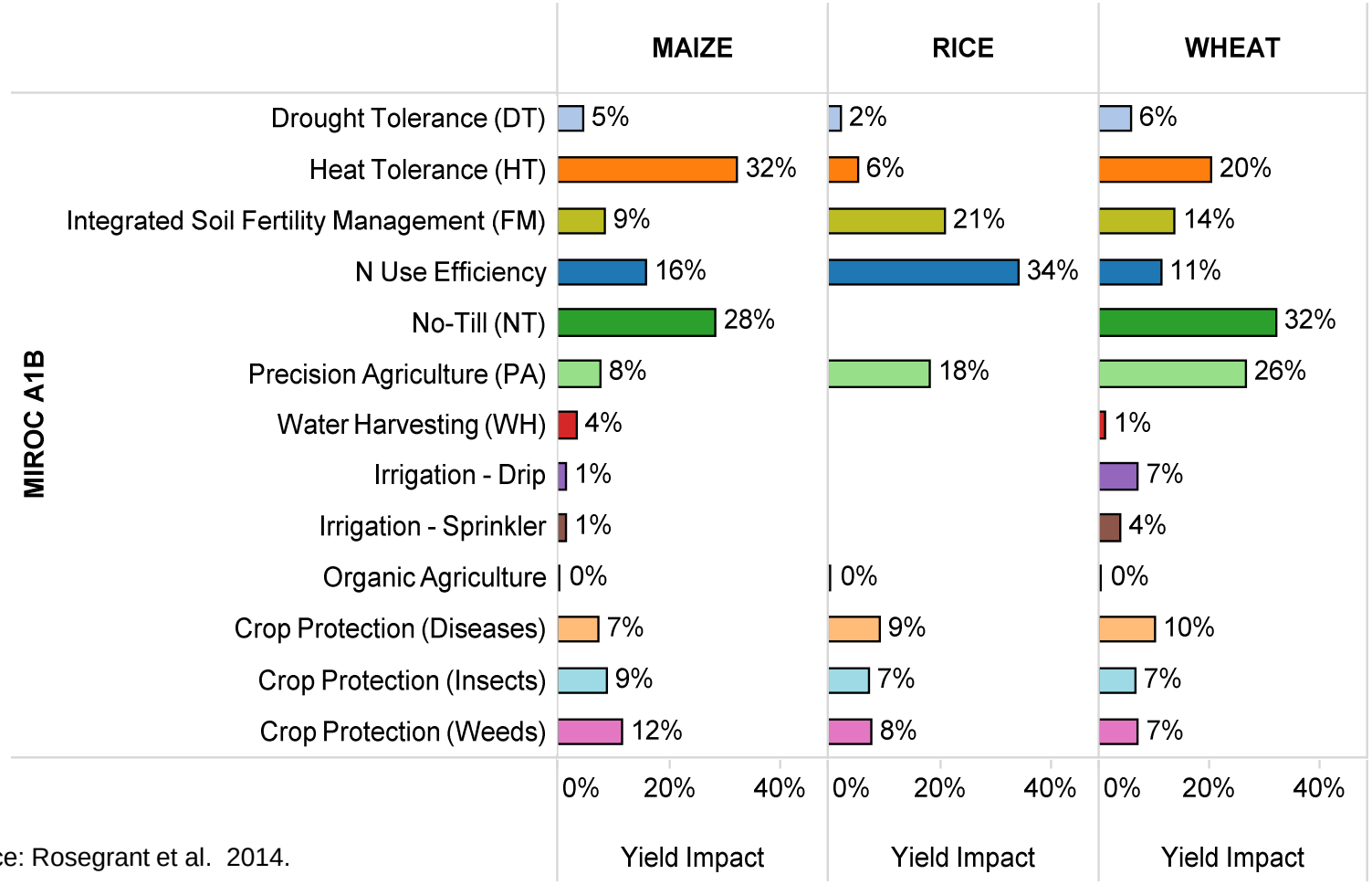
- **Global & Regional**
- **Eleven technologies**
- **Three Crops**
  - **Wheat**
  - **Rice**
  - **Maize**



- No-Tillage
- Integrated Soil Fertility Management
- Organic Agriculture
- Precision Agriculture
- Crop Protection
- Drip Irrigation
- Sprinkler Irrigation
- Water Harvesting
- Drought Tolerance
- Heat Tolerance
- Nitrogen Use Efficiency

Global DSSAT Results

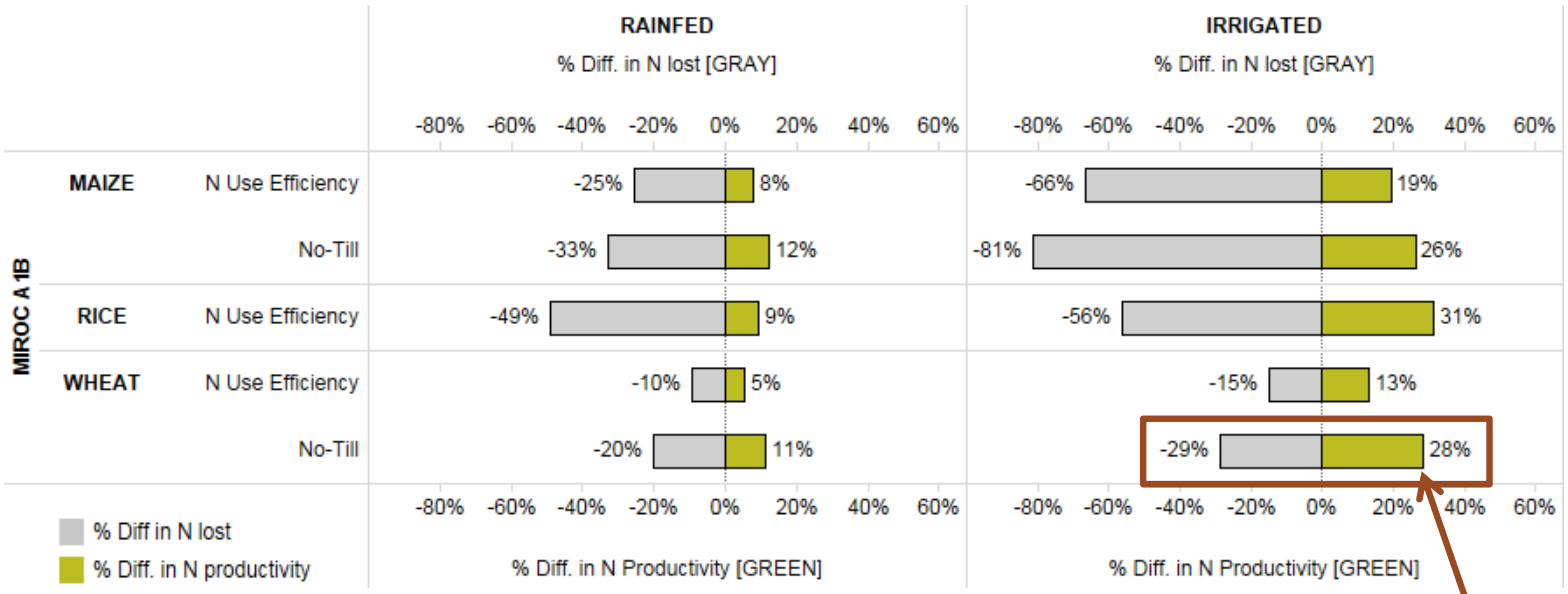
Yield Change (%) - Maize, Rice, & Wheat, 2050 vs. Baseline



Source: Rosegrant et al. 2014.

Efficient use of resources:

Change (%) in N Productivity – **Maize, Rice, Wheat**. Irrigated vs. Rainfed, 2050 vs. Baseline (DSSAT)



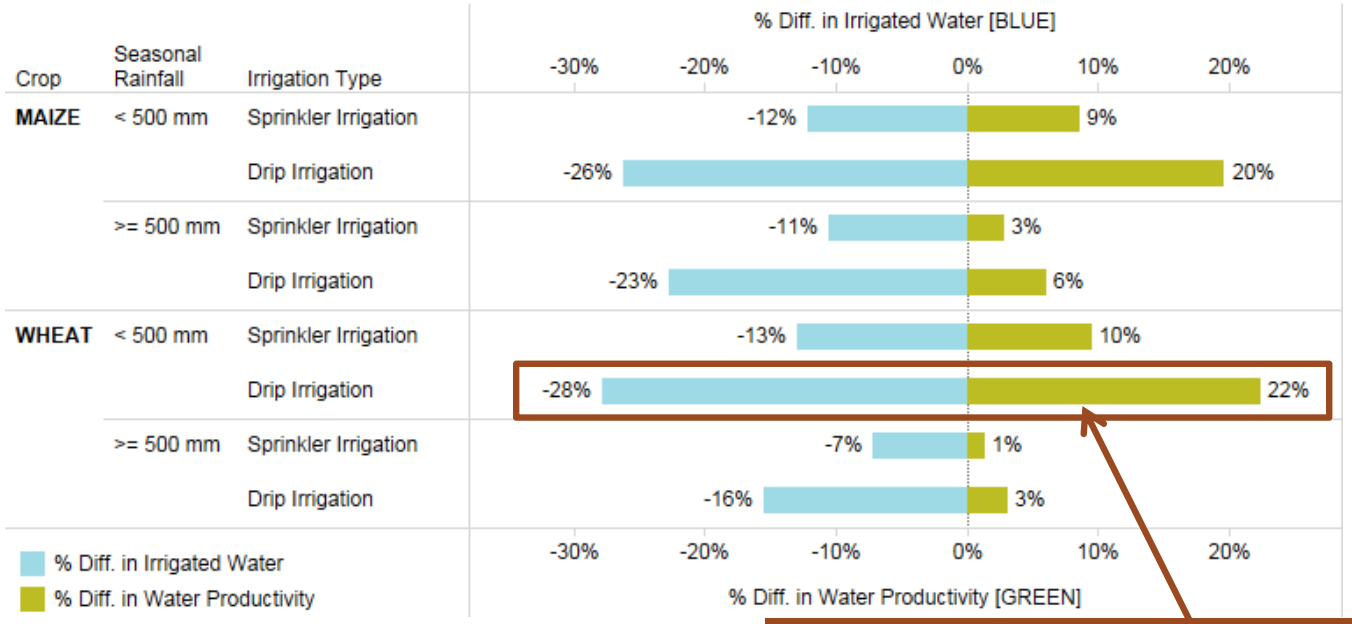
(Compared to the business-as-usual)
29% less nitrogen losses
→ 28% more N productivity

Benefits include reduced N losses, increased N productivity.

Source: Rosegrant et al. 2014.

Efficient use of resources :

Change in Site-specific Water Use – Irrigated **Maize, Wheat**



(Compared to the conventional furrow irrigation)
28% less water applied
→ 22% more water productivity

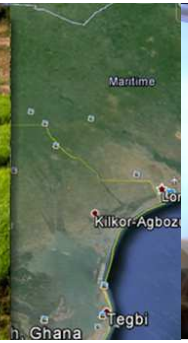
Prominent impacts of
Improved Irrigation Technologies

- Increased water savings (less water used)
- Increased water productivity (more biomass produced per unit water input)

Source: Rosegrant et al. 2014.

A nexus approach should be adopted to achieve sustainable food security



Supporting a nexus approach (1)

- **Increase investment in agric. R&D and extension services**
  that promote resource efficient inputs and practices

- **Increase resource use efficiency through**
  - Access to improved crop varieties
  - Effective input / output markets
  - Adoption of sustainable land management practices (particularly those that reduce water pollution)

- **Improve water-use efficiency**
  - Crop breeding
  - Institutions
  - Direct irrigation technology interventions

Technological innovations at the nexus

- Improved land management (No-till, precision agriculture, integrated soil fertility management)
  - Large yield impacts in many regions
- Nitrogen use efficiency in new varieties
  - Strong yield impacts
  - Reduces negative environmental impacts from fertilization
- Heat tolerant varieties
  - Reduce projected negative impacts of climate change
- Technology benefits are larger with irrigation (tradeoffs)
- Drought tolerant varieties
  - Perform as well as susceptible varieties under no drought stress
  - Significant yield benefits under drought conditions

Supporting a nexus approach (2)

- **Develop strong institutions which support resource rights**, esp. in developing and rural areas
  - Solid legal frameworks important for resource allocation

- **Employ fiscal policy that promotes sustainable, healthy diets**
  - Taxes on unhealthy foods and subsidies on nutrient-rich foods to promote healthier diets
  - Public awareness interventions on unhealthy consumption to complement fiscal measures

Supporting a nexus approach (3)

- **Address food loss and waste**
  - Increase information & data on losses and waste
  - Assess economics of reduction
  - Incentives/invest in appropriate measures
- **Promote biofuels competing less with food**
  - **2nd generation biofuels** can reduce, but not eliminate, food-fuel competition, and reduce resource degradation
  - Focus on other renewables

In conclusion

- A nexus approach is critical to end hunger and malnutrition
- Sustainable intensification (with a nexus approach) creates more with less
- Policy coherence is needed to account for interdependencies across sectors

Selected Resources

1. http://www.water-energy-food.org/en/news.html Bonn Nexus 2011 conference
2. http://wle.cgiar.org/ CGIAR Research Program on Water, Land and Ecosystems (has a dedicated nexus cluster)
3. http://www.fe2wnetwork.org/ Food, Energy, Environment and Water Network

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