Intensifying sustainable agricultural productivity to meet SDG2 (2.3 & 2.4)

Roundtable Forum for the Global Action Plan for Agricultural Diversification (GAPAD)

25-26 October 2016
Nairobi, Kenya

Timothy Sulser
Scientist, IFPRI
## Acknowledgements

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<tr>
<th>Quantitative Foresight Modeling</th>
<th>Climate Smart Agriculture</th>
<th>Gender, Assets, and Property Rights</th>
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<td>Daniel Mason D’Croz</td>
<td>Alessandro De Pinto</td>
<td>Ruth Meinzen-Dick</td>
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<td>Sherman Robinson</td>
<td>Ho-Young Kwon</td>
<td>Agnes Quisumbing</td>
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<td>Shahnila Islam</td>
<td>Jawoo Koo</td>
<td>Sophie Theis</td>
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<td>Nicola Cenacchi</td>
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<td>Mark Rosegrant</td>
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<td>Keith Wiebe</td>
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<td>...and many others...</td>
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October 2016
Sustainable Development Goals by 2030: Focus on 2.3 & 2.4

• **2.3** – Double agricultural productivity and incomes
  – For small-holders, family farmers, women, indigenous people, and other marginalized producers through land rights and access to resources, services, and opportunities

• **2.4** – Ensure sustainable food production
  – Implement resilient agriculture: increasing productivity while maintaining ecosystems and strengthening capacity for adaptation to climate change and extreme weather events

October 2016
Provide evidence-based policy solutions to end hunger and reduce poverty

IFPRI’s research and outreach at the global level and at regional and country level in Africa, Asia, Latin America, and the Middle East
3 examples from IFPRI’s research portfolio to address SDG 2

http://www.ifpri.org/

Gender, Assets, and Property Rights

Climate Smart Agriculture

Quantitative Foresight Modeling

http://www.ifpri.org/topic/gender
http://www.ifpri.org/search?keyword=climate+smart+agriculture
GENDER
Why gender matters

• Women make up a large percentage of the agricultural labor force in developing countries (on average 43%, 50% in Africa);

• Women are disadvantaged in productive asset ownership (including land and livestock), control of productive inputs (including access to credit, insurance, technology etc.);

• There are gender gaps in base education levels, access to extension and information services, natural resource knowledge;

• Female farmers produce less than men not because they are less efficient/able farmers, but because they lack equal access to resources.
Takeaways from 20+ Years of Gender Research at IFPRI

- Household decision making
- Asset access, control, and ownership
- Closing gender gaps
- Land rights
- Legal institutions and governance
- Social capital
- Sustainability
- Climate change and adaptation
- Nutrition and health
- Violence against women
- Empowerment
- DATA

Women’s Economic Empowerment

• Linked to over 50% of reductions in all child stunting from 1970-1995 (Smith & Haddad 2000)

• Shown in many studies, in many parts of the world: women’s income has greater impact on child nutrition and food security than men’s (UNICEF 2011).

• However, recent review shows there is limited or mixed rigorous evidence for standard poverty programs on measures of direct women’s empowerment (micro-credit, cash transfers, agriculture interventions) (van den Bold et al. 2013).

• Need more rigorous research on agriculture and women’s empowerment outcomes – historically not measured – or measured indirectly without standardized understanding of indicators or methodology.
Women’s Empowerment and Children’s Nutritional Status

• New tool: Women’s Empowerment in Agriculture Index (WEAI)
  – New survey-based index (PRIMARY, not secondary data)
  – Men and women from the same household are interviewed
  – Focus on men’s and women’s empowerment in agriculture

• Evidence from Ethiopia and Nepal
  – Interventions which increase women’s empowerment contribute to improving child nutrition and household well-being

http://www.ifpri.org/topic/weai-resource-center
http://dx.doi.org/10.1017/S1368980015000683
http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129781
What is CSA?

• Integrative approach to address interlinked challenges of food security and climate change
  – Sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security, and development;
  – Adapting and building resilience of food systems and farming livelihoods to climate change at multiple levels; and
  – Reducing greenhouse gas emissions from agriculture, where possible

https://www.ifpri.org/blog/climate-smart-agriculture-key-ending-hunger
Simulated Global Adoption of Selected CSA Practices

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<th>Average global impact of adoption (%)</th>
<th>Maize</th>
<th>Wheat</th>
<th>Rice</th>
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<td>Production</td>
<td>+2.4</td>
<td>+2.3</td>
<td>+2.2</td>
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<tr>
<td>Price</td>
<td>-5.2</td>
<td>-6.8</td>
<td>-7.8</td>
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<tr>
<td>Area</td>
<td>-0.3</td>
<td>-1.1</td>
<td>-1.3</td>
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</table>

Aggregated global impact across CSA

| Pop risk of hunger (%)                | -3.3  |
| Undernourished children (%)          | -0.9  |
| Emission reduction (mmt CO2/year)    | 17.2  |

**Impacts by 2050**

- Simulations using IFPRI’s IMPACT system of models and DSSAT crop model
- Maize, Wheat, and Rice only (~41% global harvested area)
- No-till; Integrated Soil Fertility Management (ISFM); Alternate Wet and Dry (AWD); Urea Deep Placement (UDP)
- Two CC Scenarios (SSP2/RCP 8.5): GFDL and HadGEM GCMs
- Baseline adoption rates by 2050 (%): No-till = 70; ISFM, AWD, UDP = 40
Baseline adoption of CSA

Adoption focus increases abatement AND production

Emissions reduction focus increases total abatement at cost of total production

Potential Tradeoffs from CSA Policy Options

Maize/Wheat/Rice CSA Options - No-till/ISFM/AWD/UDP
Size of oval shows range across climate change scenarios
Quantitative Foresight Modeling

• Forward-looking modeling for agricultural and food security futures
• Structural modeling informed by theory, expert knowledge, and latest science
• Critical context necessary for making informed policy and decision-making
• **Direction & Magnitude** of changes: UP/DOWN + BIG/SMALL

In this case:
• Precision helps inform the modeling
• But policy is not informed by the precision
Drivers of change

• Today, this season, this year
  – Weather, pests, markets, conflict, migration...

• Medium term
  – Agricultural policies, trade policies, markets...

• Long term
  – Population, income, resources, climate, preferences, technology...

Shared Socioeconomic Pathways (SSPs)
Representative Concentration Pathways (RCPs)
Socioeconomic and climate drivers

Shared Socioeconomic Pathways (SSPs)

Representative Concentration Pathways (RCPs)

2030 useful for SDGs, but the challenge continues far beyond

Changes in annual precipitation (mm) and max temperature (°C) by 2030

Changes in precipitation across Africa are variable. We can see some increases in Central and Southern Africa with declines in Northern, Western, and Eastern Africa.

Temperatures across all of Africa are projected to increase by about 1 to 2 °C without much variation.

Note: Climate change scenario uses RCP 8.5 and the Hadley Climate Model.
International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)

• A partial equilibrium agriculture sector model designed to examine alternative futures for global food supply, demand, trade, prices, and food security

• Allows:
  – Fundamental, global baseline projections of agricultural commodity production and trade and malnutrition outcomes
  – Along with cutting-edge research results on quickly evolving topics such as bioenergy, climate change, changing diets and food preferences, and many other themes

Brief description here, more info at http://www.ifpri.org/program/impact-model
IFPRI’s IMPACT Model

- Linked climate, water, crop and economic models
- Estimates of production, consumption, hunger, and environmental impacts
- High level of disaggregation
  - 159 countries
  - 154 water basins
  - 60 commodities
- Links to global modeling groups through AgMIP and all 15 CGIAR centers through GFSF

Outputs:
- Yields
- Harvested Area
- Production
- Consumption
- Commodity Prices
- Trade
- Nutrition
- Land-use and Change
- GHG Emissions
- Biodiversity
- Water Quality
- Benefit-Cost Analysis
IFPRI’s IMPACT Model: Spatial Disaggregation

- Countries: 159
- Water Basins: 154
- Food Production Units: 320

Africa’s Basins:
- CAF
- CON
- EAC
- EME
- HOA
- KAL
- LCB
- LIM
- MAD
- NAC
- NLL
- NWA
- ORA
- SAC
- SAF
- SAH
- SEN
- VOT
- WAC
- ZAM
- NIG
### IFPRI’s IMPACT Model: Commodity Disaggregation

Spatially disaggregated irrigated and rainfed agricultural production by water basin

<table>
<thead>
<tr>
<th>Cattle</th>
<th>Barley</th>
<th>Bananas</th>
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<tr>
<td>Dairy</td>
<td>Maize</td>
<td>Plantains</td>
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<tr>
<td>Eggs</td>
<td>Millet</td>
<td>Sub-tropical fruits</td>
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<tr>
<td>Pigs</td>
<td>Other cereals</td>
<td>Temperate fruits</td>
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<td>Poultry</td>
<td>Rice</td>
<td>Vegetables</td>
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<td>Sheep/goat</td>
<td>Sorghum</td>
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<td>Wheat</td>
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<tr>
<td>Groundnuts</td>
<td>Cocoa</td>
<td>Beans</td>
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<tr>
<td>Other oilseeds</td>
<td>Coffee</td>
<td>Chickpeas</td>
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<td>Oil palm fruit</td>
<td>Cotton</td>
<td>Cowpeas</td>
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<td>Palm kernel</td>
<td>Tea</td>
<td>Lentils</td>
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<td>Rapeseed</td>
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<td>Other pulses</td>
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<td>Soybeans</td>
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<td>Pigeonpeas</td>
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<td>Sunflower</td>
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<td>Cassava</td>
<td>Sugarbeet</td>
<td>Others...</td>
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<td>Other tubers</td>
<td>Sugarcane</td>
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<td>Potato</td>
<td>Refined sugar</td>
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<td>Sweet potatoes</td>
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<td>Yams</td>
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SSP2 No Climate Change

Changing composition of diets

WLD = World; EAP = East Asia and Pacific; EUR = Europe; FSU = Former Soviet Union; LAC = Latin America and Caribbean; MEN = Middle East and North Africa; NAM = North America; SAS = South Asia; SSA = Sub-Saharan Africa

Source: IFPRI, IMPACT version 3.2, November 2015
SSP2 No Climate Change

Growth in total global demand

2010 = 1.0

Source: IFPRI, IMPACT version 3.2, November 2015
Maize demand composition

WLD = World; EAP = East Asia and Pacific; EUR = Europe; FSU = Former Soviet Union; LAC = Latin America and Caribbean; MEN = Middle East and North Africa; NAM = North America; SAS = South Asia; SSA = Sub-Saharan Africa

Source: IFPRI, IMPACT version 3.2, November 2015
Sorghum demand composition

WLD = World; EAP = East Asia and Pacific; EUR = Europe; FSU = Former Soviet Union; LAC = Latin America and Caribbean;
MEN = Middle East and North Africa; NAM = North America; SAS = South Asia; SSA = Sub-Saharan Africa

Source: IFPRI, IMPACT version 3.2, November 2015
Groundnut demand composition

<table>
<thead>
<tr>
<th>Country</th>
<th>2010</th>
<th>2050</th>
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<td>EUR EAP</td>
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<td>EUR</td>
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<td>SSA</td>
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Source: IFPRI, IMPACT version 3.2, November 2015

WLD = World; EAP = East Asia and Pacific; EUR = Europe; FSU = Former Soviet Union; LAC = Latin America and Caribbean; MEN = Middle East and North Africa; NAM = North America; SAS = South Asia; SSA = Sub-Saharan Africa
Growth in global cereal production

Center point shows index of change in areas and yields; size of bubbles show change in total production 2010-2050

Source: IFPRI, IMPACT version 3.2, November 2015
Growth in global production of pulses and oilseeds

Source: IFPRI, IMPACT version 3.2, November 2015
Modeling climate impacts on agriculture: biophysical and economic effects

SSP2 WITH Climate Change

Climate
- General circulation models (GCMs)
  - RCPs

Biophysical
- Global gridded crop models (GCMs)
  - Δ Temp
  - Δ Precip
  - Δ Yield (biophys)

Economic
- Global economic models
  - Δ Area
  - Δ Yield
  - Δ Cons.
  - Δ Trade

Food security, etc

Adapted from Nelson et al., Proceedings of the National Academy of Sciences (2014)
SSP2 WITH Climate Change

Maize yields example: HadGEM (RCP8.5) to DSSAT to IMPACT (SSP2)

Maximum temperature (°C)

Annual precipitation (mm)

Change in rainfed maize yields before economic adjustments

Change in rainfed maize yields after economic adjustments

Source: IFPRI, IMPACT version 3.2, November 2015
Climate change impacts on yields after economic responses

Maize

Wheat

Rice

Sorghum

Groundnut

WLD = World; EAP = East Asia and Pacific; EUR = Europe; FSU = Former Soviet Union; LAC = Latin America and Caribbean; MEN = Middle East and North Africa; NAM = North America; SAS = South Asia; SSA = Sub-Saharan Africa

Source: IFPRI, IMPACT version 3.2, November 2015
Indexed Global Prices

- Cereals - most severe global impacts of climate change on prices: 25% increase compared to NoCC in 2050; 50% higher than 2010
- Meat - relatively modest 5% impact (indirect) of CC

Source: IFPRI, IMPACT version 3.2, November 2015
Indexed Global Prices

- Fruits and vegetables, pulses, and roots and tubers: 9% to 12% increase with CC in 2050 (about 30% above 2010 levels)
- Importance of price changes depend on integration with world markets; Opportunity for exporters; Challenge for net consumers

Roots & Tubers

Pulses

Source: IFPRI, IMPACT version 3.2, November 2015
Potential for Sustainable Intensification: Alternative Scenario Specification

- Building on previous work, current project aimed at evaluating the CGIAR research portfolio; focused on CGIAR
- Intensification scenarios
  - Investments in agricultural research and development (R&D)
  - Improvement in agricultural water management
  - Changes in postharvest losses and agricultural marketing
  - A comprehensive scenario combining elements of above three
- All 15 CGIAR Centers involved through GFSF
  - AfricaRice, Bioversity, CIAT, CIFOR, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, IITA, ILRI, IRRI, IWMI, WorldFish

Embargoed

GLOBAL FUTURES & Strategic Foresight
a CGIAR initiative led by IFPRI

October 2016
### Alternative Scenario Specification

#### How much?
- Which commodities?
- Where?

#### Potential Percent Increase

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Cereals</th>
<th>Roots &amp; Tubers</th>
<th>Pulses</th>
<th>Fruits</th>
<th>Oilseeds</th>
<th>Animal Products</th>
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<td>Dairy</td>
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</tbody>
</table>
### Potential for Sustainable Intensification

#### System Level Outcomes (SLOs) align and overlap with SDGs (but not precisely the same)

#### Using indicators where the modeling is most robust

#### Tradeoffs obvious among different types of investments, the comprehensive scenario (COMP) achieves the best outcome
Conclusion

• Many opportunities to address SDGs, but it requires a more comprehensive approach that recognizes that these types of outcomes are intertwined and part of a complex system (agricultural diversity is one solid block of this mosaic)

• A key element from IFPRI’s perspective is the need for solid data and science to back up policy recommendations
  – From the quantitative modeling perspective (ie, the IMPACT model), we really need to extend our capabilities to work with disaggregated fruits and vegetables given the VERY high demand for analysis of nutrition and health outcomes
  – Cash crops are also critical production alternatives to consider with respect to their key role in household income and livelihoods
  – Gender dimension is crucial to have included in the research/extension activities from the very beginning planning stages
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