Agriculture and Climate Change
Rural Urban Linkages

Erick Fernandes, Adviser,
Agriculture & Rural Development
75% of the world’s poor are rural and most are involved in farming.

In the 21st century, agriculture remains fundamental for poverty reduction, economic growth and environmental sustainability (WDR 2008).
Agricultural productivity growth has driven poverty reduction in Asia

Headcount index and average farm yields

Rural India 1959-1994

Headcount index and average farm yields

Rural China 1980-2001
Rural-Urban Linkages: production landscapes with environmental services

World Bank, 2006
How can we meet food and fiber demands with our land and water resources?

The world’s available land and water resources can satisfy future food demands in several ways:

1) Investing to increase production in rainfed agriculture (rainfed scenario)
   - Increasing productivity in rainfed areas through enhanced management of soil moisture and supplemental irrigation where small water storage is feasible.
   - Improving soil fertility management, including the reversal of land degradation.
   - Expanding cropped areas.

2) Investing in irrigation (irrigation scenario).
   - Increasing annual irrigation water supplies by innovations in system management, developing new surface water storage facilities, and increasing groundwater withdrawals and the use of wastewater.
   - Increasing water productivity in irrigated areas and value per unit of water by integrating multiple uses—including livestock, fisheries, and domestic use—in irrigated systems.

3) Conducting agricultural trade within and between countries (trade scenario).

4) Reducing gross food demand by influencing diets, and reducing post-harvest losses, including industrial and household waste.

5) Quantifying, valuing, and equitably sharing costs and benefits of environmental services in the rural – urban production landscape.
• Many of the major “food-bowls” of the world are projected to become significantly drier
• Globally there will be more precipitation
• Higher temperatures will tend to reduce run off
• A few important areas drier (Mediterranean, southern South America, northern Brazil, west and south Africa)
Increase in frequency of extreme events likely

In 2007, one rain event left four million hectares (15,000 square miles) flooded, which affected more than 70,000 people. Several cities were flooded, including Santa Fe and Paraná, and as many as 20 were completely isolated. Damage in Paraná was estimated to be over 10 million dollars – Potential mitigation via improved design of cropping and wetland buffers coupled with distributed hydrological and spatial modeling
Much CC adaptation = good development

- Promoting growth and diversification
- Investing in research and development, education and health
- Creating markets in water and environmental services (carbon, biodiversity, hydrology)
- Improving international trade system
- Enhancing resilience to disasters and improving disaster management
- Promoting risk management and risk-sharing, including social safety nets
Projected climate change impacts on agriculture

- Reduction in crop yields and agriculture productivity
- Increased incidence of pest attacks
- Limit the availability of water
- Exacerbation of drought periods
- Reduction in soil fertility
- Lower livestock productivity and higher production cost
- Lower availability of human resource and lower labor productivity
The Rural-Urban Continuum: A Dynamic Hydrology Analysis Framework Tool
Increasing number of urban centers and population in coastal areas globally!
Dynamic Hydrology Analysis Framework
WATER FLOWS: FIELDS TO BASINS

VIC *
(Variable Infiltration Capacity)

DHSVM (Distributed Hydrology Soil Vegetation Model) (150m)
Rural Agroforests as Models for Urban Parks with predictable Carbon, Climate, Conservation outcomes??
Aboveground Biomass in 10-yr-old Agroforests

Wandelli and Fernandes 2009
## Potential for Biomass and Carbon Stocks in Urban Parks

<table>
<thead>
<tr>
<th>System</th>
<th>Biomass Mg ha(^{-1})</th>
<th>Rate Mg ha(^{-1}) yr(^{-1})</th>
<th>Carbon Mg ha(^{-1})</th>
<th>Carbon Mg ha(^{-1}) yr(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm</td>
<td>82.0</td>
<td>9.1</td>
<td>41.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Fruit</td>
<td>66.7</td>
<td>7.4</td>
<td>34.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Timber-Pasture</td>
<td>32.5</td>
<td>3.6</td>
<td>16.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Secondary Forest</td>
<td>111.9</td>
<td>12.4</td>
<td>53.8</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Source: Fernandes, 2007

*Simple Agroforests 5.0 – 9.0
*Complex Agroforests 2.0 - 4.0
*Pastures (grass areas) -0.2 - -0.6

Source: Sanchez 2000
Urban Agroforests, Vegetation & Temperature – Lessons from Rural Ag

• The effect global warming will have on our major cities, could be offset by a modest increase in the number of urban parks and street trees.
• A recent study in Manchester (UK) calculated that a mere 10% increase in the amount of green space in cities would reduce average urban surface temperatures by as much as 4°C. (Ennos et. Al. 2009)
• “Urban areas can be up to 12°C warmer than more rural surroundings due to the heat given off by buildings, roads and traffic, as well as reduced evaporative cooling, in what is commonly referred to as an ‘urban heat island’,”
• This 4°C drop in temperature, which is equivalent to the average predicted rise through global warming by the 2080s, is caused by the cooling effect of water as it evaporates into the air from leaves and vegetation through a process called transpiration.
• Green spaces collect and retain water much better than concrete, and as the water evaporates from the leaves of plants and trees the surrounding air is cooled. This process, called transpiration, is similar to the human cooling effect of perspiration.
• Green spaces could also be designed to better collect and retain excess run-off from rainstorms thereby reducing both the risk and impact of floods from extreme rainfall events.
What policy actions are needed?

1. Reform thinking about Water and Agriculture
   • First manage rain – the ultimate source of water – then address water withdrawals from rivers and groundwater.
   • Agriculture in production landscapes – integrated ecosystem-agroecosystem linkages and multiple-use concept in the context of the rural-urban linkage.

2. Improve access to agricultural water and its use.
   • Target poverty reduction with a special focus on smallholder farmers by securing water access through land and water rights and investments in water storage, soil improvement, provision of timely and reliable agrometeorological information, and delivery infrastructure where needed.
   • Support multiple-use land and water systems—operated for domestic use, crop production, aquaculture, agroforestry, and livestock to improve water productivity and reduce poverty.

3. Manage agriculture to enhance ecosystem services & optimize production-service tradeoffs
   • Good agricultural practice can yield food, fiber, fuel, and a range of ecosystem services (agrobiodiversity, carbon sequestration, water quality/quantity).
   • In most cases productivity-ecosystem service tradeoffs will need to be managed from field to watersheds and beyond. Benefits to ‘more affluent urban areas’ could be shared with rural land and water users to promote and reward desirable management practices.
What policy actions are needed?

4. **Increase the productivity of land and water.**
   - Gaining more yield and value from less land and water can reduce future demand for water, limiting environmental degradation and easing competition for water. Especially in Africa and parts of Asia, where productivity is relatively low, more food can be produced per unit of water in all types of farming systems, with livestock systems deserving attention.
   - Large potential exists in getting **more value per unit of land and water**, especially through integrated systems and higher value production systems (agroforestry, silvopasture, aquaculture) and through reductions in social and environmental costs.
   - Distributed hydrological modeling approaches, recent and emerging remote sensing platforms, and rapidly improving downscaling techniques for regional to local climate models are already guiding land and water users and policy makers globally.

5. **Re-engineer rainfed systems in close collaboration with farmers and local institutions.**
   - Improve land and water conservation, enhance rooting depth via liming and judicious fertilizer amendments, use cereal-legume rotations to improve soil structure and, where feasible, provide supplemental irrigation. **Rehabilitate all degraded lands!!**
   - Mixed crop and livestock systems hold good potential, with the increased demand for livestock products and the scope for improving the productivity of these systems.
   - Design rural land and water management specifications with an explicit integration of downstream (urban and peri-urban) factors and needs. If the urban areas are coastal, it will also be important to assess rural to coastal flows in the light of both urban demands and projected sea-level rise.

6. **Transform existing irrigation technology and apply it to higher value agriculture and integrated food, fish, fiber production systems**
   - Recent scientific breakthroughs that enable near real time field crop evapotranspiration and linking it to new high resolution remote sensing platforms will dramatically improve water use efficiency and facilitate the design of integrated cropping systems for higher yield/value per unit of water used in the next 5-10 years.
   - Improved monitoring of water use efficiency in near real time will greatly facilitate rural-urban sharing and allocation of scarce resources at appropriate scales.