An Integrated Assessment Modeling of Food Security in Nigeria

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Outline

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Food Systems and Security

- Global change processes
  - Population growth
  - Land use change
  - Climate change
  - Increasing demands on natural resources

- Food systems
  - Production to consumption
  - Inter sector, national, ...
    - Agriculture
    - Forestry
    - Socio-economic
    - Policy
    - Science
    - Culture

- The SDG 2 and others
  - Hunger
  - Malnutrition

- Food insecurity leads to other security issues
Food Security Assessment

Why do we need to monitor...?

- Governance
  - Management
  - Inform policy

- Methods
  - Inventory
  - Modeling
  - Scenarios and projections

- Gaps
  - Data
    - Availability
    - Credibility
Food Security Assessment Models

- **Model types**
  - Fragmented Vs Integrated
  - Integrated Assessment Models
  - Deterministic Models

- **General Algebraic Modeling Systems (GAMS)**
  - Partially spatially explicit
  - Supports a range of data
  - Suited for sustainability decisions
  - Flexibility to adapt to changes in indices....equations
  - Updated versions retains initial versions options

- **Agent Based Models (ABM)**
  - Systems Models
Food Security Modeling in GAMS

Assumptions are being made

- The certainty of data is assumed
- The individual person is not represented by the averaged
- What is the appropriate resolution?
  - Country Vs State high Vs Low
- Estimates from other models...errors. Example, environmental impacts of agriculture...ghg and water contamination
- With IAM we represent the decisions of producers, farmers and household consumption...people behave rationally but not the subsistence farmer
- Demand function tells us how much consumers are willing to buy at a certain price
Food Security Modeling in GAMS

- What do we want to achieve with scenarios?
  - Max total welfare or a more equal society? Farmer or society

- Weakness
  - data
  - Validation

- Calibration
  - Basic model represent initial situation

- Chaotic human behavior
  - Predict aggregated but not individual decision
  - Use model to identify certain possible and plausible development

- How do we want to use the information?
Nigeria

- Size 923,768 km²
- Geo-political and ecological zones
- Population 200 million
- Population density 221/km²
- Urban population 51.9%
- Increasing growth rate
Land use in Nigeria

- Agriculture 77.74%
- Forests 7.68%
- Others 14.45%
The Nigerian Food Systems

- Trends of change
  - Agriculture expansion
  - Deforestation
  - Development
  - Insurgencies
  - Governance

- Monitoring and evaluation
  - If we cannot measure, we cannot manage

- Value chain
  - Actors’ inclusion
    farmers, middlemen, small scale industries, government, communities, local experts, researchers, foresters, loggers, etc.

- Land systems
- Trade
- Income
- Policies
- Management
Data needs

1. Geographic data: Satellite imageries, XY coordinates
2. Climate data
3. Land use data
4. Agricultural data
5. Biodiversity data
6. Trade/market data
7. Policy data
8. Livelihood data etc.
Food Security Modeling in Nigeria

- Objective
  - Policy measures to help attain food security

- Problems
  - Data

- Approach
  - Competing claims on land resource
  - Macroeconomic, policy, production etc.
  - Multiperspectives
Nigerian Food Security Model

1. Skills: Interdisciplinary, Qualitative & Quantitative
2. Scope: Intersectorial
3. Data: Qualitative & Quantitative
4. Data sources: robust
   1. Questionnaires
   2. Focused Group Discussions
   3. Key Informant Interviews
   4. Observations
   5. Field geographic data
   6. Archived data
Data Collection in Nigeria
1st Field work in Nigeria

- Data gathering
  - Secondary data from ministries, agencies and research institutes
  - Discussions with experts
  - XY coordinates
- Understand land use issues
- Understand data, collection process and gaps as well as how to fill in gaps

- Leaflets
- Maps
- Reports
- Articles
- Published statistics

- 7 states
- 31 Organizations
- NGOs
- Research Institutes
- Ministries
- Agencies

7 states
31 Organizations
NGOs
Research Institutes
Ministries
Agencies
Findings

- Data gotten on agricultural productivity, extension services, international trade, land use, policies, population, poverty, etc. at state level and some with gaps
- Lack of data on forestry especially for non-timber forest product
- Poor process of data aggregation
- A lack of awareness of importance of data to development
- Lack of good archival system
- No monitoring or inventory of resources
- Transparency issues
- Developed good networks and source of information
2nd Field work in Nigeria

- Qualitative survey data
  - Nigerian Annual Farmers’ Meeting NW (April 16-19, 2019)
  - National Park Communities (May 2019)
  - Other Communities (May 2019)

- Archived data

Why include stakeholder perceptions? …why farmers are hungry
Data preparation process

Data inclusion in statistical Model

- Qualitative survey data
  - Numerical: binary, ranking, constraints

- Productivity data
  - Agricultural productivity and environmental impacts

- Geographic data
  - ArcGIS

- Economic data
  - Parameters, variables, constraints

- Policy data
  - Variables, constraints
Data input in GAMS Model

- Indices…time, region, crop, farmers, resources, etc.
- Parameters…crop data, resource data, trade data, etc.
- Variables…welfare var, agric target, forestry target, price var, minimum requirement var, etc.
- Equations…objective eqn, product eqn, resource eqn, ecoservice eqn, food security eqn, etc.
  - Constraints…resource, production, etc
- Models…linear programming, non linear programming, mixed integer etc.
- Scenarios
Modeling sequence

- Welfare maximization using observed values
- + agricultural and ecosystem targets
- + food security constraints
- + changes in management scenarios
- + changes in policy scenarios
Monitoring and Evaluation - Significance

1. State of natural resources
2. Informed land use decision
3. Conflict management options
4. Inform climate and food production policies
5. Forest/species conservation
6. Support SDGs implementation
Preliminary Results

1. Agricultural systems are key
2. Need for substitute crops optimal yield
3. Efficiencies of various agricultural systems…ILUS
4. Land area needed to conserve endangered mammal species
5. Climate impact of agricultural or conservation systems
Expected Results

1. Adaptation options for farmers
2. Crop mix options for optimal yield
3. Efficiencies of various agricultural systems
4. Land area needed to conserve endangered some mammals species
5. Climate impact of agriculture or conservation systems
6. The implications of agricultural and forestry targets
7. Where we are on the global targets - SDG 2 and Aichi targets
8. Where we are on the national targets – agriculture and conservation
9. Insights into opportunity and trade offs between developmental goals
10. A base model for adoption on a range of food security issues in Nigeria
Use of Base Model

Outlook

- Improve livelihoods of subsistence farmer
  - Leveraging on economy of scale of subsistence farmers: cluster analysis

- Conflict resolution options
  - Re-establishing and establishing of grazing routes and reserves in Nigeria
Questions & Discussions

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Thank you for listening
## Interactions

<table>
<thead>
<tr>
<th>What will you rather prioritize for Nigeria and what will inform your choice?</th>
<th>What would you change, policy or otherwise to keep the rural population in the rural areas?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Reduce Hunger and Poverty</td>
<td></td>
</tr>
<tr>
<td>B. Preservation of Valuable Ecosystem Services</td>
<td></td>
</tr>
<tr>
<td>C. Slow down Climate Change</td>
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<tr>
<th>Nigerian forests are varnishing what ways do you think this forests can be preserved without depriving rural livelihoods?</th>
<th>Considering data availability issues, which trade off will you make in terms of data…?</th>
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<tr>
<td></td>
<td>A. Will you cover more spatial extent and less details or</td>
</tr>
<tr>
<td>B. vice versa?</td>
<td></td>
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