Evaluation of the CGIAR Research Program *"Policies, Institutions and Markets" (PIM)*

Volume 4 –
Evaluation of PIM Global Agricultural Modeling
June 2015

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CGIAR | Independent Evaluation Arrangement

This evaluation has been commissioned by the Independent Evaluation Arrangement (IEA) of CGIAR.

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Correct citation: CGIAR-IEA (2015) Evaluation of CGIAR Research Program on Policies, Institutions and Markets. Rome, Italy: Independent Evaluation Arrangement (IEA) of CGIAR http://iea.cgiar.org/

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Abbreviations and Acronyms

AEZ	Agro-Ecological Zone
AESD	Agriculture Engineering Services Directorate (Ghana)
AEZ	Agro-Ecological Zone
AGLINK	A partial equilibrium developed and hosted by OECD
AGLINK-COSIMO	FAO Agricultural Modeling System
AGMEMOD	Agricultural Member States Modeling
AGMIP	Agricultural Model Inter-comparison and Improvement Project
AGRODEP	Different Version of the of Household Model
CAAM	Chinese Academy of Agricultural Mechanization
CAP	Common Agricultural Policy, EU
CAPMAS	Central Agency for Public Mobilization and Statistics (Egypt)
CAPRI	Common Agricultural Policy Regionalized Impact Modeling System
CARB	California Air Resource Board
CCP	Climate Change Package
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CG Centers	CGIAR Centers
CGE	Computable General Equilibrium Model
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
COMESA	Common Market of South Africa
COSIMO	A partial equilibrium developed and hosted by FAO
CRP	CGIAR Research Program
CSSP	Country Strategy Support Program (IFPRI)
DCGE	Dynamic computable general equilibrium model
DDGS	Distillers Dried Grains with Soluble
DHS	Demographic and health surveys
DSSAT	Decision Support System for Agrotechnology Transfer
EC JRC-ISPRA	Joint Research Center for the European Commission
ECOWAS	Economic Community of West African States
EPA	(U.S.) Environmental Protection Agency
ERF	Economic Research Forum (Egypt)
ESIM	European Simulation Model
EU	European Union

EU 27	EU 27 Member States
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agricultural Organization Country Level Data Base
FAPRI	Food and Agricultural Policy Research Institute
FASOM	Forest and Agricultural Sector Optimization Model
FPU	Food processing unit
GAMS	Solution option for the CGE Models
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLOBE	A global CGE based on GTAP data
GLOBIOM	IIASA's Global Biosphere Management Model
GTAP	Global Trade Analysis Project at Purdue
GTAP-E	Energy Environmental Version of GTAP
GUI	Graphical User Interface
IADB	Inter-American Development Bank
ICARDA	International Center for Agricultural Research in the Dry Areas
ICTSD	International Center for Trade and Sustainable Development
IDO	Intermediate Development Outcome
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
IIASA GAEZ	IIASA Global Agro-Ecological Zones
ILO	International Labor Organization
ILRI	International Livestock Research Institute
ILUC	Indirect Land Use Change
iMAP	integrated Modelling Platform for Agro-economic Commodity and Policy Analysis
IMPACT	IFPRI International Model for Policy Analysis of Agricultural Commodities and Trade
IMPACT-WATER	River Basins Model covering the globe, linked to IMPACT
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least developed countries
LES	Linear Expenditure System
LSMS	Living Standard Measurement Study
MAFAP	Monitoring and Analyzing Food and Agricultural Policies
MAgPIE	Model of Agricultural Production and its Impact on the Environment
MENA	Middle-East and North Africa
MIRAGE	CGE Model Resident at IFPRI
MIRAGE-BioF	Biofuels version of the MIRAGE CGE Model
MIRAGRODEP	MIRAGE Household Model
MOPIC	Ministry of Planning and International Cooperation (Yemen)

NGO	Non-governmental organization
NRA	Nominal Rate of Assistance
OECD	Organization for Economic Co-operation and Development
PE	Partial equilibrium
PEATSim	Partial Equilibrium Agricultural Trade Simulation model
PI	Principal Investigator, i.e. the researcher responsible for a project
PIM	CGIAR Research Program on “Policies, Institutions, and Markets”
PMU	PIM Management Unit
PSE	Producer Support Equivalent
R&D	Research and Development
RED	Renewable Energy Directive
SADC	South African Development Community
SAFTA	South Africa Free Trade Association
SAM	Social Accounting Matrix
SARI-CSIR	Savanna Agricultural Research Institute (Ghana)
TRQ	Tariff Rate Quota
USA	United States of America
USDA	United States Department of Agriculture
WATSIM	World Agricultural Trade Simulation Model
WFP	World Food Program
WIID	World Income Inequality Database
WTO	World Trade Organization

Executive Summary of the Evaluation of PIM Global Agricultural Modeling

This report is the volume IV of the evaluation of the CGIAR Research Program on Policies, Institutions and Markets (PIM). It focuses on global agricultural modeling carried out in PIM. It presents the findings of an expert panel that reviewed the three main modeling systems developed by IFPRI and supporting various PIM activities in Flagship 1 on "foresight modeling" and Flagship 4 on "policy and public expenditure." The report is based primarily on in-depth reviews — also found in this volume — prepared by the three panel members on the three modeling systems, as follows:

- for the IMPACT model: Wolfgang Britz, University of Bonn;
- for the MIRAGE Trade Analysis model and the MIRAGE-BioF model: Stan Johnson, National Center for Food and Agricultural Policy, USA;
- for country-level CGE modeling: Mohamed Ali Marouani, University of Paris-Sorbonne.

The three experts also conducted a portfolio analysis of 21 PIM activities in their areas of responsibility that have been supported by W1-2 funding, interviewed the principal investigators of these activities, and consulted with a number of professional peers who have knowledge or experience of these modeling systems as collaborators, partners, or users of the modeling outputs. In addition, the author of this synthesis report (and the chair of the expert panel) conducted an in-depth review of the relatively new work on monitoring agricultural price distortions in Flagship 4 — also based on a portfolio analysis of these activities, interviews with principal investigators, and consultations with professional peers.

The in-depth reviews have a particular focus on the scientific quality of the modeling systems. Each of the modeling systems has had notable successes, but also limitations for which the panelists offer constructive suggestions to address. The entire panel acknowledges the generous cooperation and information provided by the principal investigators of the various PIM activities, inputs from the professional peers, and most importantly, access to the model documentation beyond what was publicly available.

Relevance:

- The current foresight work based on the IMPACT model was initiated with funding from the Gates Foundation before PIM was established, and is now supported by PIM funding as well. While the stated intent of the intermediate development outcome (IDO) is to improve the prioritization of CG research, this has not yet been the main driver of this research.
- The MIRAGE Trade Analysis work has been responding to the need for analyses reflecting the interests of developing countries in the Doha Round of the WTO negotiations, which developing countries do not have the capacity to perform for themselves. The MIRAGE-BioF model has responded to demand from the European Union to analyze the indirect land use consequences of European biofuel policies.
- The country-level CGE modeling activities have responded to requests mostly from governments and other international organizations (IOs).

- The monitoring of agricultural price distortions activities are an initiative of PIM management at IFPRI.
- In terms of comparative advantage, there are few organizations or institutions that have a similar combination, range, and quality of modeling systems at their disposal as IFPRI, and therefore PIM. While a few places have IMPACT-type systems, a few have MIRAGE-type systems, and more have country-level CGE systems, no one else would have the scale of effort as IFPRI does under one roof. However, IFPRI has not sufficiently explored the possible synergies among its three major modeling systems, such as harmonizing the long-term drivers of change and undertaking common work on scenarios. Each would also benefit from a wider community of practice that includes clients as well as other modelers.

Quality of Science

- Scientists leading these modeling systems are of high quality, which is attested by publications, reputation, and ability to attract research funding. There are many useful research products that have been widely disseminated. However, the review has also identified gaps in technical quality that need attention. Addressing these gaps could further enhance the value of these analytical systems.
- The IMPACT modeling system is currently undergoing a major restructuring and enhancement based on an earlier (2010) review. It is laudable that this "remodeling" of the system is also intended to make it more transparent and more accessible to other users in the CG system. However, gaps include insufficient use of the rich technological information from the other CG Centers, the use of policy wedges rather than policy instruments in linking domestic and external markets, implausible commodity price outcomes that suggest greater attention is needed on commodity market interactions, and insufficient review and interaction of researchers with clients and other analysts that could identify issues prior to releasing analytical results. The IFPRI Foresight Conference in November 2014 was a good beginning for this kind of activity.
- The MIRAGE modeling system is one of few such modeling systems operating in different places around the world. The MIRAGE Trade Analysis Model is used mainly for analyzing trade agreements, both international and regional. The MIRAGE-BioF, which is used to analyze biofuel policies in the EU, has involved much collaboration to represent the effects of biofuel policies on commodity markets, land use, and greenhouse gas emissions. A recent innovation is linking the MIRAGE model to World Bank household survey data in order to generate more disaggregated and gender-related impacts from policy changes. A significant issue with these versions of the MIRAGE model has been poor documentation and lack of transparency, which has made it difficult to evaluate the models.
- The CGE models have many country-level policy applications, have built on IFPRI expertise that is widely recognized, and has led to many requests from countries and organizations for analytical support. Suggestions for improving these models include disaggregating land and labor markets, incorporating migration, greater use of micro-econometric estimations, and adding more emphasis on employment and natural resource use outcomes.
- For the agricultural price distortion activities, IFPRI serves as a neutral and credible broker among IO partners to provide more transparent and complete country coverage for standard measures of price distortions that can support policy advice and evidence-based decision making.

Collaboration among CGIAR Centers

- The entire Flagship 1 on foresight modeling is essentially one large collaborative initiative, now involving twelve Centers. PIM has clearly added value to this initiative which started in 2009 with the involvement of only five Centers. IFPRI is drawing on the specific technical expertise of the commodity Centers to improve the technological specifications of the IMPACT model on which the whole initiative is anchored, and the other Centers are gaining access to the model to generate technology scenarios relevant to their own work.
- There has been very little collaboration between IFPRI and the other Centers in Flagship 4 on policy and public expenditures, notwithstanding the important national policy and international trade issues that should be of interest to the commodity Centers. The MIRAGE activities have only had ILRI as a collaborator. The two CGE activities reviewed in-depth have only had ICARDA as a collaborator, but some other Centers have been engaged with other CGE activities.
- The price distortions work has only IOs as partners.

Gender-Specific Research

- Gender mainstreaming in PIM is benefiting from the strong reputation that IFPRI has built up over the years in addressing gender issues. However, the three modeling teams in Flagships 1 and 4 have had the least emphasis on gender, generally because they are conducting policy research at the more aggregate (national and global) levels. Nonetheless, some of these activities are finding ways to address gender issues.
- The core welfare and nutritional indicators in IMPACT are difficult to disaggregate by gender, but tools could be developed such as linkages to household data that would enhance the gender disaggregation of results.
- Linking World Bank household survey data to MIRAGE makes it possible to generate detail on gender and other household characteristics.
- The work on the Arab Spatial Platform allows highlighting systematic differences according to gender, and an agricultural mechanization study in Nigeria incorporated some gender aspects relating to tractor ownership and earnings.
- The price distortions work plans to develop measures of trade distortions that change depending on the participation of men or women in the marketing chain. This is still in the design stage.

Partnerships

- The IMPACT team is part of the highly visible AGMIP (the Agricultural Model Inter comparison and Improvement Project) in which IFPRI acts as the coordinator of the Global Economics Team. This partnership has a high potential to guide further development of IMPACT based on a systematic comparison with similar activities at the global scale, while exploiting possibilities for collaboration.
- MIRAGE has a modeling partnership mainly with CEPII, but partners with WTO, ICTSD, and EC JRC–ISPRA for specific analytical tasks.
- Partners in the Arab Spatial project have been WFP, CAPAS. IFAD, MOPIC and ERF, while partners for the Agricultural Transformation in Africa project have been ASED, SARI-CSIR, CAAM, and several CSSP countries. Ministries of Agriculture were more involved in the Africa project than in the Arab Spatial project.

Outcomes and Impacts

- The foresight activities in Flagship 1 cannot yet demonstrate many outcomes because the foresight team has been undertaking, based on an earlier review, a thorough restructuring and enhancing of the IMPACT model, which forms the anchor for this work. The direct outputs of these activities are also large data sets which need careful dissemination activities to become useful for informing policy and public expenditure decisions on agricultural research. Outcomes are also not easy to attribute since many are joint with other contributors, visible over the long term, and global or regional in scope.
- The international trade and country-level CGE modeling teams have shown more outcomes. The MIRAGE-Biofuels work has taken the lead in understanding the trade-offs between renewable fuels, indirect land use changes, and greenhouse gas emissions and has produced a renewable fuels baseline for the European Union that is informing the debate on its biofuels policy.
- The country-level CGE modeling teams have made many contributions to improving national agricultural policy formation in a number of African countries in the context of the African Union's Comprehensive Africa Agricultural Development Program. Impacts have been apparent, as these activities have been primarily demand-driven. The most notable impact has been in Tanzania, where the analysis of reinstituting a maize export ban helped to persuade the government not to do so.

Capacity Strengthening and Sustainability

- The IMPACT team has one of the strongest training activities in PIM. These are conducted at different Centers and with different trainee groups, including some from outside the Centers. This is part of the increased effort to make IMPACT more transparent and more accessible to other users. The IMPACT model could benefit from more commodity expertise that would focus on commodity market interactions and prevent baseline outcomes from generating implausible results.
- There is little training in relation to the MIRAGE modeling system, which is likely related to the lack of adequate documentation on the modeling system. Sustainability of this system would be enhanced if resources were available for adequate documentation and training for a wider range of users. Synergies between MIRAGE and IMPACT could also be explored as a way to further enhance IFPRI's leadership in food and agricultural modeling expertise.
- There is quite a bit of capacity strengthening work in connection with the country-level CGE activities. In the Arab Spatial project, closer links need to be developed with local academics to ensure sustainability.

Organizational Performance

- The majority of principal investigators interviewed in Flagship 1 had a positive experience with the PIM Management Unit, though some face the challenge of reporting the same activities to different sponsors.
- The MIRAGE team indicated that they were satisfied with the PIM organization, while suggesting that improvements could be made in terms of reporting mechanisms and better articulating the objectives of PIM.
- The apparent gap between the MIRAGE and the IMPACT multi-market modelers in IFPRI presents the issue of the appropriate division of responsibilities between the MIRAGE and IMPACT modeling teams.

- The CGE team feels that PIM provides more flexibility than bilateral donors. PIM allowed financing of a workshop in China to which IFPRI brought practitioners from Africa to learn from the Asian experience. Team members also noted the high transactions costs associated with PIM funding.

Conclusions

- Although the review found little evidence that the foresight activities in Flagship 1 are being used by the CGIAR system to set priorities as envisioned in the IDO, the IMPACT analysis system has been used for many types of analyses for many partners and clients in many venues and is widely published. There is no similar long-term analytical system that is so widely used. During this review, IMPACT3 has been in the process of a complete overhaul, so that some of the improvements suggested by this review are already underway and others are planned. This restructuring also includes more training and increased accessibility to other Centers as well as partners. Nonetheless, there are gaps that remain to be addressed in the technical aspects of the modeling system as well as in the effectiveness of its use. Addressing these gaps should improve the efficacy of the system.
- The MIRAGE analytical system, for which two model activities were reviewed for this report, has been used appropriately for policy analysis in regional and global contexts. It has been highly regarded and very effective in policy analysis and policy advice, but it is poorly documented and not accessible to many users. A major strength of the model lies in the recent linkage to household survey data to derive more disaggregated impacts of the policy analyses. The major issues with the system are inadequate documentation and lack of transparency.
- The CGE models reviewed have been used for policy analyses in several MENA countries at the request of national governments, WFP, and ICARDA following the food price increases of 2007–2008, and in several African countries mostly in response to requests from national governments. The types of policy analysis conducted has varied in response to the specific requests, but all used some form of the standard CGE model framework for which IFPRI is famous. The efforts provide analytical support that is not usually available in the countries themselves.
- The price distortions work was initiated by IFPRI in response to a need that was identified by PIM leadership and confirmed by OECD, FAO, World Bank, and IADB, who are the key partners. The collaborating IOs each fund their own work and have a representative on the guidance board. The PIM role is to be an “honest broker” to provide a website home for all of the measures, translate each of them, explain the differences, and generally increase accessibility and transparency of the efforts. The impact pathway is via the policy advice work being done by IOs as well as IFPRI itself. Improved analysis and transparency of price distortion measures supports evidence-based decision making.

Recommendations

- The leaders of the three modeling teams should explore possible synergies in their work and broaden their communities of practice to engage their clients and other modelers in reviews of model analysis.
- PIM should explore the extent to which other Centers or CRPs have unmet needs for trade analysis that PIM could provide through different types of collaboration. PIM should also seek opportunities for other Centers or CRPs to benefit from PIM’s trade analysis work either by taking on tailored scenarios or by providing tailored reports of common analyses.

- The three modeling teams should increase their level of attention to gender issues by building upon the innovative ways in which some of their activities are addressing gender, by links with other modeling approaches, and by greater sharing of existing methodologies and data among Centers and flagships.
- Each of the three reviewers has provided more detailed recommendations and suggestions for model enhancements in the individual reports that follow. Each reviewer has tried to take a fresh look at each modeling system to identify those enhancements which may have the greatest payoff in terms of PIM objectives and impact pathways, since even the best modeling systems have limitations.
- Each of the reviewers also identified the need for sufficient human and financial resources for documentation, maintenance, and model enhancement.

1. Synthesis Report on Global Agricultural Modeling – by William H. Meyers

1.1 Introduction

This synthesis report of the expert panel on global agricultural modeling is based primarily on the in-depth reports prepared by three panel members on three major modeling systems developed by IFPRI and supporting various PIM activities in Flagship 1 on "foresight modeling" and Flagship 4 on "policy and public expenditure." The three experts also conducted a portfolio analysis of 21 PIM activities in their areas of responsibility that have been supported by W1-2 funding (Annex A), interviewed the principal investigators (PIs), and consulted with a number of professional peers (Annex B) who have knowledge or experience of these modeling systems as collaborators, partners or users of the modeling outputs. The three experts were:

- For the IMPACT model: Wolfgang Britz, University of Bonn;
- For the MIRAGE Trade Analysis model and the MIRAGE-BioF model: Stan Johnson, National Center for Food and Agricultural Policy, USA
- For country-level CGE modeling: Mohamed Ali Marouani, University of Paris-Sorbonne.

Their in-depth reports are also found in this volume — one report each on the IMPACT and CGE modeling systems, and two separate reports on the MIRAGE Trade Analysis Model and the MIRAGE BioFuels Model. These are thorough and constructive reviews that have a particular focus on the scientific quality of the modeling systems, that point out both achievements and limitations of the models, and that suggest remedies for addressing the latter. In addition to these reviews, the author of this synthesis report (and the chair of the expert panel) conducted an in-depth analysis of the relatively new work on monitoring agricultural price distortions in Flagship 4 — also based on a portfolio analysis of these activities, interviews with the principal investigators, and consultations with professional peers.

This synthesis report is organized by sections that correspond closely to the chapters in the overall evaluation report of the PIM program. Each section covers in sequence the findings with respect to the IMPACT model, the MIRAGE models, country-level CGE modeling, and the new work on monitoring agricultural price distortions.

Neither this synthesis report nor the in-depth reviews on which it is based would have been possible without the generous cooperation and information provided by the PIs of the various PIM activities, input from the professional peers, and most importantly, access to information about the models such as the model documentation that was sometimes beyond publicly available documents. The panel members are well aware that each of these modeling systems is frequently being revised, so it could also be the case that some of the suggestions made have already been addressed by changes underway during this review or already planned to be implemented later. In particular, IMPACT3 is in the process of replacing IMPACT2, so that the documentation available to our expert was that for IMPACT2 and parts of IMPACT3, which may not completely reflect the latest changes still taking place in this revision. The in-depth reports also focus on selected PIM activities being supported by these three modeling systems, and not the sum total of all the activities being supported by each of these models.

1.2 Relevance of Objectives and Design

This section addresses the extent to which the three modeling systems are supporting research activities that are responding to global, regional, and country development challenges. Therefore, it is concerned with the relevance of the objectives and the design of the activities, the plausibility of their impacts pathways for achieving their objectives, the demand for the activities, and the comparative advantage of IFPRI and PIM to conduct this research.

Selected Global Futures and Strategic Foresight Activities Based on the IMPACT Model

Supply-Side Relevance and Design

The stated intermediate development outcome (IDO) for Flagship 1 is "improved prioritization of the global agricultural research effort for developing countries," which suggests it is mostly driven by demand from within the CGIAR system. However, the tools created to pursue this objective have broader applications, and the benefits are likely to be felt by other users of the analytical system outside the CG system. One group is the AGMIP consortium where IFPRI is coordinating a network of other modelers from four different research groups in the U.S. and Europe.

The impact pathway works through contributing to the decision processes of donors and research organization using the analysis, to decisions on research priorities, through individual Centers to reach national partners, and ultimately to the outcomes realized when the prioritized research is completed and the resulting new technology is adopted. This pathway is long and difficult to trace objectively, especially when it comes to attribution, but is also rather standard for foresight modeling activities that support policy processes. Evidence-based decision making requires some means to obtain quantitative evidence, say, on coming problems (such as climate change) or alternative choices of technology or research (such as crop or livestock genetics).

What is different about the foresight work in Flagship 1 is that the (possible) decision takers have not directly commissioned the quantitative analysis, as is usually the case for ex-post and ex-ante policy impact assessments. This can be a comparative strength, making it possible to respond to new requests in a timely fashion, as in the case of the World Bank-led multi-agency report on the future of African drylands. Still, achieving the activities' objectives would likely benefit from a stronger focus on outreach and actively marketing their outputs. The newer activities in this flagship seem to be putting more emphasis on this by trying to actively involve regional partners in research and to reach regional decision makers. Also, the foresight conference in Washington in November 2014 might be seen as a step in that direction.

A large part of the effort currently taking place in this flagship is on improving the modeling tools and building the community of practice that can better utilize them to realize the impact pathways. Since this enhancement process is still ongoing (building IMPACT version 3), the present assessment of legacy outputs can be seen as contributing to this effort.

Demand-Side Relevance

This project originated with a Gates Foundation grant that started the Global Futures and Strategic Foresight program basically for the same goals laid out in PIM. Incorporating this into PIM has served to achieve greater participation of most other CG Centers and the CG System in this effort. So the initial Gates grant, now supplemented by W1-2 funding from PIM, can be seen as an external initiative that gained endorsement and sustainability by its incorporation into PIM.

Comparative Advantage

There are few PE models with a structure similar to IMPACT with a focus on the long term. There was the long-term version of WATSIM (von Lampe 1999, no longer in use) and the @2030 model (Britz and Schmidhuber 2002) developed for the Global Perspective Unit at FAO, by now also abandoned. However, both GLOBIOM and CAPRI are also regularly used for long-term analysis, similar to IMPACT which is also used for short to long-term analysis. Although FAO has struggled to develop and maintain a quantitative system to digitize its Global Perspectives analysis that was long conducted by Nikos Alexandratos and Jella Bruinsma, those efforts still continue but have not yet reached a sustainable path. This analysis suggests there are not likely to be easy alternatives to IMPACT, but IFPRI could improve its credibility by having a stronger community of practice with others doing similar work who may have made advances of use to IFPRI modelers. The in-depth report included in this volume also suggests ways to make the modeling work more broadly applicable to CG Center needs.

MIRAGE Trade Analysis and BioFuels Models

Supply-Side Relevance and Design

The objectives and design of the MIRAGE Trade Analysis Model have been geared toward emphasizing the trade policies of both developing and developed countries, and their implications for markets for food products around the world. The applications and development of the MIRAGE Trade Analysis Model have, in fact, been the primary modeling efforts responsible for analyses reflecting the interests of the developing countries in the Doha Round of the WTO negotiations and in other trade-related contexts as well.

Many developing countries simply do not have the capacity to perform these trade policy analyses for themselves. IFPRI, as the CG center focusing on the trade policy interests of developing countries, has been providing the analyses addressing their interests in the WTO Doha Round of negotiations and also in regional trade policy negotiations.

The MIRAGE-BioF Model evolved for a specific purpose, to address the EU renewable fuels directives. It has several special features related to the objectives of the task at hand. There are modeling aspects to meet these objectives and importantly, data assembly, and preparation tasks. The latter were not so well noted by the authors of the report summarizing the model and follow-on publications on the two projects (perhaps due to their modesty), but are important relative to the decisions that the Member States will make about biofuels, and likely will be used continuously in raw or processed form to support decisions by the Member States.

The impact pathways for these activities lie in the broader international realm compared with country-level CGE work. The MIRAGE analyses are at the international level and deal with policies that have a wide potential impact on markets and national economies.

Demand-Side Relevance

In addition to reflecting the interests of developing countries in the Doha Round of the WTO trade negotiations, the MIRAGE Trade Analysis Model has been used to analyze regional trade opportunities in sub-Saharan Africa (Laborde et al. 2014) and in South America (Bouët et al. 2012). Robichaud et al. (2014) also provide a version of the MIRAGE Trade Analysis Model which focuses on the disaggregation of the government sector for improved analysis of policy modeling. Thus, the MIRAGE Trade Analysis Model is getting significant use at IFPRI, and is well specified to address issues raised by sets of countries that are pursuing trade liberalization and common markets.

The MIRAGE-BioF analysis was contracted to IFPRI by the EU for analyzing EU biofuels policy. However, it also has relevance for IFPRI's developing country constituents because of the impacts of EU biofuel polices on global markets and on land use both inside and outside the EU. EU biofuel certification policy, in fact, tries to prevent effects on land use change that would be detrimental to developing country agriculture.

Comparative Advantage

For its trade policy work, IFPRI has acquired and is supporting one of the top groups of CGE modelers globally. There are, in fact, only about five modeling groups that have the capacities of the CGE modelers at IFPRI. This is especially true when we understand that the MIRAGE-BioF Model has now been fully incorporated into the MIRAGE Trade Analysis Model and related modeling activities. This inclusion of the MIRAGE BioF Model into the MIRAGE Trade Analysis system will add to the capabilities for understanding the renewable fuels movement in the EU and globally, and other policies not yet defined.

That is, there will be much to do on biofuels modeling and applications of the MIRAGE Trade Analysis Model to issues of trade, rural development, and food security. These issues are likely to continue to be a high priority for the CG Centers and will receive significant attention by domestic and international policy makers. The modeling effort that is underway on integrating the World Bank household surveys to assess gender and other food policy issues is telling in terms of the potential for the MIRAGE modeling activities and for synergies with the multi-market modeling exercises or IMPACT.

Country-Level CGE Modeling – Activities 37 and 38

Supply-Side Relevance and Design

Both of the activities analyzed fall under the narrow version of the flagship IDO which is "improved sectoral policy and better public spending for agriculture in agriculturally-dependent developing countries."

The MENA activity has three main objectives: (a) initiating a web-based knowledge platform for improving access to information and transparency; (b) identifying policies for overcoming poverty

and the triple burden of malnutrition in the Arab world; and (c) designing methodologies to assess the macro- and microeconomic dimensions of poverty, food security and malnutrition.

The Africa activity can be subdivided in two items: (a) the new mechanization activity involving in-depth country case studies in selected African countries and learning from the most recent experience of private-sector led mechanization in smallholder dominant Chinese agriculture; and (b) a more classical public policy analysis activity dealing with the export ban in Tanzania, growth options assessment in Rwanda and policy options for the domestic rice economy in Nigeria.

The impact pathways for both of these efforts are to provide credible analysis and information to decision makers so that policies can be improved. The expert panel report focused on the quantitative work with CGE models but the activities also involve several methodologies which engage the CGE model.

Demand-Side Relevance

The MENA projects originated from Governments, WFP, and ICARDA requests. They are very relevant and timely for the region for various reasons.

First, the food price increases of 2007–2008 were a heavy burden for governments that subsidized food in the region but also for households when increases in the subsidy did not fully cover the price increases. At the same time this hike was an opportunity for farmers and for the countries to increase agricultural production if appropriate policies were implemented to accompany the higher price incentives. Thus analytical work on this subject is definitely needed in the MENA region to foster evidence-based discussions and accompany policy reform.

The second reason is the lack of data and the difficulty of accessing data not only for researchers but also for policy makers. In many Arab countries, government departments have trouble getting data from other departments, mainly from the department of statistics. Thus, putting data openness at the heart of the project is clearly a public good (at the national, regional and global levels).

Finally, working on poverty issues in a region characterized by revolutions and conflicts is extremely relevant because it will be more difficult for governments in the future to achieve stability without a significant improvement in livelihoods.

The Africa projects were mainly requested by national governments. The mechanization component seems the most promising in terms of strategic research, given the unavailability of recent evidence-based research on the subject in Africa. The Tanzania study is often cited as a good example in terms of impact, because it contributed to the Government's decision not to reinstitute the maize export ban, which it had been reconsidering.

The different components of the activity seem very relevant given the needs of the region to increase agricultural production and productivity. However, with the exception of the Tanzania study, which was at the heart of the policy debate in that country, it is difficult to determine ex ante if the other components (mainly, the mechanization studies) should have risen to the top of the policy research agenda.

Comparative Advantage

Both projects build on CGE expertise in which IFPRI has been a leader for decades, leveraging this expertise with local and collaborating agencies. The nature of the research in the Arab Spatial project is more applied, while that in the mechanization activity is more strategic.

The professional peers consulted gave very positive assessments of these activities. Given the weak analytical capacities of developing countries in designing and evaluating agricultural policies, the contribution of IFPRI is valuable. There is no other organization that can match the scope and quality of IFPRI's work in this sphere.

Monitoring Agricultural Price Distortions – Activities 118 and 119

Supply-Side Relevance and Design

This initiative by PIM aims to bring together the various international organizations (IOs) that produce measures of trade policy distortion and form a collaborative effort that serves:

(a) To consolidate a global database facilitating the access to existing data, and the associated metadata, to improve transparency,

(b) To develop inter-IO collaboration to increase the country coverage and limit overlaps,

(c) To organize trainings to promote good practices and to improve the knowledge and know-how of consultants and civil servants in developing countries that may join these monitoring efforts, and

(d) To use the agricultural policy measurements collected to feed an analytical database and perform policy analysis using quantitative models.

The collaborating IOs each fund their own work and have a representative on the guidance board. There are also come senior experts, such as Tim Josling and Alberto Valdes, serving as advisors for the effort and also providing guidance to the work in Latin America and South Asia, respectively. PIM's role is to provide a website home for all of the measures, translate each of them, explain the differences and generally increase accessibility and transparency of the efforts. There will also be a training component, but that is mostly coming later.

The impact pathway is via the policy advice work being done by IOs as well as IFPRI/PIM itself. Improved analysis and transparency of distortion measures supports evidence-based decision making.

Demand-Side Relevance

Laborde as well as other experts familiar with the activity said this project was initiated by the PIM Director, who continues to play an active role in its guidance. The measurement of trade distortions has a long history, the most recent chapter being the Distortions to Agricultural Incentives study (Anderson 2009) led by Kym Anderson at the World Bank and engaging many teams and covering more countries and more years than any previous effort of this kind. However, that World Bank project came to an end and the related work that was continuing at OECD, FAO, and IADB was serving a similar purpose, but was also sometimes leading to different methods of measurement and

conflicting policy signals. PIM has responded to an identified need to facilitate a dialogue that aims to clarify and explain the different measures, not to impose common methods on organizations using them for somewhat different purposes.

Comparative Advantage

There really is no one organization that is in a better position to be the credible translator and mediator and provide access and transparency for these measures. IFPRI/PIM serves as an honest and credible broker of this information and as a mediator of possible differences among partners regarding measurement of trade distortions.

1.3 Quality of Science

This section addresses the scientific quality of the research being produced by the three modeling teams. Therefore, it is concerned with (a) the inputs to science quality, including researcher quality and quality assurance processes, (b) the designs of the modeling systems, and (c) the quality of the research outputs.

Global Futures and Strategic Foresight Activities Based on IMPACT

Scientists leading these activities are of high quality which is attested by publications and reputation, and the research facilities are fine. The internal processes to reward excellence in terms of publications and performance seems adequate to provide scientific credibility to the research outputs. There is also periodic comparison of outputs with other similar models through the AGMIP process as well as with an annual consultation of PE modelers, in which IFPRI usually participates. But we have found gaps in the technical quality that need attention. We suggest increased attention to livestock and dairy modeling systems, some economic parameters, shifting from policy indicators such as NRAs to policy instruments, more realistic price transmission relationships, documentation, and more consultation on the baseline with comparator experts and clients.

We recognize that IMPACT is still undergoing major restructuring and enhancement based on an earlier (2010) review by Channing and Robertson, so some of the present suggestions may to some extent be based on analyses that were done before some of these changes occurred.

We also suggest ways to improve “client reliability” in addition to “scientific reliability.” This distinction was highlighted by Britz and Heckelei in a 2013 conference presentation called “Modeling tools for policy analysis: dimensions of reliability.” What satisfies the journal editors is not always sufficient to serve the clients, which in this case are the CG System itself, policy makers, and other decision makers in national and international organizations. More frequent and meaningful interaction with clients is very helpful in our experience. One way to think of this is that the community of practice needs to include the clients and not only other modelers. The first Foresight Conference held in November 2014 was a first step in that direction.

The declared aim of Flagship 1 activities is to provide inputs to the long-term strategy of the overall CGIAR research program. At the current stage, it is impossible to evaluate if these aims will be achieved, as the output is not yet funneled into a new decision taking structure across CGIAR Centers. In fact, it is not clear who in the CG governance and management or guidance system is seeking this analysis. The IDO refers to “improved prioritization of the global agricultural research

effort for developing countries" and the impact pathway that was foreseen depends crucially upon uptake of this foresight analysis by the Consortium Office, the Fund Council, the Directors General, research partners, and the CRP Directors. We found little evidence that this pathway is so far operating as anticipated.

The activities themselves are to a large extent legacy ones which often existed already in a similar format before the establishment of PIM. A clear added value of the activities is to incorporate information from the different Centers in a coherent and structured way. At the same time, the Centers gain access to IMPACT as a tool which can be applied to assess possible impacts of their own research activities, though most CG Centers cannot operate IMPACT on their own.

Professional peers and some PIs noted the somewhat insufficient link between the quantitative modeling exercises with IMPACT and the richness of technology information available at different CGIAR Centers. Essentially, all the valuable information sampled by CGIAR Centers in the context of these projects is condensed into a simple shift of the supply curve in IMPACT, which implies an equivalent reduction in marginal costs. That is a rather simplistic and probably not well fitting description of how technological progress and adoption in crop production impacts economic, social, and environmental indicators of relevance. The team should hence carefully consider if some intermediate layers of analysis between the detailed technological information at the single crop level and the global modeling could provide crucial scientific evidence and increase the value of these projects especially for the other involved CGIAR Centers.

The majority of the professional peers consulted for this review also raised concerns that some published or commissioned applications of IMPACT might have gone beyond the scientifically sound application domain of IMPACT. These peers seem to be mostly concerned about the application of a comparative-static model with limited policy coverage to more short to medium term issues in agricultural markets, but also mentioned, e.g., simulated developments in commodity prices which they considered implausible. The IMPACT modeling team has clearly responded to the potential shortcomings underlying these comments by a serious investment in refactoring the model code and concept in the last years.

MIRAGE Trade Analysis and BioFuels Models

MIRAGE is one of the global CGE models in the world that include the GTAP network based at Purdue University and the MONASH model at the Centre of Policy Studies in Melbourne, Australia. MIRAGE is based primarily in France and at IFPRI.

The official documentation of the MIRAGE Trade Model, albeit rather limited, is provided in two papers, Decreux and Valin (2007) and Robichaud et al. (2014). The first publication provides the basic documentation of the model. The second publication also had an objective of developing the computer programming of MIRAGRODEP (related to the MIRAGE Trade Model) in GAMS. Both versions are highly condensed and require considerable study to understand even the basics. Perhaps this is because the MIRAGE Trade Analysis Model is a standard multi-country trade model of the type now familiar, and identified with the early work of Hertel and colleagues at Purdue University (Hertel et al. 2007). Still, given the various specializations of the MIRAGE Trade Analysis Model, additional documentation would be beneficial.

The MIRAGE-BioF model is a very large and complex variant of the MIRAGE modeling system developed for the EU project. It utilizes data from several sources for calibration, and sets the modeling system up to be "dynamically recursive" (Laborde and Valin, 2012, P. Al-Raffai et al., 2010a, and Laborde, 2011). Good general descriptions of the modeling framework and the various inputs to the process of developing the MIRAGE-BioF model are contained in Laborde (2011) and Valin et al. (2013). Production of the MIRAGE-BioF Model in fact required broad collaboration with CGE modelers and with other specialists in agricultural modeling, studying biofuels and emissions in production, such as GTAP, AGLINK-COSIMO, OECD, CAPRI PE, FAPRI, IMPACT, EPA, several scientific groups like those at CARB, IIASA, CAPII, GAEZ, IPCC, and others not specifically mentioned.

So IFPRI/PIM maintains a family of MIRAGE models specialized for different purposes. Two were analyzed in-depth in this review, but there are also others used in other activities. The most recent innovation has been linking MIRAGE-Household model to World Bank household data in order to generate more disaggregated impacts from policy analyses. Mainly due to this linkage with disaggregated household and other data, this was seen to be the most "state of art" among the PIM-supported models.

This review concludes that the lack of sufficient documentation has limited the ability to assess the MIRAGE modeling system and has also reduced transparency of the analyses conducted with these models. Increasing linkages with other participating Centers and increasing interactions across modeling families within IFPRI would generate beneficial synergies of models within IFPRI that have yet to be exploited.

Country-Level CGE Modeling – Activities 37 and 38

The development and application of country SAMs and CGE models have been one of the main stalwarts of IFPRI's analytical and policy work for a long time. Because of this successful record of work, IFPRI's work in this area is very demand-driven and highly sought. The quality of the leadership and staff is demonstrated by the quality and quantity of research outputs. Some technical issues on modeling of land and labor markets have been identified in this review that could enrich the analysis and applicability, such as disaggregating land and labor markets.

However, the review has raised a few points that could improve the effectiveness and relevance of the modeling work done. First, the team could more systematically include in its general equilibrium exercises the results of micro-econometric estimations obtained in some other projects. This would give more confidence in the results obtained.

Second, the team focuses mainly on growth, poverty and nutrition in some cases. Adding employment and natural resource availability as outcome variables would give more information for policy makers about the trade-offs. This is particularly important in the Middle East and North Africa region where unemployment (particularly for the youth) is the main challenge today and water scarcity probably the most important challenge of the next decades. The labor market block of the IFPRI DCGE model should be upgraded to include some of the elements proposed in this report, including a migration block, which would be very relevant in some countries.

Third, the projects seem to be much more effective in countries where CSSPs exist. Given that many other countries need support for reforming their agricultural policies, IFPRI could develop partnerships with regional research organizations to allow a better diffusion of its outputs.

Monitoring Agricultural Price Distortions – Activities 118 and 119

IFPRI/PIM serves as a neutral and credible broker of this collaboration process and in some sense a negotiator among partners and a translator to the outside world. The project is implemented by the best and most experienced experts available from the participating organizations and in some cases by well-known external experts of these distortions measures. There is also a guidance committee of experts.

This will be a clear public good when consistency, accessibility and transparency of these measures are achieved and the data are widely disseminated. However, the principal investigator feels that main progress so far has been the building trust among the partners.

1.4 Opportunities for and Implications of Collaboration among CGIAR Centers

This section addresses the extent to which PIM is creating opportunities for researchers to engage in relevant and effective collaborations among CGIAR Centers. It investigates what the modeling teams have so far achieved in terms of Center collaboration, and what such collaboration has so far accomplished.

Global Futures and Strategic Foresight Activities Based on IMPACT

The entire flagship has been essentially one large collaborative initiative, now involving twelve Centers (CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, IITA, ILRI, IRRI, IWMI, and Worldfish) and supported by the Gates Foundation, PIM, and CCAFS. PIM has clearly contributed to the expansion of this initiative which started in 2009 with the involvement of only five Centers.

The initiative consists of a series of projects, each led by a different Center, with support from IFPRI. The anchor of the initiative is the International Model for Policy Analysis of Agricultural Commodities and Trade, or IMPACT model, developed at IFPRI over several decades. The reasons for and the benefits of the collaboration are mutual. IFPRI is drawing on the specific technical expertise of the commodity Centers and links with crop modelers (e.g. DSSAT) to improve the technological specifications of the model, and the other Centers are gaining access to the model to generate technology scenarios relevant to their own work.

The principal investigators at the other Centers generally regard contributing to the foresight activities and gaining access to IMPACT as a highly valued and relevant activity. The other Centers have less socio-economic expertise than IFPRI, and for those working at these Centers, the activities around IMPACT have offered an opportunity to liaise across Centers with colleagues working on similar issues, however, with a different product and regional focus.

Collaborating CRPs also include Dryland Cereals, Dryland Systems, Grain Legumes, Livestock and Fish, Maize, RTB, Wheat, and WLE. Most of these were represented at the recent Foresight Conference held at IFPRI in November 2014 where several CRP Directors joined the PIM Director to discuss different ways in which they could use IMPACT model analysis. Some were more interested in impact analysis and others in foresight projections.

There is, however, some danger in a purely IMPACT-centric approach to collaborative foresight work because this contributes to an information flow that is quite narrow. One tool does not necessarily address every need. Important aspects such as introducing new technologies either show up at a resolution not covered by IMPACT, such as household types, villages or sub-regions inside countries, or relate to effects not covered by IMPACT, such as the work distribution inside the household or village. Given the positive experiences of using a tool such as IMPACT to foster collaboration, IFPRI might consider extending its toolbox to socio-economic simulation models operating at different scales and with more technological detail.

MIRAGE Trade Analysis and BioFuels Models

The global trade modeling team at IFPRI is collaborating mainly with other international organizations such as FAO, OECD, the Inter-American Development Bank, and the World Bank. ILRI has expressed some interest in collaborating with IFPRI's trade team and has outposted an ILRI staff member to IFPRI who is working with the IFPRI team, notwithstanding the technical issues involved. Most of the work of with the MIRAGE Trade Analysis Model has been for crops. Livestock represents a different set of modeling problems, since livestock cannot be effectively modeled in an annual timeframe. Poultry have a growth cycle that is shorter than the annual timeframe for crops, while cattle have a growth cycle that is longer.

Country-Level CGE Modeling – Activities 37 and 38

There has been very little inter-Center collaboration in these activities. Activity #37 had some collaboration with ICARDA, who requested support from IFPRI to analyze agricultural growth under different scenarios for their project in Iraq. Other projects in the MENA regions originated from requests from the Governments of Yemen and Egypt, the WFP, and the World Bank. In the Africa project, the requests came from national governments or local IFPRI offices.

Monitoring Agricultural Price Distortions – Activities 118 and 119

There are no CG Center partners in this activity. It is purely a collaboration of IFPRI with International Organizations, which are FAO, OECD, InterAmerican Development Bank, and World Bank. At the last group meeting in June 2014 they agreed to this official name for the group the "IO Consortium for Measuring the Policy Environment for Agriculture." The website being developed by IFPRI is http://www.ag-incentives.org , but the data portion is not yet open to the public.

Professional peers suggested several reasons for the general lack of inter-Center collaboration in economy-wide economic policies, international trade, and price distortions: (a) the commodity Centers and/or their economists have lacked the interest in these issues; (b) they are interested in these issues, but their economists are insufficiently trained in the type of modeling work being conducted by the IFPRI teams; and (c) IFPRI has failed to reach out to them. There are clearly national policy and international trade issues that should be of interest to the commodity Centers in encouraging the development of their mandated commodities, and there has been some such work in the past, such as at AfricaRice on the rice trade. The review recommends that a greater effort should be made to bring about more inter-Center collaboration in international trade, while also recognizing that this may require some in-depth training of existing staff, or different hiring practices by the commodity Centers.

1.5 Gender-Specific Research

PIM has adopted an explicit gender strategy that was approved by the CGIAR Consortium in March 2013 and has established gender-specific IDOs for each of its flagships. Therefore, this section addresses the extent to which the three modeling systems are mainstreaming gender issues in their activities.

Global Futures and Strategic Foresight Activities Based on IMPACT

Several of the PIM-supported activities aim at collecting and integrating gender-related data and parameters in the modeling activities. However, the core welfare and nutritional indicators in IMPACT are difficult to disaggregate by gender. Other core aspects of gender in the context of evolving agricultural management and food chain practices (male and female labor use, move from household to industrial production, and impacts on labor markets or the marketing chain) are not reflected in IMPACT. However, the researchers in the participating Centers often have access to data, for example, with regard to labor use at the household level in specific crop management practices, so that the impact of changes in management on household labor use could be evaluated.

The review therefore suggests searching for tools that could be applied in parallel with IMPACT in projects linked to global foresight and that could bridge the scale between individual crop management simulation in DSSAT and global modeling in IMPACT. Such tools could, for example, be simulation models at the village or regional level, but also simple approaches such as the calculation of crop budgets including labor use estimates.

MIRAGE Trade Analysis and BioFuels Models

Gender is not a major issue addressed in most of the MIRAGE-based models, since most of the research is about national and international policy and how it can be improved to better reflect the interests of developing nations. However, the breakdown of the households in the MIRAGE Household Model using the World Bank household survey data is potentially a major activity related to gender issues. By selecting households that are identified with gender in the workforce, and following through on related policies, the model is aiming to address gender issues directly. For example, what liberalization policies could be pursued first to give sectors identified with gender a fairer share of the national benefits? The fact that these policies can be traced through the national system as represented by the MIRAGE Household Model, and even traced internationally, could give a enhanced perspective on gender issues, and provide an alternative route for attracting greater attention to this set of issues.

Those involved in the development and application of the MIRAGE-BioF Model are also now working on utilizing the World Bank household surveys to conduct significant gender modeling activities.

Country-Level CGE Modeling – Activities 37 and 38

Some of these activities are finding ways of addressing gender issues, notwithstanding the difficulty of doing so at the national policy level. The work on the Arab Spatial Platform allows highlighting the systematic differences according to gender (women's literacy rates, education levels, etc.). The principal investigators have also paid attention to ensure a gender balance in the two training

workshops, particularly in the training with CAPMAS in Egypt, where they had 10 female and 4 male participants.

The agricultural transformation activity #38 in Africa has addressed gender issues by analyzing technology adoption of different farm activities according to whether the head of the household was a man or a woman — finding that female-headed households were less likely to use tractors or draft animals in Nigeria. A tractor owner-operators' survey in Nigeria also found that tractor ownership was male-dominated, and its earnings rarely shared with spouses. Perceived reasons behind such male-dominance were mixed; some viewed it as reflection of cultural norms, while others regarded females as having comparative advantages in activities other than tractor ownership.

Monitoring Agricultural Price Distortions – Activities 118 and 119

Different ways are being tested for reflecting gender differences in the distortion measures, for example, at the country level to weight distortions by the gender of who has decision making authority. If women have major decision responsibility for animals and men for crops, then a distortion that negatively affects animal price or market access would impact women more. That element of the distortion could be given a heavier weight in such a targeted measure. Likewise in value chain analysis, transport cost may be higher for women then for men, so it effects the marketing margins and again can be weighted more heavily. This is clearly quite subjective, but it is feasible.

1.6 Partnerships and Impacts

This section addresses the extent to which the three modeling systems are fostering strong and innovative partnerships for positive development impacts. Partnerships and impacts are discussed together because partnerships are a key component of the activities' impact pathways, both for producing research outputs and for helping to translate these outputs into policy and other outcomes.

Global Futures and Strategic Foresight Activities Based on IMPACT

Partnerships

The foresight work in Flagship 1 is largely a collaborative effort, anchored in IFPRI, with the other participating Centers. The IMPACT team at IFPRI is also part of the highly visible AGMIP (the Agricultural Model Intercomparison and Improvement Project, http://www.agmip.org/), in which IFPRI acts as the coordinator of the Global Economics Team. Supported by major funding from the U.K. Department for International Development and the U.S. Department of Agriculture Research Service, this is largely a network of international organizations and developed country universities such as Columbia University in New York, the University of Florida, and Oregon State University. This partnership has a high potential to guide the further development of IMPACT based on a systematic comparison with similar activities at the global scale, while exploiting possibilities for collaboration. However, partners to influence public opinion are not yet prominent, and the activities would likely benefit from a stronger focus on outreach and actively marketing their outputs.

Given the unclear sources of the parameters currently used in IMPACT, at least for supply and feed, a thorough review of alternative sources seems recommendable. On the supply side, PEs with a regional focus — such as the country modules of AGLINK — or even supply-side models could be used to deliver own- and cross-price elasticities. The wedges between primary agriculture and final demand could be based on cost-shares from SAMs such as the ones available from GTAP.

Given similar global foresight exercises in international institutions, a careful evaluation of opportunities for collaboration, e.g., in model parameterization, long-term growth rates or development of post-model indicators (nutrient, under-nourishment, environmental impacts) might be considered, as also suggested by professional peers. Whereas the successful collaboration between the IMPACT team at IFPRI and other CGIAR Centers in the context of global foresight is a success story, it seems clear that the other Centers cannot contribute to the core methodological questions around long-term analyses based on equilibrium models. In order to prevent costly duplicate efforts at the international level and to benefit from cross-fertilization between modeling teams, activities such as AGMIP should move beyond model comparison to coordinated model improvements. Here, IFPRI could play an active role and go from an approach where individual expertise is hired on a more or less regular basis to improve IMPACT to a strategy involving different modeling teams, e.g. to provide parameter data base or modules shared across models. This approach seems to be effectively used in the MIRAGE modeling work, especially for MIRAGE BioF.

However, the IMPACT team should continue to keep the necessary resources for core model improvement and model applications; international collaboration should hence not be confused with outsourcing core activities.

Effectiveness

The foresight activities in Flagship 1 cannot yet demonstrate many outcomes because the team has been undertaking, based on an earlier review, a thorough restructuring and enhancing of the IMPACT model, which forms the anchor for this work. Outcomes are also not easy to attribute since many are joint with other contributors, visible over the long term, and global or regional in scope.

The direct outputs of the foresight activities are large data sets (simulation results from IMPACT) which need carefully designed dissemination activities to become useful for informing policy design processes. Here, the outputs are to a large extent conventional (typically conference contributions, peer-reviewed journal publications, monographs). Thus, the output strategy is similar to that of more blue sky oriented research institutions such as universities. This might also reflect preferences of the involved researchers who like to keep a door open to less applied research activities. Scientific peer-reviewed output clearly adds credibility to modeling activities and should certainly be continued.

However, it is not evident that these more scientifically oriented outputs are likely to have a high impact on policy design processes. The information available in these publications is often too general to be of specific use for national and international decision makers. A clear counter-example to this is IFPRI's climate change in Africa series with its national chapters, which however draws on much more than the global foresight activities. Thus, the team could be encouraged to seek direct contact with policy makers and think about alternative formats to funnel their findings in the policy debate.

IMPACT is a long-run simulation model designed for scenario analysis. The main policy being addressed is the allocation of resources for agricultural research among competing priorities, this being important to the principal clients for the work — the CGIAR, NARs and SROs. The model itself offers very limited possibilities to explore targeted national policy interventions to countervail negative developments highlighted by the foresight activities. While the model does include ad valorem wedge instruments (PSE, CSEs, and tariffs), these are not part of the long-run analysis of climate change scenarios that the team has focused on in recent years.

Capacity Strengthening

The activities under Flagship 1 comprise training of staff in the different CGIAR Centers in using IMPACT. Supporting these activities is the development of a Graphical User Interface for the IMPACT model which should ease its application by non-experts.

The present review doubts the benefits relative to the costs of training CGAIR scientists in using the model. An overview introduction to IMPACT is certainly necessary to explain to all project participants the flow of information in the project and to motivate the team to provide the necessary input data. However, it might take quite some time until even a trained economist has gathered the necessary knowledge about the modeling in general and the model at hand to perform independent simulation exercises and judge the results of a particular simulation experiment. The fact that a user interface can ease running simulations does not imply that use by non-experts should be recommended.

A model as complex as IMPACT is a valuable tool in the hands of a well trained and experienced analyst, but should not be used as a “black box” even if it were mechanically possible. Clearly, some Centers might be in the favorable position to have trained modelers in their team or might be able to invest in building up the necessary expertise. For other Centers and for scientists who cannot undergo lengthy training, access to the general outcome of the long-term results produced by IMPACT is possible by consulting publications such as IFPRI's climate change in Africa series which provides the quantitative information from the model already in a commented upon and condensed form, which might be preferred compared to looking at raw model results.

Rather, one might investigate how researchers in CGIAR Centers could let IFPRI staff run simulations for them and discuss with them the results in detail. Doing so would also mean that the model need not to be installed (and kept updated) at the different Centers.

Impacts and Likely Sustainability

The IMPACT model has a long history and has a relatively large development team. With regard to human capital, there are no obvious concerns that crucial knowledge is either not documented or only available to one or two staff members. The involvement of external expertise, e.g., in the development process of IMPACT3 can be seen as an additional safeguard. Some professional peers have nevertheless suggested that the IMPACT team should actively try to attract additional experienced partial equilibrium modelers, and more commodity analysis expertise. Experience in policy and outlook modeling has shown that early and regular review and interaction with clients as well as with other analysts is a good way to validate a model at the same time as it informs users how to interpret analytical results and understand its strengths and weaknesses. This also helps to avoid misuse or misinterpretation of the analysis. While the Foresight Conference in November 2014

was a good start along this road, it was mostly an "in-house" interaction. Participation needs to be broadened and perhaps specialized to different user groups that IFPRI and PIM serve. And if the impact pathway outlined for IMPACT is serious, such interaction also needs to occur with decision makers in the CG system, who do not seem to be looking to IMPACT for the kinds of analysis that the IDO puts at the center of its mission.

MIRAGE Trade Analysis and BioFuels Models

Partnerships

Partnerships with other CGE modelers and CGE modeling centers are very important for the MIRAGE Trade Analysis Model. Many of these partnerships derive from CEPII in France where Laborde and other IFPRI staff came from. There are also notable partnerships with international organizations including the WTO (World Trade Organization), ICTSD (the International Center for Trade and Sustainable Development — the leading NGO on trade issues), and EC JRC-ISPRA (the Joint Research Center for the European Commission). These are typical of the high-level centers and other organizations with which the IFPRI team is collaborating. The partnerships are very effective and should contribute to the sustainability of the research. The partners are at the top of the scientific field in CGE and related modeling — an assessment confirmed by the professional peers interviewed in connection with the preparation of this review.

In developing and applying the MIRAGE-BioF Model, the IFPRI team reached out to modelers and specialists who were at the cutting edge of CGE modeling, biofuels modeling, and the assessments of emissions (Babcock and Carriquiry 2010), and they are doing this again in incorporating the World Bank household surveys into the MIRAGE model. However, there is little evidence so far of developing country users of this research beyond the WTO negotiations. The principal users appear to be the international development partners in their policy dialogues with aid-recipient countries.

Effectiveness

Bringing the MIRAGE Trade Analysis Model to IFPRI and the capacity to operate and develop the main and related versions during the past few years has been a real plus for IFPRI, PIM, and the other CGIAR Centers. Simply put, IFPRI and the Centers have now made a significant place for themselves in world and regional trade policy and related negotiations. IFPRI and the Centers now have the capacity to effectively represent the interests of the developing countries in the areas of research, evaluation, and actual trade negotiations. As the world becomes more and more connected and must address traditional and new common problems like climate change and related issues, the MIRAGE Trade Analysis Model will likely assume even more importance in research and analysis representing the interests of the developing (and developed) countries.

The MIRAGE-BioF Model has significantly strengthened the capacities of the European Union for understanding biofuels policy and its implications for indirect land use changes and greenhouse gas emissions. The application of the MIRAGE-BioF Model has produced a renewable fuel baseline for the EU, and an analytical structure that can perhaps be used by other nations trying to understand the implications of the evolution of biofuels for land use and GHG implications. With the MIRAGE-BioF Model, IFPRI has taken the lead in developing this fuller understanding of the trade-offs between renewable fuels, ILUC, and GHG emissions.

Validation of the results of the biofuel modeling exercise and the MIRAGE-BioF Model itself has been demonstrated by the continuing requests from the EU for assistance in improving their understanding of these issues, and transferring them to the Member States that are charged with the implementation of the biofuels policy. In fact, these biofuel results are now a part of EU policy. Thus, the development of MIRAGE-BioF Model and merging it into a MIRAGE Trade Analytical Model represents what will likely be a sustainable effort on the part of IFPRI and the CGIAR Centers.

Capacity Strengthening

The MIRAGE Trade Analysis Modeling system currently has strong capacity and is going about strengthening this by taking the MIRAGE model to new areas of application. Not all of these efforts will be successful. When models are stretched they are not always capable of incorporating new dimensions. But one must be impressed with the MIRAGE modeling team and their efforts to apply the model to interesting and significant domestic and international issues. This demonstrates a strong willingness of the modelers and the modeling system to accommodate and handle evolving issues.

Still, the process of understanding the implications of renewable fuels, ILUC and GHG emissions is in its infancy. For example, to date almost no work has been done on livestock production and the synergies of livestock production with feedstock and crop production systems. IFPRI and the CG Centers have after only a few years (mainly since 2010) established significant capacity for applying developing and applying the general MIRAGE Models and the MIRAGE BioF Model. And requests for drawing on this capacity simply will not likely go away in future. This speaks highly for keeping the CGE modeling capability and MIRAGE alive at IFPRI and perhaps in other CG Centers. Strengthening this capacity in the other CG Centers could come from more effective training courses on CGE modeling and changed hiring decisions at the other CG Centers.

The disaggregation effort of the MIRAGE-BioF Model should also be mentioned. This effort was herculean in terms of standard CGE modeling. It is likely to lead to other disaggregated efforts. The incorporation of the World Bank household surveys is the likely next area of disaggregated MIRAGE Model development. With this disaggregation there is a real possibility for expanding the work to address gender within these large scale models. The IFPRI staff is highly qualified to accomplish this disaggregated MIRAGE modeling effort and at the forefront of those who can.

Impacts and Likely Sustainability

One aspect of the MIRAGE Trade Analysis Model that may call for attention is the different names given to the various versions of the MIRAGE model: MIRAGE-BioF, MIRAGE Household, and other versions are examples. It may be that this is not a good “marketing” strategy. Fragmentation of a modeling effort that has a dedicated group of researchers and analysts may not be good in terms of presenting a feeling that the best of MIRAGE is always being brought to address particular policy issues.

There may also be an issue at IFPRI and PIM in terms of which modeling team does what. Some of modeling issues addressed by MIRAGE modeling team might have been addressed as well or better by the IMPACT team or vice versa. Careful distinctions between the activities of the modeling groups at IFPRI and in the CG Centers could be given more attention. This is important both for internal users inside IFPRI and PIM and for the external users of the modeling tools and analysis. Some

attention should be given this issue before it reflects negatively on the integrity of the entire modeling effort.

There will of course continue to be issues with respect to food and trade policy to which the standard CGE models and the basic MIRAGE model are well adapted to generating scenarios to assist policy actions. This is another reason for keeping and nourishing the MIRAGE modeling capacity along with the multi-market modeling activity at IFPRI. IFPRI can become an international leader in both efforts and one of few centers that have both these capacities.

Last, there is the issue of documentation of the MIRAGE Trade Analysis Model and the related models developed around it. This has simply not been adequate. With the demonstrated impacts of the IFPRI CGE modeling efforts, the time will soon come that the users of the modeling results will begin to ask questions that cannot be answered without proper documentation. In short, it is better to have such documentation in hand when the questions come rather than to be caught without it and to have to generate it quickly. Better to do this on your own terms. Of course, such documentation activity may imply the need for increased core funding as well.

Country-Level CGE Modeling – Activities 37 and 38

Partnerships

The Arab Spatial Project. The main partners of the project are the WFP, the CAPMAS (Egyptian statistical institute), IFAD and the Yemen Ministry of Planning and International Cooperation (MOPIC). The WFP has been a key partner of the Egyptian Government for a while and has been funding a lot of the data work within CAPMAS. IFAD is one of the key investors in rural poverty reduction and food security in the region. MOPIC is a coordinating ministry, which is important for a multi-sector development challenge like food security. For this reason, MOPIC now houses the National Food Security Secretariat. All these partners are relevant to get data, funding and help implementing the recommendations of the project.

A conference was also organized with ERF (the Economic Research Forum), the main network of applied economists in the MENA region. This network is composed of the best economists in the region, receives funding from various regional and international organizations, and has strong links with policy makers. Two of its former managing directors became ministers of finance in Egypt after the 2011 revolution. IFPRI should tighten its links with ERF to develop common projects with greater policy relevance and regional ownership, and with possibilities of funding.

Ministries of Agriculture have been less involved in IFPRI's research than in Africa. This could be due to the weak analytical capacities of these ministries in the region. It is often Ministries of Planning and departments of statistics that are the privileged partners of projects involving applied research. Indeed one finds in these departments the data needed as well as the statisticians and applied economists able to collaborate with international organizations. However, the issue is that agricultural policies are decided with Ministries of Agriculture, and the impact of any project would be greater if the Ministries of Agriculture were associated, given the weak collaboration between ministries in some MENA countries. Strengthening the analytical capacities of Ministries of Agriculture in the region would seem to be a strategic necessity that should be taken into account if one wants to have a significant impact on agricultural policy reform. This recommendation goes

beyond this project. It could constitute an activity in itself that PIM could collaborate with other bilateral, regional or international organizations such as the IDRC, ERF, the World Bank, etc.

The Agricultural Transformation in Africa Project. The classical, CGE component of this project has a long history of working both with research partners in African universities and research institutes, and with the immediate users of the research such as Ministries of Planning and Agriculture and development partners such as the World Bank, the EC, USAID, DFID, and the African Union — most recently in the context of the implementation of the Comprehensive Africa Agricultural Development Program (CAADP). After 2005, when the African Union and its NEPAD Secretariat (New Partnership for Africa's Development) placed greater emphasis on influencing and improving national agricultural policy formation to realize the CAADP objectives of allocating 10 percent of government budgets to agriculture and 6 percent growth in agricultural production, the provision of IFPRI's modeling expertise was the principal technical assistance offered by the international community in this regard (Poulter et al. 2014).

The partners of the mechanization component have been the Agriculture Engineering Services Directorate (AESD) of the Ministry of Food and Agriculture of Ghana, the Savanna Agricultural Research Institute (SARI-CSIR) of Ghana, the Federal Ministry of Agricultural and Rural Development of Nigeria, and the Chinese Academy of Agricultural Mechanization (CAAM). This project relies heavily on the presence of CSSPs in these countries which help identify funds, data, networks, and the most relevant partners.

Effectiveness

The two projects are fulfilling their promises in terms of outputs. While the Arab Spatial project seems to focus more on database development, access to information, and organizing workshops, the agricultural transformation project focuses more on publishing papers (mainly for the mechanization activity). The nature of the research is different. The research in the first case is more applied, while that in mechanization activity is more strategic — raising awareness about a subject that was not studied for a long period.

In terms of outcomes and impacts, the Arab Spatial project operates in a currently unstable environment. In some countries the State is weakened. While these countries definitely need the support of the international community, implementing policy recommendations will not be an easy task. Despite this, it seems that the outputs of the project were widely used by the Government of Yemen in the oil subsidy reform and in its interactions with international organizations. Yemen also established a National Food Security Council and Technical Secretariat to implement the strategy defined with IFPRI.

For the second project, the classical component (the CGE model) seems to have had a significant policy outcome through the analysis of the effects of the maize export ban in Tanzania. IFPRI's analysis contributed to the Government's decision not to reinstitute the ban, which it had been reconsidering. The mechanization component will probably not have an immediate outcome or impact, but it could encourage further research on similar themes and policy debates which could ultimately have an impact on agricultural production and smallholder farmers' incomes.

Capacity Strengthening

Numerous capacity strengthening activities were conducted for the main partners in the Arab Spatial project. These activities are very relevant and useful, but to ensure sustainability, closer links have to be developed with local academics. Indeed, formal training activities are generally useful to raise awareness and interest, but it is rare that they are sufficient to obtain autonomous practitioners, especially with sophisticated tools. A partnership with local researchers (if they are enough competent and well trained by IFPRI) would allow the tools developed to continue to be used after the end of the projects.

The principal investigator of the Arab Spatial project explained that the approach they were following consisted in starting the training with a large group, and then selecting the most suitable candidates for further training using a test approach. Due to security issues in Yemen, the partners were often trained in other countries (like Egypt) and contacts were regular through videoconferences.

Training activities in the Africa transformation project were conducted mainly in connection with project implementation needs in different countries. According to the principal investigator, deeper collaboration in terms of research with locals is very important, but it was not always easy to find the right collaborators.

One of the main recommendations of the professional peers was to set aside a special budget for capacity strengthening and to increase this budget to improve the efficiency of knowledge transfer and collaboration with locals.

Monitoring Agricultural Price Distortions – Activities 118 and 119

Partnerships

This project is solely based on partnerships. It is purely a collaboration of IFPRI with International Organizations, which are FAO, OECD, InterAmerican Development Bank, and World Bank.

Effectiveness

This was a new project in 2014, so that it is too early to observe outcomes. The efforts to date has been focused on building trust among the partners.

Capacity Strengthening

Training is going on by each of the partners, but IFPRI/PIM has not engaged in training.

1.7 Organizational Performance

Global Futures and Strategic Foresight Activities Based on IMPACT

The majority of the interviewed PIs reported positive experiences with the PIM Management Unit (PMU). Problems were mostly mentioned with the intermediate phase where old legacy projects

were running partly in parallel to the new PIM structure. In some cases, a better informational flow especially between cluster leaders and the PMU was suggested.

Some PIs face the challenge of having the very same activities contributing to several projects, often funded by different sponsors and linked to different reporting obligations. Here, to the extent possible, reporting obligations should be streamlined. This might be achieved if PIM acted as the contractual partner instead of the individual Centers such that the PIs only report to the PMU, and the PMU uses the information to report back to the sponsors.

MIRAGE Trade Analysis and BioFuels Models

Organizationally, the performance of the MIRAGE modeling team is operating well. The team is working effectively and making progress on many fronts. Their relationship with PIM management has been good. Discussions with the team members indicated that they were satisfied with the PIM organization, yet included several suggestions about improvements that could be made. The leaders of the group suggested that improvements could be made in terms of the reporting mechanisms and of better articulating better the objectives of PIM.

The MIRAGE-BioF modeling effort was started and funded with bilateral grants from the EU to study their biofuel policy and directives. Therefore, this modeling exercise came to PIM mostly complete and with few organizational problems or issues.

The staff are well connected with outside CGE and multi-market modelers globally, e.g., those at the World Bank, CEPII, IIASA and GTAP. Additionally, the MIRAGE team is well acquainted with those who specialize in estimating GHG emissions. These are the critical relationships for the biofuels project as it progresses. The MIRAGE modelers are also connected with CGE modelers and other specialists in trade and agricultural policy, but, unfortunately they do not appear to be well connected with other CG Center economists.

The apparent gap between the MIRAGE and the IMPACT multi-market modelers in IFPRI, and with the research staff at the other CG Centers presents an issue for IFPRI and PIM. What should be the division of responsibilities between the MIRAGE and IMPACT modeling teams and to what extent should the other CG Centers be involved in international trade analysis based on the MIRAGE model? (Most of the other Centers are already collaborating with the IMPACT team at IFPRI.)

Country-Level CGE Modeling – Activities 37 and 38

According to the PIs, PIM was helpful in acknowledging their work by publishing it on its website. The program has also provided more flexibility than bilateral donors. For example, it allowed financing of a workshop in China to which IFPRI brought practitioners from Africa to learn from the Asian experience. However, high transaction costs were also mentioned by the PIs due to a higher administrative burden associated with PIM funding.

Monitoring Agricultural Price Distortions – Activities 118 and 119

This is a new project in 2014.

1.8 Conclusions

A general conclusion arising from comparing these modeling and analytical activities is that those in Flagship 4 are more often arising from bottom-up, demand-side initiatives and those in Flagship 1 are more often arising from top-down, supply-side initiatives. This is a relative difference not an absolute difference and it does not mean that the work is less useful, but it does have some bearing on the recommendations. The distortions activities are even more top-down in terms of its origins, but it is providing a valuable service to IOs and through them to many country and regional clients.

Global Futures and Strategic Foresight Activities Based on IMPACT

The activities are to a large extent legacy ones which existed often already in a similar format before the establishment of PIM. A clear added value of the activities is to incorporate information from the different Centers in a coherent and structured way. At the same time, the Centers gain access to IMPACT as a tool which can be applied by them to assess possible impacts of their research activities. So clearly this increases collaboration among CG Centers.

Nonetheless, the IMPACT analysis system has also been used for many types of analyses for many partners and clients in many venues and is widely published. There is no similar long-term analytical system that is so widely used. During this review, IMPACT3 has been in the process of a complete overhaul so some of the improvements suggested by this review are already underway and others are planned. This restructuring also includes more training and increased accessibility to other Centers as well as partners. Nonetheless, there are gaps that remain to be addressed in the technical aspects of the modeling system as well as in the effectiveness of its use. Addressing these gaps should improve the efficacy of the system.

The declared aim of Flagship 1 activities is to provide input to the long-term strategy of the overall CGIAR research program. It is not clear who in the CG management or guidance system is seeking this analysis. The IDO mentioned at the beginning of section 2 and the impact pathway that was foreseen for foresight work depends crucially upon uptake of this analysis by the Consortium Office, the Fund Council, the DGs, research partners and the CRP Directors. There was little evidence that this pathway is operating as anticipated.

Professional peers have the impression that more generally the strategic foresight activities focus too much on climate change, and too little on the question which changes in the agricultural and food system are necessary to feed the world in 2050. Indeed, at least some of the projects reviewed in here which look at future technologies seem to focus almost entirely on crop improvements related to climate change, and not so much at more holistic strategies to increase agricultural output, e.g., sustainable intensification. There were also concerns raised that other important threats such as soil degradation or overexploitation of (ground)water resources have not given enough attention. Finally, there is the challenge to bring results to a more disaggregated level so as so assess impacts on the priority population groups of greatest interest to the CG System.

MIRAGE Trade Analysis and BioFuels Models

The MIRAGE analytical system, for which two model activities were reviewed for this report, has been used appropriately for policy analysis in regional and global contexts. It has been highly

regarded and very effective in policy analysis and policy advice but it is poorly documented and not accessible to many users. A major strength of the model lies in the recent linkage to household survey data to derive more disaggregated impacts of the policy analyses.

The overall value added of the MIRAGE-BioF Model exercise for the EU and Member States has been a major plus for IFPRI and PIM. IFPRI has acquired and is supporting one of the top groups of CGE modelers globally. There are, in fact, only about five modeling groups that have the capacities of the CGE modelers at IFPRI. The inclusion of the MIRAGE BioF Model into the MIRAGE Trade Analysis system will add to the capabilities for understanding the renewable fuels movement in the EU and globally, and other policies not yet defined. There will be much to do on biofuels modeling and applications of the MIRAGE Trade Analysis Model to issues of trade, rural development, and food security. These issues are likely to continue to receive significant attention by domestic and international policy makers. The modeling effort that is underway on integrating the World Bank household surveys to assess gender and other food policy issues is telling in terms of the potential for the MIRAGE modeling activities and for synergies with the multi-market modeling exercises of IMPACT.

Country-Level CGE Modeling – Activities 37 and 38

The CGE models reviewed have been used for policy analyses in several MENA countries at the request of governments, WFP, and ICARDA following the food price increases of 2007–2008, and in several African countries mostly in response to requests from national governments. The types of policy analysis conducted has varied in response to the specific requests, but all used some form of the standard CGE model framework for which IFPRI is famous. The efforts provide analytical support that is not usually available in the countries themselves.

The assessment of the activities described above by the professional peers consulted is globally very positive. Given the weak analytical capacities of developing countries in designing and evaluating agricultural policies, the contribution of IFPRI is valuable.

Monitoring Agricultural Price Distortions – Activities 118 and 119

The Distortions work was initiated by IFPRI in response to a need that was identified by IFPRI leadership and confirmed by OECD, FAO, WB, and IADB, who are the key partners. The collaborating IOs each fund their own work and have a representative on the guidance board. The IFPRI role is to be an “honest broker” to provide a website home for all of the measures, translate each of them, explain the differences and generally increase accessibility and transparency of the efforts. The impact pathway is via the policy advice work being done by IOs as well as IFPRI itself. Improved analysis and transparency of distortion measures supports evidence based decision making.

1.9 Recommendations

The CGIAR has a strong comparative advantage in conducting social science research at the intersection of food security, poverty, and sustainable agriculture. There are, for example, few organizations or institutions that have a similar combination, range, and quality of modeling systems at their disposal as IFPRI, and therefore PIM. While a few places have IMPACT-type systems, a few have MIRAGE-type systems, and more have country-level CGE systems, no one else has this scale of

effort under one roof. However, it is not clear that IFPRI has explored the possible synergies that could obtain from increased interaction among these modeling systems, such as harmonizing the long-term drivers of change and undertaking common work on scenarios. The systems should be viewed as complementary, not competing; exploring their synergies may have been hindered by their being located in three different IFPRI Divisions. Each would also benefit from a wider community of practice that includes clients as well as other modelers. *The leaders of the three modeling teams should explore possible synergies in their work and broaden their communities of practice to engage their clients and other modelers in reviews of model analyses.*

The entire Flagship 1 on foresight modeling is essentially one large collaborative initiative, now involving twelve Centers, and supported by the Gates Foundation, PIM, and CCAFS. PIM has clearly added value to this initiative which started in 2009 with the involvement of only five Centers. However, there has been very little collaboration between IFPRI and the other Centers on the important national policy and international trade issues that should be of interest to the commodity Centers. *PIM should explore the extent to which other Centers or CRPs have unmet needs for trade analysis that PIM could provide through different types of collaboration. PIM should also seek opportunities for other Centers or CRPs to benefit from PIM's trade analysis work either by taking on tailored scenarios or by providing tailored reports of common analyses.*

Gender mainstreaming in PIM is clearly benefiting from the strong reputation that IFPRI has built up over the years in addressing gender issues. However, Flagships 1 and 4 have had the least emphasis on gender issues, generally because they are conducting policy research at the more aggregate (national and global) levels. Nonetheless, some of the latter activities are finding ways to address gender issues. *Flagships 1 and 4 should increase their level of attention to gender issues by building upon these innovative approaches, by links with other modeling approaches, and by greater sharing of existing methodologies and data among Centers and flagships.*

The individual reports that follow in this volume make a number of other suggestions for improving the respective modeling systems reviewed. Even the best modeling systems have limitations, and each of the reviewers has tried to take a fresh look to identify those enhancements which may have the greatest payoff in terms of PIM objectives and impact pathways. A general concern common to all is the need for sufficient human and financial resources for documentation, maintenance, and model enhancement.

Global Futures and Strategic Foresight Activities Based on IMPACT

Experience in policy and outlook modeling has shown that early and regular review and interaction with clients as well as with other analysts is a good way to validate a model at the same time as it informs users how to interpret analytical results and understand its strengths and weaknesses. This also helps to avoid misuse or misinterpretation of the analysis. While the Foresight Conference in November 2014 was a good start along this road, it was mostly an "in-house" interaction. Participation needs to be broadened and perhaps specialized to different user groups that IFPRI and PIM serve, including decision makers in the CGIAR system.

Although the IMPACT model has a long history, a relatively large development team and the involvement of external expertise through partnerships, commodity analysis expertise appears to be in short supply. For example, livestock and dairy modeling needs people who understand the stock and slaughter and biological relationships and how to model them in a consistent way. Also a good

crop analyst would know that corn and soybean prices cannot increase much faster than wheat prices for a sustained period.

There are plans to restructure the IMPACT3 demand system to satisfy the standard demand system constraints on price and income elasticities, which was recommended long ago and again was stressed in this review. Similarly, there is a need to move away from perfect price transmission in international markets that was also recognized as a need long ago but is still not in progress. For the types of commodity analyses often conducted with IMPACT the results can be questioned if these issues are not addressed.

The individual Centers conduct research aiming at improving crop and crop management in a regional context, which gives them access to highly detailed and valuable knowledge about various impacts of current management practices and possible improvements, e.g., on soil fertility or labor use at the household level. Information at that detail can hardly be used in IMPACT. Therefore, it remains somewhat unclear if and how this valuable information available at the Centers and partially collected in the context of the projects is exploited beyond its use in IMPACT.

MIRAGE Trade Analysis and BioFuels Models

For the MIRAGE systems, there are structural gaps in the livestock sectors and a desperate need for documentation so that others would be able to use the system and understand its functioning. There is also the need for more training of users and more integration of these systems with related activities of IFPRI and possibly other CG Centers. There seems to be insufficient support for such documentation and core maintenance, which is so often the curse of modeling systems. Many want to use them, but few are willing to maintain the capacity.

The two reports on the MIRAGE models offer additional, more specific suggestions for IFPRI and PIM, several of which are listed below. These include the need for greater clarity within PIM and IFPRI on how the CG Centers other than IFPRI could be involved in the MIRAGE modeling efforts and how best to capitalize on the synergies between the MIRAGE and IMPACT modeling efforts.

- Documentation of the MIRAGE-BioF Model and other models in the MIRAGE complex. IFPRI and PIM are now exposed in terms of not having full documentation of the MIRAGE models.
- Livestock and the handling of manure have potentially major impacts on GHG emissions, but livestock was not treated realistically in the MIRAGE BioF model.
- IFPRI, PIM and the other CG Centers need to make decisions about priorities for expanding the MIRAGE model(s). There are now the MIRAGE-BioF Model, the MIRAGE Climate Change Model, the MIRAGE Household Model, the MIRAGE Government Sector Model, the integrated MIRAGE Trade Analysis Model, and others. Decisions on priorities, naming conventions, and the necessary resources to underwrite the modeling efforts need to be developed.

Country-Level CGE Modeling – Activities 37 and 38

The report on these activities makes a number of suggestions for model improvements: to disaggregate youth and gender more effectively, to consider migration and cross-border movements

of labor, and to allow substitution of annual crops with perennials in longer term analyses. These suggestions have previously been done with CGEs employed for other activities.

Additional points raised in the report could improve the effectiveness and relevance of the modeling work done. First, the team could more systematically include in its general equilibrium exercises the results of micro-econometric estimations obtained in some other projects. This would give more confidence in the results obtained.

Second, the team focuses mainly on growth, poverty and nutrition in some cases. Adding employment and natural resource availability as outcome variables would give more information for policy makers about the trade-offs. This is particularly important in the Middle East and North Africa region where unemployment (particularly for the youth) is the main challenge today and water scarcity probably the most important challenge of the next decades. The labor market block of the IFPRI DCGE model should be upgraded to include some of the elements proposed in this report, including a migration block, which would be very relevant in some countries.

Third, the projects seem to be much more effective in countries where CSSPs exist. Given that many other countries need support for reforming their agricultural policies, IFPRI could develop partnerships with regional research organizations to allow a better diffusion of its outputs.

Monitoring Agricultural Price Distortions – Activities 118 and 119

These are new activities and are progressing well, so the recommendation is to keep up the good work. Through this activity, PIM initiates productive partnerships with IOs that can increase the data and analysis for increasing evidence-based decision making in countries that IFPRI and the partners are working with on policy advice.

2. Report on Selected Foresight Modeling Activities Based on the IMPACT Model – by Wolfgang Britz

2.1 Introduction

The following review would not have been possible without the information provided by the principal investigators (PIs) of the projects reviewed, input from professional peers interviewed, and most importantly, access to the source code and parameter base of IMPACT3, beyond publicly available documents such as the model documentation of IMPACT2. The views expressed are those by the author, any errors remain with him. The review aims at a critical, but helpful assessment of the activities, trying especially to find low-hanging fruit to improve projects and IMPACT in the future which could be easily picked by the PIs and the IMPACT modeling team. As with any review process, this comprises many subjective elements; specifically what is considered important by the author to be improved might not be shared by other professional peers. Hence, the statements and recommendations herein should receive the same critical (and hopefully open) approach which the author tried to implement.

The quality of the outputs of the activities reviewed here is to a large extent contingent on the proper functioning of IMPACT to spell out consequences on the assumed changes in technologies. The review therefore focuses strongly on IMPACT, also since making judgment about the Delphi processes and crop modeling conducted in the context of the activities in the different CGIAR Centers is beyond the expertise of the reviewer. This focus on IMPACT clearly also mirrors the scientific interest of the author and his field of expertise.

2.2 Relevance of Objectives and Design

This review refers to the foresight activities #5, #13, #17, #22, #23, #90, #95 and #97 which are all strongly targeted towards IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade). The reviewed foresight activities are designed to support overall strategic decision-taking across CGIAR Centers with regard to their research activities (Table 1). Specifically, these foresight activities are intended to pinpoint regions, and where possible also markets, which require increased research and development (R&D) efforts by the CGIAR Centers due to future threats, e.g., with regard to food security, poverty, nutrition, or resource use. Equally, the activities aim, if possible, to quantify the impacts of future R&D spending on key economic, social, and to some extent also environmental indicators.

Table 1. Objectives of Foresight Activities Reviewed

Activity	Leading Center	Objectives
#5	CIAT	This activity will primarily develop and enhance methodologies and tools needed to conduct ex-ante socio-economic impact assessments of agricultural technologies and management practices. Crop modeling tools and the updated new-generation integrated IMPACT model will be used to examine specific scenarios, and assess possible futures of agriculture in tropical areas, and the potential impacts that global economic and environmental change will have on the economies of tropical countries.
#13	CIP	To enhance the representation of potato and sweet potato crops in IFPRI's IMPACT model.
#22	ICRISAT	This activity will primarily develop and enhance methodologies and tools needed to conduct ex-ante impact assessments of agricultural technologies and managements. This activity employs the updated new generation integrated IMPACT model to examine detailed scenarios, and project plausible futures of dryland agriculture and the potential impacts that global economic and environmental change will have on the economies of the semi-arid tropics.
#90	Worldfish	Deliverables compile promising aquatic (AQ) technologies from countries accounting for large majority of AQ production and review extent of typical AQ production systems with their potential environmental impact. Both are designed to provide inputs to the IMPACT model.
#95	ICARDA	#95: This activity will focus on enhancing and using the IMPACT model to forecast production, consumption, and trade of key ICARDA's agricultural commodities while assessing the effects of climate change, water availability, and other major trends.

Parallel to this more inward-directed impact pathway, the activities aim at increasing the awareness of possible sponsors and the general public about future developments in the agricultural and food system and related R&D needs, and thus at sustaining the funding of the CGIAR Centers. By doing so, these foresight activities might increase R&D spending in agriculture which in turn might increase agricultural productivity, thereby contributing to key development aims such as eradication of hunger, better nutrition or reduced poverty. In order to reach that final impact, the projects' outputs mainly provide information in rather standard format (conference contributions, peer-reviewed journal articles, research reports by the Centers). Decision takers are expected to use these outputs for better informed decisions on R&D spending.

Additionally, past foresight activities have also raised awareness of ongoing and upcoming developments of relevance for agricultural and food markets, with a focus on LDCs, such as biofuel mandates, climate change or changes in meat consumption. These aspects are not directly presented in the activities reviewed, but can be assumed to be a continuous important activity of IFPRI.

The impact pathway in the light of the overall PIM objectives is hence rather indirect; indeed, the reviewed activities are mostly directed towards the CGIAR Centers themselves. This somewhat indirect impact pathway is rather standard for foresight and modeling activities that support policy processes and as such is not a concern for the design of the activities. What might be somewhat different for these projects is that the (possible) decision takers have not directly commissioned the quantitative analysis, as it is often the case for ex-post and ex-ante policy impact assessments. This can be a comparative strength, making it possible to respond to new requests in a timely fashion, as in the case of the World Bank-led multi-agency report on the future of African drylands. Still, achieving the activities' objectives would likely benefit from a stronger focus on outreach and actively marketing their

outputs. Indeed, the newer projects seem to put more focus on this aspect by trying to actively involve regional partners in research, but also to reach regional decision makers. Also the foresight conference in Washington in November 2014 might be seen as a step in that direction.

The reviewed activities are implemented by a series of projects, typically with a PI from a CGIAR Center which takes the project lead, and some support from IFPRI. Projects involving more than two Centers are still rare. Each project typically focuses on specific regions and agricultural activities (certain crop(s) and/or farm management system(s)) in accordance with the leading CGIAR Center's research focus. The main activity of these projects is to define promising future technologies and to integrate them into the global foresight activities, which typically implies some changes to the structure and parameterization of the IMPACT model, a task typically taken over by IFPRI. These activities typically comprise (1) some data collection activity about current and potential activities (typically about a third or more of the activities), (2) the evaluation of potential activities, typically at least partially based on crop growth modeling (typically also around a third of the resources spent), and (3) the condensation of the findings in the form of future changes in crop yields/acreages which are implemented into the IMPACT modeling framework. Finally, (4) IFPRI's IMPACT model is applied to quantify the impacts of the expected future changes quantified by (3) on agricultural markets (supply, demand, trade, price) and indicators derived from these results. The rather uniform structure of these projects can be seen as rather advantageous, especially given that the layout was already found in some legacy projects, as experiences from individual projects can be generalized more or less to all projects. At the same time, structural deficits in the overall design are also carried over to all activities.

The activities have an inter-disciplinary character and try to link bottom-up type analysis at the level of individual Centers with a top-down feedback on R&D decisions. They seem to successfully link IFPRI with the other participating Centers, and also provide some scope for interaction between the Centers involved in the individual projects. Specifically, they also allow individual researchers to scope their activities in the context of possible future regional and global developments.

Most of the research has a rather applied character; methodological advancements are not at the core of what is aimed for. The collected data on current and future activities are valuable beyond the use in the individual projects, and are made available via the CGIAR Centers' data portals.

Overall, the activities continue a line of IFPRI research in collaboration with other Centers which has proven to be highly visible and relevant already in earlier reviews.

2.3 Quality of Science

Summary

The IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade) model is a global net-trade partial equilibrium model for agricultural and food commodities, with a history of almost three decades. Its core advantages are a rather detailed commodity and regional breakdown, and the link to river basin models along with the differentiation between rain-fed and irrigated agriculture. Institutionally, the close collaboration with the other CGIAR Centers is also a clear advantage for the modeling team. There are also some disadvantages to mention: the lack of a transparent baseline, partly unclear parameter sources and the lack of clear microeconomic foundations (no regularity conditions) in the behavioral equations. Surprising is that the model

seems to describe policy almost entirely by policy indicators such as nominal rates of assistance (NRAs), and not by actual policy instruments, given its title and the fact that it is hosted by IFPRI.

IMPACT and work based on IMPACT has a high visibility, which is clearly linked to the fact that the IMPACT team often succeeded in being a frontrunner in bringing attention to important developments in international food markets such as climate change, biofuel policies, or dietary changes; the related analysis was typically published in high-ranking inter-disciplinary journals. However, the possible lack of "scientific evidence" behind some analysis with IMPACT was raised as a critical point by several professional peers. These peers seem to be mostly concerned about the application of a comparative-static model with limited policy coverage to more short to medium-term issues in agricultural markets, but also mentioned, e.g., simulated developments in commodity prices which they considered implausible. The IMPACT modeling team has clearly responded to the potential shortcomings underlying these comments by a serious investment in refactoring the model code and concept in the last few years. The reviewer has tried to point out possible improvements in the more detailed assessment below.

Another point raised by professional peers and some PIs is the somewhat insufficient link between the quantitative modeling exercises with IMPACT and the richness of technology information available at different CGIAR Centers; information partially also sampled specifically in the reviewed projects related to global foresight. Basically, all the valuable information sampled by CGIAR Centers in the context of these projects is condensed into a simple shift of the supply curve in IMPACT which implies an equivalent reduction in marginal costs. That is a rather simplistic and probably not well fitting description of how technological progress and adoption in crop production impacts economic, social and environmental indicators of relevance. The team should hence carefully consider if some intermediate layers of analysis between the detailed technological information at the single crop level and global modeling could provide crucial scientific evidence and increase the value of these projects especially for the other involved CGIAR Centers. A common tool box of bio-economic analytical instruments beyond DSSAT and shared across the Centers and used in addition to the IMPACT model in global foresight related projects could close analytical gaps, e.g., related to gender-related aspects, which due to scale and data availability issues, are difficult to impossible to overcome by improvements to a global PE model such as IMPACT. Additional tools seem especially advisable as IMPACT, as a partial equilibrium (PE) model, uses behavioral equations to model supply, and not an explicit technology representation.

Finally, given similar global foresight exercises in international institutions, e.g., at FAO in the Global Perspective Unit, at IIASA, or at the World Bank, and also at national research institutions and universities, both based on partial and general equilibrium analysis, opportunities for deepening existing collaboration might be considered in fields such as model parameterization, long-term growth rates, or development of post-model indicators (e.g., nutrient, under-nourishment, and environmental impacts). The AGMIP activities, where the IMPACT team has taken a lead role, have clearly opened the door to move from model comparison to common model improvements. Whereas the successful collaboration between the IMPACT team at IFPRI and at other CGIAR Centers in the context of global foresight is a success story, it is clear that these others Centers can hardly contribute to the core methodological questions around long-term analysis based on equilibrium models.

In order to prevent costly duplicate efforts at the international level and to benefit from cross-fertilization between modeling teams, ongoing collaboration, e.g., in the context of AGMIP, should

be explored for possible coordinated model improvements. Here, IFPRI could play an active role and go from an approach where individual expertise is hired on a regular basis to improve IMPACT to a strategy involving different modeling teams, e.g., to provide a parameter data base or modules shared across models. However, the IMPACT team should continue to keep the necessary resources for core model improvement and model applications in-house; international collaboration should hence not replace core expertise for foresight modeling at IFPRI, not the least to allow for continuing strong links between the economic analysis at IFPRI and the more science-oriented research at the other Centers.

Introduction

Existing reviews of partial equilibrium models can be broadly put into two classes: reviews focusing on one or several models hosted by one institution and topic-related reviews which compare a whole range of models, but typically focus on specific (methodological) aspects.

Two reviews on IMPACT falling in the first category are available to the author: Channing and Robinson (2010) and Ryan (2003). Ryan provides firstly an extensive analysis of publications based on IMPACT in the years 1995–2002. Its main finding was that the IMPACT team produced a very high output of scientifically visible work based on 108 publications during the period covered by the review, including 29 papers in peer-reviewed journals. Furthermore, average citation counts for the publication were rather high. As a complement to the literature analysis, the review also analyzed 43 answers to a questionnaire related to IMPACT and IMPACT-based work sent to 246 different institutions. That analysis revealed that most of those who answered have consulted one or several of the IMPACT publications and in many cases also reported new findings in these publications. The respondents could also list strengths and weaknesses of IMPACT, but we will refer to those later. The interviews with professional peers underline these general findings.

The second review by Channing and Robinson is broader in scope and thus comparable to the current undertaking. It however uses a somewhat different list of PE models to which to compare IMPACT.

In order to review IMPACT, information on similar models is helpful. Here both types of reviews mentioned above can be helpful. M'Barek et al. (2012) provide a review of the so-called integrated Modeling Platform for Agro-economic Commodity and Policy Analysis (iMAP) hosted by the European Commission Joint Research Center in Seville, which comprises the PE models ESIM, AGLINK-COSIMO, AGMEMOD and CAPRI and the CGE models GLOBE and GTAP. The report is especially valuable as it comprises a rather detailed table with attributes to characterize each model which serve for a systematic comparison of iMAP models in several dimensions. That information can be used not only to compare these models to IMPACT, but also to structure the review. A topic related review focusing on modeling changes in the Common Agricultural Policy based on Partial Equilibrium models provided by Britz and Heckelei (2007) also serves partly as background knowledge for the current review.

Topic focused reviews which also cover IMPACT, e.g., in relation to impact of biofuels policies, seem of limited use for the current review.

Competing Models

When judging about an economic simulation model, it seems naturally to compare it against a set of models with a similar focus or methodology. The selection of these "competing" models will always remain to a certain extent subjective. Reviewers will typically compare models they are familiar with, as acquiring detailed information on specific models can be quite costly. In many cases, model documentations refer only to the equation structure, and miss important aspects such as parameter sources, construction of the ex-ante baseline or details with regard to the technical implementation. It is therefore not astonishing that the selection of "competing models" in here is to a large extent different from Channing and Robinson (2010), which difference is however also partly due to developments in more recent years.

From the equation structure, IMPACT is to a large extent still adhering to the famous SWOPSIM template by using iso-elastic behavioral functions. The price transmission functions in IMPACT, while written as linear functions, are also iso-elastic with a transmission elasticity of unity.

Perhaps the global PE model in use that is most common to IMPACT is the COSIMO part of the AGLINK-COSIMO system which is maintained by FAO. COSIMO and IMPACT both cover in quite some detail developing countries and are both based on equation templates. The latter does to a far lesser extent hold for the AGLINK part covering the OECD member countries of the AGLINK-COSIMO system, where equations are often market specific. AGLINK-COSIMO is solved in yearly steps as is IMPACT, but comprises recursive-dynamic features based on lagged price and quantity effects in behavioral equations. The AGLINK part also has a history of comparable length to IMPACT. As COSIMO is hosted by FAO, there seems also clear scope for common model improvements, e.g., with regard to long-term growth rates in agricultural and food markets or model parameters.

The strength of the AGLINK part of AGLINK-COSIMO from a methodological perspective is the rather detailed modeling of domestic policy support, a feature probably of limited interest for the applications conducted with IMPACT in the context of global foresight activities, despite its name which suggests a focus on policy impact analysis. However, IMPACT has also been used regularly for more short to medium-term analysis where policy detail can be key for outcomes in those agricultural and food markets where trade and domestic support policies play a major role. AGLINK was also one of the first models with a detailed description of biofuel markets and related policies. An important activity around AGLINK-COSIMO is the yearly baseline exercise which is to a large extent based on Delphi processes, backed up with model simulations, providing long-standing useful experience as to how to organize a similar analysis for IMPACT. AGLINK-COSIMO is currently realized in TROLL, an econometric package; a prototype implementation in GAMS is currently under evaluation. Different graphical user interfaces (GUIs) to support model use are available (Dominguez et al. 2012). AGLINK-COSIMO was also mentioned as a competing model in Channing and Robinson (2010). Similar to IMPACT, AGLINK-COSIMO has a double purpose by providing both a tool to develop a common view on future developments in agricultural and food markets and to provide an economic simulation model for counterfactual runs.

The FAPRI modeling system follows a similar philosophy as AGLINK by using more or less different equation structures for each market; in the case of FAPRI, these equations are typically econometrically estimated. As for AGLINK, this is partly due to a high level of detail in domestic policies, especially for the U.S. Equally similar to AGLINK, its medium-term baseline is a major output of the FAPRI modeling team who pioneered the development of stochastic baselines (Westhoff

2005). The FAPRI system, similar to CAPRI for the EU, allows modeling the U.S. with subnational regional detail. The U.S. focus can also be seen from its product list. FAPRI is solved either in an econometric package or EXCEL. The FAPRI approach of modeling was successfully exported to Europe where the so-called AGMEMOD model which covers individual EU Member countries plus some other European countries shares many of its features. FAPRI also has a rather long history. Similar to AGLINK-COSIMO, FAPRI can also provide insight in how to organize and market baseline work.

The PEATSIM model (Somwaru and Dirske 2012) by the USDA is, like IMPACT, a net-trade Multi-Commodity model based on an equation template, however, with a narrower commodity focus of 31 commodities, of which 6 are dairy products, and less regional detail with 27 countries/regions. It is however a recursive dynamic model based on a partial adjustment approach on the supply side. In contrast to IMPACT, it comprises an explicit price-dependent stock change equation. Similar to IMPACT, consumer prices are derived from producer prices by a (larger) consumer price margin which accounts for marketing and processing costs. There is no discussion in the model documentation how the elasticities collected from different models are reconciled for use in PEATSIM, or if regularity conditions are imposed. The PEATSIM model in that respect seems again rather similar to IMPACT. The trade part of PEATSIM is however different from IMPACT as domestic prices are a weighted average of import and export prices, where the weight depends on export and import quantities in the baseline. Import prices depend on “transmitted” world prices, transport margins and tariffs including endogenous ones under TRQs. Export prices depend again on the “transmitted” world prices and export subsidies. Producer prices can be lower-bounded by guaranteed prices, and can capture an economic rent under production quotas. As many other models, PEATSIM is realized in GAMS.

The market module of the CAPRI modeling at the University of Bonn (Britz and Witze 2012) is a comparative-static, spatial multi-commodity model. It has a similar detailed product list as IMPACT, however somewhat less detail with regard to countries (about 70). Methodologically, it is more similar to CGE models as it employs the Armington assumption to model bilateral trade and uses flexible functional forms (normalized quadratic for supply and feed demand, Generalized Leontief for final demand) calibrated according to micro-economic regularity conditions. It comprises a land market, and explicitly considers energy in its feed demand system. For long-term analysis, both demand elasticities and consumer price margins are income dependent, which changes are estimated econometrically based on a cross-sectional approach. The parameterization of the demand system considers also the impact of income changes on total calories demand. Similar to AGLINK-COSIMO, CAPRI features a highly detailed biofuel module which also includes markets for fossil transport fuels. CAPRI covers a wide range of bilateral trade policies (ad-valorem and/or specific rates, TRQs, minimum import price regimes), of limited interest for the applications of IMPACT in the context of global foresight activities. A Bayesian-based approach is used to construct the baseline, drawing on different sets of a-prori information such as automated trends and results of other studies.

CAPRI is realized in GAMS and uses a strict equation template, a feature it shares with IMPACT. It is equipped with a GUI, hosted on a software versioning system and attempts a release system. Similar to IMPACT, a welfare analysis is a typical part of a CAPRI simulation. The market part of CAPRI can be used in stand-alone fashion or based on sequential calibration to highly detailed programming models and regional CGEs, however these modules only cover Europe. A further unique feature of CAPRI is a spatial down-scaling component to the 1x1 km grid scale. Similar to IMPACT, CAPRI is

maintained and applied by a network of researchers. Accordingly, activities such as a yearly training session foster collaboration, as well as an institutional set-up where certain researchers oversee the development and maintenance of modules assigned to them. CAPRI is managed as an open-source project.

Of specific interest to IMPACT could hence be the way elasticities in CAPRI and consumer price margins are rendered income-dependent, how regularity is imposed and nutritional demand integrated in the parameter calibration. Equally, the GUI part of CAPRI might be worth a closer look. And finally, the Bayesian-based approach to baseline construction might be reviewed and compared to Delphi-based approaches used by AGLINK-COSIMO and FAPRI.

The GLOBIOM system (e.g., Havlik et al. 2013) by IIASA draws on the FASOM model by McCarl and combines the demand and trade specification of a Takayama-Judge type model with a programming approach on the supply side. In contrast to all other models mentioned so far, it is purely linear and uses a full dynamic optimization over the long-term simulation horizon. The demand functions are step-wised linearized and only comprise own price effects. GLOBIOM is backed up by a detailed, global GIS-based data management system which allows, similar to GTAP, for flexible regional aggregation. The high spatial resolution and focus on resource use and the application of crop growth models to assess the impact of climate change at the grid level are features which are similarly found in IMPACT. GLOBIOM seems to be the only PE with a focus of agriculture and food which also covers forestry (Böttcher et al. 2012) which seems important with regard to competition for land in the long term. GLOBIOM was not covered by the Channing and Robinson review in 2010, probably as very limited information on the model was available at that time, however, they also referred to IIASA's modeling activities. A concise up-to-date model documentation of GLOBIOM does not seem to be available.

There are few PE models with a structure similar to IMPACT with a focus on the long term. There was the long-term version of WATSIM (von Lampe 1999, no longer in use) and the @2030 model (Britz and Schmidhuber 2002) developed for the Global Perspective Unit at FAO, by now also abandoned. The review will later refer to these models as they comprise methodological solutions potentially of interest to IMPACT. However, both GLOBIOM and CAPRI are also regularly used for long-term analysis, similar to IMPACT which is also used for short to long-term analysis.

Some of the reviewed models above are either hosted at international institutions (AGLINK-COSIMO, GLOBIOM) or research institutions closely linked to governments (PEATSIM), while others are more rooted in university research (FAPRI, CAPRI, AGMEMOD), but receiving funds from governments.

Product, Item and Regional Resolution

IMPACT was over the years basically the sole global PE model covering all major calorie/protein providing products, including roots and tubers. However, that is no longer a unique selling point as, e.g., COSIMO and CAPRI now offer a similar product list. Ongoing global foresight projects involving other CGIAR Centers attempt a further disaggregation on the product side by, e.g., introducing sweet potatoes or different sorts of pulses, to render the model more relevant for regional specific analyses where such products are important. However, this disaggregation requires a careful re-parameterization especially of IMPACT's demand side to account for the increasing cross-price effects in rather disaggregated product groups. Equally, many of the products currently introduced into IMPACT are often only regionally relevant and only to a limited amount internationally traded.

That raises concerns about how price formation for these products, some primarily found in subsistence production systems, will be modelled. Currently, IMPACT allows either for international or national clearance, in the latter case, the market is depicted as completely insulated, limiting cross-commodity linkages.

The regional resolution of IMPACT2 is quite high compared to most competing models (114 regions which are further broken down to major river basins), and has further increased in IMPACT3. However, increasing the regional resolution only makes sense if either constraints at the regional level are considered important (e.g., irrigation water availability, land availability) or drivers differ across regions (e.g., climate change). In both respects, IMPACT seems to have good reason to work on the level of Food Processing Units (FPUs). Models that go beyond IMPACT at the global scale with regard to spatial disaggregation are the grid-based models GLOBIOM and MAgPIE, which however use an explicit production function approach on the supply side. Grid-based information is, however, partly used in data processing by IMPACT.

Agricultural Supply

IMPACT models supply based on iso-elastic functions. Quantity supplied is the product of production level (acreage/herd size) and output coefficient (yield/carcass weight). Both the acreage and yield equations for crops comprise an explicit shifter for water, and comprise own-price effects. As discussed below, the behavioral equations in IMPACT3 for the supply of crops no longer comprise cross-price effects; competition for land is the sole interaction between crops on the supply side incorporated in the model.

The yield equation depends additionally on input prices, and in the case of IMPACT3, also on the endogenous land price. It is not clear what behavioral model is underlying the overall response of supply to prices in IMPACT2. It is hard to imagine a profit maximization problem where only yields, and not acreages, depend on input prices. It is also not clear what inputs are covered, as the documentation only says “e.g., labor, fertilizer.” The documentation states (page 6): “The absolute values of yield elasticities with respect to own-price, capital and labor add up to the crop price elasticity,” which also remains somewhat unclear.

FAPRI as well as AGLINK-COSIMO render acreage response a function of (net) returns per unit of land, such that the acreage reacts to changes in yields, price, crop-specific subsidies to land and also input prices.

More generally, in contrast to final demand, the documentation does not mention the source of the supply elasticities. As the structure of IMPACT is rather simple — which can be seen as an advantage, especially with regard to capacity building, but also tracking simulated changes back to the shock — the quality of the simulated results almost entirely depends on its parameterization. More transparency with regard to parameter sources would not only be highly welcomed for future reviews, but might also be seen as a prerequisite to avoid a loss of trust by result users.

The major difference to other models solved in yearly steps is that IMPACT does not comprise lagged effects in the equations. This naturally eases analysis of the results and can avoid unwanted impacts such as Cobb-Web like developments over time. But it also implies that IMPACT generates a series of unrelated comparative static equilibria, such that the parameterization should rather reflect the long term. The market clearing condition (page 11, equation 21) comprises stock changes, but there

seems to be no matching behavioral equation, which fits its comparative-static nature. The solution in yearly steps seems to be mostly motivated by the interaction with IMPACT-WATER. As solution time is low, solving for each year has the advantage of producing time-series results, e.g., for publications.

In contrast to, e.g., CAPRI and ESIM, IMPACT2 does not explicitly comprise a land market. The current structure would also not allow this, since the model does not cover grassland or fodder production on arable lands. This serious shortcoming for long-term analysis is overcome in IMPACT3. However, it seems that cross-effects of supply in IMPACT3 are basically solely related to the land market; indeed there are no cross-price effects on acreages and yields of other agricultural products. One might indeed argue that in the very long term, capital and labor are fully mobile and the agricultural sector small, such that prices for capital and labor could be considered exogenous. However, condensing the interaction between crops to a market-clearing mechanism for a given fixed land endowment might go too far. This does not allow, e.g., to consider that land might not be homogenous inside a FPU, such that returns to land might differ between crop activities. The consequence of the IMPACT3 structure is that cross-price effects between crops are only modelled via changes in the price of land. However, the view that all other resources besides land are fully mobile certainly does not hold in the short to medium term, where labor and capital can be considered quasi-fixed assets. But even assuming fully competitive labor and capital markets in the long run, there will always be in any year some quasi-fixed factors in the farming sector such as farm labor and machinery, due to (human) capital specificity and physical capital lifetime. The resulting competition at the farm level between crop and animal activities for such quasi-fixed factors should lead to some cross-price effects. Additionally, especially features such as intercropping in (sub)-tropical agriculture as well as crop rotation in low extensive systems are at least hard to capture by the proposed structure; describing linkages between crops only by competition for land seems too restrictive. The team might also consider a land supply function such that total area use by the activities considered in IMPACT is endogenous. Such a land supply function is found, e.g., in the CGE LEITAP, ESIM or CAPRI. In GLOBIOM, alternative land uses such as forestry are even explicitly modeled.

One possible solution to consider to differentiate between the long and short run would be a partial adjustment approach which introduces recursive-dynamic features, used, e.g., in the @2030 model by the FAO's Global Perspective Units or PEATSIM, where long-term supply elasticities presume high factor mobility and the short-run response in individual years is a linear combination of last year's supply quantities and the long-term optimal response. But even with a partial adjustment approach, one might challenge the decision to set any cross-price elasticities in crop production on the output side equal to zero (there are some small effects left in animal production), and only use land competition for cross-effects. To the knowledge of the reviewer, IMPACT is the sole PE model using this approach.

The supply of animal products is similar to that for crops, made up of an activity level — the herd size — and a yield, i.e., the amount of milk and meat produced per head. In contrast to crops, the yield is only trend-driven. The herd size depends on own and cross-price effects and trend shifter. Generally, the livestock part needs additionally to account for (1) dietary requirements of the different herds, (2) substitution between different feedstocks, either marketable or not, and (3) the economic consequences for animal supply and feed demand. Given data availability and the structure of PE models, that is a challenging exercise. IMPACT seems to account for the dietary requirements based on "feed ratios" attached to the output quantities. These feed ratios are,

according to information from IFPRI staff, based on a biophysical model. The substitution is based on own and cross-price elasticities which are not differentiated by type of livestock. The feed demand per products is further shifted with a product-specific productivity factor. With such a setting, price changes will implicitly update the feed ratios. It is also clear from the fact the own and cross-price elasticities are not herd specific, that the current system cannot guarantee that dietary requirements expressed by the feed ratios are maintained. It is also not clear if the elasticities even attempt to reflect such a requirement. Equally, it is unclear if the cross-price effects between livestock and products used for feed reflect the feed ratio and the cost-share of feed. Here, an improved documentation would be required for more in-depth evaluation.

In the AGLINK-COSIMO model, cross-price effects from products used for feed for animals are expressed by herd-specific feed price indices. Such an approach might fit to IMPACT, the feed price index could reflect the feed ratios, updated with the assumed own and cross-price feed demand elasticities. Besides an assumption on the feed cost-share, no further information would be necessary, the herd equations could be driven by the supply elasticities multiplied by the per unit returns (output prices minus feed cost-share times feed price index). CAPRI uses for its European part an explicit cost minimization of the feed mix under a set of requirement constraints (e.g., energy, protein, dry matter min/max). The results for similar, technologically rich models could be used to derive cross-price effects for feed use. For its non-European part, CAPRI comprises solely a feed energy balance. The supply equations for the different animal products comprise cross-price effects with the feed energy price related to that balance. The feed demand system is then expressed as a profit maximization problem of the feed industry which has one output — feed energy — which is produced from the mix of feeds. Such an approach could be an alternative; with enough information, feed and protein balances per type of livestock could be introduced.

Crop Growth Model Link

The documentation states “The DSSAT analysis then applies the localized temperature and precipitation effects and simulates crop growth again, noting changes in yields, area, and production when compared to the initial simulation of current climate for temperature and precipitation.” The sentence is at least unclear, as at least standard crop growth models cannot simulate a change in acreage. Rather, they assess impacts of changes in crop management (irrigation water and nutrient applied), soil conditions, or climate on yields.

The documentation comprises easy to misread sentences such as: “For irrigated area, only the negative effects from changes in temperature and precipitation are considered.” This is one of several examples where probably simply better wording of the documentation could clarify model mechanisms and avoid misunderstandings. It is hence recommended to improve the documentation with regard to the linkage between the crop growth model and IMPACT.

Unfortunately, the author cannot provide a review of DSSAT activities from a scientific perspective and also the professional peers interviewed were not able to help in this respect. Hence, future reviews might be well advised to also draw on expertise in crop growth modeling as the work in the reviewed activities heavily relies on crop growth modeling.

Water Model

One of IMPACT's strong points is the link to IMPACT-WATER which, for a similar reason as stated above for DSSAT, is not reviewed here with regard to the hydrology. The focus here is on the interaction between IMPACT and IMPACT-WATER which is based on recursive dynamics. The documentation on IMPACT-WATER is quite comprehensive. IMPACT delivers yields and acreages of irrigated crops which determine the irrigation water demand in IMPACT-WATER to which water demand of livestock is added to arrive at overall agricultural water demand. In the overall system, if the reviewer has understood the system correctly, water demands are basically hierarchically ordered such that irrigation water use has to adjust first and will be driven even to zero before other water use adjusts to shortages.

If the reviewer understands the feedback between the water model and IMPACT correctly, the yield in the current year is adjusted if crop water requirements are not fully met. This has, however, no impact on area allocations in the current year, nor yield or acreage in following years. Again, improved documentation might be beneficial. IMPACT staff provided the information that in each year, IMPACT3 is solved twice, where the second solution considers the yield changes simulated by IMPACT-WATER to determine market clearing prices, however at fixed crop allocation. It is unclear how the underlying, stochastic short-run perspective — farmers have to allocate their land at the beginning of the season without knowing the weather and thus water availability during the growing season — fits to a comparative-static long run perspective where agents should also foresee average water availability.

While the investment in data to allow for a distinction between irrigated and rain-fed agriculture are to be applauded, and while the link between a hydrological model and an agricultural PE at global scale is to the reviewer's knowledge still unique, there seem to be basically no direct economic feedback mechanisms either in IMPACT-WATER or IMPACT with regard to changes in irrigation water availability. Such feedbacks seem currently to occur only indirectly, via reduced supply in global markets and consequent price adjustments.

Overall, there seems to be ample scope to capitalize better on the investment into IMPACT-WATER and the rain-fed/irrigation distinction by introducing more economic behavior in modeling impacts of changes in irrigation water availability. (As I understand it, the IMPACT model focuses largely on surface water since it is river basin focused. Clearly there is an interface with ground water, but this is not a part of the IMPACT modeling structure. Much work needs to be done here.)

Food Demand

Food demand is based on iso-elastic functions depending on own and cross prices and income. The price dependent part of the functions are basically driven by world market prices plus 50 percent of a so-called "marketing margin" (MI) which are described as "MI reflects other factors such as transport and marketing costs of getting goods to market and is based on expert opinion on the quality and availability of transportation, communication, and market infrastructure." MI is different from so-called "consumer price margins" which reflect the cost of converting raw agricultural products into processed ones, e.g., the difference between the price of bread and wheat on a per raw product basis.

Without such a differentiation between primary product and consumer prices, the demand system cannot be clearly attributed to an agent, as the elasticities will measure the combined effect of decisions of the food marketing and processing chain and the final consumer. As a consequence, econometric estimates of consumer behavior which are correctly based on consumer prices cannot be used directly to parameterize the demand system of IMPACT. The IMPACT model documentation states "The IMPACT demand elasticities are originally based on USDA elasticities and adjusted to represent a synthesis of average, aggregate elasticities for each region, given the income level and distribution of urban and rural population (USDA 1998). Over time the elasticities are adjusted to accommodate the gradual shift in demand from staples to high value commodities like meat, especially in developing countries." The documentation on the USDA web site suggests that these elasticities refer to consumer prices, and not to market prices. Compared to other models, at least some of the own consumer price elasticities in IMPACT seem rather high, which is astonishing given the size of the MIs. Most PE models have therefore by now introduced a consumer price margin reflecting costs of processing and marketing, an extension recommended for IMPACT as well.

A check of the elasticities currently in use (these were listed under "GF") revealed that cross-price elasticities are generally very small while being symmetric (and not the Hisksian price effect dp/dQ, which constitutes a clear violation of symmetry conditions). A typical picture of a set of price elasticities of demand is given below (USA, animal products).

	cbeef	cpork	clamb	cpoul	ceggs	cmilk
cbeef	-0.47	0.01	0.01	0.01	0.001	0.001
cpork	0.01	-0.59	0.01	0.01	0.001	0.001
clamb	0.01	0.01	-0.26	0.01	0.001	0.001
cpoul	0.01	0.01	0.01	-0.45	0.001	0.001
ceggs	0.001	0.001	0.001	0.001	-0.31	0.0005
cmilk	0.001	0.001	0.001	0.001	0.0005	-0.24

Compared to other PE models, the analysis suggests that the final demand side of IMPACT is probably much more price-responsive, and that shocks are to a large extent buffered by final demand. That effect is amplified by the linear price transmission equations without a constant term which lead to a price transmission elasticity of unity from world market price changes to consumer prices, such that the elasticities above are directly applied to world market price changes.

The review by Channing and Robsinson (2010) already suggested replacing the iso-elastic formulation of demand with a regular demand system. According to the IMPACT team, such a change is currently in discussion, but no final decision has been taken. Indeed, a different demand system might not be necessary if the elasticities used in the iso-elastic function are carefully calibrated for each year (or at least for some time points over the simulation horizon).

The documentation does not provide information about efforts to check for plausibility or guarantee for adherence to microeconomic regularity conditions, despite the fact that the demand system is used for welfare analysis (see page 26). In that context, it might be worth looking, e.g., at Witzke and

Britz (1998) which describe how a set of exogenous price and demand elasiticities can be used and calibrated to adhere to regularity conditions. Such an approach could permit retaining to the extent possible the a-priori information on exogenous elasticities while guaranteeing plausible reaction from a microeconomic viewpoint.

For the IMPACT model, especially as it also attempts to assess impacts of changes in agricultural markets on malnutrition of children (page 28f) and share at risk of hunger (page 29f), a plausible reaction of the demand system with regard to total calorie demand in response to changes in prices and income should be guaranteed. An adequate calibration approach for the demand elasticities can besides ensuring regularity conditions also control for the implicit elasticity for total calorie (and other nutrients), an approach used in CAPRI. The IMPACT team has indicated in interviews that it will work on improved parameterization of the demand system.

For long-term analysis, a clear differentiation between demand for primary agricultural products and processing/marketing is highly relevant, as with increasing income, demand for nutrients is reduced and demand for other traits (taste, variety, convenience in preparation, image …) increased.

Feed Demand

A similar point of improvement might relate to feed. It is currently unclear if the elasticities in the feed demand system ensure a plausible substitution between feeding stocks by, e.g., maintaining energy and/or protein balances (see also the comment on the supply side above). The IMPACT team is currently working on an improved livestock module whose details are not known to the reviewer. (Livestock demand and production are both limited in all of the models reviewed — a good place for IMPACT modelers to hold some kind of workshop or series of workshops to gain more effective ways to model the livestock sector all the way up to final demand.)

More generally, poor data on grassland management and on fodder production on arable lands hinder a solid assessment of the interactions between livestock and crop production. Many PEs therefore do not model fodder production directly, but only via cross-price effects in feed and supply. An initiative to improve data on fodder production and fodder shares used in the production of key animal products would therefore certainly be valuable.

Other Demand

IMPACT uses, as do many other PE models, crushing equations for oilseeds based on a Leontief relation which is hence state-of-the-art. Somewhat astonishing is the fact that dairy products are aggregated into one category. Whereas such an approach seems feasible on the supply side assuming that raw milk is not traded across supply units and that all produced dairy products stem from raw milk outputted in the same unit, it is unclear how the fact is handled that fat and protein based products are traded in different shares. Here, all other global agricultural PE models offer more insight.

How the biofuel equations are actually implemented is not documented, it is just stated that they depend on blending mandates, energy prices and PSEs. It is hence recommended to improve the documentation in this respect.

Demand for other uses (which is not clearly defined) is simply driven by, it looks like, final demand changes. One wonders why this category is then introduced at all and not already aggregated at the database level.

Market Structure, Price Transmission and Policy Coverage

IMPACT is clearly not a tool which can compete with PE models set-up to analyze in detail domestic or trade policies such as AGLINK-COSIMO, FAPRI or CAPRI. To give examples: AGLINK-COSIMO and FAPRI include market specific detail on actual policy instruments which is not feasible with a simple PSE based approach, whereas CAPRI's strong point is a detailed analysis of trade policy instruments based on an Armington-based modeling of bilateral trade. Such detailed representation is certainly not necessary in long-term analysis where the fate of currently used detailed instruments would anyhow be unclear. As such, the choice of a more indicator-based presentation of policy instruments, close to how CGEs operate, might indeed be the appropriate way to capture policies in IMPACT if its main application domain relates to global long-term analysis.

As the model documentation refers to PSEs, it is unclear how policies in LDCs are covered if, e.g., the NRA concept of the World Bank is applied in cases where no PSE/CSE calculations are available from the OECD. The PSEs express all policy interventions independent from the underlying policy instruments into one number. Some of these instruments such as ad-valorem tariffs indeed imply a perfect price transmission, other such as per unit subsidies to outputs or inputs rather dampen the price transmission. As the PSE calculations of the OECD are by now differentiated in some broader categories, it might be advisable to differentiate in the price transmission equation at least between additive and multiplicative elements (modeling the impacts in terms of explicit policies — FAPRI has moved in this direction recently).

The price linkage equations are linear and do not comprise additive elements. This implies a price transmission elasticity of unity between international prices (PW) and domestic prices faced by producers and consumers. That seems hardly appropriate for developing countries which, e.g., due to natural protection are not fully integrated into international markets. These multiplicative margins also imply that marginal transport and transaction costs change in quantities, which should be reflected in welfare analysis. Another outcome of this price transmission equation is that *given* policies do not impact how the model reacts in a simulation, only changes to policies. Whereas multiplicative margins are also widely used in CGE models, such that the same critique might be raised as well, CGEs typically apply the Armington assumption so that the impact of border protection on the trade structure in the calibration point is captured. Most PEs differentiate between policy instruments which lead to additive terms in price transmission equations (such as specific tariffs or per unit subsidies) and multiplicative ones, such as ad-valorem tariffs, which increase price differences but leave the price transmission elasticity at unity.

A consequence of these price transmission equations is that it should in most cases not matter for simulated prices and quantity changes in which region a quantitative absolute shock is implemented. To give an example: increasing the biofuel processing demand of a product by given amount in the U.S. should have the very same effect on simulated price and quantity changes in any country when introducing the same shock in another country. Clearly, if yields are shocked, the above statement does not hold, as the impact will depend on the acreage. Additionally, the welfare analysis should capture both the simulated change in the price and the original shock in this case (by-products are important here and handled explicitly in the MIRAGE-BioF model). It is hence recommended to

review the price transmission mechanism in IMPACT, especially to capture natural protection in developing countries.

The market-clearing equation comprises stock changes, but the documentation nowhere explains how these stock changes are computed.

Ex-Ante Baseline

A key element in any ex-ante analysis with equilibrium models is the so-called "ex-ante baseline", sometimes also labeled the "business as usual" scenario. In partial equilibrium, that scenario applies a larger set of exogenous growth rates, probably combined with changes in policy variables.

The IMPACT documentation suggests that growth rates for supply, different by yield and acreage growth and differentiated by rain-fed and irrigated agriculture per FPU, are used in the model. There is even a direct impact of climate change on acreage growth rates. How all these rather specific growth rates are derived remains mostly unclear. The changes in yields are an exception, which are linked to increased application of technologies simulated with DSSAT, which are the core of the projects involving participating CGIAR Centers in addition to IFPRI in foresight activities.

Final demand seems to be driven only by changes in population and GDP, as well as changes in income elasticities: "Over time the elasticities are adjusted to accommodate the gradual shift in demand from staples to high value commodities like meat, especially in developing countries." This assumption is based "on expected economic growth, increased urbanization, and continued commercialization of the agricultural sector." The income demand elasticity for beef in China, to give an example, drops from 0.86 in the year 2000 to 0.52 in 2050; the rice elasticity stays constant at -0.035. In the U.S., the income elasticity for beef is negative for all years at -0.03, constant for pork at 0.05 and drops for poultry from 0.47 to 0.24. The ones in Germany are all positive and show moderate drops over time. The approach to drive final demand developments solely by changes in population and income (and indirectly prices) is rather appealing from a theoretical background. The somewhat curious examples above might hint at the fact that the changes in elasticities have been used to somehow calibrate food demand developments over time.

It might be worth to explore the relation between per capita income and income elasticities for food categories to either directly integrate non-linear Engel curves in the demand system (cf. Ryan and Wales 1999) or to calibrate parameter sets for different time points, where income elasticities depend on income. The latter feature was already available in other PE models with a long-term horizon (e.g., von WATSIM: Lampe 1998, @2030: Britz and Schmidhuber 2002).

Feed demand is driven by changes in the supply of animal products and a feed efficiency change factor. The feed rations also carry a time index. How these exogenous changes in feed ratios are determined is not documented.

Overall, the baseline process can be termed lacking in transparency. It is unclear if the various growth rates are adjusted manually in a calibration exercise to arrive at plausible developments of quantity and price variables over time, and where these stem from in the first place. The same holds for the changes to price and income elasticities introduced over time.

2.4 Relevance and Effectiveness of Partnerships

Collaboration among Centers

Many of the activities in foresight modeling involve several Centers, and often, the PIs in these activities are not from IFPRI itself. Many of these activities already have a longer history and thus underline the fact that the IMPACT team has actively worked towards collaboration among Centers. The PIs generally regard contributing to the foresight activities and gaining access to IMPACT is a highly valued and relevant activity. Some Centers might have limited socio-economic expertise, and for the few socio-economists working at these Centers, the activities around IMPACT offer a unique opportunity to liaise across Centers with colleagues working on similar issues, however with a different product and regional focus. As such, the IMPACT model serves as an important anchor for inter-Center collaboration.

There is, however, some danger in a purely IMPACT-centric approach to collaborative foresight work because this contributes to an information flow that is quite narrow. One tool does not necessarily address every need. Important aspects such as introducing new technologies either show up at a resolution not covered by IMPACT, such as household types, villages or sub-regions inside countries, or relate to effects not covered by IMPACT, such as the work distribution inside the household or village. Given the positive experiences of using a tool such as IMPACT to foster collaboration, IFPRI might consider extending the toolbox to socio-economic simulation models operating at different scales and with more technological detail.

Partnerships

The IMPACT team is part of the highly visible AGMIP (Agricultural Model Intercomparison and Improvement Project, http://www.agmip.org/) activities, where Keith Wiebe acts as the coordinator of the group called the Global Economics Team. Supported by major funding from the U.K. Department for International Development and the U.S. Department of Agriculture Research Service, this is largely a network of international organizations and developed country universities such as Columbia University in New York, the University of Florida, and Oregon State University. This partnership has a high potential to guide the further development of IMPACT based on a systematic comparison with similar activities at the global scale, while exploiting possibilities for collaboration. However, partners to influence public opinion are not yet prominent. As stated previously, the activities would likely benefit from a stronger focus on outreach and actively marketing their outputs.

Given the unclear sources of the parameters currently used in IMPACT at least for supply and feed, a thorough review of alternative sources seems recommendable. On the supply side, PEs with a regional focus — such as the country modules of AGLINK — or even supply-side models could be used to deliver own and cross-price elasticities. The wedges between primary agriculture and final demand could be based on cost-shares from SAMs such as the ones available from GTAP.

Finally, given similar global foresight exercises in international institutions, e.g., at FAO in the Global Perspective Units, at IIASA or the at World Bank, but also at national research institutions and universities, both based on partial and general equilibrium analysis, a careful evaluation of chances for collaboration, e.g., in fields such as model parameterization, long-term growth rates or

development of post-model indicators (e.g., nutrient, undernourishment, environmental impacts) might be considered, as also suggested by professional peers. Whereas the successful collaboration between the IMPACT team at IFPRI and other CGIAR Centers in the context of global foresight is a success story, it is clear that the others Centers cannot contribute to the core methodological questions around long-term analyses based on equilibrium models. In order to prevent costly duplicate efforts at the international level and to benefit from cross-fertilization between modeling teams, activities such as AGMIP should move beyond model comparison to coordinated model improvements. Here, IFPRI could play an active role and go from an approach where individual expertise is hired on a more or less regular basis to improve IMPACT to a strategy involving different modeling teams, e.g., to provide parameter databases or modules shared across models.

Especially with regard to module development, professional peers questioned the ongoing strategy in the equilibrium modeling community (not only IMPACT) to build "satellite" modules, e.g., with regard to land use beyond agriculture, while other core activities such as econometric estimation of parameters are underfunded. These satellite modules are often far less detailed as specialized models already in the market, such that the quality of results provided by these add-ons might be questioned. Some division of labor between equilibrium modelers might hence improve the quality of all models. The development of IMPACT-WATER by a different team at IFPRI and its link into IMPACT can be seen as such an example.

However, the IMPACT team should continue to keep the necessary resources for core model improvement and model applications; international collaboration should hence not be confused with outsourcing core activities.

Effectiveness — Outputs, Outcomes, and Likely Impacts

The foresight activities supported by PIM cannot yet demonstrate many outcomes because the team has been undertaking, based on Channing and Robinson (2010), a thorough restructuring and enhancing of the IMPACT model, which forms the anchor for this work. Outcomes are also not easy to attribute since many are joint with other contributors, visible over the long term, and global or regional in scope.

The direct outputs of the foresight activities are large data sets (simulation results from IMPACT) which need carefully designed dissemination activities to become useful for informing policy design processes. Here, the outputs are to a large extent still somewhat conventional (typically conference contributions, peer-reviewed journal publications, monographs). The output strategy is thus to a large extent rather similar to that of more blue-sky oriented research institutions such as universities. This might also reflect preferences of the involved researchers who like to keep a door open to less applied research activities. Scientific peer-reviewed output clearly adds credibility to modeling activities and should certainly be continued.

However, it is not evident that these more scientifically oriented outputs have a likely high impact on policy design processes. The information available in these publications is often too general to be of specific use for national and international decision takers. A clear counter-example to this is IFPRI's climate change in Africa series with its national chapters, which however draws on much more than the global foresight activities. Thus, the team could be encouraged to seek direct contact with policy makers and think about alternative formats to funnel their findings in the policy debate.

Equally, the policy angle in the activities is not very clear. IMPACT is a long-run simulation model designed for scenario analysis. The main policy being addressed is the allocation of resources for agricultural research among competing priorities, this being important to the principal clients for the work — the CGIAR, NARs and SROs. The IMPACT model itself offers only very limited possibilities to explore targeted national policy interventions to countervail negative developments highlighted by the foresight activities. While the model does include ad valorem wedge instruments (PSE, CSEs, and tariffs), these are not part of the long-run analysis of climate change scenarios that the team has focused on in recent years. Here, the CGEs offer more possibilities, and more collaboration in that respect could be promoted.

Experience in policy and outlook modeling has shown that early and regular review and interaction with clients as well as with other analysts is a good way to validate a model at the same time as it informs users how to interpret analytical results and understand its strengths and weaknesses. This also helps to avoid misuse or misinterpretation of the analysis. While the Foresight Conference in November 2014 was a good start along this road, this was mostly an "in-house" interaction. Participation needs to be broadened and perhaps specialized to different user groups that IFPRI and PIM serve, including decision makers in the CGIAR system.

2.5 Gender Mainstreaming

Gender-Related Activities

Several of the PIM-supported activities aim at collecting and integrating gender-related data and parameters in the modeling activities. Here some word of caution might be necessary. Core indicators in IMPACT (welfare, nutritional) are difficult to disaggregate by gender. Other core aspects of gender in the context of evolving agricultural management and food chain practices (male and female labor use, move from household to industrial production, and impacts on labor markets or the marketing chain) are not reflected in IMPACT. However, the researchers in participating Centers often have access to data, e.g., with regard to labor use at the household level in specific crop management practices, so that the impact of changes in management on, e.g., household labor use could be evaluated.

It is therefore suggested to search for tools that could be applied in parallel to IMPACT in projects linked to global foresight and that could bridge the scale between individual crop management simulation in DSSAT and global modeling in IMPACT. Such tools could, e.g., be simulation models at the village or regional level, but also simple approaches such as the calculation of crop budgets including labor use estimates.

2.6 Capacity Strengthening and Sustainability

Capacity Strengthening

The activities under Flagship 1 comprise training CGIAR staff in the collaborating Centers in the use of IMPACT (the reviewer also had access to the training material). Supporting these activities is the development of a Graphical User Interface for the IMPACT model which should ease its application by non-experts.

The author remains somewhat skeptical about the usefulness of training CGIAR scientists in model use — a view not shared by all members of the expert panel or by all interviewed PIs. An overview introduction to IMPACT is certainly necessary to explain to all project participants the flow of information in the project and to motivate the team to provide the necessary input data. My experiences with systems such as CAPRI, AGLINK-COSIMO and others suggest that it might take quite some time until even a trained economist has gathered the necessary knowledge about the modeling in general and the model at hand specifically to perform independent simulation exercises and to make judgements about the results given the assumptions underlying a simulation experiment, and the structure and parameterization of the model. The fact that a user interface can ease running simulations does not imply that use by non-experts should be recommended.

A model as complex as IMPACT is a valuable tool in the hands of a well trained and experienced analyst, but should not be used as a "black box" even if it were mechanically possible. Clearly, some Centers might be in the favorable position to have trained modelers in their team or might be able to invest in building up the necessary expertise. For other Centers or for scientists who cannot undergo lengthy training, access to the general outcome of the long-term results produced by IMPACT is possible by consulting publications such as IFPRI's climate change in Africa series which provides the quantitative information from the model already in a commented upon and condensed form, which might be preferred compared to looking at raw model results. Also a second member of the expert panel reported that in his reviews of CG Center projects, all PIs were having trouble with the modeling related to IMPACT for various applications and indicated that they needed technical support. He concluded that most of the CG Center economists might not understand the modeling technology and cannot independently use the IMPACT or foresight models and that somehow this deficiency must be fixed if the vision of PIM is to be realized.

Rather, the author suggests investigating how researchers in CGIAR Centers could let IFPRI staff run simulations for them and discuss with them the results in detail. Doing so would also mean that the model need not to be installed (and kept updated) at the different Centers.

Sustainability

The IMPACT model has a long history, and has a relatively large development team. With regard to human capital, there are no obvious concerns that crucial knowledge is either not documented or only available with one or two staff. The involvement of external expertise, e.g., in the development process of IMPACT3 can be seen as an additional safeguard. Some professional peers nevertheless suggested that the IMPACT team should actively try to attract additional experienced PE modelers, and more commodity analysis expertise.

IMPACT draws to a large extent on publicly available data sources and uses widely applied software (GAMS/PATH) so that no immediate threats are visible in these two fields. It might be beneficial to involve some software engineering expertise in the further model development, to, e.g., develop a release strategy.

The foresight activities #5, #13, #17, #22, #23, #90, #95 and #97 reviewed in the context of the present in-depth analyses required in sum substantial funding, exceeding probably the financial resources of any comparable activity at the global scale. It is unclear if similar funds would be necessary in the future to maintain the core deliverables provided by these activities to fulfill the main aims of these activities.

2.7 Organizational Performance

The majority of the interviewed PIs mostly reported positive experiences with the PIM Management Unit (PMU). Problems were mostly mentioned with the intermediate phase where old legacy projects were running partly in parallel to the new PIM structure. In some cases, a better informational flow especially between cluster leaders and the PMU was suggested.

Some PIs face the challenge to have the very same activities contributing to several projects, often funded by different sponsors and linked to different reporting obligations. Here, to the extent possible, reporting obligations should be streamlined. This might be achieved if PIM acted as the contractual partner instead of the individual Centers such that the PIs only report to the PMU, and the PMU uses the information to report back to the sponsors.

2.8 Overall Value Added of the Modeling Activities

The declared aim of these activities is to provide input to the long-term strategy of the overall CGIAR research program. At the current stage, it is impossible to evaluate if these aims can be achieved as the output is not yet funneled into a new decision taking structure across CGIAR Centers.

The activities itself are to a large extent legacy ones which existed often already in a similar format before the establishment of PIM. A clear added value of the activities is to incorporate information from the different Centers in a coherent and structured way. At the same time, the Centers gain access to IMPACT as a tool which can be applied by them to assess possible impacts of their research activities.

An issue arises from the rather high aggregation and to some degree also abstraction level of models such as IMPACT. The individual Centers conduct research aiming at improving crop and crop management in a regional context, which gives them access to highly detailed and valuable knowledge about various impacts of current management practices and possible improvements, e.g., on soil fertility or labor use at the household level. Information at that detail can hardly be used in IMPACT. Instead, possible technological advances need to be condensed into a yield shifter for IMPACT. At least to the reviewer it remained somewhat unclear if and how valuable information available at the Centers and partially collected in the context of the projects is exploited beyond its use in IMPACT.

The majority of the professional peers also raised concerns that some published or commissioned applications of IMPACT might have gone beyond the scientifically sound application domain of IMPACT. These peers seem to be mostly concerned about the application of a comparative-static model with limited policy coverage to more short to medium-term issues in agricultural markets, but also mentioned, e.g., simulated developments in commodity prices which they considered implausible. Another issue is that some professional peers have the impression more generally that the strategic foresight activities focus too much on climate change, and too little on the question of which changes in the agricultural and food system are necessary to feed the world in 2050. Indeed, at least some of the projects reviewed herein which look at future technologies seem to focus almost entirely on crop improvements related to climate change, and not so much at more holistic strategies to increase agricultural output, e.g., sustainable intensification. There were also concerns

raised that other important threats such as soil degradation or overexploitation of (ground)water resources have not been given enough attention.

3. Report on the MIRAGE Global Trade Model – By Stanley Johnson

3.1 Introduction

The MIRAGE Trade Analysis Model, developed in a CGE framework, was initially constructed at CEPII (Centre d'Etudes Prospectives et d'Informations Internatonales) and was adopted by IFPRI several years ago with the hiring of David Laborde and Antione Bouët. This model has been used at IFPRI for:

- trade analysis and projections focusing on the role of and benefits for developing countries;
- conducting analyses for specific regions and countries to support changing policies;
- biofuel policy analysis and projections (primarily for the EU);
- applications with the World Bank household survey data.

The MIRAGE Trade Analysis Model, as it is called in this review, includes other MIRAGE models that have utilized this basic structure, and has evolved considerably since its move to IFPRI to encompass applications in the four uses identified above — and especially third and fourth. Unfortunately, the documentation of the various versions of the MIRAGE model has lagged behind these newer applications. More will be said about documentation later, but this has been an issue for the current in-depth assessment of the model developments and applications.

This review will focus largely on the uses of the MIRAGE Trade Analysis Model and projections in relation to policies and outcomes for developing counties. This was the original focus of the work with the MIRAGE model when taken up as a modeling activity by IFPRI. Work in the other three areas will be discussed where appropriate, but the report is primarily about model development and applications in a trade context, which in the first case has been used to reflect the interests of developing countries and in the World Trade Organization's Doha Round of negotiations. This Doha Round has had as one of its directives reducing the tariffs and trade restrictions among and between developing and developed countries.

Assessing the MIRAGE Trade Analysis Model is a challenging task because, in addition to limited documentation, the model is continuously being adapted in response to new or different versions of the issues to which it is addressed. Often the MIRAGE Trade Analysis Model has been applied to special problems related to trade analysis and projections for specific sets of developing countries. A good example is the collaborative work with Will Martin at the World Bank who has worked with Laborde and others at IFPRI on the political economy of market assess in connection with the Doha Round, using a more disaggregated trade model (Laborde and Martin 2014).

In addition, IFPRI staff have contributed to the GTAP data base (Global Trade Analysis Project), which is now used for most if not all of the CGE global and trade applications. IFPRI has not only used this data base but also more importantly had a major role in adding country contributions to it. A good example of this effort is the most recent conference on the GTAP data base which was organized by Antoine Bouët at IFPRI. Tom Hertel, the originator of GTAP at Purdue University, commented in a very positive way about IFPRI's contributions to improving the GTAP data base.

The author of this review accepts full responsibility for any errors of commission and omission. At the same time, he acknowledges the contributions of several conversations with professional peers in the field (many of whom are co-authors with the senior IFPRI research staff involved in the MIRAGE Trade Modeling effort). His sincere thanks to all who have contributed both directly and indirectly to this review.

David Laborde and Antoine Bouët — the two individuals primarily responsible for the MIRAGE Trade Analysis Model and applications at IFPRI — also agreed to communicate with the reviewer. These interviews with Laborde, Bouët, and other staff at IFPRI have been very helpful in providing the author with increased knowledge of the working of the MIRAGE models, with published papers related to the work on the MIRAGE Trade Analysis Model, and with specific trade projections and analytical exercises for developing counties.

3.2 Relevance of Objectives and Design

The objectives and design of the MIRAGE Trade Analysis Model have been geared toward emphasizing the trade policies of both developing and developed countries, and their implications for markets for food products around the world. The applications and development of the MIRAGE Trade Analysis Model have, in fact, been the primary modeling efforts responsible for analyses reflecting the interests of the developing countries in the Doha Round of the WTO negotiations and in other trade-related contexts as well.

Many developing countries simply do not have the capacity to perform these trade policy analyses for themselves. IFPRI, as the CG center focusing on the trade policy interests of developing countries, has been providing the analyses addressing their interests in the WTO Doha Round of negotiations and also in regional trade policy negotiations.

The breakdown of these countries as represented in the basic MIRAGE Trade Analysis Model is provided in Laborde and Martin (2014, Table A.3), and includes Australia/New Zealand, Bangladesh, Brazil, Canada, Chile, China, Egypt, EU–27, Hong Kong/Singapore, India, Indonesia, Japan, Korea, Rep of Taiwan, China, Middle East and North Africa, South Africa, Thailand, Turkey, and USA: The World Bank Classification — All Countries, Low and Middle Income Countries (non LDC) and High Income Countries, and LDCs (Least Developed Countries). It is clear that the MIRAGE Trade Analysis Model has added to the capacity for reflecting more specifically the interests of the LDCs. Other more recent versions have an even more refined breakdown for developing countries.

The special versions of the MIRAGE Trade Analysis Model have particular traits that distinguish them from the “basic” version. These traits relate to ongoing policy issues for developing countries. A first example is the integration of the MIRAGE Trade Analysis Model with the World Bank household survey data. This disaggregation of the household sector can offer more solid evidence of food production and marketing issues related to gender.

Gender can be recognized because the households can be represented to reflect the subsectors in which women are the major providers of agricultural production goods and services. There are currently as many as 80 different types of households used in the adaptations and applications of the household version of the MIRAGE Trade Analysis Model now under way. Although the World Bank household survey partitions households into a large number of segments, it does not include

markers for gender-related labor services and related products. Therefore, it is not possible to analyze gender aspects in the labor sector to the same extent as in the consumption sector.

Another version of the MIRAGE Trade Analysis Model — the MIRAGE BioF Model — has focused on biofuel policy in the EU (Laborde and Valin 2012). This model and its projections have now been introduced into the official EU policy for renewables, and in particular, for analyzing of the Renewable Fuels Mandate (RED) for biofuel use. This most complete analysis up to now was possible with a breakdown and modeling for each of the (then) EU–27 Member States, and has led to the development of special data sets for emissions from cropped and converted non-cropped land for each of the Member States — the so called land use changes to accommodate the increased biofuel demand. This breakdown was of importance to the EU since each Member States must come up with its own approach to meeting the EU biofuels mandate. It could also possibly provide a useful template to break down lands used for agriculture and non-cropped agricultural lands in developing countries for analyzing similar types of trade and biofuel mandates.

The MIRAGE Trade Analysis Model has also been used to analyze regional trade opportunities in sub-Saharan Africa (Laborde et al. 2014) and in South America (Bouët et al. 2012). Robichaud et al. (2014) also provide a version of the MIRAGE Trade Analysis Model which focuses on the disaggregation of the government sector for improved analysis of policy modeling, which is related to the household disaggregation model described above. Thus, the MIRAGE Trade Analysis Model is getting significant use at IFPRI, and is well specified to address issues raised by sets of countries that are pursuing trade liberalization and common markets.

Finally, it should be mentioned that the software at IFPRI has evolved to make it more possible to reflect trade policies and barriers in CGE solutions. This software goes by various names but is a method of aggregating the various trade policies and barriers into specific expressions of actual trade restrictions. This software, developed at IFPRI, was mentioned by several of professional peers interviewed and has been a major contribution of the IFPRI modeling team for use in these and other modeling efforts.

3.3 Quality of Science

The official documentation of the MIRAGE Trade Model, albeit rather limited, is provided in two papers, Decreux and Valin (2007) and Robichaud et al. (2014). The current discussion of the model draws mostly on the first of these references. The second publication also had an objective of developing the computer programming of MIRAGRODEP (related to the MIRAGE Trade Model) in GAMS. Both versions are highly condensed and require considerable study to understand even the basics. Perhaps this is because the MIRAGE Trade Analysis Model is a standard multi-country trade model of the type now familiar, and identified with the earlier work of Hertel and colleagues at Purdue University (Hertel et al. 2007). Still, given the various specializations of the MIRAGE Trade Analysis Model, additional documentation would be beneficial.

After reviewing the structure of the MIRAGE Trade Analysis Model, the quality of science section will move to the major applications of the model, the WTO Doha Round of trade negotiations and applications to more specific trade and policy issues, and to regional sets of countries and trade negotiations. This latter set of analyses has generated a number of scientific publications. This review will concentrate on only a few of these major outputs from the MIRAGE Trade Analysis Model.

Model Documentation

This discussion is brief, and is drawn from the two publications mentioned above. The author did not have access to the full model documentation (which does not seem to exist in other than computer code form) for developing this section. This was not totally unexpected since the model is continually undergoing extension to address different trade issues, and it has been extended to include the MIRAGE-BioF model, the MIRAGE Household Model using World Bank household surveys, and other specializations related to more specific applications. What is available is a relatively standard summary of the basic structure of the MIRAGE model, which is of the regular CGE type.

Demand Side

Final consumption is reflected by a representative agent for each of the regions (or countries) in the model and by an intertemporal utility function. Fixed shares go to savings and to final consumption, and below this a first-tier Cobb-Douglas function for choices. The preferences across sectors are represented by a linear expenditure system which implies a constant elasticity of substitution (CES). Consumption choices within each sector are determined by a nesting of CES functions as represented by Harrison et al. (1997). This specification allows a particular status for domestic goods and product differentiation according to geographic origin, and therefore can be incorporated with an Armington assumption.

The choice of substitution elasticities (introduced from different studies) implies that goods which do not belong to the same quality range are less substitutable than goods from the same quality range. In developing countries, for example, domestic goods compete more directly with goods from other developing countries than goods from developed countries within a sector. This is a critical assumption for the analysis, given the focus of the MIRAGE Trade Analysis Model on developing countries.

Supply Side

Factors used in production are capital, skilled labor, unskilled labor, land, and natural resources. These factors are assumed to be fully employed, and growth rates are exogenous for natural resources and for labor, both taken from World Bank forecasts, except for capital and land. Capital is related to the exogenous savings rate in the model and land availability, and in this case, is governed by a Constant Elasticity Transformation (CET) function. Land is mobile across sectors, albeit imperfectly due to the CET, but not across countries. The production function is CES, and perfect complementarity is assumed between value added and intermediate consumption. Value added is a CES function of land, natural resources, unskilled labor and a CES bundle of capital and skilled labor. Some of these assumptions can be and have been relaxed in studies giving emphasis to particular aspects of the production process.

Imperfect Competition

Sectors such as agriculture and transportation are assumed to be perfectly competitive with constant returns to scale. Oligopolistic competition is assumed to characterize the others. The resulting rather complex formulation requires three types of parameters specifying product sustainability, scale economies, and competition intensity. With external estimates of these

parameters collected from other studies, they are calibrated jointly to minimize their "distance" from the estimates subject to the consistency of constraints imposed in the model. An inverted weighting scheme is used for calculating the distance.

Capital, Investment and Macroeconomic Closure

Installed capital is assumed to be immobile — a putty-clay assumption. Investment is the only way to adjust the capital stock. Trade makes investment important as a major cross-border component. That is, international capital flows are related to assumptions about capital mobility and equalization of rates of return. The rate of return on capital is a natural determinant of investment sharing across sectors and countries, and the rate of return incorporates many determinates throughout as would be imagined. Foreign-owned firms are treated like domestic firms. Product quality is assumed to depend only on the region of production.

Labor Market

The labor market is dual for developing countries. For the modern sector (industry and services), unskilled workers are paid efficiency wages. The wage rate is independent of the supply of labor and is indexed to price inflation, upon being adjusted for taxes, and to maintain constant purchasing power. The primary sector (agriculture) pays a competitive wage consistent with the total elasticity of labor supply where the total supply is a residual from the modern sector. In developed countries, labor is considered imperfectly mobile between sectors and substitution is represented by a CET function with a value of 0.5.

Agricultural Market Special Features

Agricultural market specifications are rather complex, as the focus of the MIRAGE Trade Analysis Model is oriented to developing countries which normally have a large agricultural sector. Farm subsidies are modeled explicitly through a combination of tariffs and export subsidies. The WTO ceilings cap according to export subsidy control is included. Production quotas are also modeled and are a part of rents. There is a special set of conditions for the EU involving export subsidies. For other countries and sectors, intervention prices and subsidy rates are exogenously set. Land mobility for the agricultural sector is assumed to be imperfect. Regions are classified as land constrained or not. Labor supply is an isoelastic function of real returns to land as initially modeled by Laborde, Martin and van der Mensbrugghe (2012).

Dynamic Set Up

The model dynamics are of a sequential nature. Equilibrium can be solved for each period. The time span can be up to 29 years. Except for capital and the growth rate of production factors which are set exogenously, no technical progress from the base year is considered. This process covers only some of the features that economists would consider dynamic. Agents and the elasticities which characterize their behavior are left as in the basic initial or base model. Livestock, which is a multi-production-period enterprise, is considered only on an annual basis. These are examples that point up the limitations of the "dynamic" structure.

Baseline

GDP and population projections are used to compute the trajectory using technical progress as specified in the base year. Initial levels of skilled and unskilled labor in each region are from GTAP 6.1. The structure of the labor force is assumed constant over time. Rates of growth of the labor force are from the World Bank population projections. Annual growth rates for GDP are also from World Bank projections. Essentially, the resource and growth rates are exogenous inputs and the MIRAGE Trade Analysis Model adjusts over time to these exogenous factors.

Areas of Application of the MIRAGE Trade Analysis Model

Laborde, Bouët and other senior staff at IFPRI (and professional colleagues outside of IFPRI) have had a marked influence on the negotiations in the WTO Doha Round based on results from applications of the MIRAGE Trade Analysis Model. They have used the model, which includes the most complete set of developing countries available, to simulate increases in market access for the developing and developed countries, and shown that there are substantial benefits in terms of trade gains and welfare benefits to reductions of tariffs and other trade barriers. As mentioned earlier, this is an important endeavor since most developing countries do not possess the capacity to construct and operate CGE models like the MIRAGE Trade Analysis Model. The IFPRI team is thus making a substantial contribution through the development and application of this CGE model to reflect the interests of the developing countries and LDCs.

This work began, as mentioned earlier, when Laborde came to IFPRI and has had a strong influence on the WTO Doha Round of negotiations, especially since 2010 when the stream of papers, reports, and presentations about the interests of developing countries and LDCs emerged. This work has continued until now with several publications and presentations produced in 2014. The work has also benefited from the inclusion of the MIRAGE Trade Analysis Model and related activities in PIM.

This research is now located in Cluster 3.1 in Flagship 3 on “Inclusive Value Chains and Efficient Trade.” It was previously located in Clusters 4.1 and 4.4 in Flagship 4 on “Policy and Public Expenditure.” The research in Cluster 3.1 now comprises the following activities and applications of the MIRAGE Trade Analysis Model:

- biofuels
- trade and domestic systems and agricultural distortions
- coping with price volatility
- analysis of global and regional trade policies
- others (including the MIRAGE Household Model).

What started with the MIRAGE Trade Analysis Model has now morphed into a set of trade-related models that cover a broad area in what might be called “modeling of agriculture in general and the issues important to poor households largely in agricultural developing countries." This is a long title, but the research is broad and encompassing. The research has also been extended to analysis of regional trade agreements. Extensions of the MIRAGE Trade Analysis Model include the MIRAGE-BioF Model, the MIRAGE Climate Change Model, the MIRAGE International Investment Model, the MIRAGE Household Model, and others.

Each of these models investigates specific issues related to the basic MIRAGE Trade Analysis Model. For example, the MIRAGE-BioF model breaks out the production sector of the model. The MIRAGE Household Model breaks out the consumption sector of the model. Other breakouts have specific names and involve breaking out the government sector, climate, and special policies for the agricultural sector in regional applications.

A particular issue with these applications of the MIRAGE Trade Analysis Model is documentation. There are two approaches that might be used to document these models. The first would be to document each of the models separately. This might be cumbersome for researchers that have great demands on their time, and is probably why there is not currently more complete documentation.

A second approach would be to bring the models together and document them in one report. This would not necessarily mean additional work since the models share many components. But the code would have to be specified so that sections of it could be turned off for applications of a particular type. In general, a strategy needs to evolve and serve as the basis for documenting the various models. Whichever approach is taken, documentation should be available for all of the "MIRAGE like" models.

Other research tools in Cluster 3.1 headed by Laborde are social accounting matrices (SAMs), GTAP enhancements, information on country-specific agricultural distortions, sets of data on nutrition and trade, World Bank household surveys, and various sets of parameters for the CGE models and linkages to modelers from other institutions that have parameters that they are willing to share (Laborde 2014a). Partial equilibrium models specialized by topics or value chains are also a part of the modeling systems in Cluster 3.1. In this respect, there are questions about the relationship of the research in this Cluster to that of another IFPRI modeling team in Flagship 1 based on the IMPACT model. This is an area worth monitoring, should these respective modeling efforts become duplicative.

Biofuels

The MIRAGE-BioF Model will only be reviewed briefly in the current report since it is the subject of another report in this volume. The major application has been to the EU and to the (then) 27 Member States that made up the EU. (The 28th member, Croatia, joined in 2013.) As such, the MIRAGE-BioF Model is not directly about developing countries. The MIRAGE-BioF modeling project has been supported by bilateral funding from the EU and has focused on the effects of the EU biofuels mandate on related land use changes. An early comparison of the MIRAGE-BioF Model and a GLOBIOM Model developed at IIASA contains a very good description of the comparative features of the two modeling approaches (Valin et al. 2013). Apparently, the GLOBIOM Model was the first to break out and model the specific member countries of the EU, which approach was then adopted by the MIRAGE-BioF Model.

This breaking out of the EU 27 countries was in some sense a precursor to the other disaggregation efforts in the basic MIRAGE Trade Analysis Model (Laborde and Valin 2012). The work on biofuels was started in earnest during 2010 and continues to date in collaboration with the EU. The EU has embraced the MIRAGE-BioF Model as one of the major elements in developing its biofuel policy for transportation and to understand the implications of the related mandate for biofuel use on changes in land use. In the EU and in other developed and developing countries, this focus on biofuels and land use changes is likely to be a continuing issue for research and policy actions.

Trade and Domestic Systems and Agricultural Distortions

This work involves measuring distortions along the agricultural value chains in both developed and developing countries. Here the focus is global with more specific emphasis on developing countries, which often have policies that discriminate against the agricultural sector. The thrust of this research is to identify, measure, compare, and contrast policies that discriminate against agriculture and distort value chains across countries and products. This work has been in some cases closely tied to regional and global trade analysis.

There are a number of papers that address this topic in the literature on the trade and growth of agriculture in developing countries. Three papers that address this topic by means of CGE-type models are Bouët et al. (2012); Bouët, Dienesch, Laborde, and Kimberly (2010); and Bouët, Laborde, and Deason (2013). The papers are about global trade patterns, competitiveness and growth in Africa, Asia and Latin America, and highlight the historical issues with agricultural trade in these countries and their recent growth. Non-competiveness is a major problem to which domestic and trade-related distortions contribute.

Of course, there are other hindrances to the development of trade and the growth of agriculture in Africa, but anti-competitive forces are important. The second paper referenced is about the costs and benefits of duty-free and quota-free market access. The focus is on poor countries and again the emphases is on distortions and how they might be removed by allowing quota-free and duty-free trade for poor countries. The third reference is directly about trade distortions and their cost to agriculture.

Coping with Price Volatility

Coping with price volatility through trade and domestic polices is the focus in this research area. A hallmark of the research is analyses of combinations of broader policies including tariffs, safeguard mechanisms, social safety nets and storage policies in the context of regional and global trade systems. Again, this is an IFPRI research program that aims to assist countries in making and monitoring policies that are of importance to food production and consumption and to the share of the population which is poor in developing countries (Badiane et al. 2013, Bouët, Laborde and Deason 2013, and Deason, Laborde, Minot, Rashid and Torero 2013 — all chapters in a book by Badiane et al., *ReSAKSS Annual Trends and Outlook Report, Promoting Agricultural Trade to Enhance Resilience in Africa*.)

The first of these references provides a good overview of the various domestic and international trade policy options that have been and are being considered and employed by African countries.

Policies of developed countries have had a major effect on price instability in African countries. Domestic policies related to government stock holding were favored by the USA and EU during the period leading up to the 2000s. These policies were ultimately viewed as overly expensive and were dropped in favor of private sector holding of stocks. The private sector holds fewer stocks than the public sector, and this has had an impact on the volatility of world prices of food grains, maize, soybean, rice and wheat (soft and hard), as shown by Deason Laborde, Minot Rashid, and Torero (2013).

The recent price volatility is thus due in part to this difference in stocks policy by major exporting countries. This aspect of stocks holding was not sufficiently noted in the paper by Deason, Laborde, Minot, Rashid and Torero (2013) in the reviewer's opinion.

Policies that were mentioned and discussed in the two references include consumer price controls, producer price controls, taxes and other restrictions on international trade, public procurement of grains, state trading companies that are monopolies, commodity exchanges, market information systems, futures markets at international levels (the Chicago Board of Trade), contract farming, safety nets, and many others that are combinations of these policies. The reason that the Cluster 3.1 activities include these policies is that price volatility remains a major issue in many developing countries. As well, it includes political economy and institutional aspects. For example, some citizens of these countries benefit when prices are unstable and are reluctant to change policies.

Analysis of Global and Regional Trade Policies

Application of the MIRAGE Trade Analysis Model for the WTO Doha Round and within regions has been a major part of the (now) Cluster 3.1 research program during the past four years, and is represented by a number of professional papers, conference presentations, book chapters, technical reports, and working papers — Laborde, Martin and van der Mensbrugghe (2012), Laborde (2014a), Laborde (2014b), Bouët and Laborde (2010), Bouët, Laborde and Deason (2013), and many others. The work has involved close cooperation with the World Bank and their more aggregated model of global trade (Laborde and Martin 2012, and Laborde and Martin 2014).

Supporting developing economies in their agricultural policy reforms at the WTO has occupied a significant share of IFPRI researchers' time involved on the MIRAGE Trade Analysis Model. They have gained credibility with the WTO Doha Round staff and presented several versions of trade liberalization scenarios before this trade forum. In general, the thrust of the analyses presented has been to provide analyses of consequences of increased market access on exports, imports, income, and welfare for the developing and developed countries.

These analyses have also been extended to regional trade agreements such as the ones involved in COMESA, SAFTA, SADC, and ECOWAS. Often these regional trade agreements have suggested major trade liberalizations only to discover that the countries involved are generally reluctant to live up to them. The MIRAGE Trade Analysis Model has been helpful in getting the countries to make the moves indicated in the agreements. Runs of scenarios related to liberalization of trade relations, and the incidence of benefits for countries and for poor people within these countries, have facilitated movement in these regional trade arrangements. Still, questions remain about how accurate CGE models can be (Hertel et al. 2007).

In addition to applications of the MIRAGE Trade Analysis Model for guiding the Doha Round, for the WTO staff, and for regional trade analysis and negotiations, there has been significant analysis in the political economy of trade and related negotiations (Mattoo and Martin 2011 — a World Bank book which includes several chapters by Laborde and Martin). This activity has been primarily in cooperation with the World Bank researchers. The substance of these research papers is "why do the countries not take more advantage of the results of trade models that show that liberalization, however defined, is a preferred course of action?"

A somewhat oversimplified answer has been that all agents in the countries analyzed do not benefit equally from the various forms of liberalization. And many times the losers are politically powerful in the countries of interest. This suggests designing trade liberalization policies so that there is some kind of pay-off for those who feel that the results from models are not sufficient to merit supporting the reforms. This is yet another complexity for the analysis of trade and trade modelers that is being taken up by IFPRI and the World Bank.

It should be said that what has been called the MIRAGE Trade Analysis Model and applications of it are meeting high standards of scientific quality. The Cluster 3.1 researchers have brought IFPRI into a leadership role in analysis to support the interests of developing and developed countries. This has been accomplished in a relatively short time period and should be seen as a feather in the cap of the PIM program.

Others (Including the MIRAGE Household Model)

This model is in its initial stages, but holds promise for generating useful scenarios related to developing countries and households of different types. Differentiating household types make is possible to distinguish the results of policy changes on different types of households. Thus, this disaggregation in the MIRAGE Household Model aims to provide a more detailed analysis of the results of trade liberalization and domestic policy related distortions.

Some of these household types are ones in which women are heavily involved in supplying labor. This is especially in the case of the agricultural sector in Africa. If successful, this disaggregation of the household or consumption sector in the MIRAGE Trade Analysis Model can make it possible for large-scale CGE models to say something concrete about gender. Traditionally, addressing gender has been a source of some resistance when working with large-scale models like MIRAGE Trade Analysis Model. These new types of results which may be forthcoming from the MIRAGE Household Model are suggested in the IFPRI working papers by Bouët, Estades and Laborde (2012), which have been or soon will be submitted for publication in refereed journals.

The World Bank household survey data, which are available for many of the developing countries, are what makes this disaggregation of the consumption sector of the CGE models a manageable task. These data are attractive for this work since they are collected using more or less the same type of sample design. This makes the multi-country structure of the MIRAGE Household Model attractive in terms of isolating and comparing the incidence of benefits of trade liberalization for households in different countries, for example. The drawback in using these data is that, although the households are partitioned into a large number of segments, the markets for the labor services they provide and the related products are not segmented. Most CGE models are stuck with only one unskilled labor market. Answers to this drawback will perhaps come later.

3.4 Relevance and Effectiveness of Partnerships

Partnerships with other CGE modelers and CGE modeling centers are very important to Cluster 3.1. Many of these partnerships derive from CEPII in France where Laborde and other IFPRI staff came from. There are also notable partnerships with international organizations including the WTO (World Trade Organization), ICTSD (the International Center for Trade and Sustainable Development — the leading NGO on trade issues), and EC JRC-ISPRA (the Joint Research Center for the European Commission). These are typical of the high-level centers and other organizations with which the

IFPRI team is collaborating. The partnerships are very effective and should contribute to the sustainability of the research. The partners are at the top of the scientific field in CGE and related modeling — an assessment confirmed by the professional peers interviewed in connection with the preparation of this review.

However, the research does not yet involve much collaboration with researchers in the other CG Centers. ILRI has expressed some interest in collaborating with the IFPRI's trade team and has outposted an ILRI staff member to IFPRI who is working with the IFPRI team, notwithstanding the technical issues involved. Most of the work with the MIRAGE Trade Analysis Model has been for crops. Livestock represents a different set of modeling problems, since livestock cannot be effectively modeled in an annual timeframe. Poultry have a growth cycle that is shorter than the annual timeframe for crops, while cattle have a growth cycle that is longer.

Interviewees suggested several reasons for the general lack of inter-Center collaboration in international trade: (a) the commodity Centers and/or their economists have lacked the interest in these issues; (b) they are interested in these issues, but their economists are insufficiently trained in the type of modeling work being conducted by the IFPRI team; and (c) IFPRI has failed to reach out to them. There are clearly international trade issues that should be of interest to the commodity Centers in encouraging the development of their mandated commodities, and there has been some such work in the past, such as at AfricaRice on the rice trade. Should there be a desire to have greater collaboration, in-depth training may have to be offered by the IFPRI staff in the Cluster 3.1 or different hiring policies may have to be used within the other CG Centers.

3.5 Gender Mainstreaming

Gender is not a major issued addressed in the work of four of the five areas discussed in section 3 above, since most of the research in these four areas is about national and international policies and how these could be improved to better reflect the interests of the developing countries. There is some talk about gender, but little in the way of addressing policies that could have a direct effect on gender issues.

However, the work on the MIRAGE Household Model using the World Bank household survey data is potentially a major activity related to gender issues. Here, gender issues can be addressed by selecting households that are identified with gender in the workforce, and following through on related policies. For example, what liberalization policies could be pursued first to give sectors identified with gender a fairer share of the national benefits? The fact that these policies can be traced through the national system as represented by the MIRAGE Household Model, and even traced internationally, could give a enhanced perspective on gender issues, and provide an alternative route for attracting greater attention to this set of issues.

3.6 Capacity Strengthening and Sustainability

Bringing the MIRAGE Trade Analysis Model to IFPRI and the capacity to operate and develop the main and related versions during the past few years has been a real plus for IFPRI, PIM, and the other CGIAR Centers. Simply put, IFPRI and the Centers have now made a significant place for themselves in world and regional trade policy and related negotiations. IFPRI and the Centers now have the capacity to effectively represent the interests of the developing countries in the areas of

research, evaluation, and actual trade negotiations. As the world becomes more and more connected and must address traditional and new common problems like climate change and related issues, the MIRAGE Trade Analysis Model will likely assume even more importance in research and analysis representing the interests of the developing (and developed) countries.

One aspect of the MIRAGE Trade Analysis Model that may call for attention is the different names given to the various versions of the MIRAGE model: MIRAGE-BioF, MIRAGE Household, and other versions are examples. It may be that this is not a good "marketing" strategy. Fragmentation of a modeling effort that has a dedicated group of researchers and analysts may not be good in terms of presenting a feeling that the best of MIRAGE is always being brought to address particular policy issues.

There may be an issue at IFPRI and PIM in terms of which modeling team does what. Some of modeling issues addressed by the (now) Cluster 3.1 team might have been addressed as well or better by the IMPACT team, or vice versa. Careful distinctions between the activities of the modeling groups at IFPRI and in the CG Centers could be given more attention. This is important both for internal users inside IFPRI and PIM and for the external users of the modeling tools and analysis. The reviewer suggests that some attention should be given this issue before it reflects negatively on the integrity of the entire modeling effort.

Last, there is the issue of documentation of the MIRAGE Trade Analysis Model and the related models developed around it. With the demonstrated impacts of the IFPRI CGE modeling efforts, the time will soon come that the users of the modeling results will begin to ask questions that cannot be answered without proper documentation. In short, it is better to have such documentation in hand when the questions come rather than to be caught without it and to have to generate it quickly. Documentation should come along with the various CGE models that are generated at IFPRI. Better to do this on your own terms.

With these minor qualifications, the reviewer and the professional peers contacted perceive that the MIRAGE Trade Analysis Modeling system currently has strong capacity and is going about strengthening this by taking the MIRAGE model to new areas of application. Not all of these efforts will be successful. When models are stretched they are not always capable of incorporating new dimensions. But one must be impressed with the Cluster 3.1 researchers and their efforts to apply the model to interesting and significant domestic and international issues. This demonstrates a strong willingness of the modelers and the modeling system to accommodate and handle evolving issues.

3.7 Organizational Performance

Organizationally, the performance of the (now) Cluster 3.1 is operating well. The team is working effectively and making progress on many ronts — in the five areas indicated in the Quality of Science section. Their relationship with PIM management has been good. Discussions with the team members indicated that they were satisfied with the PIM organization, yet included several suggestions about improvements that could be made. The leaders of the group suggested that improvements could be made in terms of the reporting mechanisms and in terms of articulating better the objectives of PIM. They also referred to some PIM activities that were less successful in terms of generally accepted scientific standards and expressed concern about the future of such

projects. These were gentle suggestions, not negative in terms of intent, and made in the spirit of helping the PIM succeed.

3.8 Overall Value Added of the Modeling Activities

The modeling activities based on the MIRAGE Trade Analysis Model are providing good results for PIM and IFPRI. The activities aim to provide outputs in terms of various scenarios to be used by policy makers to improve their policies. A significant outcome for developing countries has been the general acceptance of runs related to liberalization of trade policy in the Doha Round. This has been an important achievement with IFPRI's research reflecting the interests of the developing countries. Special software developed at IFPRI to represent trade policy barriers has made it possible to represent complex trade restrictions in CGE models. Continuing along this path and supporting the developing countries with major modeling capability could ultimately give the developing countries a more important say in the evolution of global trade policy. Recently, there have been investigations into the political economy of trade policy and negotiations which could add to these positive outcomes.

The modeling activities are much broader than the efforts associated with the narrow definition of the MIRAGE Trade Analysis Model. An example is the acceptance and continuing use of the results of the MIRAGE-BioF model by the EU in designing its policies for changing land use due to the biofuels mandate. This is an example of the impact of the modeling work for developed countries, which the EU is funding with bilateral contracts. However, this work has spawned the idea of disaggregating the sectors in the MIRAGE model, which in turn is leading to the use of the World Bank household surveys to disaggregate the household sector in the MIRAGE Household Model. Of course, the biofuels work in the EU has implications for developing countries as well.

The MIRAGE Trade Analysis Model has also been an important contributor to the analysis of regional trade agreements. This work should continue, and will give these regional trade agreements more scenarios to choose from in determining their policy choices. These are but a few of the positive outcomes from the work of the MIRAGE team at IFPRI.

The professional peers with whom this reviewer spoke reiterated these positive outcomes from the MIRAGE Trade Analysis Modeling activity at IFPRI. Some made very impressive comments about the leader of this group, Laborde. One in particular said that Laborde has an almost uncanny ability to formulate CGE models and to catch the substance of discussions related to policy change.

Other applications have been impressive as well. Work on price volatility and barriers to competitive functioning of the economies of developing countries is moving forward with positive outputs.

In general, IFPRI and PIM have an important resource in the MIRAGE modelers and one that has put them in the center of the debates about trade policy and implications of new technologies for trade results. The researchers making up this team are young and aggressive, and are likely to succeed in their efforts to take on traditional and new issues.

Nonetheless, there remain some issues that PIM and the MIRAGE team should attend to:

- the poor documentation of the various models that are now a part of the MIRAGE Trade Analysis Modeling activity;

- the limited collaboration with staff at the other CG Centers. If the other CG centers are to embrace CGE modeling, additional training or different hiring policies would need to be pursued;
- the weak integration with the other modeling efforts taking placed at IFPRI. The scope of the respective modeling efforts could be better defined in IFPRI and for the other CG centers participating in PIM.

4. MIRAGE-BioF Model for Assessing the Indirect Land Use Changes Resulting from European Biofuel Policies – By Stanley Johnson

4.1 Introduction

This review has benefited from comments by Laborde and Bouët (two of the primary authors of the adaptation of the MIRAGE CGE model to the EU renewable fuels issue) as well as other professional peers who have given liberally of their suggestions and comments (see Annex). The endeavor that was reviewed was the development and application of a special version of the MIRAGE Model — the MIRAGE-BioF Model — for application to the EU biofuels legislation and the Renewable Energy Directive (RED), in particular. The review is, however, dependent only on the views of the author. All of its suggestions and comments about the MIRAGE-BioF Model and its application for the EU Member States are the responsibility of the author alone.

What we now know as the MIRAGE-BioF Model was constructed in two stages, initially for the EU with partial disaggregation to reflect differences in the Member States, and subsequently disaggregated to reflect all of the (then) EU 27 Member States that were a part of the EU. This was a massive undertaking, both for the partially disaggregated EU and for the EU 27, not only to assemble the necessary data from a variety of sources but also to apply the MIRAGE-BioF Model to identify the impacts of indirect land use changes (ILUC) on cropping patterns, GHG emissions, and other aspects related to the implementation of the renewable fuel directive for the entire EU.

The authors of the MIRAGE-BioF Model drew heavily on other modeling efforts related to emissions of GHG from biofuels, on CGE and multi-market partial equilibrium models of other nations' rules and directives, on specific studies of emissions, and on the use of IPCC-derived emission standards with their strengths and weaknesses. To deal with the adaptation of IPCC standards and for estimating emissions, the authors conducted several simulations of the policy directive and related model parameters to give a feeling for the possible inaccuracies in the process of implementing the MIRAGE-BioF Model.

The MIRAGE-BioF Model implementation results are the most complete of those available in a CGE context. The development of the MIRAGE-BioF Model version of this CGE model was a stretch relative to usual applications of the CGE modeling technology. Most applications of CGE models involve more aggregated domestic sectors and sets of world economies. This application provides great detail for the agricultural sector and is devoted to facilitating an understanding of the implications of bringing into production additional land to meet the demands for biofuels dictated by the EU biofuel directive. As such, it represented an exhaustive test of the capacity of CGE models for the task at hand and worthy of review for itself and for others that may attempt to use CGE models for such efforts.

4.2 Relevance of Objectives and Design

The major regulations impacting the EU biofuels market are the Biofuels Directive (2003/30), the Fuel Quality Directive (2009/30), and the EU Energy and Climate Change Package (CCP). The CCP, which was adopted by the European Council in 2009, includes a "20/20/20" in mandatory goals for the year 2020, one of which is a 20 percent share for renewable energy in the total EU energy mix. A part of this 20 percent share is a 10 percent minimum target for renewable energy consumed in the transportation sector. This goal, which is to be achieved by all EU Member States, is the driver behind the increasing demands for biodiesel and ethanol, and the increases in land use — the subject of this application of the BioF Model.

Under the EU regulatory system, biofuels must meet specific criteria to count against the 10 percent renewable fuel goal. The Renewable Energy Directive (RED), a part of the CCP, specifically lays out the sustainability requirements. These requirements include minimum GHG emissions reductions as well as other criteria which focus, for example, on food price impacts. The RED became the law on June 25, 2009, and was to be reflected in national legislation by December 5, 2010. But, for most EU Member States, full implementation is expected to drag out over a longer period. This is in part related to uncertainties about the application of IPCC standards of emissions.

The RED creates a framework, but the Member States have the freedom to implement specific Member State systems for compliance. This is a particular issue for the smaller states and complicates the process of supplying imported biofuels into the EU market, and has introduced uncertainty into trade for some American, Brazilian and other countries' feedstock and fuel commodities. Another barrier to trade is the absence of international standards for the calculation of GHG emission savings, which the MIRAGE-BioF Model exercise addressed.

The "Global Trade and Environmental Impact Study of the EU Biofuels Mandate" and "Assessing the Land Use Change of European Biofuel Policies" are the two related IFPRI studies mentioned above on the partially disaggregated EU and the EU 27 versions, respectively. Results of the first of these two projects are summarized in a report by Al-Riffai et al. (2010a), and results of the second project are summarized in a companion report by Laborde (2011). Both projects addressed the biofuels policies of the European Union, the latter with some improvements in the modeling technology of the MIRAGE-BioF Model and a disaggregated structure representing the 27 Member States. The projects were funded bilaterally by contracts with the European Union. Subsequently, the MIRAGE-BioF Model has been subsumed into the MIRAGE Trade Analysis Model at IFPRI.

Thus, the MIRAGE-BioF Model evolved for a specific purpose, to address the EU renewable fuels directives. It has several special features related to the objectives of the task at hand. There are modeling aspects to meet these objectives and importantly, data assembly, and preparation tasks. The latter were not so well noted by the authors of the two summary reports and follow-on publications on the two projects (perhaps due to their modesty), but was important relative to the decisions that the Member States will make about biofuels, and likely will be used continuously in raw or processed form to support decisions by the Member States.

In this report we confine our review to the two reports mentioned above and related literature that has been published and/or produced in the form of reports that are accessible on the web. Work on renewable fuels and the RED has continued at IFPRI, but the MIRAGE-BioF Model has now been

subsumed into the more general MIRAGE Trade Analysis Modeling System, which is reviewed by this author in a related report in this volume.

One additional comment about IFPRI and the EU application of the MRAGE-BioF Model study is important. It relates to why IFPRI, which is dedicated to the interests of developing countries, would undertake such a study. The answer is that the biofuels mandate of the EU was a major potential market disturbance. Only the USA mandate for ethanol used as a gasoline additive had at the time a larger potential impact on world markets. Therefore, a real question emerged about the impact of the EU mandate on international prices and trade for food commodities, and their impacts on developing countries.

Hence, the application of the MIRAGE-BioF Model to the EU land use change and GHG emissions question is important not only for the EU, but also for its implications for world markets for food commodities. The fact that the bulk of this analysis occurred during a period when there was an unusual spike in world prices for food commodities made understanding of the impacts on world prices even more important as a policy consideration.

4.3 Quality of Science

The MIRAGE-BioF Model is a very large and complex modeling system as developed for the EU 27. It utilizes data from several sources for calibration, and sets the modeling system up to be "dynamically recursive" (Laborde and Valin 2012, Al-Raffai et al. 2010a, and Laborde 2011). Good general descriptions of the modeling framework and the various inputs to the process of development of MIRAGE-BioF are contained in Laborde (2011) and Valin et al. (2013). Production of the MIRAGE-BioF Model in fact, required broad collaboration with CGE modelers and with other specialists in agricultural modeling studying biofuels and emissions in production including GTAP, AGLINK-COSIMO, OECD, CAPRI PE, FAPRI, IMPACT, EPA, several scientific groups like those at CARB, IIASA, CEPII, GAEZ, IPCC, and others not specifically mentioned.

Data Assembly

The MIRAGE-BioF Model application reports do not fully discuss the problems of assembling the appropriate data for the modeling exercise to be undertaken. In fact, this discussion is absent in the final reports for the two studies. Parameters were drawn from a set of modeling systems like FAPRI, AGLINK-COSIMO, GTAP, IMPACT, and other major analytical structures. A drawback from the assembly of these different parameters is that often they were not generated from the same systems as in the MIRAGE-BioF Model. In short, we do not know about the congruence of the parameters with the structure of MIRAGE-BioF Model. This is a issue for almost all CGE models used in agricultural applications, and is among the reasons that the scenarios were developed for the application of MIRAGE-BioF Model. In short, it is a common general criticism of CGE modeling efforts for agriculture.

For the data collection task, the MIRAGE-BioF Model is on safer ground. Data from FAOSTAT, GTAP, USDA, FAO-AEZ, as well as other sources were assembled for each of the EU 27 Member States. Not only were the data assembled, but they were put into a form that made them easy to introduce into the MIRAGE-BioF Model. The same is true for the GHG emissions data adapted to cropping practices, soil type, and some other conditioning factors. This raw data will likely form the starting set of

information for many of the Member States in fashioning their compliance policies for the RED. Assembling and organizing it has been a major contribution of the application of the MIRAGE-BioF Model.

But we should not think that the task of finalizing the GHG emissions data is complete. The MIRAGE-BioF Model incorporated some of the suggested modifications related mainly to crop management systems. However, there are many other GHG emission factors to contend with. Among the factors that influence GHG emissions from ILUC are soil types (sandy versus loam soils, for example), no-till cropping systems which are not widely used in the EU (reduce GHG emissions), applications of livestock manure as fertilizer instead of synthetic fertilizer and timing of applications, timing of tilling and other tillage tasks for crops, and cropping systems in use on traditionally cropped land. Much research remains to be done before the GHG emissions are fully understood.

Ways to Incorporate Biofuel Production

A useful illustration of ways to incorporate bioenergy into CGE models is provided by Kretschmer et al. (2008). He classifies three basic approaches to integrating bioenergy into CGE models.

The first is called the implicit approach which avoids explicit modeling of bioenergy production technology and incorporates ad hoc procedures for determining quantities of biomass required to achieve certain production targets. Examples of modeling efforts in this category are Dixon et al. (2007) which projected economy-wide effects of replacing petroleum with biofuel, and Banse et al. (2008) in an extended version of the GTAP-E CGE model which developed ethanol use as a fuel-nesting product. These approaches leave out important parts of the production technology and by-products associated with biofuels.

The second involves a “latent technology” approach that incorporates production technologies that are present but not active in the base year, but become active in later years of the application of the model. Inputs on cost structures of different types of biofuels are necessary for modeling these latent technologies. Boeters et al. (2008) and Kretschmer et al. (2008) use this approach for studying the impacts of the 10 percent mandatory target in the EU.

The third approach, used for the MIRAGE-BioF Model, is to disaggregate bioenergy production using a social accounting matrix along with the GTAP data base to provide the underlying structure for biofuel production. Recently, Britz and Hertel (2009) linked the European CAPRI-PE model with GTAP CGE model to investigate the impacts of the EU biofuels directive on global markets and environment. One idea from this application was to utilize this model to gain results for farming practices and their impact on the EU, ILUC, and GHG.

This short summary provides a characterization on how biofuel production can be modeled, and indicates the complexity of the MIRAGE-BioF Model application.

Indirect Land Use Change in the Basic Model

The Biofuels mandate may have significant implications for determining land use patterns. Increases in agricultural production require additional land. The EU mandate is estimated to require 1.73 million hectares of land without trade liberalization and 1.87 million hectares with trade liberalization — one tenth of the total arable land in France, for example. Further review of these

results shows that the increase in land use was less than 6 percent globally and about 0.15 percent for the EU. The difference between the land use with a continuation of current EU policies and with trade liberalization is perhaps just a rounding error.

The real difference between the trade liberalization scenario and the status quo policy scenario for the EU is the mix of crops. In the trade liberalization scenario, more oilseeds for biodiesel are grown in the EU (which have yields per hectare that are lower than yields for feedstock used in ethanol production) which has a comparative disadvantage in biofuel feedstock for ethanol production. The total extension of cropland use in the EU is less than 0.15 percent under either of the trade scenarios. Under the trade liberalization, ethanol production is concentrated in sugar cane production – primarily in Brazil. This shift allows the EU to continue to specialize in oil seeds for biodiesel production, primarily rapeseed. Meat production decreases due to decreases in cereal production and reductions of pasture land (implying in particular, decreases in cattle production).

Indirect Land Use Change in the EU 27 Basic Model

A major change between the first and second of IFPRI's MIRAGE-BioF Models for the EU was the disaggregation of the indirect land use changes to represent the (then) 27 Member States (Croatia became the 28th member state in 2013). This was a major task in the context of the MIRAGE-BioF model, and in fact, would be for any other CGE model. CGE models are generally developed for more aggregated representations of countries or sets of countries. As already mentioned, these results from this disaggregation of indirect land use changes should provide information valuable to the individual EU countries, since under RED each country must come up with its own estimates of indirect land use change and of related GHG impacts.

The indirect land use change estimates for the EU 27 required specialized assumptions and data. A sketch of the approach is provided here. Each country produces a certain quantity of goods as estimated through a "nesting" of crop production functions. Intermediate inputs and value added are aggregated through Leontieff technology, each being a CES composite of different aggregates of inputs and factors, respectively. Final goods go to consumers (public and private agents) and firms, or are exported to foreign markets. The consumption demand system as represented by a LES-CES structure is recalibrated each year along the baseline to reproduce consistent income and price elasticities.

Imported goods are differentiated from domestic goods following the Armington assumption, which allows the modelers to distinguish different levels of market integration. Real exchange rates between regions are endogenously adjusted to maintain the current account as a share of the world GDP. The model is recursively dynamic, and total factor productivity is adjusted along the baseline following GDP projections. Total factor productivity in each agricultural sector is adjusted to match crop yield projections of the AGLINK-COSIMO model for each region (OECD 2010). These were likely conservative estimates of crop yields, but were taken directly into the MIRAGE-BioF Model.

The MIRAGE-BioF Model includes a detailed description of biofuels in the consumption chain, a modeling of binding incorporation mandates, and by-products for the ethanol and oil sectors (wheat, corn, sugar beet) and for rapeseed, soybean, sunflower, and palm fruit, respectively. Particular attention was given to the final and intermediary consumption and substitution possibilities of similar products (vegetable oils, oilseed meals, ethanol feedstock and by-products)

and rigidities of inputs in the production chain (vegetable oil to produce biodiesel, sugar raw products to produce refined sugar, etc.).

Improvements to Better Characterize ILUC

A first set of major innovations in the application of the model involved the refinement of agricultural production functions. Elasticities of fertilizer use with respect to price changes were derived from the IFPRI IMPACT model (Rosegrant et al. 2008). Elasticities of other inputs constituted the complement that matches the final endogenous yield elasticity target. Following the recommendation of the CARB expert group on elasticities (which has been seriously questioned by Babcock and Carriquiry 2010), the MIRAGE-BioF Modeler application assumed an average magnitude of 0.2 for these elasticities — EU 27 is closer to 0.15, U.S. to 0.2 — and developing countries to 0.3 to take these different regions into account.

The land rent values were represented in the model through a volume of productive land equivalents using several databases, for example, the GTAP-AEZ land database and the FAO STAT. The complete land rent allocation proposed in the GTAP framework was not followed because substituting land rent on a value basis corresponding to areas with completely different land rent yields created conceptual problems. Therefore, the MIRAGE-BioF Model CET functions operate on land rent values that have similar yields (in dollars per hectare) within an agro-ecological zone (AEZ), which ensures that substitution occurs at a 1:1 technical ratio, and that the overall land area is preserved when total land rent is fixed.

The CET nesting approach, already used in some previous works (OECD 2001 and Banse et al. 2008) appeared as an important prerequisite to represent flexible enough production functions and obtain a good fit with the calibration of price elasticities. Thus, by default, perfect substitution is assumed within each region for location of production across AEZs. Transformation elasticities are endogenously calibrated to fit the regional level land supply elasticities from the FAPRI elasticity database, which ensures consistency with aggregated regional observations on agricultural system responses.

A second set of innovations introduced in the model for land-use change were mechanisms that allows for land-use expansion for different land covers. Again by default, in the MIRAGE-BioF Model cropland expansion into new land such as pasture, forests, savannah, or other natural cultivable land was through specific calibrated elasticities (OECD 2001; Barr et al. 2010; and Roberts and Schlenker 2010). The value of these elasticities decreased linearly as a function of the distance to cultivable land using the IIASA GAEZ database. Levels of expansion into pasture, forest, or other land cover were therefore determined by historical shares. A coefficient of marginal productivity was also applied to this new land to reflect the fact that expansion can occur to land of different qualities from the land currently being cropped.

Crop Yield Initial Levels and Rates of Change and Implications for ILUC

The projections to 2020 utilize assumptions for initial yield levels and rates of increase that appear to be rather low, for example 3.2 percent for corn and 0.25 percent for wheat. Rapeseed production per hectare is projected to increase by 1.4 percent. It is not clear whether these are figures are for the entire period or by year — the assumption is that they are for the entire period. More discussion

of the initial yield levels and the rates of change would have been desired, given the sharp relationship between yields and ILUC.

In the USA, yield increases for corn over the 20 year period 1990–2010 doubled by comparison. As well, during this period, petroleum and agricultural feedstock prices were not statistically related, suggesting that, among other factors, yield increases and increases in land use adjusted to accommodate the biofuel mandate in the USA (Myers et al. 2014). Higher initial yield levels and rates of yield increase would have resulted in the EU mandate having a much reduced impact on ILUC than has been projected.

This is the current author's main concern with the projections for both the trade liberalization and status quo scenarios. In short, with higher initial yield levels and rates of change used in the projections, there is a possibility that the EU biofuel mandate would result in little if any change from current land use. This could have been easily tested by running the MIRAGE-BioF Model with different initial yield levels and rates of increase. Again, the reviewer's hypothesis is that the rates of yield increase were rather low especially in the eastern part of the EU.

Dynamic Recursive CGE Models

The dynamic recursive structure of the MIRAGE-BioF Model and in fact other CGE dynamic models requires some comment. The model is dynamic in terms of adjustments in some of the resource variables conditioning the MIRAGE-BioF Model. This makes the dynamics of the model very restrictive, since the behaviors of the groups modeled do not change with the changes in resources from one period to another. As well, livestock, which have a natural period of production that is not annual, are modeled superficially. This characterization is customary in CGE modeling approaches these days, but it is surely not dynamic in terms of how other non-CGE economists view economic systems. The reason for the convention is that CGE models are like input-output models giving a snapshot of the equilibrium at a point in time. The dynamic equilibrium is thus a mechanical way of connecting these snapshots together.

Greenhouse Gas Emissions

GHG emissions were treated rather mechanically once the ILUCs in the Member States were settled. The IPPC methodology, which is based on mostly conceptual physical/chemical relationships, was employed. Two types of emissions were considered:

- emissions from biomass lost by deforestation: conversion of forest to cropland or pasture; and
- emissions from release of carbon in soil: cultivation of new lands utilizing several management practices.

In short, as Al-Raffai, et al. (2010) suggested:

- emissions Production EU biofuel = Production variation (biofuel) * EU Emissions factor (biofuel) = EU Production for domestic demand (biofuel)
- emissions Consolidated EU (biofuel) = EU production for domestic demand (biofuel) * EU emissions factor (biofuel) + (imports biofuel) * Exporter emissions factor (biofuel)

- emissions Consolidated World (biofuel) = Sum over (regions) (production * region * Regional Emissions factor (biofuel)
- carbon payback = Land use change initial emissions/Annual emissions savings.

These are brief summaries of the rules for calculating the emissions on new and existing lands, and how adjustments were made for impacts of imported biofuels in countries of origin.

In short, the process for calculating GHG emissions was rather standard once the land use changes had been estimated. One should not be overly critical of this mechanical approach. It was consistent with current developments in the field on GHG emissions estimation at the time of the MIRAGE BioF Model application. But in this age it is far from complete and consistent. As mentioned, different tillage methods for crops yield very different carbon emissions; applications of animal manure compared to synthetic fertilizer have major impacts on emissions (as well as different methods of application and storage); and different soil types have different impacts on emissions — to list again a few of the adjustment factors that ultimately need to be taken into consideration before emissions standards are really set for the Member States. We are far from definitive answers for GHG emissions and standards.

Food/Feed/Fuel Controversy

The fuel or feed (or food) controversy was addressed by the MIRAGE-BioF Model, although not a major objective of the modeling exercises for the EU or world markets in the trade liberalization scenario. Attention is given to the significant share of the livestock feed market that will be assumed by distillers dried grains with solubles (DDGS), a by-product of the production of ethanol and oilcake for biodiesel. The availability of these by-products makes the impact of biofuels production much less of a negative factor for livestock production (and food) than has been argued. In fact, the only biofuel feedstock that does not produce a valuable by-product suitable for livestock feed is sugar cane.

Even partially adjusting for these by-products and their possible importance to livestock production leads to estimates of increases in value added for the EU of .08 percent cattle and .07 percent for “other animals.” In the USA, these value added numbers are lower — .04 for cattle and .03 for other animals. In Brazil, the impact is actually negative due to the fact that sugar does not have a by-product and the livestock sector will suffer with competition for other crops and sugar cane. The difference between cattle and other animals in these calculations of by-product implications is their rumination digestion system. In the trade scenario, these markets do not appear to be completely and explicitly modeled (Al-Riffai et al. 2010b).

The general conclusion was that the EU biofuel policy would have little impact on livestock markets (and food). However, as the EU biofuels policy progresses, these estimates may need to be revised. Domestic and international markets for DDGS and oilcake will become better developed and the use of DDGS more effective. For soybeans, of course, the soymeal market is already fully developed.

Levels of Price Increase Projected to Meet the RED

Prices will be higher for feed grains and oilseeds as projected by the MIRAGE-BioF Model due to the increased demand for feed grains and oilseeds. These prices were not a factor of major interest in the write-ups of Al-Riffai et al. (2010a) or Latrobe (2011). Perhaps this is because the markets for

feedstock, oilseeds and processed biofuel fuel were at all-time highs in terms of prices during the period when the model was constituted and applied. Obviously, for the domestic economy and for the trade scenarios these prices were important. Price differentials and transport costs in addition to restrictions related to policy are what make trade happen.

The most important consideration was to understand the influence of the EU biofuels policy on ILUC. Still, in the status quo and liberalized trade policy scenarios, it would have been helpful to have price levels more explicitly defined and incorporated. In retrospect, the price levels during this period were influenced by factors much wider than the initiation of biofuels policies in the USA and EU (Myers, et al. 2014). These authors showed that biofuel feedstock and petroleum prices were not correlated over the 1990–2010 period by means of sophisticated time-series analysis of monthly data and allowing for different regimes in the data series.

An exercise that would have been good for the analysis of ILUC would have been to investigate the price levels operating during these simulations and in the base period, and to compare these with current price levels — which seem more consistent with long-term levels. Relatedly, how much of the ILUC is due to the unusually high prices during this period and how much is due to the biofuels mandate? It is almost a certainty that land use expanded during this period due to the high prices quite unrelated to the mandated demands for feedstock for ethanol and biodiesel. How can one separate these influences on prices and ILUC?

Finally, without price changes, how do Member States incorporate the restrictions on ILUC into their implementation plans? Is it through policy and modifications of the Common Agricultural Policy (CAP) or relative incentives as reflected in price changes? These and other questions could have been at least partially answered with the presentation of additional domestic and international price information actually available from the MIRAGE-BioF Model solutions. The reviewer's view is that this parsing related to the EU mandated biofuels policy and the unusually high prices should have been done, and would have improved the analysis.

Trade Policy and Implications (in a Broad Sense) for International Markets for Biofuel and Biodiesel

In the simulations of the MIRAGE-BioF Model, the trade policy scenario plays an important role. This is partially due to the fact that trade, in particular for oils and feedstock and ethanol, was already occurring due to actions of selected Member States which had moved to renewable fuels ahead of the biofuels policy for the EU. Trade in ethanol and especially biodiesel was well established prior to 2010. How much of this trade was factored into the export results for USA and Brazil?

Still, the results of the model simulations were instructive and have been generally verified by the experience from 2010 to date. The results are that vegetable oil imports are lees dominant for the EU, which has a comparative disadvantage in grain production for ethanol feedstock. The imports of soybean oil come largely from the USA and to a lesser extent from Brazil and include some palm oil imports from Southeast Asia. Ethanol imports come largely from Brazil where sugar is a more efficient feedstock than corn in the USA.

Again, as mentioned in the above paragraph, prices domestically and internationally would have been important other factors in reviewing the two simulations. These prices appear minimally in Laborde and Valin (2012) as expressed in their estimates of changes in world producer price levels

(Table 9). The author of this report views these prices to be too high in general, especially for sugar and oils. Producer price changes are approximately 2 percent for maize and wheat; 15 percent for soybeans; 30+ percent for sunflower, rapeseed and other oilseeds; and just over 10 percent for sugar. Clearly, these kinds of price increases are out-of-bounds given the small land-use changes estimated. The reviewer's guess is that these price estimates were influenced by the price spike at the time of the completion of the MIRAGE BioF Model exercise, and would not be so high if estimated under current market conditions.

4.4 Relevance and Effectiveness of Partnerships

The development of the MIRAGE-BioF Model and the application exercise for the EU biofuel directive has involved many partners, but not many from the other CG Centers. Universities from many countries were involved in establishing the MIRAGE-BioF Model and in generating parameters for specializing the MIRAGE BioF Model for the EU 27. Collaborators have included researchers from American and European universities; groups developing and using CGE and multi-market models; state agencies, the California Air Resources Board (CARB); and many other specialized modelers, e.g., Britz and Hertel (2011).

Those who developed and applied the MIRAGE-BioF Model reached out to modelers and specialists that were at the cutting edge of CGE modeling, biofuels modeling and assessments of emissions (Babcock and Carriquiry 2010). This strategy may represent a future approach for IFPRI and PIM in expanding applications of the various MIRAGE models. In fact, this approach is currently occurring with the new application of MIRAGE incorporating the World Bank household surveys.

Still, it is unfortunate that none of the contributors to the MIRAGE-BioF Model appear to have been from the other CG Centers. Economists at the other CG Centers have apparently not been prepared or inclined to work with such demanding models in terms of economic theory. If the other CG Centers are to be a part of PIM's CGE modeling efforts, they will have to adopt different hiring strategies or become involved in extensive training programs. In short, IFPRI has significant modeling and application capacities, but there have been few economists or others who can participate from the other CG Centers. This is an issue that needs addressing by IFPRI and the PIM with some priority.

4.5 Gender Mainstreaming

The MIRAGE BioF Model and its application has had no gender mainstreaming activities. However, those involved in the development and application of the MIRAGE-BioF Model are now working on utilizing the World Bank household surveys to conduct significant gender modeling activities (as indicated by PIM activity #58, "Policy reform and income distribution: Improving models and databases in global economic models"). If this type of disaggregated modeling effort is to be emphasized, then there is even more reason to try to bring into the modeling effort staff at the CG Centers that have the capacities to work with the CGE modelers.

4.6 Capacity Strengthening and Sustainability

The MIRAGE-BioF Model has significantly strengthened the capacities of the EU for understanding the implications of its biofuels policy for ILUC and GHG emissions. The application of the MIRAGE-

BioF Model has produced a renewable fuel baseline for the EU, and an analytical structure that can perhaps be used by other nations trying to understand the implications of the evolution of biofuels for land use and GHG emissions. With the MIRAGE-BioF Model, IFPRI has taken the lead in developing this fuller understanding of the trade-offs between renewable fuels, ILUC, and GHG emissions.

The MIRAGE BioF Model has already established itself as a major analytical tool of IFPRI. Validation of the MIRAGE-BioF Model and its results have been demonstrated by the continuing requests from the EU for assistance in improving their understanding of these issues, and transferring them to the Member States that are charged with the implementation of the biofuels policy. In fact, these biofuel results are now a part of EU policy — as mentioned at the beginning of this review. Thus, the development of the MIRAGE-BioF Model as an extension of the basic MIRAGE Trade Analysis Model represents what will likely be a sustainable effort of IFPRI and PIM.

Those responsible for the MIRAGE-BioF Model have continued to produce solid research, to influence policy actions supported by the research, and to provide public information related to the biofuels topic. Specifically, during the years 2012–2014, they have produced the following:

- Research results from the MIRAGE-BioF Model were used in the EC proposal for biofuel policy reform during October 2012. This was the first time that such modeling results have been used directly by EU legislation.
- Two EU parliamentary votes in 2103 supported the reform, using MIRAGE-BioF Model estimates and conclusions.
- The EU Council agreed in June 2014 to include MIRAGE-BioF Model figures in their draft directive (10300/14).
- The research partnership with the EC research body, JRC-ISPRA, has been reinforced.
- Media coverage has been large, including on TV and radio, and in newspapers.
- A special article in NATURE referred to the IFPRI results and their influence on policy reform.
- Two peer-reviewed journal articles have been produced from the MIRAGE-BioF Model analysis.

Still, the process of understanding the implications of renewable fuels, ILUC and GHG emissions is in its infancy. For example, to date almost no work has been done on livestock production and the synergies of livestock production with feedstock and crop production systems. IFPRI and PIM have after only a few years (mainly since 2010) established significant capacity for developing and applying the general MIRAGE Models and the MIRAGE BioF Model. And requests for drawing on this capacity will not likely go away in the future. This speaks highly for keeping the CGE modeling capability and MIRAGE alive at IFPRI.

The disaggregation effort of the MIRAGE-BioF Model should be mentioned, as well. This effort was herculean in terms of standard CGE modeling. It is likely to lead to other disaggregated efforts. The incorporation of the World Bank household surveys is the likely next area of disaggregated MIRAGE Model development. With this disaggregation there is a real possibility for expanding the work to address gender within these large scale models. The IFPRI staff is highly qualified to accomplish this disaggregated MIRAGE modeling effort and at the forefront of those who can.

One drawback to the MIRAGE effort at IFPRI is the documentation of the various MIRAGE models. This has simply not been adequate. It was quite difficult for this reviewer to determine the structure

of the MIRAGE-BioF Model and other structures in the MIRAGE modeling system at IFPRI. There is good reason to document, and to do it before other users ask for it, and set standards that are difficult to handle. It is better to do the documentation early and without "assistance" from model users.

There will of course continue to be issues with food and trade policy to which the standard CGE models and basic MIRAGE are well adapted to generating scenarios to assist policy actions. This is another reason for keeping and nourishing the MIRAGE modeling capacity along with the multi-market modeling activity at IFPRI. IFPRI can become an international leader in both efforts and one of few centers that have both these capacities.

4.7 Organizational Performance

The MIRAGE-BioF modeling effort was started and funded with bilateral grants from the EU to study their biofuel policy and directives. Therefore, this modeling exercise came to PIM mostly complete and with few organizational problems or issues.

MIRAGE-BioF Model development and application is also a special project within PIM being conducted with a small team from IFPRI. The staff is well connected with outside CGE and multi-market modelers globally, e.g., those at the World Bank, CEPII, IIASA and GTAP. Additionally, the MIRAGE team is well acquainted with those who specialize in estimating GHG emissions. These are the critical relationships for the biofuels project as it progresses. The MIRAGE modelers are also connected with CGE modelers and other specialists in trade and agricultural policy, but, unfortunately they do not appear to be well connected with other CG Center economists.

The apparent gap between the MIRAGE and the IMPACT multi-market modelers in IFPRI, and with the research staff at the other CG Centers presents an issue for IFPRI and PIM. What should be the division of responsibilities between the MIRAGE and IMPACT modeling teams and to what extent should the other CG Centers be involved in international trade analysis based on the MIRAGE model? (Most of the other Centers are already collaborating with the IMPACT team at IFPRI.)

4.8 Overall Value Added of the Modeling Activities

The overall value added of the MIRAGE-BioF Model exercise for the EU and Member States has been a major plus for IFPRI and PIM. IFPRI has acquired and is supporting one of the top groups of CGE modelers globally. There are, in fact, only about five modeling groups that have the capacities of the CGE modelers at IFPRI. This is especially true when we understand that the MIRAGE-BioF Model has now been fully incorporated into the MIRAGE Trade Analysis Model and related modeling activities. This inclusion of the MIRAGE BioF Model into the MIRAGE Trade Analysis system will add to the capabilities for understanding the renewable fuels movement in the EU and globally, and other policies not yet defined.

That is, there will be much to do on biofuels modeling and applications of the MIRAGE Trade Analysis Model to issues of trade, rural development, and food security. These issues are likely to continue to receive significant attention by domestic and international policy makers. The modeling effort that is underway on integrating the World Bank household surveys to assess gender and other food policy

issues is telling in terms of the potential for the MIRAGE modeling activities and for synergies with the multi-market modeling exercises of IMPACT.

Open questions for IFPRI and PIM arising from this review are listed below and should receive attention in the near future. These are:

- documentation of the MIRAGE-BioF Model and other models in the MIRAGE complex. IFPRI and PIM are now exposed in terms of not having full documentation of the MIRAGE models.
- Joint decisions with the EU, IFPRI and PIM need to be made about further use of the MIRAGE-BioF Model to assist EU Member States in coming into compliance with the biofuel mandate. The EU will need assistance in policy implementation. Is this country-specific analysis within the scope of IFPRI's mandate and responsibilities?
- How does the 6 percent increase in land use compare to yield increases that could make it possible to have essentially no increase in land use to comply with the biofuel mandate in the EU. A 6 percent increase in yields over a 10-year period is not out of the ballpark in terms of assumptions.
- The GHG emissions results are likely highly variable. How variable they are should be checked and rechecked as the scientific data become more complete.
- GHG emissions are specific to crops, soil types, cover crops, and other cropping technologies used in the EU. To what extent was this difference in GHG emissions introduced into the calculations?
- Livestock and the handling of manure have potentially major impacts on GHG emissions, but livestock was not treated realistically in the MIRAGE BioF model.
- How will the other CG Centers become involved in the MIRAGE modeling efforts?
- Concrete decisions need to be made about institutionalizing and keeping an effective MIRAGE modeling group at IFPRI.
- IFPRI, PIM and the other CG Centers need to make decisions about priorities for expanding the MIRAGE model(s). There are now the MIRAGE-BioF Model, the MIRAGE Climate Change Model, the MIRAGE Household Model, the MIRAGE Government Sector Model, the integrated MIRAGE Trade Analysis Model, and others. Decisions on priorities, naming conventions, and the necessary resources to underwrite the modeling efforts need to be developed.

Finally, all of the experts that were contacted about the MIRAGE-BioF Model and the application to EU biofuels policy were very complimentary about the work of the IFPRI modeling group (see Annex for the list). They were complimentary about the disaggregation to estimate indirect land use changes and CGG emissions for the EU 27 countries. Several viewed this MIRAGE-BioF Model and its application as a unique modeling accomplishment. They were also complimentary about the effort to assemble the data necessary to conduct the MIRAGE-BioF modeling effort and to gain the confidence of the EU establishment in terms of using their results in official pronouncements on biofuels policy.

5. Report on Selected Country-Level CGE Modeling Activities – By Mohamed Ali Marouani

5.1 Introduction[1]

The report deals with two activities: PIM activity #37 on "Databases and tools for analyzing pro-poor growth and food security in Arab countries" and activity #38 on "Case studies of country specific policies to promote agricultural transformation and poverty reduction in Africa." These two activities (especially the second) rely on various methodological frameworks and cover two different regions. They will be analyzed separately except for the Dynamic Computable General Equilibrium (DCGE) model which is used in both activities and which is described in detail in Diao et al. (2012).

Although characterized by different income levels, sub-Saharan Africa and the MENA region (if we except the Gulf countries) have in common serious food security concerns, high youth unemployment, and a very large informal sector. Applied research is also limited by data scarcity and access (mainly in some MENA countries).

5.2 Relevance of Objectives and Design

The Arab Spatial Project

Relevance

The activity has three main objectives: (a) initiating a web-based knowledge platform for improving access to information and transparency, (b) identifying policies for overcoming poverty and the triple burden of malnutrition in the Arab World, and (c) designing methodologies to assess the macro- and microeconomic dimensions of poverty, food security and malnutrition.

This project is highly relevant and timely for the region for various reasons. First, the food price increases of 2007–2008 were a heavy burden for governments that subsidized food in the region but also for households when increases in the subsidy did not fully cover the price increases. At the same time this hike was an opportunity for farmers and for the countries to increase agricultural production if appropriate policies were implemented to accompany the higher price incentives. Thus analytical work on this subject is definitely needed in the MENA region to foster evidence-based discussions and accompany policy reform.

The second reason is the lack of data and the difficulty of accessing data not only for researchers but also for policy makers. In many Arab countries, government departments have trouble getting data from other departments, mainly from the department of statistics. Thus, putting data openness at the heart of the project is clearly a public good (at the national, regional and global levels).

[1]. The author would like to thank the principal investigators of the activities and the professional peers consulted for the helpful discussions during the evaluation process.

Finally, working on poverty issues in a region characterized by revolutions and conflicts is extremely relevant because it will be more difficult for governments in the future to achieve stability without a significant improvement in livelihoods.

However, it seems to me that the relevance of the project could be improved by adding three elements to future work on the MENA region. The first element us the employment dimension. Unemployment, particularly youth unemployment, is a major issue for policy makers in the region. This dimension could have been added to the project at a moderate cost. The technical considerations will be discussed in the next section, but on the policy side, job creation should be mainstreamed in any analysis, even before poverty, because poverty is often a consequence of unemployment in the region. One could respond to this comment by saying that there are international organizations specializing in this issue such as the ILO, the World Bank, and the UNDP. While this is true, I am not proposing that IFPRI work on labor market reforms or economy-wide policy reforms to create jobs. I propose that IFPRI focus not only on agricultural production, GDP growth, and poverty reduction when analyzing agricultural policy reform options, but also on job creation. For example, cereal production is becoming increasingly capital-intensive so that a crop reallocation in favor of cereals would probably not create many jobs, although it could increase cereal availability in the country. IFPRI's research should allow policy makers to see the trade-offs and be able to make decisions based on the most important dimensions, including jobs.

The second missing element is inequality. Although any work on poverty will have to deal directly or indirectly with inequality, it appears important to me to highlight this aspect from the beginning. Any policy reform will have distributional impacts, which IFPRI has the tools to analyze. In a burgeoning democracy such as Tunisia, for example, it would be very useful to feed the policy debate with empirical work on this aspect.

Lastly, climate change and particularly water scarcity are becoming major concerns in the region. The principal investigator (PI) has done significant work on this issue, including a book on the region with a World Bank colleague, *Economics of Climate Change in the Arab World*. However, these issues do not seem to be addressed in the current project. My proposition is similar to the first one on job creation. In water scarce countries, agricultural policy reform scenarios analyzed should also present the impacts on water consumption.

Design

According to the PI, most of the projects in the MENA region originated by requests from governments, other CGIAR Centers, or international organizations. In Yemen, the Government actively approached IFPRI after the food price increases, and the two parties have since established strong links in developing the food security policy. The work of IFPRI has also contributed to other policy reforms such as the oil subsidy reform. In Egypt, IFPRI was contacted by the World Food Program which has close links to CAPMAS (the Egyptian statistical institute) to include a food security module in a household survey. IFPRI was in this way associated with the data openness initiative launched by CAPMAS. In Iraq, ICARDA had a big project and sought the collaboration of the IFPRI team to perform a quantitative analysis of agricultural growth prospects under different scenarios. In Syria, where the project was cancelled after the launch of the civil war, IFPRI's intervention originated from a World Bank request.

Thus, it seems that a significant part of this activity has been demand-driven, although in some cases the demand has originated not directly from governments but through the channel of other international organizations working closely with these governments.

The Agricultural Transformation Project in Africa

Relevance

This project can be subdivided in two parts: (a) a new mechanization activity involving in-depth country case studies in selected African countries and learning from the recent experience of private-sector led mechanization in smallholder dominant Chinese agriculture; and (b) more classical public policy analysis activities (similar to previous IFPRI work) dealing with the maize export ban in Tanzania, assessing growth options in Rwanda, and assessing policy options for the domestic rice economy in Nigeria.

The mechanization component seems the most promising in terms of strategic research, given the unavailability of recent evidence-based research on the subject in Africa. The Tanzania study is often cited as a good example in terms of impact, because it contributed to the Government's decision not to reinstitute the maize export ban, which it had been reconsidering.

The different components of the activity seem very relevant given the needs of the region to increase agricultural production and productivity. However, with the exception of the Tanzania study, which was at the heart of the policy debate in that country, it is difficult to determine ex ante if the other components (mainly, the mechanization studies) should have risen to the top of the policy research agenda.

Design

The mechanization activity started in Ghana. In 2007–2008 the Government implemented three programs for agricultural transformation, one of which was mechanization. In 2011, IFPRI was approached to evaluate the programs through its Ghana Strategy Support Program. According to the PI, this led to the idea of starting a research project on mechanization in 2012. In Ethiopia where IFPRI also has a Country Strategy Support Program (CSSP), the Government also approached IFPRI to implement a mechanization study. The third country in the region where a study has been conducted is Nigeria with support from the Nigeria Strategy Support Program. Thus, the projects in Africa seem to have originated from bottom-up processes. The work on China was launched to derive insights from a region of the world where the mechanization process started much earlier and has accelerated since the late 1980s. The purpose was also to facilitate South-South knowledge exchange.

In conclusion, the two activities #37 and #38 are quite relevant and have a high potential for local ownership due to various strategic partnerships with governments (Yemen), CGIAR Centers (ICARDA), and other international organizations (WFP, World Bank) for the Arab Spatial project and due to associations with IFPRI's CSSPs in Africa. My principal concern is that French speaking countries (the Maghreb in the MENA region, and francophone West and Central Africa) are not covered by the activities, while many of these countries could certainly benefit from IFPRI's support. The PI of the MENA project told me that Tunisia was supposed to be the part of activity the Arab Spatial project, but that its involvement was delayed.

5.3 Quality of Science

Given that the dynamic CGE model has been used in both activities, I start my assessment with this tool and then I discuss separately the other aspects of the two activities as I did in the previous section.

The IFPRI DCGE Model

Country-level general equilibrium modeling has been a trademark of IFPRI's work on public policy impact analysis since the 1990s when Sherman Robinson was the director of the Trade and Macroeconomics department. IFPRI contributed to the popularization of this tool in developing countries through its Social Accounting Matrices (SAMs), CGE models, and toolkits available online.

In this subsection I will discuss the current version of the IFPRI's DCGE model as described by Diao and Thurlow (2012) and further developed in subsequent IFPRI research papers. I will not present the whole structure of the model but will focus on the most relevant and innovative aspects of the model given IFPRI's objectives, as well as on potential improvements.

Dynamics

The first important decision one has to make when developing a CGE model is to choose between a static model, a dynamic-recursive model, or full-fledged intertemporal model. IFPRI has convincingly chosen the second option. Static models are unable to deal with growth issues, which are at the heart of development policy debates. Intertemporal models allow the endogenization of household savings rates, but must be run over very long periods (usually not less than 40 years) and usually2 rely on the unrealistic hypothesis of perfect foresight over the whole period. Thus, despite the obvious caveat of fixed savings rates, recursive models seem the most relevant approach given IFPRI's purpose of analyzing medium-run growth options. It is also easier to explain such models to policy makers, than to describe forward-looking rational expectations frameworks.

Consumer Behavior

The IFPRI DCGE model relies on a linear expenditure system demand function (including minimum subsistence levels for each product), which is quite standard but particularly relevant when analyzing the agricultural sector. Indeed, this allows for lower price elasticities for some products such as food and for non-unitary income elasticities of demand (unlike Cobb-Douglas specifications). This means that a shock affecting agricultural prices will have a different impact depending on the level of the elasticities. Income elasticities are estimated using household survey data, which gives more strength to the results obtained.

The Production Function

The DCGE model uses a constant elasticity of substitution production function with capital, land and labor as production factors. This specification is relatively standard in CGE modeling, but some issues can already be raised at this point.

[2]. There is a possibility of introducing uncertainty, but this complicates the model.

First, land disaggregation seems necessary given the weak substitutability, for example, between land used for cereals and for citrus fruits. At least, the model should distinguish between irrigated and non-irrigated land because some crops cannot survive without irrigation in many countries. IFPRI researchers' response to this comment is that they have a regional disaggregation (described later) in the model which allows them to take these differences into account. But this means making the implicit assumption of homogeneous regions in terms of land quality and water availability.

The second missing aspect in the model is labor disaggregation by age. Actually, the labor market is the least developed aspect in the model (this will be developed later). Labor disaggregation by age is very important, especially in regions such as the Arab world, characterized by the highest youth unemployment rates in the world. The youth and non-youth are often weakly substitutable. Thus, a given shock affecting the labor market will not have symmetrical effects on both categories, depending on the relative intensities of the sectors affected by the shock. For example, David and Marouani (2013) show that liberalizing trade in services would benefit the youth much less than the non-youth in Jordan and Tunisia.

The third aspect is the possibility of increasing the relevance and credibility of the results by estimating the parameters of the production function, whenever it is possible. To perform such estimations would require raw micro data on factors (labor, capital and land) use as well as on prices (wages, capital income and land prices). I do not know if this information is available in the farm surveys of the countries for which the models have been developed. Where data is available, the estimations would be very helpful. Some CGE modelers are starting, for example, to estimate elasticities of substitution between different categories of labor, using labor force surveys or firms' surveys.

Regional Production

Disaggregating the model into regions with specific technical coefficients and regional specific factors such as land and farm labor is definitely a relevant dimension in the IFPRI DCGE model. Market segmentation in countries where IFPRI is involved, as well agro-ecological differences are thus better taken into account, although intra-regional differences are ignored as stated above. This segmentation allows the possibility of having different prices between surplus and deficit regions (Diao et al. 2013).

However, given that regional SAMs are not available, or would require a daunting effort to make them available, some assumptions are required and these assumptions have an impact on the results. For example, the share of cross-border exports in maize surplus regions has been fixed in an ad hoc way in the research on export bans in Tanzania.

The Labor Market

In the Diao and Thurlow (2012) description of the DCGE model, the labor market is assumed perfect without unemployment or rigidities. Thus, the existence of dual urban labor markets in developing countries, with a formal and informal segments, is completely absent from the model. Labor supply is exogenous and migration (internal or external) non-existent.

This standard neoclassical representation of the labor market should be improved to introduce a more realistic treatment of employment issues, and consequently of poverty and inequality.

Assuming no unemployment (or underemployment) necessarily induces an overestimation of the positive income effects of a given shock. Similarly, the existence of immigration could significantly modify the outcome of a shock. For example increasing the wages on plantations in Malaysia might benefit mainly migrants, who constitute the bulk of the labor force of this activity.

In the MENA region it is definitely not possible to ignore migration phenomena (emigration and immigration), especially since 2011, and the millions of refugees that are having a very significant impact on small economies like Jordan, Lebanon or Tunisia.

Labor supply evolution is exogenous in IFPRI's DCGE model. It is based on demographic projections and on current participation rates for workers with different education levels. This has two shortcomings. First, the skill composition of the population is assumed constant, which is probably true in developed countries (steady state level), but cannot be assumed in countries where education levels are increasing dramatically (which is particularly the case in the MENA region). Second, participation rates do not react to economic incentives, which is a strong assumption.

The Microsimulation Module

The current IFPRI DCGE model has a top-down micro-accounting module that allows the passing down of consumption changes for each household group to its corresponding household in the survey. Previous work with IFPRI's collaboration (Bourguignon, Robilliard and Robinson 2004) included agents' behavior in the micro framework, which allowed the change in occupational choices (from active to inactive, for example). This had the advantage of dealing with intra-group inequality, while micro-accounting applied the same shock to all group members. However, micro-accounting is easier to implement because it does not entail micro-econometric estimations and its results can be satisfactory if household disaggregation is large in the macro framework (in the Tanzania model there are 315 household groups according to the authors).

One of the strengths of the IFPRI microsimulation module is its inclusion of changes in households' nutritional status. Changes in food consumption quantities obtained from the DCGE model are applied to household survey data to estimate changes in total household caloric availability.

Other Aspects

From my discussions with professional peers, the conclusion is that IFPRI modeling research is of good quality and the members of the team have a very positive image. According to peers, the decentralization resulting from the expansion of IFPRI's country offices makes its work more productive than in the past. Peers also suggest that the IFPRI team emphasize using the CGE models more for explaining causal effects rather than only for "forecasting."

The Arab Spatial Platform

One of the main objectives of the project has been to develop a knowledge platform (the Arab Spatial Food Security Atlas) available online for decision makers, researchers, and the public. This platform is based on the food security system concept, described in Ecker and Breisinger (2012). According to the authors, food security at the household level depends on macroeconomic stability, good governance, and some key sectors such as agriculture, water, and transportation. The system can also be heavily affected by shocks such as climate change, conflicts, international price hikes,

etc. The objective has been to monitor the main variables affecting the food security system as well as the outcome indicators and the projects dealing with food security in the country.

This database seems very useful for policy makers, international organizations, journalists, and students as well as researchers because it consolidates data from different sources and gives information at the governorate level in some cases. However, I do not think it will constitute a major input for applied research because there is no possibility of accessing raw data in the platform, while this has been what attracts researchers as shown by the various survey databases that have the highest success among the development research community (LSMS, DHS, WIID database on inequality, etc.). In the Arab region, this would be even more important due to the difficulty of accessing raw data by researchers.

The Mechanization Project

Although the study on the export ban in Tanzania received a lot of attention due to its timeliness, the main project of activity #38 has been the mechanization study. The objective of the project has been to determine the main constraints facing small farmers to adopting mechanization services through three African country case studies (Ghana, Nigeria and Ethiopia) and through learning from the experience of private-sector led mechanization in smallholder-dominant Chinese agriculture.

Three papers from this activity have been published in very good journals. The first (Yang et al. 2013) examined the reasons for the success of the Chinese mechanization experience, despite land fragmentation. This article found that the existence of inter-regional markets for farmer owned "combine service enterprises" allowed these cluster enterprises to reduce fixed costs by taking advantage of harvests that occurred at different times in different provinces. However, this very interesting paper in explaining the Chinese success is not enough to understand the less successful mechanaiztion outcomes in Africa. A twin paper would be needed to analyze each factor in the success of the Chinese experience, what would be possible to implement in Africa, and what would not be. For example, if a country does not have harvests that occur at different times, the interregional market would probably not develop. Moreover, some points in the paper on China should be deepened, such as the success of clusters with the support of the Government. In many African countries, governments tried to promote the development of cooperatives but with little success. Is the difference in outcomes due to different incentive schemes or to farming systems more adapted to clusters than others? Or to other reasons?

The first paper on Ghana (Diao et al. 2014) combined qualitative interviews, data analysis and a literature review for analyzing the emergence of a demand for mechanization as well as supply constraints to a successful development of mechanization. Farming systems evolution was proxied by land use intensity, which has constantly increased in Ghana, potentially inducing increased demand for mechanization by Ghanaian farmers. The authors then relied on the induced technical change model to analyze the factors that could entail a higher demand for mechanization. Agro-ecological and socio-economic factors as well as urbanization were behind the increase of the land-labor ratio in Ghana, creating a higher demand for labor-saving technology.

A supply chain analysis was adopted to analyze the alternative supply models. The main model relying on private firms heavily subsidized by the government does not seem viable due to the low level of the utilization of the equipment (there are no interregional operations such as in China to

allow decreasing fixed costs). The second model based on tractor ownership by medium and large-scale farmers' ownership and contracting to small farmers seems much more promising.

The second paper on Ghana (Houssou et al. 2013) consisted in calibrating a firms' investment model with field-based assumptions on costs, revenues, and tractor efficiency, and comparing the modeled outcomes to actual profitability. The authors distinguish four zones: low operational scale/negative profitability, low operational scale/negative investment profitability, high operational scale/low profitability, and high operational scale/low investment profitability. The conclusion was that most specialized service firms operated in the two first zones, which confirmed the results of the previous article.

The objective of the paper on Nigeria (Takeshima et al. 2013) was to investigate how mechanization affects the income of smallholder farmers. The methodology was based on a cluster analysis to investigate how farm types are associated with the use of mechanization and on a linear programming model to assess the demand for mechanization and its impact on farmers' income.

The cluster analysis revealed that mechanization was associated with input-intensive production. Tractor use in the north was associated with increased nonfarm income-earning activities, rather than expansion of cultivated area. In the South, it was highly concentrated among large-scale rice producers. The linear model showed that farmers' income would increase by reducing land preparation costs, even if the area cultivated and production did not increase.

These papers have been positively assessed by peers who are familiar with this literature. A first remark concerns the issue of using country-level or large regional averages. The risk is that heterogeneity and specificities are lost when analyzing the behavior of farmers and advocating for policy reform. A second remark concerns how the administrative frontiers between countries do not correspond to the relevant agro-ecological zones. Thus, whenever it is possible, it would be more relevant to extend the analysis to neighboring countries. Finally, it was suggested to incorporate the results of the mechanization project in the IFPRI DCGE model. This suggestion would also be valid for all the related micro studies that the IFPRI team realizes.

5.4 Relevance and Effectiveness of Partnerships

The Arab Spatial Project

The main partners of the project are the WFP, CAPMAS, IFAD and the Yemen Ministry of Planning and International Cooperation (MOPIC). The WFP has been a key partner of the Egyptian Government for a while and has been funding a lot of the data work within CAPMAS (Egypt statistical institute). IFAD is one of the key investors in rural poverty reduction and food security in the region. MOPIC is a coordinating ministry, which is important for a multi-sector development challenge like food security. For this reason, MOPIC now houses the National Food Security Secretariat. All these partners are relevant to get data, funding and help implementing the recommendations of the project.

A conference was also organized with ERF (the Economic Research Forum), the main network of applied economists in the MENA region. This network is composed of the best economists in the region, receives funding from various regional and international organizations, and has strong links with policy makers. Two of its former managing directors became ministers of finance in Egypt after

the 2011 revolution. IFPRI should tighten its links with ERF to develop common projects with greater policy relevance and regional ownership, and with possibilities of funding.

Moreover, I noticed that Ministries of Agriculture do not seem to be associated with the projects in which IFPRI is involved. This could be due to the weak analytical capacities of these ministries in the region. It is often Ministries of Planning and departments of statistics that are the privileged partners of projects involving applied research. Indeed one finds in these departments the data needed as well as the statisticians and applied economists able to collaborate with international organizations. However, the issue is that agricultural policies are decided with Ministries of Agriculture, and the impact of any project would be greater if the Ministries of Agriculture were associated, given the weak collaboration between ministries in some MENA countries. Strengthening the analytical capacities of Ministries of Agriculture in the region would seem to be a strategic necessity that should be taken into account if one wants to have a significant impact on agricultural policy reform. This recommendation goes beyond this project. It could constitute an activity in itself that PIM could collaborate with other bilateral, regional or international organizations such as the IDRC, ERF, the World Bank, etc.

The Agricultural Transformation Project in Africa

The classical, CGE component of this project has a long history of working both with research partners in African universities and research institutes, and with the immediate users of the research such as Ministries of Planning and Agriculture and development partners such as the World Bank, the EC, USAID, DFID, and the African Union — most recently in the context of the implementation of the Comprehensive Africa Agricultural Development Program (CAADP). After 2005, when the African Union and its NEPAD Secretariat (New Partnership for Africa's Development) placed greater emphasis on influencing and improving national agricultural policy formation to realize the CAADP objectives of allocating 10 percent of government budgets to agriculture and 6 percent growth in agricultural production, the provision of IFPRI's modeling expertise was the principal technical assistance offered by the international community in this regard (Poulter et al. 2014).

The partners of the mechanization component have been the Agriculture Engineering Services Directorate (AESD) of the Ministry of Food and Agriculture of Ghana, the Savanna Agricultural Research Institute (SARI-CSIR) of Ghana, the Federal Ministry of Agricultural and Rural Development of Nigeria, and the Chinese Academy of Agricultural Mechanization (CAAM). This project relies heavily on the presence of CSSPs in these countries which help identify funds, data, networks, and the most relevant partners.

5.5 Effectiveness — Outputs, Outcomes, and Likely Impacts

The two projects are fulfilling their promises in terms of outputs. While the Arab Spatial project seems to focus more on database development, access to information, and organizing workshops, the agricultural transformation project focuses more on publishing papers (mainly for the mechanization activity). The nature of the research is different. The research in the first case is more applied, while that in mechanization activity is more strategic — raising awareness about a subject that was not studied for a long period.

In terms of outcomes and impacts, the Arab Spatial project operates in a currently unstable environment. In some countries the State is weakened. While these countries definitely need the support of the international community, implementing policy recommendations will not be an easy task. Despite this, it seems that the outputs of the project were widely used by the Government of Yemen in the oil subsidy reform and in its interactions with international organizations. Yemen also established a National Food Security Council and Technical Secretariat to implement the strategy defined with IFPRI.

For the second project, the classical component (the CGE model) seems to have had a significant policy outcome through the analysis of the effects of the maize export ban in Tanzania. IFPRI's analysis contributed to the Government's decision not to reinstitute the ban, which it had been reconsidering. The mechanization component will probably not have an immediate outcome or impact, but it could encourage further research on similar themes and policy debates which could ultimately have an impact on agricultural production and smallholder farmers' incomes.

5.6 Gender Mainstreaming

The work on the Arab Spatial Platform allows highlighting the systematic differences according to gender (women's literacy rates, education levels etc.). The PIs also paid attention to ensure a gender balance in the two training workshops, particularly in the training with CAPMAS in Egypt, where they had 10 female and 4 male participants.

According to the PIs of the transformation activity, it has not always been easy to introduce a gender dimension in their project. This being said, they addressed gender issues by analyzing technology adoption of different farm activities according to whether the head of the household was a man or a woman. The evidence obtained suggested that female-headed households were less likely to use tractors or draft animals in Nigeria. The tractor owner operators' survey in Nigeria provided preliminary indications that tractor ownership was male-dominated, and earnings were rarely shared with spouses. Perceived reasons behind such male-dominance were mixed; some viewed it as reflection of cultural norms, while others regarded females as having comparative advantages in activities other than tractor ownership.

5.7 Capacity Strengthening and Sustainability

The Arab Spatial Project

According to the PI, the following capacity strengthening activities were conducted:

- 2-day training of 14 statisticians and analysts (with 10 females) at Central Agency of Public Mobilization and Statistics (CAPMAS), Cairo, Egypt;
- 5-day training workshop of 12 economists (2 females) at the Ministry of Planning and Economics in computable general equilibrium modeling;
- support for the national accounts team of CAPMAS in building economic databases (Social Accounting Matrix);
- support for the national accounts team of CAPMAS in building economic models (CGE) for policy research;

- provision of remote technical support and capacity strengthening for the Yemen Ministry of Planning (MOPIC) based Food Security Technical Secretariat;
- provision of capacity strengthening to the M)PIC based Modeling Team on computable general equilibrium modeling.

These activities are very relevant and useful, but to ensure sustainability, closer links need to be developed with local academics. Indeed, formal training activities are generally useful to raise awareness and interest, but it is rare that they are sufficient to obtain autonomous practitioners, especially with sophisticated tools. A partnership with local researchers (if they are competent enough and well trained by IFPRI) would allow the tools developed to continue to be used after the end of the projects.

The Agricultural Transformation Project in Africa

The following were the capacity strengthening project mentioned by the PI:

- a brown bag seminar was provided to local researchers in Nigeria at which some of the research methods were presented;
- several enumerators, mostly Nigerian Master's students (including a few females), were trained in the use of survey software (CSPro) and Tablet PC for data collection;
- detailed questionnaires interviewing tractor owner-operators were developed in collaboration with the local university conducting research on agricultural mechanization in Nigeria.

The Ghana survey was jointly conducted with a local institute and the Ghana team was provided training for over 40 enumerators in the use of computer-assisted survey interviews using Microsoft Access. The partner institute for the survey and training was the Savanna Agricultural Research Institute.

China's mechanization work was presented at various places in different provinces in China, such as Zhejiang University, the annual China Agricultural Economics Review/IFPRI joint meeting, and Allied Social Science Association meetings.

According to the PI, deeper collaboration in terms of research with locals is very important, but it has not always been easy to find the right collaborators.

Lessons Learned

The PI of the Arab Spatial project explained that the approach they were following consisted in starting the training with a large group, and then selecting the most suitable candidates for further training using a test approach. Due to security issues in Yemen, the partners were often trained in other countries (like Egypt) and contacts were regular through videoconferences.

One of the main recommendations of the professional peers was to set aside a special budget for capacity strengthening and to increase this budget to improve the efficiency of knowledge transfer and collaboration with locals.

5.8 Organizational Performance

According to the PIs, PIM was helpful in acknowledging their work by publishing it on its website. The program has also provided more flexibility than bilateral donors. For example, it allowed financing of a workshop in China to which IFPRI brought practitioners from Africa to learn from the Asian experience. However, high transaction costs were also mentioned by the PIs due to a higher administrative burden associated with PIM.

5.9 Overall Value Added of the Modeling Activities

The assessment of the activities by the professional peers consulted was globally very positive. The contributions of IFPRI is valuable, given the weak analytical capacities of developing countries in designing and evaluating agricultural policies.

The few points raised during this evaluation could improve the effectiveness and relevance of the modeling work done. First, the team could more systematically include in its general equilibrium exercises the results of micro-econometric estimations obtained in some other projects. This would give more confidence in the results obtained.

Moreover, the team focuses mainly on growth, poverty and nutrition in some cases. Adding employment and natural resource availability as outcome variables would give more information for policy makers about the trade-offs. This is particularly important in the Middle East and North Africa region where unemployment (particularly for the youth) is the main challenge today and water scarcity probably the most important challenge of the next decades. The labor market block of the IFPRI DCGE model should be upgraded to include some of the elements proposed in this report, including a migration block, which would be very relevant in some countries.

Finally, the projects seem to be much more effective in countries where CSSPs exist. Given that many other countries need support for reforming their agricultural policies, IFPRI could develop partnerships with regional research organizations to allow a better diffusion of its outputs.

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Annex A. Basic Information about the Portfolio of Activities Reviewed

Act #	Title	Flagship/ Cluster	Center	Principal Investigator	Legacy/ New	Start Year	Regions/ Countries	W1-2 Funding (US$ '000)			Bilateral Funding (if known)	% Gender
								2012 Actual	2013 Actual	2014 Budget		
5	Assessment of possible futures of tropical agriculture, alternative technologies/management systems, and policy interventions; Add 2013: mapping of the CRPs	1.1	CIAT	Steve Prager (formerly Bernardo Creamer)	Legacy	2012	Mainly LAC Asia	204.6	325.0	275.0		20%
13	Development and enhancement of methods for targeting, impact assessment and priority setting of promising potato and sweet potato technologies	1.1	CIP	Guy Hareau (formerly Ulrich Kleinwechter)	Legacy	2012	LAC SSA Global	356.4	261.8	300.0		0%
17	Developing data and tools towards improved modeling of agroforestry and NRM in maize systems	1.1	ICRAF	Frank Place	New	2012	SSA: Ethiopia, Malawi, Rwanda, SSA Global	92.5	104.8	100.0	U.S. agencies for collecting agro-forestry data	0%
22	Assessment of plausible futures of dryland agriculture in Semi-Arid Tropics (SAT) and alternative technologies/management systems and policy interventions	1.1	ICRISAT	S. Nedu-maran	Legacy	2012	SA: India, Myanmar, SA global SSA: Ethiopia, Kenya, Mali, Niger, Tanzania, SSA global	331.6	306.2	350.0		20%

Act #	Title	Flagship/ Cluster	Center	Principal Investigator	Legacy/ New	Start Year	Regions/ Countries	W1-2 Funding (US$ '000)			Bilateral Funding (if known)	% Gender
								2012 Actual	2013 Actual	2014 Budget		
23	Development and enhancement of methods and tools for better targeting, impact assessment and priority setting for ICRISAT mandate crops; Add 2013: Development pathways and its determinants in rural Sahel: case of some villages in Burkina Faso and Niger	1.1	ICRISAT	Cynthia Bantilan, Jupiter Ndjeunga	Legacy	2012	SA: Bangladesh, India SSA: Burkina Faso, Ethiopia, Malawi, Niger Global	232.9	330.0	160.0		20%
78	Food supply and demand projections for IITA mandate crops under alternative drivers of change and R&D investments	1.1	IITA	Arega Alene	Legacy	2012	SSA: DRC, Ghana, Mali, Nigeria, Sierra Leone, Tanzania, Zambia, regional	243.0	306.0	350.0		20%
82	Global futures for agriculture	1.1	ILRI	Dolapo Enahoro, Signe Nelsen	Legacy	2012	Global SSA: Tanzania, Uganda, etc.		539.1	600.0	Gates Foundation	0%
90	Promising aquaculture technology scenarios from Asia and Africa and their analysis through IMPACT	1.1	World-fish	Tran Van Nhuong	New	2013	Global SA: Bangladesh SEA: Indonesia, Philippines SSA: Zambia		159.3	200.0		0%
94	Enhancing foresight and strategic futures for maize and wheat	1.1	CIMMYT	Sika Gbegbelegbe	Legacy	2013	SA SSA		300.0	350.0		0%

Act #	Title	Flagship/ Cluster	Center	Principal Investigator	Legacy/ New	Start Year	Regions/ Countries	W1-2 Funding (US$ '000)			Bilateral Funding (if known)	% Gender
								2012 Actual	2013 Actual	2014 Budget		
95	Strategic foresight of promising ICARDA's agricultural technologies and management systems	1.1	ICARDA	Aden Aw-Hassan	New	2013	MENA: Lebanon, Syria, MENA countries Global		222.7	300.0		20%
97	Global Futures and CGIAR Strategic Foresight Program	1.1	IFPRI	Keith Wiebe	Legacy	2013	Global		937.7	1,476.1		0%
	Dublin conference	1.1	IFPRI	Gerard Nelson	New	2013	Global		4.8			20%
125	A global study on linking food production with groundwater depletion and potential	1.1	IWMI	Karen Villholth	New	2014	Global with focus on SA, SEA and SSA			200.0		0%
118	Monitoring agricultural price distortions	4.1	IFPRI	David Laborde	New	2014	Global SA: India			400.0		0%
119	Adding the gender dimension to the agricultural policy monitoring	4.1	IFPRI	David Laborde	New	2014	Global			202.0		50%
37	Databases and tools for analyzing pro-poor growth and food security in Arab countries	4.3	IFPRI	Clemens Breisinger	New	2012	MENA: Egypt, Iraq, Yemen, MENA global	174.8	328.0	306.5		33%
38	Case studies of country specific policies to promote agricultural transformation and poverty reduction in Africa	4.3	IFPRI	Xinshen Diao	New	2012	EA: China SSA: Ghana, Malawi, Nigeria, Rwanda, Tanzania	91.3	587.1	500.0		50%
40	The emergence of employment opportunities outside of agriculture for rural workers and its welfare implications: evidence from South and Central Asia	4.3	IFPRI	Valerie Mueller	New	2012	CA: Tajikistan SA: Bangladesh, Nepal, Pakistan	121.3	312.0	350.0		33%

Act #	Title	Flagship/ Cluster	Center	Principal Investigator	Legacy/ New	Start Year	Regions/ Countries	W1-2 Funding (US$ '000)			Bilateral Funding (if known)	% Gender
								2012 Actual	2013 Actual	2014 Budget		
58	Policy reform and income distribution: improving models and databases in global economic models	4.3	IFPRI	Antoine Bouet, David Laborde	Legacy	2012	LAC: Brazil, Peru, Uruguay SEA: Indonesia, Vietnam SA: India, Pakistan SSA: Senegal, Tanzania, Uganda Global	147.9	378.0	218.0		100%
96	Updating Social Accounting Matrices for African Countries	4.3	IFPRI	Xinshen Diao, James Thurlow	Legacy	2013	EA: China SEA: Vietnam SSA: Botswana, Kenya, Lesotho, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Tanzania, Zambia		311.9	307.2	USAID, Global Develop-ment Network	33%
57	Structural changes in the global trading system and consequences for agricultural markets	4.4	IFPRI	David Laborde	Legacy	2012	Europe MENA: Morocco USA Global	260.7	187.4	267.0	EC	0%
127	Support to the 2014 GTAP (Global Trade Analysis Project) conference on June 18-20, 2014 in Dakar on "New Challenges in Food Policy Trade and Economic Vulnerability"	4.4	IFPRI	Antoine Bouet	New	2014				30.0		0%

Act #	Title	Flagship/ Cluster	Center	Principal Investigator	Legacy/ New	Start Year	Regions/ Countries	W1-2 Funding (US$ '000)			Bilateral Funding (if known)	% Gender
								2012 Actual	2013 Actual	2014 Budget		
	Analysis of the Indirect Land Use Change Impact of Biofuels	4.4	IFPRI	David Laborde	New	2012	Global EU				EC, OECD, CEPII	0%

Annex B. List of Professional Peers Consulted

(in addition to the Principal Investigators of the activities reviewed in Annex A)

Name	Position	Organization
Global Futures and Strategic Foresight Activities Based on IMPACT		
Harald Grethe	Professor, Agricultural Policy and Market analysis	University Hohenheim, Bonn
Michael Obersteiner	Program Director of the Ecosystems Services and Management (ESM) Program	IAASA, Laxenburg, Austria
Claudia Ringler	Researcher, Focus on river basin modeling	IFPRI
Josef Schmidhuber	Deputy Director, Statistics Division; format HoU Global Perspective Unit	FAO
Peter Verburg	Professor, Land Use Modeling	University Amsterdam, The Nehterlands
Martin von Lampe	Senior Scientist	OCED
Keith Wiebe	Senior Research Fellow	IFPRI
Stanley Wood	Senior Program Officer, Agricultural Development Program	Gates Foundation
MIRAGE Trade Analysis and BioFuels Models		
Jean-Paul Chavas	Professor, Agricultural and Applied Economics	University of Wisconsin, Madison
Klaus Frohberg	Professor, Institut für Lebensmittel- und Ressourcenökonomik	Landwirtschaftliche Fakultät Universität Bonn
Tom Hertel	Professor, Agricultural Economics	Purdue University, GTAP
William Martin	Research Manager, Agriculture and Rural Development	World Bank
Dominique van der Mensbrugghe	Director and Research Professor, Center for Global Trade Analysis	Purdue University
Hugo Valin	Research Scholar, Ecosystems Services and Management	IIasa, Austria
Country-Level CGE Modeling — Activities 37 and 38		
Channing Arndt	Senior Research Fellow	UNU-WIDER
Céline Bignebat	Research Fellow	INRA
Clemens Breisinger	Senior Research Fellow	IFPRI
Xinshen Diao	Deputy Division Director and Senior Research Fellow	IFPRI

Name	Position	Organization
Hans Lofgren	Senior Economist	World Bank
Terry Roe	Professor	University of Minnesota
James Thurlow	Senior Research Fellow	IFPRI
Monitoring Agricultural Price Distortions — Activities 118 and 119		
Jean Balie	MAFAP Manager	FAO
Derek Byerlee	Retired	World Bank
Hélène Gourichon	Economist	FAO
Tim Josling	Retired	Stanford University
David Laborde	PI	IFPRI
Demeke Mulat	Economist	FAO
William Martin	Research Manager, Agriculture and Rural Development	World Bank
Guillaume Pierre	Economist	FAO
Alberto Valdes	Retired	World Bank