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## Report to the GTAP Advisory Board 2017

Wageningen Economic Research (previously LEI), part of Wageningen University and Research (WUR), has been a member of the GTAP consortium since November 1996. We use the GTAP database and model for a variety of research activities related to the agri-food sector and beyond.

In particular, the standard GTAP model constitutes the basis of the MAGNET model, a modular CGE model approach developed at Wageningen Economic Research. Hence the name MAGNET, short for "Modular Applied GeNeral Equilibrium Tool". MAGNET has the standard GTAP model at its core with all extensions added in a modular fashion. It allows the user to select which additional modules he/she wishes to include by adjusting the model settings and by including the relevant data. See annex 2 for an overview of the current structure of the MAGNET model.

In addition to Wageningen Economic Research, MAGNET is used and developed by researchers from the Joint Research Centre of the European Commission (JRC) and the Thünen Institute (TI), with the cooperation being organized in a MAGNET consortium. A website has been launched (<http://www.magnet-model.org/>) in order to provide access to project information, module descriptions and publications. Consolidating and developing MAGNET, we continue to hold regular update meetings and research seminars at Wageningen Economic Research to present research and address specific issues in depth.

The following presents a summary of the activities of the MAGNET group at Wageningen Economic Research in 2016/2017.

### People

Annex 1 gives an overview of the current team members and main research interests in relation to CGE modelling with GTAP/MAGNET.

Marijke Kuiper, Lindsay Shutes and Andrzej Tabeau have been managing the MAGNET team at Wageningen Economic Research. They have been given the task of coordination and programming activities in the GTAP/MAGNET work on a day to day basis. Hans van Meijl remains the scientific leader and contact person for GTAP/MAGNET work.

In 2016, Martine Rutten unfortunately left MAGNET team. Michiel Van Dijk has (temporarily) gone to work for International Institute for Applied Systems Analysis (IIASA) in Austria to obtain foreign research experience. He remains part-time at Wageningen Economic Research.

Marie-Luise Rau participated at the GTAP Preferential Trade Agreements (PTA) Mini-Course "Applied Policy Analysis: Mini-course on Preferential Trade Agreements" in Oct/Nov 2016.

### Awards

George Philippidis GTAP Research Fellow 2015-2017

### Looking ahead – focus areas for the coming year

The sizeable group of researchers involved with MAGNET work makes it worthwhile to exploit potential economies of scale, overcoming limits posed by project-driven research as done at Wageningen Economic Research. For the coming year work on the following cross-cutting themes is planned, funded by a range of projects (more details can be found under CGE-related research).

- *Bio-based economy*: MAGNET has been extended with a large number (about 20) new sectors related to the supply of biomass (residues, plantations, pellets) and conversion of biomass (electricity, chemicals). In 2016, MAGNET was extended with a sector that produces biokerosene and conventional kerosene. The focus in 2016/2017 is on various assessments of the socio-economic and environmental impacts of bioenergy use and especially on synergy and trade-off effects of strategies to avoid undesirable land use change and food security effects.
- *Waste*: MAGNET will be extended with a waste management system. It will include introducing waste generated by households and producers and various prototypical options of dealing with waste by including new sectors like incinerators, landfills and recycling and composting sectors. In such a system there will be a direct link between waste and bio-economic sectors in the model.

- *Food and nutrition:* Following the FoodSecure project, the SUSFANS project shapes the MAGNET work on the incorporation of food waste as influenced by underlying economic incentives, imperfect competition in the food supply chain, incorporation of micronutrients, and improved consumption and nutrition at household level detail in 4 EU countries (France, Italy, Denmark, Czech republic) better capturing the variability in nutritional content of especially processed food (across income levels and over time in long term projections). Future interest lies in the computation of health effects of changing diets and feedback effects onto the economy (labor time, productivity; wellbeing; health care costs).
- *Microsimulation tool for modelling diets:* In order to reflect better the ongoing processes of food systems transformation connected to diet quality changes and corresponding nutrition-health linkages, an effort will be made to build a microsimulation tool that will enable to link macro drivers with household/individuals' consumption choices. Tracing aggregate consumption to the household and/or individual level will enable to estimate precisely the nutritional outcomes (both macro and micronutrients) and will be useful for capturing the health effects linked to consumption of particular foods (relevant for food-borne disease burden in developing countries and obesity-related diseases in developed countries). *Food security and environment nexus:* exploiting the modular character of MAGNET we will analyze the food security implications of the bio-based economy and climate change; i.e. combining several main strands of MAGNET developments to assess potential food security/environment trade-offs.
- *Energy and Climate Change:* detailed energy sectors (including renewable electricity sectors wind, solar and biomass) will be added and in combination with the new bioeconomy and emission modules IPCC scenario's will be quantified to 2050 (and sometimes 2100). Mitigation and adaptation scenario's will be assessed. The climate module will be added to MAGNET. It will calculate climate related variables: CO<sub>2</sub> concentration, radiative forcing, and temperature as well as impact of climate on land productivity. Land use related emissions will be modelled and implemented into MAGNET.
- *Water:* An explicit accounting of water use in agriculture will be included in the MAGNET model within the framework of examining the global confluence of water, energy, climate and food. Initially this will be implemented as an ex-post analysis to assess the change in water demand. Further developments will most likely include supply constraints for agricultural water demand via a hydrological model as well as possibilities for demand management by including a water endowment in the agricultural production structure.
- *Fisheries:* The effort to make fish stocks dynamic in MAGNET will continue. Fish stocks will be modelled as completely mobile for countries fishing in a common sea or ocean. Fish stocks however are not expected to move between seas. To capture this dynamic of the fish stocks the world will be divided into four oceans: Atlantic, Indian, Pacific and Southern Ocean. Countries adjacent to these sea areas get assigned fish stocks based on historic catches but are able to freely trade fish stocks. The mobility of natural resources will be modelled similarly to the capital mobility as used by dynamic GTAP model leading to endogenous fish stocks.
- *Dynamic Natural Resource Stocks:* Magnet will be extended with dynamic natural resource stocks developments for gas, coal and crude oil. Available stock of resources will be endogenous in the model instead of exogenous.
- *Afforestation:* Potential impacts of afforestation on resilience of food and forest systems under economic and climate stress at multiple scales will be further investigated. For example carbon sinks support the stabilization of the climate, however the additional land needed for afforestation reduces the stock of crop land and the land reserve, which may affect local and global food availability and may contribute to upward pressure on food prices. Depending on the structure of the system for paying for afforestation, this activity could either support or hinder communities whose livelihoods depend on forests and agriculture, as well as the urban poor who may be faced with higher food prices with no compensation. The above will have consequences for food and nutrition access and socio-economic stability. The political economy aspect of financing the REDD initiative which until now has not been considered within a general equilibrium framework will be explored here.

- *Sustainable Development Goals*: Expand the coverage of SDG indicators produced by the model for evaluating progress towards the SDGs in an ex-ante modelling framework.
- *International transfers*: An international transfers module will be added to MAGNET based on the theory, data and code of the MyGTAP model. The module will capture international flows in foreign aid, remittances and foreign income. It is expected that the module will be used to evaluate the impact of changes in foreign aid on food security.
- *Imperfect competition*: In response to the relatively recent advances in the modelling literature on the role of market power, an imperfectly competitive market module will be incorporated into MAGNET. The module will permit the user to switch between perfect competition, Spence-Dixit-Stiglitz-Krugman type monopolistic competition and the more recent Melitz model.

## **CGE-related research in 2016/2017**

### *Land supply*

- Recalibration and revision of land supply elasticities. Survey of land supply elasticities was prepared. Calibration procedure of land supply function was developed and programed.
- Improvement of agricultural land availability estimates – using newly developed data provided by the Dutch Environmental Agency (PBL). New land availability estimates have been added to MAGNET data base and used in several projects.

### *Afforestation*

- Afforestation is considered an important and possibly rather cheap climate mitigation option. The possibility of converting an agricultural land was implemented in MAGNET. Economic effects of afforestation, especially for food security, have been investigated by running several scenario experiments.

### *Data and model management software*

- GTAP database version 9 is implemented in MAGNET, incl. an update of various additional sectors.
- Electricity split
  - Electricity has been split into 5 electricity sectors: electricity from (1) coal, (2) gas, (3) nuclear, (4) solar and wind (5) hydro and thermal
  - The old electricity sector is now a transport sector of electricity
  - Emissions attributed to the different electricity sectors have been calculated
- Meat split: oap has been split into pig and poultry, adding for each three of different production systems with varying input intensity to facilitate the link to IMAGE.
- R Code that facilitates the post-processing of MAGNET output by automatically converting har files to gdx and upload them into R has been developed.

### *Emission module*

- Magnet has been extended with an emission module.
- Both CO<sub>2</sub> and Non-CO<sub>2</sub> emissions published by GTAP have been included.
- Emissions for the newly introduced biofuel sectors, fertilizer sectors and energy sectors are also calculated.
- The emission module makes it possible to solve MAGNET either with a CO<sub>2</sub> tax or with an emission reduction target.
- A system of emissions permit trading is to be incorporated into the model which follows the work of the GTAP-E model.

### *Linking of models and long term scenario development*

- AgMIP: Comparison of alternative approaches for long-term scenarios for agricultural markets and trade
  - Wageningen Economic Research/MAGNET and PBL/IMAGE teams are busy with quantification of RAPs (Representative agricultural pathways) and climate scenarios. The SSP1, 2, 3, 4 and 5 story lines and macro-economic assumptions are used. Teams involved are GCAM, AIM, IIASA (GLOBIOM for land use part), PIK (Remind-MagPie). For

- JRC, mitigation and adaptation scenarios are analyzed by Wageningen Economic Research\PBL (MAGNET-IMAGE), IIASA (Globiom), PIK (Magpie) and UniBonn (CAPRI).
- Five global economic models (ENVISAGE, FARM, MAGNET, IMPACT and MAGPIE) with a focus on agriculture were used to analyze climate impacts on agri-food-sectors in combination with the three SSPs and their associated changes in crop- and region-specific changes in agricultural productivity. Also, it was investigated whether the impacts of climate change would differ if restrictive trade policies would be in place or if trade would be liberalized.
  - Impact of different shocks on scenario results will be investigated. The decomposition method will be used.
  - Next to more usual suspects for (soft) model linking (GLOBIOM and CAPRI), in SUSFANS a link with a micro-level diet model (SHARP) is being developed. This provides a new set of challenges with the need to simultaneously account for diversity in the population (age, sex and education) and diet composition and needs. Combining forces with similar needs in the CGIAR sponsored A4NH project a approach is being developed where a micro-simulation diet model bridges the macro and micro level approaches. This will be tested for European countries in SUSFANS and low income countries in A4NH.

#### *Examining the impact of high and low prices*

- We examined the impact of high and low prices using a SSP2 baseline and a high and low price variant. The results are forthcoming as a FAO trade and markets division working paper and used as input in the forthcoming FAO-UNCTAD Commodities and Development report 2017: Commodity markets, economic growth and development.

#### *Impacts of trade policies: tariffs and non-tariff measures*

- Application of MAGNET for assessing trade policies (focus agri-food trade), in particular tariff and NTM liberalisation (state of the art methods). For modelling the NTM liberalisation, the size of the shock is crucial. Thus NTM data work has started in several smaller projects that can be considered as pilots and could be applied in a standard CGE application.
- Investigation of NTMs in the context of trade agreements continues, in particular EU and DCFTAs agreements.

#### *Impacts of bioenergy production and use*

- Land use effects of biofuel use in Brazil (BE Basic project): Biofuel production and use scenarios have been developed and implemented in MAGNET to analyze the impacts of biofuel policies on land use changes in Brazil. MAGNET is soft-linked to a spatial allocation model PLUC of Utrecht University which is applied in this exercise for Brazil and uses land demand changes derived from MAGNET (Verstegen et al., 2015). MAGNET is integrated with BLUM partial equilibrium model of the Brazilian agricultural sector and biofuel sectors. This project is carried out together with Agricultura, Energia e Sustentabilidade (ICONE) in Sao Paulo (Brazil) and Utrecht University.
- Biofuel production and use scenarios will be developed and implemented in MAGNET to analyze the impacts of biofuel policies on food security in Ghana. The analyses will be done at household level, possibly results will be given for nutritional values. This project is carried out in collaboration with Utrecht University.
- MAGNET is used to evaluate the land use change and food security effects of the use of residues and waste, using the sustainable potential of wheat straw for energy production in the EU and the total global potential of crop harvest residues in 2030 as case studies This is done based on a shock of output subsidies. This project is carried out in collaboration with the Netherlands Environmental Assessment Agency. A similar analysis is done for the world.

#### *Food loss and waste*

- An analyses of the socio-economic and environmental effects of reducing food loss and waste in agricultural supply, food processing, food retail and in the household consumption phase in France in 2030 is carried out using MAGNET. This project is commissioned by the French Environment and Energy Management Agency (ADEME) and is coordinated by Vertigo Lab.

#### *Household modeling*

- The household module has been applied in several studies this year including analysis of four future worlds that vary in terms of equality and sustainability (the FoodSecure scenarios) and an analysis of the impact of high and low prices on growth and poverty (FAO-UNCTAD project).
- The additional household detail highlights that average national level changes not necessarily make all households better off. Furthermore, the inequality scenarios in FoodSecure highlighted the importance of accounting for changes in skill rates when assessing equity issues.

#### *Global household database*

- In the context of SUSFANS multiple household groups are being introduced for five European countries (Italy, France, Denmark, Czech Republic and Netherlands). Driven by a surprising amount of difficulty in securing access to national SAMs with multiple households for high-income countries and lessons learned from the FoodSecure work SUSFANS will develop a data processing protocol to generate the relevant data for splitting the GTAP accounts while preserving underlying distributions in population and diets to facilitate a link to the micro-level human nutrition models.

#### *Food security*

- The stakeholder defined FoodSecure scenarios have been implemented in MAGNET to 2050. The four scenarios are defined as combinations of two axes: equal/unequal and sustainable /unsustainable. The development of global/regional and household level food and nutrition security in each future world is analysed using a newly developed suite of 10 indicators covering the four dimensions of food and nutrition security: availability, access, utilisation and stability.

#### *Consumption and nutrition*

- Nutrition indicators developed earlier have been integrated with household module making nutrition indicators available by household type and are part of the indicators used in the scenarios developed as part of FoodSecure.
- An agenda for improvements of consumption and nutrition has been set out in the SUSFANS project work plan (see also looking ahead; food and nutrition), and focuses on incorporating micronutrient indicators, adding multiple households for 4 EU countries, improving household consumption and nutrition, and accounting for food waste and underlying economic incentives.
- In the longer term the CGIAR flagship programme, coordinated by Wageningen UR and administered by Wageningen Economic Research on Food systems for Healthier Diets will shape much of future work on diets and nutrition.

#### *Imperfect competition*

- Under the auspices of the Jobs and Growth project financed by the European Commission (JRC), a study is currently underway to examine the export competitiveness of the EU dairy sector. To this end, a Melitz model variant is employed, following the work of Akgul et al. (2016). This model is particularly pertinent for this topic, since as well as including the traditional 'scale' and 'variety' effects associated with market power and endogenous product differentiation, the Melitz model also explicitly contemplates the self-selection of firms by sales markets, which allows the user to contemplate changes in exports at the extensive margin (i.e., penetration into previously untapped export markets).

#### *CAP module*

- The current CAP module employs detailed auditing data supplied by the European Commission (DG Agri). The data covers the split of pillar 1 payments (market support) between coupled (including article 68/69) and decoupled payments, whilst the coverage of pillar 2 (rural development) covers Axis 1 to 6. From this data, a CAP baseline has been developed, although the coverage of years is limited. An update to this work will be carried out this year with, potentially, more years of time series data. In addition, the modelling of the CAP budget module has been modified to permit more detailed policy shocks by specific CAP measures as well as the creation of an 'own-resources' component where CAP expenditure is explicitly co-financed by Member States. The rebate component of this module will also be updated with the change of benchmark years from 2007 to 2011.

### Fisheries

- The database used by MAGNET was extended to include both wild catch fisheries, aquaculture and fish processing sectors. Interactions between aquaculture and fisheries, for example fisheries providing fishmeal and fish seed to aquaculture were taken into account. Feed is also explicitly modelled and attention is given to the competition between aquaculture and cattle sectors for available feed. Since the size of the fish stock is one of the primary drivers for the fisheries sector, attention was given to dynamic modelling of the fish stocks. There are three features that distinguish MAGNET in modelling fish stocks: i) fish stocks are treated independently of other natural resources, removing thus the unwanted competition of mining sector and fisheries over the same natural resource, ii) the stocks of fish follow a biological surplus production function with the possibility for biomass regeneration, iii) excessive harvest of fish (and hence declining biomass stock) increases the costs of production, which is addressed in a relationship between returns to fish stock and harvest rate. Given that the parameters of fish stocks vary significantly across fish types, three broad fish types were included in MAGNET: Pelagic Marine fish, Demersal Marine Fish and Crustaceans.

### Sustainable Development Goals

- First steps have been taken to introduce a range of official and supporting indicators for measuring progress towards the Sustainable Development Goals in an ex-ante modelling framework.

## MAGNET related 2016/2017 publications

### Journal articles & book chapters:

- Smeets Kristkova, Z., Gardebroek, K., van Dijk, M. and H. van Meijl, 2017. Impact of R&D on factor-augmenting Technical change. *Economic Systems Research*, 1-33.
- van Vuuren, Detlef P., Stehfest, E., Gernaat, D., Doelman, J., van Berg, M., Harmsen, M., de Boer, H.-S., Bouwman, L., Daioglou, V., Edelenbosch, O., Girod, B., Kram, T., Lassaletta, Lucas, P., van Meijl, H., Müller, C., van Ruijven, B., van der Sluis, S. and A. Tabeau, 2016. Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. *Global Environmental Change*, Volume 42, January 2017, Pages 153–168. <http://www.sciencedirect.com/science/article/pii/S095937801630067X>.
- Sanjuán, A. I., Philippidis, G. and H. Resano (2017). Pulling back the curtain on 'behind the border' trade costs: The case of EU-US agri-food trade, *Spanish Journal of Agricultural Research*.
- Rutten, M., Achterbosch, T., de Boer, I., Crespo Cuaresma, J., Geleijnse, M., Havlík, P., Heckeley, T., Ingram, J., Marette, S., van Meijl, H., Soler, L.-G., Swinnen, J., van 't Veer, P., Vervoort, J., Zimmermann, A., Zimmermann, K., Zurek, M. Metrics, models and foresight for European sustainable food and nutrition security: the vision of the SUSFANS project, *Agricultural Systems*, (forthcoming, 2.7 Impact factor).
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42, January 2017, Pages 153–168. <http://www.sciencedirect.com/science/article/pii/S0959378016300681>.

- Boulanger, P., Dudu, H., Ferrari, E. and G. Philippidis. 2016. Russian Roulette at the Trade Table: A specific factors CGE analysis of an agri-food import ban, *Journal of Agricultural Economics*, 67(2): 272-291.
- Dixon, P., van Meijl, H., Rimmer, M., Shutes, L. and A. Tabeau. 2016. RED versus REDD: Biofuel policy versus forest conservation, *Economic Modelling*, Vol. 52, pp 366-374.
- Helming, J. and A. Tabeau. 2016. The economic, environmental and agricultural land use effects in the European Union of agricultural labour subsidies under the Common Agricultural Policy. *Regional Environmental Change*. *Under review*.
- Kuiper, M., L. Shutes, M. Verma, H. van Meiji, and A. Tabeau (forthcoming). Exploring the impact of alternative population projections on prices, growth and poverty developments. *Commodities and trade policy research working papers*, Trade and Markets Division, FAO.
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- Rutten, M. and A. Kavallari, (2016), "Reducing food losses to protect domestic food security in the Middle East and North Africa", forthcoming in *African Journal of Agricultural and Resource Economics*, 11(2).
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- Smeets Kristkova, Z., Van Dijk, M. and H. van Meijl. 2016. Assessing the impact of agricultural R&D investments on long-term projections of food security. Chapter in *Frontiers in Economics and Globalization*, Vol. 17, p. 1-19. Emerald Group Publishing Limited.
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### **Conference papers**

- Dudu, H., Smeets Kristkova, Z. 2017. Impact of CAP Pillar II Payments on Agricultural Productivity. Paper accepted for presentation at EAAE Congress in Parma, 2017.
- Kuiper, M. 2016. Technical change – an elusive game changer in long term agricultural projections. Presentation at the AAEA 2016 meeting, Boston.

- Philippidis, G., van Berkum, S., Tabeau, A. and M. Verma. 2016. Agricultural and Food Trade in the Commonwealth of Independent States: Assessing the impact of Alternative Trade Arrangements, Paper presented at the 155th EAAE Seminar 'European Agriculture towards 2030 Perspectives for further East-West Integration', 19-21 September, Kiev, Ukraine.
- Shutes, L., Verma, M. and M. Kuiper. 2016. Changing diets in a changing world: the impact of urbanisation on agriculture. Shutes et al. Presented at the 19th annual conference on Global Economic Analysis, Washington D.C. 15-17 June 2016
- van Dijk, M., Mandryk, M., Gramberger, M., Laborde, D., Shutes, L., Stehfest, E., Valin, H. and K. Zellmer. 2016. Scenarios to explore global food security up to 2050: Development process, storylines and quantification of drivers, FOODSECURE working paper.
- van Dijk, M., Philippidis, G. and G. Woltjer. 2016. Catching up with history: A methodology to validate global CGE models, FOODSECURE working paper.
- van Meijl, H, et al. 2016. Africa's unequal food future. African Association of Agricultural Economics, 23-26th September, Addis Ababa
- Wolf, V., Deppermann, A., Tabeau, A., Banse, M., van Berkum, S., Haß, M., Havlik, P., Philippidis, G, Salamon, P. and M. Verma. 2016. Linking three market models to project Russian and Ukrainian wheat markets till 2030, 155th EAAE Seminar, September 19-21, 2016, Kiev, Ukraine.

### **Reports & working papers**

- Dudu, H., Smeets Kristkova, Z, 2017, Impact of CAP Pillar II Payments on Agricultural Productivity, JRC Technical Report No: EUR; doi: 10.2760/802100
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- Kuiper, M., Shutes, L. and D. Oudendag. 2017. With food and nutrition security hinging on inequality, labour allocation beyond agriculture proves a neglected key driver in long term FNS projections. FoodSecure report.
- Philippidis, G., M'barek, R. and Ferrari, E. (2016) Drivers of the European Bioeconomy in Transition (BioEconomy2030): An Exploratory Model Based Assessment, Joint Research Centre Policy Report, European Commission, EUR 27563 EN; doi:10.2791/529794 <https://biobs.jrc.ec.europa.eu/sites/default/files/generated/files/documents/drivers-of-the-eu-bioeconomy-in-transition.pdf>
- Rutten, M., T. Achterbosch, et al. (2016), Metrics, models and foresight for European sustainable food and nutrition security: the vision of the SUSFANS project. SUSFANS project position paper, under journal review.
- Rutten, M., Tabeau, A. and F. Godeschalk (2016), "An Economic Tool for Tracing the Origins of Nutrients with Entry Points for Action", under journal revision (2<sup>nd</sup> round).
- Rutten, M., A. Zimmermann, P. Havlík, A. Leip, T. Heckeley and T. Achterbosch (2016), Modelling Sustainability and Nutrition in Long Run Analyses of the EU Agri-Food System: Work Plan for the SUSFANS Toolbox, D9.1 of the SUSFANS project, H2020 / SFS-19-2014: Sustainable food and nutrition security through evidence based EU agro-food policy, GA no. 633692.
- Shutes, L., Valin, H., Stehfest, E., van Dijk, M., Kuiper, M., van Meijl, H., Tabeau, A., Verma, M., Oudendag, D., van Zeist W.-J. and P. Havlik, *forthcoming*, Food and Nutrition Security and Sustainability in Long-Term Projections: An Assessment of the FoodSecure Scenarios. FoodSecure working paper, foodsecure.eu.
- Tabeau, A. and J. Helming, 2016. D3: Land Supply Elasticities. Overview of Available Estimates and Recommended Elasticities Values for MAGNET. Specific Contract 154208.X20 Scenar 2030: Parameters and Model Chain Preparation.
- Van Dijk, M., Philippidis, G. and G. Woltjer. 2016. Catching up with history: A methodology to validate global CGE models, FOODSECURE working paper.

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## Annex 1 – MAGNET team at LEI



*Hans van Meijl*

[Hans.vanMeijl@wur.nl](mailto:Hans.vanMeijl@wur.nl)

- Team leader
- CAP
- Bio-based economy
- Food security
- Climate Change



*Marijke Kuiper*

[Marijke.Kuiper@wur.nl](mailto:Marijke.Kuiper@wur.nl)

- MAGNET management team
- Developer
- Food security
- Poverty
- Bio-based economy



*Lindsay Shutes*

[Lindsay.Shutes@wur.nl](mailto:Lindsay.Shutes@wur.nl)

- 
- MAGNET management team
- Food security
- Poverty
- Sustainable Development Goals



*Andrzej Tabeau*

[Andrzej.Tabeau@wur.nl](mailto:Andrzej.Tabeau@wur.nl)

- MAGNET management team
- Baseline
- Scenarios
- Land use
- Nutrition
- Bio-based economy



*Michiel van Dijk*

[Michiel.Vandijk@wur.nl](mailto:Michiel.Vandijk@wur.nl)

- Technical change
- Land use change
- Developing countries



*Edward Smeets*

[Edward.Smeets@wur.nl](mailto:Edward.Smeets@wur.nl)

- Biofuels and biobased materials
- Land use change
- GHG emissions



*Myrna van Leeuwen*

[Myrna.vanLeeuwen@wur.nl](mailto:Myrna.vanLeeuwen@wur.nl)

- Single country CGE (ORANGE)
- Agricultural policy



*Heleen Bartelings*

[Heleen.Bartelings@wur.nl](mailto:Heleen.Bartelings@wur.nl)

- Developer
- Sector splits
- Biobased economy
- Fertilizers
- Climate change modelling
- Fisheries and aquaculture



*Zuzana Smeets Kristkova*

[zuzana.kristkova@wur.nl](mailto:zuzana.kristkova@wur.nl)

- General equilibrium modelling
- R&D and technical change
- Food security and economic development



*John Helming*

[john.helming@wur.nl](mailto:john.helming@wur.nl)

- Common Agricultural Policy
- Agriculture



*Marie-Luise Rau*

[marieluise.rau@wur.nl](mailto:marieluise.rau@wur.nl)

- Trade (trade policy)
- Trade agreements
- Non-tariff measures
- Developing countries



*Diti Oudendag*

[diti.oudendag@wur.nl](mailto:diti.oudendag@wur.nl)

- HH modelling
- GHG emissions
- Magnet Database(s)

*Monika Verma*

[monika.verma@wur.nl](mailto:monika.verma@wur.nl)

- Consumption
- Food loss and Waste
- Households
- Non-tariff measures
- Climate change



*Jason Levin-Koopman*

[jason.levin-koopman@wur.nl](mailto:jason.levin-koopman@wur.nl)

- Water scarcity
- Biofuels
- Climate change

*George Philippidis*

[george.philippidis@wur.nl](mailto:george.philippidis@wur.nl)

- Bioeconomy
- Climate change modelling
- EU Common Agricultural Policy (CAP) modelling
- International trade, EU trade and enlargement



*John Doornbos*

[John.Doornbos@wur.nl](mailto:John.Doornbos@wur.nl)

- Software development

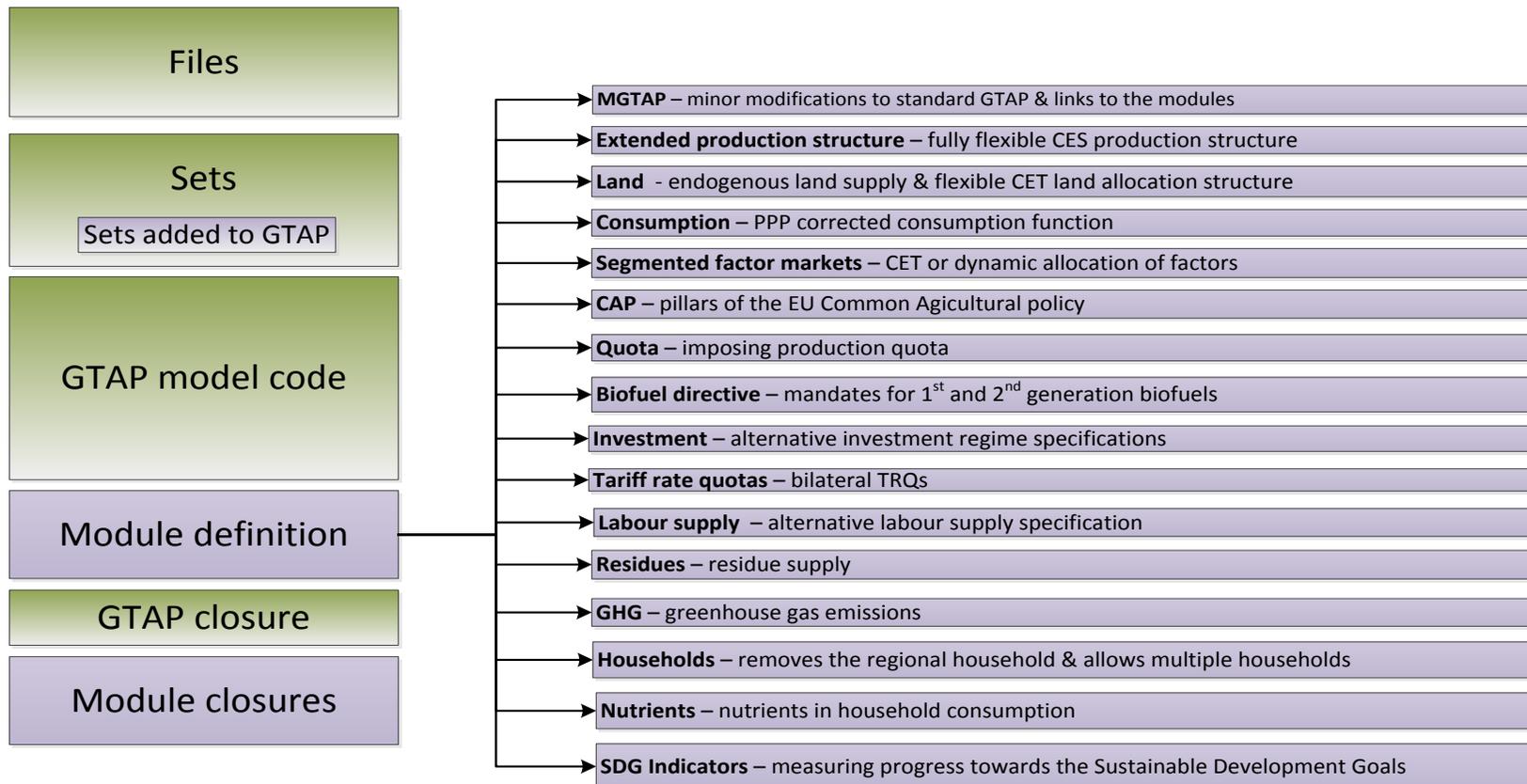


*Barbara van der Hout*

[Barbara.vanderHout@wur.nl](mailto:Barbara.vanderHout@wur.nl)

- Software development

## Annex 2: Overview of the structure of the MAGNET model



Key:-

GTAP

MAGNET