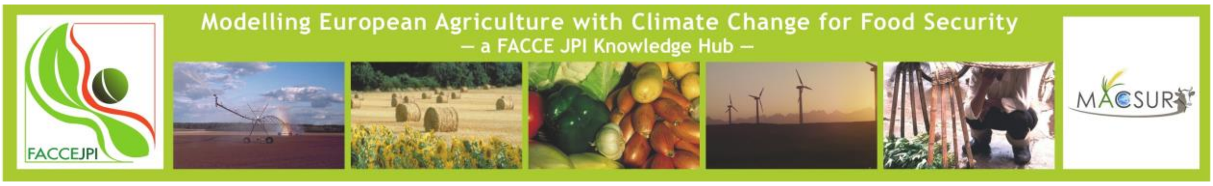

FACCE-MACSUR

Deliverable T3.2: Storylines regarding climate change and scenarios

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Abstract/Executive summary

WP3 develops the tools for assessing the productive and economic impact of climate change and the potential of mitigation and adaptation strategies. This is achieved by focussing, along with CropM and LiveM, on significant crossing issues in specific geographical areas, natural and human resources, and farming systems. Following, the storylines regarding climate change and scenarios in the hot-spots.

Introduction

The hot spots defined in collaboration with researchers from the CropM and LiveM, include Mediterranean areas (task 3.1: Gabriele Dono with contributions of Sharon Brody, Ruslana Rachel Palatnik, Uri Mingelgrin), with climate risks to food security related to desertification and water stress; Central and Northern Europe (task 3.2: Heikki Lethonen with contributions of Martin Schönhart), where the impact of climate change is assessed on future patterns of food supply; Sub-Sahara Africa (task 3.5: Luciano Gutierrez with contributions of Stefan Sieber and Peter Zander) where climate-risk assessment concerns global food security issues, and trade patterns between Europe and Africa. Hot-spots are also defined in terms of climate change issues for intensive livestock systems (task 3.3), and for Rural development (task 3.4: Erwin Schmit) as key European response policy. A task for comparative analysis of the hot-spots has also been defined (T 3.6: Davide Viaggi with contributions of Matteo Zavalloni).

Deliverable T3.1 (www.Macsur.eu) described the hot-spots showing their appreciable differences in agro-climatic and geo-pedological, as well as differences on equipment and farm structures. This variety ensures a representativeness of the impacts of climate change. In short, it has been seen that climate change is expected to generate a slight increase in maximum daily temperature and even more minimum in Italian Mediterranean, while rainfalls decrease, even if their variability increases. In *Israel* climate change is expected to increase temperature of 3-5^{o}C at 2100 with larger variability, alongside a 10-30% drop in current annual average rainfall. In ***Central and Northern Europe***, 1-2°C annual mean temperature increases are expected in *Austria* up to 2050; while rains are predicted with higher uncertainty. The western *Northern Germany* areas could experience an increase of mean temperature with larger CO_2 concentration levels; in the eastern continental climate areas larger increases of mean temperature are expected in *summer*. Climate change increases mean temperature and rainfall in *Finland*, even if rain is likely to increase more in *winter* than during the growing season. More frequent extreme weather conditions are also predicted. No specific variations of weather components are predicted for ***Sub-Saharian Africa*** hot spots.

Climate change should differently affect farm sector in hot-spot areas. EPIC and DSSAT simulations indicate an increased uncertainty on yields of reused crops, grains and hay (drops in non-irrigated grasslands). Estimates on livestock parameters by LiveM indicate rises of temperature and humidity could reduce milk quantity and quality, increase heads mortality and lengthen calving periods. *Crop farms* suffer uncertain yields (along with prices) and larger needs of irrigation water: volumetrically water pricing increases irrigation costs for crop and livestock farms. In *Israel* increase of temperature boost water demand above the increase expected under current climate, drops in annual rainfall reduce freshwater supplies. Higher and more variable temperatures, and rainfall patterns, enhance migration of pests and weeds to new areas. Impacts on *Austrian* agriculture are expected to vary according with natural and structural differences; livestock production is expected to reduce. Western *hot-spots* of *Northern Germany* could profit with a slight rise in yields from increased mean temperature and CO_2 fertilizer effect. Increases of temperature and rainfall in *Finnish hot-spots*, coupled with more frequent extreme weather conditions boost pests and plant diseases. Besides, longer growing season can increase yields and reduce costs, especially in least favoured areas. Higher probability of drought (or flood) rises risks for silage grass production. Also, an increased pressure of pests and plant diseases is expected. In ***Sub-Saharian Africa*** hot-spots the uncertainty in climate change projections and in CO_2 fertilization, requests complementing the analysis of climate change impacts by a risk assessment analysis of new production options.

The next section describes storylines for the impact and possible resilience of agricultural structures in the hot-spots of the conditions of climate change and agricultural production.

Results

Storylines regarding climate change and scenarios

DSSAT and EPIC models applied to observed and synthetically estimated climate conditions for current and future scenarios to define the impact on water requirements and crop production in the ***Mediterranean zone***. Also the impact of temperature and humidity (THIndex) on milk quality (somatic cells content) and quantity, calving interval length and heads mortality is considered. The impacts on agricultural and livestock production were estimated in collaboration with researchers from the Italian teams of CropM and LiveM. The obtained results and preliminary estimates based on regional and farm discrete stochastic programming models indicate that Italian *dairy cattle farms* could suffer for an increased uncertainty on yields of reused crop that implies greater forage cropping and purchasing of feeds. Surges of humidity and temperature can reduce quantity of milk and its quality with an increase of Somatic Cells content; those increases could also increase mortality of heads and lengthen the calving period. New water pricing may worsen economic results give more water for irrigation and livestock is requested. Resilience of those farms could base on increasing fodder production by integrating (partly replace) ryegrass - corn silage system with less water demanding crops (triticale and sorghum). Given current technology and breeds, it could be difficult offsetting the impact of increased temperature and humidity on milk production. *Sheep milk farms* suffer increased uncertainty on yields of reused crop, hay and grains (mainly decreases hay production from non-irrigated grasslands). Resilience could base on increased purchasing of hay and renting in of grazing land. This does not prevent worsening of economic results for sheep farms lacking of irrigated areas to be allocated to the production of grass hay. *Crop farms* suffer more uncertain yields (along with prices) and larger needs of irrigation water, especially with volumetrically based water pricing in vegetables farms. Resilience could be based on extensive farming from silage corn, hay and feeding grain, and energy crops.

In *Israel*, recent periods of drought have highlighted the variations in annual water replenishment, stressing the importance of sourcing new supplemental resources such as recycled effluent water from treated domestic sewage and industrial wastewaters, water harvesting through a network of rain-fed reservoirs and desalination of seawater and brackish saline groundwater. The government decided to expand desalination to reduce freshwater required by agriculture. Also of concern is the efficiency of water use in agriculture, whilst reducing the amount of fresh water and increasing the use of recycled water. Drip irrigation is a key tool in efficient water use in Israel. Agricultural water is charged on a tiered structure, with different prices being charged for freshwater, recycled effluent water and extracted groundwater. The prices take into consideration the quality and cost of supplying the water, but also include a government incentive to encourage the use of different water types. Israel’s agricultural challenge is now to reduce the quantity of water required by the agricultural sector, along studying further possibilities for resource-use efficiency and alternative source identification in response to decreasing freshwater availability and climate changes.

In the ***Central Europe regions***, impacts on Austrian agriculture are expected to be diverse in magnitude and variability due to the natural and structural differences in production conditions (actually, precipitation sums ranges between 500-600 mm/yr in eastern regions, and >2000 mm/yr in western and alpine regions). However, in general, alpine areas are expected to be hotspots of climate change impacts. In estimating the resilience of farms to climate change it is also considered crucial considering the conditions of Common Agricultural Policy reform, especially with milk quotas abolition, further greening and reductions in agricultural budgets. Autonomous adaptation modelling has to allow adaptation of livestock numbers, shifts in cultivars and among land uses, soil management and cover crops, and land use intensity. Induced adaptation has to include policy measures to alleviate potential impacts from climate change, for instance, a premium for reduced tillage and cover crops. Irrigation is introduced at broader scales. For hot spots in Germany, with the help of expert knowledge alternative plant production activities will be considered consisting of type of crop, production intensity, technic, machinery, labour, and yields, hence a so called core-adapter-approach. Plant production includes cereal, oilseed, grassland, and fodder crops. Products of this production partly are sold, serve as fodder or are further input for the biogas plant. Cooperating with the project partner of CropM plant production techniques are going to be supplemented. Up to this point livestock production can only be modeled hence the dressed-animal approach for milk cows whereas non-land dependent pig and poultry production maybe included into the research via the black-box approach. Time horizon for adaptation in farm management will be studied at short-term, middle, and long-term by considering operational adaptation (changing intra-farm processes as timing, and localization of production activity or associated task, like switch to drought resistant crop species) and strategic adaptation (changing the intensity of production, extensification).

In the Finnish ***Northern Europe hot-spots*** both the productivity potential due to longer growing season due to climate change, and the likely increase in climate and market related risks will be considered. Specific themes deserving special attention are drought (or flood) risks for silage grass production, future developments of such risks and their direct and indirect cost implications for farms; similar analysis in the case of pig farms in the context of high cereals and protein feed prices. Also relevant are economic benefits of higher productivity and resulting production re-organisation, including machinery choices and logistic benefits due to higher yields (especially logistic and roughage storage costs in dairy production). Such benefits are less important but probably still significant in the case of cereals-pigmeat production. The GHG mitigation costs include changes in logistic costs of feed and manure, which are conditional on the distance from different field parcels to farm centre, and on the development of feed crop yields. Different adaptations can be taken into account as in the case of manure processing such as mechanical separation of slurry into liquid and solid fractions. More efficient utilization of manure nutrients with related additional costs and cost savings can be analysed from the viewpoint of farm level profitability and reduced need for purchased inorganic fertilizers. Also relevant is increased pressure of pests and plant diseases, the role of new cultivars – the benefits of improved crop protection management versus additional costs. This task is primarily attacked using farm level dynamic crop rotation models whose applications will be modelled on dynamic farm level management, land use and crop rotation analysis in climate and market scenarios of longer than 20 year span. Analogous issues are addressed by Norway and Scottish researchers.

In Tanzanian hot spots of ***sub-Saharian Africa area*** the potential upgrading strategies that will be considered in the Dodoma and Morogoro regions in Tanzania may be related to 1) Natural resources: water harvesting (for semi-arid Dodoma); ripping and other minimum tillage techniques; agroforestry (erosion control and nutrient cycling); ridging; nutrient mining from waste; biochar utilisation; drip irrigation. 2) Food production: mineral or organic fertiliser input; intercropping; improved animal feed; cover crops; improved crop varieties; pest and disease control; new crop types; new livestock breeds. 3) Processing: Improved solar drying of foods and vegetables; conservation technics; fortification; oil extraction; cassava drying. 4) Markets and institutions: Savings and credit cooperative societies (SACCOS); warehouse receipt systems (storage, speculation); certification; horizontal and vertical coordination; outgrower schemes; contract farming; communication techniques; rural energy. 5) Consumption: Diet diversification; nutrition awareness training (showcases for meal recipes); adapting new food habits; school feeding. Other upgrading strategies cross-cutting all FVC components are better education, capacity building and credit systems.

Discussion

In Mediterranean hot spots, Italian *dairy cattle and sheep farms* could suffer for an increased uncertainty on yields of reused crop with greater forage cropping and purchasing of feeds. Higher humidity and temperature can reduce quantity and quality of milk, also with increased mortality of heads and lengthen the calving period. Resilience could base on increasing fodder production by integrating ryegrass - corn silage system with less water demanding crops. *Crop farms* suffer more uncertain yields and larger needs of irrigation water, especially with volumetrically based water pricing. Resilience could be based on extensive farming of silage corn, hay and feeding grain, and energy crops. In *Israel* the most important challenge for agricultural sector is now to reduce the quantity of irrigation water required, along studying further possibilities for resource-use efficiency and alternative source identification in response to decreasing freshwater availability and climate changes.

In the ***Central Europe regions***, diverse impacts on Austrian agriculture are expected according to natural and structural differences in production conditions, even if alpine areas are expected to be hot-spots of climate change impacts. In German hot spots time horizon for adaptation in farm management will be studied at short-term, middle, and long-term by considering operational adaptation (changing intra-farm processes as timing, and localization of production activity or associated task, like switch to drought resistant crop species) and strategic adaptation (changing the intensity of production, extensification).

In the Finnish ***Northern Europe hot-spots*** both the productivity potential due to longer growing season due to climate change, and the likely increase in climate and market related risks will be considered. Sensitive themes are drought (or flood) risks for silage grass production. Also relevant economic benefits are expected from higher productivity and resulting production re-organisation. The GHG mitigation costs include changes in logistic costs of feed and manure. Also relevant is increased pressure of pests and plant diseases, the role of new cultivars – the benefits of improved crop protection management versus additional costs.

In Tanzanian hot spots of ***sub-Saharian Africa area*** the potential upgrading strategies are related to natural resources (e.g. water harvesting), food production (e.g. mineral or organic fertiliser input; intercropping), processing (e.g. conservation technics), markets and institutions (e.g. savings and credit cooperative societies), consumption (e.g. diet diversification).

References

Deliverable WP3 T3.1, 2013, http://www.macsur.eu/index.php/internal-documents/TradeM/Deliverables/WP3-D-T3.1/