4FCROPS

Future Crops for Food, Feed, Fiber and Fuel

Minutes of the final 4FCROPS workshop

"Successful scenarios establishment of non-food crops in EU27"

Lisbon, 19/11/10

The workshop took place in the New University of Lisbon (www.unl.pt)

KAПE CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

Final Workshop of the 4FCROPS Project
"Successful scenarios for the establishment of non-food crops in EU27"

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FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Lisbon, 19 November 2010

Final Workshop of the 4FCROPS Project

“Successful scenarios for the establishment of non-food crops in EU27”

Chairman: Prof. Melvyn Askew, CENSUS BIO

8:30 - 9:00	**Registration**	
9:00 - 9:20	4F CROPS: Presentation of the final results	*Dr. Efi Alexopoulou, CRES*
9:20 - 9:40	Modeling land availability for energy crops in Europe	*Dr. Ewa Ganko, EC BREC*
9:40 - 10:00	Agronomic aspects of future energy crops in Europe	*Dr. Walter Zegada UNIBO*
10:10 - 10:30	Overview of the markets for energy crops in EU27	*Myrsini Christou, CRES*
10:30 - 10:40	Questions	
10:40 - 11:00	**Coffee Break**	
11:00 - 11:30	Environmental Impact Assessment of Energy Crops	*Dr. Ana Luisa Fernando UniNOVA*
11:30 - 12:00	Life Cycle assessment of selected future energy crops for Europe	*Nils Rettenmaier Ifeu*
12:00 - 12:20	Economic viability of energy crops for biofuels in EU27	*Prof. Peter Soldatos AUA*
12:20 - 12:30	Questions	
12:30 - 13:30	**Lunch break**	
13:30 - 13:50	Strategies to reduce land use competition and increasing the share of biomass in the German Energy Supply	*Dr. Martin Knapp KIT*
13:50 - 14:20	Limited EU targets fail to support fast implementation of energy crops for biofuels transportation in South Europe	*Prof. Spyros Kyristis, AUA*
14:20 - 14:50	Strategies for implementing non-food crops under different future scenarios	*Dr. Wolter Elbersen DLO-FBR*
14:50 - 15:00	Questions	
15:00 - 16:30	Round table discussion	
16:30	**End of the workshop**	

4F CROPS: Presentation of the final results
Dr. Efi Alexopoulou, CRES

Dr. Efi Alexopoulou welcomed the invited speakers and participants and thanked ***Prof. Melvyn Askew*** for accepting the invitation to be the chairman of this workshop.

Dr. Alexopoulou presented in brief the project 4FCROPS (www.4fcrops.eu) that was the reason for the organisation of this thematic workshop. 4FCROPS started in June 2008 and will finish in November 2010. The project is a dissemination and support action one and its main aim is to survey and analyse all the parameters that will play an important role in a successful non-food cropping systems alongside the existing food crops systems.

The project is being accomplished its aims through eight work packages: 1) land use in EU27, 2) cropping possibilities, 3) cost analysis of non-food crops and socio economics impacts, 4) environmental analysis, 5) regulatory framework, 6) best practices scenarios, 7) dissemination and support actions and 8) management and coordination.

Key element to the success of the 4FCROPS is the thematic workshops that have been scheduled. Up to now two thematic workshops had been organised; the first in Bologna (September 2008) with theme **"Market needs of non-food crops in EU27"**, the second in Madrid (24/3/09) with theme **"Which are the key future non-food crops in EU27?"**, the third with theme **"Can the production of non-food crops be environmentally friendly and economic viable?**, the fourth with theme **"Towards the sustainable insertion of non-food crops in the EU agriculture"** and today is the last one.

Another important element to the project success is the scientific committee of the project that consisted from the work packages leaders and invited stakeholders that have an advisory role in the scientific committee and participate in the thematic workshops.

4FCROPS had been invited to participate in the twinning opportunity between EU and Canada that started last year with a workshop (February 2008 in Montréal) and continued last year in Pisa in the second workshop (June 2009), while the third workshop took place in Canada (October 2010).

4FCROPS have been invited to participate in the twinning opportunity with Argentina and MERCOSUR project. The first meeting of this twinning opportunity took place in Buenos Aires (7&8/5/09) and the second took place in Athens (30/6 and 1/7/10) organised by CRES.

Modeling land availability for energy crops in EU
Dr. Ewa Krasuska (EC BREC)

Dr. Ewa Krasuska, as WP leader in 4FCROPS project had the responsibility to estimate the available land for the cultivation of non-food crops at three time frames, now, in 2020 and in 2030.

A simplified approach method was used based on land allocation and balancing procedures with core assumption food production has a priority. The current available land the fallow land, the set-aside land and the area of the land occupied with non-food crops were included, while for the 2020 and 2030 estimations it was also added surplus land released from food/fodder crops surplus.

The most important parameters of the used model for the land availability were: a) the changes in food demand, b) the growth in crop production intensity and c) food import/export balance.

The main results of this study are listed below:

- The current available land for non-food crops cultivation taking under consideration that only the fallow land and the set aside land can be sued is 13.2 million ha and the bigger part of it (80%) remained fallow.
- Taking into account two parameters ***the population prospects*** and the ***crop production improvements*** a surplus land will be available for non-food crops that will be 20.5 million ha in 2020 and 26.3 in 2030.
- The surplus land generated in the coming decade will come mainly from cereals cropping areas. So, countries/regions that have large areas covered with cereals are expecting to offer most significant areas of surplus land for energy crops in the future.
- The current fallow land area is quite heterogeneous. In the central and northern EU it could be easily brought into production. In southern EU, fallow land is included in long-term-rotation-schemes.
- GIS approach would be of an excellent value for the land potential estimates. Analysis of land quality, crop suitability, nature conservation areas, etc. Much reduced estimates are expected.
- A set of perennial non-food crops can be recommended for the entire EU area for diverse climatic and agronomic conditions.

Agronomic aspects of future crops in Europe
Dr. Walter Zegada, UNIBO

Dr. Walter Zegada presented the main agronomic aspects of future crops (in EU. The future crops for fibre and fuel categorised in several groups: perennial herbaceous crops (giant reed, switchgrass and miscanthus), short rotation woody crops (poplar, willow and eucalyptus), annual crops (sorghum and hemp), and oilseed crops (Ethiopian mustard).

The perennial herbaceous crops have several advantages that the most important are: low production costs, suitability to marginal lands, low water needs (switchgrass, miscanthus), low nutrient and agrochemical requirements. The annual crops sorghum and hemp have low establishment cost (by seeds), are deep rooted crops, high cellulose content (hemp) and fermentable carbohydrates (sweet sorghum) and relatively low nutrient requirements.

The most suitable energy crops (in terms of agronomic management, climatic adaptability and potential biomass production) for northern Europe are some fast growing trees and perennial grasses such as poplar, willow, and miscanthus.

Under Mediterranean climates of southern Europe eucalyptus, sweet sorghum, and giant reed are promising energy crops.

In general, most of the perennial grasses and woody crops are largely undomesticated and are at their early stages of development and management. These crops, however, show some advantages over annual crops in terms of agricultural inputs, yields, production costs, food security, reduced greenhouse gas emissions, and environmental sustainability

Important cultivation and management practices that need further development and evaluation are: appropriate selection of species and genotypes, crop establishment, water needs, fertilization timing and rates, control of weeds and pests, and harvest time and method.

Overview of the markets for energy crops in EU27.
Dr. Myrsini Christou, CRES

Dr. Myrsini Christou presented an overview of the markets of energy crops in EU27, which currently are: ***energy production*** (solid biomass, wastes and biogas) and ***biofuels*** (first and second generation biofuels), while the non-energy markets are ***paper & pulp*** (paper and paperboard) and ***biomaterials*** (fibre-based composites, bioplastics, biopolymers, surfactants, biosolvents, biolubricants, pharmaceutical products and enzymes).

Biomass is likely to contribute to around two-thirds of the expected renewable energy share in 2020 (PRIMES projections) in terms of primary energy consumption. About 230-250 Mtoe of bioenergy are needed to meet the EU's target of 20% share of renewables.

A key question is how can this target be met in an economically and sustainable manner without causing major distortions in the food, feed and other respective markets.

Accounting for food and feed requirements, it was estimated that some 22-46 Mha (up to 72 including Ukraine) could be freed up for growing bioenergy crops by 2030. Similar results were obtained by EEA and the 4FCrops project.

Central and Eastern European Countries (CEEC) are expected to expand significantly the biomass crops production potential. In Bulgaria, Poland, Romania and Czech Republic about 33 Mha could become available for bioenergy crops by 2030 with a corresponding energy potential of almost 12 EJ (288 Mtoe).

Despite high expectations with biomass use, the commercial marketplace of energy crops still faces a number of barriers (competitiveness with fossil fuels, technical constraints of feedstock, low energy density and logistic issues, lack of certification and regulation criteria, land use conflict with food and feed crops, uncertain and undefined environmental and social benefits etc).

Nonetheless, there is more than one reason to believe that energy crops will steeply develop in the near future and the fact that there are already examples of concrete international bioenergy trade is further convincing.

Growing energy crops for bioenergy or biofuel gives farmers the opportunity to diversify their production and can provide an outlet to traditional cropping options.

The bioenergy market is still in its infancy, and to be implemented it needs realistic and coherent roadmaps and policy initiatives aiming at boosting the use of bioenergy, while encouraging the private investments in this sector. Therefore, further research on crops and technology, demonstration projects, appropriate certification and regulation systems is necessary.

Environmental Impact Assessment of Energy Crops
Dr. Ana Luisa Fernando, UniNOVA

Dr. Ana Luisa Fernando had in 4FCROPS to evaluate the environmental effects due to the production of different energy crops in Europe. The environmental impact assessment of the 15 selected non-food crops (4FCROPS) carried out and compared with two traditional crops wheat and potato, while the grass fallow was reference system.

The categories EIA used were: emissions to soil, air and water, Impact on soil, impact on mineral and water resources, waste production and use and Implications on biodiversity and landscape. In the EIA analyses three weighting scenarios were used: a) WS1 - all indicators have the same weight, b) WS2 - greater emphasis on GHG emission drivers, namely N-fertilizer related emissions and soil degradation and c) WS3 - greater emphasis on biodiversity.

The environmental impact assessment resulted in the following conclusions:

- Regarding the studied categories it was found that the growing energy crops do not inflict higher impact on the environment compared to wheat and potato farming for food, traditional crops in Europe.
- The annual non-food crops had more impact on the environment compared to the perennial markedly due to biodiversity and erosion.
- The annual and woody crops are more damaging to soil quality
- Greater concern for erosion and water availability existed in the Mediterranean region, while the fertilization emissions are the deeper impacts in northern Europe
- Differences among crop types, not so evident for the remaining categories

Life Cycle assessment of selected future energy crops for Europe
Dr. Nils Rettenmaier, IFEU

Dr. Nils Rettenmaier presented the results of the LCA analyses for the 15 selected crops (as leader of the work package of 4FCROPS for the environmental analyses).

As land-use competitions are increasing, it is necessary to allocate the limited amount of biomass to the different sectors (food / feed / fiber and fuel) in such a way which achieves the highest environmental benefits. LCAs are a suitable tool for environmental assessments. It is also suitable scientific tool for policy analysis and decision making.

When the bioenergy compared with the fossil fuels the following advantages were recorded:

- Environmental advantages in terms of energy and GHG savings for all crops, environmental zones, and bioenergy chains
- But: Ambiguous results or even disadvantages other impact categories
- No scientifically objective conclusion regarding overall environmental performance can be drawn.
- The conclusion has to be drawn on subjective value-choices.
- An objective decision for or against a particular biofuel or bioenergy carrier cannot be made. However, based on subjective value-choices, a decision is possible.
- If, for example, energy savings and greenhouse effect is given the highest priority, all biofuels and bioenergy carriers assessed are to be preferred over their fossil equivalents.
- The amount of energy and greenhouse gases that can be saved greatly differs depending on the crops, conversion paths and main products, i.e. the entire life cycle has to be taken into account.

When the bioenergy compared with bioenergy the best energy crops and bioenergy chains are the herbaceous lignocellulosic crops are the most land-use-efficient options in terms of energy and GHG savings. The stationary use of biomass (heat and/or power) usually outperforms the mobile use as transport biofuel (but quantitative results depend on case-specific conditions, in particular the replaced power mix). Bioethanol shows better results than all diesel substitutes. Finally, regarding first and second generation EtOH, no clear tendency could be found.

Economic viability of selected energy crops for biofuels in the EU27 Prof. Peter Soldatos, AUA

Prof. Peter Soldatos (AUA) was responsible for the economics analyses of the future non-food crops in 4FCROPS. Because the economic analysis it is very site specific it is not possible to run an economic analysis of a crop and the results to be applicable in all the sites of cultivation In Europe. So, in 4FCROPS project several case studies were developed (crop – site of cultivation – market of the selected crop).

In today presentation Prof. Soldatos chosen to show the economic viability of three selected energy crops in specific areas and markets, which were: ***rapeseed in Germany*** (Central Atlantic climatic zone) for biodiesel production, ***sunflower in northern Greece*** (North Mediterranean climatic zone) for biodiesel production and sweet sorghum in Italy (North Mediterranean climatic zone) for bioethanol production.

Rapeseed in Germany reached quite low yields when cultivated in marginal land that eliminate the profits. On the other hand when it is cultivates in more fertile land generates good profits when selling price is 270 euro per tone. The total producer cost is around 150 euro/tone. Farmers are happy with contracted profits between 300 and 600 euro/ha.

Sunflower in Greece with a selling price of 237 €/t (2008) the farmer is hardly breaking even. The cultivation on marginal land (low fertility land) is excluded. Being a food and an energy crop at the same time, minimises the risk. The land rent in Greece is quite expensive (389 eur/ha/yr in 2008) and half of the cost of production is due to land rent. In case that the crop will be irrigated the yields will be higher but bottom line economics are not improved. In Greece the price of sunflower has been fluctuating significantly.

Sweet sorghum in Italy the selling price is not established, but may be estimated in comparison with prices of other sugar producing plants; 20 euro per tone does not seem unreasonable. With a production cost of around 10 euro per tone the profitability seems secured. The cultivation in marginal land cultivation is not so profitable. Sweet sorghum it is not irrigated in Italy (in Greece though, if irrigated, economic results are improving) and 75% of the production cost is due to land rent and raw materials.

Strategies to reduce land use competition and increasing the share of biomass in the German Energy Supply
Dr. Matrin Knapp, KIT

Dr. Martin Knapp (KIT) investigated the strategies that should be followed In Germany in order to reduce the land competition and increasing the share of biomass in energy supply.

In Germany the energy forced fundamentally by legislation. The area used for growing crops for the industrial, chemical and energy sectors had been doubled within 5 years. In 2009 land area of 1.75 million hectares used for energy production, while another 250,000 hectares are being cultivated for renewable materials.

The strategies to reduce land use competition and increasing the share of biomass in Green Energy Supply are:

More efficient ways of agricultural biomass production

- Increase in plant yields of major energy crops
- Classical breeding leading to most increases
- Genetic engineering unlikely to play significant role
- Further automation in agriculture

Microalgae production systems for bioenergy production

- Yield of algae up to 3 times higher than of terrestrial crops
- Microalgae need less space to grow (e.g. in fermenters)
- This could be reducing the demand of fertile land
- Extending the biomass production to marginal land and deserts or seawater areas

Highly efficient conversion of biomass to energy

- Cultivation of new special energy plants
- Using more parts of the plants for energy generation
- Reducing the direct demand of land for energy purposes
- More valuable and storable energy products (fuel and electricity)

Innovative Technologies converting organic residues

- Significant amounts of organic residues not yet used
- Straw, hay, residual wood, organic waste as energy source
- Technical solutions for use of this available biomass
- Conversion of a higher amount of this biomass to energy
- Low energy density, regional variability and wide distributions

Strategies for implementing non-food crops under different future scenarios, Dr. Wolter Elbersen, DLO-FBR

Dr. Wolter Elbersen (DLO-FBR) in 4FCROPS had the responsibility to develop the strategies for implementing non-food crops under different scenarios in EU (WP6). The scenarios are quite important for helping to look into the future.

The following steps were taken to form the scenarios:

- Identification of what is biomass from the energy demand in 2020 (National Renewable Action Plans),
- What is biomass for chemical demand in 2020,
- How to fill in the biomass demand,
- What is the role of crops,
- What to do

Four scenarios were developed: a) global economy, b) continental economy, c) global co-operation and d) regional communities.

According to NREAC the total biomass demand in 2020 in EU27 is expected to be 655.74 Mton DM and will be categorized as follows (biomass demand for chemicals has not been included):

- Carbohydrates for first generation biofuels 17.77 Mton DM
- Sugars from second lignicellulosic crops for 2nd generation biofuels 1.55 Mton DM
- Oils and fats: 29.49 Mton DM
- Biogars substrate (manure, crop and by-products): 125.94 Mton DM
- Solid biofuels for thermal conversion (mainly chips and pellets): 469.76 Mton DM
- Black liquor: 11.26 Mton DM

Scenarios affecting the chemical industry

- Chemical industry is adapted to biomass + sust requirements
  Focus on functionalized molecules (polyesters, furanics)
- Without sust. requirements chemical industry will make unfunctionalized base chemicals (C2, C3): fitting current infrastructure
  Chemical industry will demand biomass that fits the existing infrastructure → ethanol converted to ethylene replaces naphtha, syngas from biomass
- Chemical industry will follow energy: use glycerin from biodiesel industry, FT chemicals from BTL industry,

The demand for non-food crops will be fulfilled though: a) factsheet per crop type, b) swot analyses per crop type, c) role of crop type in different scenarios and d) by setting priorities and suggested action per crop type.