Ministry of Agrarian Policy and Food of Ukraine

"Status and prospects of raw materials for biofuel production in Ukraine"

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Agriculture in Ukraine

Total area of land resources:
- 60.4 million hectares (5.7% territory of Europe)

Agricultural land:
- 41.6 million hectares or 69% of Ukraine (almost 19% of Europe)
- including 32.4 million hectares of arable land or 55% of the country

Note: The per capita is Ukraine 0.8 ha of farmland, 0.7 ha of arable land, average European rate -respectively 0.44 and 0.25 ha.

Crop production plays a key role in the agricultural sector it has the most significant share in the gross domestic product of agriculture Ukraine (last five years more 50%)

It forms the basis of the livestock fodder and provides food security in the country
Agricultural lands

Area - 41.6 million hectares

- 32.5 million hectares (78%): arable
- 5.5 million hectares (13%): fallow
- 2.4 million hectares (6%): perennial plants
- 0.8 million hectares (2%): pastures
- 0.3 million hectares (1%): grasslands
Dynamics of cereals and legumes production, millions of tons

2000: 24.5
2001: 39.7
2002: 38.8
2003: 20.2
2004: 41.8
2005: 38.0
2006: 34.3
2007: 29.3
2008: 53.3
2009: 46.0
2010: 39.3
2011: 56.7
2012: 46.2
2013: 63.0
2014: 63.9
2020 task: >80.0
Dynamics of production of oilseeds by years, million tons

<table>
<thead>
<tr>
<th>Culture</th>
<th>% of the gross congregation in 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunflower</td>
<td>50</td>
</tr>
<tr>
<td>Soy</td>
<td>36</td>
</tr>
<tr>
<td>Rape</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

2000: 3.7
2005: 5.7
2008: 10.3
2011: 12.4
2012: 12.1
2013: 16.2
2014: 16.2
2020 forecast: 16.5
Energy balance of Ukraine

Imports and own production of coal, gas, and petroleum products in million tons (billion m³).
The structure of alternative and renewable energy sources Ukraine

- Bioenergy: 71.9%
- Wind Power: 5.4%
- Geothermal energy: 5.4%
- Small hydropower: 8.7%
- Straw: 32%
- Wood: 17%
- Solid waste: 12%
- Biogas: 14%
- Bioethanol and biodiesel: 19%
- Peat: 6%

*Forecast according to Energy Strategy 2030*
Sustainability requirements (Directive 2009/28 /EU)

(Cabinet of Ministers of Ukraine adopted Resolution № 791-p “Approved plan of action regarding the implementation of the EU Directive 2009/28 /EU“ from 3/09/2014)

Restrictions on land use:
- with high biodiversity and high consistency of the organic matter - bio raw materials can not be grown
- with high carbon content (wetlands, forests with defined level of growth)
- peatlands

Support soil quality:
- minimizing erosion
- maintaining the stability of organic matter in soil
- optimal use of by-products

Social sustainability of biofuels:
- no competition with food crops
- no negative impact on working conditions, land rights, biosafety
- Improvements of the social structures - local areas
Sustainability requirements to reduce greenhouse gas emissions

Total emissions for conventional fuel used as the basis of comparison is 83.8 g (CO2 equivalent) / MJ
Measures to reduce greenhouse gas emissions in the energy crops

- Minimizing the number and intensity of cultivation
- Using wide-combined units to perform few manufacturing operations at the same time
- Biologization of agriculture (green manure, crops more compatible cultures, etc.)
- Prevent combustion by-products in the fields
- The use of GM plants as raw materials for biofuel production
Exit bio methane and biogas reproducible raw materials

- Biogas output of substrate
- Methane output of substrate
- Methane output of dry mass

### Liquid Manure of Cattle
- Biogas output: 110-275 m³/tonne
- Methane output of substrate: 180-360 m³/tonne
- Methane output of dry mass: 130-330 m³/tonne

### Pig Manure
- Biogas output: 20-30 m³/tonne
- Methane output of substrate: 20-30 m³/tonne
- Methane output of dry mass: 70-140 m³/tonne

### Solid Cattle Manure
- Biogas output: 11-19 m³/tonne
- Methane output of substrate: 33-36 m³/tonne
- Methane output of dry mass: 12-21 m³/tonne

### Chicken Manure
- Biogas output: 200-360 m³/tonne
- Methane output of substrate: 130-330 m³/tonne
- Methane output of dry mass: 180-360 m³/tonne

### Grain Silage
- Biogas output: 60-120 m³/tonne
- Methane output of substrate: 60-120 m³/tonne
- Methane output of dry mass: 110-275 m³/tonne

### Straw
- Biogas output: 130-270 m³/tonne
- Methane output of substrate: 130-270 m³/tonne
- Methane output of dry mass: 70-140 m³/tonne

### Corn Silage
- Biogas output: 11-19 m³/tonne
- Methane output of substrate: 11-19 m³/tonne
- Methane output of dry mass: 11-19 m³/tonne

### Fodder Beet
- Biogas output: 20-35 m³/tonne
- Methane output of substrate: 20-35 m³/tonne
- Methane output of dry mass: 20-35 m³/tonne

### Sugar Beet
- Biogas output: 50-72 m³/tonne
- Methane output of substrate: 50-72 m³/tonne
- Methane output of dry mass: 50-72 m³/tonne

### Silage Sorghum Sugar
- Biogas output: 110-190 m³/tonne
- Methane output of substrate: 110-190 m³/tonne
- Methane output of dry mass: 110-190 m³/tonne

### Grain Cereals
- Biogas output: 20-35 m³/tonne
- Methane output of substrate: 20-35 m³/tonne
- Methane output of dry mass: 20-35 m³/tonne

**Additional Notes:**
- The calculations are based on the conversion of organic materials into biogas, which can then be used as a renewable energy source. The output values vary depending on the type of material and the efficiency of the biogas production process.
The use of residual fermentation as fertilizer

1 cubic meters biogas gives us ≈ 5.4 kg solid and 16.8 kg liquid bio-fertilizers, which have the following advantages:

- chemical composition of fermentation residues is less aggressive than raw manure, the nitrogen content in them is higher, and the smell is less intense
- significant amounts of nitrogen readily available to plants, also - phosphorus, potassium, sulfur and trace elements
- content of nitrogen compounds is maintained around 70%, potassium and phosphorus - 100%

Therefore a farmer should compensate only 30% of nitrogenous substances by using chemical fertilizers

Biogas fermentation residues can be considered a high-quality organic fertilizer, which has a corresponding economic equivalent. They can replace expensive fertilizers (price is dependent on oil and gas)

<table>
<thead>
<tr>
<th>Contents</th>
<th>Raw materials of plant origin</th>
<th>Animal waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry weight, %</td>
<td>7,0</td>
<td>6,1</td>
</tr>
<tr>
<td>Acid-base balance</td>
<td>8,3</td>
<td>8,3</td>
</tr>
<tr>
<td>Organic matter (nitrates) g / kg dry weight</td>
<td>51</td>
<td>42</td>
</tr>
<tr>
<td>Nitrogen g / kg dry weight</td>
<td>4,7</td>
<td>4,8</td>
</tr>
<tr>
<td>Ammonium g / kg dry weight</td>
<td>2,7</td>
<td>2,9</td>
</tr>
<tr>
<td>Phosphorus g / kg dry weight</td>
<td>1,8</td>
<td>1,8</td>
</tr>
<tr>
<td>Potassium g / kg dry weight</td>
<td>5,0</td>
<td>3,9</td>
</tr>
</tbody>
</table>
Greenhouse gas emissions and use of fermentation residues as fertilizer

Production of one ton of nitrogen fertilizer meets the energy value of about two tons of oil. Through the use of fermentation residues as fertilizer substitute, there is saving in greenhouse emissions by 16.24 kg CO2 eq. / ton compared with mineral fertilizers. Thus greenhouse emissions are reduced by about 67%.

There is also significant reduction in greenhouse emissions if you compare it with manure. Remains of fermentation are less miry and can penetrate the soil much quicker. It reduces emissions of nitrogen and nitrous oxide. The biggest savings achieved during the fermentation of manure of cattle.
Potential for growing bioenergy crops

Maze area was 5 million hectares in 2014. A substantial portion of the grain crop goes for export, despite its high post-harvest drying costs. Therefore, it is reasonable to use of these areas (about 2 million hectares) to grow corn for silage instead. This will allow us to recieve about 40 billion cubic meters of biogas or 21.2 billion cubic meters biomethane.

Sugar beet can be used as an alternative to corn. In recent decades planted area of sugar beet in Ukraine has decreased significantly, from 1.6 million hectares in 1990 to 333 thousand hectares in 2014. This negatively affected the structure of crop rotation and farming culture in general. Therefore, the potential of sugar beet as a feedstock for biogas production in Ukraine can be increased to 1 million hectares (more than 5 billion cubic meters of biomethane).

Promising crop for biogas production are sorghum sugar, which unlike sugar beet can be grown in arid southern regions of Ukraine. The early timing of harvesting sugar sorghum for energy purposes makes it a good precursor to winter crops. Estimated harvested area of this crop in Ukraine may be about 500 thousand hectares, which will provide about 5.5 billion cubic meters of biomethane.
Bioenergy potential of agriculture in Ukraine

✓ Energy crops (willow, miscanthus, poplar, switchgrass)
✓ Wastes sunflower
✓ Wastes of corn for grain
✓ Straw cereal crops
✓ Straw rape
✓ Woody biomass
✓ Liquid biofuels (bioethanol, biodiesel)
Potential production of pellets and briquettes (million tonnes)

- Straw cereals: 5.7 million tonnes
- Straw rape: 4.27 million tonnes
- Husk oilseeds: 0.37 million tonnes
- Energy crops: 0.26 million tonnes
- Wastes corn: 2.1 million tonnes
- Wastes sunflower: 0.77 million tonnes
- Waste wood industry: 1.07 million tonnes
- Wood (Agrarian forest): 14.58 million tonnes
- Wood (State Committee of Forestry Ukraine): 10.3 million tonnes
- Peat: 9.97 million tonnes

Total: 50 million tonnes
Promising crops for biofuel production

- sugar beets
- fodder beet
- sugar sorghum
- miskantus
- pampiniform millet
- energy willow

- bioethanol
- biogas
- solid biofuel
Sugar sorghum

It is a tall plant height 3,0-4,0 meters. From one hectare can be harvested 90 - 100 tonnes of sugar biomass. By the end of the growing season in the juice of the stems accumulate up to 16-18% sugar. One can get 40-50 tons / ha of juice and 25-30 t / ha dry weight, which is used to produce ethanol, butanol and biogas. Squeeze the green mass, used for briquettes and pellets. Hectare sugar sorghum crops during the growing season 125-135 days to absorb 55 tons of carbon dioxide into the atmosphere and emits about 40 tons of oxygen.
The possible use of raw sugar sorghum

Sugar sorghum (100 t / ha green weight)

Food goals (Up to 4 t / ha sugar syrup)

Solid biofuels (Up to 21 t / ha)

Bioethanol (Up to 4 t / ha)

Biogas (13 thousand m3) + Eco-friendly fertilizer
Miscanthus - a perennial herb of the family of cereals, of type C4 photosynthesis, which has about 40 species. Miscanthus is highly environmentally friendly culture: after four years of growing it collects 15-20 tons of underground biomass, which is equivalent to 7.2-9.2 t / ha of carbon. Duration of use plantation - about 20 years, but commercial cultivation - 15 years. Low operating costs growing open up the possibility of using this crop for the production of solid fuels. Dry biomass yield is 15-20 t / ha. Biomass can be harvested annually using conventional forage harvesters, and the resulting mass can go directly to generate heat or processed into briquettes or pellets. Recommend grown on unproductive soils not suitable for growing other crops.
Millet pampiniform (Panicum virgatum L.) – is one of the perennial rhizomatous grass which is grown in order to obtain biomass. Plant height, depending on variety and climatic conditions is 100-250 centimeters. Refers to C4 photosynthesis by rationally using nitrogen and moisture. Capacity ranges from 6 tons of dry matter in northern soils with low fertility to 25 tons in the south of European soils with high fertility. With the good care you can harvest for 15 years. Svitchgras can be used as raw material for pulp industry.
Forest resource opportunities in Ukraine

- Stock of wood in the forests estimated at 1.8 billion cubic meters

- Average annual supply of wood biomass 4.5 cubic meters per 1 ha.

- Overall growth in the country is around 40.0 million cubic meters per year.
Timber production from woodland
(million cubic meters)

- Round timber: 6.2 (44%)
- Industrial raw materials: 3.6 (26%)
- Wood fuel: 2.6 (18%)
- Waste: 1.7 (22%)

TOTAL: 14.1
• Estimated total amount of potential energy resource from wood biomass in Ukraine provided its full use can reach: 6.5 - 7.0 million cubic meters.
The advantages of using pellets

- Food residues combustion - less than 1%
- Easy of transportation and storage of pellets
- No harmful air emissions
- Popularization of environmental technologies

1 ton of pellets =

1.6 tons of wood
475 m³ natural gas
500 liters diesel fuel
685 liters of nitrogen
546 kg hard coal
Agricultural regions - prospectives

- Creating new markets for the agricultural sector (e.g. Growing bioenergy feedstock)
- Development and maintenance of agricultural regions (e.g. Agriculture, biofuel production and its use in the region)
- New jobs, infrastructure development in rural areas
- Reducing dependence on energy imports
- Ecological safety
- Introduction of innovative technologies of production and processing of agricultural products
- An important prerequisite
  - Support at the national political level (government)
  - Desire to implement a national strategy in the biofuels field
Thank you for the attention!