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THE PROSPECTS OF USING SORGHUM AND ASTER CROPS AS A BIOMASS SOURCE TO ENHANCE UKRAINE'S ENERGY SECURITY

Manushkina T.M., PhD in Agriculture, Docent
Mykolaiv National Agrarian University
https://orcid.org/0000-0001-5843-271X
Roubík H., PhD, doc. Ing.
Czech University of Life Sciences in Prague, Czech Republic

Анотація. У роботі розглядаються перспективи розвитку біоенергетики в Україні з акцентом на використання фітоенергетичних культур, зокрема соргових і айстрових рослин. Описано переваги біомаси як відновлюваного джерела енергії, її екологічну нейтральність та роль у підвищенні енергетичної безпеки країни. Визначено потенціал цукрового сорго та топінамбура як ефективної сировини для виробництва біопалива й теплової енергії. Наголошено на необхідності розроблення адаптованих технологій вирощування енергетичних культур для умов Південного Степу України, а також окреслено можливості створення локальних енергетичних систем на основі біомаси.

Ключові слова: біоенергетика, біомаса, фітоенергетичні культури, сорго, топінамбур, біопаливо, енергетична безпека, екологічна нейтральність, зміни клімату, стале сільське господарство.

Bioenergy is a sector of the energy industry that utilizes organic substances of plant or animal origin (biomass) as energy resources, which possess energy value and can be used as fuel. Currently, biomass can become one of the important sources of raw materials for energy production, as the demand for it is increasing, and fossil fuel resources are depleting. In modern conditions, biomass is one of the main renewable

energy sources in many countries and ranks fourth in the world in importance. Biomass provides more than 2 billion tons of equivalent oil energy per year, accounting for about 14% of the total world's energy consumption (in developed countries, more than 30%, sometimes up to 50 to 80%) [1, 2].

When biomass is used for energy purposes to produce heat, electricity, and fuel, a distinction is made between energy crops and organic waste. Organic waste includes residues generated in agriculture, forestry, households, and industry, such as wood processing waste, straw, grass, leaves, manure, and organic household waste. Energy crops are fast-growing perennial trees, shrubs, and grasses, as well as special annual plants with high dry matter content for use as solid and liquid biofuels. Biomass from energy crops, which is regularly cultivated and whose use as an energy source does not reduce the amount of green spaces in the region, is recognized as a renewable resource and is considered ecologically neutral (having a zero carbon dioxide emission balance) [2, 3].

For Ukraine, bioenergy is one of the strategic directions for the development of the renewable energy sector, as it has a high level of dependence on imported energy resources, particularly natural gas. By the middle of the 21st century, alternative energy is projected to provide almost half of the energy resources and biomass, more than 20%. If biomass is cultivated on unused or underutilized fields, this share for Ukraine can increase to 25%. In the post-war period, the relevance of strengthening the energy security of rural areas through the creation of local energy systems based on the use of alternative energy from biomass of energy crops will grow. Sorghum (sweet, grain, broomcorn, and others) and aster family plants (Jerusalem artichoke, sunflower, cup plant, forage sunflower) can serve as biomass. Moreover, the process of burning biomass or its processed products (alcohol, biogas) is entirely ecological. Due to climate change, the need for efficient use of land, material, and human resources, it is relevant to develop modern, environmentally safe technologies adapted to the Southern Steppe zone of Ukraine for cultivating sorghum and aster family crops that will provide alternative energy sources with raw materials [3].

Currently, sweet (forage) sorghum is mainly grown for silage and green fodder. Taking into account the high sugar content (18–19%) in its juice, it can be used to produce sugar syrup (sorghum honey) and alcohol. The leaf-stem mass can be used as a heat carrier in a closed-loop alcohol production cycle. In Ukraine, five types of sorghum are common, four of which are cultivated, mainly in the southern parts of the country. Dzhugara and sweet sorghum are grown on small areas in the Steppe. In terms of energy value, sweet sorghum is the most attractive compared to other crops due to its much lower water requirements and the possibility of obtaining, along with the harvest of leaves and stems (30–40 tons/ha), a significant grain yield (2.5–3.0 tons/ha), which can also be used to produce bioethanol. Taking into account grain yield, alcohol production per hectare increases significantly and reaches 7,000 liters or more per year. Additionally, sweet sorghum is better suited for mechanization of the cultivation process and seed reproduction [3].

Cultivating Jerusalem artichoke can serve as an effective means of addressing public concerns about converting food into fuel raw materials and rising food prices. Jerusalem artichoke is a high-yielding, multi-purpose crop characterized by several

economically valuable traits, particularly a high yield of raw materials per unit area for bioethanol production. Jerusalem artichoke is unpretentious to growing conditions and can be cultivated on low-productive and marginal lands, which are considered an important reserve for expanding areas under energy crops [4].

The use of sorghum pellets and Jerusalem artichoke leaves can solve a number of environmental, technological and fire safety problems, providing a powerful impetus for the use of biomass to produce thermal energy and diversifying traditional fossil fuels, as well as creating effective mechanisms in Ukraine to stimulate the thermal energy production sector from biomass. Moreover, unexplored issues include the use of solid biofuel pellets, which can be an alternative to coal, giving impetus to the development of related industries such as mechanical engineering, light, and processing industries. A comprehensive analysis of the formation of productivity of crops from the sorghum and aster family according to weather and climatic conditions will make it possible to identify the most potentially high-yielding species and hybrid compositions while maintaining ecological balance and ensuring maximum energy security for the country.

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Abstract. The article examines the prospects for the development of bioenergy in Ukraine, focusing on the use of phytoenergetic crops, particularly sorghum and aster plants. It highlights the advantages of biomass as a renewable energy source, its carbon neutrality, and its role in strengthening the country's energy security. The potential of sweet sorghum and Jerusalem artichoke as efficient raw materials for biofuel and thermal energy production is discussed. The need for the development of adapted cultivation technologies for energy crops under the conditions of the Southern Steppe of Ukraine is emphasized, along with the opportunities for creating local energy systems based on biomass.

Keywords: bioenergy, biomass, energy crops, sorghum, Jerusalem artichoke, biofuel, energy security, ecological neutrality, climate change, sustainable agriculture.