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POTENTIAL AND ECONOMIC EFFICIENCY OF USAGE OF CROP PLANT REMAINS

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The level of productivity of main products (grain, seeds) has been given. Potential (general and energy) of crop plant remains has been calculated. The article contains economic efficiency of production of by-products such as plant remains (straw and stems) of winter wheat, corn, sorghum and sunflower. The results indicate that crop plant remains as raw materials for biofuel production have high profitability.

Keywords: productivity, main products, plant remains, potential, crops.

Problem statement. Development and usage of renewable energy sources especially plant phytomass for biofuel production is very important for energy dependence reduction in Ukraine. Because of rising in prices for energy resources and their deficit involving renewable energy in particular biomass into economics of our country is very urgent. Today plant biomass as fuel occupies the fourth place in the world according to output. The part of biomass in total output of primary energy is 10%in the world and this part is less than 2% in Ukraine [8]. That is why for wide introduction of renewable energy sources it is necessary to study the potential of plant resource and possibilities of its usage for obtaining cheap fuel.

Analysis of the main researches and scientific publications. In connection with the problem of production and usage of biofuel in Ukraine and in the world there is the necessity of energy sources diversification, examination of available energy in the country and possibility of involving potential sources of renewable energy.Ukraine suffers from deficit in provision with energy on the account of mining raw materials and that is why searching of additional alternative energy sources on the base of reduction of bad influence on environment is very important. Production of bio raw materials and development of markets of “Bio raw materials” and “Biofuel” can be such energy sources [4].

Ukraine has great potential of biomass available for energy usage and prerequisites for expanding usage of plant remains on biofuel. Energy strategy of Ukraine to 2030 year [3] expect dynamic growth of biomass energy usage to 5 million ton of oil equivalent or 2.5% from total power consumption in 2015 year and in 2030 year growth to 20 million ton or 10% [2].

Winter wheat, corn and sunflower occupy the largest areas both in Poltava region and in Ukraine. Sorghum is also promising crop. These crops are used for producing bread, peeled grains, oil and as feed for animals. By-products as straw, stems, stubbles and peelings are not usually used and left in the field.

Analysis of crops production in the region and in Ukraine shows [1] that crops form average and high level of productivity and have high economic indicators. At present studying ways of getting the main production of field crops and possibility of using plant remains has not been paid enough attention. In connection with this fact study of potential of by-products and plant remains (straw and stems) productivity at certain agrarian enterprise (in this case farm) is very urgent problem nowadays.

Research purpose. The experiment was conducted on farm “Olenka-2005”in Reshetylivka district, Poltava region during 2014-2015 years. The purpose of this experiment was to establish the level of productivity of main products and to determine potential of crops by-products.

Research object is the level of productivity of main products and potential of usage of crops plant remains.

Research subject is winter wheat, corn, sorghum and sunflower.

The following tasks were set:

1. To determine productivity of winter wheat, corn, sorghum and sunflower during the experiment years.

2. To establish productivity of main products and gross yield of by-products (straw and stems) of winter wheat, corn, sorghum and sunflower.

3.To calculate cost of plant remains of winter wheat, corn, sorghum and sunflower.

Research methods. Generally accepted [7] and special [5] methods were used. Productivity of main products was determined by recalculation of each crop capacity on standard humidity and purity. By-products yield was established applying special methods such as generalized evaluation of technically available biomass potential [6].

Potential of plant remains (P_{pr}) was determined according to formula (1):

$P_{pr} = GY \times K_{pr} \times (1 - K_{pl}) \times K_{pu}$, t (1),

GY gross yield of main products, t/ha;

K_{pr} – coefficient of plant remains;

K_{pl} – coefficient of plant remains losses;

K_{pu} – coefficient of plant remains usage.

Energy potential of plant remains (E_p) was determined according to formula (2):

$E_p = P_{pp} \times Q / 7000$, т у. п. (2),

P_{pp} – potential of plant remains, t;

Q – low combustion heat of plant remains, kilocalorie / kg;

7000 – caloric power of 1 kg oil equivalent (biofuel), kilocalorie.

Research results. According to the results of two years experiments the productivity level of main crops such as winter wheat, corn, sorghum and sunflower has been established. (table 1).

1. Productivity of crops, t/ha (2014–2015 years)

Crop	Years		+ / – to the previous year	Average during the years
	2014	2015		
Winter wheat	2,9	3,8	+ 0,9	3,4
Corn	7,8	9,6	+ 1,8	8,7
Sorghum	4,4	1,2	– 3,2	2,8
Sunflower	3,8	3,7	– 0,1	3,8

Depending on the weather during years of vegetation in 2014 year corn productivity was 7,8 t/ha, sorghum productivity was 4,4 t/ha, sunflower productivity was 3,8 t/ha, winter wheat productivity was 2,9 t/ha. In 2015 year corn formed the highest productivity of 9,6 t/ha (+1,8 t/ha to the previous year), winter wheat formed 3,8 t/ha (+0,9 t/ha to the previous year), sunflower formed 3,7 t/ha (almost at the level of last year) sorghum formed 1,2 t/ha (less on 3,2 t/ha than the previous year).

On average during two years corn for grain, winter wheat and sunflower had stable and high productivity.

Gross yield of main products depended upon area under crops and crop productivity during years of the research. (table 2).

2. Gross yield of crops, t (2014–2015 years)

Crop	Years		Together during two years	Average during the years
	2014	2015		
Winter wheat	313,2	562,4	875,6	437,8
Corn	1760,1	2426,9	4187,0	2093,5
Sorghum	528,0	12,0	540,0	270,0
Sunflower	338,2	481,74	819,94	409,97

Corn had the highest gross yield of main products both during two years and on average. Winter wheat, sunflower and sorghum had less gross yield.

Considerable part of unused plant remains is reasonably to involve into energy production. It is important to define what part of crop remains can be used for energy needs without bad influence on

soil fertility. Potential of plant remains (table 3) is determined according to coefficients and gross yield of crop main products. (table 2).

3. Potential of plant remains for biofuel production, t (2014–2015 years)

Remains, crops	Years		Together during two years	Average during the years
	2014	2015		
Straw, winter wheat	197,3	354,3	551,6	275,8
Stems, corn	1584,1	2184,2	3768,3	1884,2
Stems, sorghum	332,6	7,6	340,2	170,1
Stems, sunflower	828,6	1180,3	2008,9	1004,5
Total	2942,6	3726,4	6669,0	3334,6

On average during two years corn stems have the highest potential of plant remains (1884,2 t), sunflower stems have 1004,5 t of plant remains potential, straw of wheat (275,8 t) and sorghum (170,1t) have the least potential. This influenced on general amount of plant remains obtained in 2014-2015 years: corn had 3768,3t, sunflower had 2008,9t, wheat had 551,6 and sorghum had 340,2t.

Results of calculation of plant remain energy potential according to formula 2 are shown in the table 4.

4. Energy potential of plant remains, (2014–2015 years)

Remains, crops	Years		Together during two years	Average during the years
	2014	2015		
Straw, winter wheat	84,6	151,8	236,4	118,2
Stems, corn	740,0	1020,3	1760,3	880,2
Stems, sorghum	142,5	3,3	145,8	72,9
Stems, sunflower	378,8	539,6	918,4	459,2
Total	1345,9	1715,0	3060,9	1530,5

On average during two years of the experiment energy potential of corn plant remains was the highest (880,2 t oil equivalent), energy potential of sunflower plant remains was 459,2 t oil equivalent, plant remains of wheat (118,2 t oil equivalent) and sorghum(72,9 t oil equivalent) had the lowest energy potential. Together during two years of the experiment corn stems had the highest energy potential (1760,3 t oil equivalent), sunflower stems had less energy potential (918,4 t oil equivalent). Wheat straw (236,4 t oil equivalent) and sorghum stems(145,8 t oil equivalent) had the lowest energy potential.

Energy potential of crop plant remains was13459 t oil equivalent in 2014 year, in 2015 year energy potential was1715,0 t oil equivalent and during two years it was 3060,9 t oil equivalent. Calculation of cost of crop by-products (straw and stems) on the farm in 2015 is given. (table 5).

5. Cost of by-products of agricultural crops, 2015 year

Remains, crops	$E_{pp.}$, t	Cost, UAH		Mean value, UAH
		minimal	maximal	
Straw, winter wheat	151,8	45540,0	75900,0	60720,0
Stems, corn	1020,3	306090,0	510150,0	408120,0
Stems, sorghum	3,3	990,0	1650,0	1320,0
Stems, sunflower	539,6	161880,0	269800,0	215840,0
Total	1715,0	514500,0	857500,0	686000,0

Note: $E_{pp.}$ – energy potential of plant remains, t;
Minimal. – minimal cost of plantremains – 300 UAH/t;
Maximal – maximal cost of plant remains– 500 UAH/t.

Among experimented crops corn plant remains have the highest cost(with minimal remains cost we get 306090,0 UAH, with maximal cost we get 510150,0 UAH, on average we get 408120,0 UAH) and sunflower plant remains(with minimal remains cost we get 161880,0 UAH, with maximal cost we get 269800,0 UAH, on average 215840,0 UAH).

Sorghum stem production is the least reasonable from the economic point of view (with minimal plant remains cost we get 990,0 UAH, with maximal cost we get 1650,0 UAH, on average we get 1320,0 UAH).

Conclusions: 1. Corn and sunflower stems have the highest potential of plant remains, winter wheat straw and sorghum have the lowest potential on farm "Olenka-2005". On average during two years corn and sunflower stems have the highest energy potential (1760,3 t oil equivalent and 918,4 t oil equivalent), wheat straw and sorghum stems have the lowest energy potential (236,4 t oil equivalent, 145,8 t oil equivalent). Energy potential of plant remains of crops as a whole on the farm was 13459 t oil equivalent in 2014, energy potential in 2015 was 1715,0 t oil equivalent and during two years energy potential was 3060,9 t oil equivalent.

2. Selling available potential of plant remains as raw materials for biofuel economic efficiency will be 514500,0 UAH with minimal their cost and 857500,0 UAH with maximal their cost.

So, study of plant remains usage as raw materials for biofuel taking into account agroecological aspects is perspective approach of further research.

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