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ENERGY-SAVING TECHNOLOGIES IN AGRICULTURE OF UKRAINE

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Abstract: A well-known fact is that the world supplies of traditional fuel are decreasing and the world energy production from the alternative sources is constantly increasing. Each year the number of countries displaying a keen interest in development and application of regenerative energy is rising.
Biomass is a considerable and perspective kind of fuel for Ukraine. Nowadays obtaining energy from biomass (wood, straw, plant remainders of agricultural production, manure, organic particle of hard domestic offcuts) is the field developing quickly and dynamically in many countries of the world. In favour of biomass speaks the fact that it has large power potential and refurbishable character.
In our research we considered the use of straw for the receipt of energy and its practical value for a particular enterprise. As well as any type of power resource from biomass, burning of straw has a number of advantages. The advantage is that straw is indeed a regenerative source and is reproduced every year with the new harvest of grain crops. It is accessible for users, especially in rural locality that will allow saving part of facilities on traditional power carriers.

Keywords: biomass, biofuel, bioenergy, regenerative energy sources, alternative energy sources, ecologization

MOTIVATION AND RESEARCH QUESTIONS

In Ukraine renewable energy sources occupy for today very insignificant part in common energy consumption. Now a price on power mediums from traditional sources is enough low, therefore the use of renewable energy sources is not competitive from the economic point of view. But we know that stock coal and petroleum through the set time will run out, and what then? What to do?! Moreover experience of other countries which use the types of energy relatively safe and cheap,

that practically inexhaustible and have grandiose power potential is very important. Research workers and economists of whole world all anymore pay the attention to hydroenergetics, wind engines, use of energy from biomass as a less dangerous energy source from the point of view of environmental protection.

For development of untraditional energy sources Ukraine has no legislative acts, support of the state, in spite of it a theme gains the popularity and is studied by researchers. However without the state support, as experience of the developed countries shows, the question of the use of renewable energy sources can not be decided and develop. Rising in price of power mediums in the world markets results in a fact, that countries which are power dependent upon the import of power mediums should develop their own potentials to partially decrease this dependence and strengthen power safety.

The use of alternative energy sources has a global perspective for the further successful development of civilization. In the world there can be observed phenomena that violate the sustainability of civilized society: running out of traditional energy sources, increasing the cost of their production, heavily polluted environment, the biosphere is destroyed, formation of excessive amounts of organic waste from industrial, agricultural and domestic origin. Removing all these problems should be carried out rapidly.

Many scientific works of economists are dedicated to the development of bioenergy and alternative energy sources. Among them there are works of O. Adamenko, E. Wakh, T. Zhelyezna, M. Zhovmir, V. Dolinsky, V. Zinchenko, M. Kabat, M. Kalinchyk, Yu. Matveev, I. Stoyanenko. The research of theoretical and practical aspects of the use of alternative energy sources from biomass are highlighted in works of domestic and foreign scholars: O. Gauf, G. Heletukha, V. Dubrovin M. Korchemnyi, H. Lins, M. Mkhitaryan, D. Shpaar, A. Shpychak, H. Strubenhoff, G. Shtrobel, H. Schultz and other scientists.

The great socio-economic importance of getting the energy from biomass, prospects of development of bioenergy, development of the market of alternative energy sources led to the choice of research topic, its relevance, purpose, objectives and areas of study.

According to the research of authors [Takács-György, Domán, Tamus, Horská, Palková, 2015] in order to examine the knowledge on renewable energy, the respondents got a list and they had to mark what they know. At first most of the respondents identified the characteristics of traditional renewable energies like wind, solar and water energy. The issues of the energy plants, biopellets and biomass were the least recognizable ones.

The development of bioenergy is very important for Ukraine since it has considerable potential of biomass, which is available for energy - about 24 million tons EF / year, and of peat - about 0.6 million tons EF / year. The main components of biomass potential are straw and other agricultural waste (stalks, starts, husks, etc.), as well as wood waste, liquid fuel from biomass, various kinds of biogas and energy crops. The primary use as fuel requires the existing waste of solid biomass beginning

from wood and straw, while the cultivation and use of energy crops (willow, poplar, miscanthus). Waste of biomass (without the share used in other sectors of the economy) can provide more than 10% of Ukraine's needs in primary energy. This figure exceeds the average consumption of biomass as an energy source in Europe, and makes 3 percent [Kuzmenko and Perederiy 2015].

The main sources of biomass in Ukraine is agricultural residues both of crop industry - straw of cereals, sugar beet, sunflower and livestock products - manure. Normally, part of this production is consumed by agricultural sector itself - as bedding, for feeding animals, organic fertilizer, but these wastes can also be considered the potential of biomass for obtaining energy.

As the authors calculated, there can be provided 5% of the country's needs in energy resources only through the straw of cereals. Of course, no country is able to use 100% of straw only for energy purposes, significant part of it is plowed as fertilizer or used for the needs of animal husbandry. Developed countries use about 25% of obtained straw for energy purposes, which is recommended for adoption in Ukraine.

The increase of production of grain is one of basic tasks of agriculture. Production of grain is seasonal, and its consumption takes place throughout the year, that is why there is a large necessity in creating the necessary conditions for its long-term storage.

Irrespective of the purpose of eventual consumption of corn – for food or bioenergetics, for the long-term storage of grain it needs to be dried. Technologies of drying of grain are perfected from year to year: new methods are developed, grain dryers of new modifications are created, efficiency of the use of existing aggregates is increased. One of perfection methods of process of drying of grain is the use of grain dryers which allow saving electric power by the method of its replacement on the use in production of caldrons for burning of straw.

Data and Methods

Most often they use the following methods of calculating the efficiency of investments, which are based on the concept of discounting:

- method of determining Net Present Value (NPV),
- method of calculating Internal Rate of Return (IRR),
- method of calculating of Payback Period (PBP).

Net Present Value is the difference between the sum of cash flows, discounted to present value, and the sum of the discounted present values of all costs required for the project [1]. Calculation of the net present value can be expressed by the following formula:

$$NPV = \frac{H_{-m}}{(1+i)^{-m}} + ... + \frac{H_{-1}}{(1+i)^{-1}} + H_0 + \frac{H_1}{(1+i)^1} + ... + \frac{H_n}{(1+i)^n} + \\ - \frac{B_{-m}}{(1+i)^{-m}} - ... - \frac{B_{-1}}{(1+i)^{-1}} - B_0 - \frac{B_1}{(1+i)^1} - ... - \frac{B_n}{(1+i)^n} \quad (1)$$

or as the sum:

$$NPV = \sum_{t=-m}^{n} \frac{H_t}{(1+i)^t} - \sum_{t=-m}^{n} \frac{B_t}{(1+i)^t} \quad (2)$$

where H – revenues for the period,
B – expenditures for the period,
i – discount rate to bring the cash flow to the present value,
n, m – sequence numbers of the calculation period.

The choice of rate of discounting is an important moment. In the wide understanding the rate of discounting is alternative investment possibilities with the similar level of risk. Otherwise, this is the rate of profitability which investors expect on the investments, and which can stimulate them to investing. The choice of approach to determination of rate of discounting depends on a particular situation and information which an analyst owns.

The method of Net Present Value (NPV) is considered basic at the analysis of investment projects, but it has certain disadvantages. The first problem is related to prognostication of such initial indexes as the marginal cost of capital, sum of future investments and expected profit margin. The second problem consists in the fact that a discount rate is permanent for all operating period of investment project. However depending on the economic changes in a country a discount rate can be multiplied or be diminished. On the basis of offered approach we develop software for automation of calculation of optimization of the biomass using at introduction and estimation of innovative project from the use of energy-saving technologies.

Another method of calculation of efficiency of investments is the Internal Rate of Return (Internal Rate of Return). Its essence consists in determination of such rate of discounting, at which the present value of the expected profits will be equal to the present value of capital investments. The search of rate takes place in the alternative way [Steinhauser et al. 1992].

The method of calculation of Payback Period is popular enough in Ukraine. Its widespread application is explained by simplicity of calculations, as this method foresees the search of necessary period of time which the sum of initial investments comes back for. For determination of PBP they compare the cumulative sum (sum with a growing result) of cash flow with the sum of initial investments.

It is important to mention, that this method shows the degree of risk of project. The longer term is needed for returning of investment sums, the greater is probability

of emerging of unfavorable circumstances. And vice versa, the less is the term of recoupment, the greater is the sum of cash flow at the beginning of implementation of project and, accordingly, the better are the terms for support of liquidity of firm.

MAIN RESULTS

Briquettes are the most powerful type of fuel from a straw. A problem consists in the fact that the briquetting machines for straw are rather expensive and unaffordable for potential users in Ukraine. That is why baling of straw, that is already practiced in our country is a more real variant.

Baling considerably diminishes the volume of straw and allows mechanizing a number of operations at storage, transporting of straw and use of caldrons.

Chemical composition of ash of straw is characterized by high maintenance to potassium that predetermines formation of fusible slag. In the straw of barley, oat, rape there is high content of chlorine, which can result in corrosion at the improper technology of burning.

For providing the observance of technology of burning humidity of straw must make no more than 20-25%, optimum - 15%. The heating value of straw of cereals with optimum humidity is 13,6-15,6 MJ/kg, which is 2 times less, than of coal. On the average 3 t of straws with its heating value can replace a 1000 cubic meters of natural gas or 1 ton of diesel fuel.

As calculations prove, the content of energy in 1 litre of diesel fuel and in 2,4 kg of straw is identical. Thus one roll weighing 250 kg can replace 105 litres of diesel fuel or 105 cubic meters of natural gas. The economy is not hard to count. A straw on our farm does not almost have a substantive cost, it is taken into account only on those farms, where the process of its plowing into the soil takes place or where it is used as bedding for animals. In these cases there is natural balance of straw rather than money accounting. The substantive cost of one center of straw at the end of 2015 approximately makes 90 UAH, so the price of 3 t is 2700 UAH. Cost of 1 litre of diesel fuel in a money equivalent made about 14 UAH, 1000 litres of diesel fuel – 14 000 UAH. 1000 cubic meters of gas – 7188 UAH. Thus, every roll of straw that is used in a caldron for its burning results economy on the farm, and each ton of straw burned saves 12300 UAH compared with diesel fuel, and 4500 UAH compared with gas.

After burning of straw there remains 3-5% of ash which contains a number of nutrients (in the form of salts), mainly potassium, phosphorus and calcium, and can be applied into the soil as a fertilizer [Kuzmenko and Perederiy 2015].

Such type of grain dryer that uses as energy for drying the energy of straw burning is planned to be put into operation on the facilities of Agronomical experimental station.

Our farm chose on a shaft grain dryer ZSh-8000, heat-generator for it THS-500 with a control console and device of support of the set temperature and supply of warning signals, hardware for serving the equipment, norias with productivity

of 50 t/h/14 м with a control console. A general investment in a grain dryer made up 1 mln UAH.

REQUIREMENTS TO THE STRAW QUALITY

The straw, which is delivered for burning, must meet certain requirements to reduce the risks of emerging exploitation problems in the process of producing energy. Storage, preparation, dispensing, supply, combustion and environmental consequences of these operations contain potential problems. Moisture content of straw is one of the most important criteria for the quality of the fuel. Usually the moisture content varies between 10-25%, but can sometimes be higher. The heating value and the price of straw depend on the moisture content.

All thermal power plants determine the maximum acceptable moisture content of straw supplied. The high water content can cause problems during storage and irregularities in the work of the station as a whole, and also reduce power and increase costs for preparation, dispensing and supply of straw into the boiler (and possibly reduce the efficiency of the boiler). The acceptable maximum moisture content of the straw, which is supplied, is different for different stations within the limits of 18-22%. Different types of straw have different properties during combustion. Some species burn almost explosively almost leaving no ashes, others burn more slowly leaving on the lattice the "skeleton" of ash. The experience gained at different stations of centralized heat supply is not always identical. Differences in the combustion process can not always be explained by conventional laboratory measurements [Mesel-Veselyak and Pashtetskyy 2011].

Multi-periodical estimation of efficiency of investment project will help us to give an answer to the question: whether the loss of the capital invested in a grain dryer will take place in connection with its exploitation during 5 years. On the other hand, these calculations can help us to find out how much this investment is profitable, taking into account the changes of money value in time. In order to give complete and exhaustive estimation to the investment project of acquisition of grain dryer, it is necessary to take into consideration that an enterprise is able to pay an investment both by own capital and by a credit which is paid by the farm during 5 years.

On the basis of the statistical reporting of Agronomical experimental station we calculated that on the average for a year the farm gets: 1600 t of grain crops, 370 t of corn. The minimum term of application of a grain dryer is 5 years. Humidity of wheat at harvesting is 22 percent, corn - 32 percent. Normative humidity while storage for wheat and corn is 14 percent.

Due to the use of own dryer as compared to the grant of services on an elevator the economy is 40 UAH per tonne for the decline of humidity on 1 percent, and this is our saving. Alternatively, using own grain dryer there emerge costs for the purchase of straw (about 105 t), additional salaries, maintenance of the installation.

The farm has an opportunity to take a loan in amount of 500 000 UAH for 5 years term, at 28% per annum.

From the calculations conducted by us it is possible to draw conclusion that our variant of calculation of project is advantageous even only due to the saving of drying compared to the provision of services by third parties. This is proved by the indexes of Net Present Value, which show a difference between the present cost of income and expenses on investing. The indicator of 548 044 UAH in funding options through a loan is positive, and therefore has the right to existence and implementation. Even greater effect can be achieved considering the effect from the possibility of providing our services to other farms.

Table 1. Multiperiod calculation of investments in the conditions of getting the loan

Indicators	0	1	2	3	4	5
Grains without corn, t		1600	1600	1600	1600	1600
Corn, t		370	370	370	370	370
Cash flow without considering a loan						
Revenues, UAH						
Savings due to the use of own dryer, UAH		748 800	748 800	748 800	748 800	748 800
Total revenue, UAH		748 800	748 800	748 800	748 800	748 800
Expenditures, UAH						
Buying equipment, UAH	-1000000					
		-10000	-10000	-10000	-10000	-10000
Deduction (1%), UAH		-94349	-94349	-94349	-94349	-94349
Costs of straw, UAH		-29250	-29250	-29250	-29250	-29250
Remuneration, UAH		-50000	-50000	-50000	-50000	-50000
Costs of repairs, UAH		-183599	-183599	-183599	-183599	-183599
Total expenditures, UAH						
Cash Flow I	-1000000	565201	565201	565201	565201	565201
Loan (28%)						
Debetor's account, UAH	*500000*	*442525*	*368964*	*274802*	*154275*	*0*
Annuity, UAH		197474	197472	197472	197472	197472
Sum of loan, UAH	50000					
Interest on loan, UAH		140000	123908	103310	76945	43197
The body of the loan, UAH		57472	73564	94162	120527	154275
Payment for services for obtaining the loan, UAH	-5000					
Cash Flow of loan, UAH	495000	-197472	-197472	-197472	-197472	-197472
Cash Flow II	-505000	367729	367729	367729	367729	367729
Discounting factor (22%)	1	0,81967	0,67186	0,55071	0,45140	0,37000
Discounted Cash Flow II	-505000	301417	247064	202511	165993	136060
NPV	548044					
IKV	67%					

Source: own elaboration

In calculations a discount rate was accepted as 22% annual. From the economic point of view a discount rate (or discount factor) is profitability of investments, which usually an investor gets from the investments of similar nature and risk. Essentially, this is a possible rate of profitability. On the enterprise the determination of rate of discounting is complicated as a result of variety of investment possibilities and variety of financing through own and borrowed sources. Rate of income that is used for discounting of cash flow from the capital investments must respond to minimum requests as to profitability that provides the expected level of profit.

For our project the Internal Rate of Return was 67%, that is more than alternative (22%) and proves positive estimation of the offered investment. We return all invested capital in total and have a sufficient profit.

The payback period of the proposed project is:

PBP1 = -505 000 + 301 417 = -203 583 UAH

PBP2 = --505 000 + 301 417 + 247 064 = 43 481 UAH

Thus, in a year the investment will not have time to pay off, and in the second it will pay off fully.

And the entire term of a full payback will be 1.82 years.

To assess the influence of the main factor parameters on performance indicators of the project we will conduct a sensitivity analysis of the project.

The sensitivity analysis is a technique of analysis of the project risk, which shows how the value of the net present value (NPV) of the project will change at a given change in input variable all else being equal.

During this analysis, consistently changing the possible values of varying factor indicators we can determine the oscillation range of the selected for risk assessment of the project final indicators of its efficiency as well as the critical values of factor indicators that question the appropriateness of the project proceeding. The higher the degree of dependence of the efficiency indicators of the project on individual factor indicators of its formation, the more risky it is considered according to the results of the sensitivity analyzes.

Conducting of the sensitivity analysis is very a simple operation, exposed to algorithmization and is reduced to the following steps:

The 1st step. Identifying the key variables that affect the value of the net present value (NPV).

The 2nd step. Determining the analytical dependence of the net present value (NPV) on the key variables.

The 3rd step. Calculation of the base situations - determining the expected value of the net present value (NPV) at the expected values of key variables.

The 4th step. Changing one of the input variables to the desired for the analyst value (in%). Moreover, all other input variables are fixed.

The 5th step. The calculation of the new value of the net present value (NPV) and its percentage change.

The 4th and the 5th steps are carried out sequentially for all input variables, they are entered into the tables and are represented graphically, that is, the analyst receives a series of answers to the question "what if?".

The 6th step. Calculation of the critical values of the variables of the project and identifying the most sensitive of them.

The 7th step. Analysis of the obtained results and the formation of the sensitivity of net present value (NPV) to changing of different input parameters.

The critical value of the indicator is the value, at which the net present value is equal to zero (NPV = 0).

Accordingly, the key factors that may affect the net cash flows are: costs of services of the elevator, repair costs, the cost of the baled straw for incineration.

When studying the impact of changes in cash flows on the changes of the factor indicator - changes in the cost of services of the elevator - we have the following indicators of cash flows. As a basis we take a zero fluctuation of the factor indicator.

Table 2. Dependence of the net present value (NPV) on changes in the cost of services of the elevator

Years	Change of the factor indicator of value of service of the elevator, UAH						
	-15%	-10%	-5%	Base	+ 5%	+ 10%	+ 15%
1	-505000	-505000	-505000	-505000	-505000	-505000	-505000
2	209352	240040	270729	301417	332106	362795	393483
3	171600	196754	221909	247064	272218	297393	322527
4	140656	161274	181893	202511	223130	243748	264366
5	115292	132192	149092	165993	182893	199793	216694
6	94501	108354	122207	136060	149912	163765	177618
Total	226400	333615	440830	548044	655259	762474	869688

Source: own elaboration

From the Table 2 we see that reducing the cost of service of the elevator underestimates the cash flows, the own installation is used less efficiently. Next we will calculate the cash flow fluctuations depending on changes in the cost of repairs. The results are shown in Table 3.

Table 3. Dependence of the net present value (NPV) on changes in the cost of repairs

Years	Change of the factor indicator of repair costs, UAH						
	-15%	-10%	-5%	Base	+ 5%	+ 10%	+ 15%
1	-505000	-505000	-505000	-505000	-505000	-505000	-505000
2	307565	305516	303467	301417	299368	297319	295270
3	252102	250423	248743	247064	245384	243704	242025
4	206641	205265	203888	202511	201134	199758	198381
5	169378	168250	167121	165993	164864	163736	162607
6	138835	137910	136985	136060	135135	134210	133285
Total	569522	565363	555203	548044	540885	533726	526567

Source: own elaboration

Accordingly, we see that the cash flows decrease with increasing the repair costs. We will calculate the impact of the last factor indicator, value of the baled straw, on the net cash flows.

Table 4. Dependence of the net present value (NPV) on the change of value of the baled straw

Years	Change of the factor indicator of costs of baled straw, UAH						
	-15%	-10%	-5%	Base	+ 5%	+ 10%	+ 15%
1	-505000	-505000	-505000	-505000	-505000	-505000	-505000
2	313018	309151	305284	301417	297551	293684	289817
3	256572	253402	250233	247064	243894	240725	237555
4	210305	207707	205109	202511	199913	197315	194717
5	172381	170252	168122	165993	163863	161734	159604
6	141296	139550	137805	136060	134314	132569	130823
Total	588572	575062	561553	548044	534535	521026	507517

Source: own elaboration

Summing up all the above, we shall summarize the sum of cash flows in Table 5, from which we will see, which factor has a greater impact on the productive indicator of the net present value (NPV).

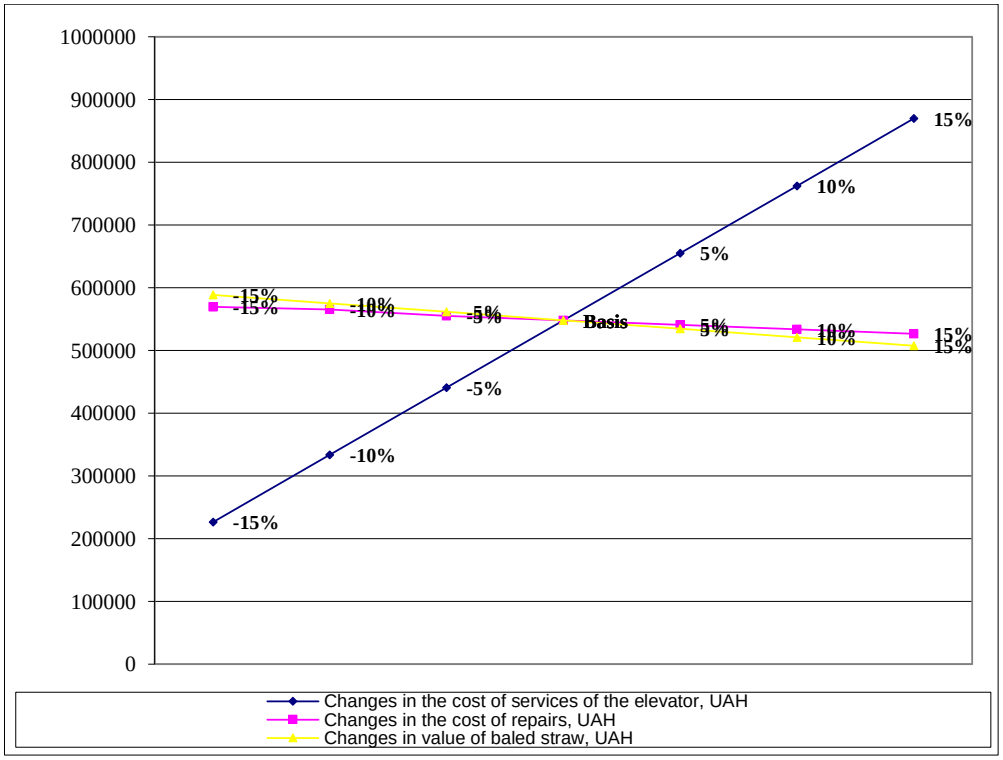
Table 5. Expression of dependence of a productive indicator of net present value (NPV) on the factor indicators

Factor	-15%	-10%	-5%	Base	+ 5%	+ 10%	+ 15%
Changes in the cost of services of the elevator, UAH	226400	333615	440830	548044	655259	762474	869688
Changes in the cost of repairs, UAH	569522	565363	555203	548044	540885	533726	526567
Changes in value of baled straw, UAH	588572	575062	561553	548044	534535	521026	507517

Source: own elaboration

As you can see, all factor indicators have different effects on cash flow. So, how can we determine, which one has the greatest degree of influence and how to insure in the process of the project implementation from potential risks caused by this factor? For this purpose, we will draw a graph of sensitivity of the net present value (NPV) in the following figure. Accordingly, the highest branches are the determining factor that affects the cash flows; the degree of influence is measured by the angle of inclination of the branch of cash flows.

Figure 1. Graph of sensitivity of the net present value (NPV) of the innovative project with using energy saving technologies



Source: own elaboration

Based on the Figure 1, we will note that changes of the cost of services of the elevator and changes in the value of baled straw have the most decisive influence.

Therefore, the company should pay attention to these factor indicators - changes in the cost of services of the elevator, or changing the amount of dried grain per season, repair costs, changes in the value of baled straw. A critical indicator is the change in value of services of the elevator from 40 UAH to 29.77 UAH for drying of 1 ton per 1 percent.

CONCLUDING REMARKS

This investment in energy-saving technologies is advantageous and economically reasonable. All invested capital comes back, the achieved efficiency is higher than alternative, and we get a sufficient profit that enables us to recommend a grain dryer for introduction.

In the process of exploitation of the object supervisors of the investment project should pay the special attention to probable changing of expenses on services of elevator, repair and changes in the cost of the baled straw, which pursuant to the analysis of sensitiveness can greatly influence the size of Net Present Value of the project.

The question of energy security is very aggravated against the background of modern food problem, which is caused by the growth of food consumption, reduction of agricultural land and the increasing number of natural disasters. An alternative way of solving it is the development of bioenergy. The next issue for research is the dialectic of food security and energy production from biomass and it is obvious, but logical contradiction "food versus fuel" can be perceived only partially, as rising of the world prices for most agricultural commodities is largely due to the growth of world population and changing in its food priorities [Perederiy 2013].

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