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POSSIBILITIES OF UTILIZATION OF STRAW FOR ENERGETIC PURPOSES IN THE OPINION OF FARMERS FROM LUBLIN REGION

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Abstract. The goal of the present study was estimation of the scale of straw production in Poland and, particularly, in Lublin region, in order to assess a straw balance and determine its amount possible to assign for energetic purposes. Conducted was a comparative analysis of costs of energy production from straw and other carriers. Identified were opinions of users of straw-fed boiler houses compared to the opinions of users of traditional fuels.

Key words: energy from straw, straw production, costs of energy

INTRODUCTION

A reasonable utilization of renewable sources, as well as shaping and protecting of the environment, became at present one of the most important areas of a general economical policy and of the social-economical development policy.

Theoretically Poland has a great potential of renewable energy sources, exceeding consumption of all fossil fuels. Unfortunately, a full exploitation of that potential is limited by technical, urbanist, demographical and economical possibilities. That's why only its small part may play a practical role [Tymiński 1997].

Straw makes an energetic stuff competitive to traditional fuels. In farming straw is used for many purposes – for feeding animals, for bedding, as an organic fertilizer or isolation material. Despite its numerous applications, in some parts of Poland appear its surplusses, possible for utilization for energy production.

MATERIALS AND METHODS

Tested were 14 users of straw-fed boiler houses, as well as 28 users of boiler houses working on traditional fuels. The evaluation was conducted in 2005 in Lublin region.

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Drawn up was a straw balance in order to estimate straw surplusses possible to apply for energetic purposes. The assessment was performed for Poland in general and for Lublin region in the years 1999–2004.

For evaluation of straw crops used were indicators determining the relation between straw crop and grain crop [Harasim 1994]:

- winter wheat – 0.91,
- winter triticale – 1.13,
- rye – 1.44,
- winter barley – 0,87,
- spring wheat – 0.94,
- spring barley – 0.86,
- oats – 1.08,

Straw crops were computed as a product of grain crops of separate cereal species and indicators listed above. The total straw income was calculated from multiplying its crop by the area of cereal growing.

In order to assess possibilities of straw utilization for energetic purposes, its crops were lessened by its farm consumption. It was assumed, that straw first of all should be used in animal production (for fodder and bedding) and as a fertilizer, to balance the organic matter in soil. Calculations were done according to the following formula (Gradziuk 2003):

$$N = P - (Z_s + Z_p + Z_n)$$

when:
N – straw surplus for alternative utilization,
P – straw production from basic cereals and rape,
Z_s – straw demand for bedding,
Z_p – straw demand for fodder,
Z_n – straw demand for plowing.

The straw demand for fodder and bedding was evaluated on the basis of farm animal population and yearly norms for separate species (Table 1 and formulas by Gradziuk):

$$Z_s = \sum_{i=1}^{n} q_i s_i \qquad \text{i} \qquad Z_p = \sum_{i=1}^{n} q_i p_i$$

when:
Z_s – straw demand for bedding,
Z_p – straw demand for fodder,
q_i – population of a certain animal species or breeding group,
s_i – straw for bedding demand norm for the same species/group,
p_i – straw for fodder demand norm for the same species/group.

In order to identify the factors positively influencing taking a decision about installing a straw-fed boiler house, as well as factors restraining it, the farmers were interviewed.

In co-operation with supporters and opponents of straw-fed boiler houses, the analysis of a force field was conducted. Its graphic model was illustrated in the Figure1.

Table 1. Standards of yearly straw demand for fodder and bedding and of manure production (in tons per year)
Tabela 1. Roczne normy zapotrzebowania na słomę na paszę i ściółkę oraz produkcji obornika (w tonach rocznie)

Specification	Fodders (p_i)	Bedding (s_i)	Manure (o_i) (dry matter)
Cattle:			
cows	1.2	1.0	2.5
others	0.8	0.5	1.5
Pigs:			
sows	–	0.5	0.625
others	–	0.2	0.4
Sheep	0.2	0.2	0.25
Horses	0.8	1.0	2.0

Source: Majewski E., Wojtkiewicz M., Zabrzewska W., 1983: Ćwiczenia z organizacji i ekonomiki gospodarstw rolniczych – zbiór danych liczbowych. Wydawnictwo SGGW-AR, Warszawa. Kozakiewicz J., Nieściór E., 1984: Słoma i sposoby jej użytkowania w gospodarstwach rolniczych. IUNG, Puławy.
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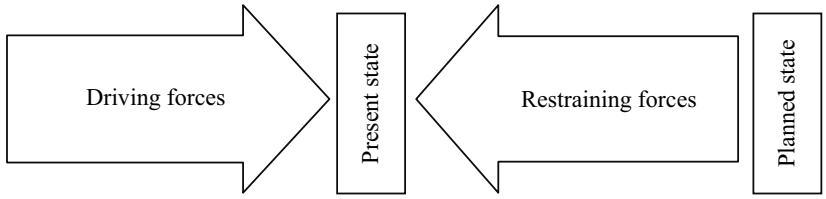

Fig. 1. The model of force field analysis
Rys. 1. Model analizy sił pola
Source: Own study.
Źródło: Badania własne.

In an analysis of a force field every change is defined as a lack of balance between driving forces and restraining forces. Those forces act simultaneously, in opposite directions. The balance is achieved in another point than the desired one. Specified were the following Modelling and Decision Support Tools:

Step 1. Definition of two groups of factors: supporting and restraining changes, what enabled achieving a full image of circumstances accompanying planned actions.

The driving forces were defined, interviewing 14 users of private, straw-fed boiler houses. The restraining forces were identified through investigations among 28 owners of private boiler houses working on traditional fuels, neighboring with owners of straw-fed boiler houses.

Step 2. Ranking the separate forces according to their importance, from 1 to 5 points. The weights of separate factors were defined on the basis of research conducted using questionnaire forms. The lowest point score was assigned to factors influencing the users' decisions to the lowest degree. The highest mark was assigned to those factors, what exerted the highest influence on taking a decision of installing a straw-fed boiler house.

Step 3. Summing up the results weighing in favor or against the planned change.

Step 4. That step was a complementary one, assuming planned actions within the program of changes strengthening the driving forces, whereas weakening the restraining forces.

RESULTS

Straw production is influenced by many factors. The most important from them are the following ones: the area of growing straw-producing plants; the amount of crops; plant species and varieties; fertilizing; weather etc.

In the years 1999–2004 straw crops in Poland exceeded demand for it, resulting from farm production. The average yearly surplus in tested years reached 7697.5 thou. tons. Growing straw surplusses were caused by its decreasing consumption for fodder and bedding, from 16 860 thou. tons in 1999 to 14 729 thou. tons in 2004. That, in turn, was caused by the reducing population of farm animals.

In analysed years observed were also fluctuations in straw crops, what influenced a level of its surplusses. Such fluctuations seem rather disadvantageous, but characteristical for agriculture and resulting from some years with poorer harvest. Such significant fluctuations, occurring every several years, make one of the obstacles restraining non-agricultural straw utilization (Table 2).

Table 2. The balance-sheet of straw utilization in Poland, in the years 1999–2004 (in thou. tons)
Tabela 2. Bilans zużycia słomy w Polsce w latach 1999–2004 (w tys. ton)

Years	Straw production (P)	Straw for bedding (Z_s)	Straw for fodder (Z_p)	Straw for fodder and bedding together (Z)	Straw for plowing (Z_n)	Balance (N)
1999	28 228	10 203	6 657	16 860	2 599	9 085
2000	21 962	9 449	6 165	15 614	3 368	2 981
2001	30 148	9 240	5 866	15 106	3 630	11 862
2002	25 257	9 251	5 521	14 772	3 026	7 714
2003	22 090	9 220	5 506	14 726	2 968	4 850
2004	28 253	9 371	5 358	14 729	4 114	9 693

Source: Own study.
Źródło: Badania własne.

The calculations conducted for Lublin region confirm general tendencies occurring in Poland.

From the balance sheet, elaborated for the Lublin region, results, that an average amount of straw for utilization, in the years 1999–2004, reached about 808 thou. tons yearly. In 2000 those surplusses amounted only 370 thou. tons, whereas in 2003 they were triple higher – reaching 1.2 mln tons (Table 3).

In the Lublin region noted were growing straw surplusses, caused by decreasing demand for fodder and bedding (from 1435 thou. tons to 1067 thou. tons). The least demand for straw to be plowed as an organic fertilizer noted was in 2003 (337 thou. tons), whereas its highest level noted was in 2004 – 649 thou. tons.

Table 3. The balance sheet of straw utilization in in the years 1999–2004 (in thou. tons)
Tabela 3. Bilans zużycia słomy w latach 1999–2004 (w tys. ton)

Years	Lublin region					
	Straw production (P)	Straw for bedding (Z_s)	Straw for fodder (Z_p)	Straw for fodder and bedding together (Z)	Straw for plowing (Z_n)	Balance (N)
1999	2 531	819	617	1 435	456	639
2000	2 342	756	588	1 344	629	369
2001	2 968	758	575	1 332	576	1 059
2002	2 247	716	497	1 213	451	585
2003	2 638	707	485	1 192	337	1 109
2004	2 804	620	447	1 067	649	1 088

Source: Own study.
Źródło: Badania własne.

Assuming the same levels of straw production and surplusses, as it was in the years 1999–2004, in subsequent years foreseen was a significant growth of straw production and its surplusses for energetic utilization (Fig. 2).

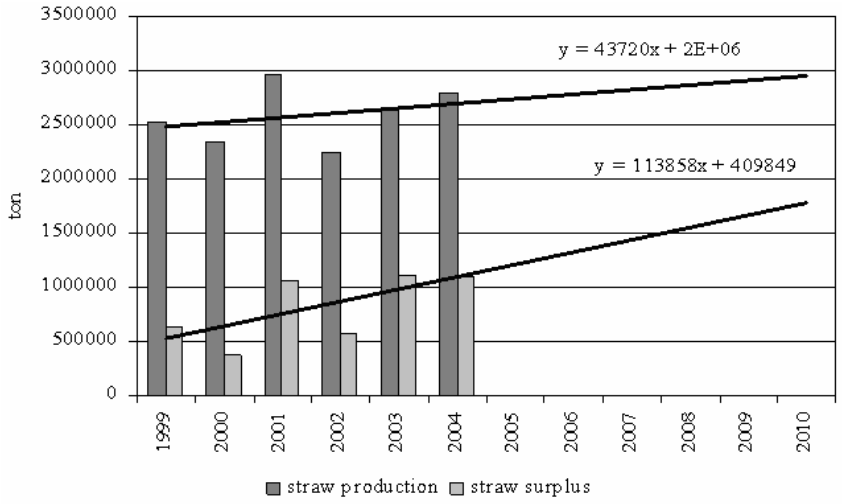

Fig. 2. Production and technical potential of straw for energetic utilization in Lublin region in the years 1999–2010
Rys. 2. Produkcja i potencjalna produkcja słomy na cele energetyczne w regionie lubelskim w latach 1999–2010
Source: Own study.
Źródło: Badania własne.

In the Table 4 shown are calculations of heating of a single-family house with different kinds of fuels. Calculations were done for the unheated building with an area of 100 m^2.

The highest costs were spent for heating with electricity, using the round-the-clock system, whereas the lowest ones appeared by using straw as a fuel.

Table 4. Calculations of costs of heating with different kinds of fuels
Tabela 4. Kalkulacja kosztów ogrzewania różnymi rodzajami paliwa

Fuel	Unit of measure	Calorific value (MJ/kg)	Boiler efficiency (%)	Fuel consumption (kg/kWh)	Unit cost (PLN)	Price of (1 kWh)	Cost of heating of 100 m^2 floor area (PLN) (180 days)
Straw	kg	14	80	0.321	0.1	0.032	444.34
Wood	kg	16.5	80	0.273	0.15	0.041	565.53
Coal	kg	28	70	0.184	0.45	0.083	1 142.60
Fueloil	l	42.7	92	0.092	2.51	0.230	3 179.76
GZ-50	m^3	34.4	92	0.114	1.35	0.154	2 122.87
Propane	l	46	92	0.085	3.00	0.255	3 527.86
Electricity – night rate	kWh	3.6	98	1.020	0.222	0.227	3 068.93
Electricity round-the-clock rate	kWh	3.6	98	1.020	0.373	0.381	5 261.58

*heating cost based on average yearly demand for heat per 1m^2
*koszt ogrzewania oparty jest na średniorocznym zapotrzebowaniu ciepła na 1m^2
Source: Own study.
Źródło: Badania własne.

On the basis of interviewing users of boiler houses for traditional fuels, defined were factors, which, in their opinions, restrained investments in straw-fed boiler houses.

Farmers using private boiler houses using traditional fuels weren't keen on taking up straw technology because of its high investment costs. That factor exerted the greatest influence on their decisions (136 points). Next factors in that ranking, with weights 124 and 122 points, respectively, were: lack of straw surplusses and problems with its loading (Fig. 3).

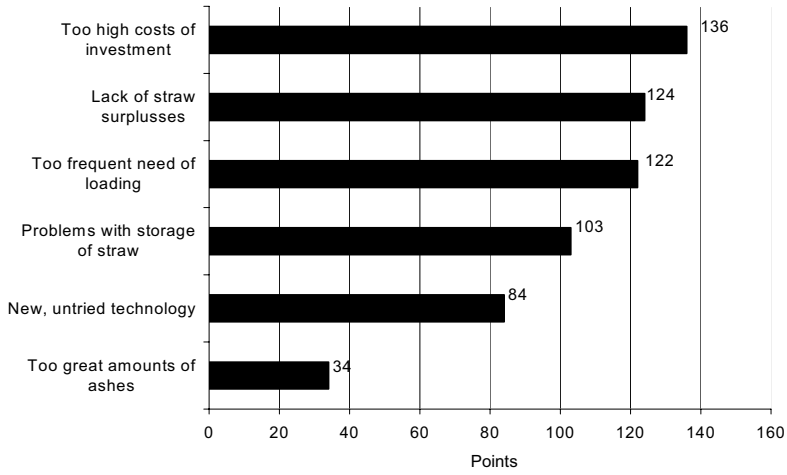

Fig. 3. Factors restraining installation of straw-fed boiler houses
Rys. 3. Czynniki hamujące instalację pieców na słomę
Source: Own study.
Źródło: Badania własne.

Users of straw-fed boiler houses chose that way of heating first of all because of possibilities for utilization of straw surplusses in their farms. The next factor, according to its importance, was easy accessibility of that fuel (61 points) and its low price (54 points) (Fig. 4).

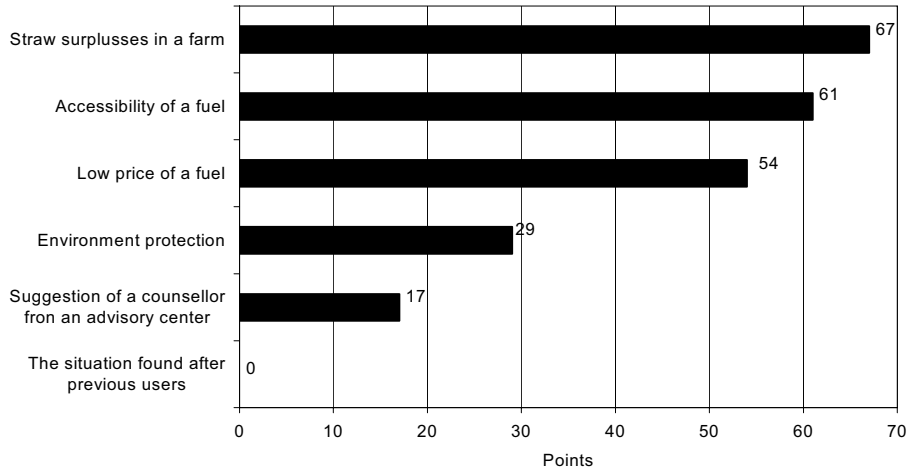

Fig. 4. Factors supporting installation of straw-fed boiler house
Rys. 4. Czynniki przemawiające za instalacją pieców na słomę
Source: Own study.
Źródło: Badania własne.

Factors influencing either positive, or negative decisions, were ranked, assigning them weights according to their importance. Weights were assigned on the basis of point scores, from 1 to 5. 1 meaned the lowest influence on the interviewed user,s decision, whereas 5 – the highest one (Fig. 5).

In general opinions of interviewed persons factors witnessing against energetic utilization of straw prevailed. Such a situation may be changed through improving education activities and possibilities of obtaining financial support for that investment. The conducted research confirmed a strong need for taking up such activities.

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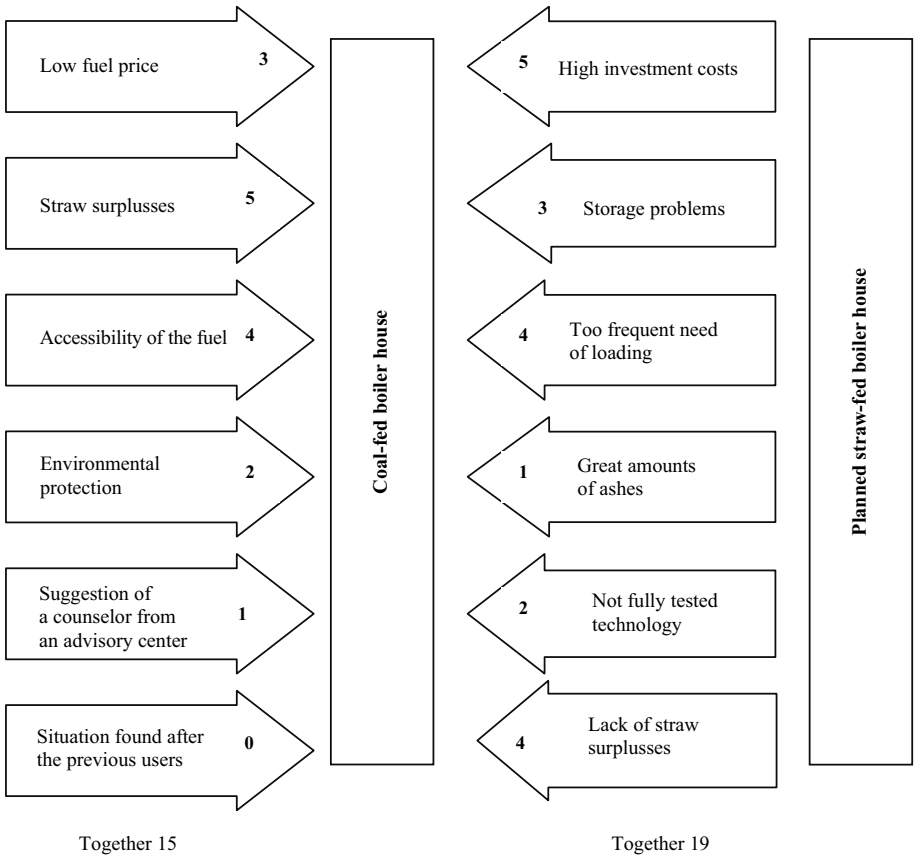

Fig. 5. Analysis of the force field, concerning influence of separate factors on decisions taken by the users

Rys. 5. Analiza siły pola dotycząca wpływu poszczególnych czynników na decyzje podjmowane przez użytkowników

Source: Own study based on interviews carried out.

Źródło: Badania własne.

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MOŻLIWOŚCI PRZEZNACZENIA SŁOMY NA CELE ENERGETYCZNE W OPINII ROLNIKÓW REGIONU LUBELSKIEGO

Streszczenie. Celem artykułu było oszacowanie skali produkcji słomy w Polsce, ze szczególnym uwzględnieniem regionu lubelskiego, w celu ustalenia bilansu słomy oraz ilości, jaka może być przeznaczona na cele energetyczne. Przeprowadzono analizę porównawczą kosztów produkcji energii ze słomy oraz z innych źródeł. Przedstawiono także opinie użytkowników domów z zainstalowanymi piecami na słomę w porównaniu z opiniami osób stosujących tradycyjne rozwiązania energetyczne.

Słowa kluczowe: energia ze słomy, produkcja słomy, koszty energii

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