FARM MACHINERY AND PROCESS MANAGEMENT IN SUSTAINABLE AGRICULTURE

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FARM MACHINERY AND PROCESS MANAGEMENT IN SUSTAINABLE AGRICULTURE

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INTRODUCTION

It is for the 5th time that the International Scientific Symposium on "Farm Machinery and Process Management in sustainable Agriculture" is organized as a forum for international researchers to exchange ideas and experiences on that important aspect of agriculture. Our determined effort in organizing the Symposium is a proof that Sustainable Agriculture is not a fashion or temporary trend.

Agriculture has been changing dramatically. New technologies, mechanization, increased chemical use privileged production maximization. Despite positive aspects of the changes there is a growing concern at the cost of changes. Sustainable Agriculture may be the solution to those changes.

There are many definitions of Sustainable Agriculture but in general it can be described as a method of farming that is not only humane and socially ethical, but can sustain itself. It addresses many environmental and social concerns but at the same time proffers innovative and economically viable opportunities to all in the food production system.

The important aspect of Sustainable Agriculture is its systems perspective, from the individual farm and local ecosystem to communities affected by farming both locally and globally. A systems approach implies interdisciplinary efforts and responsibility of all participants in the system; farm owners and workers, policymakers, researchers, retailers, and consumers.

Multifaceted aspect of Sustainable Agriculture is especially visible in the transition process from more traditional farming. Such transformation requires interdisciplinary coordination among many fields of research and practice. It also requires high effort in education towards all stakeholders of food system. We are convinced that the Symposium will make its own unique contribution to the transition process towards the Sustainable Agriculture.

The Symposium is the result of a successful and rewarding collaboration between the Lublin University of Life Sciences and the Walloon Agricultural Research Centre. The constant support by sponsoring institutions is gratefully acknowledged.

The Organizing Committee

CHANGES IN DISTRIBUTION PATTERNS OF AGGREGATE SIZE DISTRIBUTION AND MEAN WEIGHT DIAMETER IN A CORN FIELD UNDER HEAVY TRAFFIC

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Abstract

The objective of this study was to define and evaluate changes in distribution patterns of aggregate size distribution (ASD) and mean weight diameter (MWD) within a corn field following field traffic. The results indicated that the proportions of soil aggregates smaller that 4 mm significantly decreased and MWD increased from 5.23 mm to 12.46 mm after harvesting. Spatial distribution maps of ASD and MWD showed that the effects of field traffic on ASD and MWD were more effective in the upper 15 cm layer. It was concluded that heavy field traffic produced higher fraction of aggregates larger than 4 mm which are not desirable because of a reduction in soil-root contact area and root penetration.

Keywords: *field traffic, soil compaction, aggregate size distribution, mean weight diameter*

Introduction

Soil compaction is a serious problem in mechanized agriculture and it is one of the most important causes of soil structural degradation. Soil compaction has important consequences on crop production and on the environment. Heavy field traffic causes soil compaction which has negative effects on plant root development and yield by altering soil characteristics such as soil bulk density, aggregate size distribution, mean weight diameter, infiltration, hydraulic conductivity and penetration resistance.

The extent of the soil compaction problem is a function of soil type and water content, and further vehicle weight, speed, ground contact pressure and number of passes, and their interactions with cropping frequency and farming practices [3, 7]. Evaluating the impacts of soil compaction on soil structural parameters has great importance for making effective soil management decisions. While a number of parameters have been used for this purpose, bulk density, total porosity and penetration resistance [1, 2, 4, and 6] are the most commonly used ones. For accurate assessment of changes in soil structure due to compaction, measurements of bulk density and total porosity are not sufficient [5], therefore some other parameter should be considered.

The objective of this study was to define and evaluate changes in distribution patterns of aggregate size distribution (ASD) and mean weight diameter (MWD) within a corn field following harvesting.

Material and methods

The study area, located at the Ataturk University Farmland, covers 1 hectare area (80×125 m) under corn production. Soil in the study area formed on alluvial parent material. The experimental field was divided into 5 transects in the short distance and 6 transects in the long distance. At each intersection of the transects (30 points), a nearly 3 kg soil sample from 0-15cm and 15-30cm soil depths was taken just before and after corn harvesting. Soil samples were air-dried and separated into 10 different aggregate size fractions (<0.25, 0.25-0.5, 0.5-1, 1-2, 2-4, 4-9.5, 9.5-19.1, 19.1-25.4, 25.4-38.1 and 38.1-50.8 mm) and aggregate size distribution (ASD) and mean weight diameter (MWD) were determined. Undisturbed soil samples were also taken from the same places and depths for bulk density determinations.

A New Holland TD 65D marked 2650 kg tractor, a TURKAY T-MSM marked 450 kg slag machine and a trailer with an empty weight of 1500 kg and with a capacity of 3950 kg were used in slaging. But the trailer was loaded about 2350 to 2550 kg cut corn depending on water contents of corn during field operations. Total pressure from a single pass in one direction was about 25.46 kg cm^{-2}.

General properties of the soil in the study area were determined using the standard methods. Distribution maps of ASD and MWD was obtained using the GS+ geostatistical software.

Results and discussion

General properties of the soil in the experimental field were given in Table 1. Soil layers showed significant differences in clay, silt, sand contents, organic matter content (OM), bulk density (BD) and water aggregate stability (WAS).

The t-test results indicated that changes in bulk density and water stable aggregates following field traffic due to harvesting was statistically very significant at $p<0.01$. While the bulk density of 0-15 cm soil layer before harvesting was on the average 1.17 g cm^{-3}, it increased to 1.34 g cm^{-3} with an increasing rate of about 15%. Similarly, the bulk density of 15-30 cm soil layer increased from 1.34 g cm^{-3} to 1.43 g cm^{-3} by harvesting. However, the increasing rate (6.7%) in bulk density value for the deeper soil depth was much lower. On the other hand, the WAS percentage of soil significantly decreased with compaction. For the surface soil layer, the percentage of water stable aggregates decreased from 60.5% to 44.3% with a decreasing rate of 26.6% following compaction. Similarly, it decreased from 50.4% to 41.9 % for the 15-30 cm soil layer. The differences in WAS values before and after harvesting was statistically significant for both soil layers, but the effect of soil compaction on WAS was more pronounced in the top soil layer.

Table 1. General properties of the soil in the experimental field.

Soil property		0-15 cm			15-30 cm		
		Min.	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**
Clay, %		15.7	17.8	17.1B	19.8	19.9	19.9A
Silt, %		40.7	40.9	40.8A	30.7	34.6	32.6B
Sand, %		41.5	43.4	42.1B	45.5	49.5	47.5A
OM, %		1.08	1.50	1.27A	0.38	0.64	0.52B
BD, g cm^{-3}	Before	1.07	1.38	1.17Bb	1.18	1.46	1.34Ab
	After	1.16	1.45	1.34Ba	1.30	1.53	1.43Aa
WAS, %	Before	43.0	78.1	60.5Aa	34.9	69.9	50.4Ba
	After	23.1	56.0	44.3Ab	30.2	54.7	41.9Bb

A, B: mean comparisons between soil layers ($p<0.01$)
a, b: mean comparisons before and after harvesting ($p<0.01$)

The results indicated that soil aggregate size fractions were significantly altered with field traffic due to harvesting. Before harvesting, the amounts of soil aggregates was the highest (19.6%) for 1-2 mm size fraction and the lowest (3.5 %) for 25.4-38.1 mm and no aggregates with a size greater than 38.1 mm was obtained for the 0-15 cm soil layer (Figure 1a). However, the amounts of soil aggregates was the highest (16.9%) for 9.5-19.1 mm size fraction and the lowest (5.2%) for <0.25 mm following harvesting. The amount of aggregate fractions in <0.25, 0.25-0.5, 0.5-1, 1-2 and 2-4 mm size groups decreased with the rates of 126, 109, 83, 48 and 13%, but it increased in 4-9.5, 9.5-19.1, 19.1-25.4 and 25.4-38.1 mm aggregate size fraction with the rates of 1.5, 38, 60 and 69.% following harvesting. Moreover, about 6% of aggregates were in the 38.1-50.8 mm size fraction which was not found in soil before harvesting. The amount of aggregates with a size of greater than 4 mm also significantly increased following harvesting. These results indicated that clod formation occurred during compaction. Similar results were also obtained for 15-30 cm soil layer.

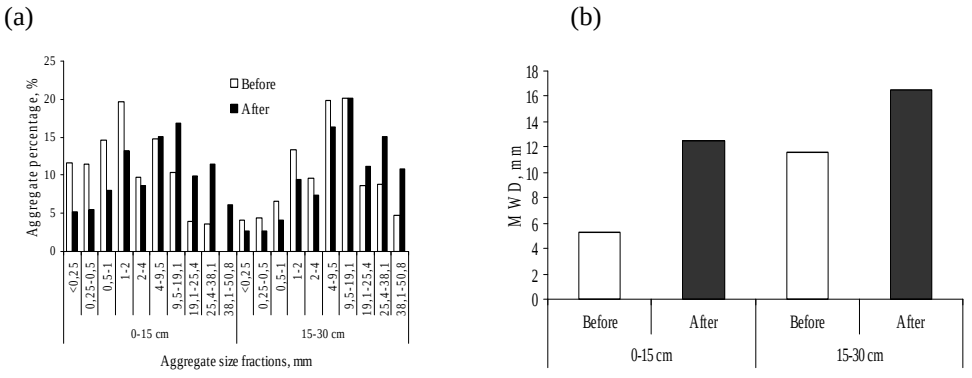

Figure 1. Changes in aggregate size fraction (a) and mean weigh diameter (b).

Since soil compaction caused clod formation which lead to increase the amounts of soil aggregates greater than 4 mm, the MWD of soil following harvesting significantly increased (Figure 1b). While the MWD was on the average 5.23 mm before harvesting, it increased up to 12.46 mm after heavy field traffic in the 0-15 cm soil depth. Similar results were also obtained for 15-30 cm soil layer. Spatial distribution patterns of MWD before and after field traffic are given in Figure 2. The highest values are located in the north side of the research side in where additional compaction was occurred because of trailer operations for slaging.

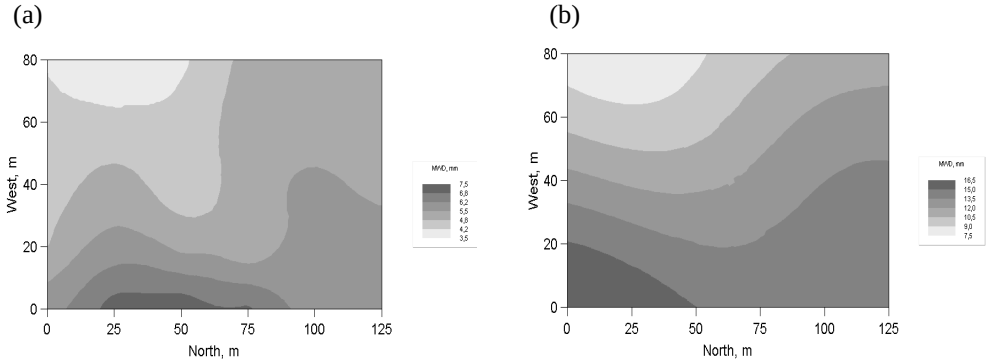

Figure 2. Distribution patterns of MWD before (a) and after (b) field traffic.

Conclusion

Results of this study clearly indicated that heavy field altered soil aggregate size fractions and increased MWD because of clod formation.The effect of soil compaction on ASD and MWD and was more pronounced in the top soil layer. Heavy field traffic produced higher fraction of aggregates larger than 4 mm which are not desirable because of a reduction in soil-root contact area and root penetration.

References

[1] Aksakal, E.L., Oztas, T., 2010. Changes in distribution patterns of soil penetration resistance within a silage-corn field following the use of heavy harvesting equipments. Turk J. Agric. For., 34: 173-179.

[2] Boone, F.R., 1988. Weather and other environmental factors influencing crop responses to tillage and traffic. Soil Till. Res., 11 (3/4): 283–358.

[3] Chan, K.Y., Oates, A., Swan, A.D., Hayes, R.C., Dear, B.S., Peoples, M.B., 2006. Agronomic consequences of tractor wheel compaction on a clay soil. Soil Tillage Research, 89: 13–21.

[4] da Silva, A.P., Kay, B.D., Perfect, E., 1994. Characterization of the least limiting water range of soils. Soil Sci. Soc. Am. J., 58 (6): 1775-1781.

[5] Dexter, A.R., 1997. Physical properties of tilled soils. Soil Till. Res., 43 (1-2): 41-63.

[6] Pagliai, M., 1998. Soil porosity aspects. Int. Agrophys., 4: 215–232.

[7] Radford, B.J., Yule, D.F., McGarry, D., Playford, C., 2007. Amelioration of soil compaction can take 5 years on a vertisol under no till in the semi-arid subtropics. Soil Tillage Research, 97: 249–255.

APPLICATION OF SOME HERBICIDES IN WEED CONTROL OF MAIZE (*Zea mays* L.) AND THEIR ENVIRONMENTAL RISK

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Abstract

The application of herbicides in weed control is related with an environmental risk. Some soil-applied herbicides in weed control of maize are evaluated for three pedo-floristic situations in Albania in order to find the treatment with low environmental risk.

The selected herbicides: pendimethalin, metolachlor, alachlor, terbuthylazine and rimsulfuron were chosen for the main types of weed flora in maize under these conditions.

The evaluation of the environmental risk was based on a "Ground Water Danger Index" (GWDI), which was calculated as the proportion of the active ingredient applied which leaches downwards. The fraction of the active ingredient which can leach was estimated with Groundwater Ubiquity Score (GUS) and Attenuation Factor (AF).

The lower values of GWDI using AF index occurred in the case of the treatment with pendimethalin, terbuthylazine in clay and loamy soil as well as in the treatment with rimsulfuron in sandy soil, whereas the higher values occurred for the treatment with alachlor in three soils.

As the result, under these conditions the treatment with alachlor in weed control of maize has a high environmental risk, while the treatments with pendimethalin, terbuthylazine and rimsulfuron have lower environmental risk for the groundwater contamination.

Therefore, the choice of the herbicide should be made from among these herbicides or others, depending on their efficiency and environmental aspects.

Keywords: herbicide, weed, environmental risk, groundwater, Zea mays (L.)

1. Introduction

Many herbicides are in use for weed controls of maize, some of them are registered and used in Albania. In agricultural practices, one or mixture of two or more herbicides can be applied in sequence in different times during crop cycle. The reduction of the using cost and the improvement of performance are required. Actually, the choice of treatments in weed control of maize is usually based on the efficiency and the environmental risk.

Different models were proposed to estimate the reduction of yield caused by the presence of weeds and to recommend the treatments for weed control [1, 2, 6], and also to predict the potential pollution of herbicides.

The objective of this study was the evaluation of the potential risk of groundwater contamination from some soil with herbicides applied in weed control of maize in order to find the treatment with low environmental risk for groundwater contamination.

2. Materıals and methods

2.1. The pedo-climatic conditions

The soils, which we referred, are situated in the west part of Albania as the most important area of soil cultivated with maize. In this study three different soils by texture are selected: 1 - clay soil, 2 - loamy soil and 3 - sandy soil; this choice was based on influence of soil texture in the fate of herbicides in soil.

2.2. The herbicides

Between many soil-applied herbicides that are recommended in weed control of maize five were selected. The active ingredient (a.i.), dosages (rate of application) and the price of the considered herbicides for the different weed control of maize are given in Table 1.

Table 1. The herbicides: price ($/l or $/kg) and dosages (a.i.) (g/ha) according to the soil.

Trade name	The active ingredient (a.i.) %	The price ($/l or $/kg)	Dosage (g/ha)		
			Clay soil	Loamy soil	Sandy soil
Stomp 330E	Pendimethalin, 31.7	20	900	900	800
Dual Vegoil	Metolachlor, 68	25	1900	1900	1900
Lasso	Alachlor, 41.5	10	1600	1600	1600
Click FL	Terbuthylazine, 37	12	900	750	750
Titus	Rimsulfuron, 25	1000	15	15	15

2.3. Quantification of the risk to groundwater from herbicides

A danger index was calculated for groundwater, considered as water source for human drinking. The toxicity of herbicides is expressed on the basis of the guidelines (Gl) [5], for the water destined for human consumption. The "GroundWater Danger Index" (GWDI), therefore was esteemed by the equation, as follows:

$$GWDI = L*R / Gl$$

where, L is the fraction of active ingredient (a.i.) which leaches down to the water table, R is the rate of application for the used a.i. and Gl is the guidelines.

Different approaches can be used to calculate the amount of herbicide (L) which reaches the groundwater. In this study two approaches of different complexity were used: an index of leach ability - Groundwater Ubiquity Score -GUS- proposed by Gustafson [3] and an empirical model - Attenuation Factor-AF [4]. These approaches allow the quantification of the amount of herbicide, that reaches a given soil depth and the soil is considered as homogeneous till to depth of water table.

3. Results and dıscussıon

The calculated values of AF and GUS for every soil are presented in Table 2, and these are used to calculate the Groundwater Danger Index (GWDI) as potential environmental risk index.

Table 2. AF and GUS calculated according to the soil.

Herbicide	GUS (clay, loamy & sandy soil)	AF (clay soil)	AF (loamy soil)	AF (sandy soil)
Pendimethalin	0.60	0.0059	0.0168	0.0857
Metholaclor	3.32	0.8073	0.8428	0.9005
Alachlor	2.08	0.3323	0.4144	0.5815
Terbuthylazine	2.81	0.6517	0.7102	08110
Rimsulfuron	3.42	0.7669	0.7958	0.8148

As the result, by using AF and GUS index was estimated the GWDI as risk index of groundwater pollution by herbicides. The calculated values of GWDI as an environmental risk index are presented in Table 3.

Table 3. The values of GWDI index according to the soil

Herbicides	$GWDI_{GUS}$ (clay, loamy & sandy soil)	$GWDI_{AF}$ (clay soil)	$GWDI_{AF}$ (loamy soil)	$GWDI_{AF}$ (sandy soil)
Pendimethalin	0.10	0.0032	0.009	0.04
Metolachlor	23.34	3.067	3.203	3.42
Alachlor	86.08	17.72	22.1	31.01
Terbuthylazine	2.69	0.488	0.444	0.507
Rimsulfuron	0.17	0.019	0.019	0.02

The calculated values of GWDI in all soils by using GUS index range from 0.10 for pendimethalin to 86.08 for alachlor.

The lower calculated value of GWDI by using AF index was in the treatment with pendimethalin on clay and loamy soil and in the treatment with rimsulfuron on sandy soil, while the higher values were resulted in the treatment with alachlor on three soils.

The results demonstrated that was discordance between the herbicides with high potential to contaminate the groundwater expressed by the values of AF and GUS index and the herbicides with high environmental risk expressed by the value of GWDI index. These results can be explained as the value of GWDI index depends on the potential of the herbicides to contaminate the groundwater (L), the rate of application (R) and the guideline (Gl) which were quite different among the herbicides.

In this context, the treatment with alachlor has low potential to contaminate the groundwater but it has high environmental risk because the guideline of alachlor is very low 0.3 µg/l, while the treatment with rimsulfuron has high

potential to contaminate the groundwater but it has low environmental risk as the rate of application for rimsulfuron is very low 15g/ha (a.i.).

4. Conclusıons

Under these conditions of west part of Albania, the optimal treatments in weed control of maize are with pendimethalin, rimsulfuron and terbuthylazine and they should be the main herbicide for this purpose, while the treatments with alachlor and metolachlor must be limited because they present high environmental risk.

5. References

[1] Cussans G. W., Rolph J. 1990. HERBMAST- a herbicide selection system for winter wheat. *EWRS Symposium Integrated Weed Management in Cereals*, Helsinki, 4-6 June 1990, 451-457.
[2] Forcella F. *et al*., 1993. Field evaluation of a bioeconomic weed management model for the corn belt, *USA. 8th EWRS Symposium "Quantitative approaches in weed and herbicide research and their practical application"*, Braunschweig, 755-760.
[3] Gustafson D. L., 1989. Groundwater Ubiquity Score: a simple method for assessing pesticide leachability. *Environ. Toxic. Chem*., 8, 339-357.
[4] Rao P. S. C. *et al*., 1985. Indices for Ranking the Potential for the Pesticide Contamination of Groundwater. *Proceedings Soil Group Science Society*, 44, 1-8.
[5] WHO, 1984. Guidelines for drinking water quality. Vol.1, Geneva: World Health Organization.
[6] Wilkerson G. G. *et al*., 1991. HERB: decision model for post-emergence weed control in soybean. *Agron. J*., 83, 413-417.

ASSESSING THE CAPACITY OF SUGAR BEET FARMS' MACHINERY AND EQUIPMENT

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Keywords: sugar beet, production system, decision support software

Introduction

In spite of 27% reduction of sugar production enforced by sugar market regulations, and decrease in sugar beet cultivation area by 23% [Bzowska, Ostroga 2010, Ostroga 2010], Lublin Region stays the Poland's third biggest producer of both sugar beet and sugar [Turski R., Uziak S., Zawadzki S. 2007]. As the crop is important for the economy of this rural region, the authors undertook a survey on local sugar beet farms' machinery and equipment to assess the potential of improving the production capacity.

The survey concerned the farms and sugar beet plantation size, condition of the equipment, cultivation methods, and output. Apart from machinery and equipment dedicated solely to sugar beet growing, tractors and trailers were also considered. The age of the machines was established and the scale of new purchases determined.

Methods

Data was collected by means of questionnaires filled by the farmers [Stachak 2006]. Respondents were selected purposefully, with help of sugar factories supply departments, according to the quality of crops. Geographically, the distribution of the farms picked for the survey was similar to the distribution of sugar beet plantations in the region (e.g., the biggest sugar beet acreage is located in Hrubieszów county, and most surveyed farms were located there – Fig. 1). Checking whether the farms growing methods were appropriate and state-of-the-art was done on the basis of the available research on the subject [Bzowska-Bakalarz, Bieganowski 2008, Nowakowski 2003, Przybył 2006, Przybył i in. 2004, Šařec i in. 2009, Szeptycki 2005, Zimny 2007].

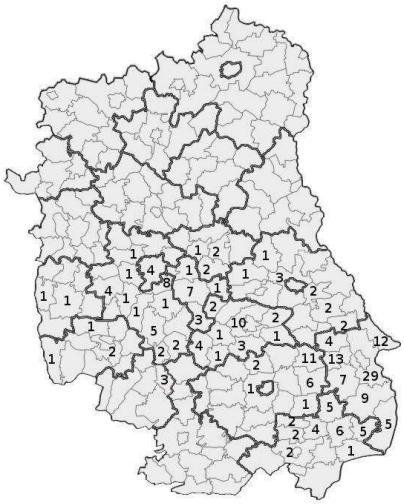

Figure 1. Location of farms selected for the survey (map courtesy of *www.wikipedia.pl*)

Results

A trend to increase the plantation size provides opportunity to introduce innovation to growing methods. However, considering the scale of investment in new machinery and equipment recorded during three years of analysis, the opportunity was not exploited: the farmers, especially those operating in small and medium-sized scale, did not tend to buy new machines.

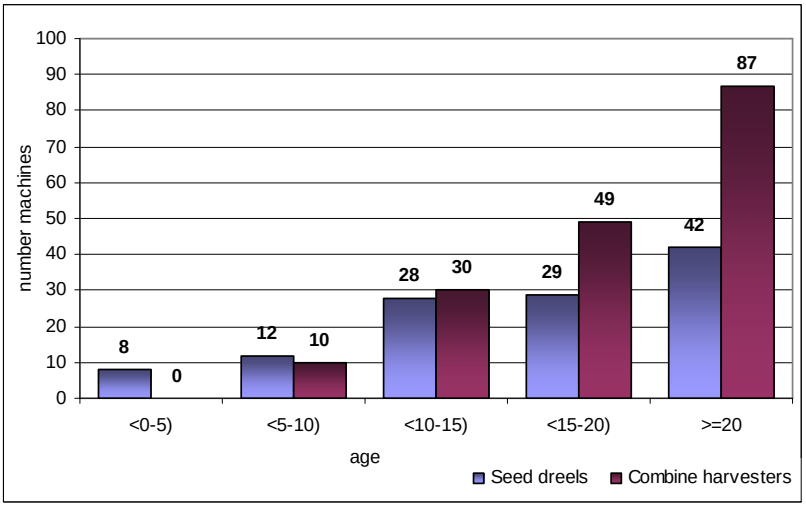

Figure 2. The age of seed drills and sugar beet combine according to the survey

For instance, 60% of seed drills and 42% of sugar beet combine harvesters used by the surveyed farmers were in operation for no less than 20 years. The age structure of other machines also proved unsatisfactory. This indicated a need for investment, switching to some forms of shared use, or services.

Discussion

A seeming self-sufficiency of sugar beet farms in terms of machinery and equipment results from their relying on old and obsolete apparatus – the basis of traditional farming methods. Many farmers depend on support from their neighbors – this may be the basis for creating producer groups.

References

[1] Bzowska – Bakalarz M., Bieganowski A. (red.). 2008. *Kodeks dobrych praktyk w produkcji buraków cukrowych*. Wyd. Instytutu Agrofizyki im. Bohdana Dobrzańskiego PAN, Lublin. ISBN 978-83-89969-11-8
[2] Bzowska-Bakalarz M., Ostroga K. 2010. *Assessment of chances for keeping sugar beet production in Lubelskie Voivodeship.* Inżynieria Rolnicza 6 (124). 5 -11.
[3] IUNG. 2004. *Program zrównoważonego rozwoju rolnictwa i obszarów wiejskich województwa lubelskiego. Tom 1, Diagnoza i prognoza rozwoju*, opracowanie na zlecenie Urzędu Marszałkowskiego Województwa Lubelskiego, Lublin. Typescript.
[4] Littell R. C., Stroup W. W., Freund R.J. 2009. *SAS for linear models*. John Wiley & Sond, Inc. ISBN 0-471-22174-0.
[5] Ostroga K. 2010. *Techniczne i technologiczne uwarunkowania produkcji buraków cukrowych na tle aktualnej organizacji rynku rolnego*. PhD thesis. Uniwersytet Przyrodniczy Lublin. Typesricpt.
[6] Przybył. J., Sęk T., Kowalik I., Dach J. 2004. *Integrowana uprawa buraka cukrowego.* Journal of Research and Applications in Agricultural Engineering. Vol.49 (1). 16- 21
[7] Stachak S. 2006. *Podstawy metodologii nauk ekonomicznych*. Wyd. Książka i Wiedza, Warszawa. ISBN 83-05-13437-7
[8] Šařec P., Šařec O., Srb K., Dobek T. 2009. *Analiza produkcji buraka cukrowego w zależności od różnych technologii przygotowania roli*. Inżynieria Rolnicza. Nr (1). s. 273-280.
[9] Szeptycki A. 2005. *Ocena efektywności modernizacji technologii w produkcji roślinnej na przykładzie zbioru buraków cukrowych*. Inżynieria Rolnicza Nr (7). 323-330.
[10] Turski R., Uziak S., Zawadzki S. 2007. *Środowisko przyrodnicze Lubelszczyzny, Gleby*. Wyd. Lubelskie Towarzystwo Naukowe.
[11] Zimny L. 2007. *Uprawa konserwująca buraka cukrowego*. Gazeta Cukrownicza, nr 2. 55-58.

AUGMENTED REALITY IN AGRICULTURE

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Keywords: augmented reality, agricultural engineering

Abstract

Augmented reality (AR) is a system combines the real world with world generated by the computer. It usually uses the image from the camera with generated in real-time 3D superimposed graphics. User of AR can observe objects on the screen shot camera as well as computer- elements generated imposed on the real world.
AR elements appear more frequently in the real world, and are now available for normal user. Examples are mobile phones, in which there are applications that "enriching" the actual image of the built-in camera with additional elements, such as information about objects in the vicinity. Another application is systems to facilitate parking and car steering.

Agriculture is an area where advanced technology is always introduced with a delay. Currently, it appears that new techniques and technologies appear in it very quickly. Probably, also augmented reality will soon become popular, especially since there are many areas in which its implementation might be advisable. The condition is however a reduction in the cost of this technology so its use would be cost effective. Certain elements of the AR in agriculture are already present, but many opportunities to use these techniques in the future can be predicted. Below are given few examples of possibility of applications of this technology in agriculture.

1. The research areas - due to the financial capabilities the probability of placing AR in the research centers is much greater. In many cases, the technique of "enrichment" of an image for further elements are already used to varying degrees (but are not often referred to as AR). For existing objects on the screen are added dimension lines, descriptions, coordinate systems and other virtual objects to help investigate and analyze the shot areas.
2. Another place where the AR probably will visit in the near future is the cabin of modern tractors and mobile machinery. Some components of this system already exist and are used in the form of simple displays that show the use of GPS, the conduct of the tractor or machine. Adding the large display or special glasses, where on the image fields will be imposed lines drawn by the computer which are showing the way for passage or plot

boundaries, is a logical development of existing solutions. Analogous solutions exist in military technology, but are still very expensive.

3. The solutions, which can be introduced into animal production, is a system of farm monitoring, cowshed or piggery. Use of suitable software may allow determining individual “pieces” on the screen, with simultaneous administration of the relevant information about them. The following can be shown; the data registration, information on the health status, etc.
4. In crop production it is possible to identify plants with a camera and appropriate software. This gives the ability to detect pests and to plan appropriate protective procedures.

The presented examples show some possible solutions offered by the application of augmented reality in agriculture. Of course, places where this technology can be applied are much more. Probably in the near future, with the development of technology and falling prices of equipment, these solutions will increasingly appear in farms. They will become an indispensable part of precision farming. It can be assumed that the carrier of the new technology will be smartphones, with built-in camera, screen and powerful processor, with advanced software.

MICRORATES OF HERBICIDES IN CHEMICAL PROTECTION SYSTEMS OF SUGAR BEET AS ELEMENT OF SUSTAINABLE AGRICULTURE

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Key words: sugar beet, herbicides, microrates, weed control

Introduction

Significant changes took place in the protection of sugar beet against weeds in the last thirty years (Wilson 1994; Paradowski and Adamczewski 2002). The main change was from one treatment of high dose of herbicide to chemical protection systems with 3-4 times using microrates of herbicides (Dexter 1994; Woźnica et al. 2004; Domaradzki 2007). These activities correspond with principles of sustainable agriculture. According to them pesticides must be used only when it is essential and in as low doses as possible (Jensen 2004).

The aim of conducted investigations was the assessment of effectiveness of microrates of herbicides in chemical protection systems of sugar beet as element of sustainable agriculture.

Methods

The field trials were conducted in the years 2007–2009. They were conducted with the use of method of random blocks, in four replications, on fields of 25 m^2. All the experiments were located in farmers' fields, on black soils of class II. In the research 4 herbicides were used, applied separately and in mixtures. Examined herbicide mixtures always contained herbicides Betanal Progress 274 OF and Safari 50 WG and adiuvant Atpolan 80 EC, supplemented with Goltix 70 WP or Flirt 460 SC and were applied 4 times. The components of mixtures in two reduced doses (by 50% and 67%) were used. As a standard the herbicide Betanal Progress 274 OF 3 was applied 4 times in full recommended dose (1 $l \cdot ha^{-1}$). The characteristics of tested herbicides, i.e. the content of the active substances and the doses, are presented in Table 1. The application was performed with the use of backpack sprayer Gloria with a spraying pressure of 0.25 MPa and a volume per hectare of 250 $l \cdot ha^{-1}$.

The efficiency of the tested herbicide mixtures was assessed 3 weeks after the last application.

The trials were harvested by hand at the growth stage of technical maturity.

Results

The conducted trials indicated that the weed control efficacy of investigated herbicide mixtures depended on the dose and type of the components. Better results were obtained using the highest doses of herbicides. Among tested systems the best weed control effect was obtained after application the mixtures Betanal Progress 274 OF + Flirt 460 SC + Safari 50 WG + Atpolan 80 EC; in doses reduced by 50% characterized average weed control was 92%. This combination very effectively (87-97%) controled *Amaranthus retroflexus*, *Polygonum persicaria*, *Galium aparine*, *Brassica napus* and *Anthemis arvensis.* Only *Chenopodium album* and *Polygonum convolvulus* were medium sensitive and its control ranged from 80 to 81%. Application of herbicides in reduced doses, to 33% of recommended, in classic systems caused decrease of average efficacy to 83%. The worse weed control effect was observed in relation to *Chenopodium album, Polygonum convolvulus* and *Brassica napus*.

Average weed control of up to 91% was observed for the system based on 4 times application of the mixture Betanal Progress 274 OF + Goltix 700 SC + Safari 50 WG + Atpolan 80 EC of 50% at dose recommended in classic systems.. This mixture applied 4 times effectively (in 87-94%) controled *Amaranthus retroflexus*, *Polygonum persicaria*, *Galium aparine*, *Brassica napus* and *Anthemis arvensis.* Medium sensitive (82-83% efficacy) were *Chenopodium album* and *Polygonum convolvulus.* Reduction of herbicide doses in this chemical protection system (to 33% of full doses) caused decrease average weed control efficacy to 81%. The worst controled were *Chenopodium album, Amaranthus retroflexus, Polygonum convolvulus* and *Brassica napus.* This weed species were destroied on the level of 61-84%.

The average weed control effectivenes of standard systems (Betanal Progress 274 OF applied three or four times) was lower and amounted to 83-87%.

The yield obtained from the untreated control was significantly lower compared to yields from treated plots. All tested weeding systems based on mixtures (3 herbicides + adiuvant) gave the increase of yield in comparison to standard systems (Betanal Progress 274 OF applied three or four times). The yield of sugar beet roots from plots treated with examined herbicides oscillated on the level of 52.05-63.26 $t \cdot ha^{-1}$. In the case of untreated plots it was 26.95 $t \cdot ha^{-1}$. The upmost level of yielding (62.77-63.26 $t \cdot ha^{-1}$) insured application mixtures Betanal Progress 274 OF + Goltix 700 SC + Safari 50 WG + Atpolan 80 EC and Betanal Progress 274 OF + Flirt 460 SC + Safari 50 WG + Atpolan 80 EC used at the dose reduced to 50% of recommended in classic systems. Despite some differences, the yield of sugar beet roots not differed significantly between the herbicide treatments.

Table 1. Characteristics of investigated herbicides.

Herbicide	Active substance (a.s.)	Content of a.s.	Base dose in treatment systems	Investigated doses
Betanal Progress 274 OF	phenmedipham + desmedipham + ethofumesate	91 $g \cdot l^{-1}$ + 71 $g \cdot l^{-1}$ + 112 $g \cdot l^{-1}$	1 $l \cdot ha^{-1}$	100%, 50%, 33%
Flirt 460 SC	chloridazon + quinmerac	418 $g \cdot l^{-1}$ + 42 $g \cdot l^{-1}$	2 $l \cdot ha^{-1}$	50%, 33%
Goltix 700 SC	metamitron	700 $g \cdot l^{-1}$	1 $l \cdot ha^{-1}$	50%, 33%
Safari 50 WG	triflusulfuron-methyl	50%	30 $g \cdot ha^{-1}$	50%, 33%
Atpolan 80 EC*	paraffin oil	76%	1.5 $l \cdot ha^{-1}$	100%

* – adiuwant – adjuwant

Table 2. Weed control efficacy of microrate herbicide systems and its influence on yield of sugar beet root.

Herbicide system	Number of treatments	Dose of components	Yield of roots [$t \cdot ha^{-1}$]	Weed control [%]							
				average	in it dominant species						
					CHEAL	AMARE	POLPE	GALAP	POLCO	BRSNX	ANTAR
Untreated object	–	–	26.95	–	–	–	–	–	–	–	–
Betanal Progress 274 OF + Goltix 700 SC + Safari 50 WG + Atpolan 80 EC	4	50%	63.26	91	79	92	94	93	83	82	93
	4	33%	55.66	81	61	84	92	92	77	73	94
Betanal Progress 274 OF + Flirt 460 SC + Safari 50 WG + Atpolan 80 EC	4	50%	62.77	92	80	94	97	95	81	87	97
	4	33%	60.19	85	68	93	94	96	72	79	87
Betanal Progress 274 OF	4	100%	59.81	87	87	90	78	90	91	100	88
Betanal Progress 274 OF	3	100%	52.05	83	77	86	57	89	91	98	83
		LSD (0.05)	11.761								

ECHCG – *Echinochloa crus-galli*, GALAP – *Galium aparine*, CHEAL – *Chenopodium album*, POLCO – *Polygonum convolvulus*, AMARE – *Amaranthus retroflexus*, BRSNX – volunteer *Brassica napus*, POLPE – *Polygonum persicaria*, ANTAR – *Anthemis arvensis*

Discussion

The conducted trials indicated the possibility of optimization of herbicide application in the sugar beet protection system by using mixtures of appropriate components in microrates. The applied herbicide mixtures

showed high efficacy in weed control and the activity of herbicides was depended on the dose of mixture components. The best effect was obtained using the herbicides in doses reduced to 50% of recommended in classic systems. All tested weeding system based on mixtures gave the increase of yield in comparison to standard systems.

The first trials concerning microrates efficacy in sugar beet were conducted in USA. Their results proved a high efficacy of herbicides used in the doses reduced from 50% to 60%, without the significant decrease of weed control efficacy and sugar beet yielding [Dexter 1994, Wilson 1994]. A similar effect was observed in the first trials carried out in soil and climatic conditions of Poland by Woźnica et al. (2004). Authors attained success applying herbicides in the doses lowered by 50-60%. It was confirmed in another trials carried out in Poland [Domaradzki 2007, Krawczyk et al. 2007].

Summing up, it may be stated that herbicides applied in appreciable lowered doses in chemical protection systems of sugar beet allowed to reduce weed infestation effectively. The microrates of herbicides also put less pressure on environment. These activities are corresponding with assumption of sustainable agriculture [Jensen 2004].

References

[1] Dexter A.G. 1994. History of sugar beet (Beta vulgaris) herbicide rate reduction in North Dakota and Minnesota. Weed Technol. 8: 334–337.
[2] Domaradzki K. 2007. Optymalizacja stosowania herbicydów w systemach chemicznej ochrony buraka cukrowego. Progr. Plant Protection/Post. Ochr. Roślin 47, (3): 64-73.
[3] Jensen J.E. 2004. Weed control: presence and future – the Danish view. J. of Plant Diseases and Protection, Sp. Issue XIX: 19-26.
[4] Krawczyk R., Adamczewski K., Głowacki G. 2007. Wpływ mikrodawek herbicydów na zachwaszczenie i plon buraka cukrowego. Progr. Plant Protection/Post. Ochr. Roślin 47 (3): 159–163.
[5] Paradowski A., Adamczewski K. 2002. Ocena wpływu zmiany technologii odchwaszczania buraka cukrowego na przestrzeni 15 lat. Biul. IHAR 222: 271–277.
[6] Wilson R.G. 1994. New herbicides for postemergence application in sugar beet (*Beta vulgaris*). Weed Technol. 8: 807–811.
[7] Woźnica Z., Adamczewski K., Szeleźniak E. 2004. Stosowanie mikrodawek herbicydów w uprawie buraka cukrowego. Progr. Plant Protection/Post. Ochr. Roślin 44(1): 523–5.

CONTEMPORARY CHALLENGES FOR THE QUALITY OF EDUCATION IN THE FIELD OF AGRICULTURAL ENGINEERING AT UNIVERSITIES

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Key words: quality, quality education, quality management, agricultural engineering

Abstract

The quality of education at universities is an important element in the functioning of higher education. This is due to the constant development of higher education. The changes put before the university authorities, new challenges, include the need for a professional approach to the management of universities. The main problem is the selection of university management strategies, effective resource management, quality assurance system and quality of education.

How many scientific disciplines and education as the field of agricultural engineering feel of a world-wide problems; the most important is the ability to remain competitive. This seems particularly important, since the creation of the European educational space, whose distinguishing characteristic is to provide quality education. Over the past 10-15 years in many countries we are witnessing a decline in the number of engineers and, consequently, lowering the prestige of the engineering profession [1].

There are various definitions of quality, formulated by leading representatives of school management. And so, in the opinion of Peter Drucker [2], "the quality of the product or service is not what the manufacturer put into it, but it is what one customer has and what it is willing to pay". Definition of the American Society of Quality Control [3] is: "Quality is the totality of features product or service, deciding on their ability to meet the identified or potential needs". However, in case of the quality of education, this issue must be considered from the viewpoint of the service, because university education is a kind of educational service. Hence, the quality can be defined as the ability of schools to meet students' expectations or demands of the labor market [4].

Quality of education from the perspective of universities can be understood as the changes taking place in the students under the influence of the learning process, while the environment of the university is interested in changes in social life caused by the activities of university graduates [5].

The quality of education is also influenced by other factors, which may be lower, for example:

- Academic staff (lack of systems to monitor the process of teaching, knowledge transfer obsolete or even incompetent transfer of knowledge, lack of motivation for self-education, ill-directed requirements for students),
- Lack of effective mechanisms for accelerating the evaluation of training programs,
- Too many students per teacher, resulting in lack of time for thorough verification of students' knowledge [4].

A process of continuous improvement of the quality of education when we can speak basic conditions are fulfilled its function. The university should have as stable nature, the education system should operate smoothly and academic staff should be completed as a team. All actions should serve to improve the quality of education but it is worth paying particular attention to those that exert a decisive influence on the quality of education and are in the range and possibilities of the university.

The main activities to improve the quality of higher education in the Colleges can include:
- Proper selection of academic staff,
- Overestimate the educational criteria
- Improvement of education programs,
- Improving the educational process of education.

The aim of the work is to analyze the current and future tasks for agricultural engineering, resulting from changes in areas within the scope of agricultural engineering.

References

[1] Tsyganov A., Naskowa E., Kamiński E., The quality of engineering education, Problems of agricultural engineering, No. 2/2005, page 75.
[2] Drucker P. F., Innovation and Entrepreneurship: practice and principles, Warsaw 1992, page 15.
[3] Griffin R. W., Fundamentals of organizational management, Warsaw 1999, page 615.
[4] Jura J., Wojciechowski Z., Quality of education, Publishing house Customs School, Warsaw 2005, page 11-12.
[5] Piasecka A., Iskra G., The concept of quality of education in relation to higher education, Materials National Scientific Conference "Quality of education in the knowledge society", Lublin 2006, page 35.

TRACTORS AND SELECTED AGRICULTURAL MACHINES MARKET IN POLAND

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Keywords: tractor, telehandler, combine harvester, market, sales

Introduction

Equipment of machines in agricultural farms reflects their economic situation. New machines allow the use modern technologies, increase farms productivity, allow to increase the scale of production. At the same time it has effect on economic strength of farms and their competitiveness on the market. Investments in equipment affect further chances for farm development.

Aim

The aim of this presentation is to analyse Polish market of tractors and selected agricultural machines. This material shows the market share of main producers of these products. It also presents the sales results of combine harvesters and telehandlers. Tractors were divided into groups according to the brands and engine power. Combines harvesters were divided according to the brands, farms arable land area and number of installed straw walkers.

Results

Comparative analysis of the number of agricultural tractors registrations in 2009 and 2010 was made. According to the results of the analysis, 13,886 agricultural tractors were registered in Poland in 2009. In 2010, the number of registrations was higher by 3.5% and amounted to 14,380 units. Both in 2009 and 2010, the largest recorded number of registration occurred in months: March and April. Since Polish accession to the European Union, sale of the new tractors is steadily increasing. Currently, there are twice more tractors sold than five or six years. For each year - except the crisis in 2008 – the number of sold tractors was higher than every previous year. Figure 1 shows the results of analysis of number of registrations in 2009 and 2010.
Figure 2 shows the number of tractors registrations divided into brands of main producers. The largest market share (about 25%) belongs to CNH Group. Next 15% belongs to Zetor. Same Deutz-Fahr Group - SDF (containing three brands: Deutz-Fahr, Same and Lamborghini) has about 10% of the market and it sells over 1,400 tractors. The most popular brand

belonging to SDF is the Deutz-Fahr (over 72%), second is Lamborghini (almost 15%) and third - Same (almost 13% of all sold SDF tractors in 2010).

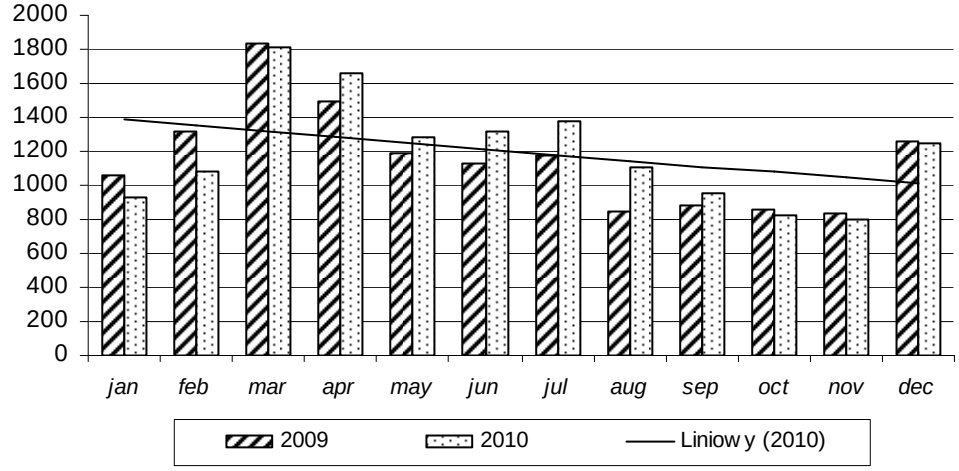

Figure 1. Number of tractors registration in 2009 and 2010.

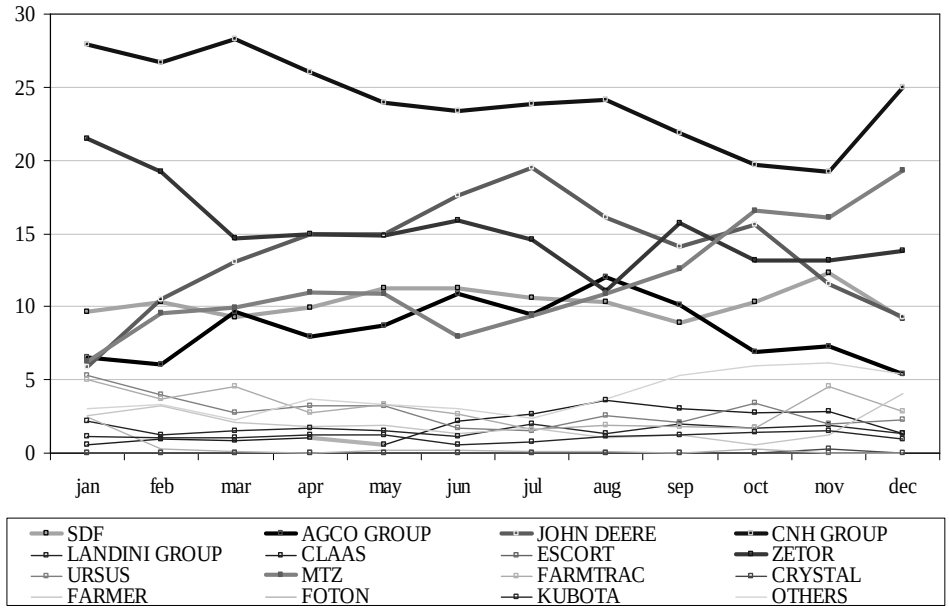

Figure 2. Market share of main tractor producers in 2010.

All main tractor producers offer many different kind of tractors. Farmers can choose from wide range of machines equipped with engines from low engine power (less than 50 HP/37 kW) up to tractor with engines with power over

250 HP/184 kW. Almost 40% of tractors sold in 2010 were equipped with engines with power from 80 to 100 HP (59-74 kW). Almost 90% of machines were equipped with less than 150 HP/110 kW engines.

Table 1. Tractors registration divided by engine horse power.

Power [HP]	Power [kW]	Quantity	Market share [%]
mini	mini	583	4.05
50-80	37-59	2204	15.33
80-100	59-74	5740	39.92
100-120	74- 88	2393	16.64
120-150	88 – 110	1975	13.73
150-180	110 - 132	580	4.03
180-200	132 – 147	222	1.54
200-220	147 – 162	130	0.90
220-250	162 – 184	67	0.46
> 250	> 184	154	1.07
others	others	328	2.28
total	total	14376	100.00

Table 2 represents the sales results of combines up to May 2011. The largest market share belongs to New Holland. Almost 40% of combines sold in analysed period was branded by New Holland. Almost one third of combines were produced by Claas. Same Deutz-Fahr, after many different organizational changes, comes back on the market of combine producers.

Table 2. Combines sales results (up to May 2011).

Brand	Quantity	Market share [%]
Claas	265	27.40
New Holland	384	39.71
John Deere	155	16.04
Deutz-Fahr	32	3.30
Fendt and MF	96	9.94
Others	35	3.61
Total	967	100.00

Many farmers decided to buy a telehandler to their farms. These machines are very useful and can be used to do many different kind of operations. Manitou is the market leader and it has over 45% of market share. Other producers also have in their offer such machines, for example New Holland, JCB, Merlo. Same Deutz-Fahr offers these machines also. Deutz-Fahr telehandlers had about 6% of market share in 2010.

References

Same Deutz-Fahr Poland materials

OPTIMISATION OF HERBICIDE DOSES APPLIED IN THE SUSTAINABLE SYSTEM FOR MAIZE CULTIVATION

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Key words: herbicide systems, lowered doses, herbicide mixtures, maize, weed control

Introduction

Restrictive UE standards have considerably limited the list of permissible biologically active substances of plant protection products meeting the criteria of good agricultural practice. Triazine withdrawal from the register list of herbicides permitted for use, as well as immunity developed by some weed species, resulted in the search for alternative means and methods of their control [Gołębiowska and Kaus 2009].

The recommended maximum dose of herbicides provide high efficiency and fast operation compared to most weed species, without regard to their sensitivity. However, herbicides are used frequently in a certain excess, than would appear from the actual weed infestation. High hopes for effective weed control are associated with the possibility of combining new chemicals in mixtures at reduced doses [Praczyk and Skrzypczak 2009].

Developing systems for the application of herbicide mixtures in reduced doses, safe to natural environment, becomes an increasingly more important issue in selected plant cultivation regarding the requirements of sustainable agriculture. High demands on the assumptions of sustainable agriculture will be largely enforced the design of chemical weed control systems using minimal doses of herbicides supported the addition of various substances to improve their effectiveness.

The aim of the study was to evaluate the effectiveness of the destruction of weed communities in maize cultivation on two different types of soils with the use of mezotrione and nikosulfuron and their mixtures used in reduced doses, in different times and stages of development [Sutton *et al.* 2002]. Second aim was effect of oil adjuvants Actirob 842 EC oraz Atpolan 80 EC, featuring diversified chemical properties, on higher efficacy of mezotrione and nikosulfuron and their mixtures, applied in reduced doses according to *Echinochloa crus-galli*, and annual dicotyledonus weeds in different times and stages of development.

Methods

In the years 2007-2009 field experiments were conducted on the evaluation of some herbicide mixtures efficacy regarding crop maize. The layout of the experiments was a complete randomized block design in four replications. The area of each maize plot was 25 m^2. Selectivity and efficacy of herbicides and their mixtures were evaluated for each system. The experiments were established on two types of soil: haplic phaeozems and haplic cambisols in the south-western region of Poland. Mezotrione and nicosulfuron weed control effect, as well as its mixture used once and according to divided doses system in diffrent dates and phases of maize plant development, along with additive adjuvants Actirob 842 EC and Atpoan 88 EC, were assessed on selected soil stands.

Weed control was visually assessed on the basis of estimated analysis of weed infestation which took place 4-5 weeks after spraying. Maize harvesting was done manually in the phase of full maturity, more determined grain yield and dry matter containing over 15% moisture.

Results and discusion

The assessment of weed infestation of maize cultivated on haplic phaeozems points to low diversity of plant species, as well as to its low intensity. High efficiency of weed control was obtained applying mesotrione + nicosulfuron in divided doses with adiuvant Atpolan 88 EC which resulted in statistically higher yield than those in the objects untreated with herbicides and than the yield obtained when mesotrione and nicosulfuron were used separately. High weed control effect was also obtained for half of this mixture dose (tab.1).

On haplic cambisols was observed high intensity of *Echinichloa crus-galli*, *Setaria* spp., *Chenopodium album* and *Amaranthus retroflexus* occurence. *Artemisia vulgaris* proved to be a perennial, troublesome weed. The mentioned species were most effectively controlled by herbicide mixtures composed of mesotrione + nicosulfuron with Actirob 842 EC as well as Atpolan 88 EC EC applied once in 1/3 full dose. For those objects significantly highest grain yields were obtained (tab.2). Similar results of positive interaction studies of efficacy herbicides with ajuvants have been reported by Woźnica [2003].

Table 1. Effectiveness of selected herbicide applied in full and reduced doses to weed control on haplic phaeozems and influence on maize yield in 2007-2009.

Treatment	Dose ($l \cdot ha^{-1}$)		Weed control (%)					Yield of grain ($dt \cdot ha^{-1}$)
			ECHCG	SETVI	CHEAL	SOLNI	OTHER***	
Untreated	-	-	*17	*8	*22	*9	*11	45.2
Callisto 100 SC	1.5	1/1 DP** BBCH 12	88	86	98	100	100	108.9
	1.0	2/3 DP** BBCH 12	75	77	96	90	95	100.6
	0.75	1/2 DP** BBCH 12	70	68	85	87	86	93.6
Milagro 040 SC	1.5	1/1 DP** BBCH 12	94	92	85	96	100	100.1
	1.0	2/3 DP** BBCH 12	88	86	78	90	92	92.5
	0.75	1/2 DP** BBCH 12	82	80	63	86	87	90.1
Milagro 040 SC + Callisto 100 SC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	96	97	92	88	100	100.5
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	90	88	89	90	92	96.5
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	88	86	83	86	87	91.1
Milagro 040 SC + Callisto 100 SC + Actirob 842 EC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	98	100	97	100	100	106.1
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	95	92	93	98	93	105.0
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	90	87	98	86	90	101.2
Milagro 040 SC + Callisto 100 SC Atpolan 88 EC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	100	100	100	100	100	111.7
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	95	95	95	98	96	110.0
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	93	90	90	95	93	106.1
							NIR. LSD $_{(0.05)}$	1.06

** - number of weeds per m^2, **DP full dose*

****Other:* AMARE, ANTAR, VIOAR, AETCY, THLAR, LAMPU, STEME ANGAR

ECHCG *Echinochloa crus-galli*, SETVI *Setaria viridis*, CHEAL *Chenopodium album*, SOLNI *Solanum nigrum*, AMARE *Amaranthus retroflexus*, ANTAR *Anthemis arvensis*, VIOAR *Viola arvensis*, AETCY *Aethusa cynapium*, THLAR *Thlaspi arvense*, LAMPU *Lamium purpureum*, STEME *Stellaria media*, ANGAR *Anagallis arvensis*,

Table 2. Effectiveness of selected herbicide applied in full and reduced doses to weed control on haplic cambisols and influence on maize yield in 2007-2009.

Treatment	Dose ($l \cdot ha^{-1}$)		Weed control (%)						eld of grain ($dt \cdot ha^{-1}$)
			ECHCG	SETVI	CHEAL	AMARE	ARTVU	OTHER***	
Untreated	-	-	*27	*9	*49	*13	*5	*11	42.7
Callisto 100 SC	1.5	1/1 DP** BBCH 12	86	85	100	94	98	100	96.5
	1.0	2/3 DP** BBCH 12	72	73	92	90	95	96	91.1
	0.75	1/2 DP** BBCH 12	63	61	89	89	86	88	89.8
Milagro 040 SC	1.5	1/1 DP** BBCH 12	92	90	84	92	99	98	
	1.0	2/3 DP** BBCH 12	85	85	72	89	90	94	
	0.75	1/2 DP** BBCH 12	82	80	60	100	86	85	
Milagro 040 SC + Callisto 100 SC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	95	95	94	100	100	100	100.5
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	90	90	86	90	90	98	98.3
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	84	81	80	85	85	93	96.5
Milagro 040 SC + Callisto 100 SC + Actirob 842 EC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	100	100	100	100	92	100	113.2
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	92	95	90	90	95	95	112.6
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	88	90	88	85	85	93	109.6
Milagro 040 SC + Callisto 100 SC Atpolan 88 EC	0.8 + 1.0 + 1.5	1/1 DP** BBCH 12 + BBCH 15	98	96	96	100	92	100	110.2
	0.53 + 0.67 + 1.5	2/3 DP** BBCH 12 + BBCH 15	92	93	86	92	94	95	94.1
	0.40 + 0.50 + 1.5	1/2 DP** BBCH 12 + BBCH 15	86	88	85	85	85	92	91.1
								NIR. LSD $_{(0.05)}$	0.992

** - number of weeds per m^2, **DP full dose*
****Other*: ANTAR, VIOAR, GALAP, FUMOF, GERPU
ECHCG *Echinochloa crus-galli*, SETVI *Setaria viridis*, CHEAL *Chenopodium album* AMARE *Amaranthus retroflexus* ARTVU *Artemisia vulgaris* ANTAR *Anthemis arvensis*, VIOAR *Viola arvensis*, GALAP *Galium aparine*, FUMOF *Fumaria officinalis*, GERPU *Geranium pusillum*.

References

[1] Gołębiowska H., Kaus A. 2009. Efektywność chemicznej regulacji zachwaszczenia w różnych systemach uprawy kukurydzy. Acta Sci. Pol. s. Agricultura, 2009 8(1): 3-16.
[2] Praczyk T., Skrzypczak G. Herbicydy. Państwowe Wydawnictwo Rolnicze i Leśne. Poznań, 2004.
[3] Sutton P., Richards C., Buren L., Glasgow L.: Activity of mesotrione on resistant weeds in maize. Pest Management Science, 2002, 58 (9): 981-984.
[4] Woźnica Z.: Współdziałanie adiuwantów a skuteczność chwastobójcza herbicydów. Prog.Plant Protection/Post.Ochr.Rośl., 2003, 43(1): 472-480.

UNIT COST OF MILK PRODUCTION IN FARMS WITH VARYING DEGREES OF ENVIRONMENTAL SUSTAINABILITY ACCORDING TO 2008 POLISH FADN DATA

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Keywords: farm, environment, sustainability, milk, cost, profit

Introduction

The aim of this paper is to examine the impact of environmental sustainability of farms on the level of individual economic costs of milk production.

The idea of sustainable development is based on the trend of ecological economics, whose basic premise is the possibility of development of the economic system only within the environmental system, as the global ecosystem (biosphere) has its natural limits. Sustainable agriculture cannot exist without sustainable farms. In sustainable farm, the agricultural practices do not violate environmental sustainability.

The method and source material

Proposals to define and to measure the sustainability of agricultural holdings are discussed in the pages of Polish and the world literature. Controversy also indicates the lack of the universal approach to this issue. In the present study, a method of measuring the four-level scale of environmental sustainability developed by Ms. Wioletta Wrzaszcz is used. To determine the sustainability of the farm, she chose those variables that reflect both the positive agricultural practices (within the adopted recommendations) as well as negative impacts on the natural environment. The level of environmental sustainability has been defined as the average normalized value of six selected diagnostic variables:

a) the number of groups of plants grown on arable land,
b) the coverage ratio of arable land vegetation in winter,
c) the balance of organic matter in soil,
d) the share of cereals in crop structure,
e) the livestock density on the unit of area of agricultural land,
f) the balance of nitrogen in the soil.

The empirical basis of that paper are 2008 farm data from farms which kept accountancy for the Polish FADN, classified by W. Wrzaszcz according to their degree of sustainability. For the analysis of unit costs of milk production an own developed method adapted to the accounting database of Polish farms has been used. The analysis was conducted on the basis of data from nearly

1,500 farms specialized in milk production, in which the share of milk in total production value was at least 60%.
The study includes annual milk production, direct costs, general economic costs, depreciation, cost of external production factors and costs of own production factors calculated per one dairy cow. In view of the fact that in the FADN costs of own production factors (land, work and capital) do not exist, they were estimated by using an original valuation method. Therefore, calculation of the economic costs of milk production was possible as well as calculation of economic surplus per 1 head of milk cow and 100 kg of milk, including gross margin, operating surplus, income and profit from milk production. All these volumes were analyzed on the background of selected information characterizing the size of farms and cattle, including dairy cows.

Results

The study showed that dairy farms with a greater level of sustainability are bigger in terms of arable land area and they keep more cattle, including dairy cows. This may indicate that for farms with bigger area it is easier to meet the conditions for environmental sustainability.
With the increase on the level of sustainability also increase of milk yield and milk price of cows is observed, resulting in a significant increase of production value from a cow. While in farms with the lowest level of sustainability milk yield was 4882 kg with an average price 98.0 PLN of 100 kg of milk obtained on the market, in farms with the highest level of sustainability these indicators amounted to 5306 kg and 103.8 PLN. However, higher milk yield required higher direct costs, especially feeding stuff costs. For this reason, in farms with the lowest degree of sustainability, direct costs per 100 kg of milk were amounted to 36.6 PLN, when in the farms with highest degree of sustainability – to 38.4 PLN.
Farms with the lowest level of sustainability achieved the amount of subsidies per cow higher by 17% comparing to the group of farms with the highest level of sustainability. As a result, gross margin along with direct subsidies to 100 kg of milk were respectively 84.4 PLN and 83.7 PLN.
At the same time there was a tendency of overhead costs per cow with increasing levels of sustainability. The amount of that group of costs per 100 kg of milk differed by 404 PLN (1378 PLN to 974 PLN).
Total accounting costs, including depreciation next operating costs and costs of external factors (wages, rent and interest paid) in low-sustainable farms amounted to 4346 PLN per cow and 89.0 PLN per 100 kg of milk, and in highly sustainable farms - 3938 PLN and 74.2 PLN. Total income with subsidies in these two groups of farms amounted respectively: 1560 PLN and 2540 PLN per cow, and 32.0 and 47.9 PLN per 100 kg milk.

Estimated costs of own production factors (land, labour and capital) declined with increasing levels of sustainability (from 2987 PLN to 2071 PLN per cow). Total value of economic costs amounted to 7333 PLN and 6009 PLN per cow, and 150.2 PLN and 113.3 PLN per 100 kg milk. This level of costs irrespective of the level of sustainability of farms generated a loss of production amounting to 2383.5 PLN per cow at a low level of sustainability and 347.5 PLN in farms with highest level. In farms with lowest level of sustainability subsidies did not offset loses. This group carried out the loss of 1427 PLN per cow and 29.2 PLN per 100 kg milk. The subsidies received by farms with medium and high degree of sustainability increased revenues to more than economic costs. So thanks to these, these farms have carried out a profit. Its highest level amounting to 469 PLN per cow and 8.8 PLN per 100 kg of milk carried out the group of farms characterized by the highest level of environmental sustainability.

Summary

Account of the milk production profitability without subsidies showed that it was profitable in 2008 at the level of accounting costs for all four analyzed groups of farms specialized in this production. But account of profitability at the level of economic costs (which included the costs of own production factors (land, labour and capital) showed that this activity resulted in losses.

The level of environmental sustainability of dairy farms increases with the size of the area and hence also the scale of milk production. Value of milk production as well as variable direct costs increased with increasing degree of sustainability of farms. Conversely, the remaining other groups of production costs (overheads, depreciation, costs of external production factors and estimated costs of own production factors) retained. With the increase in the degree of sustainability level, the declining unit cost of milk production is observed.

Economic results of milk production as measured by variety of economic margins are positively correlated with the degree of environmental sustainability of farms.

Value of milk at market prices without subsidies did not cover the economic costs of its production in 2008, so that it was unprofitable. Taking into account the subsidies received, production was not profitable for farms with the lowest level of sustainability; the other groups reached the profit amounted to 1.9% - 8.3% of production value.

THE RESEARCH OF AGRICULTURAL MACHINES MAINTENANCE AND REPAIR SERVICES IN A SPECIAL PRODUCTION

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Keywords: agricultural machines, maintenance, special production

Introduction

The usage of modern means of mechanization in Polish agriculture requires specialised technical background. The maintenance workshops network, currently being built with considerable support of equipment manufacturers, is highly diverse considering the quality of service. The time (needed on removing technical or technological faults occurred during their use) is the measure of reliability of machines operation systems [Skrobacki, Ekielski 2006]. The seasonality of works in agriculture negatively affects the use of service facilities and generates the need to study the course of developments in this market segment [Juściński, Piekarski 2008a; Juściński, Piekarski 2008b]. Taking into consideration the fact of simultaneous occurrence of many causes leading to the heterogeneity of demand, the maintenance services require many intensive logistic works [Juściński, Piekarski 2009]. The aim of the research was to determine the potential of network of maintenance workshops for agricultural machinery operating in Western Pomerania.

Methods

The research, determining the potential of network of maintenance workshops for agricultural machinery, was conducted in months I-VI 2009 in Western Pomerania. The source materials were obtained by using the method of questionnaire with a closed structure. The study included 30 agricultural maintenance workshops for agricultural machinery. The sample size was chosen by using the method of purposive sampling. The sample was made more detailed according to method of selection of typical individuals. The evaluation of collected data was made using the statistical analysis of R-Spearman statistical correlation.

Results

The promptness of realization of specific agrotechnical practices plays a crucial role on a farm. Facing a machine failure, some farms with outdated construction equipment decide to repair it themselves while farmers with modern machinery must have it repaired by a specialized workshop. More than half (57.8%) of researched workshops, in order to use their full repair

potential, takes a machine for repair in less than 3 days from the date of notification. In 32.6 % analyzed workshops the time of expectation on repair ranged from 4 to 7 days. In other service plants it takes more than 7 days.
The repair time is an extremely important element in the total repair. Over half of repairs (53%) is made in 2 days from the moment of arrival of a machine to workshop. Workshops make 20% of ordered repairs in a day, while the remaining 27% of repairs is made in 3 to 7 days time. The repair time of agricultural machines depends on the degree of damage. When the failure of specific machine is repetitive and typical, workshops are earlier supplied with spare parts and the repair time is relatively short. When the failure is rare, workshops are not able to eliminate it earlier than in 3 days.

Repairs last longer when farm works are not being done. In 47% of cases, they may take up to 3 days. 41% of repairs is made in time from 4 to 7 days, and the remaining 12% of failures is eliminated in more than 7 days. During field work off-season, mainly the machines that are used seasonally are taken for major repairs. There are also the repairs of machines which at this time are rarely used. The extension of repair time also results from the fact that workshops are supplied with less spare parts.

Conclusion

1. The level of execution of the routine technical maintenance and repairs is one of the most important factors having the essential influence on the process of machines, tractors and agricultural transport means wear.
2. The factors which have a decisive influence on the technical maintenance and repairs are design solutions of individual items of machines, the workshops equipment of technical facilities with modern tools and devices, as well as the technical level and the qualifications of repair staff.

References

[1] Juściński S., Piekarski W. 2008a. Systemy logistyczne w procesie zarządzania dystrybucją ciągników i maszyn rolniczych (Logistic systems in the management of agricultural tractors and machines'distribution). Acta Agrophisica. vol. 12(1). p. 113-124.
[2] Juściński S., Piekarski W. 2008b. Analiza statystyczna obsługi serwisowej ciągników rolniczych w aspekcie odległości od siedziby firmy. Inżynieria Rolnicza Nr 2(100). p. 57-65.
[3] Juściński S., Piekarski W. 2009. Rozkład zapotrzebowania na przeglądy serwisowe ciągników rolniczych w aspekcie terminów agrotechnicznych. Inżynieria Rolnicza Nr 8(117). p. 31 – 38.
[4] Skrobacki A., Ekielski A. 2006. Pojazdy i ciągniki rolnicze, Wyd. Wieś Jutra, Warszawa.

ANALYSIS OF DIFFERENT STRATEGIES OF MACHINERY INVESTMENT IN FARMS

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Keywords: investment strategies, farm machinery, management, net present value

Introduction

Historically, machinery ownership has been the norm for farmers and ranchers in the U.S. and Europe. Increasingly, the high cost of machinery has forced producers to consider alternatives to machinery ownership for some portions of the production process. Due to the high cost of harvesting equipment and the relatively low annual hours of use for this equipment, alternative means to accomplish the task of harvesting has been the first production process analyzed for cost efficiencies. With increasing machinery prices for all types of equipment, this type of analysis is also being applied to the combination of cost and production efficiencies realized with custom operators who bring in large equipment capable of meeting limited windows for completing field work.

The example used relates to the task of harvesting small grain crops for a case farm. The case farm used in this example is a Montana dryland small grain farm. The farm size is 1,214.1 hectares with 704.2 cropped hectares. The crop mix for this operation is 339.9 hectares acres of hard red spring wheat (HRSW), 72.8 hectares of winter wheat on recrop, 121.4 hectares of recrop barley, 161.9 hectares of winter wheat on fallow and 509.9 hectares of summer fallow. The case farm uses a no till production system. The farm size, crop mix, tillage system and ratio of cropped acres to summer fallow are representative of the average dryland farm in Montana.

Methods

There are several methods to evaluate alternatives means of accomplishing a particular farming task rather than the traditional method of purchasing needed equipment [AAEA 2000, Edwards W. 2008, Kastens E. 1997]. Evaluation methods can incorporate more than one criterion, but often focus on a small number of criteria. For example, machinery size, width, horse power, cutting capacity, etc., focuses on the ability to accomplish a particular task within a given time frame, acres per hour covered. Time frames are often determined by the size of the operation, production practices and labor constraints. An example is purchasing a spray coupe with a large boom to help avoid bottle necks in production during critical times of the

year, seeding and spraying weeds (chemical summer fallowing) during the spring of the year. In this instance, the farm manager is not optimizing the size of an individual machine to match the number of days to spray weeds. The farm manager is trying to optimize the production process by eliminating possible bottlenecks, such as a short supply of labor, by creating added field capacity in the machinery compliment.

However, there are definite trade-offs between optimizing physical production practices based on the requirements of getting all operations done within a window of time, versus the financial and economic considerations for the individual machine and the entire farming operation.

The primary methodology used is after tax net present value financial analysis of expense streams. The task management options analyzed are purchasing, leasing, and custom/rental, to accomplishing a particular farming task. Methods discussed here and the software used is intended for individual firm decision makers and addresses a limited scope of possible decision making criteria. Table 1 summarizes relevant variables for the three task management options evaluated. The purchase option analyzed includes an outright purchase or trades in, both of which includes terms for financing and incorporate tax benefits of deducting cash and non-cash expenses. The software used here does not include possible income streams generated by the machine purchased, such as buying a larger combine than necessary to complete harvest on the farmer's operating and doing custom work with the combine. Since only expenses are considered, the net present values used to evaluate the task management option are the net present value of the expense streams over the analysis period for each option. These values are negative so the selection criteria are to choose the smallest negative number of the three options evaluated.

A breakeven acreage analysis, not shown here, is included in the software. This analysis uses economic rather than financial analysis. This analysis estimates the operating and ownership cost of up to three power units and five pulled implements. The economic cost estimates are used to estimate the breakeven acreage necessary to justify owning the machine, or combination of machinery, to accomplish a particular task. Breakeven acreage is calculated using selected cost estimates and the custom rate charged to accomplish the same task.

While the example here uses as many of the variable values across task management options as possible for analysis, it is not necessarily the case that purchased and leased equipment would be the same or kept the same number of years. The custom hire/rental option only requires the task be completed. The lease option includes a variable lease term in years with an option to buy the leased equipment after the original lease term expires. The buyout option allows variable financing terms at the time the buyout occurs.

If the buyout option is not selected, the software assumes the lease in renewed continually until the end of the analysis term to assure a relevant time period comparison between options.

While the example here uses the same variable values across as many of the task management options as possible, it is not necessarily the case, or required by this software, that purchased and leased equipment be the same or kept the same number of years. The purchase option and the lease option both involve considerable participation from the producer. The custom hire option does not require as much involvement and the rental option may involve the producer just as much as the purchase and lease options.

Table 1. Summary of required input values for the Purchase, Lease and Custom Hire/Rental task management options.

Terms	Purchase Combine	Lease Combine	Custom Hire or Rent Combine
Combine Federal and State Marginal Tax Rate	33.0%	33.0%	33.0%
Discount Rate	4.0%	4.0%	4.0%
Current Market Value of Trade In	$0.0	NA	NA
Undepreciated Value of Trade In	$0.0	NA	NA
Original Cost of the Old Machine Sold or Traded	$0.0	NA	NA
Specify Option (Sell = 1, Trade = 2)	1	NA	NA
Machinery Group Number	1	NA	NA
Depreciation Class Life for Tax Purposes	7 Year Class	NA	NA
Capital Gains Tax Rate	0%	NA	NA
Annual Cash Operating Expense	$31,100	$31,100	$31,100
Annual Cash Operating Expense After Buyout	NA	$28,000	NA
Annual Rental/Custom Work Payment	NA	NA	$52,200
Expected Annual Inflation Rate for Operating Costs	3.0%	3.0%	3.0%
Purchase or Lease Price Established	$375,000	$375,000	NA
Dollar Amount of Purchase or Lease Buyout Price Financed	$300,000	$ 28,125	NA
Lease Term in Years	NA	3	NA
Interest Rate for Financed Amount	7.00%	7.50%	NA
Number of Years Financed	5.0	5.0	NA
No Buyout = 1, Lease Buyout = 2	NA	2	NA
Number of Years for Analysis Period	15	15	15
First Year Tax Deduction For Amount Expensed	$100,000	NA	NA
Investment Credit Taken	$0.0	NA	NA
Salvage as a Percent of Lease Buyout Amount	NA	20.0%	NA

Results

Table 2 shows the net present value of each of the task management options included in this analysis. These values are all negative numbers as there is not income stream included in this analysis. For this analysis, the lowest negative number was the Purchase option. This value is an estimate of the present value of the steam of expenses and other cash outlows, principal payments, over the fifteen year analysis period. Figure 1 shows the annual flows for each task management option. While the results shown in Table 2

clearly indicate the purchase options has the smallest negative net present value, it is not clear from the pattern of expenses in Figure 1 which option would be preferred. The pattern of expenses/outflow differs for each task management option.

Table 2. The net present value of the task management options evaluated.

	Purchase Combine	Lease Combine	Custom Hire or Rent Combine
Net present Value	$528,766	$567,953	$855,677

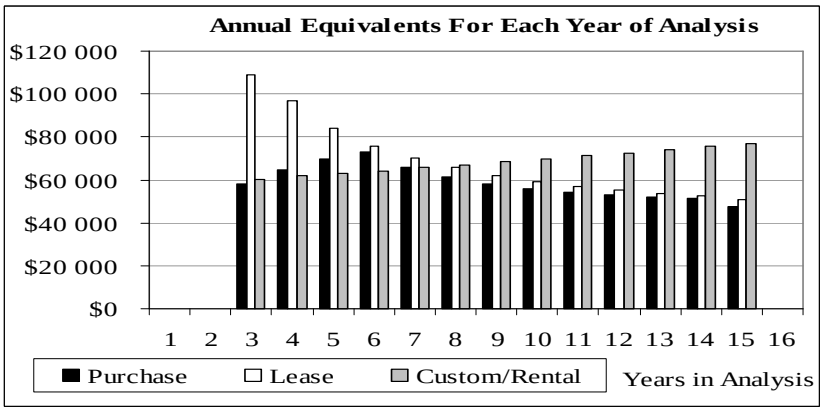

Figure 1. Comparison of the estimated annual streams of expenses and other cash outflows for each task management option considered.

Discussion

While this type of analysis is routinely recognized as a methodology to compare the least cost method to accomplish a particular task, it lacks the type of comprehensive consideration given to a particular task and how that task must be managed within the context of all possible day-to-day farming operations.

Given the difficulty of a complete analysis that includes the optimization of all factors of production, this type of limited analysis provides information to producers regarding the financial implications of their machinery investment decisions.

References

[1] American Agricultural Economics Association (AAEA) *Commodity Costs and Returns Estimation Handbook, A Report of the AAEA Task Force on Commodity Costs and Returns*, February 1, 2000.
[2] Kastens, Terry, *Kansas State University Farm Machinery Operation Cost Calculations*, Extension Bulletin MR-2244, May 1997.
[3] Edwards, William, *Replacement Strategies for Farm Machinery*, Ag Decision Maker, Iowa State University Extension, October 2008.

ESTIMATING ECONOMIC AND ENERGY BUDGETS FOR FARM LEVEL AGRICULTURAL PRODUCTION

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Keywords: energy cost, energy inputs, agricultural energy consumption, budgets, economics

Introduction

Estimating cost of production is a common first step in preparing business management information for producers, their business partners and lenders. In recent years, emphasis has also been placed on energy consumption during the production process. Initially, the focus was placed on farming practices, such as tillage systems, that could help manage the impacts of volatile fuel prices. Volatile input prices for fertilizer and chemicals in combination with concerns about environmental quality have also prompted interest in overall energy use budgets, in addition to the typical economic based budgets estimates. This presentation will review software that combines budgets estimates by tillage system and crop mix for both economic and energy use analysis. The case farm used in this example is a Montana dryland small grain farm (Table 1).

Table 1.The main characteristic of case farm

Farm size	**3,000 acres**	**1,214.1 ha**
with cropped	1,740 acres	704.2 ha
The crop mix for operation:		
- spring wheat	840 acres	339.9 ha
- winter wheat on recrop	180 acre	72.8 ha
- recrop barley	300 acres	121.4 ha
- winter wheat on fallow	400 acres	161.9 ha
- summer fallow	1260 acres	509.9 ha

The case farm uses a no till production system. The farm size, crop mix, tillage system and ratio of cropped acres to summer fallow are representative of the average dryland farm in Montana. The machinery complement for the case farm is valued at approximately $509,000.

Methods

Estimates for the economic and energy budgets are provided by an Excel spread sheet. Economic estimates for machinery costs are prepared

using procedures described in the American Agricultural Economics Association (AAEA) [1]. Operating and ownership costs are estimated for each piece of machinery based on how it is used on each crop in the enterprise mix.

An energy use budget is estimated for each crop. Energy use is estimated for the three major energy sinks in agriculture, fuel, fertilizer and chemicals. Fuel used is estimated for each crop enterprise based on how each piece of machinery is used in the specified crop mix. Estimates for nitrogen, phosphate, and potash are based on weight of applied active ingredient by crop enterprise. Nitrogen fertilizer is applied using a yield based goal for each enterprise. Phosphate and Potash were applied using a soil fertility banking concept. Energy estimates for chemicals are also based on chemicals applied for the specific crop mix.

Energy use in production of consumed fuel, applied fertilizer and pesticides, are all converted to MJ of energy required to produce these inputs. There is considerable variation in the energy required to produce various inputs for small grain crops [2 - 6].

Results

Tables 2 - 7 and Fig. 1 summarize results of the detailed calculations made in the Excel spreadsheet used for this analysis. Each table shows selected summarized information from the spreadsheet.

Table 2. Summary of machinery complement hectares of use, hours of use and estimated operating and ownership costs by tillage system.

Machinery Complement	**Total Hectares Machinery Use**			**Total Hours Machinery Use**			**Total Costs in USD**		
	Mech Till	Min Till	No Till	Mech Till	Min Till	No Till	Opera-ting	Owner-ship	Total
Heavy Disk	510.3	510.3	0.0	97	97	0	1 941	2 946	4 887
Tool Bar	2 235.6	1 215.0	194.4	425	231	37	3 543	4 381	7 924
Harrows	704.7	704.7	194.4	134	134	37	536	938	1 474
Air Seeder	704.7	704.7	704.7	117	117	117	6 719	10 285	17 004
Self Propelled Spray Coupe	704.7	1 725.3	3 256.2	46	113	213	1 286	1 335	2 622
Water Tender	704.7	1 725.3	3 256.2	10	25	47	515	300	816
Tractor 325 HP 4WD	4 155.3	3 134.7	1 093.5	773	579	191	50 683	14 209	64 892
						Totals	65 225	34 394	99 619

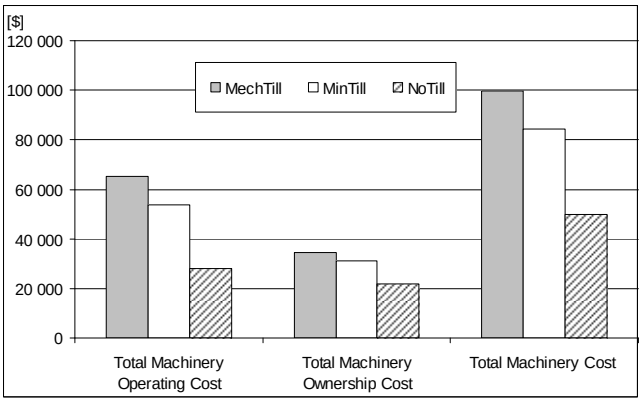

Fig. 1. Summary of economic cost estimates for machinery use by tillage system.

Table 3. Summary of enterprise total income and expenses (in USD) for the no till case farm crop mix.

	Summer Fallow	**Hard Red Spring Wheat**	**WW on Recrop**	**Barley on Recrop**	**WW on Fallow**	**Totals**
Enterprise Total Income	0	236 846	61 135	78 024	165 379	541 385
Enterprise Total Expenses	63 384	102 306	25 554	36 366	47 306	274 916
Enterprise Net Income	-63 384	134 540	35 582	41 658	118 073	**266 469**

Table 4. Summary of total estimated total income and expenses by tillage system (in USD).

	Mechanical Till	**Minimum Till**	**No Till**
Total Income by Tillage System	541 385	541 385	541 385
Expenses by Tillage System			
- Summer Fallow	44 736	54 394	63 384
- Crop Enterprises	211 532	211 532	211 532
Total Expense by Tillage System	256 268	265 926	274 916
Net Farm Income by Tillage System	285 117	275 458	**266 469**

Table 5. Summary of energy (in MJ) required to produce applied active ingredient by type of fertilizer for each crop enterprise in the no till case farm (calculated based on expected yields).

	Summer Fallow	**Hard Red Spring Wheat**	**WW on Recrop**	**Barley on Recrop**	**WW on Fallow**	**Total**
Nitrogen	0.0	2978.5	3772.8	4964.2	4368.5	16084.1
Phosphate	0.0	317.4	317.4	317.4	317.4	1269.7
Potash	0.0	156.4	156.4	156.4	156.4	625.7
					Totals	**17979.4**

Table 6. Summary of energy (in MJ) required to produce applied chemicals (herbicides) by enterprise in the case farm.

Herbicidies	Summer Fallow	Hard Red Spring Wheat	WW on Recrop	Barley on Recrop	WW on Fallow	Total
Mechanical Till	0.0	345.4	223.3	305.2	223.3	1097.3
Minimum Till	643.2	345.4	223.3	305.2	223.3	1740.4
No Till	1060.1	345.4	223.3	305.2	223.3	2157.4

Table 7. Summary of energy in MJ required by tillage system for the three major energy sinks in agricultural operations.

Type of Energy	Mechanical Till	Minimum Till	No Till
Fuel	1 838 889.4	1 484 732.6	730 593.8
Fertilizer	17 979.4	17 979.4	17 979.4
Chemical	1 097.2	1 740.4	2 157.4
Total MJ by Tillage System	**1 857 966.0**	**1 504 452.4**	**750 730.6**

Discussion

Two simplifying assumptions were made in the included case farm. The first that the same machinery complement can be used for each type of tillage system and the second that the production process for the cropped enterprises is held constant across tillage systems. These assumptions will typically not be true across a wide spectrum of individual farming operations, but the variations that can be expected will be relatively small. While the simplifying assumptions help with comparative analysis, the software used allows complete flexibility for including minor variations by cropping system for the production process.

References

[1] American Agricultural Economics Association. *Commodity Costs and Returns Estimation Handbook*, A Report of the AAEA Task Force on Commodity Costs and Returns, February 1, 2000.
[2] *Conversion rates for petroleum-based fuels and electricity are from the DOE,* Monthly Energy Review, August 2004.
[3] *2008 Energy Balance for the Corn-Ethanol Industry*, USDA, Agricultural Economic Report Number 846, June 2010.
[4] *The 2001 Net Energy Balance Of Corn-Ethanol,* Hosein Shapouri*, U.S. Department of Agriculture (USDA), Office of the Chief Economist (OCE), 300 7th Street SW., Room 361, Washington, D.C. 20024, USDA/Agricultural Research Service (ARS), Eastern Regional Research Center, 600 East Mermaid Lane, Wyndmoor, PA. 19038.
[5] Pimentel, David. 2003. *Ethanol Fuel: Energy Balance, Economics, and Environmental Impacts are Negative*. Vol.12, No.2.: 2003 International Association for Mathematical Geology, Natural Resources Research.
[6] CRS Report for Congress, *Energy Use in Agriculture: Background and Issues*, November 19, 2004, Received through the CRS Web Order Code RL32677.

LIMIT OF THE REDUCTION OF THE SPRAYING VOLUME

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Keywords: spraying techniques, reduction, volume/hectare

Abstract

At the moment in Belgium, the average volume/hectare sprayed on large crops ranges from 150 l/ha to 200 l/h, for a spraying speed of 7 to 9 km/h. The most used nozzles sizes are ISO-03 (blue) and ISO-04 (red). They constitute 85 % of the used nozzles in Belgium [1].

Last years, users tend to reduce the volume/hectare. This reduction allows increasing of the working time efficiency and the speediness of the treatment. In this way, the user operates just in time which can be decisive for the success of the treatment. However, this reduction modifies the spray quality and deposit, which could limit the biological efficiency of the treatment.

The objectives of this study are to determine the limits of the reduction of the spraying volume in function of the pesticides (contact, systemic, radicular, etc.), the nozzle type (flat fan, conventional, air-injection, etc.) and the spraying conditions (RH %, T° and wind).

Introduction

To ensure a good biological efficiency, the pesticides require different spraying quality, i.e. impacts density (impacts/cm²) and impacts size, following their action mode (contact, systemic, radicular, etc.). For example, a contact pesticide requires numerous and little impacts which cover completely and regularly the target [1]. On the other hand, a systemic pesticide could be efficient with bigger and less numerous impacts, since the active ingredient works after being entered in the plant and transported by the sap to the action zone. Therefore, it is important to find the right spraying quality and deposit regarding the pesticides types and atmospheric conditions [4].

Table 1 gives the minimum values of the impacts density (impacts/cm²) and the average diameter of the droplets (µm) regarding the action modes of the pesticides in order to ensure a good biological efficiency.

The values shown in the table 1 constitute a good basis for further comparisons. However, they do not take into account the particular conditions during the treatment (weather conditions, state of the plant, etc.). It is required to reach these values but it does not allow totally solving the complex equation of the spraying, as there are numerous unknown factors.

Table 1. Minimum values of the impacts density and droplets size regarding the action modes of the pesticides.

Action mode of the pesticide		**Impacts density (impacts/cm²)**	***Average diameter of the droplets (µm)**
Contact		30-70	100-300
Systemic	Leave's penetration	20-30	100-200
	Root's penetration	20-30	300-450

* Average diameter of the sprayed droplets. The diameter of the impact is greater and will depend on the surface characteristics of the target and the physic-chemic characteristics of the sprayed product.

Material and method

In 2010, a trial has been installed in a field of wheat. The aim was to study the consequence of the reduction of the volume/hectare (from 200 l/ha to 100 l/ha) and its interaction with 2 types of nozzles: conventional flat fan nozzle and air injection nozzle.

To reduce the volume/hectare without modifying the forward speed (± 8 to 10 km/h during all the trials) and the spraying pressure (2.3 to 3 bars for the conventional flat fan nozzles and 3.8 to 5.2 bars for the air injection nozzles), two nozzle sizes have been used for each nozzle type (Table 2).

Table 2. ISO size of the used nozzles during the trials.

Volume/hectare (l/ha)	**Size of the conventional flat fan nozzles**	**Size of the air injection nozzles**
200	ISO 04	ISO 03
100	ISO 02	ISO 015

The quality of the spray deposits have been measured with water sensitive paper that the dimension is standardized (76 × 26 mm) [3]. They have been placed in the crop (see figure 1).

Figure 1. Water sensitive paper positioned in the field.

In total, 80 samples were collected (2 volume/hectare × 2 types of nozzles × 4 repetitions × 5 samples/repetition). Afterwards, the water sensitive papers are treated by a process of numerical image analysis. This system allows to define the quality of the deposit. This one is characterised by:

- Coverage rate of the spraying (%): percentage of the analysed surface covered by the spraying.
- Impacts density: number of impacts by cm².
- Impacts size: average diameter of the impacts (µm).

Results and analysis

Table 3 gives the characteristics of the spray deposit regarding the volume/hectare and the nozzle types. The values correspond to the average of 20 measurements. The standard deviation is given in brackets.

We observe in the table 3 that the coverage rate (%) is directly linked to the volume/hectare. When this one decreases, automatically the coverage decreases proportionally. Taking into account similar trials and results, treatment at 200 l/ha produces usually a coverage rate from 30 to 40 % of the target. On the other hand, treatment at 100 l/ha gives a coverage rate from 15 to 30 %.

We observe also that the density of impact increases (46 to 57 impacts/cm²) and the average diameter of the impacts decreases (620 to 542 µm) in the same time when the volume/hectare decreases.

The air injection nozzles produce greater impacts than the conventional flat fan nozzle regardless the volume/hectare.

The coverage rate decreases also when we use the air injection nozzle.

Finally the impacts density is linked to the nozzle types. The density of impacts decreases significantly when air injection nozzles are used. There is a risk not to reach the required level of 30 impacts/cm² to ensure a good efficacy of the contact pesticides.

Table 3. Characteristics of the spray deposit regarding the volume/hectare and the nozzle types.

Volume/hectare (l/ha)	**Nozzle types**	**Coverage rate (%)**	**Impacts density by cm²**	**Average diameter of impacts (µm)**
200	Conventionnal	49 *(σ = 10)*	58 *(σ = 27)*	551 *(σ = 67)*
	Air injection	42 *(σ = 5)*	33 *(σ = 9)*	689 *(σ = 100)*
	Average	46 *(σ = 9)*	46 *(σ = 23)*	620 *(σ = 110)*
100	Conventionnal	24 *(σ = 5)*	78 *(σ = 11)*	466 *(σ = 54)*
	Air injection	21 *(σ = 4)*	36 *(σ = 9)*	618 *(σ = 91)*
	Average	22 *(σ = 5)*	57 *(σ = 23)*	542 *(σ = 107)*

References

[1] Huyghebaert B., Pekel S., Dubois G., Bodson Cl. 2011. *Les limites de la réduction du volume/ha, résultats 2010*. Livre Blanc Céréales-Gembloux, éditions février 2011, partie 9, p. 29-34.
[2] Huyghebaert B. 2010. Synthèse de la réunion pomme-de-terre Syngenta 2010. *Optimiser la technique de pulvérisation.* Ghislenghien 2010, pp.11.
[3] Jamar L., Mostade O., Huyghebaert B., Pigeon O., Lateur M. 2009. *Comparative performance of recycling tunnel and conventional sprayers using standard and drift-mitigating nozzles in dwarf apple orchards.* Elsevier. Crop Protection 29 (2010) 561-566.
[4] Parafiniuk S., Kopacki M. 2009. *Effectiveness of fighting the bean's (Uromyces Phaseoli) rust in field cultivation using standard and large drop nozzles.* IV International Scientific Symposium 'Farm Machinery and Process Management in Sustainable Agriculture', Lublin, Poland 2009, pp. 59-60.

NEW TECHNIQUES AND TECHNOLOGIES OF POTATO PRODUCTION IN SUSTAINABLE AGRICULTURE

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Keywords: potato production, integrated production, sustainable agriculture

Abstract

The main aim of integrated sustainable agriculture is to obtain high yields of very good quality at reduced doses of mineral and organic fertilizers and pesticides. It implies the use of such rules of agricultural technology and mechanization to all applicable operations in complex production technology were harmless to the environment and have a positive effect on vegetation conditions. This includes soil operations for planting, precise fertilizing, precise and timely planting, proper cultivation and protection of crops against diseases and pests.

The following problems should be attended in the integrated production of potatoes.

1. Determining the appropriate crop rotation and selection of appropriate varieties of potatoes to soil conditions; the best soils are of class III and IV, rich in assimilable minerals, humus content > 2% and slightly acidic (pH of 5.0 - 6.5).
2. Application of soil subsoiler to post-crop or fall cultivation in order to crumble subsoil to a depth of 50 - 60 cm allowing better storage of water and easier assimilation of minerals by plants rinsed into deeper soil layers. Field experiments have shown increase of potato yields due to soil crumbling from 10-30%.
3. Sowing of the second crop (after harvests) such as mustard, pea, lupine or phacelia and their late autumn plowing to enrich the soil humus and minerals to prevent erosion. Plowing of the previously shredded second green crop can fully replace the full dose of manure traditionally used on farms.
4. Introduction to the soil, before plowing, of bacterial-fungal fertilizer, which speed-up the decomposition of second green crop,shredded straw and manure and may obtain phosphorus from unattainable minerals. Field experiments have shown that spraying before plowing of the second crop or manure with soil fertilizer, at the dose of 0.9 l/ha dissolved in 300 liters of water, have contributed to the increase of humus content in soil, have improved water and air properties; the effect has been an increase in potato tuber yield of 12-15 %.

5. The use of precise methods of fertilization, taking into account the needs of the varieties grown, its utilization and the soil richness in minerals, with application of computers and the up to date detailed maps of soil richness. In addition, making a row fertilization using the new generation of fertilizer (Nitrophoska, Yara, ENTEC) on both sides of tuber, which slows the release of nutrients to the soil solution, allows to reduce the dose of fertilization and to obtain a higher yield compared to the traditional methods of fertilization. Experiments have shown an increased of the potato yield by 10-15% using row fertilization with new generation of multi-component fertilizers. Fertilizer dispenser or drill can be combined with the planter.
6. Reducing the spring soil cultivation operations and prevention excessive soil compaction using a power harrow with the use of active machine based on cultivator, rotary cultivator, rotary harrow, which provides proper soil preparation for planting in one machine passage. It applies to soil cultivation by heavy and twin wheels tractors.
7. In adverse weather conditions, for most f of potatoes uses, to apply foliar intervention to dry leaves after short rows at a lower temperature in the doses recommended by the producer. Recommended fertilizers are: Alkalin PK 10:20, Adob Mn, Basfoliar 36 E, Florovit U, Plonvit K, Sonata Z, Wuxal Kombi and 10% urea solution. Studies have shown an increase in tuber yields of 12-18% and improve in quality. Modern sprayers can be equipped with sensors to analyze the level of chlorophyll in the leaves and on-board computer controls the nozzles of sprayers.
8. In the integrated production system it is very important to precise plant, under optimum agronomic dates for particular region, with tuber sprouted in spacing of 75 cm. Planting density should be adjusted according to tuber size, potato usage and soil quality. The depth of planting and the height of tuber earth up are very important in the planting technique. Too deep planting and high earthed up extend the emergence period and in the case of cold spring, which occurs quite often in Poland, it is followed by *Rhizoctonia solani* sprouts infection, which then attacks the stems and leaves and can reduce yields by 10-20%. The best production results are obtained if the density of plants in average soil conditions is:
   - 60,000-85,000 plants per 1 ha of seed production in the multiplication,
   - 50,000-60,000 plants per 1 ha for early varieties lifted on the early crop,
   - 40,000-50,000 plants per 1 ha for potatoes and industrial potatoes
   - 28,000-36,000 plants per 1 ha for potato chips and crisps.

9. The appropriate mechanical - chemical cultivation of plantation with a minimum of herbicides used in the period just before plant emergence on the wet soil to preserve the plantation free of weeds for a crop period. An important factor is the appropriate earthed up plants before spraying high and wide ridges that tubers are not exposed to infection of *Phytophthora infestans* and greening.
10. Chemical protection of plantation against *Leptinotarsa decemlineata* and *Phytophthora infestans* should take into account the level of resistance of varieties and its application should be based on the monitoring of disease risk. The selection of crop varieties resistant to the pathogen is of high importance. For seed production the chemical protection should be based on the signaling of the flight of *Aulacorthum solani* by spraying aphicides.
11. To prevent yield declines as a result of periodic drought on larger seed production and potatoes appropriated for food processing, when the soil moisture at a depth of 10 cm falls below 60% field water capacity, field should be irrigation of reel or bridge sprinkling machine with 15-20 mm dose of water
12. Achieving the desired size of tubers of good quality and minimal mechanical damage requires proper preparation of the plantation to crop. This can be accomplished by mechanical shredding of potato stalks prior to crop and then precision spraying with expensive defoliant of Reglone at a dose of 1-2 l/ha only in the rows of plants with leavings of potato stalks. Early and medium early varieties can be lifted in 7-10 days after spraying, and the medium late and late - after 15-20 days of potato stalks destruction.
13. On larger plantations, with cheap labor, it is possible to make crop with the use of two-rowed potato diggers loading potatoes directly on driving trailer. Domestic or foreign loading diggers can be equipped with a small selection table to remove clods of earth and stones; they also have a wide coated rod sifter, brushes for cleaning tubers out of the sand and feed elevator with cascade ending chute with fall sensor setting the height of fall on a trailer to about 20 cm. The performance of these diggers is up to 1 ha per hour with minimal mechanical damage to tubers. In the integrated system of production two-phase harvest is introduces on an increasing scale. Two-row potato elevator-digger lifts and cleans the dirt potatoes, leaves them in rows on the field, and after 2-3 hours, when the tubers are warmer and the skin becomes more elastic, are collected with a harvester equipped, instead of blade, in pick-up brush or paddle, short sifters and capacious potatoes tray of up to 10 tons. Such combine harvesters can operate at a speed up to 12 km/h with yield to 1.5 ha/h. On small plantations, which are dominant in Poland,

different types of labor intensive vibratory diggers and elevators are applied to harvest.

14. In a sustainable system of production which uses modern techniques of fertilization, cultivation; efficient plant protection products and prolific variety, it is possible, to achieve high yields of good quality potatoes in each direction of use with lower costs.

EFFECT OF STORAGE ON THE BIOLOGICAL PROCESSES IN THE RAPE SEEDS AND OIL

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Keywords: rapeseed, oil, storage period, carotenoids, chlorophylls

Abstract

Oil crops and mainly rapeseed are one of the most important sources of feed and energy in Europe, located after cereals. They are one of the most productive species in our climate. This plant is estimated to be significant as a valuable material for processing in different branches of industry mainly because it is a renewable source producing no water pollution; its production is easy and can be a new income source for agriculture. Traditional and other uses have been for lamp oils, soap making, lubricating oils, plastics manufacturing and an insulating material. It can be used as an animal feeds, production of cooking oil and energetic purposes such as oil burners for heating, production of biodiesel (estimates for 2006: more than 4.0 million tons of rapeseed oil went into biodiesel) and biomethane. Nutrition properties together with attractive colour and thermal stability of rape oils used for roasting are important factors determining oil usability in food industry. In the production processes carotenoid and chlorophylls content together with the level of glucosinolates are of importance. Carotenoids are responsible for the attractive colour of oil and are assumed to play a significant role in the protection against the attacks of free radicals, while chlorophylls are technically undesirable due to the unattractive smell and the visual darkening of the oils containing certain levels of chlorophylls. In case of fuel industry the required raw material should be characterised by a low content of pigments and a relatively high thermal stability.

The aim of the presented study was to assess the effect of the storage period and conditions on the quality and biological processes in the rape seeds and oil. Experimental material consisted of the industrial rape seeds from the Oil Plant in Bodaczów, taken randomly from the bulk raw material supplied by different contractors. All the samples came from the Lublin area (South-East Poland) and consisted of a mixture of different varieties (winter seeds: Bazyl, Bojan, Californium, Cabriolet, Casoar, Kaszub, Lisek and Libomir) collected by individual suppliers. Seeds were stored under standard laboratory conditions.

The physico-chemical parameters (humidity, crude fat, sulphur-containing species, viscosity) and biological value (products of oxidation) of the winter rape seeds stored under laboratory conditions for up to three years were analyzed. The levels of carotenoids and chlorophylls in oils as well as time – induced lipid oxidation products and the resistance to temperature-induced oxidation were estimated by the levels of the end products of lipid peroxidation, reacting with thiobarbituric acid (TBARS).

For almost all the seeds examined the minimal technological quality requirements were met. In general, the tendency of decrease of crude fat and of increase in humidity of samples was observed in samples stored for longer periods although no statistical differences were found. All the seeds were characterised by a similar content of sulphur-containing species which didn't change over a time. Although oils were characterised by comparable viscosities the results obtained from the samples stored for longer period showed higher multiplicity of data thus a greater standard error.

Samples were characterised by a diverse content of chlorophylls and carotenoids. In spite of prolonged storage time the level of carotenoids remained constant within the experimental error while the level of chlorophylls decreased. Once the presence of carotenoids is highly demandable, chlorophyll is an unnecessary additive causing problems with industrial processing of the oils. As lowest possible contents of carotenoids and chlorophylls would be appreciated in the production of biodiesel where the technological processes require elimination of pigments and conversion of fats into their methyl esters.

Interestingly, the oxidation of the lipids was not higher in the oils pressed from older seeds. The initial amounts of TBARS in oils were not correlated with the levels of carotenoids or chlorophylls. No statistical correlation was found between samples containing higher amounts of carotenoids with the TBARS concentration after 3 or 6h of thermal degradation at 125^{o}C. Such a result demonstrates that biological processes taking part in seeds and oils are very complex.

Although in many cases seeds show a relatively high technological value the wide-scale production of goods from rapeseed stored for longer periods is strongly dependent on the costs of seed drying and storage.

CLIMATIC INFLUENCE ON WINTER RICE PRODUCTION IN BANGLADESH WITH IMPLICATION TO FUTURE PROJECTION: A MODELLING APPROACH BY ORYZA2000

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Key words: Bangladesh, rice, temperature, rainfall, yield

Abstract

Effects of climate change on BR29 rice yield, a popular winter rice variety in Bangladesh, were assessed using a bio-physical simulation model ORYZA2000. The yields of BR29 over the time of 2046-2065 and 2081-2100 were simulated for 3 districts in Bangladesh, after looking at the current trend of 1994-2008 at 14 major rice growing districts. Required data on soil characteristics, and winter rice management practices were collected from Soil Resources Development Institute (SRDI) and Bangladesh Rice Research Institute (BRRI) respectively. Hindcasted, reanalyzed and projected climate datasets on daily basis were provided by Bangladesh Meteorological Department (BMD), National Center for Environmental Prediction (NCEP) in combined to Asian Precipitation Highly Resolved Observational Data Integration Towards Evaluation of Water Resources (APHRODITE's water resources) project and Meteorological Research Institute (MRI), Japan correspondingly, besides collecting rice data from Bangladesh Bureau of Statistics (BBS). After examining crop models satisfactory performance toward reproducing the field data, simulation studies were carried out for the future. As compared with the present, a significant reduction in average rice yield of 6 and 12% respectively, over the period of 2046-2065 and 2081-2100 is estimated for the 3 selected locations having a fixed planting date January18. Future increases in daily maximum temperatures would be the main reason for yield decreases, while higher solar radiation associated with increased carbon-dioxide might have some marginal positive effects; although not balancing the strong negative effects of global warming. Projected rainfall pattern and distribution would have also a significant negative impact on future yields; claiming as 33 and 43% higher water demand correspondingly, over the earlier mentioned time courses and transplanting date. Different transplanting dates, with projected climate are expected to shorten the growing season and thus reducing the yields. ORYZA200 is considered as a very useful research tool to investigate the possible impacts of climate change for other cases by reducing the uncertainty with high resolution climate model's ensembles and calibrated data's.

THE INFLUENCE OF SOME SPRAYING PARAMETERS AND HERBICIDE FORMULATION ON ITS EFFECTIVENESS

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Keywords: herbicide, formulation, efficacy, type of nozzles, spraying volume

Introduction

Current trend in plant protection tends to enhance herbicide efficacy, reducing pesticides active ingredients applied on arable fields, simultaneously. Appropriate selection of spraying parameters affects accuracy of covering spraying surfaces by herbicide solution and consequently quantum of retained and absorbed active ingredient of herbicide. In weed control, herbicide formulation is an important determinant of its active ingredient activity by building up its physicochemical properties [Zabkiewicz 2007]. Present research performances trends towards production of herbicide formulation are characterized by better spray solution retention, spreading on the leaves surface and uptake on the plant tissue that finally affects herbicide effectiveness. Spraying parameters, such as spray volume and type of nozzle, play an important role in weed control effect because of their influence on covering and distribution of spray solution on plants surfaces [Sttainer et al. 2006, Kierzek and Wachowiak 2009].

The objective of this study was the evaluation of some spraying parameters on two formulations (water dispersible granules - WG and oil dispersion - OD) of two sulfonylurea herbicides: the mixture iodosulfuron methyl sodium + amidosulfuron and iodosulfuron methyl sodium + mesosulfuron methyl efficacy.

Materials and methods

Research included two types of experiment:

1. evaluation of the influence of spray volume (125, 250 and 320 l/ha) on herbicide effect was performed under both glasshouse and field conditions,
2. evaluation of type of nozzle (extended range flat nozzle TeeJet XR 11003-VS and drift guard flat nozzle TeeJet DG 11003-VS) on herbicide effect was carried out in glasshouse.

Glasshouse experiment involved five weed species as tested plants. Grass weeds (*Apera spica-venti, Alopecurus myosuroides*) were sprayed by the mixture iodosulfuron methyl sodium + mesosulfuron methyl, that is primarily

aimed to grass and small number of broadleaved weeds control. Plants of *Anthemis arvensis*, *Galium aparine* and *Thlaspi arvense* were treated by iodosulfuron methyl sodium + amidosulfuron, that is appropriate to control broadleaved weeds. Field experiments were established at two locations of winter wheat that varied with respect to weed infestation. At the first experimental site wheat was mainly infested by grass and small number of broadleaved weeds therefore plots were sprayed by the mixture iodosulfuron methyl sodium + mesosulfuron methyl. At another location, infested by broadleaved weeds, the mixture iodosulfuron methyl sodium + amidosulfuron was used. At the time of herbicide treatment weeds were at early growth stages (2-4 leaves). Field treatment was made at the full tillering of wheat, when weeds growth stage varied between 4 and 12 leaves.

Each herbicide was used in recommended and reduced by half doses. The mixture iodosulfuron methyl sodium + mesosulfuron methyl, used as WG formulation, was applied in combination with adiuwant Actirob 842 EC, to ensure high effect of weed control. Herbicide application under glasshouses conditions was made using laboratory sprayer "Aporo". Experiment 1 was performed using standard nozzles (TeeJet XR 11003-VS) operated at different speed and pressure to obtain three levels of spray volume: (125, 250 and 320 l/ha). Field experimental plots were sprayed by knapsack sprayer "Gloria" equipped with standard - TeeJet XR 11003-VS nozzle. At experiment 2, sprayer operated at constant speed of 2.5 km/ha and the pressure of 200 kPa producing standard spray volume of 250 l/ha.

Three weeks after treatment, weeds were harvested from each pot or field plots and their fresh weight was determined. Herbicides efficacy was assessed on the base of fresh weight reduction influenced by herbicides activity in comparison with untreated object.

Results

Considering the influence of herbicide formulation, the mixture iodosulfuron methyl sodium + mesosulfuron methyl was more efficient against weeds, when was applied as water dispersible granules compare to oil dispersion and its activity was more dependent on examined spraying parameters. Another tested herbicide, the mixture iodosulfuron methyl sodium + amidosulfuron, did not prove differences with respect to formulation, at type of nozzle as well as spray volume study.

Spray volume affected the activity of the mixture iodosulfuron methyl sodium + mesosulfuron methyl, resulting in decrease of activity as along rise of water volume used for herbicide treatment. Significant differences were observed in case of reduced dose application. Comparable weed control effect at recommended and reduced dose level was obtained only for the lowest (125 l/ha) spray volume. Effectiveness of the mixture iodosulfuron

methyl sodium + amidosulfuron was not related to spraying volume, markedly (tab. 1a). Field experiment resulted in decrease of efficacy at the highest spray volume for both herbicide rates of the iodosulfuron methyl sodium + mesosulfuron methyl used as oil formulation (tab. 1b).

Table 1. The influence of spray volume on the efficacy of two formulations of the mixtures methyl sodium + mesosulfuron methyl and iodosulfuron methyl sodium + amidosulfuron

a. glasshouse experiments

Spray volume (l/ha)	Efficacy (%)							
	iodosulfuron methyl sodium + mesosulfuron methyl				iodosulfuron methyl sodium + amidosulfuron			
	OD		WG		OD		WG	
	2.4 + 12 g/ha	1.2 + 6 g/ha	2.4 + 12 g/ha	1.2 + 6 g/ha	3.75 + 15 g/ha	1.875 + 7.5 g/ha	3.75 + 15 g/ha	1.875 + 7.5 g/ha
125	93a	91a	94a	93a	93a	92a	94a	91a
250	92a	85b	94a	92a	94a	92a	95a	91a
350	94a	77c	92a	91a	94a	92a	94a	91a

b. field experiments (average from 2007-2009)

Spray volume (l/ha)	Efficacy (%)							
	iodosulfuron methyl sodium + mesosulfuron methyl				iodosulfuron methyl sodium + amidosulfuron			
	WG		OD		WG		OD	
	2.4 + 12 g/ha	1.2 + 6 g/ha	2.4 + 12 g/ha	1.2 + 6 g/ha	3.75 + 15 g/ha	1.875 + 7.5 g/ha	3.75 + 15 g/ha	1.875 + 7.5 g/ha
125	95a	91a	94a	89a	98a	95a	94a	94a
250	89a	88a	88a	85b	98a	96a	95a	93a
350	86b	85b	84b	80b	99a	96a	92a	94a

values marked by the same letter do not differ significantly
OD - oil dispersion, WG - water dispersible granules

Type of nozzle did not affect activity of iodosulfuron methyl sodium + amidosulfuron. Herbicide treatment with drift guard nozzle resulted in significant diversification of the mixture iodosulfuron methyl sodium + mesosulfuron methyl efficacy with respect to its formulation. Plants treated by oil formulation were poorly controlled than sprayed by granules formulation. There were also reported essential differences between recommended and reduced doses activity. Usage of TeeJet DG 11003-VS gave considerably weaker weed control effect than TeeJet DG 11003-VS, at both doses level (tab. 2).

Table 2. The influence of type of nozzles on the efficacy of two formulation of the mixtures methyl sodium + mesosulfuron methyl and iodosulfuron methyl sodium + amidosulfuron

Type of nozzle	Efficacy (%)							
	iodosulfuron methyl sodium + mesosulfuron methyl				iodosulfuron methyl sodium + amidosulfuron			
	OD		WG		OD		WG	
	2,4 + 12 g/ha	1,2 + 6 g/ha	2,4 + 12 g/ha	1,2 + 6 g/ha	3,75 + 15 g/ha	1,875 + 7,5 g/ha	3,75 + 15 g/ha	1,875 + 7,5 g/ha
TeeJet XR 11003-VS	88a	80b	93a	92a	97a	95a	95a	95a
TeeJet DG 11003-VS	85b	68c	91a	89a	97a	96a	94a	96a

values marked by the same letter do not differ significantly
OD - oil dispersion, WG - water dispersible granules

Discussion

Correctly application method should result in great quantity of herbicide active ingredient deposited and uniformly distributed on plant surface. It can be obtained by optimizing of spraying parameters such as spray volume, size of droplets, herbicide dose and formulation. Results obtained from these experiments show, that herbicide efficacy was influenced by interaction of kind of active ingredient, herbicide dose and formulation, spray volume and type of nozzle used in herbicide treatment.

Increase of spray volume leads to dilution of herbicide and reduction of spray solution retention on treated plants, giving herbicide effect decrease [Shaw et al. 2000]. In the present study, weaker efficacy with respect to herbicide formulation was observed for only iodosulfuron methyl sodium + mesosulfuron methyl. Activity of water dispersible granules formulation, that was applied under controlled conditions was not related to spray volume, but differences occurred only in case of oil formulation used in reduced dose. The OD is a new formulation that combines the advantages of solid and liquid formulations. This formulation improves retention of spray solution and its spreading on the leaves surface. Therefore it was expected that activity of oil dispersion herbicides should not be significantly related to other factors such as spraying parameters. However results of presented research are in disagreement with this assumption, but only with respect to iodosulfuron methyl sodium + mesosulfuron methyl. WG formulation was used, according to producer recommendation, with addition of adjuvant, whilst the same formulation of another investigated herbicide does not require usage of adjuvant. Thus joint application (WG formulation + adjuvant) was probably more profitable than single one (OD formulation alone). Efficacy of iodosulfuron methyl sodium + mesosulfuron methyl (WG and OD) applied under field conditions was dependent on spray volume for both recommended and reduced dose, resulting in weaker weed control at the highest spray volume. Proven differences between field and glasshouse

experiments are due to higher herbicides activity under controlled environment conditions and also different weeds growth stage and the time of spraying [Domaradzki and Kieloch 2007]. The efficacy of oil dispersion herbicide has also been reported for the mixture iodosulfuron methyl sodium + mesosulfuron methylsodium, giving better OD than WG effect [Kerlen and Brink 2006], but other researcher did not find differences between formulation [Paradowski and Jakubiak 2006].

Type of nozzle affects size of droplets and also spray distribution on plant surface. Results obtained from this research proved better herbicide efficacy when TeeJet XR 11003-VS was used for spraying. These differences were found for only the mixture iodosulfuron methyl sodium + mesosulfuron methyl applied as oil formulation. More pronounced diversification for reduced rate was observed. Nozzle TeeJet DG 11003-VS is especially useful under windy weather conditions, because it produces larger droplets, that are less vulnerable to drift. Similarly to these findings, it was reported previously that better herbicide efficacy could be performed using nozzles producing small droplets [Shaw 2000; Kierzek and Wachowiak 2005].

References

[1] Domaradzki K., Kieloch R. 2007. *Działanie różnych dawek herbicydów z grupy regulatorów wzrostu i pochodnych sulfonylomocznika na Galium aparine i Stellaria media w zależności od ich fazy rozwojowej*. Annales UMCS, 2008, LXII (2): 1-8.

[2] Kerlen D., Brink A. 2006. *OD_{esi}® – Die neue innovative, Formulierungstechnologie für Sulfonylharnstoffe, dargestellt am Beispiel von ATLANTIS® OD*. Journal of Plant Diseases and Protection, Sonderheft XX, 1033–1037.

[3] Kierzek R., Wachowiak M. 2005. *Zwalczanie chwastów jedno- i dwuliściennych przez łączne stosowanie herbicydów oraz różnych parametrów opryskiwania.* Prog. Plant Protection/Post. Ochr. Roślin 45 (2): 790-793.

[4] Kierzek R., Wachowiak M. 2009. *Wpływ techniki ochrony roślin na skuteczność wykonywanych zabiegów.* Problemy Inżynierii Rolniczej, 2: 75-81.

[5] Paradowski A., Jakubiak S. 2006. *Ocena skuteczności chwastobójczej łącznego stosowania preparatu Atlantis OD z innymi herbicydami w pszenicy ozimej.* Prog. Plant Protection/Post. Ochr. Roślin 46 (2): 196–199.

[6] Shaw D.R., Morris W.H., Webster E.P., Smith D.B. 2000. *Effects of spray volume and droplet size on herbicide deposition and common cocklebur (Xantium strumarium) control.* Weed Technol. 14: 321-326.

[7] Stainer C., Destain M.F., Schiffers B., Lebeau F. 2006. *Droplet size spectra and drift effect of two phenmedipham formulations and four adjuvants mixtures.* Crop Protection, 25: 1238-1243.

[8] Zabkiewicz J.A. 2007. *Spray formulation efficacy – holistic and futuristic perspectives.* Crop Protection, 26: 312-319.

PRELIMINARY ASSESSMENT OF THE IMPACT ON THE EFFICIENCY BIOSTIMULATORS BEAN YIELDS (*Phaseolus vulgaris* L.)

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Keywords: biostimulator, Asahi SL, Kelpak, yield

Introduction

The biostimulators applied in cultivation of plants stimulate life processes and they increase stress conditions their hardiness, contribute to obtainment of larger and better qualitatively yield [Przybysz et al. 2008]. Asahi SL is a biostimulator which contains compounds from the nitrophenols group and Kelpak which the main component is extract from seaweed *Ecklonia maxima*. Asahi SL stimulates the synthesis of natural hormones to increase their activity. Improving the process of assimilation of mineral compounds by plant increase their hardiness on stress conditions as well as positive effect on their yield's quality [Kositorna and Smoliński, 2008]. Active elements in seaweed extracts are trace nutrients and plant hormones like cytokinins and auxins [Jensen 2004]. Kelpak contains 11 mg/litre of natural auxins and 0.031 mg/litre of natural cytokinins [Russel 2002]. Kelpak's plant hormones protect plants against stress such as disease and insects, cold weather and drought. The positive Kelpak effects on root growth, plant growth, resistance to disease and increase of yield was observed [Matysiak and Kaczmarek, 2008, Russel 2002, Verkleij 1992, Zodape 2001].

Methods

In 2010 the experiment was conducted on experimental plots of Institute of Agricultural Sciences PWSZ in Chełm the laid in Depułtycze Królewskie. It was established in a randomized block design, in 4 replications, on plots about area 4.5 m^2. The aim of this study was to determine the influence of biostimulators Asahi SL and Kelpak on bean (*Phaseolus vulgaris* L.) cultivar Raba growth and yield. The bean's seeds were sown on the 8th of May 2010 on depth 3 - 4 cm, in spacing of drills 45 cm, applying the density of 50 plants per 1 m^2. Plants were sprayed with Asahi SL in concentrations 0.1 % and 0.3 % or Kelpak in concentrations 0.2 % and 0.4 %. Two forms of plant's spraying was applied, the first in the 2 – 3 leaves stage (the 23rd of June), the second in the 2 – 3 leaves stage and on beginning of the bean's blooming (the 5th of July). Received results were compared with combination in which biostimulators were not applied. The number and the weight of

seeds, the number of pods in plant and the weight of thousand seeds was estimated.

Results

The results of this study showed beneficial effect of the application of biostimulators on the yield of beans. Increase in seed yield by 26% was achieved in combination, in which the plants sprayed once with 0.3% Asahi SL solution. Plants that grow in the combination, where the plant applied once spraying 0.1% Asahi SL solution obtained increasing the number of pods by 13% and thousand seed weight by 6%. Spraying plants with a solution of 0.4% Kelpak at the stage of 2-3 leaves increased seed yield by 31% and the number of pods by 18%. Thousand seed weight increased by 2% was observed in combination, in which the double spraying of plants used Kelpaku 0.4% solution.

References

[1] Jensen E. 2004: *Seaweed: Fact or fancy?* Organic Broadcaster, s. 12.
[2] Kositorna J., Smoliński M. 2008. *Asahi SL biostimulator in protection of sugar beet from herbicide stress. Biostimulators in modern agriculture. Fields crop.* Z. T. Dąbrowski (editor), Warszawa: 41-49.
[3] Matysiak K., Kaczmarek S. 2008. *Potential advantages of Kelpak bioregulator applied to some field crops. Biostimulators in modern agriculture. Fields crop.* Z. T. Dąbrowski (editor), Warszawa: 99-106.
[4] Przybysz A., Małecka-Przybysz M., Słowiński A., Gawrońska H. 2008. *The effect of Asahi SL on growth, efficiency of photosynthetic apparatus and yield of field grown oilseed rape. Biostimulators in modern agriculture. Fields crop.* Z. T. Dąbrowski (editor), Warszawa: 7-17.
[5] Russell C.L. 2002. *Kelp based growth stimulants. Science or snake oil?* Internal Technical Bulletin of Cobbett Pty Ltd, (CD).
[6] Verkleij F.N. 1992: *Seaweed extracts in agriculture and horticulture: A review.* Biol. Agric. Hortic., 8: 309-324.
[7] Zodape S. 2001: *Seaweeds as a biofertilizer.* J. Sci. Ind. Res., 60, 5: 6378-382.

INVESTMENT OPPORTUNITIES IN SELECTED FARMS

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Keywords: family farm, investment, fixed assets

Introduction

Enterprise to development must manage well-thought-out investment policy. Similarly, in the case of a farm, except that the production activities of market risks in addition to the farmer must pay particular attention to the possibility of adverse weather conditions. This applies directly to crop production and livestock indirectly.

In the period of intense transformation of Polish agriculture, the issue of implementation of investment opportunities is becoming very important, especially in technical measures in the farm family. Currently, large impulses affecting the improved ability of farms to invest are the EU funds directed under the Rural Development Programme 2007-2013. In the years before and after accession to the European Union, Polish farmers can benefit from support to investments under the Special Accession Programme for Agriculture and Rural Development, Sectoral Operational Programme Restructuring and Modernisation of the Food Sector and Rural Development for 2004-2006 and Rural Development Programme for 2004-2006.

The aim of the study is to analyze investment opportunities in selected farms.

Materials and methods

Material represents data from 21 farms in which the development project (NCBiR 12 00 43 06/2009) implemented by the Institute of Technology and Life Sciences in Falenty questionnaire-interview was conducted involving the development of the farm activities of description for 2009. Financial resources that a farmer can spend on investment activity on the farm (excluding housing and domestic investment) determined from the methodology used by Wójcicki [2009] after the modification:

$$P_{in} = (d_{br} - w_r)/2 - k_i + n_i$$

where:
P_{in} – financial resources for investment activities [PLN/year]
d_{br} – gross income of the farmer family [PLN/year]
k_i – investment credits [PLN/year]

w_r – remuneration for work of the farmer and his family [PLN/year]
n_i – the investment outlays [PLN/year]
Remuneration for work of the farmer and his family in 2009 was taken as Wójcicki [2010] at 12 PLN for one man-hour.

Analysis of results

The area of analysed farms amounted from 14.87 to 85.00 hectare of arable area (table 1).

Table 1. The general characteristic of analysed farms.

Specification	minimum	maximum	average	standard deviation
Arable area (ha)	14.87	85.00	38.56	19.92
Livestock Unit (LU)	4.52	116.60	41.49	27.60
Livestock Unit (LU/ha)	0.30	1.89	1.08	0.47
European Size Unit (ESU)	12.05	61.87	31.60	16.45
Value of fixed assets buildings (PLN)	273 000	2 334 300	768.139	484 967
Value of fixed assets buildings (PLN per ha)	4 684	88 120	19 918	20 076
Value of fixed assets machinery and equipment (PLN)	231 600	1 320 300	851 672	304 361
Value of fixed assets machinery and equipment (PLN/ha)	7 943	58 061	22 084	10 362

Source: own study.

Preliminary analysis of the performance of farms developed on the basis of the descriptions of farm activities carried out shows that from among the 21 analyzed farms two of them have no financial capacity because computed the financial resources it has the farm on the investment activity is negative. This situation proves that farms are not able to provide to the farmer even income parity of 12 PLN gross price for one man-hour. Other farms have the ability to finance investments from own resources at very different levels from 2266 PLN to 129386 PLN per year. In terms of 100 PLN replacement value of fixed assets (buildings, machinery and equipment), this volume contains from 0.40 PLN to 8.57 PLN.

References

[1] Wójcicki Z. 2010. *Technologiczna i ekonomiczna modernizacja wybranych gospodarstw rodzinnych.* Part II. Instytut Technologiczno-Przyrodniczy w Falentach. ISBN 978-83-62416-12-7.
[2] Wójcicki Z. 2009. *Potrzeby i możliwości inwestycyjne rozwojowych gospodarstw rodzinnych.* Problemy Inżynierii Rolniczej nr 3. 5-12.

SUSTAINABLE MODERNIZATION OF SELECTED FAMILY FARMS

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Keywords: modernization of farms, sustainable agriculture

Introduction

The farmer as each producer has to make decisions, both on current production and development strategy of the farm. Recently, development strategy and the associated technical modernization gained on particular significance, mainly due to programs implemented by the ARMA offering financial support.

According to Wasąg [2010] a decisive influence on the modernization of farms has the financial support of EU programs, which is why farmers in making decisions regarding the modernization of the farm should take into account the foundation of sustainable agriculture related to the farm.

The main objective of the modernization is understood as:

- achieve the highest level of commodity production,
- ensure parity standard of living and working family members,
- implement processes in agricultural production, taking into account the environmental requirements [Sawa and Kocira, 2010].

Aim of this study is an analysis of selected family farms with regard to sustainable modernization.

Materials and methods

Materials are data obtained in the development project NCBiR 12 00 43 06/2009. The detailed lists of conducted activities of both economic and planned modernization were made in each of the analyzed farms. The interviews and discussions with farmers were administered to discuss investing activities on schedule modernizations. The analysis was based on methods of comparative and tabular-descriptive, detailing some of the indicators in the field of economics and farms mechanization.

The measures of integrated evaluation in the process of agricultural production and indicators for these evaluations were used for the evaluation of farms with regard to sustainability modernization [Sawa and Kocira, 2010].

Analysis of results

Before the planned modernization the analyzed farms have had the agricultural area of: 24.11 ha, 28.10 ha and 73.65 ha (Table 1). As a result of the planned modernization, the increase of the area by 4 ha of agricultural land was expected only in the first farm. None of the analyzed three farms complied with all the criteria for sustainable modernization. However, all farms have improved the balance of organic matter fulfilling the requirements in this regard.

Net commodity production per Cereal Unit both before and after modernization was at a satisfactory level.

Table 1. The general characteristic of analyzed farms.

Specification	Farm 1		Farm 2		Farm 3	
	2009 rok	modernization	2009 rok	modernization	2009 rok	modernization
Area [ha of agricultural area]	24.11	28.11	28.10	28.10	73.65	73.65
Livestock density [Livestock Unit]	20.89	20.89	18.89	18.89	58.32	58.32
Labor inputs of family members [man-hour]	4816	4527	5281	5300	5299	3299
Energy expenditure [kWh]	42589	44050	34726	33692	68239	67687
Reproduction or degradation of organic matter, indicator 0.4–1.5 $t \cdot ha^{-1}$ of agricultural area	0.613	0.891	0.438	0.780	0.305	0.564
Net commodity production, >55 Cereal Unit $\cdot ha^{-1}$ of agricultural area	63	60	58	63	55	54

Source: own study.

References

[1] Sawa J., Kocira S. 2010. Kryteria zrównoważonej modernizacji gospodarstw rodzinnych. Problemy Inżynierii Rolniczej. 3, p. 33-40.

[2] Wasąg Z. 2010. Efektywność wykorzystania środków UE przez gospodarstwa rolne na przykładzie wybranych programów. Inżynieria Rolnicza. 3 (121), p. 231-236.

ESTIMATION OF THE CHEMICAL PLANT PROTECTION OF CHRYSANTHEMUMS USING CONVENTIONAL AND AIR INJECTION NOZZLES

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Keywords: chrysanthemum, standard and thick drop nozzles, fungicides railway track

Abstract

Chrysanthemum grandiflorum Ramat./Kitam. is an important world-wide grown and high-value crop, which production has increased in recent years. In Poland, this ornamental is traditionally used for decorating tombs on the All Saints Day. Recently, these beautiful ornamentals cultivated in pots are getting very popular all year round. Unfortunately, the beauty of chrysanthemums is spoiled by many soil-borne and air-borne pathogenic fungi (especially *Sclerotinia sclerotiorum, Botrytis cinerea* and *Puccinia horiana*).

Necrotic lesions, on roots, stems and leaves are the most common symptoms of the diseases. The aim of the study was to determine the influence of the fungicides sprayed by means of standard and thick drop nozzles on the healthiness of the cultivar Tripoli Darc grown in the fields. The experiment was set up in RZD Czesławice in years 2007-2009, according to the method of random blocks. The healthiness of chrysanthemum was estimated at the blooming period in October. The fields were sprayed four times in 14 day intervals, using Dithane NeoTec 75 WG (a.i. mancozeb), Sumilex 500 SC (a.i. procymidone) and Amistar 250 SC (a.i. azoksystrobine). Sprayings have been done with conventional flat fan nozzles (RS-MM 110 03) and air injection nozzles (ID 120 03). Spraying pressure was 3 bars and working speed was 4 km/h.

Table 1. Mean height and the number of paralyzed plants.

Kind of preparation/ nozzle	Mean height of plants in the blocks (cm)				The number of paralyzed plants in the blocks							
	I	II	III	IV	I A	I B	II A	II B	III A	III B	IV A	IV B
Control	37.30	32.40	31.90	33.18	9	0	6	3	6	3	8	1
Dithane/RS-MM	37.82	38.20	36.00	35.20	7	2	7	2	6	3	7	2
Dithane/ID	38.00	39.10	36.90	34.90	7	2	8	1	7	2	6	3
Sumilex/RS-MM	38.67	37.55	39.10	37.95	7	2	7	2	8	1	7	2
Sumilex/ID	38.52	38.90	39.40	38.40	7	2	7	2	8	1	6	3
Amistar/ RS-MM	40.10	39.90	41.15	37.12	7	2	6	3	6	3	7	2
Amistar/ID	40.00	41.15	42.18	40.90	7	2	7	2	8	1	7	2

A – *ill plants*, B – *healthy plants*

Crop from each field as well as the paralysis of plants treated with three fungicides were compared in a controlled way. The analysis of the results of the three-year investigation discovered that the type of nozzle used did not have influence on the quality operation against pathogenic fungi in the security of chrysanthemums. Regarding the effect on health status and plant development chemical treatment with Amistar 250 SC seemed to have the biggest influence on healthiness of chrysanthemum plants.

THE STUDY ON CONSTRUCTIONAL SOLUTIONS OF MINERAL FERTILIZER DISTRIBUTORS WHICH AFFECT THE QUALITY OF SOWING

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Keywords: irregularity of fertilizer, quality of spread, rotary disc spreader

Introduction

The level of agricultural production is more and more conditioned by the application of industrial production means. The inappropriate use of such means can influence the quality of agricultural materials and pose a threat to environment. In order to achieve optimal crop yield modern and environmentally-friendly agriculture requires precise, economical and reliable fertilizing technique. Precise fertilization does not only mean accurate and fluent dosing by means of pin feeders [Podleśna 2006]. Separating nozzles used in pneumatic spreaders are of key importance in effective spreading of fertilizers. In spreaders with disc spreading systems, inclined discs are used to ensure a ballistic trajectory of ejected fertilizer. Such a trajectory enables fertilizer to drop onto cereal plants like falling rain. In addition a trajectory of that shape ensures regular spread, limited influence of wind on fertilizer trajectory, gentle fall of fertilizer, top dressing and zonal fertilizing without fixing additional elements. Simultaneously, the velocity of flying fertilizer is smaller than in the case of horizontal setting of discs.

Material and methods

The effect of work of mineral fertilization machines depends on many various, interacting factors. The physical and mechanical properties of fertilizers are of major significance since large diversity of these properties creates difficulties in the designing and construction of fertilizer distributors, and also it influences the quality of sowing.

The application of fertilizers is conducted with a particular accuracy, mainly characterized by a variation coefficient connected with the surface irregularity (the longitudinal and transverse one in relation to the direction of the unit ride) of the distribution of a fertilizer dose on a field surface. The transverse irregularity of spread mainly depends on the type of distributing unit, the longitudinal irregularity, however, on the fertilizer dosing unit. The irregularity of fertilizer distribution on a field surface influences yielding of

crops, including a fall in crops and the incomplete utilization of a fertilizer as well as the pollution of the natural environment [Kamiński 2000].

The irregularity of fertilizer spread is a phenomenon which occurs in every case of fertilizer application, both by hand and a machine. Generally, two types of irregularity can be identified, i.e. the punctual and belt one (the transverse and longitudinal one). The punctual irregularity results from a random distribution of fertilizer granules or grains sowed using any method and it is measured on definite, small areas. The belt irregularity results from a diverse fertilizer mass distribution in transverse and longitudinal directions in relation to the movement of the distributor. It is measured on large areas which are equivalent to the width of a sowing belt or a definite section of the distributor ride. This irregularity is measured using relative mean deviation or relative standard deviation, variation (irregularity) coefficient of fertilizer mass distribution. Many researchers claim that determining of longitudinal irregularity is inexpedient, because deviations from the mean distribution vary within a small range and the irregularity coefficient is small. For this reason, numerous methodological recommendations advise to replace measuring of longitudinal irregularity with the measurement of fertilizer dosage irregularity on a sowing disc [Witek 2000].

The regular distribution on a sowed field surface is one of the basic factors determining the quality of sowing. The question of distribution regularity is especially important in the case of applying various fertilizer doses, as it is practiced in modern precision farming in environment-friendly agricultural technologies. The basic criterion of evaluating the quality of fertilizer distributor work is the relative standard deviation of fertilizer transverse distribution. The transverse distribution is connected with the working width of a machine determined in such a way that allows for the overlapping of fertilizer spread belts from successive rides of a fertilizer distributor moving on the field in a sewing shuttle way. Another criterion is obtaining of the planned dose of fertilizer per 1 hectare, which is a variable in the function of the distance covered by a machine according to the plan of fertilization [Yilidrin 2006].

The distribution regularity is also affected by the shape of a distributing paddle, its height and place on the sowing disc. Some spreader manufacturers use diagonal cuts in paddles in order to optimize regular spread at a close distance from the discs. It is also crucial that a fertilizer spreader should be properly leveled otherwise fertilizer particles are ejected from the disc onto the field along different trajectories. Even 5^{O} of disc deviation results in considerable differences in the quality of fertilizer spread [Yilidrin 2008].

References

[1] Kamiński J. R.: 2000. *Metoda oceny wpływu parametrów tarcz rozsiewających na efektywność nawożenia.* Prace Naukowe IBMER Warszawa. 5 – 30.
[2] Podleśna A.: 2006. *Zasady zrównoważonego nawożenia*. Wieś Jutra. 7 (96). 6 – 8.
[3] Witek A.: 2000. *Równomierność dozowania nawozu na zespół roboczy rozsiewacza tarczowego.* Problemy Inżynierii Rolniczej Nr 1. Warszawa. 11 – 17.
[4] Yilidrin Y.: 2006. *Effect of vane number on distribution uniformity in single-disc rotary fertilizer spreaders.* Applied Engineering in Agriculture. Vol. 22 (5). 659 – 663.
[5] Yilidrin Y.: 2008. *Effect of vane shape on fertilizer distribution uniformity in single-disc rotary fertilizer spreaders.* Applied Engineering in Agriculture. Vol. 24 (2). 159 – 163.

USING THE ROSIN-RAMMLER EQUATION TO DETERMINE THE QUALITY OF SPRAYING

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Key words: quality of spraying, volume distribution of drops, irregularity of spraying

Introduction

Quality is a parameter defining a degree of fulfilling assumed aims. Tasks of spraying include removing reasons which hinder growth and plant yielding through bringing chemical agent in a particular place and in a specific dose with minimal effects for the environment. Most often in plant protection pressure sprayers are used which change potential energy of compressed liquid into kinetic energy of sprayed liquid. Amount of produced drops and their spectrum depend on operating pressure, size and shape of a nozzle and parameters of sprayed liquid. Air movement also has a big influence on the quality of spraying since along with the size of drop it decides about regularity of distribution of chemical agent and its impact on natural environment.

Aim, scope and principles

The aim of this study is to determine the size and amount of drifting of drops produced in sprayer with different wind velocity. A spectrum of drops produced by a flat stream sprayer LU 12003 in the pressure range 0.1 – 0.5 MPa was considered in the research [Szulc et all 2004]. In the calculations water was assumed as the sprayed liquid and the process of evaporation was not taken into account.

Accomplished tasks

The assumed aim was achieved by determining:

- The way which is travelled by a drop with diameter d from the moment of liquid outflow from a sprayer to reaching fall velocity;
- The distance l, to which a drop will move while falling with velocity v_{op} and wind effect in horizontal plane with velocity v_w(1-3m/s);
- The function of Rosin – Rammler $\Phi_3(d)$ for sprayer LU 12003 in the pressure range 0.1 – 0.5 MPa [Orzechowski, Prywer 2008];
- The dependence of function $\Phi_3(d)$ on the size of drifting l liquid;

Research results and their analysis

The conducted calculations of the Rosin – Rammler function have revealed that the increase of pressure in sprayer contributes to production of drops with bigger homogeneity. Heterogeneity of drops causes irregular spraying through their drifting by wind. As results from figure 1 with the spraying pressure 0.1MPa and wind velocity 1m/s, 38.7% of the volume(mass) of sprayed liquid is subject to drifting; it refers to the drop with diameter d<240μm. For instance 5% of liquid is drifted within the distance $l \geq 1$m [for l = 1m - $\Phi_3(d)$ = 0,05]. On the basis of this diagram we can also state that within the distance 0 to 1 m from sprayer 33,7% of liquid is drifted and 4% within the strip 1 – 2m. Over 2m from sprayer less than 1% of liquid is drifted, which does not have a significant impact on uniformity of spraying but with a large scale of agrotechnical sprayings in a particular area it affects the environment.

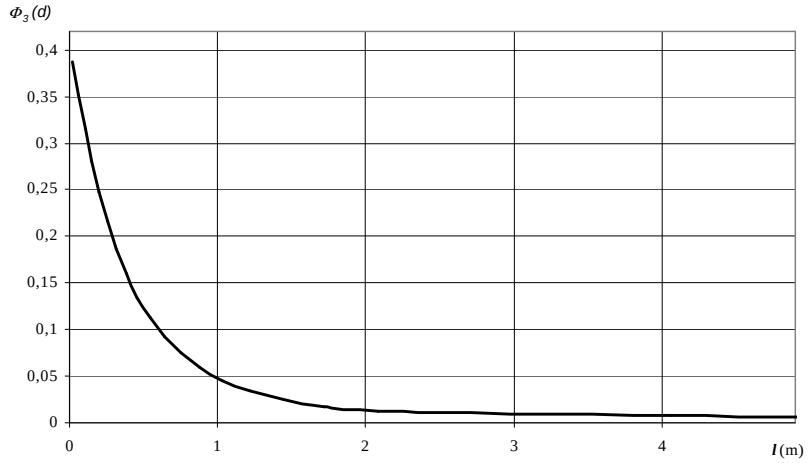

Figure 1. The size of drifting of drops with the spraying pressure 0,1 Mpa and wind velocity 1 m/s (diameter of drops 50 – 240 μm).

Conclusions

1. Heterogeneity of produced drops by sprayer has the influence on regularity of spraying.
2. Irregularity of spraying occurring as a result of drifting of drops by wind is significant.
3. The biggest irregularity of spraying occurs within a small distance from sprayer. With the increase of this distance the amount of drifted liquid is decreasing rapidly.

References

[1] Orzechowski Z.,Prywer J. 2008. Wytwarzanie i zastosowanie rozpylonej cieczy. WNT Warszawa.
[2] Szulc T., Sobkowiak B., Rogacki R., Popławski Z., Sadowski K. 2004. Wyniki badań rozpylaczy dla sprzętu polowego i sadowniczego. PIMR Poznań.

THE ENERGETIC ANALYSIS OF BLACK LOCUST TIMBER ACQUIRED IN FOREST STANDS ON CLAY SOIL

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Keywords: biomass energy, black locust

Introduction

The increased demand for energy, as well as ecological demands for environmental protection within the energy producing sector, contributes to the increased use of renewable energy sources (RES) [4]. The dominant, over 90% share within this field, is the energy of biomass [2]. Furthermore the increase of use of agricultural and not forest biomass is sought after [4].

In many cases the quality of soil is connected with the species of harvested plants. Not all kinds of soil ensure satisfying harvests and physical qualities of raw materials [5].

Taking the above ecological and economical factors of production of biomass as source of energy into account, research has started on the energetic analysis of black locust timber, acquired in forest stands on clay soil.

Methods

The research samples were taken in three monoculture forest stands located within two sites: Piaseczno - forest stands No. 1 and 2, aged 35 and Zawidza - forest stand No. 3, aged 41. Within all of the selected stands, with the use of sample tree method [1], a single tree - with an average height and diameter of trunk, was selected and chopped down. The chopped trees were then cut into trunks and branches, which served as source of samples for further laboratory tests that enabled us to determine:

- the relative moisture of fresh timber trunks and branches in bark content with the use of dryer-scale method, by drying the samples in temperature of 105°C in convection dryers;
- the density of timber trunks and branches in bark - both fresh and dry, with the use of weighing and volumetric calculations;
- the calorific value of dry timber trunks and branches in bark - with the use of calorimetry, using KL-12Mn static calorimeter;
- the volumetric calorific value of dry timber in bark, as the product of density and calorific value.

Results

The results of research were introduced in table 1.

Table 1. Physical qualities black locust timbers in bark.

No. forest stand	Assortment	The relative moisture of fresh timber [%]	The density of fresh timber [kg·m^{-3}]	The density of dry timber [kg·m^{-3}]	The calorific value of dry timber [MJ·kg^{-1}]	The volumetric calorific value of dry timber [GJ·m^{-3}]
1	trunk	30	828	648	17.77	11.51
	branches	32	796	554	18.01	9.98
	whole tree	30	824	636	17.80	11.32
2	trunk	28	838	707	18.12	12.81
	branches	33	894	645	17.67	11.40
	whole tree	29	847	698	18.05	12.60
3	trunk	27	855	726	17.61	12.78
	branches	37	880	718	17.75	12.74
	whole tree	29	859	725	17.63	12.78
Average	trunk	28	840	694	17.83	12.37
	branches	34	857	639	17.81	11.37
	whole tree	29	843	686	17.83	12.24
Standard deviation	trunk	1.36	13.65	40.67	0.26	0.74
	branches	2.66	53.00	82.16	0.18	1.38
	whole tree	0.76	17.79	45.63	0.21	0.80

There was a substantial difference observed within test conditions, between the moisture content of fresh timber trunks in bark and branches in bark. The examined stands of black locust the average relative moisture content of timber branches in bark was 21% higher than the value of this parameter for timber trunks in bark, with the standard deviation being relatively 2.66 and 1.36 (tab. 1).

Some minor differences in density of fresh and dry timber trunks and the corresponding parameters timber branches in bark were also observed. The average density of fresh timber branches in bark was 2% higher than value of this parameter for timber trunks in bark, with average density of dry timber branches in bark being 8% lower than the density for timber trunks in bark. The standard deviations for these parameters were, in case of fresh timber - 53.00 and 13.65; 82.16 and 40.67 for dry timber, correspondingly (tab. 1). The calorific values of both dry timber trunks and branches in bark were almost equal and their average values were, correspondingly 17.81 and 17.83 [MJ·kg^{-1}]. The standard deviation for these parameters of timber trunks in bark was 0.26; while for the timber branches in bark it had the value of 0.18. The difference between the selected values of density of the inspected sorts of timber largely influenced the volumetric calorific value. The average of this parameter for timber trunks in bark was 12.37 and for timber branches

11.37 [GJ·m^{-3}]. The standard deviations for these values were, accordingly 0.74 and 1.38 (tab. 1).

Discussion

The timber of black locust is perceived as a very good source of energy, being the heaviest kind of timber that can be harvested from re-growing plantations, within the natural conditions in Poland [6].

During the examination, comparison with the timber of willow and poplar [3; 6] has showed that the black locust timber contained approximately half the content of water, had an almost 70% higher density and only slightly lower calorific value. From the point of view of energy production the black locust timber has favourable physical characteristics, with the lead parameters being its moisture content and timber density, a source of its large volumetric calorific value.

The energetic plantations of black locust, planted on clay soil stands can form an alternative for production of valuable raw material, bringing about, at the same time, measurable ecological effects, agreeable with the conception of sustainable development.

References

[1] Bruchwald A. 1999. *Dendrometria*. SGGW. Warszawa.
[2] GUS. 2010. *Energia ze źródeł odnawialnych w 2009 r.* Warszawa
[3] Krzysik F. 1974. *Nauka o drewnie.* PWN. Warszawa.
[4] *Rozporządzenie Ministra Gospodarki z dnia 14 sierpnia 2008 r. w sprawie szczegółowego zakresu obowiązków uzyskania i przedstawienia do umorzenia świadectw pochodzenia, uiszczenia opłaty zastępczej, zakupu energii elektrycznej i ciepła wytworzonych w odnawialnych źródłach energii oraz obowiązku potwierdzania danych dotyczących ilości energii elektrycznej wytworzonej w odnawialnym źródle energii.* Dz.U. 2008. Nr 156 poz. 969.
[5] Świętochowski A., Grzybek A., Gutry P. 2011. *Wpływ czynników agrotechnicznych na właściwości energetyczne słomy.* Problemy Inżynierii Rolniczej. Nr 1. 41-47.
[6] Zajączkowski K. 2007. *Robinia akacjowa jako roślina energetyczna.* Wokół Energetyki. Vol. 10. s. 30-33.

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INCOMES, EXPENDITURES AND PROFITS IN DEVELOPING FAMILY FARMS

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Keywords: agriculture, farm, technical means, methodology

Summary

Within the frames of realized 3-year's (2009-2012) research and development project on "Technological and ecological modernization of selected family farms", the specialists from the Institute of Technology and Life Sciences, as well as from agricultural universities in Poznań, Kraków, Lublin and Siedlce, investigate the equipment and activities of 53 selected family farms, localized in different regions of Poland. Investigations are carried out according to settled methodology (Wójcicki et al., 2009) and the synthetic results of particular research tasks realized within the project have been published in successive monographs (Wójcicki, 2010; Wójcicki, Kurek, 2011; Kurek, Wójcicki, 2011). This paper contains the synthetic results of productive-financial activities in 2009 year for 53 selected modernized family farms. The farms of acreage from 8.5 to 150 ha AL, are characterized by using their crop production mainly for fodder of raised cows and other cattle or swines. Besides the general characteristics of surveyed farms (Table 1) and obtained by them incomes, expenditures and profits (Table 2), detailed analysis included material and non-material inputs born during a year for production and service activities. Surveyed objects were divided into five acreage groups (Table 1), by 10 farms in groups I – IV, and 13 farms in group V (Kurek, Wójcicki, 2011).

Table 1. General characteristics of surveyed farms.

Farm acreage group	**Number of farms (pcs.)**	**Average AL area (ha) per 1 farm**			**Livestock density (LU) per 1 ha AL (agricultural land)**	**Value of permanent assets (thous. PLN per 1 ha AL)**	
		AL (agricultural land)	**inclusive:**				
			AL (arable land)	PG (permanent grassland) and other		technical means	buildings and structures
I	10	16.01	9.77	6.24	1.26	33.22	57.61
II	10	24.67	16.76	7.91	1.07	33.86	41.38
III	10	32.44	24.73	7.71	1.22	26.51	29.82
IV	10	48.85	33.82	15.03	1.12	25.28	19.80
V	13	86.48	76.96	9.52	0.62	11.85	13.13
In total	53	44.23	34.93	9.30	0.83	22.15	24.73

Source: own results

Differential balance between estimated incomes (effects) of a farm and the expenditures (inputs) born indicates (table 2) the profits obtained by surveyed object in 2009, and thus, the possible payment to be available to the members of farm owner family for their work.

Table 2. Incomes obtained by surveyed farms in year 2009.

Farm acreage group	**Incomes, expenditures and profits (thous. PLN) in 2009**					
	average per 1 farm			average per 1 ha AL		
	incomes	expenditures	profits	incomes	expenditures	profits
I	164.35	123.72	40.63	10.26	7.73	2.53
II	261.65	184.86	76.79	10.61	7.49	3.12
III	281.78	179.76	102.02	8.69	5.54	3.15
IV	447.65	297.92	149.73	9.16	6.10	3.06
V	743.4	625.07	118.33	8.60	7.23	1.37
On average	400.35	301.67	98.68	9.05	6.82	2.23

Source: own results 2011

Balances of financial-economic activity in investigated farms showed that they obtained extraordinary gross incomes amounting on average to 9.05 thous. PLN per 1 ha AL, whereas the commodity average for surveyed farms in 2009 was twice lower.

In the structure of average incomes 52.1 % made the value of sold animal production and 16.5 % the market agricultural production, while 31.6 % gross incomes were extra charges and recoveries (13.5 %), credits (12.9 %), non-agricultural production (2.8 %), as well as the retired pays and other (2.2 %). The inputs (expenditures) born by surveyed farms in 2009 year amounted on average to 6.82 thous. PLN per 1 ha AL, what was equivalent to 75.36 % of gross income value (balance sum). In the structure of these average inputs 28.3 % took the replacement and development investments, 25.8 % purchase of agricultural origin products, 12.8 % mineral fertilizers and other agrichemicals, 11.2 % direct energy carriers, 10.2 % tax duties and other immaterial, 5.6 % the charges and materials, 3.3 % services and others material, and 2.8 % the salaries of outside workers.

The agricultural profit (of farms) amounted on average to 4.65 thous. PLN per ha AL, whereas the gross profit of farmer's families reached on average 2.61 thous. PLN/ha AL; that enabled to obtain quite high wages for the own work: 29.50 PLN/work hour of productive labour or 22.55 PLN/work hour of general labour inputs of the family members on average.

The activities of surveyed farms in 2009 ought to be positively estimated, as almost all farms under investigation fulfilled the demands made to developing family enterprises.

The year 2009 was propitious to productive and incoming activities for surveyed farms and – according to the preliminary comparative analyses – it was better than the average balance results obtained in 2010, and then the results assumed in modernization projects for 2015.
It will be also better than the results expected to be obtained in crop production on investigated farms in 2011.
The Institute of Technology and Life Sciences (ITP) has originated, and is still developing, an extensive base of empirical data concerning the equipment and activity of selected family farms; it is a basis to preparing detailed scientific-technical comparative analyses connected with investigations on technological modernization of developing family farms in Poland.

References

[1] Kurek J., Wójcicki Z. 2011. Wyposażenie techniczne i nakłady pracy w wybranych gospodarstwach rodzinnych. (Technical equipment and labour inputs in selected family farms). Problemy Inżynierii Rolniczej. No.3 (in press).
[2] Kurek J., Wójcicki Z. 2011. Technologiczna i ekologiczna modernizacja wybranych gospodarstw rodzinnych. (Technological and ecological modernization of selected family farms). Part IV, ITP – Falenty (prepared to publication).
[3] Wójcicki Z. et al. 2009. Technologiczna i ekologiczna modernizacja wybranych gospodarstw rodzinnych. (Technological and ecological modernization of selected family farms). Part I. pp. 149.
[4] Wójcicki Z. 2010. Technologiczna i ekologiczna modernizacja wybranych gospodarstw rodzinnych. (Technological and ecological modernization of selected family farms). Part II. ITP Falenty, pp.89.
[5] Wójcicki Z., Kurek J. 2011. Technologiczna i ekologiczna modernizacja wybranych gospodarstw rodzinnych. (Technological and ecological modernization of selected family farms). Part III. ITP Falenty pp.122.

TRANSMISSION OF THE FUEL PRICES INTO TRACTOR OPERATION COSTS

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Keywords: tractor operation costs, fuel prices, price transmission

Introduction

Liquid fuels are one of the most important energy sources used in agriculture and therefore they contribute greatly into the production costs. Continues fluctuation of crude oil prices influence the constant changes in the prices of the diesel. In years 2001-2011 the average diesel price in Poland doubled, whereas from 2007 increased by ca 40%. The above is due to both changes in the price of the crude oil and also fluctuations in the exchange rate of the currency in which the oil is purchased. The fuel cost is the major contributor (approximately 50%) to the operation costs of tractors.

Material and methods

The main purpose of the analysis was to assess the influence of the fluctuation of crude oil price on fuel price and unit operational costs selected tractors in years 2007-2011. Fluctuation in crude oil may represent an additional factor stimulating the price transmission to agriculture product market [1, 3]

The analysis was based on the following data; the average crude oil price REBCO (Russian Export Blend Crude Oil) [7], currency exchange rates [6] and price of diesel on the Polish market from January 2005 to June 2011 [5].

The above using data was used to calculate the unit operational costs applying methodology as described in [2]. The calculations were done for selected tractors grouped in two classes depending on their power (70 KM - ca. 53 kW) and 110 KM - ca 80 kW) and in two classes depending on the producer (“Eastern” and “Western”). The power classes reflect the most popular tractors purchased by the farmers in Poland.

The brands and the models of the tractors considered were Zetor (Proxima 75 and Forterra 115), John Deere (5415 and 6420 SE) and New Holland (TN70NA and T6020). Economic life-time was assumed to be 18 years and the 500 hours of average annual work.

Results

The collected data indicates that the monthly average oil REBCO price increased during the period under consideration by 116%; although, in 2008 the price was higher than in the first half of the current year. The maximum

price in the period was $135.38 for barrel and has dropped recently to $112.88 (Fig. 1). Political conditions, such as e.g. the war in Iraq, were the major factors influencing the price fluctuations.

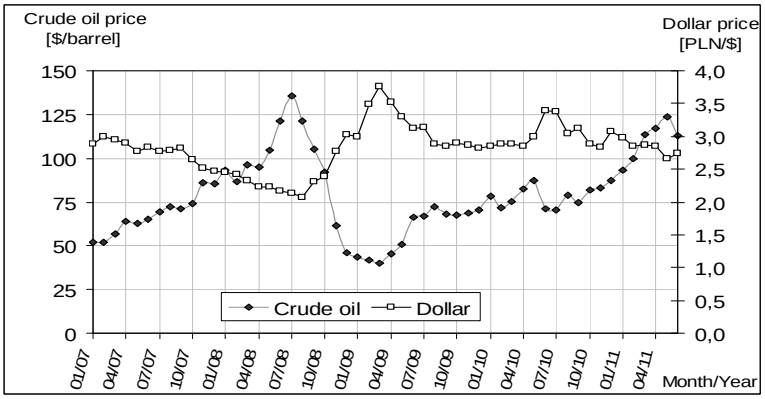

Figure 1. Monthly average oil REBCO price and the exchange rate US dollar ($) and Polish Zloty (PLN) for period 2007-2011.

It is worth noting that there was no direct relation between the price of crude oil and the price of fuel petrol on the Polish market. It was due to the fact in the periods of dramatic increase of the oil price the exchange rate of US dollar to Polish zloty decreased. During the period under consideration, the US$/PLN exchange rate varied from 2.07 to 3.77 (Tab. 1).

It is quite evident that the monthly average oil price has the tendency to increase; increased from 3.57 PLN/l in January 2007 to 4.96 PLN/l in June 2007, high increments were noted in July 2008 up to 4.68 PLN/l and again in April 2011, when the price crossed the barrier of 5 PLN/l (Fig. 2 and Tab. 1).

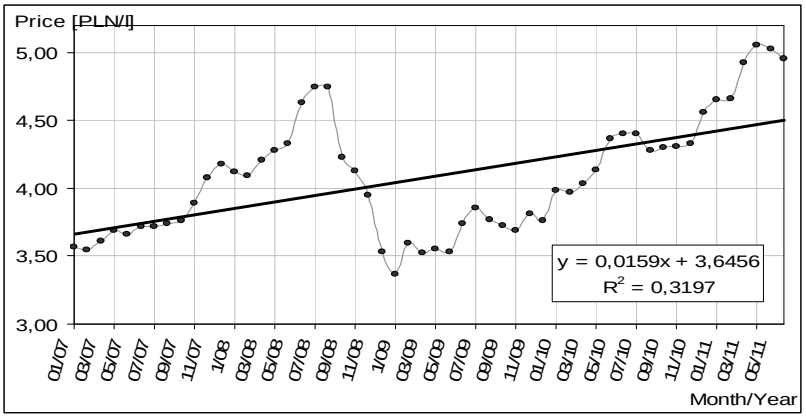

Figure 2. Monthly average diesel fuel prices in Poland for period 2007-2011.

However, despite 62.2% percentage increase in crude oil prices, the price of diesel increased only by 29.7% (Tab. 1).

Table 1. Yearly average prices of crude oil, diesel and US$ for period 2007-2011.

Average oil REBCO price [US$ / barrel]	**2007**	**2008**	**2009**	**2010**	**2011**	**2007-2011**	**Change [%]**
Average	67.52	96.61	57.62	78.56	109.51	78.73	62.2
Maximum	85.87	135.38	72.33	87.29	123.47	135.38	-
Minimum	52.20	46.30	40.27	70.69	93.19	40.27	-
Average US$Exchange Rate [PLN]	2007	2008	2009	2010	2011	2007-2011	
Average	2.7796	2.3791	3.1632	3.0159	2.8386	2.8285	2.1
Maximum	2.9973	3.0338	3.7674	3.3953	2.9822	3.7674	-
Minimum	2.473	2.0665	2.8248	2.8297	2.6541	2.0665	-
Average oil REBCO price [PLN / barrel]	2007	2008	2009	2010	2011	2007-2011	
Average	186.15	223.90	180.70	236.40	309.94	218.25	66.5
Maximum	216.26	288.26	210.65	268.23	333.07	333.07	-
Minimum	155.85	140.46	151.71	205.71	277.91	140.46	-
Average diesel price [PLN / l]	2007	2008	2009	2010	2011	2007-2011	
Average	3.77	4.28	3.68	4.27	4.89	4.09	29.7
Maximum	4.22	4.68	3.93	4.50	5.08	5.08	-
Minimum	3.51	3.96	3.44	3.95	4.66	3.44	-

During the period under review, the prices of tractors remained relatively unchanged. The manufacturers tried to adjust their prices to purchasing capacity of the farmers. However, in case of tractors produced in developed countries (Western Europe and USA) the price depended also on the Euro or US dollar exchange rate. Tractor prices were normally fixed for a year, with changes usually taking place in autumn/winter. For the analysed period the prices of the selected tractors varied between 102 to 227 thousands of Polish Zloty and increased between 8% and 22% (Tab. 2)

Table 2. Net prices of tractors considered for period 2007-2011.

Tractor	Power [kW]	Minimum Price [PLN]	Maximum Price [PLN]	Change [%]
Zetor	53	102 000	130 500	21.8
Zetor	81	150 000	166 000	9.6
John Deere/ New Holland	53	128 000	137 000	6.6
John Deere/ New Holland	81	209 000	227 000	7.9

The calculated tractors' operational costs varied from 51.34 PLN/h to 87.06 PLN/h. The lowest costs were observed for tractors Zetor of 53 kW power; these are relatively cheap tractors with low fuel consumption. The highest costs were noted for tractors John Deere and New Holland with power of 83 kW (Fig. 3).

The share of the fuel cost in the total operational cost was fluctuating from 48% to 58%, depending on the period (Fig.4).

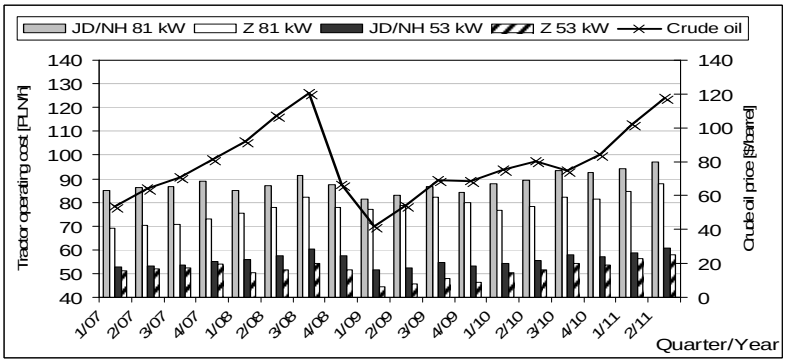

Figure 3. Tractor operational costs vs oil price.

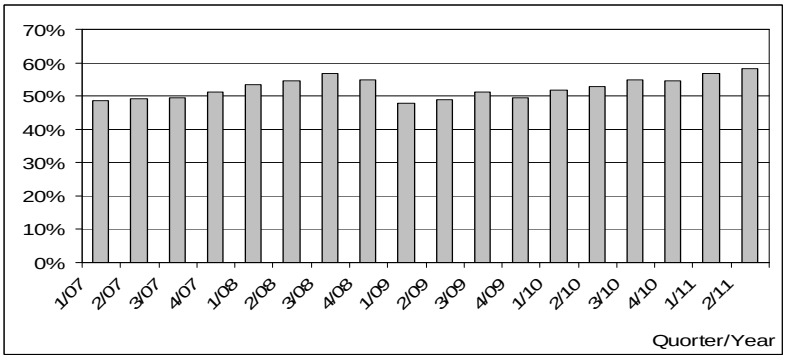

Figure 4. Fuel cost as the share of the operational costs for the selected tractors in 2007-2001 (by quarters).

Conclusions

Despite huge increment of the oil prices on the international market in period 2007-2011 the price of diesel on the Polish market increased only approximately half of that. That indicates that the price transmission was asymmetric which has been also confirmed by other market research [4]. Also, the price dynamic for tractors was lower than that of the fuel prices. These are the reasons that the unit operational costs of the selected tractors increased only by ca 15%. Fuel price had the highest contribution (ca 50%) in the total operational costs.

References

[1] Figiel Sz., Białek A. 2005. *Zagadnienie transmisji cen na rynkach produktów rolnych i żywnościowych.* RN Seria, t.VII, z.5, Warszawa- Poznań, p. 26-32
[2] Lorencowicz E. 2007. *Poradnik użytkownika techniki rolniczej w tabelach.* APRA Bydgoszcz. pp.131
[3] Rembeza J. 2010. *Transmisja cen w gospodarce polskiej.* Wyd. Politechniki Koszalińskiej. Koszalin. pp.181
[4] Wlazlowski, S., Nilsson, B., Binner, J., Giulietti, M. and Milas, C., *New York Mark-ups on Petroleum Products*, Manchester School (September 2009). MSH-2009-0003.R1.
[5] www.e-petrol.pl
[6] www.money.pl
[7] http://www.wikinvest.com/futures/Russian_Export_Blend_Crude_Oil_(REBCO)

FUEL AND SPECIFIC ENERGY CONSUMPTION FOR SOIL TILLAGE DEVICES AT DIFFERENT WORKING DEPTHS

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Keywords: fuel consumption, soil tillage, working depth, mouldboard plough, disc harrow, subsoiler

1. Introduction

Soil tillage in conventional tillage systems is one of the most energy consuming processes. The intensity of soil tillage depends on the number of soil tillage operations, kind of device (active driven by PTO or passive by drawbar power), implement geometry and depth of operation (Loibl 2006, Godwin 2007). Fuel consumption of soil tillage is correlated with intensity of soil tillage. In the energy flow from engine to implement there are efficiency loses in the engine, transmission and wheel-soil interface (Schreiber et al. 2004, Jahns and Steinkampf 1982). From the average fuel consumption for ploughing (25 litre/hectare) only 5 litre/hectare of the fuel energy is used for the necessary drawbar power (Kutzbach 1989). Depending on the soil constitution, the fuel consumption increases per centimetre ploughing depth between 0.5 and 1.5 l/ha (Moitzi et al. 2006; Kalk and Hülsbergen 1999). Moreover slippage, which is an expression of the traction efficiency, affects the field performance and the fuel consumption.

This paper deals the influence of working depth on slip and fuel consumption during stubble field skimming with a short disc cultivator, ploughing with a 2x4-mouldboard plough and subsoiling with a subsoiler (fixed tines) in a representative region for cereal growing in the Eastern region of Austria.

2. Materials and methods

2.1 Site description

The experiments (Table 1) were conducted on the arable fields at the research station Gross Enzersdorf (Lower Austria) of the University of Natural Resources and Life Sciences (BOKU) in Vienna.

The experimental site is situated in the semi-arid region with an average rainfall of 546 mm and average temperature of 9.8°C. The silty loam soil belongs to the soil type Chernozem.

Table 1. Overview of the investigations.

	Ploughing	**Stubble field skimming**	**Sub soiling**
Soil tillage device (working width)	2x4 mouldboard plough (170 cm)	Short disc harrow (300 cm)	Subsoiler (300 cm)
Time of investigation	3th November 2005	31st July 2008	21st October 2008
Previous crop	corn	winter rapeseed	corn
Mean water content in the soil (gravimetric)	14.3 % (0-30 cm)	18.3 % (0-20 cm)	16.9 % (0-40 cm)
Mean bulk density	1.35 g/cm^3	1.40 g/cm^3	1.39 g/cm^3

2.1 Tractor with measurement equipment

For the investigation a four-wheel-tractor (Steyr 9125) with an engine power of 92 kW (DIN) was used. The engine with exhaust turbo supercharger has 6 cylinders with a displacement of 6,600 cm^3. The transmission (Steyr-Power-4) is a full synchron multistep powershift with 4x6 gears. The basic weight is 6220 kg and was ballasted with a front ballast of 830 kg.

For the measurement of the fuel consumption a high-performance flow-meter (AVL PLU 116H) with a proportional – integral (PI) – controller was integrated in the fuel system of the tractor. The signals of the radar sensor, transmission sensor, inductive sensor and flow-meter (Table 2) were recorded with a scan frequency of 1 Hz with a multi-channel datalogger (Squirrel Datenlogger 2020).

Table 2. Processing parameter and their measurement.

Process parameter	**Measurement engineering**
Vehicle speed (v)	Radar sensor: generates a rectangular signal (130 pulses/m = 27,8 Hz/(km/h)
Wheel speed (v_0)	Transmission sensor (inductively transducer), generates a alternative current (0.4 - 3.8 V), rectified with diode rectifier
Engine speed (n_M)	Inductive sensor: generates a rectangular signal: 0-12 V
Position lifting system	> 50 % = 12 V, < 50 % = 0 V
Fuel consumption (B)	Flow-meter (PLU 116 H), inductive displacement sensor generates a digital rectangular signal (22 - 2800 Hz)

3. Results

3.1 2x4 mouldboard plough

Whereas the fuel consumption in l/ha increases linearly with the working depth, the fuel consumption in l/h increases according an quadratic polynomial function (Figure 1). At the working depth of 35 cm the engine was well loaded, which resulted in a declining increase of the hourly fuel consumption. The mean engine speed ranged between 1732 and 1873 rev/min, the vehicle-speed from 6.69 - 6.80 km/h, the field performance between 1.13 - 1.19 ha/h. Slip increased from 3.3 % to 6.12 % with rising working depth.

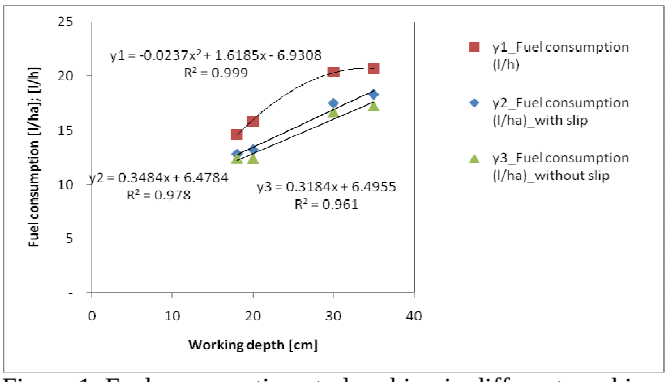

Figure 1. Fuel consumption at ploughing in different working depths (18, 20, 30 and 35 cm).

3.2 Short disc harrow

The mean engine speed ranged between 1711 and 1733 rev/min, the vehicle-speed from 8.10 - 8.22 km/h, the field performance between 2.43 - 2.47 ha/h. Slip increased from 3.4 % to 6.0 % with rising working depth.

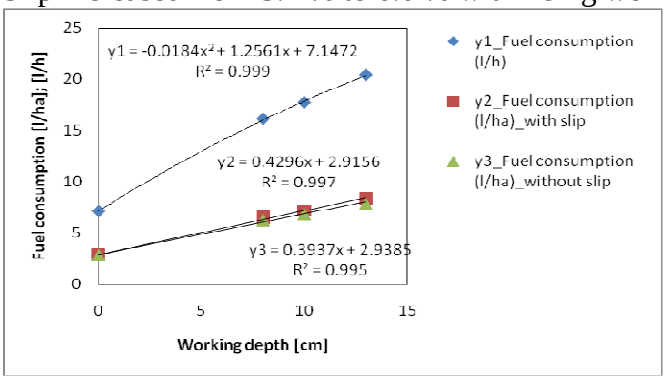

Figure 2. Fuel consumption at stubble field skimming with a disc harrow in different working depths (0, 8, 10 and 13 cm).

3.3 Subsoiler

The mean engine speed ranged between 1691 and 1720, the vehicle-speed from 3.17 - 3.41 km/h, the field performance between 0.89 - 1.02 ha/h. Slip increased from 4.3 % to 16.4 % with rising working depth.

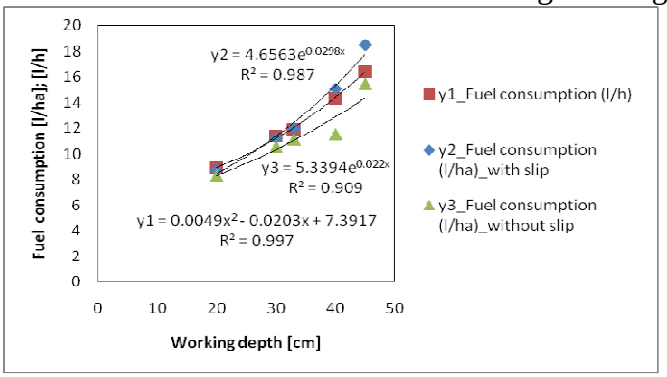

Figure 3. Fuel consumption for subsoiling in different working depths (20, 30, 33, 40 and 45 cm).

3.4 Specific energy consumption

The effective moved and loosened soil for ploughing is 100 % of the measured working depth and working width, while it is estimated 70 % for the short disc harrow and subsoiler. The so calculated specific energy consumption (parameter which describes the energy intensity of the moved soil) decreases with the increased working depth (Figure 4). The increase after the minimum at 33 cm working depth for the subsoiler is the combined effect of increased slip and hourly fuel consumption.

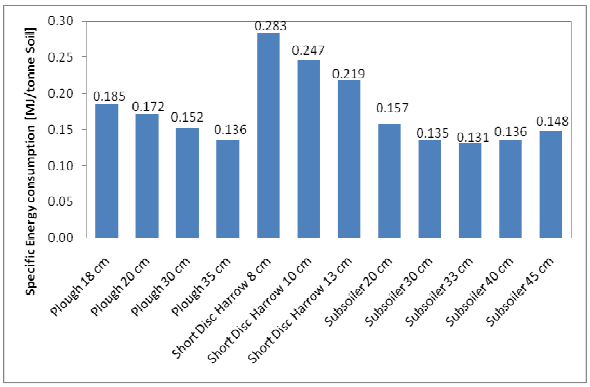

Figure 4. Specific energy consumption for soil tillage devices at different working depth.

4. Conclusions

- The slip in soil tillage is an important factor for analysis of fuel consumption.
- With increasing working depth, the slip rises.
- The fuel consumption [l/ha] increases linearly with working depth for mouldboard plough and short disc harrow.
- For subsoiling the fuel consumption [l/ha] increases disproportionately.

5. References

[1] Godwin R.J. 2007. A review of the effect of implement geometry on soil failure and implement forces. Soil & Till. Res. 97. 331-340.
[2] Jahns G., Steinkampf H. 1982. Einflussgrößen auf Flächenleistung und Energieaufwand beim Schleppereinsatz. Grundlagen der Landtechnik Bd. 32. Nr. 1. S. 20 – 26.
[3] Kalk W.-D., Hülsbergen K.-J. 1999. Dieselkraftstoffeinsatz in der Pflanzenproduktion. Landtechnik 54(6). 332-333.
[4] Loibl B. 2006. Classification of Tillage Systems by including Soil Covering. 61 Landtechnik SH/2006. 302 - 303.
[5] Moitzi G., Weingartmann H., Boxberger J. 2006. Effects of tillage systems and wheel slip on fuel consumption. In: The Union of Scientists - Rousse: Energy Efficiency and Agricultural Engineering. 7. - 9. June 2006. Rousse. Bulgaria. 237-242
[6] Kutzbach H-D. 1989. Lehrbuch Agrartechnik Band 1: Allgemeine Grundlagen – Ackerschlepper – Fördertechnik; Verlag Paul Parey 1989.
[7] Schreiber M., Schutte B., Kutzbach H.D. 2004. Kraftstoffverbrauch bei der Bodenbearbeitung. 59 Landtechnik 4/2004. 2004-2005.

COMPARISON OF ENERGY CONSUMPTION FOR PELLETS AND BRIQUETTES PRODUCTION FROM PLANT BIOMASS

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Keywords: plant biomass, pellets, briquettes, production, energy consumption

Introduction

The pellets and briquettes production from plant biomass is becoming more and more common and it may be predicted that it will be highly significant also for agricultural production. The current trends in professional energy development aim at the growing use of renewable energy sources, particularly of biomass. It is one of the main unconventional energy sources in Poland [Niedziółka, Szymanek 2010]. Plant biomass, especially straw, needs a lot of storage space. That is why, in order to improve the energetic efficiency of the fuel, it should be properly processed. Hence, there is a tendency for the compacting of solid biomass by its pelleting or briquetting [Hejft 2011, Mani at.al. 2006, Wach 2011].

Materials and methods

The following raw materials were used for the pellets and briquettes production: cereal straw and meadow hay. Moisture of the raw materials was approximately 11-16%. Pellets from the tested plant materials were produced in pelleting machine with flat matrix (fig. 1a). Rotational speed of matrix was 230 and 290 rpm. Briquettes were produced in the screw briquetting machine JW-08 (fig. 1b). The temperature in the compaction chamber in this briquetting machine was: 200, 225 and 250°C. Moisture content was determined by means of dryer-weight method with conformity to PN-ISO 6540 norm. Plant materials, prior to briquetting, were shredded in chaff cutter to theoretical length of 20 mm. While before the pelleting the plant materials were additionally crushed using chopper with sieves of 3 mm openings. Energy consumption during the compaction of biomass was recorded using a power and time converter type of Lumel PP83, cooperating with the computer.

a) b)

Figure 1. Compacting machines for: a) pelleting, b) briquetting.

Test results

The average power consumption for compacting of cereal straw, at a speed of 230 rpm matrix, amounted to 0.143 kWh·kg^{-1}, and at a speed of 290 rpm obtained a value of 0.125 kWh·kg^{-1}. The average energy consumption for pelleting of hay meadow, at a speed of 230 rpm matrix amounted to 0.155 kWh·kg^{-1}, and at a speed of 290 rpm reached a value of 0.132 kWh·kg^{-1}.

Comparing the energy consumption of the process of compaction plant materials, it was found that increasing the speed of a matrix from 230 to 290 rpm caused a decrease in energy consumption by about 15.0% for pellets with hay and about 12.5% in the case of straw pellets.

Based on the results of research it was found that with increasing temperature in the chamber briquetting decreased energy consumption. In the case of 200°C range of energy consumption was from 0.145 to 0.183 kWh·kg^{-1}, for temperature 225°C from 0,134 to 0,169 kWh·kg^{-1}, whereas for 250°C from 0,114 to 0,152 kWh·kg^{-1}.

In turn, comparing the energy consumption of plant material briquetting process, it was found that lower power consumption values were recorded for cereal straw (0.128-0.145 kWh·kg^{-1}), and higher for hay meadow (0.152-0.183 kWh·kg^{-1}). The decrease in energy consumption in the production of briquettes between the temperature of 200 and 250ºC for cereal straw was about 13.0%, and for hay meadow has obtained a value of about 20.0%.

Conclusions

Based on the obtained results can be stated the following conclusions:

1. The energy consumption of the pelleting plant materials in relation to the unit formed agglomerates decreased with increasing rotational speed thickening matrix of pelleting machine. More favorable results were obtained in the case of compaction of the crushed cereal straw, and slightly less favorable in the case of hay meadow.
2. The energy consumption of the briquetting process of plant materials decreased with increasing temperature of chamber thickening. The lowest energy consumption occurred during briquetting cereal straw, and much more for hay meadow.

References

[1] Hejft R. 2011. *Energochłonność procesu peletowania i brykietowania.* Czysta Energia, No. 6, p. 40-41.
[2] Mani S., Tabil L., Sokhansanj S. 2006. *Effects of compressive force, particie size and moisture content on mechanical properties of biomass pellets from grases.* Biomass and Bioenergy, No. 30, p. 648-654.
[3] Niedziółka I., Szymanek M. 2010. *An estimation of physical properties of briquettes produced from plant biomass.* Teka Komisji Motor. i Energ. Rol., Vol. X, p. 301-307.
[4] Wach E. 2011. *Aktualności z rynku pelet w Polsce i Europie*. Czysta Energia, No. 6, p. 42-44.

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AGRICULTURAL COMPETITIVENESS AND EUROPEAN INTEGRATION: RE-DISCOVERING THE SUSTAINABLE DEVELOPMENT

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Keywords: agricultural competitiveness, trade balance, standards of living, sustainable development

Abstract

The liberalization of international trade, due to the elimination of market barriers between countries, within the context of economic unions, like the European Union (EU), the commercial preferential regimes and the expansion of globalization, has caused increased competitiveness, at both geographical and sectoral level. Concepts such as: development, productivity, effectiveness and competitiveness have acquired a new dimension for the productive sectors since the wider an economy is, the more the dual nature of competitiveness, domestic and international, is reinforced.

A number of definitions regarding competitiveness and its measurement tools have been proposed, depending on the level of the analysis, i.e. country or region, industry, firm and product level. For some researchers, competitiveness is seen as the ability to perform well, while for others it is the generation and maintenance of a comparative advantage of countries. Besides the above, competitiveness is also defined as the management of decisions and processes taking into account the interests of society, and where investments, and R and D are crucial for sustaining and improving the comparative advantage of countries on a long term basis. Scholars of international competitiveness are studying the relationships between growth and the trade balance of an open economy, trying at the same time to identify their determining factors.

In the beginning, the notion of competitiveness was used to demonstrate the ability of a firm or an industry to cope with the competition of its opponents. Later on, such notion was of a wider application both at the level of centralized policy formation, even at the level of the EU, and in the form of an index measuring the ability of local economic systems: "regional competitiveness". The European Commission views the improvement of competitiveness in Europe's lagging regions as vital to "social cohesion" [4].

Although the notion of a competitive business is to a large extent straightforward, there is still no persuasive theory to explain national competitiveness. R. Landau (1992) defines a nation's competitiveness "as the ability to sustain an acceptable growth rate and real standard of living for

their citizens while efficiently providing employment without reducing the growth potential and standard of living for future generations" [3]. European Commission (2009) documents state accordingly: "competitiveness is understood to mean a sustained rise in the standards of living of a nation or region and as low a level of involuntary unemployment as possible" [1]. These definitions combine competitiveness with sustainability and social goals.

The European Competitiveness Report (2009) reviews the EU's overall competitiveness performance as well as the external and internal aspects of competitiveness. External aspects concern the international presence of production sectors whose main goal is the maintenance and increase of their export market share. In particular, this report explores the external dimension of competitiveness by analyzing the consequences of recent developments among the BRIC countries (Brazil, Russia, India and China) in the global arena. Internal aspects are related to the shaping of the productivity level at a European level and the factors that influence this [1].

If we are to examine the competitiveness of firms, this concept can be defined as the immediate and future ability of, and opportunities for, entrepreneurs to profitably design, produce and market value worldwide whose price and non-price qualities form a more attractive package than those of foreign and domestic competitors. At an international level, competitiveness measures whether a commodity can compete with similar goods in the international market, given the costs incurred in the production process. If a product is competitive, then it can co-exist with the imports of a country and/or can be exported. By contrast, if the product is not competitive, then it needs protection from imports, its export potential is low and only if it is subsidized, can the competitiveness of such a product improve in relation to its price.

Jan Fagerberg (1988) notes that "factors related to technology and capacity are indeed very important for medium and long run differences across countries in growth of market shares and GDP, while cost-competitiveness plays a more limited role than commonly assumed". He develops a model of international competitiveness which relates growth in market share to three sets of factors: the ability to compete in technology, in price, and in delivery [2].

Regarding the agricultural sector, the measurement tools of its competitiveness are production growth, productivity and international competitiveness. In spite of this, due to the difficulty of measuring the above, the tool which is widely used is international competitiveness. This is expressed by the ability of a country to deliver products in a competitive price, better quality and differentiated in comparison to the competition. The

competitiveness of an export country is usually measured by taking into account two criteria: price competitiveness and performance competitiveness, which includes quality competitiveness.

In low-income countries, such as Greece before its accession to the EU, development planners were continually confronted with the question of whether to export agricultural products, import them, or strive for food self-sufficiency, but such a dilemma was never an issue for Greece. Since 1962, when the Association Agreement between Greece and the EU entered into force, the country was exposed to international economic interests and no policy was implemented to restrict their expansion. The accession of Greece to the European Economic Community in 1981 marks the complete opening of the Greek economy to globalization and the international politico-economic system.

However, the Common Agricultural Policy application found country's agriculture unprepared and weak to face the aggressive strategies of European and non-European multinational firms. The price increase of a large number of products due to the increase of their production cost but also due to the leveling out with the average European prices reduced their international competitiveness. Exports were limited to a small number of products or had to be subsidized.

Because of intrinsic weaknesses, such as in livestock production and the limited flexibility of many crop productions, the position of Greek products deteriorated not only globally but particularly in the domestic market. The rise of standards of living due to the increase of income of the Greek consumer, a result of EU capital inflows, contributed to the increase of imports which had as a result the upheaval of the market. Furthermore, every effort for food self-sufficiency, as in livestock products, was inhibited because of their high production costs. The Greek market constituted a small but easily accessible market for the disposal of EU products. The agricultural product and food trade balance moved from a surplus in 1981 (€ 36.65 million), and in 1982, a year after the accession, to a deficit (€ -34.8 million), a deficit which is becoming larger and larger (-2.446.16 millions of Euro in 2009). The deficit stopped growing only in the last year (2010) because of the economic crisis and the fall in demand which brought about a decrease in imports (-1.951, € 48 million).

If one of the EU integration objectives is a sustained rise in the standards of living of a nation, which is an objective that is linked to competitiveness as well as to sustainable development, in the case of Greece this seems to be totally temporary and extrinsic. The EU capital inflows after the country's accession did not contribute to the growth of the productivity and competitiveness of the economy. A large part of incomes was a consequence of lending and when this ceased, all the weaknesses of the Greek production

system were revealed. Since 2007, when the highest level of GDP per capita, based on purchasing power parity, was 98% of the EU average, the GDP per capita has continuously fallen and in 2010 it was 89% of the EU average.

The aim of this study is to present the strengths and weaknesses of Greek agriculture through the analysis of its international competitiveness after the country's accession in the EU and till 2010. We do not include the period before the accession of Greece to the EU for two reasons. The first one is related to the fact that the comparison between the periods before and after the accession shows great discrepancies in regards to the growth dimension of the agricultural sector and its dynamics due to the EU capital inflows. The second reason concerns the trends of product prices and their impact on competitiveness. This study analyzes Eurostat data related to the trade balance of Greece. The only products whose trade balance shows a surplus are the Mediterranean ones and fish farms when integrated in a suitable Greek environment. We intend to show the inadequacies of the existing policy and the necessity of a new approach of sustainable development, based on the principles of an endogenous agricultural and rural development.

The Greek economic crisis can be considered as an opportunity to redefine the country's entire development strategy. As far as the agricultural sector is concerned, this re-establishment could use the principles of sustainability, showing proper respect to the economical, social and environmental characteristics of the regions. As a result, agriculture will correspond better to the local and more generally to the Greek society needs as well as becoming less dependent on international interventions.

References

[1] European Commission (2009). *European competitiveness report.* Commission staff working document, SEC (2009)1657 final [21/08/10], 216p. available on : ec.europa.eu/enterprise/newsroom/cf/itemlongdetail.cfm?item_id=3908

[2] Fagerberg J. (1988). *International competitiveness*. In The Economic Journal, n^{o} 98, 355-374 .

[3] Harrison R., Kennedy P. (1997). *A neoclassical economic and strategic management approach to evaluating global agribusiness competitiveness.* In Competitiveness Review, n^{o} 7, 14-25.

[4] Kitson M., Martin R., Tyler P. (2004). *Regional competitiveness: An elusive yet key concept?* In Regional Studies, n^{o} 9, 991-999.

SIMULATION OF AGRICULTURAL BOOM SPRAY

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Key words: flat nozzles, nozzle testing, testing device

Introduction

Growing demands concerning safe application of plant protection substances create a situation where next to farmer training the technical efficiency of the equipment becomes crucial. To a great extent, the method of evaluation of the technical condition of nozzles relies on a visual assessment. Only the liquid system is checked with the use of specialist measuring equipment. A particularly important stage of the evaluation is the quality test of the operation of the nozzles that assesses the quality and regularity of the spray. Such tests are inconvenient due to the fact that they are carried out on nozzles which are already aggregated with the tractors and are done in particular conditions which agree with the established methods.

Conditions and methods of testing

As part of a research project MNiSW 493/N-Belgia/2009/0 entitled "Establishing methods and equipment for extensive quality testing of the work of agricultural nozzles, as well as validation of the methods", which is done at Department of Machinery Exploitation and Management in Agricultural Engineering, University of Life Sciences in Lublin (UP) a device was constructed for assessment of the technical condition of agricultural nozzles. The device for testing nozzles allows for an assessment of such parameters as: spray unit outflow at an assumed pressure, the regularity of the distribution of the sprayed liquid, and angle of the stream.

The device has a pattern with the width of the grooves measuring 50 mm, a container of the spray, a hydraulic system and electronic system for recording the level of the liquid in the measuring containers.

The results

The testing individual control of the technical condition of the flat nozzles was carried out with the testing device at UP in Lublin. For testing, flat nozzles exploited in field conditions were used: Albuz ADI 110 03; TTD JET RS 110 04 R. The liquid pressure was 3 bar, the height of the installed nozzles above the spray patternator was 500 mm, and the time of an individual test of the nozzle was 60 s. The results obtained were set on Excel spreadsheet.

The spreadsheet contained the distribution of the sprayed liquid from individual nozzles into the virtual spray boom. Next, the mean value and standard deviation were specified, as well as the CV coefficient of the virtual field spray boom. The results were again set in a table and compared with the results obtained in the laboratory of CRA-W Gembolux in Belgium.

Table 1. The comparison of the obtained coefficients of variation.

Type of nozzle	Number of nozzles. Items.	CV coefficient of variantion [%]	
		Testing device at UP in Lublin. Virtual pattern. Spacing of grooves 50 mm	Laboratory CRA-W Gembloux Spacing of grooves 100 mm
Albuz ADI 110 03	24	14.2	11.1
TTDJET RS 11004 R	20	16.9	16.0

Summary

The results of tests presented here point to the fact that it is possible to assess the technical condition of the boom spray by means of the method evaluating the technical condition of individual nozzles.

The comparison of the results obtained at a patternator with spacing of 50 mm provides clearer criteria of evaluation of the CV coefficient, and hence, the coefficient will be higher, which is supported by other authors: Sawa, et al. [2002], Szulc, et al. [2001].

References

[1] Sawa J., Kubacki K., Huyghebaert B., 2002. Metodyczne ograniczenia w obowiązkowych badaniach opryskiwaczy. Problemy Inżynierii Rolniczej, 4(38) s. 17-25.

[2] Szulc T., Sobkowiak B. 2001 Badania Funkcjonalne rozpylaczy dla sprzętu do ochrony roślin. Materiały konferencyjne nt. Racjonalna Technika Ochrony Roślin. Skierniewice. s. 148-156.

ASSESSMENT OF THE DEGREE OF FATIGUE THE EXPERIMENTAL AGRICULTURAL STATION "JASTKÓW" LTD. WORKERS DURING HOP HARVESTING

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Keywords: fatigue, subjective methods, Japanese questionnaire, hop farming

Introduction

Hop farming is one of the areas of crop production, although dealing with a marginal position, but accompanied by a man almost from the beginning of civilization. Hop is one of the most important raw material in beer production. Hop production is one of the most labor-intensive and energy-intensive areas of agriculture, and technological process is complicated and has very uneven workload throughout the year [Zaorski 2002; Migdal, Zaorski 1996]. Hop harvesting is a stage of hop production, consuming about 40% of the annual workload. Once plants reach technological ripeness, in a short period of time there is a cumulation of work associated with the harvesting and initial maintenance of the hop cones, which suggests the occurrence of employees fatigue [Rosner 1985].

Agricultural Experimental Station "JASTKÓW" Ltd. was established in 2001 and continues the 60-year tradition of hop cultivation in this farm. Currently, the company is one of the largest producers of hop in Poland. 25 people are working at hop harvest, including two people with technical and technological surveillance. Supported workstations are located on the plantation and at the harvest resort.

Jobs on the plantation are:
- Cutting plant,
- Cutting off plants from the grid carrier,
- Laying of plants on the trailer,
- Bringing plants into the picking position.

Jobs at the harvest resort:
- Feeding the plants into the picking combine,
- Chores around the position of picking,
- Selection of pollutants,
- Receiving cones from combines and pouring to the dryer,
- Technical support of dryer and humidifier,
- Packing of cones,
- Sewing of packaging, marking and weighing of raw material.

Methodology and aim of the study

The aim of this study is to determine the degree of fatigue of the Experimental Agricultural "JASTKÓW" Ltd. workers during hop harvesting. The objective was achieved by conducting a survey - Japanese questionnaire of subjective feelings of fatigue [Yoshitake 1978]. The questionnaire consists of 30 questions divided into three groups of symptoms related to activity, motivation and physical fatigue (A, B, C). Each group contains 10 questions, to which a subject answers "YES", "NO" - thus marking the presence or absence of the symptom of fatigue. During the workday, workers filled out a questionnaire three times - before starting work, during lunch break and after work. The study was conducted from 5 to 21 September 2011, during the hop harvest.

Results and summary

Surveys conducted showed that among the supervisory staff performed a type of fatigue A>B>C. The highest intensity characterized a group of symptoms of decrease in activity, and the most often indicated symptoms were: eye fatigue, leg heaviness, slowness and heaviness of movement. However, among the workers dominated the physical fatigue symptoms - trembling limbs, hoarse voice, feeling of thirst. Work performed by workers during the harvest of hops performed the type of fatigue C>B>A characteristic of the physical work.

References

[1] Migdal J., Zaorski T. 1996. Poradnik plantatora chmielu. Wyd. IUNG, Puławy.
[2] Rosner J. 1985. Ergonomia. PWN, Warszawa ISBN 83-208-04-79-5
[3] Yoshitake H. 1978. Three Characteristic Patterns of Subjective Fatique Symptomps, Ergonomics. T. 21. Nr 3. p. 231-233.
[4] Zaorski T. 2002. Zarys dziejów chmielarstwa polskiego. Wyd. IUNG, Puławy.

PRINCIPLES OF SAFETY MANAGEMENT AND OCCUPATIONAL HEALTH IN THE SELECTED FOOD INDUSTRY

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Keywords: management system occupational health and safety, risk assessment

Introduction

An important part of the management of the food industry is a safety management and occupational health. It includes all the elements work together which help establish policy and objectives of the company. It also provides carry out tasks related to the management of occupational risks occurring in the workplace. The basic elements of safety management system and occupational health may include among others: a safety policy, participation of workers who had been trained and made aware of the risks, so increasing their competence and motivation to work. Basic requirements for safety management system resulting from the law under which it is necessary for example, use of plant protection, occupational risk assessment, training employees, etc. Is also very important internal communication that enables the development and shaping of safety culture. It involves the transfer of information on health and safety within a food plant by both employers and employees. May rely on promoting, for example in the form of posters, correct and safe behavior of employees. Employees should be able to report observed irregularities and hazards in the workplace [Ejdys 2010]. A necessary condition for effective functioning of the health and safety management work is complete and unanimous support of management. Expressing their commitment to health and safety problems, top management should: establish, in cooperation with employees, health and safety policies and give employees information about this policy, provide the necessary resources to implement policy and carry out periodic reviews of health and safety management system [PN-N-18001:2004]. An effective system of health and safety management in enterprises of the food industry relies primarily on improving working conditions. Its functioning depends on the attitude and commitment of employees [Ejdys 2010; Hale 2003]. A measurable effect of this may be the reduction of accidents and occupational diseases and other ailments related to work [Pawłowska, Pęciłło 2002]. Therefore, top management should be well-managed company, and above all, pay attention to safety aspects.

Aim and materials

The aim of this work is to check the status of occupational health and safety at the plant fruit and vegetable processing. For achieving the developed questionnaire was used, which was carried out among both executives and lower-level employees. The survey contains 30 questions, grouped thematically. Questions relate to, inter alia, health and safety training, protective clothing used, risk assessment.

Analysis of results

When assessing the safety of the employees were the biggest problem with the assessment of information flow. Although managers and direct supervisors informed about the risks, preventive measures in the workplace, inter alia, through posters, leaflets, safety signs, cards, risk assessment, workers believe that the internal communication is very poor. Only 42% of survey respondents commented that the flow of information is correct. In accordance with Article. 237 of the Labor Code providing training in health and safety is the responsibility of the employer and the employee's responsibility is the need to participate in these trainings. Observations indicate, however, that the health and safety training are carried out at very different levels, often are not preserved any standards in this area, and it conducts staff is not prepared in substance and can not meet the needs of trainees. With time, this situation causes an increase in negative attitudes to training and the increasing reluctance. It is worth noting that although employees are aware of the need to receive training health and safety, it is in the study only 53% of people declare that they remember and distinguish between the training completed, while the remainder 47% of respondents could not indicate what training accomplished. In another study addresses the theme of the block of personal protective equipment, including clothing and footwear. This issue is extremely important from the standpoint of both safety and hygiene of the employee. Properly used personal protective equipment to reduce the level of occupational risk, and in some cases cause the accident risk and the risk of occupational diseases is reduced to an acceptable level. The results of this study indicate that all respondents - the workers were aware of the need for personal protective equipment (protective clothing, footwear, earplugs to protect against noise).

On the basis of questionnaires and received answers to some questions could be assumed that health and safety rules in the selected plant fruit and vegetable processing are not followed. However, my own observations, discussions with management, employees of the security services indicate that the company has developed and implemented safety management system, systematically carried out training and compliance with the procedures and provisions. Lack of understanding on the part of employees

may result from the downplaying of OSH. Employees do not pay attention that the system safety management and occupational health and functioning properly there, but you do not want to obey him.

References

[1] Ejdys J. 2010. Kształtowanie kultury bezpieczeństwa i higieny pracy w organizacji. Oficyna Wydawnicza Politechniki Białostockiej, Białystok.
[2] Hale A. 2003. Safety management in production. Human Factors and ergonomics in manufacturing, vol. 13 (3) s.185-201 Viley Periodicals, Inc.
[3] Kodeks Pracy (Dz.U. 1998 r. nr 21 poz. 94 z póź. zm.).
[4] Pawłowska Z., Pęciłło M. 2002. Co to jest system zarządzania bezpieczeństwem i higieną pracy i jak go wdrożyć w przedsiębiorstwie? wyd. CIOP, Warszawa.
[5] Polska Norma PN-N-18001 Systemy zarządzania bezpieczeństwem i higiena pracy. Wymagania, PKN, Warszawa 2004.

THE RHEA PROJECT: A FLEET OF AUTONOMOUS ROBOT ABLE TO PERFORM PHYSICAL WEED CONTROL IN HERBACEOUS AND VEGETABLE CROPS

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Keywords: precision crop protection, physical weed control, precision hoeing, flaming, row-detection, weed detection

Introduction

Weed management is a major issue in agriculture. An effective weed control is absolutely necessary in order to achieve satisfactory yields and appropriate gains. In this concern, herbaceous and vegetable crops are two of the most sensitive sectors [2]. Promoting the sustainable use of agrochemicals is a recent issue of the European Union (Directive 2009/128/EC). In this respect, both the "alternative" equipments (for instance the machines for physical weed control) and the recent applications of precision farming may play an important role [1, 2, 4].

The European Project RHEA (Robot Fleets for Highly Effective Agriculture and Forestry Management) fits into this context and aims to realize a fleet of autonomous aerial and ground mobile units for crop protection.

RHEA Project: an overview

The RHEA Project (Robot Fleets for Highly Effective Agriculture and Forestry Management) is an UE funded (within the 7th FP) research project. The leader of the project is Prof. Pablo Gonzalez-de-Santos of CSIC (Spain). The project started in 2010 and involves 15 European partners (universities, research centres, spin-off companies, private enterprises) allowing to have a synergic support from different technical, engineering, agronomic competences such as robotics, informatics, farm machinery, weed science, telecommunications etc. The project aims at designing, realizing and testing an autonomous and robotic system able to perform both chemical and non chemical weed control in herbaceous crop and pesticide application on fruit and forestry tree canopy. This important goal can be obtained by means of a robot fleet, including ground and aerial units, working closely together. Each unit will be equipped with a detection system and an actuation system, and

work in three different scenarios: precise application of herbicides in wheat, physical weed control in maize and pesticides application on olive tree canopy.

The aerial mobile units will be based on quadrotors, which will be able to acquire relevant data (images and videos from the field) and to send important information to a base station and the ground mobile unit, like the localization of weed patches. The ground mobile unit, that is the same for all the operative machines, will be based on an ordinary tractor, powered by a 37.5 kW engine. It will be equipped with specific sensors for the automatic guidance, the weed-crop discrimination, weed density assessment, etc.
This work takes into account just one scenario and aims to describe the machine designed to perform mechanical and thermal weed control in maize, which will be realized at the University of Pisa.

The machine for physical weed control in maize

This machine will be equipped with rigid elements for shallow soil cultivation between the rows and couples of burners for selective in-row flaming, as maize is tolerant to thermal shock (Figure 1).

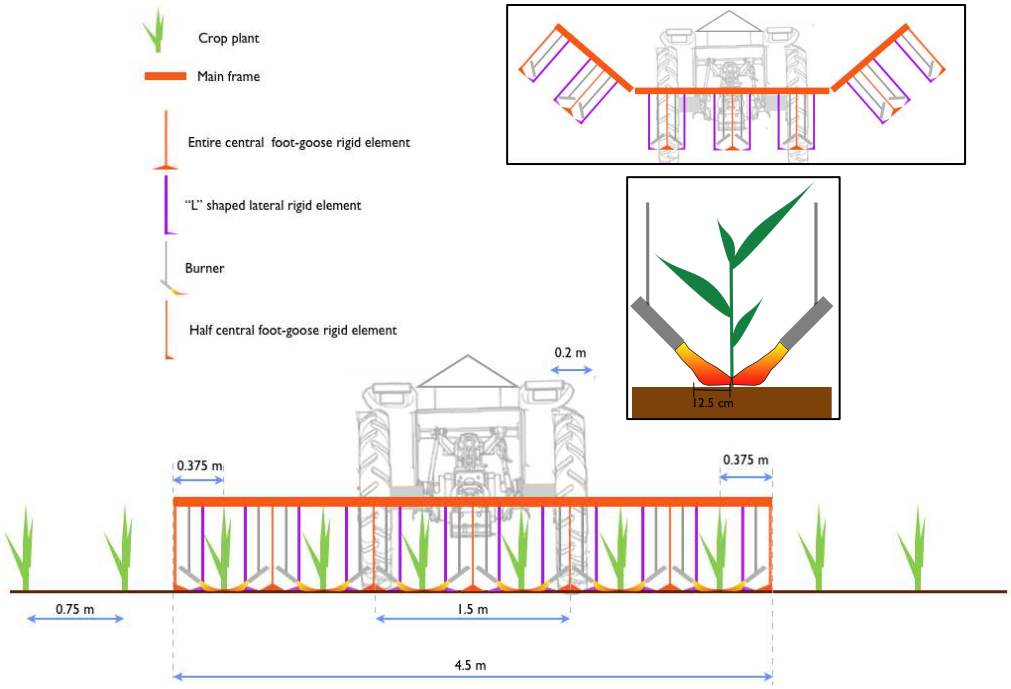

Figure 1. Scheme of the machine for precision physical weed control in maize. Detail of the fold frame (top box) and of a couple of burners (bottom box).

In order to enhance the precision of the treatment, the hoe will be equipped with directional wheels connected to an electronic row detection system. The thermal treatment will be performed only in case of weed detection by the perception system, while the mechanical treatment will be always performed (Figure 2).

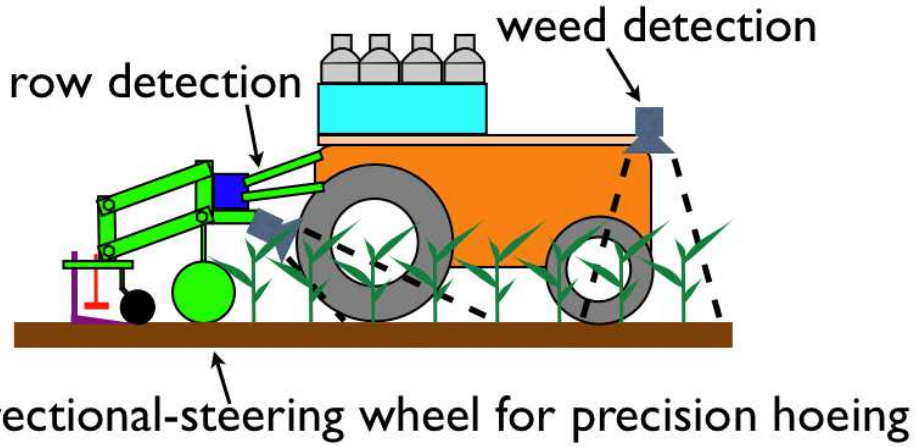

Figure 2. Scheme of the perception and actuation system of the ground mobile unit.

The LPG dose per surface unit (hence the intensity of heat transfer) will be adjusted according to the level of weed canopy, which will be detected separately in the different bands where the burners will operate. The working width of this machine will be 4.5 m. This measure covers 6 inter-row spaces of 0.75 m each. The frame of the machine will be folding in three parts (Figure 1). The operative machine will be provided with 5 entire hoeing units (each working 5 inter-rows strips 0.5 m wide) and two half hoeing unit (working 2 inter-rows strips 0.25 m wide). Each tool will till the soil at a depth of 4-5 cm by means of one foot-goose central anchor and two "L" shaped lateral sweeps. The thermal weed control on six entire rows of the crop will be ensured by six couples of 25 cm wide rod burner. The flame will hit just the weeds growing in the "in-row" space and the lower, heat-tolerant part of the crop plant. Thus, weed detection will be needed just to perform precise weed control in the rows.

Final remarks

This project will last until 2014 and the machine will have to be ready by the end of 2013. However, this machine will represent a good opportunity for the farmers in order to lower the use of herbicides and give an "extra quality" to their production.

References

[1] Ascard J., Hatcher P.E., Melander B., Upadhyaya M.K. Thermal weed control, In: Upadhyaya M.K., Blackshaw R.E. (Eds.), *Non-chemical weed management*, Cabi, Oxon, UK, 2007, pp. 155-175.
[2] Bàrberi P. Weed management in organic agriculture: are we addressing the right issues?, *Weed Research*, 2002, 42, 176-193.
[3] Cloutier D.C., van der Weide R.Y., Peruzzi A. & Leblanc M.L. Mechanical weed management, In: Upadhyaya M.K., Blackshaw R.E. (Eds.), *Non-chemical weed management*, Cabi Oxon, UK, 2007, pp. 111-134.
[4] Rueda-Ayala V., Rasmussen J. & Gerhards R. Mechanical Weed Control, In: Oerke E.C., Gerhards R., Menz G., Sikora R.A. (Eds.), *Precision Crop Protection – the Challenge and Use of Heterogeneity*, Springer Dordrecht Heidelberg London New York, 2010, pp. 279-294.

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MONITORING OF LEAF MINERS *(Agromyzidae)* ON WINTER WHEAT PLANTATIONS IN WIELKOPOLSKA AS PART OF INTEGRATED PEST MANAGEMENT

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Key words: leaf miners, *Agromyzidae*, winter wheat

Introduction

In Poland about a dozen species of leaf miners occur on cereal and locally they might occur in high abundance [Walczak 1995]. Those leaf miners include flies belonging to the *Agromyzidae* family. The species are very similar to each other and identification is sometimes possible only based on the male genital structure [Beiger 1989, 2004]. Their widespread occurrence contributes to a reduction in leaf assimilation surface. Leaf miner larvae mostly damage first - flag and second leaves. Feeding larva damage leaves of winter wheat and reduces the yield parameters. Locally they cause losses of economic significance. Effective methodology of pest chemical control have not been developed till now. Studies carried out so far, in terms of integrated methods of cereal protection have shown that a good practical method of indicating time of chemical control against these pests is controlling the number of adults trapped on yellow traps [Walczak 2009].

The aim of the study was to determine the harmfulness of leaf miners and their species composition on winter wheat.

Methods

Monitoring of cereal leaf miner flights in winter wheat was carried out at two locations on Wielkopolska district (Baborówko and Słupia Wielka) in vegetation seasons 2009/2010 and 2010/2011.

In order to determine the dates of the treatments, it was necessary to catch adult flies. The researchers used yellow 25 x 40 cm sticky traps placed on three control plots to catch the adults. The traps were attached to stakes so that they were right above the crops. All traps were replaced once a week. The average number of flies caught in the three traps was calculated. The inspections, which were designed to determine the number of stalks with damaged leaves, were conducted in the selected crops of winter wheat. Results were expressed as the number of mines per 100 stalks analyzed.

To determine the abundance of leaf miners on experimental plots, and selected wheat plantations located in the proximity of the experiments in

May, leaves with visible larvae or pupa inside were collected for breeding. The collection enabled the researchers to obtain imagines. Mines on the winter wheat leaves which were typical for particular species were identified using a key [Beiger 2004]. In addition, the species identification was conducted based on the male genitalia [Beiger 1989].

Results and discussion

Catching of leaf mining flies in the year 2010 was conducted between April 12 and June 14, and in the year 2011 between April 11 and June 13. In 2010, the presence of first leaf miners was found flies on mid-April. In the week, with maximum flights the average number of caught pests per yellow trap was 65.7 in Baborówko and 30.3 in Słupia Wielka. In 2011as in 2010, the presence of first leaf miners was found flies on mid-April. In the week, with maximum flights the average number of caught pests per yellow trap was 71.3 in Baborówko and 39.7 in Słupia Wielka.

In 2010 on some plantations were observed on average to 4.5 mines on 100 analyzed stalks, and in 2011 to 9 mines on 100 analyzed stalks (Table 1). In 2010 and 2011 the number of leaves damaged by leaf miner larvae decreased in comparison with previous years; in 2007 on average to 16 mines on 100 analyzed stalks were observed. One major reason may be differences in weather conditions in the surveyed years. In the year 2009 because of low humidity and soil leaf miner flights was delayed. The long and cold winter 2009/2010 and 2010/2011, and spring frosts have contributed to the later to come in of pests on crops of winter wheat.

In 2010 a total of 100 winter wheat leaves, with larvae or pupas inside the mines to be bred in a laboratory, were collected. There were 78 specimens bred to the pupa stage, while 67 specimens reached the imago stage. Additionally, from among the miner leaf larvae and pupa collected for breeding, three parasitics *Hymenoptera* also reached the imago stage (Table 2). In 2011 a total of 167 winter wheat leaves, with larvae or pupas inside the mines to be bred in a laboratory, were collected. There were 136 specimens which were bred to the pupa stage, while 120 specimens reached the imago stage. Additionally, from among the miner leaf larvae and pupa collected for breeding, three parasitic *Hymenoptera* also reached the imago stage (Table 2).

In 2010 and 2011 a total of 267 winter wheat leaves, with larvae or pupas inside the mines to be bred in a laboratory, were collected. There were 214 specimens which were bred to the pupa stage, while 187 specimens reached the imago stage. Additionally, from among the miner leaf larvae and pupa collected for breeding, six parasitic *Hymenoptera* also reached the imago stage (Table 2).

Adults bred in a laboratory were determined to species based on the construction of male sexual apparatus miner. *Chromatomyia nigra* on the basis of morphological features mines identified following species: *Chromaomyia fuscula* i P*oemyza superciliosa.* They were the dominant species during the study.

It was also discovered that the species composition of *Agromyzidae* damaging the winter wheat, changes in particular years. The results differ from the results of the previous research (Walczak 1998), where the dominant species were *Phytomyza nigra* (Mg.) and *Agromyza ambiqua* (Fll.).

Table 1. Number of mines the leaf found on experimental plots of winter wheat in 2010 and 2011.

Place	Year	Date	Cultivar	Average number of mines
Słupia Wielka	2011	18.05	Bogatka	12
Baborówko		17.05	Banderola	6
Słupia Wielka	2010	21.05	Bogatka	5
Baborówko		21.05	Alcazar	4

Table 2. Number of sampled leaves and obtained pupaes, flies, parasitic hymenopterans in laboratory rearing in 2010 and 2011.

Place	Year	Number of leaves collected	Bred to the grub stage	Bred to the fly stage	The number of parasitic *Hymenoptera*
Baborówko	2010	43	26	25	1
Słupia Wielka		57	52	42	2
Total		**100**	**78**	**67**	**3**
Baborówko	2011	50	38	33	1
Słupia Wielka		117	98	87	2
Total		**167**	**136**	**120**	**3**
Total (2010,2011)		**267**	**214**	**187**	**6**

Conclusions

1. Research reported damaged crops in the form of mines.
2. Monitoring of leaf miners flights was conducted from April to June in the years of research.
3. In the year 2010 and 2011 the number of leaves damaged by leaf miner larvae on the winter wheat plantations was similar and significantly decreased in comparison with the results obtained in 2007.

4. Dominant species on winter wheat crops in years of research were*: Ch. fuscula, Ch. nigra* and *P. superciliosa., Ch. Fuscula.*
5. Based on the research and literature data, the species composition of *Agromyzidae* damaging winter wheat in particular years varies.

References

[1] Beiger M. 1989. *Miniarki (Agromyzidae) – Szkodniki Roślin Użytkowych.* Wyd. Nauk. UAM, Poznań, 155 pp.
[2] Beiger M. 2004. *Owady Minujące Polski. Klucz do Oznaczania na Podstawie Min.* Bogucki, Wyd. Nauk., Poznań, 893 pp.
[3] Walczak F. 1995. *Miniarki (Agromyzidae) – Szkodniki Upraw Zbożowych.* Materiały 35 Sesji Nauk. Inst. Ochr. Roślin, 2: 15 — 18.
[4] Walczak F. 1998. *System for warning and control of leaf mining flies and leaf beetles on cereal crops.* J. Plant Prot. Res. 38(1): 65 — 69.
[5] Walczak F., Gałęzewski M., Rosiak K., Kubsik K. 2009. *Dynamika lotu miniarek (Agromyzidae) występujących na pszenicy ozimej w warunkach Wielkopolski.* Prog. Plant Protection/post. Ochr. Roślin 49 (2): 577—580.

WEB DSS FOR BIO-ENERGY PROJECTS EVALUATION

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Keywords: biomass supply, energy crop, farm model, decision optimization, DSS

Introduction

In order to comply with the goals set in the EU Directive 2009/28/EC Poland will have to reach the 15% electric energy share from renewable energy sources (RES) in 2020. Around 90-95% of this share is going to come from solid biomass co-fired with coal and lignite in the main-network power stations. These two fossil fuels are crucial to the Polish energy security and therefore will continue to play an important role in years to come. Co-firing solid biomass is a low-risk RES strategy for Poland due to the utilisation of the existing technical infrastructure. It is also a very cost-effective RES-E (electricity generation from RES) technology. Of various energy crops available, especially perennial energy crops are useful due to such merits as good energy and carbon balance, high carbon sequestration and low nitrogen leaching.

It has been calculated that the 90% biomass share in RES-E will require the total cultivation area of perennial energy crops of about 1 million ha [3]. Since the total area under perennial plantations is currently about 10,000 ha, a very rapid growth will be necessary to meet the obligation. There are plenty of factors uncertain or unknown but essential for the successful realisation of such a large-scale venture. One of the all-important issues is an exhaustive knowledge of the economy of energy crops production, vital to decision making. This is especially of great consequence in view of the fact that the investment in perennial crops poses an immediate economic burden associated with long-term commitment and delayed returns. The international experience shows that twofold actions are implemented to encourage farmers to switch a part of their land to this activity. A government support for plantation establishment is combined with a fixed price for biomass purchased by power plants. In an era of government funds with a high opportunity cost, it is of primary importance to induce farmers to produce desired quantities in the least costly way. In other words, the financial support level and the price level should be efficiently balanced. This is what the theory has to say on the matter.

The DSS concept

In order to meet this challenge, that is to fill the knowledge gap on the extent to which the Polish farmers would actually consent to grow energy crops, the Institute of Soil Science and Plant Cultivation - State Research Institute (IUNG-PIB) plans to publish in the Internet a spatial DSS for the evaluation of biomass-production penetration into the existing agricultural systems. The framework of the DSS (with all inherent models and software) was developed at the Agricultural University of Athens. It was tested initially on the local data acquired from farms of the Karditsa prefecture (Thessaly district).

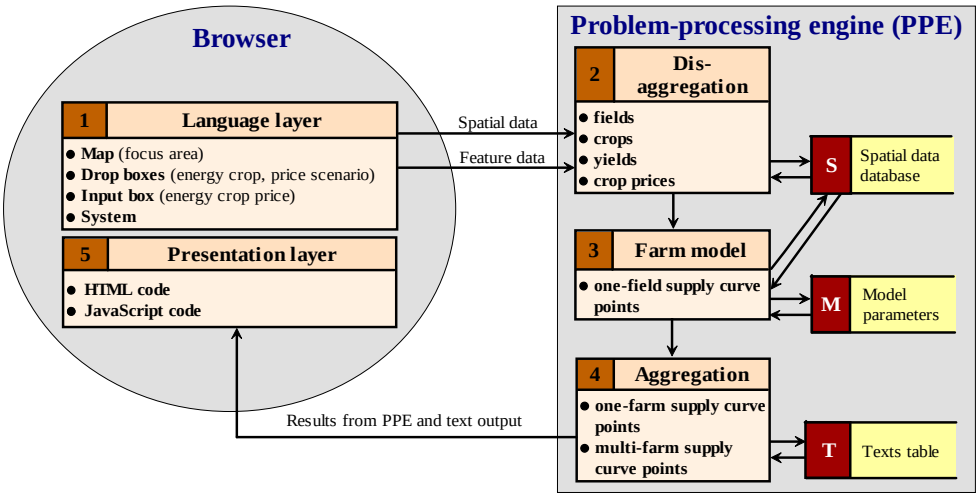

Figure 1. Data and information flow in the Web-DSS for bio-energy projects evaluation.

The DSS has the conventional, model-driven architecture [1], comprising four components (subsystems): a language layer, a presentation layer, a database and a problem-processing engine (Fig.1). The language and presentation layers are integrated into one interface capable of handling both feature and spatial data and information. The underlying concept for connecting the interface with the problem-processing engine is on-the-fly disaggregation and aggregation of data. The user begins with a scenario building: she selects a focus region (an administrative unit or a collection of such units) from a map and enters some global feature data (e.g. the target energy crop and its price). Then a simulation can be started. The user-entered spatial data are disaggregated in the problem-processing engine - the farms lying in the focus region are selected from the database to create a collection of data used for further processing.

The basic level for calculations is the farm level, i.e. the level on which the real world decisions are made [2]. By the same token the core model of the problem-processing engine is the economic model of the farm. The investment decisions in energy crop cultivation are resolved for each individual field of the farm upon taking into account the opportunity cost for the field. For opportunity cost calculation such farm data as business-as-usual crops, estimated yields, production costs, prices and benefits from promotion policies are used. The model finds an optimum decision for each farmer based on the profit maximization subject to the relevant constraints. From the results calculated and spatially aggregated the engine generates a potential assessment of biomass supply from the focus region. By running a number of simulation experiments some tendency in (hypothetical) farmers' responses can be determined with regard to energy crop cultivation at given prices. In fact the problem-processing engine changes the cropping plan so as to obtain the optimal crop mix for each energy crop and its price entered by the user. All fields under crop on the farm or in the collection of farms are taken into account, including business-as-usual crops and the energy crop. In one presentation option the changing cropping plan against various prices of the energy crop is output in tabular form so that comparisons can be made. Another option is generation of graphs of supply curves (energy crop quantity versus its price) for any collection of input data, from a single farm up to a collection limited only by the availability of data. And, since most of the results have spatial context, every point on the supply curve can be visualized in a corresponding map.

The key factor that determines the usability of the results is the preparation of the data. In the original DSS the test data were prepared from a survey of 70 representative farms in the Karditsa prefecture. Crop suitability maps were used for business-as-usual crops (tobacco and other conventional crops comprising the observed crop mix) and three alternative energy crops (sunflower, cynara and sorghum). The purpose of the simulations was to evaluate the feasibility of ex-tobacco growing farms to switch to energy crop cultivation. The data introduced later made it possible to build more complex scenarios - crop plans with such crops as wheat, maize, cotton, tomatoes, white beans, alfalfa, and many more.

Polish pilot DSS version

The Polish counterpart of the DSS will be initiated for a pilot area. High-resolution maps (grid up to 30x30 m) will be used on agroclimate, soils and water resources. Production costs will be calculated using detailed technology models and sample farm data. The acquisition of sufficiently detailed survey data for all the country is hardly possible. However, one way of resolving the problem is to construct farm models [4], representative of

particular regions and taking into account the local organisational and technical nuances. From the models the economic data can be acquired and used for the development of mathematical functions from which the data necessary for the DSS operation can be derived on-the-fly. Whatever the solution to the problem of data, it is essential to cover as much of the area as possible, so that the implications of policies promoting biomass production can be studied with the aid of the tool.

References

[1] Holsapple C.W. 2008. DSS Architecture and Types. In: Burstein F., Holsapple C.W. (Eds.), Handbook on Decision Support Systems 1: Basic Themes. Springer-Verlag, Berlin.

[2] Rozakis, S. 2010. A Web-based Spatial DSS for estimating biomass-to-energy supply in Thessaly. In: Manos B., Matsatsinis N., Paparrizos K., Papathanasiou J. (Eds.), Decision Support Systems in Agriculture, Food and the Environment: Trends, Applications and Advances. Hershey, New York.

[3] Zaliwski A.S., Faber A., Pudełko R., Biberacher M., Gadocha S., Borzecka-Walker M. 2011. Biomass supply for co-firing in main-network power stations in Poland (unpublished results).

[4] Zaliwski A., Hołaj J. 2006. Modelowanie technologii produkcji kukurydzy na ziarno w aspekcie efektywności ekonomicznej [Modelling of grain maize production technology in the aspect of economic effectiveness]. Inżynieria Rolnicza, 6(81):407-414.

TESTING DEVICE FOR AGRICULTURAL NOZZLES

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Keywords: agricultural nozzles, spraying quality, mandatory inspection, testing device

Abstract

Using nozzles presenting a poor spraying quality for the application of Plant Protection Products in agriculture increases the potential risks of the environmental contamination and decreases the biological efficacy of the treatment. The spraying quality of nozzles is characterized by such parameters as: flow rate, individual pattern (spraying angle, coefficient of asymmetry, etc) and transverse distribution under the boom (Coefficient of Variation). Studies on nozzles are conducted considering the requirements of ISO standard 5681-1:1996. However, it should be stressed that separate measuring devices are necessary to determine the different parameters of the spraying quality parameters of the nozzles. Moreover, in order to check the working characteristics of the nozzles in a practical way, one should remember that nozzles are usually fixed on the sprayer boom.

At present, very complex, multi-sided activities are undertaken on the organizational and technological levels, which aim at applying pesticides in a precise way. Organizational factors are principally connected with theoretical preparation (training) of the operator on the performance of these treatments, but in a manner that would motivate to practically observe (apply) the principles of good plant protection practices. On the other hand, technological factors, related to the improvement of the construction and the mandatory periodic inspection, will determine the technical state of the equipment for plant protection. In our opinion, one of actually very important factors is the good choice of nozzles, and also the parameters measured to evaluate the performances of these nozzles.

The methodology followed during the study is to determine and measure the performances of each single nozzle, register these parameters in a

database and finally enlarge the results by computer processing. The basic measured parameters of each single nozzle are the flow rate and the individual spray pattern measured on a 50 mm grooved table (according 5681-1:1996).

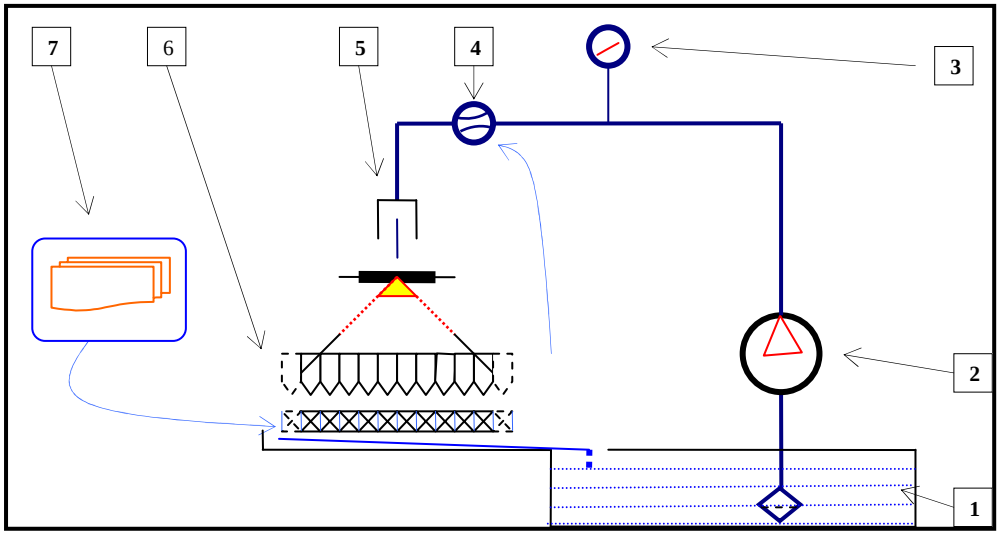

Figure 1. Device for complex measurements of agricultural nozzles (schematic)

1. Water reservoir and filter of pump,
2. Pump in hydraulic arrangement,
3. Manometer,
4. Flow-meter,
5. Nozzles container and telescopic liquid feeder system,
6. Groove table,
7. Measuring (electronic) device with computer.

Figure 2. Device for complex measurements of agricultural nozzles

The computed processing allows determining the transverse distribution of the whole spray boom under a virtual 100 mm grooved table. The process allows also determining the best sequence of placing the nozzle on the boom.

Testing device for complex measurements of agricultural nozzles is presented on Fig. 1 and Fig. 2.

PHOTOVOLTAIC AND GEOTHERMAL INTEGRATION SYSTEM FOR GREENHOUSE HEATING: AN EXPERIMENTAL STUDY

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Keywords: greenhouse heating, renewable energy sources, hot water, low enthalpy energy

Introduction

Greenhouse crops are one of the most innovatory examples of modern agriculture and it is envisaged for them to expand more and more in future, especially in areas with unfavourable climatic conditions. They are one of the highest man-made forms of agricultural activity, because of the intense technological and bio-agronomic inputs in confined portions of the agricultural environment (Scarascia Mugnozza, 1995).

Energy consumption is one of the main cost factors in commercial greenhouses since high amounts of energy are used for greenhouse climate control in order to obtain good yields and high quality (Korner et al., 2004).
The conventional greenhouse heating systems supplied from fossil fuel have a strong negative impact on agro-ecosystems (Scarascia Mugnozza, 1992).

Energy necessary to heat 1 m^2 of greenhouse area ranges from 500 to 2700 MJm^{-2} yr^{-1}, depending on the site, the cultivated plants, the greenhouse covering and the level of climate control.
The use of fossil fuel for greenhouse heating has a major impact on the cost and environmental sustainability of vegetable production.
The recent raise of prices of energy produced from fossil fuels has further increased productive costs of horticultural protected cultivations.

Many efforts have been made to reduce greenhouse energy consumption in greenhouse climate control, while interest has recently been aroused in alternative energy sources, which include renewable energy sources (Vox et al., 2006).

Renewable energy sources are particularly appropriate to ensure optimal microclimatic conditions for the growth of greenhouse crops and provide a major impetus to the ecological conversion of greenhouse heating systems (Ozgener, 2005; Scarascia Mugnozza, 2009). In this context, the greenhouse heating with geothermal heat pump result to be very convenient in terms of environmental and economic (Ozgener, 2010; Adaro et al., 1999).

Aim of the research was to assess the potential of the system in terms of energy production, efficiency and economy.

Materials and methods

The performance analysis of integrated photovoltaic and geothermal systems for greenhouse heating was investigated in an experimental study carried out at the University of Bari, Southern Italy.
Two experimental greenhouses with the same geometric and constructive characteristics (Fig. 1), have been realized, one of them heated and one unheated for comparison.

A 7.2 kW low enthalpy heat pump (Fig. 2) combined with a 120 m vertical double U-bend ground heat exchanger was installed in order to satisfy the thermal energy demand of 48m^2 single plastic skin greenhouse.
The electrical energy for heat pump operation is provided by an array of photovoltaic panels with a pick power of 1620 W.

The main physical and environmental parameters were measured over the winter period in order to analyze the energetic performance of the above mentioned integrated system for greenhouse heating (Fig. 3).

Figure 1. Experimental greenhouses.

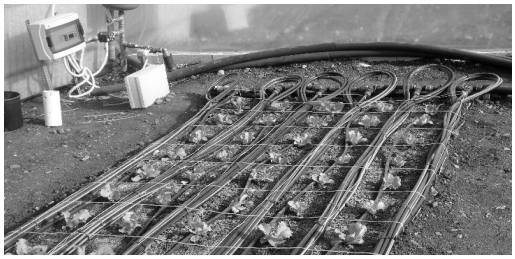

Figure 3. Heating system inside the greenhouse.

Figure 2. Heat pump and boiler.

Particularly the thermal energy extracted from the soil, the electrical energy adsorbed by heat pump, the internal and external greenhouse air temperatures, the plant working fluid temperatures were measured and recorded continuously by suitable sensors connected to a data logger (Fig. 4).

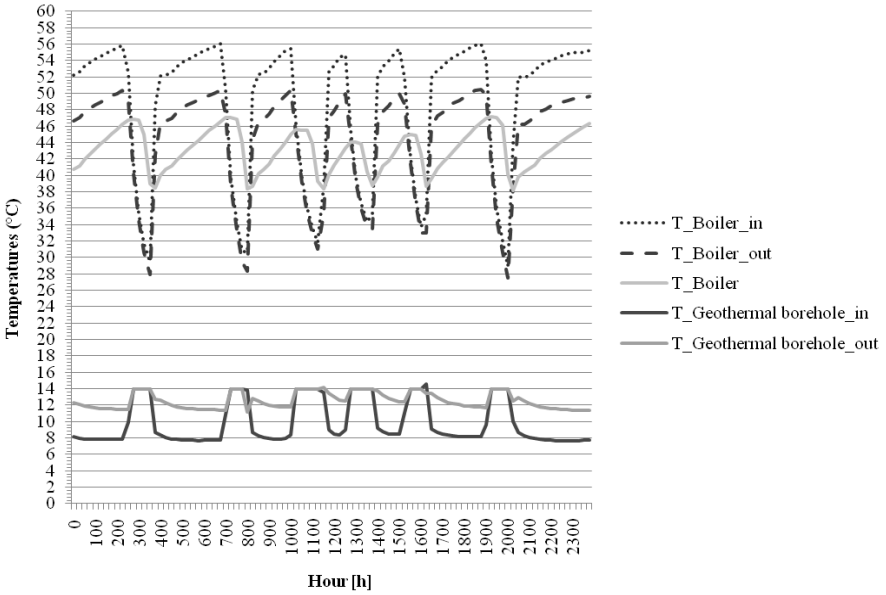

Figure 4. Heating system water temperatures on January 1, 2011.

Results

The heat pump turned 1620 kWh of electric energy in 6480 kWh of thermal energy during the three winter months of working (from December to February). In the same period the photovoltaic panels produced 2226 kWh of electrical energy. Then the electric energy required for heat pump operation was supplied entirely by photovoltaic panels.

The obtained results showed that the use of geothermal sources integrated with photovoltaic panels can supply the total heating energy demand of greenhouse. The 75% of the thermal energy (4860 kWh) was provided from the soil with an economy saving of 40% compared to the traditional heating systems.

The difference between the heating greenhouse and the external air temperatures was 6°C; moreover the difference between the heating and not heating greenhouse air temperatures was 8°C (Fig. 5).

As well know, due to the phenomenon of nocturnal thermal inversion the air temperature inside the not heated greenhouse was less than the external one, then the use of the heat pump has been useful both to avoid the nocturnal thermal inversion and to increase the air temperature inside the greenhouse.

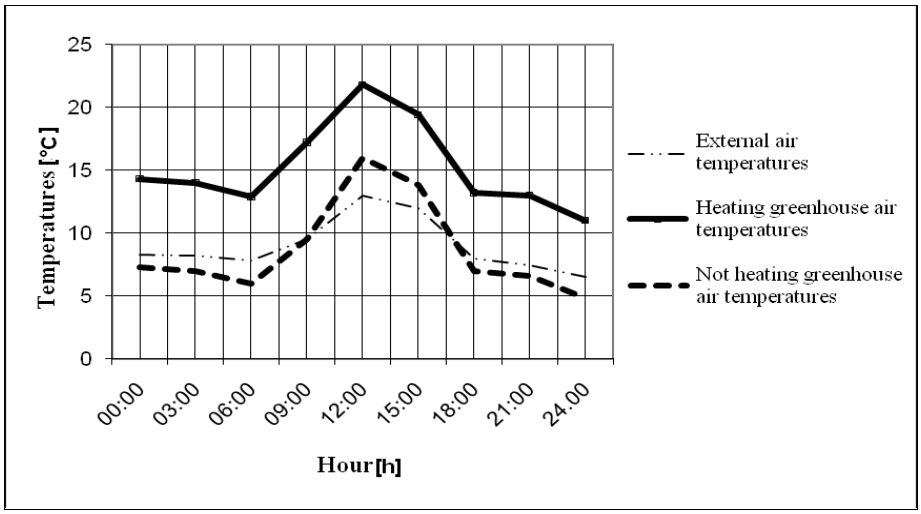

Figure 5. External and internal greenhouse air temperatures on January 1, 2011.

Discussion

The obtained results clearly show that the greenhouse energy demand can be effectively, efficiently and ecologically satisfied by the realized experimental system.

The coupling of heat pump with photovoltaic panels allowed to decrease the CO_2 emissions and to save primary energy of fossil fuels.

The environmental benefits of the realized system will be evaluated by life cycle assessment in the next step of the research.

References

[1] Adaro J. A., Galimberti P. D., Lema A. I., Fasulo A., Barral J. R., 1999, *Geothermal contribution to greenhouse heating*. Applied Energy 64: 241-249.

[2] Korner O., Bakker M.J., Heuvelink E., 2004, *Daily Temperature Integration: a Simulation Study to quantify Energy Consumption*. Biosyst. Eng. 87 (3): 67–77.

[3] Ozgener O, Hepbasli A., 2005, *Performance analysis of a solar assisted ground-source heat pump system for greenhouse heating: an experimental study*. Building and Environmen 40:1040–50.

[4] Ozgener O, 2010, *Use of solar assisted geothermal heat pump and small wind turbine systems for heating agricultural and residential buildings*. Energy 35:262–268 40:1040–50.

[5] Scarascia Mugnozza G., 1992, *Soluzioni costruttive e impiantistiche serricole a basso impatto ambientale*, Colture Protette n. 11.

[6] Scarascia Mugnozza G., 1995, *Sustainable greenhouse production in mediterranean climate: a case study in italy*, MEDIT 6 (4), 48-53.

[7] Scarascia Mugnozza G., Anifantis A., 2009, *Dal fotovoltaico al termico*, Colture Protette Vol. 6: 40-43.

[8] Vox G., Scarascia-Mugnozza G., Schettini E. 2006. *Photovoltaic solar cells and wind turbine for greenhouse climate control in Mediterranean areas*. Intl. Conf. Agricultural Engineering, AgEng2006 Bonn, Germany, 3-6 September 2006.

PROTECTION OF THE *SPARTINA PECTINATA* PLANTATION INTENDED FOR ENERGETIC PURPOSES AGAINST WEEDS

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Key words: *Spartina pectinata,* weed control, herbicides

Introduction

Perennial plants, i.e., *Spartina pectinata* used for energetic purposes, are the most exposed to competitive influence of weeds in the 1st and 2nd year of growing. A huge difficulty in the production of biomass of *S. pectinata* plants is the lack of appropriate recommendations connected with a chemical regulation of weeding at the moment of setting up a plantation and in the following years (Rola et al. 2006). The biggest threats for the *S. pectinata* plantation are the existing weed species: annual and perennial ones, monocotyledons and dicotyledons, which in some extreme cases can lead to liquidation of such a plantation. Monocotyledonous species, i.e., *Elymus repens, Agrostis alba, Setaria glauca, Echinochloa crus-galli* or *Apera spica-venti*, because of belonging to the same family as *S. pectinata – Poaceae,* are especially strenuous and difficult to eliminate (Sekutowski et al. 2010).

The aim of the research was the evaluation of chosen herbicides with respect to selectiveness and effectiveness in regards to existing state and the degree of overgrowing with weeds of the *S. pectinata* plantation.

Methods

The field research was held in years 2009-2010 at the *S. pectinata* plantation using the random blocks method in 3 repetitions on the fields of 25 m^2 each. Three herbicides were tested in the research and were applied in the phase of 2-3 shoots and 3-5 leaves of *S. pectinata.* Phytotoxicity of tested herbicides was evaluated with the bonitation method, 7, 14 and 28 days since the moment of application the herbicides defining the state and type of *S. pectinata* plants harm on the 9º scale comparing to the control object, where: 1- no reaction while 9- totally damaged. The state and degree of overgrowing with weeds of the plantation was evaluated at the beginning of vegetation with the quantity method giving species and a number in pcs/m^2. The weed control on the fields was established on the basis of the estimated analysis done 3-4 weeks after application of herbicides, giving the obtained result in percentages.

Results

All of tested herbicides which were used in *S. pectinata* plantings caused, in the first week after the application, visible symptoms of phytotoxicity effect in the form of leaves chlorosis. In the following week these symptoms were still visible (Shado 300 SC herbicide), and in the case of the Maister 310 WG herbicide the symptoms were intensified. These symptoms totally receded only in the case of the Zeus 208 WG herbicide. After next two weeks the chlorosis of *S. pectinata* leaves was not observed after applying every of the herbicides. The herbicide Maister 310 WG was an exception and after applying it, there was 25% growth restrain sustaining to the end of *S. pectinata* plant vegetation (tab. 1).

Table 1. Phytotoxicity effect of herbicides on *S. pectinata* (mean from 2009-2010).

Treatment	Dose per ha	Time of application	F (1:9)					
			$A_{(7)}$	U	$A_{(14)}$	U	$A_{(28)}$	U
Untreated	-	-	1	b	1	b	1	b
Zeus 208 WG	0,3 kg	T-3	1-2	ch	1	b	1	b
Shado 300 SC	1,5 l	T-3	4-5	ch	3	ch	1-2	b
Maister 310 WG + Actirob 842 EC	150 g 2,0 l	T-3	1-2	ch	2-3	ch, zw	1-2	zw

F - phytotoxicity to herbicides in 9^0 scale where: 1 - no reaction, 9 - totally damaged;
U - type of injury; b - no reaction; ch - leaf chlorosis; zw - growth inhibition;
$A_{(7)}$ - 7 days after herbicide application;
$A_{(14)}$ - 14 days after herbicide application;
$A_{(28)}$ - 28 days after herbicide application;
T-3 = development stage 2-3 shoots (3-5 leaves of *S. pectinata*)

The best results in the regulation of overgrowing with weeds were achieved applying the Maister 310 WG herbicide. This preparation effectively limited the existence of *Echinochloa crus-galli, Chenopodium album, Viola arvensis* and *Geranium pusillum*. The effectiveness of two other herbicides (Shado 300 SC and Zeus 208 WG) was significantly weaker. It resulted probably from the specificity of these preparations and from a limited spectrum of effectiveness with respect to existing weed species (tab. 2).

Table 2. Effectiveness of herbicides for *S. pectinata* plantation (mean from 2009-2010).

Treatment	D	T	Weed control [%]					
			ECHCG	SETVI	CHEAL	VIOAR	GERPU	POLCO
Untreated [no. per sq. m]			(10)	(15)	(6)	(10)	(8)	(6)
Zeus 208 WG	0,3 kg	T-3	71	68	58	72	72	69
Shado 300 SC	1,5 l	T-3	81	57	78	85	77	72
Maister 310 WG + Actirob 842 EC	150 g 2,0 l	T-3	92	75	83	86	80	64

D - dose per ha; T - time of application; T-3 = development stage 2-3 shoots (3-5 leaves of *S. pectinata*); ECHCG - *Echinochloa crus-galli*; SETVI - *Setaria viridis*; CHEAL - *Chenopodium album*; VIOAR - *Viola arvensis*; GERPU - *Geranium pusillum*; POLCO - *Polygonum convolvulus*

Discussion

Results achieved during the conducted research proved the possibility of applying practically all tested herbicides in the chemical regulation of overgrowing with weeds of the *S. pectinata* plantation. According to Miziniak (2008), Rola et al. (2009), the basic problem in this type of research is the choice of appropriate herbicide according to its selectiveness (or lack of it) not only in regards to *S. pectinata* plant but also to other plants grown for energetic purposes, i.e., *Salix viminalis* or *Miscanthus x giganteus*. According to Rola et al. (2006) plants used for energetic purposes are the most sensitive to the herbicides effect in the phase of forming new sprouts and leaves. The author of this article is of a similar opinion. Phytotoxicity effect of tested herbicides in regards to *S. viminalis* or *M. x giganteus* plants was stated also in the previous research which, however, after a few weeks, since the moment of application, receded (Skrzypczak et al. 2008, Sekutowski and Rola 2009, Sekutowski et al. 2009). According to Skrzypczak et al. (2009a, 2009b) mechanical removal of weeds on the energetic plants plantation is possible but only to a specific developmental phase. In the opinion of this thesis' author, this method is unprofitable on bigger plantations because in the vegetation season, a few mechanical operations must be done, which significantly increase the costs of the plantation protection. The alternative to the mechanical method seems to be applying of appropriate herbicides. This is the reason why the author of this work does research on a wide scale which aims to test and introduce to a wide agricultural practice as big number of herbicides as possible, which will be effective and safe not only for *S. pectinata* plants but also for other species, i.e., *S. viminalis* or *M. x giganteus*.

Conclusion

Unfortunately, in the available professional literature there is only little information connected with the usefulness of herbicides to protect *S. pectinata* plantation. Because of this fact, in a further perspective, it seems to be natural that a bigger number of herbicides will be tested and introduced in adequate systems of chemical regulation of weeds (increasing effectiveness) similar to those, which are applied successfully in other plant cultivations. Using herbicides in such systems can be taken into consideration in the herbicide protection of mass production plantations of energetic plants such as *S. pectinata*.

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References

[1] Miziniak W. 2008. *Wpływ herbicydów na wybrane odmiany wierzby energetycznej (Salix vinimalis).* Prog. Plant Protection/Post. Ochr. Roślin 48 (1): 301-306.
[2] Rola J., Sekutowski T., Rola H., Badowski M. 2006. *Problem zachwaszczenia plantacji wierzby krzewiastej - Salix viminalis.* Prog. Plant Protection/Post. Ochr. Roślin 46 (1): 81-87.
[3] Rola J., Sekutowski T., Rola H., Badowski M. 2009. *Problem chwastów na nowo zakładanych plantacjach Miscanthus giganteus.* Pam Puł. 150: 233-246.
[4] Sekutowski T., Rola J. 2009. *Zbiorowiska chwastów i ich zwalczanie na plantacji Miskanthus giganteus.* Biul. Inst. Hod. Aklim. Rośl. 253: 331-340.
[5] Sekutowski T., Rola J., Kaus A. 2009. *Zbiorowiska chwastów występujące na nowo zakładanych plantacjach roślin wykorzystywanych na cele energetyczne i metody ich ograniczania.* W: Produkcja biomasy – wybrane problemy. Wyd. Wieś Jutra, Warszawa: 40-47.
[6] Sekutowski T., Rola J., Rola H. 2010. *Możliwość ochrony miskanta olbrzymiego przed chwastami jednoliściennymi.* Prog. Plant Protection/Post. Ochr. Roślin 50(3): 1395-1399.
[7] Skrzypczak W., Waligóra H., Szulc P., Panasiewicz K. 2008. *Możliwość zwalczania chwastów w pierwszym roku uprawy wikliny.* Prog. Plant Protection/Post. Ochr. Roślin 48 (2): 669-673.
[8] Skrzypczak W., Szulc P., Waligóra H. 2009a. *Wpływ pielęgnacji mechanicznej na zachwaszczenie plantacji wikliny.* J. Res. Appl. Agric. Eng., 54(4): 94-96.
[9] Skrzypczak W., Waligóra H., Szulc P. 2009b. *Analiza zachwaszczenia wierzby energetycznej po zastosowaniu pielęgnacji mechanicznej.* J. Res. Appl. Agric. Eng., 54(4): 97-99.

THE ANALYSIS OF ENERGY CONSUMPTION IN LINK OF ROTATION: WINTER RYE - POTATO IN SYSTEM OF ORGANIC FARMING

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Keywords: organic farming, winter rye, potato, link of rotation, energy consumption

Introduction

The efficiency of agricultural production can be measured in energy consumption. In the organic farming system the energy efficiency rate is highly dependent on the applied technology and the crops obtained [Hill 2009, Sławiński 2010]. According to Szeptycki and Wójcicki [2003], the efficiency of energy inputs in agriculture is influenced, among others, by: the type of production and its intensity, the level of mechanization, applied technology and production organization. The effectiveness of technology should be considered in the link of rotation which is of particular importance in the system of organic farming, because the effect of organic fertilization and applied agronomic treatments lasts several years. The evaluation of effectiveness cannot be limited to the analysis of individual treatments but it should be considered comprehensively in the full-scale production process. The aim of the study was the analysis of energy consumption in link of rotation: winter rye - potato in system of organic farming.

Methods

The study was conducted in 2008-2010, in north-western Poland, in 10 organic farms. Potato crop of early varieties was in these farms' growing structure every year. In all farms a forecrop for potato was winter rye grown for grain. Cultivation was carried out in similar natural and productive conditions, mainly on soils of class IIIa and IVb. Farms were self-sufficient in terms of equipment including means of mechanization and did not use the services from outside. Cumulated energy consumption structure was presented individually for separate streams of energy and for agronomic treatments performed in the implemented technologies. Energy consumption of materials and energy value of crop was defined in megajoules (MJ) based on rates of specific energy consumption [5]. Energy efficiency rate (E_{ee}) was calculated from the relation between energy value of crop (P_e w $GJ \cdot ha^{-1}$) and energy expenditures incurred for its formation (N_e in $GJ \cdot ha^{-1}$). The collected data was presented as a 3-year average and was reduced to the area of 1 ha.

While estimating the productivity, plant crops were converted into cereal units (1 t rye = 10 c.u., 1 t potatoes = 2.5 c.u.) [2].

Results

The productivity of link of rotation: winter rye - potato, formulated in cereal units converted to 1 ha, amounted to nearly 90 c.u. per year (Table 1). This value depended mainly on the productivity of potato (73%). Grain and straw yield of winter rye was 27% of productivity of analyzed link.

Table 1. Productivity of link of rotation: winter rye - potato (the average in the years 2008-2010*).*

Cultivated species	Winter rye	Potato	Link of rotation
Main crop [t·ha^{-1}]	2.15	18.7	-
Secondary crop [t·ha^{-1}]	1.89	-	-
c.u.·ha^{-1}	24.3	65.5	89.8

Potato production in organic system involves the need to incur more than 2.5 times energy expenditures than the cultivation of rye. Bulb yield, however, carries a large energy potential, but only about 90% higher than rye. Comparing the obtained energy value of crop to the expenditures incurred on its formation, it was found that rye is characterized by definitely higher energy efficiency rate than potato. High energy efficiency rate of rye, at a lower (than potato) rate of energy consumption, increases energy efficiency of link of rotation and reduces its energy consumption rate (Table 2).

Energy expenditures incurred to produce 1 cereal unit in link of rotation: winter rye - potato averaged 390.8 c.u.·ha^{-1}. Obtaining 1 cereal unit in rye cultivation needed a consumption of nearly 409 MJ, in potato cultivation- 384.2 MJ.

Table 2. Selected elements of the energy assessment of link of rotation: winter rye - potato (the average in the years 2008-2010).

Energy beam	Winter rye	Potato	Link of rotation
Energy expenditures [MJ· ha^{-1}]	9935	25163	35098
Energy value of main and secondary crop [MJ· ha^{-1}]	22743	45034	67777
Accumulative energy profit [MJ· ha^{-1}]	12808	19871	32679
Energy efficiency rate	2.29	1.87	1.93
Energy consumption rate	0.44	0.56	0.52
Energy consumption rate per unit [MJ· j.z.$^{-1}$]	408.8	384.2	390.8

Conclusion

1. Productivity of link of rotation: winter rye - potato depends mainly on potato yielding.
2. Rye has a definitely higher energy efficiency rate than potato.
3. High energy efficiency rate of rye, at a lower (than potato) rate of energy consumption, increases energy efficiency of link of rotation and reduces its energy consumption rate.

References

[1] Hill H. *Comparing Energy Use in Conventional and Organic Cropping Systems.* ATTRA-Sustainable Agriculture Information Service. 1-8. 2009.
[2] *Katalog norm i normatywów.* Wydanie III, Wyd. SGGW, Warszawa 1999.
[3] Sławiński K. *Porównanie energochłonności uprawy wybranych gatunków roślin towarowych w gospodarstwie ekologicznym i konwencjonalnym.* Journal of Research and Applications in Agricultural Engineering Vol. 55 (4), 99-101, Poznań, 2010.
[4] Szeptycki A., Wójcicki Z. *Postęp technologiczny i nakłady energetyczne do 2020 r.* IBMER. Warszawa. s. 14-20. 2003.
[5] Wójcicki Z. *Wyposażenie techniczne i nakłady materiałowo – energetyczne w rozwojowych gospodarstwach rolniczych.* IBMER. Warszawa. 111-131. 2000.

MODEL OF THE CERTIFICATION OF THE FOOD SAFETY MANAGEMENT SYSTEM FOR GROUPS OF AGRICULTURAL PRODUCERS

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Key words: groups of agricultural producers, certification, food safety management system, multiple sites

Abstract

As everybody knows the international standard concerning the management of the food safety is the norm PN-EN ISO 22000:2006 "Food safety management systems; the requirements for organization throughout the food chain" [3]. Applying this norm is very wide both in the food chain, as well as generally in all companies cooperating with the food industry, in particular it applies to manufacturers of the agricultural produce, fodders, primary products, manufacturers of the food products, operators of the transport (logistic and transport companies), to companies providing storing services, wholesale companies, subcontractors of mentioned above, zones of the retail market (shops, supermarkets), zones of food services (restaurants, bars, catering), to producers of machines and devices, packaging materials, cleaning products, elements and the additional substance, pesticides, fertilizers, medicines, dietary products and organizations providing services, etc.

The food safety management system is an instrument being supposed to help food business operators to achieve the high standard safeties of the food. The norm PN-EN ISO 22000:2006 is a document containing requirements concerning not only implementing, but also functioning and improving of management system directed at providing the safe food to the customers [3].

Taking all these to the attention and considering the place of agricultural producers in the food chain it may be reasonably assumed that:

1. implementing the food safety management system by agricultural producers, this is the action consisting in verifying functioning of the agricultural producer to requirements determined in the norm PN-EN ISO 22000:2006 [3],
2. submitting to the voluntary certification, consisting in the evaluation conducted by the independent certificating unit and confirming fulfilling the requirements of specific standard by giving a suitable certificate and leading the supervision of this certificate, in the period of his importance,

3. maintaining and improving the food safety management system by agricultural producers.

If in actions associated with the first and third item agricultural producers can get the help both on the part of the university, local governments or other non-governmental organizations, in the scope of the second item they must individually pick it up decision on the submitting of the certification. Taking into consideration, that the activity of agricultural producers can be led in the form of groups, so-called groups of agricultural producers, which are acting pursuant to the regulations of the act from 15 September 2000 about groups of agricultural producers and their associations and about the amendment of other acts [1], then it is possible to apply the group certification. The group of agricultural producers is then treated as the multiple site [2]; in this case the group of agricultural producers is receiving a certificate for activity conducted by the group as the entrepreneur, with enumerating all group members undergoing the certification.

References

[1] Act from 15 September 2000 about groups of agricultural producers and their associations and about the amendment of other acts, Journal of Laws No. 88, pos. 983 with later amendment.
[2] IAF Mandatory Document for the Certification of Multiple Sites Based on Sampling, Issue 1 of 20 November 2007.
[3] PN-EN ISO 22000:2006 "Food safety management systems; the requirements for organization throughout the food chain", PKN Warsaw, September 2005.

MODERNIZATION OF TECHNICAL INFRASTRUCTURE ASSISTED WITH EU FUNDS IN THE PRODUCER GROUP FOCUSED ON MILK PRODUCTION[1]

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Keywords: producer group, milk production, EU funds, technical infrastructure

Summary

The scope of the paper covers the entire producer group located in the Silesia province, more precisely six individual farms aimed at the milk production belonging to this producer group. The scope of work included production year 2009/2010. The land resources of surveyed farms had the range 28.50-78.00 ha of cropland. Farms affiliated in discussed producer group very willingly benefited from EU structural funds. The greatest interest was the Rural Development Programme (RDP) for 2004-2006, from which not benefited only one farmer.

Table 1. Investments implemented in the framework of EU funds (since 2004).

No.	Specification	Holdings						
		Average	1	2	3	4	5	6
1	Tractor	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	Large press	0.50	0.00	0.00	1.00	1.00	0.00	1.00
3	Mower	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	Combine harvester	0.00	0.00	0.00	0.00	0.00	0.00	1.00
5	Stellar rummage	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	Rotary rake	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	Self loading trailer	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	Straw cutter	0.00	0.00	0.00	1.00	0.00	0.00	1.00
Investments in technical facilities from funding from the EU funds [thousands PLN·farm^{-1}]								
9	Value of investments	549.23	320.80	710.00	380.40	644.60	300.00	800.00
10	The value of EU subsidies	288.99	176.72	355.00	220.00	382.25	230.00	400.00

The RDP intended for subsequent years (2007-2013) was used by three farmers. Also, three farmers carried out activities under Sectoral Operational

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Programme (SOP). The purpose of the use of EU funds in the surveyed holdings was the modernization of park machinery by purchase of machinery and tools listed in Table 1. Investments in the producer group was at the average level of 549.23 thousands PLN·farm^{-1}. The value of funding investment took out on average 289.99 thousands PLN·farm^{-1}.

Farmers, in connection with the Polish accession to the European Union, have taken numerous measures to improve the working and operation of their farms. As declared, in all the farms improved product quality and animal welfare conditions, as well as increased the number of herds. Partially producers decided to increase the area of the farm as well as legalizing the leases. Each of the let fulfils the EU requirements, regarding the management of manure. In addition, farmers belonging to the discussed producer group willing to use the free training provided mainly by The Agency for Restructuring and Modernisation of Agriculture (ARMA) and the Agricultural Advisory. The subjects of these meetings are very diverse and focus on food safety, operation of producer groups and cross compliance rules.

INFLUENCE OF INCREASING SHARES OF MISCANTHUS ON PHYSICAL AND MECHANICAL PROPERTIES OF PELLETS PRODUCED IN AN INDUSTRIAL SOFTWOOD PELLETS PLANT

Part 1: Material & Method

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Abstract

It has been possible to pelletize Wood-Miscanthus mixtures (12.5 – 25 & 50%) without modifying production process settings of a softwood pellets plant. Pure Miscanthus material tested in the same conditions has led to unstable production, mainly explained by hammermill overfeeding. The unstable production has been identified as the main responsible factor of the low quality of pellets produced with pure Miscanthus for these trials. The pellets produced were tested in a 25 kW boiler and compared with agro-pellets of various origins: winter barley straw, rapeseed straw, reed, old hay, Miscanthus, & wood pellets. During the trials, O_2, CO, CO_2, CH_4, SO_2 and NO_x emissions were measured. The flue gas chlorine content was also determined and the data were linked to the specifications of the fuels used. Trials showed that pure agro-pellets do not reach the combustion quality of wood or wood-Miscanthus mixes.

Keywords: pellets, miscanthus, solid biofuels, wood, mixture, physical properties, combustion, emissions, straw, agro-pellets

1. Introduction

Wood-burning technology is well established, especially for pellets. The market for pellets is growing rapidly as well as industrial and non industrial scales; and the European demand may outstrip the raw material resources without importing as a consequence. It is an important issue to identify new biomass resources.

Another consideration is that farmers are looking for new outlets, notably by producing crops for energy. However, agricultural products are reputedly not ideal for fuel use, as several studies have shown [1, 2, 3, 4].

Trials have been setup already to study pure agro pellets production, especially Miscanthus. These studies have demonstrated this raw material does not lead to specific problems regarding pelletizing [5, 2]. Fuel pellets could then be considered as an interesting output for this agricultural diversification. But the effects on combustion of raw material from agricultural origin are known. On one hand these products lead to slagging and fouling due to ash content and composition. On the other hand the chlorine and sulfur content lead to toxic and corrosive emissions [3, 6, 7]. Consequently, it has been suggested the use of additives to mix with agricultural raw materials, as limestone for instance [8]. Indeed some additives are known to improve the combustion behavior, especially the ash melting. Another possible way to improve the use of these difficult raw materials is to mix it with wood, in order to dilute the impact on combustion.

The first objective is here to evaluate the influence of the Miscanthus proportion on the physical and mechanical properties of the produced pellets. The measured values are compared to the limit fixed by the European standard EN 14961 (parts 1 - 2 – 6) [9,10, 11], with following question to answer: "Up to what proportion may Miscanthus be added to wood without exceeding limits given by these documents and changes in the process?" Trials have been performed on five "wood – Miscanthus mixtures" in an industrial pellets production line. Additionally, this study has for objectives to describe the influence of Miscanthus proportion on variability of the assessed properties.

The second goal is then to characterize the produced pellets combustion behavior and to compare it with pure wood and pellets made of other agricultural raw materials. It therefore appears useful to characterize emissions (especially NO_x, SO_2 and Cl) from specific resources and to link it to the physical and chemical properties of agro-fuels that affect their combustion emissions. The tests described here were conducted in a small scale boiler (25 kW) in order to be representative of domestic use or closed-circuit use by farmers (likely to be medium or low power).

2. Material & Methods

2.1. Pelletizing trials on wood-Miscanthus mixes

a. Raw material mixtures preparation

Five mixtures have been prepared in sufficient amount to insure at least one hour pellets production. About one ton raw material has been prepared for each mixture. Miscanthus proportions were (in mass) 0%, 12.5%, 25%, 50% and 100% - pure Miscanthus. Mixture were prepared prior to the experiments and stored in big bags. For the trials, the big bag was unloaded directly in the production chain, just upstream the hammermilling step.

b. Pellets production chain

Pelletizing trials have been performed on a common softwood pellets production chain. The process is characterized by following steps: raw material delivery, dryer, material mixing, hammermill, hopper, screw, pellet press (6 mm diameter, 45 mm length), cooler, fines sieving, packing.

Production parameters were kept unchanged for the five tested mixtures. Not any problem had to be noticed during processing, except for pure Miscanthus material. In this case, overfeeding of the hammermill has been observed, which induced unstable press feeding. The hammermill overfeeding may be explained by a higher coarseness of Miscanthus particle size distribution, compared to other mixtures.

c. Sampling

Raw material samples were taken just upstream the pellet press. In order to reduce the impact of sampling schedule and to avoid periodicity effects, samples were made of six subsamples taken within two minutes. Ten raw material samples were taken for each mixture at intervals of 6 minutes.

Ten pellets samples were taken downstream the cooler, within one hour at fix time intervals. Pellets (and fines) samples were made of two successive 6 liters subsamples.

d. Physical, mechanical and chemical properties

All the used procedures and methods to determine the raw material and pellets properties are the ones listed in the European standard EN 14961 [9]. Samples were

divided using riffle and rotary dividers.
The raw material mixtures were characterized regarding the ash content, moisture content and particle size distribution after milling. Minor and major elements have been measured for pure wood and Miscanthus only. Chemical content of mixtures were calculated based on pure raw material content and composition.
Prior to properties measurements, pellets and fines are separated and the fine content is stated. Additionally the fines ash content is measured for each mixture.
Measurements on pellets were performed for: durability (DU in %), particle density (PD in g/cm³), length and diameter (in mm), gross calorific value (GCV in MJ/kg), moisture content (MC in %) and ash content in %.

2.2 Combustion trials

a. Pellets raw material

Beside the mixed wood &Miscanthus pellets produced through the production experiments (2.1), 4 other agricultural crops pellets (produced by a prototype pellets press) have been used for combustion trials. Additional raw materials were: Reed, old Hay, winter Barley straw & rapeseed straw. Table 1 shows the various fuels tested and the name used below to denote each fuel

Table 1. Raw materials tested and replicates (n).

Tested Fuel	*Name*	*n*
0% Miscanthus / 100% wood	wood	2
12.5% Miscanthus/87.5% wood	misc 12.5	2
25% Miscanthus / 75% wood	misc 25	2
50% Miscanthus / 50% wood	misc 50	2
100% Miscanthus / 0% wood	Miscanthus	1
Reed	reed	1
Old hay	hay	1
Winter barley straw	winter barley	1
Rapeseed straw	rapeseed	1

b. Pellets properties

The tested pellets properties are shown in Table 2. The pellets properties were compared to those specified in the EN 14961-2 and prEN 14961-6 (wood and non woody biomass pellets standards). It appears most of the components comply with standards specifications except Cl and S content. Durability varied from 90% to 98% according to the production method. Moisture content leveled around 10% except for Miscanthus, reed and hay, where it was higher. Agro-pellets ash content was higher than wood pellets. Lastly, fines accounted for no more than 1% of the material except for 100% Miscanthus.
All the produced and tested pellets complied with the EN 14961-1 standard; regarding the maximum length proportion (Less than 5% of the pellets were between 40 and 45 mm long).
The fines content (particles under 3.15 mm) ranged from 3.2 up to 9.8% for pellets made of agricultural raw materials. Pellets containing wood never exceed 2% fine content.
In addition, it has to be noticed the high share of small and broken pellets (length small than the 6 mm diameter). Pellets made of agricultural residues have a proportion of such particle ranging from 20 to 65%. Pellets containing wood are under 5% regarding this property.

No conclusion may be drawn regarding the influence of the raw material origin on the length distribution of pellets. Indeed most of the agricultural pellets were produced by a prototype press while Miscanthus pellets were produced by an industrial press having settings prepared for wood. Nevertheless the length distribution of the produced pellets has been considered has acceptable to be used in combustion trials.

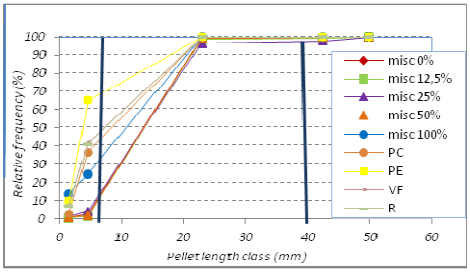

Figure 1. Length distribution of pellets used for combustion tests. Miscanthus shares in the wood Miscanthus pellets are stated in percentage after the misc abbreviation, *PC: rapeseed straw, PE: winter barley straw, VF: old hay, R: reed*

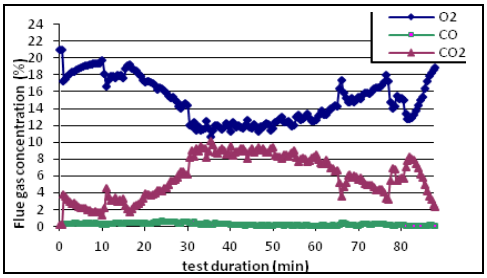

Figure 2. O_2, CO and CO_2concentration over time (min) in the Winter Barley straw test.

c. Boiler

An HS Tarm Multi-Heat multi-fuel boiler was used for the tests. This model is suitable for burning (agro) pellets, cereals and wood chips. The nominal power of the boiler is 25 kW. The nominal efficiency is 86-87%. It is stoked automatically via an auger. Ash is removed manually. Between 7 and 10 kg of pellets were burned per trial (see table 3 for test sample size and burning conditions).

d. Measuring Equipment

The installation diagram of the equipment used for these trials is provided in Figure 6.Two measuring lines were set up for the purpose of this study.

The first line being dedicated to SO_2, CO, CH_4, NO, CO_2 and O_2concentration measurements in the flue gas. The following equipment was used:

ى Vacuum pump: to keep an isokinetic sampling rate throughout the trial.

ى Peltier cooler: to condensate water content prior to gas analysis.

ى Peristaltic pump: to remove condensates to prevent liquid entering the gas analyser.

ى Filter paper: back-up filter to keep dust out of the gas analyser.

ى Rotameter: to control the sampling rate. The water circulation rate in the boiler is thus known and averaged 368 l/h.

ى Gas analysers: to analyse the gas SO_2, CO, CH_4, NO, CO_2 and O_2 content. The analysers first have to be calibrated using a standard gas.

- ✦*Magnos 6G* oxygen analyser (Hartmann & Braun):for continuous measurement of the oxygen content of gas mixes in ranges from 0 to 100% O_2 by volume.
- ✦Uras 14 infrared absorption analyser (Hartmann & Braun):the Uras 14 continuously measures SO_2, CO, CH_4 and NO in gas mixes.
- ✦Fuji infrared gas analyser: this device continuously measures the CO and CO_2 concentration in a gas in ranges from 0 to 10% by volume (CO) and 0 to 20% by volume (CO_2).

ى Data Logger (Testo 350 454):used to record the data& transfer it to the computer

The oxygen concentration during the trials varied from 11.3% to 14.5%. CO was the most prevalent element, amounting to nearly 2,300 mg/m³ at 13% O2 in the case of winter barley straw whereas the Belgian standard (Decree published on 12/10/2010 [2]) is 5,000 mg/m³ in 2011, 3000 mg/Nm³ in 2012-2013 and 1,500 mg/Nm³ from 2013 to 2016.

Figure 2 shows the O2, CO and CO2 concentration curve during the winter barley straw pellet test.

The second measuring line was dedicated to chlorine concentration determination in the flue gas. The following equipment was used for this purpose:

ى Vacuum pump: to maintain an isokinetic sampling rate throughout the trial.

ى Flow meter: to control the sampling rate.

ى Gas washing bottles (4): used to trap chloride ions in flue gas by passing the gas through water in order to measure the concentrations according to the ISO 10304 standard. Chloride concentration resulting from combustion was determined by relating the gas flow rate through the washing bottles to the flue gas flow rate.

Parallel to the washing bottle set a Pitot tube was installed to measure the flow rate ofthe sampled flue gas. The ΔP (dynamic pressure) measured by the Pitot tube averaged 0.0095 hPa.

Flue gas & water (in & out) temperature were measured by thermocouples and PT100 sensors. The IN: water temperature was between 21 and 39°C and the OUT: water temperature ranged from 35 to 57°C. The desired value is a boiler IN / OUT temperature difference (δT) of 20°C. A maximum variation of 12°C in relation to the desired value was observed during the tests. The flue gas temperature varied between 106°C and 122°C (Table 3).

Figure 3. Type 1

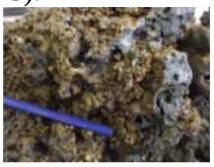

Figure 4. Type 2

Figure 5. Type 3

The slag was classified in three different types on a qualitative basis (visual). The first case, called Type 1 (Figure 3) contained almost no slag. In the second case, Type 2, (Figure 4) some slag formation was observed. Lastly, the third case, Type 3, (Figure 5) is in between type 1 & 2 and contains friable slag designated as 'pre-slag'. This was removed from the core of the boiler together with the ash and therefore caused no problems.

Table 2. Pellet composition and element content with regard to CEN/TS 14961 2 & 6 - B: wood. *M 12.5: misc 12.5; M 25: misc 25; M: misc; R: reed; VF: hay; PE: winter barley; PC: oilseed rape - Type 1: Ashes; Type 2: slag; Type 3: pre-slag*

Material	*B*	*M 12.5*	*M 25*	*M 50*	*M*	*R*	*VF*	*PE*	*PC*
Moisture (%)	9.5	10.0	9.6	8.1	20.4	21.7	11.7	12.5	13.1
Ash content (%)	0.9	1	1.2	1.7	2.6	5.5	6.1	5.2	5.8
Durability (%)	98.0	98.0	97.9	98.0	90.5	91.3	95.2	93.9	89.8
Net density (g/cm³)	1.3	1.3	1.3	1.3	1.3	0.8	1.2	0.9	1.2
Fines (%)	0.7	0.7	1.2	1.3	14.8	0.9	0.3	1.0	0.9
GCV (MJ/kg)	20.23	20.12	20.01	19.79	19.36	18.84	18.70	18.68	18.81
N (%)	***0.08***	***0.08***	***0.09***	***0.11***	***0.14***	*1.02*	***1.21***	***0.57***	***0.69***

Material	*B*	*M 12.5*	*M 25*	*M 50*	*M*	*R*	*VF*	*PE*	*PC*
C (%)*	51	50.5	49	48	47	46	46	47	48
H (%)*	6.3	6.3	6.2	6.15	6.1	5.8	5.9	6.0	6.0
O (%)*	42	42	42	42	42	42	40	41	41
NCV (MJ/kg)	16.86	16.86	16.81	16.91	16.45	13.98	15.23	14.94	14.96
Cl (mg/kg)	***< 100***	***< 100***	***< 100***	***< 100***	***< 100***	*2600*	*5700*	*3300*	*1500*
S (mg/kg)	***<500***	***333***	***465.5***	***731***	*1262*	***1200***	***1400***	***970***	*2800*
Na (mg/kg)	21	33.3	45.63	70.25	119.5	300	180	340	160
Si (mg/kg)	125	189	253.75	382.5	640	1100	7200	8200	2300
Ca (mg/kg)	1426	1408	1389.5	1353.5	1282	3600	4600	4800	1100
K (mg/kg)	387	459	531.88	676.75	966.5	1000	1700	1500	1100
Mg (mg/kg)	181.5	191	201	220.5	259.5	800	1300	600	790
Cd (mg/kg)	***<0.5***	***<0.5***	***<0.5***	***<0.5***	***<0.5***	**< 0.4**	**< 0.4**	**< 0.4**	**< 0.4**
Cr (mg/kg)	***<8***	***<8***	***<8***	***<8***	***<8***	**6.3**	**2.8**	**5.0**	**3.1**
Cu (mg/kg)	***<5***	***<5***	***<5***	***<5***	***<5***	**5.3**	**4.2**	**3.7**	**6.6**
Zn (mg/kg)	***< 100***	***< 100***	***< 100***	***< 100***	***< 100***	**32**	**24**	**8.1**	**12**
As (mg/kg)	***< 0.8***	***< 0.8***	***< 0.8***	***< 0.8***	***< 0.8***	**0.38**	**0.3**	**0.26**	**0.21**
Mg (mg/kg)	***< 10***	***< 10***	***< 10***	***< 10***	***< 10***	**1.3**	**1.0**	**0.7**	**0.6**
Hg (mg/kg)	***<0.05***	***<0.05***	***<0.05***	***<0.05***	***<0.05***	**< 0.05**	**< 0.05**	**< 0.05**	**< 0.05**
Ni (mg/kg)	***< 10***	***< 10***	***< 10***	***< 10***	***< 10***	*12*	**1.8**	**2.5**	**4.3**
Slag type	1	3	3	3	2	3	3	3	3

**: Characteristic value according to standard EN 14961 – 1, i.e. not measured in trial*

Val: Value conforming to grade WP A1 according to CEN/TS 14961 – 2

Val: Value not conforming to grade WP A1 according to CEN/TS 14961 – 2

Val: Value not conforming to any of the CEN/TS 14961 – 6 quality classes

Val: Value conforming to CEN/TS 14961 – 6

Val: Value not conforming to CEN/TS 14961 – 6

Table 3. Test Characteristics. *Average flue gas temperature, t° in and t° out (t° in: boiler inlet water temperature; t° out: boiler outlet water temperature), Flue gas flow rate (Q), Chlorinated water volumes in washing bottles, Quantity of fuel burned (kg)*

Substrate	*Flue gas t° (°C)*	*IN water t° (°C)*	*OUT water t° (°C)*	*δ T (°C)*	*Q (Nm³/s)*	*Total volume (l)*	*Qty pellets burned (kg)*
wood	110.23	20.74	53.58	32.84	0.0176	0.847	10.000
misc 12.5	110.23	35.79	54.93	19.13	0.0154	0.914	7.648
misc 25	108.90	39.06	57.48	18.42	0.0109	0.935	8.787
misc 50	119.84	34.09	56.70	22.61	0.0120	0.900	8.202
misc 100	129.46	27.49	53.65	26.17	0.0132	0.850	9.968
reed	113.28	19.09	45.81	26.72	0.0175	0.856	10.080
hay	99.56	16.58	38.75	22.17	0.0159	0.832	10.002
winter barley	113.88	17.99	44.40	26.41	0.0168	0.822	9.997
rapeseed	117.17	20.42	47.76	27.34	0.0162	0.826	10.080

e. Data recording

All the above mentioned data were recorded at a 30s time interval and recorded by the data acquisition computer. The data were averaged when the boiler was operating at full speed, i.e. for 30 minutes. The average test duration was 1 hour 41 minutes.

For each fuel, ash content was determined according to the Belgian standard 'Solid Biofuels - NBN Ash Content Determination' CENT/TS 14775 (January 2005).

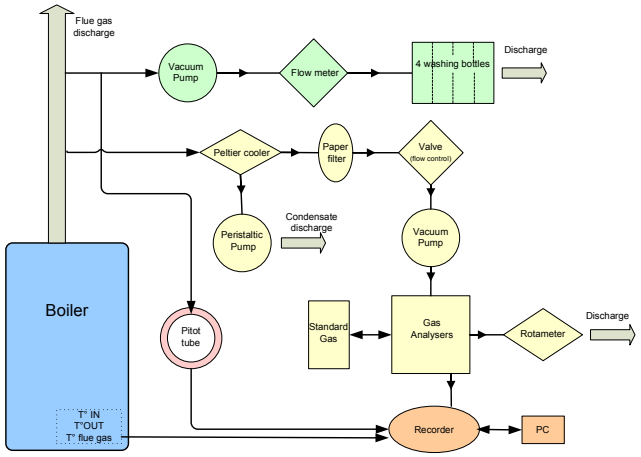

Figure 4. Combustion test equipment layout.

f. Reference Concentration

Following data acquisition the element concentration (NO, CH_4, CO, etc.) was expressed in ppm or mg/m3. The results were reduced to a 13% oxygen content in mg/m³ (Table 4).

The conversion formula used is shown below.

$$[mg/m^3] = [ppm]*\alpha$$

where $\alpha = 0.717$ for CH_4

$\alpha = 1.25$ for CO

$\alpha = 1.44$ for NO

$$[mg/m^3]_{ref\ to\ 13\%O2} = [mg/m^3]*\frac{(21-13)}{(21-[O2])}$$

The SO_2 and CH_4 concentrations were the lowest between 0 and 64 mg/m³. NO concentrations varied from 50 to 290 mg/m³. Lastly, the CO concentrations ranged from 30 to 2,300 mg/m³.

The quantities of SO_2, CH_4, CO and NO emitted per kg of pellets burned were calculated (g/kg) from the mg/m³ concentrations, flue gas volume (Nm³) and quantity of pellets burned (kg).

Table 4:SO_2, CH_4, CO and NO concentration at 13% O_2

Substrate	*SO_2*	*CH_4*	*CO*	*NO*
	Ref. conc. 13% O2 (mg/m³)			
wood	14.06	0.00	189.98	144.09
misc 12.5	12.81	29.09	1193.24	51.18
misc 25	10.16	13.18	799.95	74.56
misc 50	13.99	1.94	143.16	107.99
Miscanthus	47.44	0.10	30.38	155.52
reed	57.05	2.32	1140.80	311.68
hay	20.15	5.05	1439.24	318.88
winter barley	36.88	16.42	2271.60	176.95
oilseed rape	37.33	3.31	417.47	253.41

g. *Combustion Efficiency*

The combustion efficiency was 90% overall (Table 5). It was calculated by a method derived from European standard EN 15378. The formula is shown below. Factors A and B in the formula refer to the fuels. For the considered pellets, the values of 0.765 and 0.000 have been considered for A and B, respectively.

Eff = 100 - losses

With losses = ($t°_{flue\ gas} - t°_{oxidizer}$) * (

A, B = fuel-specific factors

Table 5.Efficiency of different agro-pellets.

Substrate	*Efficiency %*	*Substrate*	*Efficiency %*
wood	92.9	reed	91.7
misc 12.5	89.1	hay	91.3
misc 25	91.2	winter barley	89.1
misc 50	84.6	oilseed rape	91.4
Miscanthus	89.5		

References

[1] Obernberger I., Brunner T., Bärnthaler G. (2005), Chemical properties of solid biofuels – significance and impact, Elsevier p.10.

[2] Hartmann H., Turowski P., Roßmann P., Ellner-Schuberth F., Hopf N. (2007), Grain and straw combustion in domestic furnaces – Influences of fuel types and fuel pre-treatments, 15th European Biomass Conference & Exhibition, 7-11 May 2007, Berlin, p.6.

[3] Van Loo S., Koppejan J. (2007) Handbook of biomass combustion and co-firing, IEA Bioenergy Y task 32, earthscan, p.266-272.

[4] Nikolaisen L. *et al*. (2002) Quality characteristics of biofuel pellets, Danish Energy Agency, p.137 + appendix.

[5] Fritz M., Formowitz B., Jodl S., Eppel-Hotz A., Kuhn W., 2009, Miscanthus: Anbau und Nutzung - Informationenfür die Praxis, 37p, Berichteausdem TFZ 19, Technologie- und Förderzentrum für NachwachsendeRohstoffe (TFZ).

[6] Pastre O, 2002, Analysis of the technical obstacles related to the production and utilization of fuel pellets made from agricultural residues, 57p, Pellets for Europe, ALTENER 2002-012-137-160, EUBIA.

[7] Hartmann H.,Rossmann P., Turowsky P., Ellner-Schuberth F., Hopf N., Bimüller A., 2007, Getreidekörner als Brennstoff für Kleinfeurengen, 126p, Berichteausdem TFZ 13,.Technologie- und Förderzentrum für NachwachsendeRohstoffe (TFZ).

[8] Nikolaisen L, Norgaard Jensen T, Hjuler K., Busk J., Junker H, Sander B., Baxter L., Bloch, 2002, Quality characteristics of biofuel Pellets, 137p, Report, DTI, Denmark.

[9] [EN 14961-1:2009, Solid biofuels - Fuel specifications and classes - Part 1: General requirements, CEN, 2009.

[10] prEN 14961-2:2010, Solid biofuels - Fuel specifications and classes - Part 2: Wood pellets for non-industrial use, CEN, 2010.

[11] prEN 14961-6:2010, Solid biofuels - Fuel specifications and classes - Part 6: Non-woody pellets for non-industrial use, CEN 2010.

INFLUENCE OF INCREASING SHARES OF MISCANTHUS ON PHYSICAL AND MECHANICAL PROPERTIES OF PELLETS PRODUCED IN AN INDUSTRIAL SOFTWOOD PELLETS PLANT

Part 2: Results & Conclusions

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Abstract

It has been possible to pelletize Wood-Miscanthus mixtures (12.5 – 25 & 50%) without modifying production process settings of a softwood pellets plant. Pure Miscanthus material tested in the same conditions has led to unstable production, mainly explained by hammermill overfeeding. The unstable production has been identified as the main responsible factor of the low quality of pellets produced with pure Miscanthus for these trials. The produced pellets were tested in a 25 kW boiler and compared with agro-pellets of various origins: winter barley straw, rapeseed straw, reed, old hay, Miscanthus, &wood pellets. During the trials, O_2, CO, CO_2, CH_4, SO_2 and NO_x emissions were measured. The flue gas chlorine (content was also determined and the data were linked to the specifications of the fuels used. Trials showed that pure agro-pellets do not reach the combustion quality of wood or wood-Miscanthus mixes.

Keywords: pellets, miscanthus, solid biofuels, wood, mixture, physical properties, combustion, emissions, straw, agro-pellets

3. Results

3.1. Pelletizing trials on wood Miscanthus mixes

a. Raw material and pellets moisture content.

The raw material moisture content stays stable for the different mixture and is about 10%, which is appropriate moisture content for pelletizing process. The standard deviation indicates variations of this parameter within mixtures are low.

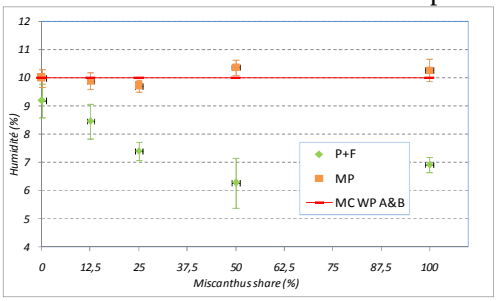

Figure 5. Mixture moisture content prior and after pelletizing (standard deviation as error bar). *– P+F : Pellets and Fines – MP : raw material – MC WP A&B : class A and B moisture content limit*

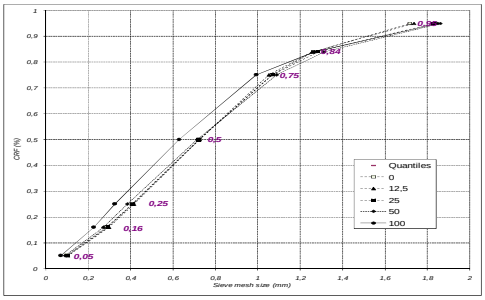

Figure 6. Cumulated relative distribution and quantile for particle size of the tested mixtures, prior to pellets press feeding – 100 - 50 – 25 - 12,5 – 0 are the Miscanthus proportion for the different mixtures.

Pelletizing process induces moisture content losses, which is not surprising as the

material is heated during the process. The variability of moisture content is higher compared to the raw material variability for this property.
If pure Miscanthus is not considered, the moisture content difference between raw material and pellets seems to become higher for higher Miscanthus shares in the mixture. But the moisture content of the produced pellets remains lower than 10%, which is the limit stated in EN 14961.

b. Raw material Particle size distribution

After milling, particle size distributions are similar for all mixtures, except for pure Miscanthus. If pure Miscanthus is not considered, 95% (quantile 95) of the particles have a size less than 1.8 mm. The median size of the distribution is about 0.7 mm. The particle size distribution of pure Miscanthus is smaller, 95% of the particles have a size less than 1.7 mm and the median size is about 0.6 mm. The thinner particle size distribution of pure Miscanthus may be explained by the overfeeding of the hammermill that occurred for that material. As particles remain longer in the milling chamber particlesthey become thinner. This could indicate the use of Miscanthus to produce pellets should be subordinate to pre-milling of the material or to process settings modification.

c. Mixture content influence on pellets Durability

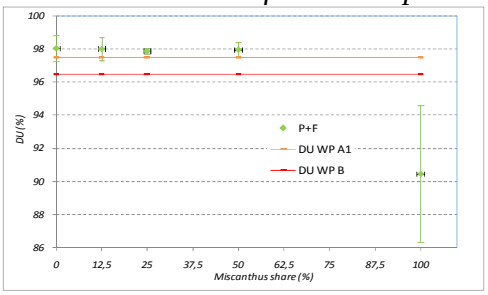

Figure 7 . Pellets mean durability for different wood-Miscanthus mixtures. (Standard deviation as error bar) – *P+F : Pellets & Fines – MP : Raw material – DU WPA1 : class A1 durability limit – DU WP : class B durability limit*

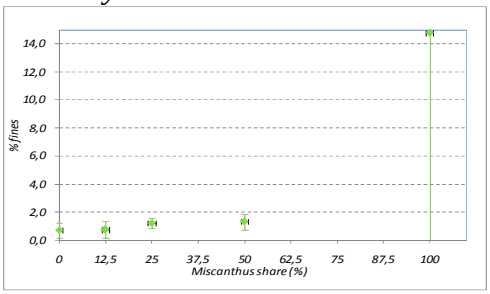

Figure 8. Fines proportion after cooling (but before screening) for different wood-Miscanthus mixtures. (Standard deviation as error bars)

The pure Miscanthus mixture has led to highly unstable production, if DU is considered. Moreover, in this case, the pellets mechanical durability is low. This low quality results have to be linked with problems that occurred during production for that mixture. In consequence, it may not be concluded the raw material as a direct influence on the durability of the production. Indeed other hypothesis may be proposed: the thinner particle size distribution compared to other mixtures, the unstable press feeding and the not adapted process settings regarding Miscanthus.
The other mixtures lead to more stable production and higher product durability. This allows the classification of the produced pellets in class A1, if only Durability is regarded.

d. Fines proportions

Except for pure Miscanthus (which produce up to 15% fines) the fines proportion after cooling is under 2% for all tested mixture. No comparison with EN14961

quality classes has been done for this property, as pellets will be further screened in a next step of the production.

e. Particle density

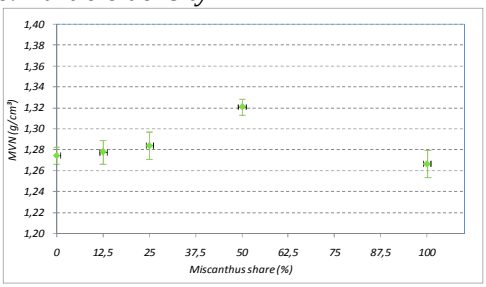

Figure 9 . Pellets particle density for different wood Miscanthus mixtures (Standard deviation as error bar).

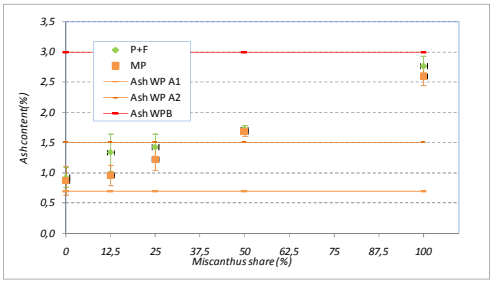

Figure 10 . Ash content for increasing shares of Miscanthus in the raw material and in the pellets produced. (Standard deviation as error bar – n=10) – *P+F : Pellets & Fines – MP : Raw material – Ash WP A1, Ash WP A2, Ash WP B: Ash content limits for classes A1, A2 & B, respectively*

Up to a share of 50% Miscanthus in the mixture, the particle density of the produced pellets seems to increase as a function of the Miscanthus proportion. Pellets made of 100% Miscanthus seem of lower particle density, which is most probably a consequence of the unstable production of this mixture. Further trials should include a 75% Miscanthus mixture, which would confirm the influence of the Miscanthus proportion on the particle density.

f. Ash content

Not surprisingly, the ash content increases as the Miscanthus share. No significant difference between ash content of raw material and the produced pellets has been observed, for any of the tested mixtures. This indicates there were no segregations between Miscanthus and wood

g. Gross calorific value

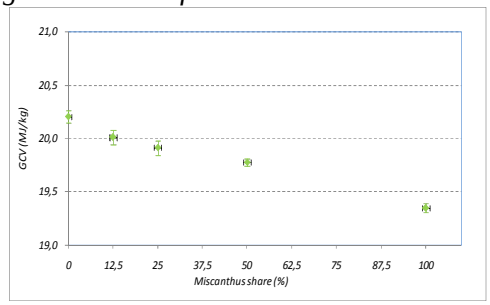

Figure 11 . Gross calorific value depending on the Miscanthus share in the mixture.

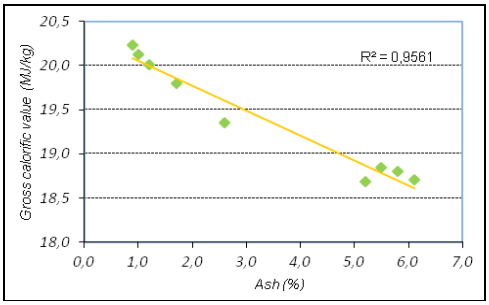

Figure 12. Gross Calorific Value (MJ/kg) plotted against Ash Content (%).

The higher the Miscanthus proportion is, the lower the gross calorific value is. This is explained by the higher ash content of the mixtures containing higher share of Miscanthus.

3.2. Combustion trials

a. Interaction between Properties of Test Fuels

The tests clearly illustrated the interaction (R^2=95%) between the gross calorific value and the ash content (Figure 7).

These interactions have already been shown many times in the literature (for instance: [1]).

b. Combustion related Parameters

CH_4 and CO Emissions

Both, CH_4 and CO are combustion quality indicators, the higher is the concentration, the combustion is the poorest. The CH_4 concentration scale (Figure 13) is much lower than for CO (Figure 14). This is because methane forms upstream of carbon monoxide. The observation in Figure 8 thus shows the CH_4 concentration rising exponentially in the flue gas as the quantity of wood in the mix increases. This is confirmed by Figure 14, but the observation has not been explained. On the other hand, the high CO and CH_4 concentration from the winter barley pellets is probably attributable to incomplete combustion because of the short length of the pellets

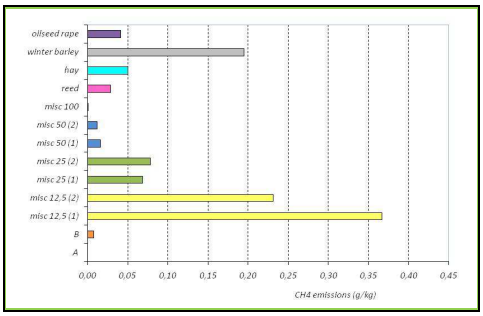

Figure 13. CH4 emissions in combustion flue gas per kg of pellets burned (g/kg) for the different substrates.

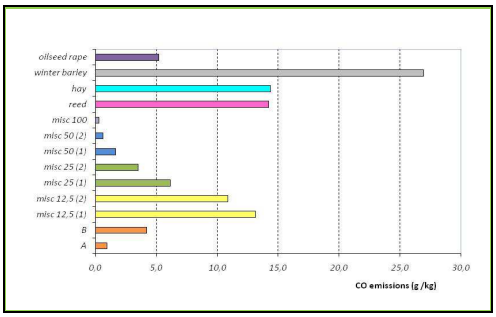

Figure 14. CO emissions in combustion flue gasper kg of pellets burned (g/kg) for the different substrates.

c. Fuel related Parameters

NO Emissions

Figure 14 shows the NO emissions for each fuel. The substrate composition, and especially the nitrogen (N) content, affects significantly NO emissions (R^2: 79% – Figure 15). This has already been shown, notably in [2].

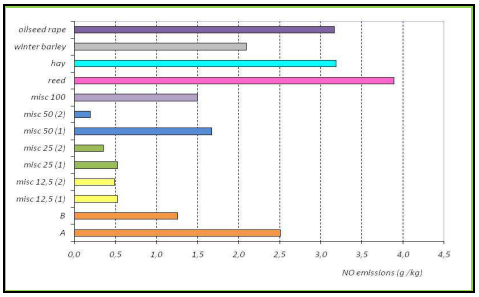

Figure 15. NO emissions in combustion flue gas per kg of pellets burned (g/kg) for the different substrates.

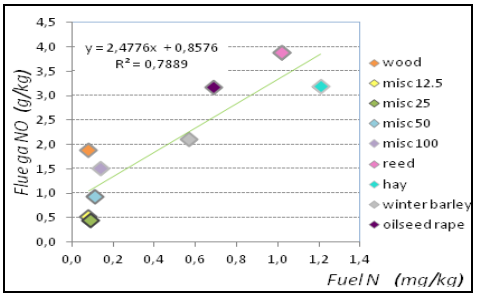

Figure 16. Average NO Concentration in flue gas (g/kg of pellets burned) according to substrate N content.

Reed was the only substrate to deviate from standard EN 14961-1 (Table 2). This is confirmed by the observation in Figure 15.

SO_2 Emissions

The SO_2 emissions are shown in Figure 17. The observations reported in [3] concerning the strong effect of the fuel S content on SO_2 emissions were not confirmed by the here described tests (Figure 18). The moisture content appears to affect the flue gas SO_2 values more significantly than the S concentration (Figure 19).

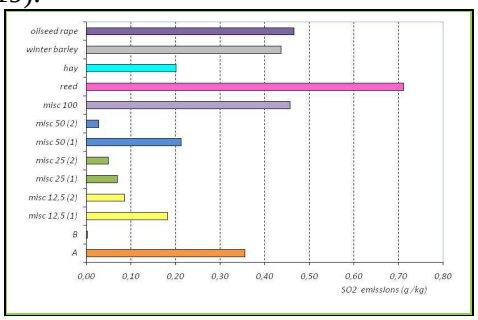

Figure 17. Flue gas SO_2 emissions per kg of pellets burned (g/kg) for the different substrates.

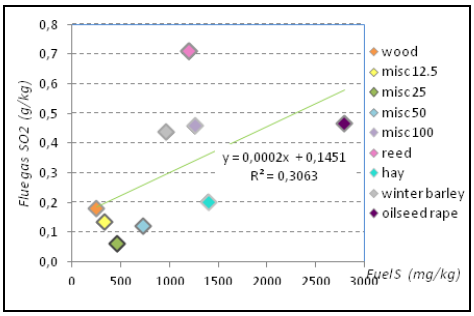

Figure 18. Average flue gas SO_2 concentration (g/kg of pellets burned) according to substrate S content.

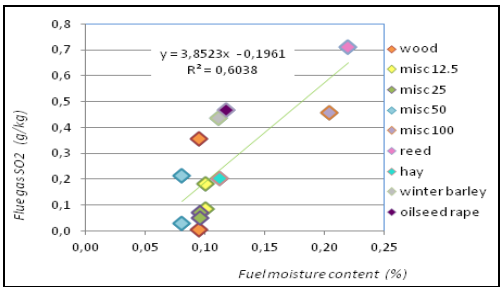

Figure 19. Flue gas SO_2 concentration (g per kg of pellets bBurned) trend according to fuel moisture content.

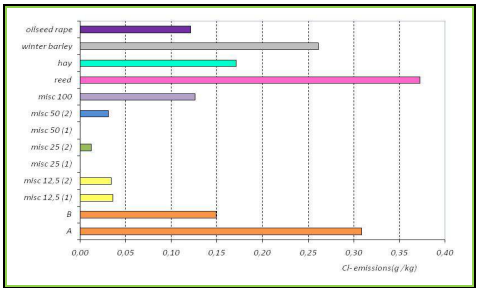

Figure 20. Flue gGas Cl^- discharge per kg of pellets burned (g/kg) for the different substrates.

Cl^- Emissions

Chloride concentrations (Figure 20) were of the same order of magnitude as the SO_2 concentrations.

Surprisingly, wood emitted more than the Miscanthus mixes, although the pellets complied with EN 14961-1. The four agro-pellets did not conform to pre-standard prEN 14961-6 in terms of fuel chloric concentration (Table 2).

Slag production

Miscanthus was the only fuel to induce slagging (Type 2) (Table 2). Wood produced none (Type 1), and all the other fuels produced a friable clinker (Type 3).

Pellet behavior with regard to slag formation clearly depends on the mix, as shown by [3,4]. Slag formation is thus linked to varying concentrations of silicon, calcium, potassium and magnesium.

5 Conclusions

It has been possible to pelletize wood-Miscanthus mixtures without modifying production process settings of a softwood pellets plant. Pure Miscanthus material tested in the same conditions has led to unstable production, mainly explained by hammermill overfeeding. The unstable production is identified as main responsible factor of the low quality of pellets produced with pure Miscanthus for these trials. These results suggest that pelletizing wood – Miscanthus mixtures may be done on softwood pellets production plants, without modifying process settings.

The unstable production observed with pure Miscanthus material prevents to drawn any conclusion regarding the possibility to pelletize that material. Especially it has been shown possible by previous studies. However, it indicates the process settings (e.g. hammermill design) have to be adapted to that material. Or the Miscanthus has to be prepared prior to delivery. The better option should be indentified after assessment of the overall efficiency of the process.

Concerning Miscanthus shares up to 50% in softwood, following observations have been noticed. The Miscanthus share seems not to influence the durability of the produced pellets, lead to higher particle density, higher ash content, lower gross calorific value, and seems not to influence the pellets length distribution.

The measurement performed during these trials have highlighted the sulfur content of the produced pellets is high, without being problematic. This was surprisingly not the case for chlorine, which was measured at low levels in the product. Trials should be repeated and further setup to determine to which extend agricultural practice (harvesting or conditioning) could enhance lixiviation of these elements.

The combustion trials allow confirming the relationship between NO emissions and the fuel N concentration. However, the tests did not clearly show a similar interaction with S. The tests could indicate that SO_2 emissions may be affected by the fuel moisture content. This remains to be confirmed. The complexity of combustion and the many interactions between the parameters involved is thus confirmed.

The agro-pellet material that performed best in emission terms was old hay. Reed, on the other hand, is less recommendable being systematically the worst polluter. Moreover, the reed pellets did not conform to four values according to the prEN 14961-6 standard.

Results for the wood-miscanthus mixes were good overall. Taking into account the pellet composition and compliance with the EN 149641-2 standard, the 12.5% miscanthus - 78.5% wood sawdust appears to be the best compromise, except that the combustion parameters were less good (CO concentration very much higher than with the other mixes). The combustion parameters therefore need to be adapted to the fuel. The 25%-75% or 50%-50% mixes can be recommended. The 100%Miscanthus pellets are not recommended because of the amount of slagging.

However, on completion of these two series of trials, the results are fairly encouraging for the future, regarding both agro-pellets and wood-Miscanthus mixes.

6. References

[1] Obernberger I., Brunner T., Bärnthaler G. (2005), Chemical properties of solid biofuels – significance and impact, Elsevier p.10.
[2] Hartmann H., Turowski P., Roßmann P., Ellner-Schuberth F., Hopf N. (2007), Grain and straw combustion in domestic furnaces – Influences of fuel types and fuel pre-treatments, 15th European Biomass Conference & Exhibition, 7-11 May 2007, Berlin, p.6.
[3] Van Loo S., Koppejan J. (2007) Handbook of biomass combustion and co-firing, IEA Bioenergy Y task 32, earthscan, p.266-272.
[4] Nikolaisen L. *et al*. (2002) Quality characteristics of biofuel pellets, Danish Energy Agency, p.137 + appendix.
[5] Fritz M., Formowitz B., Jodl S., Eppel-Hotz A., Kuhn W., 2009, Miscanthus: Anbau und Nutzung – Informationen für die Praxis, 37p, Berichteausdem TFZ 19, Technologie- und Förderzentrum für Nachwachsende Rohstoffe (TFZ).
[6] Pastre O, 2002, Analysis of the technical obstacles related to the production and utilization of fuel pellets made from agricultural residues, 57p, Pellets for Europe, ALTENER 2002-012-137-160, EUBIA.
[7] Hartmann H.,Rossmann P., Turowsky P., Ellner-Schuberth F., Hopf N., Bimüller A., 2007, Getreidekörner als Brennstoff für Kleinfeurengen, 126p, Berichteausdem TFZ 13,.Technologie- und Förderzentrum für NachwachsendeRohstoffe (TFZ).
[8] Nikolaisen L, Norgaard Jensen T, Hjuler K., Busk J., Junker H, Sander B., Baxter L., Bloch, 2002, Quality characteristics of biofuel Pellets, 137p, Report, DTI, Denmark.
[9] EN 14961-1:2009, Solid biofuels - Fuel specifications and classes - Part 1: General requirements, CEN, 2009.
[10] prEN 14961-2:2010, Solid biofuels - Fuel specifications and classes - Part 2: Wood pellets for non-industrial use, CEN, 2010.
[11] prEN 14961-6:2010, Solid biofuels - Fuel specifications and classes - Part 6: Non-woody pellets for non-industrial use, CEN 2010.
[12] Magnette P. (2010) Arrêté royal réglementant les exigences minimales de rendement et les niveaux des émissions de polluants des appareils de chauffage alimentés en combustible solide, Moniteur belge le 2010-11-24, p.4.

Acknowledgements
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INFORMATION SERVICE "REGIONAL SIGNALIZATION" AS AN ELEMENT OF CEREALS INTEGRATED PRODUCTION AND CONTROL

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Key words: monitoring, integrated production and control, cereals

Introduction

One of the most crucial elements of plant protection is efficient monitoring of pests and diseases occurred on the agricultural plants. Providing correct signalization and advisory service, one has to remember that in terms of first appearance or in developmental stages of pests/diseases significant differences, sometimes 3 weeks, are observed between different regions of the country. Within voivodeship regions these differences reach 2 weeks, and about 1 week within the county. Moreover, at the same place (one village – different plantations) a few days differences of pests or diseases appearance can be observed. The main purpose of regional signalization is determining the optimal time of chemical control on the specific plantation which gives opportunity to reduce the costs, number of chemical treatments and subsequently risk of environmental pollution

Methods

Taking into consideration the demand of producers for accurate information regarding optimal chemical treatments terms and determining the necessity of their performance, diseases/pests regional monitoring since 2005 at the Plant Protection Institute has been providing. The results are published on the Institutes' website (www.iorpib.poznan.pl) under "Sygnalizacja Agrofagów" (Pests/diseases signalization) (figure 1).

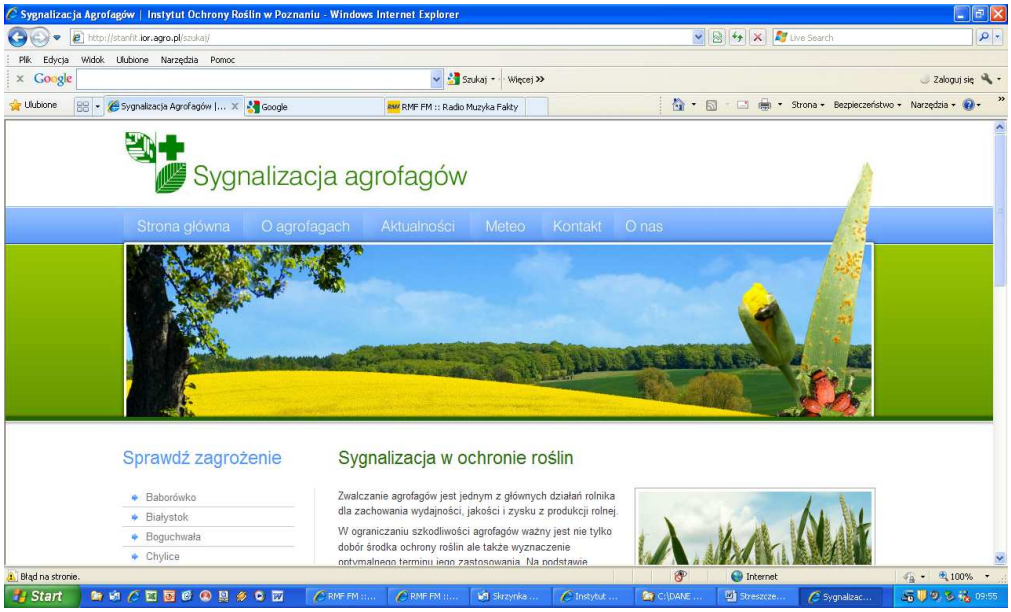

Figure 1. “Regional signalization” web page.

Except information about first appearance and next developmental stages the above website provides information regarding pests and diseases biology too. Such information helps the producers estimate their individual situations on the field.

Results

During vegetation season 2010 observations were provided in 12 places (1. Baborówko, 2. Słupia Wielka, 3. Winna Góra, 4. Kościelna Wieś; 5. Sośnicowice; 6. Chylice, 7. Boguchwała, 8. Nienadówka, 9. Białystok; Nienadówka, Krzeczowice, Głuchów) in Poland Observation were concentrated on: – powdery mildew, rust, cereal leaf beetles, saddle gall midges and aphids in cereals, late blight and colorado beetle in potatoes, cercospora leaf spot, aphids, cutworms and beet fly on sugar beets.

As an example, field observation results aimed at powdery mildew occurrence on winter wheat, in table 1 are shown.

Table 1. Powdery mildew (*Blumeria graminis* f. sp. *tritici*) on winter wheat – 2010.

Date of obser-vation	Develop-mental stage	Places								
		1	2	3	4	5	6	7	8	9
		% of winter wheat infected stalks								
19th of April	tillering							1%	1%	
26th of April	tillering	5% plants treatment was done							1%	
27th of April	tillering							5%		
04th of May	shooting		1%	1%						
05th of May	shooting	1%					20% time of treatment			
10th of May	shooting		1%	1%	1%					
11th of May	shooting									<50% time of treatment
12th of May	shooting									
14th of May	shooting		<50% time of treatment	<50% time of treatment		<50% time of treatment				
17th of May	shooting				30% time of treatment					
26th of May	shooting							5%		
07th of June	earing								1%	

EFFECT OF Mg TREATMENT ON INDIAN TOBACCO (*Lobelia inflata L.*)

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Summary: *Lobelia inflata* L. a native North–American species seems to possess various pharmaceutically significant properties. The results indicate the favourable effects of Mg-fertilization and are in harmony with our previous *in vitro* and *in vivo* experiments. It has been estimated that an established population can produce some 2.5 kg/ha total alkaloid under Mg treatment.

Keywords: Indian tobacco **(***Lobelia inflata* L.), Mg treatment, HPLC, lobeline

Introduction

Indian tobacco, a native North American species seems to be a useful medicinal plant that can be introduced in Hungary. *Lobelia inflata* L. belongs to the order *Campanulales*, to the family *Lobeliaceae*. The plant itself can reach the height of 60 cm, its stem is square-chinned, roughly-haired, its lower part is often red-violet coloured and anthocyaned. Their leaves are diffuse-positioned, mildly-haired. *Lobelia inflata* L. is an annual plant [1] but biennial populations can be found, too.

The herb contains some 20 piperidine skeleton alkaloids. Its main alkaloid is the lobeline that due to its stimulating effect on the respiratory centre is used in cases of gas- and narcotic poisoning. It is also used in anti-smoking preparations [4]. Recently, significant amounts of polyacetylene compounds have been isolated from the plant (lobetiol, lobetolin and lobetyolin).

Materials and methods

During the open field trials carried out in 2009-2010 at the University of West-Hungary, Agricultural and Food Sciences, we used N and Mg ground and leaf fertilizers.

The nutrients were applied in the following methods and quantities: untreated (control), 50 and 100 kg/ha N ground fertilizers, and 50 kg/ha Mg ground fertilizer. The propagation of the experimental plants was carried out by seed-sowing in the glasshouse, with seedling planting. Sowing was done in seeding boxes on the 15th of January, 2010.

After seedling planting, seedlings were transplanted to cell trays between the 1st of May and the 5th of May. The growing of seedlings in the glasshouse lasted one and a half month. The spilling of the N fertilizer (34%) onto the soil was carried out at the previous day before the sowing. The planting was done on the 15th of June, 2010.

We planted out 27 plants (seed sowed and tissue-cultured alike) each treatments. The significant damage caused by Spanish slug (*Arion vulgaris*) in the first two days caused major problems in the care of the plantation. In the course of care of plants we used mechanical weed control. Chemical weed-killers were not applied. Some plants among the transplanted ones develop seedstalk while others stay in the rosette phase. The measuring of the stock of plants was accomplished four times: 8 July, 17 July, 24 July and 1 August. In each treatment 7 plants were measured (plant height, leaf length and width).

The first harvesting was done on the 5th of August. Here we measured the weight of biomass then the cut plants were dried in a shady and well-aired place in the glasshouse. The weight of the biomass was measured on the 30th of August.

The total alkaloid content was determined by the spectrophotometric method elaborated by *Mahmoud* and *El-Masry* [3] and modified by *Krajewska* [2].

Results and discussion

The analysis of total alkaloid content also underlined the favourable effect of Mg. The alkaloid content was highest in both roots and above-ground plant parts, as compared to the untreated control and N-application (Figure 1).

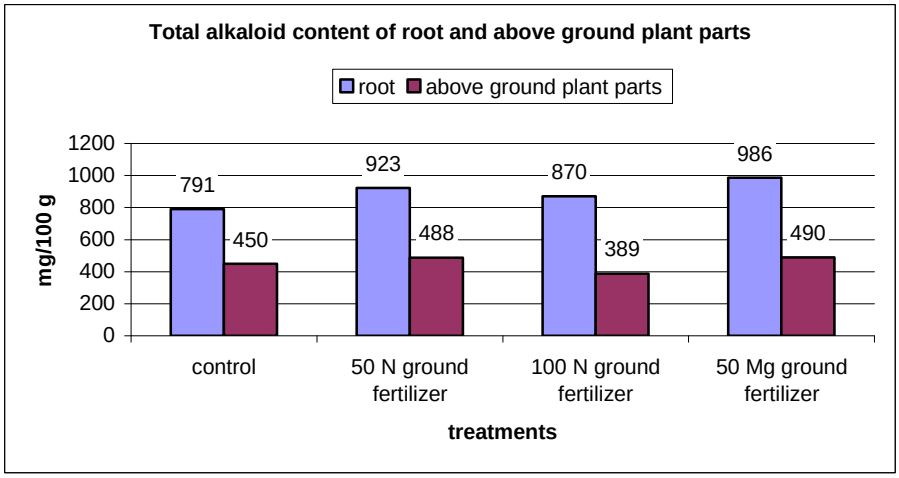

Figure 1. Total alkaloid content (mg/100g) of root and above ground plant parts.

The total alkaloid content of *root:* control 791 mg/100 g, 50 kg/ha Mg-treatment: **986** mg/100 g, 50 kg/ha N-treatment: 923 mg/100 g, 100 kg/ha N-treatment: 870 mg/100 g. The total alkaloid content of *above ground plant parts*: control 450 mg/100 g, 50 kg/ha Mg-treatment **490** mg/100 g, 50 kg/ha N-treatment 488 mg/100 g, 100 kg/ha N-treatment 389 mg/100 g.

The lobeline content was highest in both roots and above-ground plant parts, as compared to the untreated control and N-application except the 50 kg/ha N-treatment (above ground plant parts). The lobeline content of *root*: control 515 µg/g, 50 kg/ha Mg-treatment: **629.5** µg/g, 50 kg/ha N-treatment: 533 µg/g, 100 kg/ha N-treatment: 565 µg/g. The lobeline content of *above ground plant parts*: control 234 µg/g, 50 kg/ha Mg-treatment: **281.2** µg/g, 50 kg/ha N-treatment: 294,6 µg/g, 100 kg/ha N-treatment: 255.4 µg/g (Figure 2).

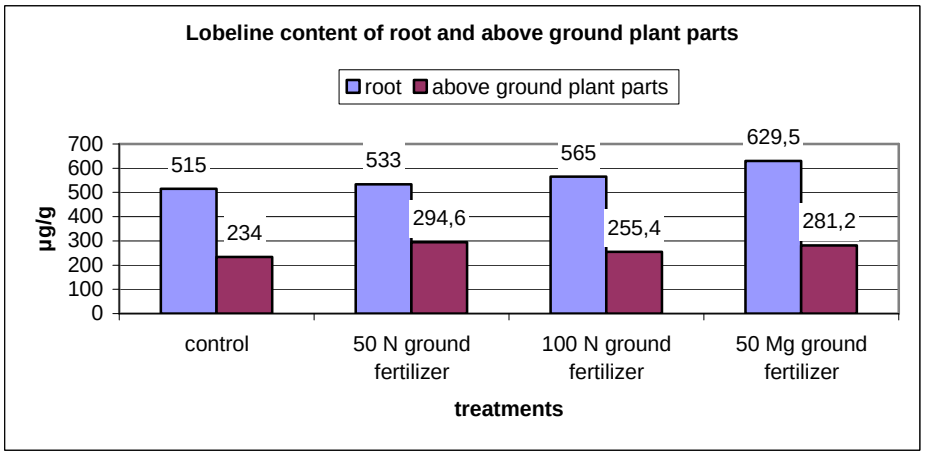

Figure 2. Lobeline content (µg/g) of root and above ground plant parts.

Conclusion

Our observations indicate that the acclimatization of *in vitro* micropropagated plants is a much more labour demanding and delicate process than the propagation by glasshouse transplant raising.

The results indicate the favourable effect of Mg-fertilization and are in harmony with our previous *in vitro* and *in vivo* experiments. The determination of alkaloid composition and lobeline content by HPLC (High Performance Liquid Chromatography) has already been accomplished. With respect to the lobeline content determined by HPLC it can be stated that values of plants treated with Mg were the highest, except the 50 kg/ha N-treatment (above ground plant parts).

References

[1] Kelly, C. A. (1992): Reproductive phenology in *Lobelia inflata* L. (*Lobeliaceae*) and their enviromental control. Americana Journal of Botany, 79: 1126-1133.
[2] Krajewska, A. (1986): Újtípusú regulátorok hatása a *Lobelia inflata* L. szövettenyészetekre. Kandidátusi értekezés, Budapest.
[3] Mahmoud, Z. F., El-Masry, S. (1980): Colorimetric determination of lobeline and total alkaloids in Lobelia and its preparations. Sci. Pharm., 48: 365-369.
[4] Szőke, É., Máthé, Á. (2007): GVOP 3.1.1.-2004-05-0309/3.0 Kutatási]elentés. NKTH, Budapest.

ENERGETIC RESOURCES OF SELECTED AGRICULTURAL HOLDINGS RECEIVING SUBSIDIES FROM THE EUROPEAN UNION

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Keywords: agricultural holding, installed capacity, amount of subsidy

Abstract

Seventy (70) agricultural holdings from the Biłgoraj County were analyzed with respect to the amount of received subsidies, farmland area (FL), economic size and business earnings. Tractors form the basic source of power in the analyzed holdings. Their number and capacity increased together with the increase in the amount of the subsidy. A considerable increase in the installed capacity was noted after receiving subsidies from the EU, relative to the period without subsidies, e.g. a threefold increase occurred in subsidies between 100–150 thousand PLN. The balance of the structure of capacity shows that in the target year (after subsidizing) an average of 61% of the total installed capacity (kW) comes from tractors, 15% from combine harvesters and 24% from engines operating within the agricultural holding.

The average level of installed capacity of tractors in holdings ordered with respect to the mean amount of subsidies was high and amounted to 68.1%, for engines within the farmyard it was 18.8%, and for combine harvesters it was only 13.1%. The level of installed capacity (kW·100 ha^{-1} FL) increased twofold in holdings with smaller areas, of up to 10 ha FL (1009.7 kW · 100 ha^{-1} FL) and this trend continued for holdings with the lowest economic livelihood and with low business earnings. The share of tractors with a capacity exceeding 50 kW was the highest in larger holdings with respect to their economy and area, for the economic size of 16–40 ESU and for the area of 30–50 ha FL it was 82.8 and 85.3%, respectively. It was found that in the target year the installed capacity in means of animal production (engines within the farmyard) was the highest in holdings with the lowest and the highest amount of subsidies (67.5 and 77.6 kW·100 ha^{-1} FL). Whereas in holdings grouped according to their area and economic size the highest installed capacity was observed, respectively: in the range from 30–50 and over 70 ha FL (112.4 and 89.9 kW·100 ha^{-1} FL) and 8–16 and over 40 ESU (84.5 and 78.1 kW·100 ha^{-1} FL). This is due to the greatest livestock levels in these holdings (LSU·100 ha^{-1} FL; *LSU – Livestock U*nit). In the analyzed holdings, a high installed capacity within a farmyard was caused also by the fact that almost all machinery was permanently aggregated with electric motors.

USING THE SUM OF EFFECTIVE TEMPERATURES FOR PEST CONTROL IN THE CONTEXT OF INTEGRATED CROP PROTECTION

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Keywords: *Agrotis segetum* Schiff., *A. exclamationis* L., light trap, sums of effective temperatures, degree days, *Beta vulgaris* L.

Introduction

Larvae of lepidopterous insect (*Agrotis segetum* Den. & Schiff.) and (*A. excamationis* L.) are common pest insects in Poland. Larvae feed on the foliage of the sugar beet plants and can completely defoliate and kill a plant.

A good knowledge of local pest population is essential for effective plant protection, as the pest development can then be forecast and the treatment can be timed accordingly. The day-degree model is based on the fact that insect developmental rates depend on temperature [1]. Insects require a fixed number of accumulated heat units above a lower development threshold for completing a stage [2, 3]. These heat units are generally termed “degrees day” and their sum is termed the “sum of effective temperatures” [4].

The turnip moth (*A. segetum*) and the heart-and-dart moth (*A. exclamationis*) in Poland produce one generation, while the turnip moth can rarely have an incomplete second generation. According to the experimental data of Kozhanchikov [5], the turnip moth requires a total effective temperature of 1,000°C for a complete generation. The lower developmental threshold for the egg is 10°C, larva and prepupa 9°C, and pupa 10°C. The overall lower threshold for a single generation of the turnip moth is 10°C [6]. Larchenko [7] used phenological data and temperature indices of meteorological stations and established the total effective temperature for the complete development cycle of *A. segetum* as 550 to 750°C at a threshold of 10.2°C. The lower developmental threshold established by Merzheevskaja [6] for the *A. exclamationis* was 11°C. The developmental threshold of the larva was 11.1°C, egg -10.5°C, prepupa and pupa -11.6°C. The total effective temperature required for complete development of the heart-and-dart moth was 703°C degree days.

Methods

The study was conducted from 2005 to 2008 in the Kujawsko-Pomorskie regions and 2007 to 2010 in the Wielkopolska. Imagines of the cutworm,

caught by means of light traps, are the subject of the present study. Light traps were installed in three locations: at Winna Góra (52°12'N 17°27'E), in Więcławice (52°78'N 18°25'E), and Poznań (Poznań-Grunwald 52°23'N 16º54'E). The biological material for the research – adult moths – was collected using light traps. Moths (males and females) caught in the light traps were controlled three times a week Traps were made during the time of the pest presence (May-October). For sugar beet, the field experiments were conducted in the growth phase from two leaves unfolded to the rosette growth, being an equivalent of stages 12-38/39 in the BBCH scale.

Rearing method was used as described by Kowalska [8] and Jakubowska [9]. Experiments were conducted with *A. segetum* and *A. exclamationis* taken from the live moths caught in light traps.

Insects were reared in the laboratory under controlled conditions (temperature: 17 ± 1ºC; 20 ± 1ºC and 24 ± 1ºC; photoperiod: 18L: 6D h; r.h.: 50-70%). Larvae were fed on the fresh leaves of sugar beet and adults on a 10% sucrose solution. There were 10 individuals per box for high-, optimum-, low-temperature treatments. Observations on egg laying, egg incubation and larvae development (from stage L_1 to L_3) of both species were performed.

The cultures of both species were carried out under controlled conditions, and at the same time cultivation of cutworms was conducted in field conditions.

Based on previous studies and own observations concerning biophenology of cutworms, two assumptions were made for the purpose of determining the date of chemical control, as follows:

- The date of chemical control is determined according to the signalling indications based on a control of the first moths' flight by means of a light trap – using the previously applied method. According to Zach [10] when more than one turnip moth is caught in a light trap during one night, it is the critical number that indicates to the beginning of the mass flight. Then, 30-35 days have to be added to the date of the mass flight of *A. segetum*, and this is how the optimum date for the pest control treatment is specified. However, at the same time the value of the calculated heat sum for the indicated number of days must be controlled and compared with the values obtained in the culture on the pests studied,
- The results of studies will be used after confirming the moths' flight based on the control of the cutworms' flight by means of a light trap.

Both approaches should appoint a similar date of pest control treatment.

The statistical analysis was performed using the straight-line regression method in order to examine the size and significance of the influence of temperature and humidity of the air on the developmental periods of cutworms studied. Determined the relationships between the following six meteorological characteristics are sought based on values of the average daily

temperature and humidity - for the period of incubation of eggs, hatching of larvae and the entire developmental period of cutworms – independent variables (*x*) and duration (number of days) of those three periods of development separately for each of the (*Noctuinae*) species studied - the dependent variables (*y*) [11].

Results

In the research period, in all air temperature ranges, the development of 716 individuals of *A. segetum* and 871 individuals of *A. exclamationis* (in total 1587 individuals of both species of *Noctuinae*) was observed in the controlled conditions, while as many as 320 individuals in total were observed in the field conditions, in all years.

Based on the analysis of independent variables in individual ranges of temperatures in the controlled conditions in terms of their individual impact on duration of the studied developmental period of the two studied species and in the field conditions, it was found that:

- the sum of heat had a very significant impact on the development of the two species in each range of temperatures in the controlled conditions, while in the field conditions on the development of *A. exclamationis* only; in case of *A. segetum* the regression coefficient ranged from 69.1% at 24^{o}C to 99.9% at 20^{o}C,
- the sum of effective temperatures had a very significant impact in case of the two species in all ranges of temperatures both in the controlled and field conditions. The identified regression coefficient was lowest in case of the development of *A. segetum* in the controlled conditions at the temperature of 24ºC (32.4%), and in the field conditions for *A. exclamationis* it was 39.9%,
- the sum of the humidity of air had a very significant impact on the development of both species examined. The calculated regression coefficient in all ranges of temperatures in the controlled conditions, when contemplated all together, fitted in the range from 80% to over 90%. Only in the field conditions it amounted to 57.3% for *A. exclamationis*.

Determination of sums of heat and effective temperatures for supporting identification of dates for controlling cutworms on the sugar beet.

Table 1. Comparison of parameters determined in the years of research for supporting the determination of the date of pest control treatment.

Year	Number of days of studied developmental period of cutworms	Heat sum of studied developmental period of cutworms	Effective temperatures sum calculated for physiological zero for eggs (10.5^{o}C) and caterpillars (11.1^{o}C)	Effective temperatures sum calculated for average physiological zero of 10.9^{o}C
2007	24.2	504.1	244.2	244.8
2008	24.8	501.4	237.3	237.7
Final result	25.1	501.1	229.2	230.0

Application of research results for determining the optimal date for chemical pest control in respect of cutworms.

Table 2. Influence of the date of the chemical control against to *Agrotis* sp. Of the sugar beet in 2007-2010.

Years	Date of the chemical control	Sum of heat of the developmental period cutworms	Sum of effective temperatures calculated for the average physiological zero 10,9ºC	Developmental stage
Date of the treatment according to the signalling				
2007	19.VI	602,1ºC	-	L2/L3
2008	26.VI	627,7ºC	-	L2
2009	22.VI	479,7ºC	-	L2
2010	5.VII	588,8ºC	-	L2/L3
Date of the treatment according to the phonological criterion				
2007	16.VI	544,7ºC	250,4ºC	L2
2008	28.VI	644,3ºC	241,0ºC	L2
2009	24.VI	503,8ºC	130,6ºC	L2/L3
2010	1.VII	512,0ºC	185,8ºC	L2

Discussion

Forecasting and controlling the development of the cutworms' population is very difficult because there is no correlation between the number of moth individuals caught and the number of caterpillars on crops. Therefore it is very important do develop methods of forecasting and evaluating the intensity of occurrence of the *Noctuinae* studied. This issue was observed in the end of the 1970's [12]. A very important element here is to identify the moments of laying eggs and hatching of caterpillars. This will allow to improve methods of discovering first developmental stages of cutworms. Rearing of the pest turns out to be very helpful for this purpose. In the literature there are many Polish and foreign papers on rearing cutworms. In Poland, rearing researches on heart-and-dart moth (*A. exclamationis*) and setaceous hebrew character moth (*Xestia c-nigrum*) were initiated by Kowalska [8], who studied the impact of storing eggs and pupae of sataceous hebrew character moth in low temperatures on their vitality. For rearing of *A. segetum* and *A. exclamationis* for purposes of this paper the author used the methodology developed by Kowalska [8]. Rearing observations on cutworms were kept worldwide since the 1960's. Very helpful were the papers of Hariss et coll. [13, 14] concerning the impact of temperature and relative humidity of air on the development of individual development stages of *Agrotis ipsilon*. Rivnay [15] observed the impact of photoperiod on duration of individual development stages of *Agrotis ipsilon* in Israel. Reese et coll. [16] studied the impact of various ranges of temperatures and humidity on duration of the eggs' incubation and caterpillars' growth. Results obtained from rearing the two studied cutworm species in the controlled and field

conditions allowed identification of these meteorological factors that have impact on the development of the studied moths. Literature indicates that temperature and humidity have a diversified impact in individual development stages of pests, i.e. other conditions are needed for the periods of eggs' incubation, caterpillars' hatching and their further development. Similar observations can be found in the paper of Tribel et coll. [17], who conducted the rearing of *Noctuinae* in controlled conditions in various ranges of temperatures with great variations, and as there were no average values given, it is difficult to compare the results obtained. However in case of the research by Meržheevskaya [6] similar results were obtained.

In USA, Denmark, Germany, the Netherlands there are researches conducted that focus on short-term forecasting based on the so-called degree-days, i.e. on summing up of temperatures from the agreed date, in order to determine the sum of heat that is necessary for obtaining the adequate development stage of a pest. Such researches have been conducted since the 1970's and 1980's. In the 1990's and currently, papers dealing with similar topics have been published in the Czech Republic, where Honěk [18, 19] as well as Honěk and Kocourek [4] are pioneers in this area. These authors studied the impact of effective temperatures sums for various orders of insects with determination of regression equations, while in her paper in the USA Brandenburg [20] presented a simple manner of using the degree-day method.

References

1. Kostal V. 1992. Kostal, Prediction of flight activity in three species of the genus Delia (Diptera: Anthomyiidae) by day-degree model. Acta Entomologica Bohemoslovaca 89: 21-28.
2. Taylor F. 1981. Ecology and evolution of physiological time in insects, American Naturalist 117: 1-23.
3. Pruess K.P. 1983. Day-degree methods for pest management, Environmental Entomology 12: 613-619.
4. Honěk A., Kocourek F. 1990. Temperature and development time in insects: a general relationship between thermal constants, Zoologicae Jb. Systematica 117: 401-439.
5. Kazhanchikov I.V. 1941. Range and annual changes in population of the turnip moth and beet webworm in relation to heat and moisture conditions), Zoologiciejskij Zhurnal 20: 30-45. (in Russian)
6. Meržheevskaya O.I. 1989. Larvae of Oulet Moths (*Noctuidae)*. Biology, morphology, and classification, Amerind Publishing Co. Pvt. Ltd., New Delhi 1989, p.420.
7. Larchenko K.I. 1949. Principles of growth and reproduction of the turnip moth (*Agrotis segetum* Schiff.), Izvestiya Akademia Nauk SSSR, ser. hiol. 4: 470-494. (in Russian)

8. Kowalska T. 1962. The method of rearing of *Agrotis c-nigrum* L. and *A. exclamationis* L. (*Lepidoptera, Noctuidae)* under laboratory conditions, Bulletin of the Institute of Plant Protection 14: 35-41. (in Polish)
9. Jakubowska M. 2009. Improving the forecasting of short-term chemical protection of sugar beet against *Agrotis segetum* (Den. et Schiff.) and *Agrotis exclamationis* (L.) (*Lepidoptera: Noctuinae).* PhD thesis, Institute of Plant Protection – National Research Institute (IPP-NRI). Poznań, Poland 2009, p.1-196. (in Polish)
10. Zacha I. 1966. Forecast and signaling in plant protection, Státni Zemědělskě Hakladetestri, Praha, 1- 66. (in Czech).
11. Walczak F. 2003. Application of multiple regression in the prediction of optimum timing for chemical control of Cereal beetles (*Oulema* spp.) in Wielkopolska region (Poland), Scientific Dissertations, Institute of Plant Protection – National Research Institute (IPP-NRI). Poznań, Poland, 12: 1-132. (in Polish)
12. Lipa J.J., Wiklendt M. 1971. Effect of storage At low temperatures on viability of eggs and pupae *Agrotis c-nigrum* (L.) (*Lepidoptera: Noctuidae*), Scientific Papers, Institute of Plant Protection. Poznań, Poland 13, 1: 163-168. (in Polish)
13. Harris C.R., Begg J.A, Mazurek J.H. 1958. A laboratory methods of mass rearing the black cutworm, *Agrotis ypsilon* (Rott.), for insecticide tests. Canadian Entomology XC: 328-331.
14. Harris C.R., Mazurek J.H., White G.V. 1962. The life history of the black cutworm, *Agrotis ipsilon* (Hufnagel), under controlled conditions. Canadian Entomology 94: 1183-1187.
15. Rivnay E. 1964. A contribution to the biology and phenology of *Agrotis ipsilon* Rott. in Israel, Volcani Agriculture Research Station National, p. 295-309.
16. Reese J.C, English L.M., Yonke T.R., Fairchild M.L. 1972. A method for rearing Black Cutworms. Journal of Economic Entomology 65: 1047-1049.
17. Triběl S.O., Fědorenko W.P., Łapa, O.M. 2004. Moth. Nayposhirenishi in Ukraïni form. Kyiv, Koloobig p. 1-77. (in Russian)
18. Honěk A. 1996. The relationship between thermal constants for insect development:
a verification, Acta Societatis Zoologicae Bohemicae 60: 115-152.
19. Honěk A. 1999. Constraints on thermal requirements for insect development, Entomological Science 2: 615-621.
20. Brandenburg L. 2005, available online at: http://groundsmag.com/mag/grounds_maintenance_forecast_pest_problems/

KEYWORDS INDEX

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"Farm Machinery and Process Management in Sustainable Agriculture", have reached this year a small celebration. Yes, it is for the 5th time already that the Department of Machinery Exploitation and Management in Agricultural Engineering of the Faculty of Production Engineering, University of Life Sciences in Lublin and Walloon Agricultural Research Centre in Gembloux, Belgium organized the Symposium. This year the Symposium is held again in Lublin, Poland.

The following proceedings contain 46 reviewed abstracts presented at the Symposium. It shows an appropriate balance between theoretical and more practical papers both presenting development made in the area of sustainable agriculture. Such development shows a great effort and success made by researchers working on different topics but all linked to sustainable agriculture.

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