It has already become a tradition for the Department of Machinery Exploitation and Management of Production Processes of the Faculty of Production Engineering, University of Life Sciences in Lublin and Walloon Agricultural Research Centre in Gembloux, Belgium to organize the International Scientific Symposium “Farm Machinery and Processes Management in Sustainable Agriculture”. This year the symposium takes place in Lublin, Poland and the University of Life Sciences in the host of the event. As always the symposium is an important occasion for scientists and practitioners to show progress in sustainable agriculture. It is also our great hope that it will stimulate the participants to start new ideas, exchange them with colleagues and to implement them in practice.

The following proceedings contain 45 reviewed extended-abstracts presented at the Symposium. It shows developments achieved in the theory and practice in the area of sustainable agriculture. Both the methodological and practical aspects of sustainable agriculture are outlined and presented.

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VI International Scientific Symposium

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INTRODUCTION

The VI International Scientific Symposium on "Farm Machinery and Process Management in Sustainable Agriculture" is taking place in Lublin, Poland. Once again 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 aim of the Symposium is to present the on-going and also concluded research on the sustainability of agriculture. Sustainable Agriculture may create solutions to ever growing concerns related to production maximization achieved by mechanization increased chemical use.

We understand 'sustainability' in its broadest meaning as meeting needs without compromising future generations. In terms of agriculture it entails a commitment to satisfy human food needs and to enhance the quality of life for farmers and society as a whole, now and into the future. Agriculture is often considered as composed of three different systems: economic, ecologic and social. Therefore, the sustainable agriculture must be based on interlocking of three spheres; farm profitability, environmental responsibility and quality of life for farm families and rural communities. In simple terms that translates to economic profitability, environmental health and social equity.

There is however a global context to sustainability; these are size and growth of population, conservation and restoration of biological base, optimization of energy output and economic efficiency. Sustainable agriculture can be the solution to those global issues by integrating all these components into a solid production system that benefits all participants.

We hope that once again this Symposium will be the platform for an international synergy and cooperation between experts from different countries who are working on specific areas related to sustainable agriculture.

The Organizing Committee

THE THEORY OF WORKING BODY FOR PROCESS OF DIVISION OF TOPS OF A SUGAR BEET

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Keywords: sugar beets, mathematical model, statistical characteristics of crops, sugar-bearing mass loss, tops residues

1. Introduction

Increase in pollution of a root heap with green mass by 1% decreases sucrose yield by 0.1%, and storage of root crops in piles with a content of tops about 4% causes the daily loss of sugar on average of 0.012% [Pohorilyi, 2004]. Along with the modern machines for removing foliage are operating with significant losses of sugar-bearing mass. Therefore, a relevant search of technical solutions which allows avoiding these losses is a current issue.

Analyses of numerous designs of working members for removing foliage are considered enough in detail in works of L. Pogorilyi, V. Bulgakov, M. Tatianko, R. Gevko, V.Martynenko M.Helemendyk, F. Kozibrody, S. Synii, M. Berezovyi, etc. However, at present there are no machine designs for removing foliage that meet agro-technical requirements concerning losses of sugar-bearing mass [Helemendyk 1996, Bulgakov 2010, Kepe 1996, Vilde 1998].

As in [Borys, 2009] it is found that cutting without a template is mainly used in modern machines, so it is necessary to identify the main factors of sugar-bearing mass losses and determine key ways to reduce them.

2. Material and methods

The study was carried out using the methods of probability theory and mathematical simulation. It is suggested that the height of the heads of root crops is distributed by the normal law. The algorithm of process of cutting without a template is used. The material from experimental studies of protrusion height of heads of root crops was used in the research.

3. Results

As a result of the application of cutting without a template the quality of removing beet tops is not good enough and sugar-bearing mass losses in tops

exceeding agro-technical requirements are possible. Due to an increase in the thickness of the cut part of a root head, the content of tops residues on sugar beet roots will decrease, but the loss of sugar-bearing mass will increase.

According to the test results [Agricultural Technology, 2007], the number of sugar beet roots with tops height more than 2 cm was 2% on average for the machines of the flow sheet; for highly cut tops (with tops height less than 2 cm but equal or more 0 cm) − 26.6%; for low cut tops (below of green leaves) − 7.5%; and satisfactorily cut roots − 60.1%. This statistics indicates the presence of sugar-bearing mass loss and significant residues of tops on roots. These results are given for an average operating speed of the machine of 6 km/h, which is a low speed, and it was chosen due to a desire to obtain satisfactory quality of work of passive knives. Digging up bodies can operate at significantly higher speeds.

In the article [Borys, 2009] it was found that the main factor contributing to the loss of sugar-bearing mass under cutting without a template is the distribution of heights of heads above the soil, in particular, its statistical properties of the mean and standard deviation.

It is also known that these factors may vary within wide limits and be different for various crops of sugar beet. Most of these factors are formed by sugar beet cultivation techniques, soil and climate conditions. Along with the statistical characteristics of the distribution of the height of root heads above the soil, the sugar-bearing mass loss is greatly influenced by their number per hectare. Therefore it is important to examine the degree of integrated effects of these factors on the loss of sugar-bearing mass.

The well-known parametric model of the root head and foliage is used for this modeling [Borys, 2009].

Relationships between the parameters of the root head and foliage are as follows:

$$\left.\begin{aligned} h_{зл} &= ah + b; \\ d_1 &= mh + n; \\ d_{зл} &= d_1 + 2h_{зл}tg\alpha \end{aligned}\right\}, \tag{1}$$

where $h_{зл}$– a distance from the top of the head to the base of green leaves;

h–height of the projection of the root head above the soil;

d_1–the diameter of the top of the root head;

$d_{зл}$–the diameter of a bunch of tops;

α–a half cone angle of the root head;

a, b, m, n–are constants.

The loss of sugar-bearing mass and the residues of tops on heads for roots of a preprogrammed range of heights of root heads projection over the soil are determined by the equation:

$$M_i = F\left(h_i;h_3\right)\cdot P\left(h_i;h_{i+1}\right)\cdot N_{i,} \tag{2}$$

where, F (h_i; h_z) – sugar-bearing mass losses or residues of tops on roots; $F(h_i;h_з) = V_к \cdot \rho$, for tops $F_c(h_i;h_{зг}) = V_г \cdot \rho_г$, where $V_к$, ρ and $V_г$, $\rho_г$ – respectively the volume of the root and density foliage; N_i – number of roots of a set range per unit area, $P(h_i;h_{i+1})$ – the probability of occurrence of the range of the projection height of heads over the soil is estimated as follows:

$$P\left(h_i;h_{i+1}\right) = \frac{1}{\sigma\sqrt{2\pi}}\int_{h_i}^{h_i+1}\exp\left(-\frac{\left(h-m\right)^2}{2\sigma^2}\right)dh \tag{3}$$

The integral in the equation 3 is not defined in quadrature, so the probability of occurrence of roots of a specified interval of the roots projection height is defined by a numerical integration by Simpson's rule. Summing up the residues of tops and loss of sugar-bearing mass for all intervals of the projection height, we obtain the total residues of tops and losses of sugar-bearing mass per unit area:

$$BM = \sum_{i=a}^{b}\left[N\cdot F\left(\frac{h_i+h_{i+1}}{2};h_ç\right)\cdot\left(\frac{h_{i+1}-h_i}{3m}\sum_{j=0}^{m}c_j\cdot f(h)\right)\right], \tag{4}$$

$$GM = \sum_{i=a}^{b}\left[N\cdot F_c\left(\frac{h_i+h_{i+1}}{2};h_ç\right)\cdot\left(\frac{h_{i+1}-h_i}{3m}\sum_{j=0}^{m}c_j\cdot f(h)\right)\right], \tag{5}$$

where, m – the number of intervals: m = 2U; U = 1,2,3,4,...;
c_j – the coefficient under the values of the integrand at the appropriate points, c_j = 1,2,3,4,2,4,…,2,4,1.

Losses of sugar-bearing mass and the residues of tops on root crops depending on the standard deviation and the density of plants per hectare are calculated. The method [Borys, 2009] was used, a program in the environment of VBA MS Excel 2010 was developed, and the graphs of these relationships were built.

The calculation of sugar-bearing mass loss was performed in the operating range 60-80 mm of the height of cutting root heads without a template [Zuiev, Toporovskyi, 1988].

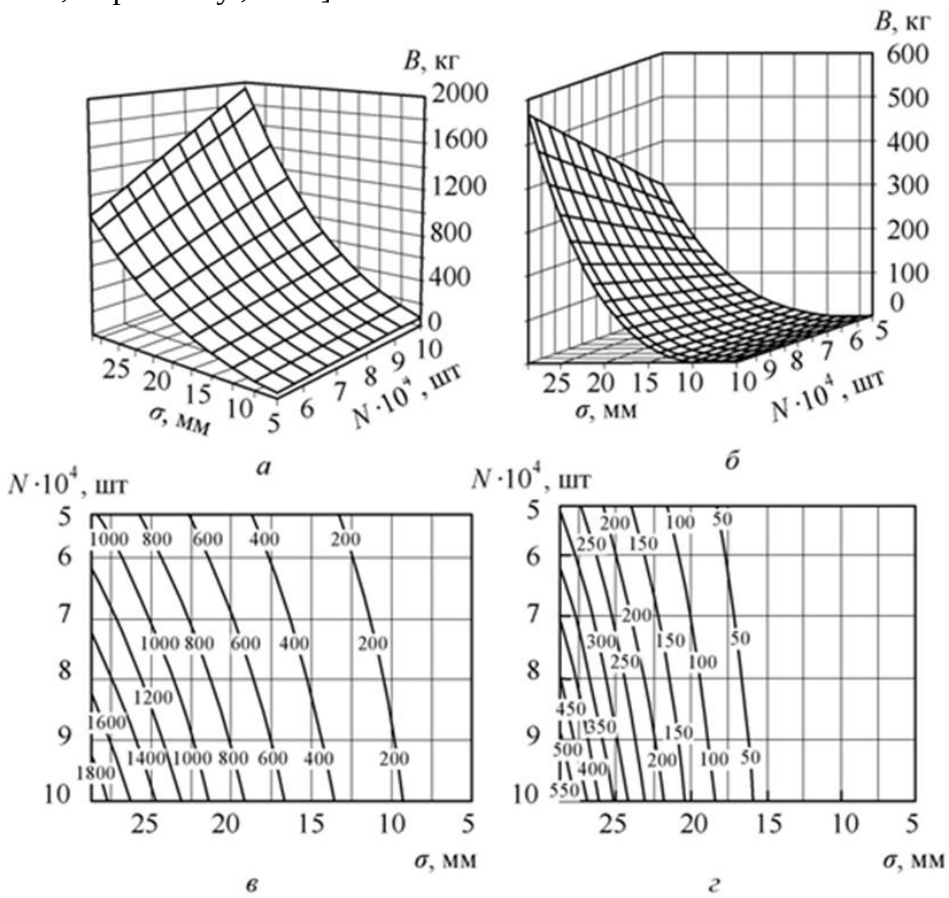

Figure 1. Graphs of sugar-bearing mass loss under the height of cutting without a template of 60 mm (*a*) and 80 mm (b); two-dimensional cross sections of these graphs under the height of cutting without a template of 60 mm (c) and 80 mm (d)

Based on the plots of Fig. 1, it can be stated that the loss of sugar-bearing mass increases sharply under an increase of both the standard deviation and density of roots per hectare. It should be noted that in the case of the lower limit of the operating range of the height of cutting root heads without a template (Fig. 1, b, d) agronomic requirements concerning sugar-bearing mass loss are met, but in this case we should expect the excessive pollution of piles with tops and therefore it is advantageous to reduce the specified height of cutting. In the case of the upper limit of height of cutting without a template, an unacceptable zone exists concerning agronomic requirements on sugar-bearing mass loss (more than 2% of the total mass of roots) (Fig. 1 a,

c), and in this case it is advisable to increase the height of cutting without a template to prevent losses of sugar-bearing mass.

There arises a necessity of creation of an automatic control system of cutting height of heads of root crops given the above features of separation of sugar beet tops using cutting without a template. The functions of this system are the constant monitoring of the dimensional characteristics of root crops, determination of their statistical characteristics and the continuous optimization of the cutting height to prevent the loss of sugar-bearing mass.

4. Conclusions

Results of the study show that the sugar-bearing mass loss depends on statistical characteristics of the height of the root head projection above the soil and thickness of the head roots per hectare that in turn can vary within wide limits. It is established that under the extreme values of the statistical characteristics of the root head projection above the soil and their thickness per hectare the losses of sugar-bearing mass exceed agronomic requirements twofold. The necessity of creating an automatic control system of the height of root heads cutting is substantiated.

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THE THEORY OF VIBRATING EXCAVATION OF ROOT CROPS OF A SUGAR BEET

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Keywords: sugar beet, root crop, vibrating digging up tool, the spring environment, the differential equations of movement, fluctuation, amplitude, frequency

1. Introduction

Use of vibrating excavation of a sugar beet root from a ground has a number of essential advantages in comparison with other ways. It is characterized by less damage of root, decrease in losses of a crop at harvesting, more intensive clarification of root crops from the stuck ground, less smaller blocking up of a digger working channel from a ground and residues of weeds. Therefore this technological process requires detailed analytical research, further development and wide introduction of advanced vibrating digging tools.

2. Material and methods

Thorough theoretical and experimental researches of vibrating excavation of sugar beet root were rather widely described in works [1–6]. So, in work [6] the process of a root crop withdrawal from the ground is considered in most general case – at asymmetrical claw of a root crop by vibrating digging up working body. The given process is described by means of kinematic and dynamic equations of Aler. System of the differential equations received in work [6] describes spatial oscillatory process of the root crop fixed in the ground, as in the spring environment, with one point of fastening. In the given work the process of vibrating withdrawal of a root crop of a ground is considered at symmetric claw of a root crop by both shares of vibrating digging up body.

At such claw of a root crop by digging up shares the process of the further full withdrawal of a root crop of a ground is possible. Therefore we investigate process of direct withdrawal of a root crop of a ground at its symmetric claw by vibrating digging up working body.

To construct mathematical model of direct withdrawal of a sugar beet root crop from the ground, which is carried out under the action of vertical troubling forces which it is given to a root crop from vibrating digging up working body, and traction effort owing to translational movement of digger.

3. Results

At first let's make the necessary formalization of technological process which will be considered. Despite of that process of withdrawal of a ground of a sugar beet a root crop will take place for a short time interval (as translational speed of a root crop machines can reach 2 *m/s*) it is possible to divide technological process into separate interconnected, consecutive operations conditionally. As, it was marked above the withdrawal is possible, only at symmetric claw of a root crop by working body and simultaneously with translational fluctuations of a root crop occurs angular fluctuations of a root crop around of a conditional point of fastening on some angle. At the first stage of withdrawal, and especially at the first fluctuations, renew force at angular fluctuations, and so, and its moment concerning a conditional point of fastening, will be maximal. That is why the angle of inclination of a root crop will be insignificant enough and a full (or partial) restoration of its vertical position owing to translational movement of the digger will be possible. Nevertheless, owing to action of forward translational fluctuations of a root crop together with a ground surrounding it, the compaction of the specified ground will decrease, and renewing force at angular fluctuations will be decrease too. So, with each following fluctuation the angle of an inclination of a root crop will increase, and restoration of the previous position – to decrease. The root crop will be loosened around of a conditional point of fastening with gradual increase of an inclination angle of a root crop forward on a digger course. It will lead to the break of a root crop connections with a ground in the direction of digger`s movement, beginning from the top part of a conic surface of a root crop in unloosened ground, gradually approaching to a conditional point of its fastening. So as it was stated above it follows, that the destruction of connections of a root crop with a ground occurs simultaneously in two directions – along the translational digger's movement and in the direction perpendicularly to specified (on depth of a root crop arrangement in the ground). Thus the force of connections of a root crop with a ground and the forces of a ground spring will gradually decrease to such minimal size when oscillatory processes will pass into the processes of continuous moving of a root crop upwards and forward – along the translational digger movement, and also continuous turn of a root crop around its mass center on some angle to full withdrawal of a root crop from a ground. Forces of a ground spring will simply pass into the force of resistance of the loosened ground at a root crop movement in a digger working channel. After that the stage of direct withdrawal of a sugar beet root crop from a ground is begun.

For construction of mathematical model first of all we shall make the equivalent scheme of a root crop interaction with working surfaces of vibrating digging up working body at its direct withdrawal (fig.).

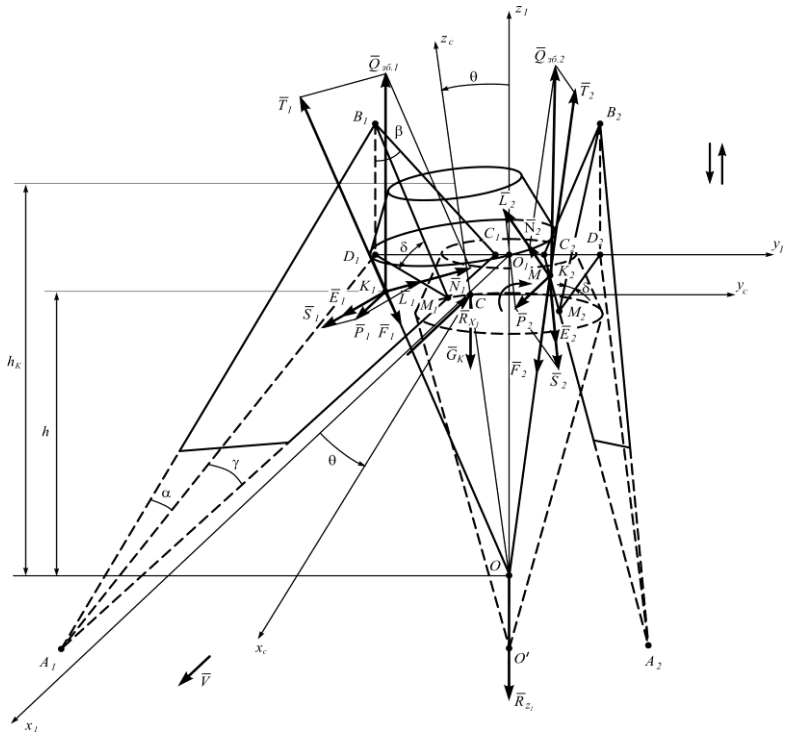

Figure 1. Equivalent scheme of vibrating excavation of a sugar beet root crop from a ground

Carrying out the necessary transformations we shall receive the differential equation of turn of a root crop around axis Cy_c at direct vibrating withdrawal from a ground (i.e. at the action of troubling forces on it) which has a following view:

$$\left(\frac{3}{80}+\frac{3}{20}tg^2\varepsilon\right)m_k h_k^2\frac{d^2\theta}{dt^2}=-H\left(-h_k+h-z_1\right)\sin\theta\sin\omega t+2P_1\cos\theta\left(-h_k+h-z_1\right)+$$
$$+2\left(\frac{1}{2}fH\cos\delta\sin\omega t+fP_1\sin\gamma\right)\sin\left(\gamma+\alpha_{K1\ \max}\sin\omega t\right)\cos\varepsilon\left(-h_k+h-z_1\right)\sin\theta+ \quad (1)$$
$$+2\left(\frac{1}{2}fH\cos\delta\sin\omega t+fP_1\sin\gamma\right)\cos\left(\gamma+\alpha_{K1\ \max}\sin\omega t\right)\cos\gamma\left(-h_k+h-z_1\right)\cos\theta-$$
$$-M,$$
$$\omega t\in[2k\pi,\ (2k+1)\pi],\quad k=0,1,2,...$$

The differential equation of turn of a root crop around axis Cy_c at usual withdrawal (i.e. at the absence of troubling forces), has a following view:

$$\left(\frac{3}{80}+\frac{3}{20}tg^2\varepsilon\right)m_k h_k^2\frac{d^2\theta}{dt^2}=2P_1\cos\theta\left(-h_k+h-z_1\right)+2fP_1\sin^2\gamma\times$$
$$\times\cos\varepsilon\left(-h_k+h-z_1\right)\sin\theta+fP_1\sin 2\gamma\cos\gamma\left(-h_k+h-z_1\right)\cos\theta-M, \quad (2)$$

$$\omega t\in\left[(2k-1)\pi,\quad 2k\pi\right],\qquad k=1,2,...$$

The differential equation (1) is nonlinear. It is possible to solve it by the application numerical methods and for each step of application of numerical algorithm of mean z_1 is necessary to find from the second equation of system for the corresponding moment of time t_k. The differential equation (2) which includes the magnitude z_1 which is replaceable and, is also nonlinear, and for each moment of time t_k the mentioned magnitude z_1 is necessary for defining from the second equation of system.

Thus, it is finally possible to consider, that the constructed mathematical model of direct withdrawal process of a sugar beet root crop from a ground at its vibrating excavation. The received results enable to define kinematic modes of vibrating excavation root crops at the conditions of inviolate and constructive parameters of vibrating digging up bodies.

4. Conclusions

1. Two systems of the differential equations which describe plane-parallel movement of a root crop in a ground at its direct withdrawal which is carried out under action of vertical troubling forces which is given to a root crop from vibrating digging up body, and traction effort which arises owing to translational movement of digger.

2. Solution the given differential equations gives an opportunity to find out the law of movement of a root crop in longitudinal-vertical plane at direct withdrawal from a ground.

3. Results received enable also to define kinematic modes of vibrating excavation of root crops from their conditions of inviolate not damage and to find rational constructive parameters of vibrating digging up working bodies.

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APPROPRIATE MECHANICAL HARVESTING SYSTEMS FOR DIFFERENT TYPES OF OLIVE ORCHARDS

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Keywords: olive harvesting, mechanical harvesting

1. Introduction

In the last decades olive growers spent a substantial part of their gross return to face high costs of manually cultural practices, due to shortage of manpower.

Olive crop is in a critical situation due to low product price and high production costs.

In order to face the problem it is mandatory to increase competitiveness on the global market, reducing costs and improving fruit quality. Low mechanization level penalizes the sector.

Olive harvesting mechanization systems allow achieving these goals [Amirante, Tamborino 2012]: costs – reducing manpower needs and quality – better work rates make possible to harvest in the optimal harvest timing.

For mechanical harvesting, different types of olive orchards must be considered: (a) traditional (<150 trees per hectare), (b) high density olive orchards (300 to 400 trees per hectare) and (c) hedgerow olive orchards (1000 to 2000 trees per hectare). For each olive orchard type, an appropriate harvesting system is required.

2. Material and methods

2.1 Traditional olive orchards

First experiments took place in Northeast of Portugal (Trás-os-Montes) in Verdeal, Cobrançosa and Madural cultivars and in the South of the country (Alentejo) mainly with Galega and Picual cultivars.

Three treatments were compared: trunk shakers mounted on the front loader of a tractor was used to detach olives, collected by manually moved canvas (system I) or by mechanical rolling canvas (system II) or by an inverted umbrella (system III) mounted on the front loader of a tractor (combined with the shaker) [Almeida, 2007a].

Trees with large canopies (volume superior than 100 m^3 / 200 m^3 and trunk perimeter superior than 2 m / 3.5 m) are not suitable for trunk shakers.

So other experiments took place in Northeast of Portugal (Trás-os-Montes) in Verdeal, Cobrançosa and Madural cultivars to evaluate the performance and operational conditions of a spike rotor able to turn around

its axle providing the brushing action to detach olives [Almeida, 2007b]. This equipment work in conjunction with hand held shakers concentrated in lower branches.

Trees are harvested one by one in this type of olive orchard.

2.2 High density olive orchards

Experiments took place in Northeast and South of Portugal mainly with, Cobrançosa and Picual cultivars. Specific mechanical rolling canvas equipment has been designed to collect olives detached by trunk shakers.

Trees are harvested one by one.

2.3 Hedgerow olive orchards

This kind of olive orchard is becoming usual in some olive producers regions. Observations in order to evaluate equipment performance and operational conditions took place in central region of Portugal.

An over row equipment is an appropriate equipment. Olives are detached and collected simultaneously row by row, not tree by tree.

3. Results

3.1 Traditional olive orchards

In this type of olive orchards field tests show a performance of 40 to 70 trees per hour (Fig.1) is easily achieved [Almeida, 2007a], considering the harvesting systems using a trunk shaker. Trunk shakers can detach 80% to 90% of olives produced [Michelakis, 2002].

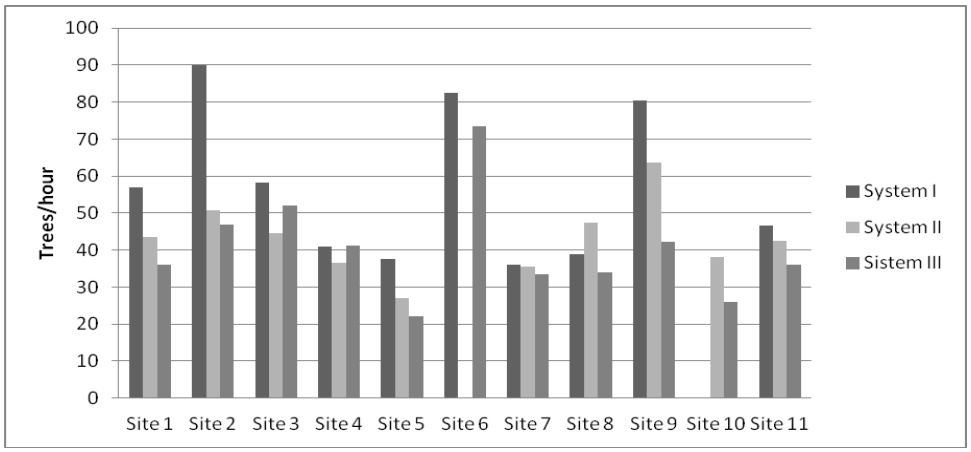

Figure 1. Harvesting systems using trunk shakers in traditional orchards.

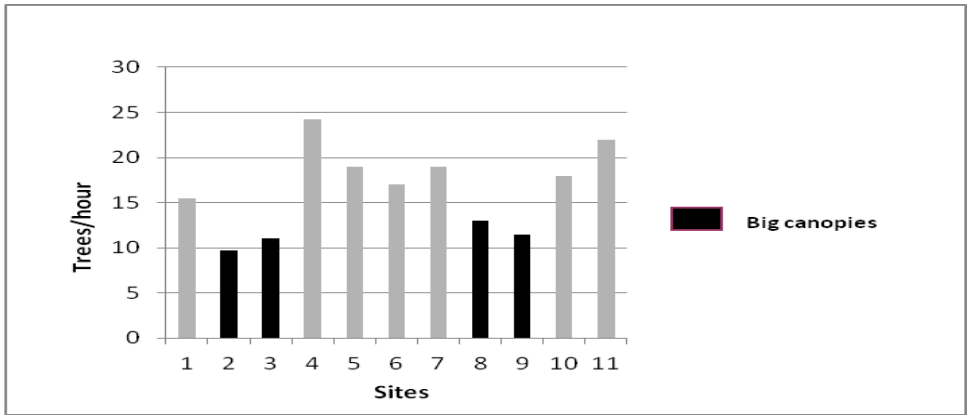

Figure 2. Spike rotor work rates

For trees with a canopy and trunk not suitable for shakers, a spike rotor is a useful equipment, despite the lower performance – 12 to 25 trees per hour [Almeida, 2007b], but this equipment usually detaches 100% of the olive production (Fig. 2).

In slopes special trajectories to move the harvesting equipment inside olive orchards are necessary to minimize the risk of accidents. These solutions are necessary for a safe work, but can jeopardize the equipment performance.

Work rates in slopes are lower than in olive orchards in flat areas. In these field trials, in average, System I work rate have a reduction of 36%; System II work rate have a reduction of 26%; System III work rate have a reduction of 20% (Fig. 3).

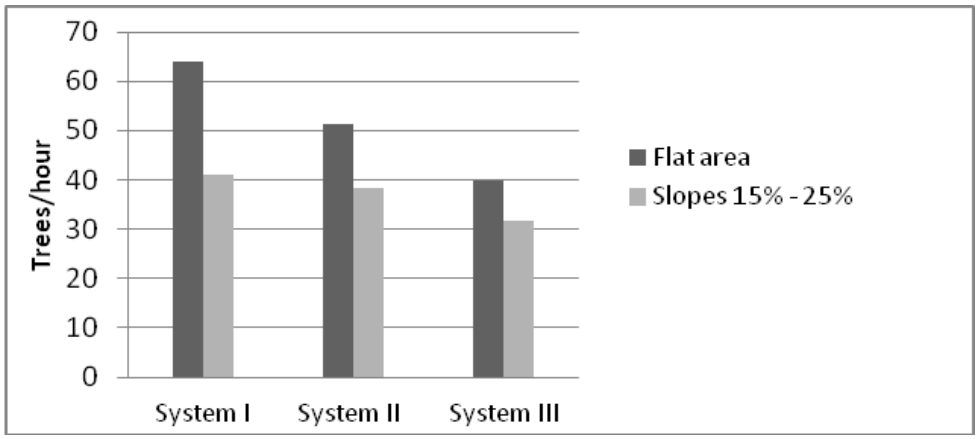

Figure 3. Average work rate results in traditional orchards according slopes

3.2 High density olive orchards

The reduced space between trees along lines does not allow the inverted umbrella work or a satisfactory work of conventional mechanical rolling canvas.

A specific mechanical rolling canvas has been designed to collect olives detached by trunk shakers. The performance achieved is 40 to 50 trees per hour [Peça, 2008].

3.3 Hedgerow olive orchards

In this kind of olive orchards, harvesting is a continuous work, row by row.

Olives are harvested and collected simultaneously, using an overrow equipment. In this case, expected performance is 3 to 3.5 hours per hectare.

4. Conclusions

4.1 Traditional olive orchards

Experiments and their evaluation show that the most suitable system is the trunk shaker (to detach olives) combined with the inverted umbrella (to collect detached olives) [Almeida, 2007a]. Despite the performance is not the best, it needs the minimum of manpower and the costs by production harvested are lower.

The system using the spike rotor in conjunction with hand shakers may be regarded as a useful tool for olive harvesting of trees with large canopies (volume between 100 m^3 and 200 m^3 and the trunk diameter between 2 m and 3.5 m), bearing in mind that values close to 100% of detachment can be reached and that for such trees trunk shakers are inadequate. However, to make operational costs competitive it is important to improve work organization and above all to increase olive production on these traditional olive orchards. In the former aspect, the increase in the number of hand held shakers concentrated in lower branches should be envisaged in the near future.

Some of these old traditional olive orchards with autochthonous cultivars with large canopies are able to produce high quality olive oil, factor of a great importance in a so competitive market.

4.2 High density olive orchards

In this case the most suitable harvesting system includes a trunk shaker with the specific mechanical rolling canvas referred. The performance can be greatly improved if two rows are harvested simultaneously, using one trunk shaker and two mechanical rolling canvas.

In these two types of olives orchards - traditional olive orchards and high density olive orchards, trees are harvest one by one - the most important factor affecting performance is the operational time to move equipment from

one tree to the next. In order to get a better performance a good trafficability conditions for equipment is needed. This objective can be achieved by an adequate soil management that reduces the soil water content in harvesting season.

4.3 Hedgerow olive orchards

The continuous harvesting system with an overrow equipment is by now the recommended procedure. This harvesting system requires a tree below a certain height, width, and with trunk access or clearance below the canopy for the fruit catching frame. It is not been fully demonstrated that the topping, hedging and hand pruning required to maintain the adequate tree size will produce annual economic crops [Ferguson, 2006].

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SHAPING AN ORGANIZATIONAL CULTURE IN AGRICULTURE ENTERPRISE – A CASE STUDY

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Keywords: organizational culture, corporate image, agricultural enterprise

1. Introduction

In the literature, organizational culture is defined generally as social norms and value systems to stimulate workers, appropriate organizational climate, governance, shared meanings and symbols, patterns of cognition, behavior requirements. Deshapande and Parasurman state that organizational culture is unwritten and often unconscious set of principles which fill the space between rules and reality hence [Zbiegień - Maciag 1999]. The most famous definition to determine Edgar Schein [1986], according to which organizational culture is a set of core values and standards of behavior, dominant in the organization, encouraged by the spirit and manifesting itself through artifacts.

Organizational culture is variable and depends on many external and internal factors, that affect the company (type of environment and type of organization, the characteristics of the organization and characteristics of participants) [Aniszewska, Gielnicka 1999].

Looking outward to the achievements of economic thought, organizational culture is - besides strategies of the company, its organizational structure and procedures for the execution of tasks - forming part of the so-called organizational resource companies. Thus, organizational culture affects the effectiveness of the company [Bagieński 2010].

2. Material and methods

The aim of this study was to identify and analyze the basic principles of the firm operation – values, that are the main points of reference in the shaping image and culture of the agriculture company. The following areas of research were distinguished:

a/ subject scope: Farm Frites Poland Two Ltd. (FFPD) – the agricultural company is actively engaged in business activities (crop production – about 3200 hectares of arable land);

b/ scope of the study: the characteristics of the operation conditions of the selected company according to the second level of Schein's model [Peszko 2013];
c/ time range: the years 2009 - 2011 according to statistical and economic data, and 2012 according to empirical research;
d/ spatial scope: the area of the Company operations: municipalities Damnica and Główczyce, Pomorskie province.
Applied research methods were as follows:
a/ method of analysis of the literature, especially in the first stage of research and logical inference method to isolate the internal and external conditions of activity of the test subject;
b/ stakeholders analysis method to distinguish entities of the enterprise environment, which directly or indirectly affect the Company's operations;
c/ case study method.

3. Results

Starting the FFPD business was associated with the construction by a Dutch investor a modern factory fries in Lęborg in 1994 (sister company of Farm Frites Poland Joint-stock Company).
Potato cultivation and reproduction are based on the best seed material imported from Holland, Scotland and Germany.
Currently about 1,000 hectares of potatoes is grown at Farm Frites Poland Two yearly. The farm uses a four-year crop rotation. Within the structure of sowing areas can be distinguish other cultivations like rape and cereals (wheat, rye) (around 700-800 ha), and a range of complementary crops like corn, grass and radish .
To meet the annual demand for raw materials (more than 200 thousand tons), factory of potato products in Lęborg, cooperates very closely with FFPD and 70 smaller potato producers mainly from the Zachodniopomorskie, Pomorskie and Wielkopolska provinces within the vertical integration. It should be noted that FFPD and other producers cooperating with the Lęborg factory generate more than 2% of the harvested potatoes in Poland annually.
As mentioned earlier, the aim of the research was to identify and analyze the basic principles of the company, the values and norms which are the main points of reference in shaping the image and culture. Based on research conducted in the reporting company and the information contained in the available documents of the company, such elements would definitely include:

- care of the highest quality and food safety,
- innovation and progress implementation in agriculture,
- dialogue with stakeholders,
- integrity and traditions of cooperation,

- production and other activities in accordance with the concept of sustainable development.

As each of food supply chain, end consumer and his requirements for quality and safety of the product produced are playing a major role. FFPD produced by well-known international and national standards, following above-average recommendations for farming and crops.

One of the consequences involved in ensuring food safety is to have a so-called certificate of product quality - GlobalGAP (GAP - Good Agricultural Practice). FFPD was the first farm in Poland which obtained such certificate in the production of potatoes. In addition, the farm is audited annually by an independent certification organization for the agricultural sector in Europe - ECAS MPS (MPS is an international organization dedicated to the implementation of sustainable development and corporate social responsibility). Since 2001, the company is also included in the McDonald's Agricultural Assurance Programme (MAAP). The McDonald's standards apply to all links in the supply chain.

The FFPD is also a member of SAI Platform (called the Sustainable Agriculture Initiative Platform) uniting the world's largest food producers. The main aim of the association is to guarantee food safety and sustainable development.

In the FFPD , at every stage of production quality is the most important thing - to maintain quality all employees are involved. Develop the habit of employees continuously monitor individual processes, next to the technological advancement, is recognized as a priority action for the improvement of quality in the company. Quality control and supervision of the production process facilitates its own laboratory, which allows the monitoring of basic parameters of derived plant products.

Meeting the higher standards of potato cultivation the Farm Frites Poland Two was nominated by a worldwide network of McDonald's to the role of Flagship Farm (holding flag - business cards). Thus, the company has become a model of good agricultural practices for other suppliers of potatoes for McDonald's. The aim of the Flagship Farms programme is to share experiences and promote sustainable farming practices that are not only good for the environment, but also cost-effective and ethically unproblematic. The FFPD as a model producer of potatoes using its own specialists, shares their knowledge with cooperating farms.

In the dialogue with stakeholders, the company is involved in many different initiatives (especially for their crew) and is strongly committed to social issues (a variety of activities for the local community).

Authenticity and tradition of cooperation is another important value taken into account in shaping the organizational culture of the FFPD. The flagship product of the farm - potatoes are the raw material for the production of

frozen potato products which, through the factory in Lęborg, it provides the most known brands: Farm Frites, Aviko and McDonald's.
The last basic principle of the company functioning, which also makes its corporate culture and image, is the action in accordance with the concept of sustainable development. Among the unwritten company management instruments it should be mentioned the basic principles applicable to all employees, such as a policy of continuous improvement of the production process, innovation, quality improvement and care about environmental protection and efforts to reduce costs.
Annual plans like technical and financial budget and capital budget which are performed in the farm favor the implementation of the idea of SD. Financial and technical budget refers to the theory of organic farming and is based on the creation of the internal balance of the company, connecting the production and inputs.

4. Conclusions

Included synthetically selected issues related to the organization's culture in the agricultural company FFPD, demonstrated the importance of the multidimensionality of the concept, and how much impact it can have on the company functioning.
Results of this study confirmed that organizational culture has an impact on improving competitiveness and increasing the efficiency of the company. Based on example of the analyzed entity can be concluded that significantly improves the functioning of the organization and helps to achieve financial success. Organizational culture pursues the seemingly contradictory tasks: provides both durability and stability of the company and great flexibility, i.e. the ability to adapt to changing external conditions.

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MODERNIZATION OF FARMS IN LOWER SILESIA

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Keywords: modernization, investments, individual farm

1. Introduction

Investment processes in agriculture is the basis of the development and the competitiveness of farms on European market. The new possibilities of investment funding in this sector of national economy already appeared in the short period before Poland entering to UE structures. Investments decisions are dependent on many factors where the level of farm income seems to be the most important [Kusz, 2009]. Moreover one of the most import and economic reason of long term investment development is willing to invest [Woś, 2000]. These processes become more intensive after implementation in Poland the system of direct payments and more visible in larger farms [Poczta, 2006].

In financial perspectives PROW 2004-2006 and PROW 2007-2013 the part of the cash designated on the modernization grew up significantly. The numbers of farmers applications testify several times higher number of potential beneficiaries than established limit. For over last 10 years the essential growth of machines prices for agriculture purposes has been noticed. There is a straight dependency between own capital participation and possibility of co-financing from public budget what cause a real income [Rowiński, 2008].

Participation in investments programmes became the only chance to modernize the machine's park for many farms. However in the report to the whole population of agricultural farms the part of individuals which participated in modernization did not cross 2%. Undertaken investments in larger area groups were covered from own canters and with co-financing by credit bank. Exceptionally profitable situation in agriculture in years 2011 and 2012 caused intensification of investment processes in individual farms. The analysis of the investment process was the aim of the present study in studied community of farms.

2. Material and methods

Investigations were conducted in years 2012/2013. The purposeful selection of farms lay within 3 administrative districts of the Lower -Silesian province. Source data base materials came from agricultural farms, which

received refinance to the investment for "Modernization of agricultural farms" within PROW 2007-2013. Investigations covered 229 individual farms where applications were accepted by regional division of ARMA in Wrocław. For the research purposes farms has been divided into five area groups: 1.00 -14.99 ha; 15.00-29.99 ha; 30.00-49.99 ha; 50.00-99.99 ha; over 100 ha.

The largest part of farms made up located in Wrocław Poviat - 41%, then Średzki Poviat - 34% and Kłodzki Poviat - 25%. The aim of the study was indication the main directions of modernization changes and the qualification of the scale of modernization processes (the category of investment expenditures). The detailed analysis of origin and size of modernization undertakings with regard to the groups of fixed assets and its use were executed.

3. Results

The population of farms under investigation administered the surface over 32.9 thousands ha. The area group over 100 ha was represented in great number (table 1).

Table 1. Area and number of farms under investigation

No.	Area group (ha of UAA)	Farms	
		Number	Area of UAA (ha)
1	1.00 - 14.99	7	79.15
2	15.00 - 29.99	27	641.63
3	30.00 - 49.99	35	1458.34
4	50.00 - 99.99	78	5568.34
5	above 100	82	25182.17
6	Total	229	32929.63

Source: Own study on the basis of Agency of Restructuring and Modernisation of Agriculture, Wrocław Division

The predominant direction was of plant production with the share above 86%. Cereals and industrial plants predominated in the structure production.

Winter wheat predominated in cultivar structure and from the group of industrial - rape. The typical plant production was conducted in studied objects, however orchard and horticultural plants were noted down only in 4% of farms.

In the range of the animal production the cattle and swine were predominated - with the largest part in largest farms over 100 ha (suitably share in the stock: 37% and 35%).

Economic results of farms determine the investment possibilities and the reason of realized undertakings. For the application purposes the standard

gross margins for selected activities is calculated. This indicator influence for economic power of farm (ESU) (table 2) and possibilities of co-financing from EU programmes.

Table 2. Value of standard gross margins in PLN per farm and per hectare

No.	Number of European Size Unit	Standard Gross Margin	
		PLN/farm	PLN/ha
1	4 – 8.00	34,197	1202.65
2	8 – 16.00	59,090	1332.37
3	16 – 40.00	239,989	2904.14
4	40 – 100.00	300,237	1373.14
5	above 100	1382,800	2103.71
6	Total	239,607	1666.5

Source: Own study on the basis of Agency of Restructuring and Modernisation of Agriculture, Wrocław Division

The average value in economic size group 4-8 ESU of overage surplus was over 34 thousands of PLN and value per 1 ha was lowest from the all groups and reached only 1,202.65 PLN. With the growth of SGM in units under consideration the economic size of farm grew too. The highest average value of standard gross margin per 1 ha of UAA was noted down in the group of farms 16 - 40 ESU and was average 2,904.14 PLN. Generally together with the growth of ESU value the value of overage surplus grows up only except in the group 40 -100 ESU. This value was smaller - almost 1,600 PLN / 1ha of UAA in comparison with the group of farms 16-40 ESU. In farms under investigation the total value of standard gross margins was 240 thousands of PLN (1666.5 PLN/ha). 7% of farms did not possess machines and they uses only external services however 93% of farms possessed at least 1 machine. In the structure of tractors predominated in the compartment of 51-100 HP. 50% of studied objects possessed at least 1 combine harvester. The Bizon mark predominated, however in the category of newer machines Claas brand.

Studied farms within the working "Modernization of agricultural farms PROW 2007-2013" bought with refinancing of UE support machines which improved and accelerated works in agricultural farms. The total of 578 agricultural machines, devices and grain silos were bought. Tractors were bought mainly and they made up 23% all bought machines, aggregates make up second group - 23%. Ploughs were bought often – in 13% of cases and agricultural trailers 9%. Combine harvesters in the structure made up only just 5%. The remaining machines by type are follows: mowers, presses, adapters to maize, front loaders, seed planters, sprayers and others were also bought which made up in the structure the largest percentage - 26 %.

In the structure of bought tractors in three poviats above the half of machines possessed power from 101 to 151 HP. No one tractor below power 51 HP was bought. The number of tractors with power above 201 HP, 51-101 HP and 151-201 HP was on the approximate same level. It results from the largest demands on the tractors with average power engine and was connected with the area structure of agricultural farms under consideration. Tractors with power 101-151 HP were bought mainly by farms with surface from 50 ha to 200 ha.

The farmers purchased mainly the tractors of New Holland and John Deere brand - above 20 % in both marks. The large interest were pleased to the tractors of Deutz Fahr and made up above 10 % in the structure of bought tractors. Tractors Valtra, Class and Pronar were bought the least - more less than 2 %. In 33 % of farms the machine mark wasn't identified.

The highest number of combine harvesters was bought in Wrocław and Środa Śląska Poviats (14 and 20 pieces). The highest percentage of bought combines constituted New Holland mark (43%) and Claas mark (25 %) the lowest share of combine harvesters were Case and Deutz Fahr (7%).

From studied agricultural farms agricultural machines were purchased in amount of 90 pieces of tillage aggregates, secondly above 70 of ploughs were bought. So the large quantity of bought these two machines was connected with the function of basic agricultural, indispensable in every farm leading plant production. Also bought in smaller quantity were: grubers and disk harrows, chisel – plowers, and power harrows.

Table 3. Average value of investment in area groups in selected poviats.

No.	Area group	Average value of investment per ha in area groups in selected poviats in PLN		
		kłodzki	średzki	wrocławski
1	1,00 – 15,00	27 062.35	12 198.5	16 079.24
2	15,00 – 30,00	10 095.61	7166.72	10 790.3
3	30,00 – 50,00	5 592.8	9224.2	5539.21
4	50,00 – 100,00	4 878.11	6173.2	6640.26
5	over 100	2 269.23	2 454.28	1861.48
6	Total	3 692.78	3 508.4	2808.83

Source: Own study on the basis of Agency of Restructuring and Modernisation of Agriculture, Wrocław Division

Average value of the investments was the highest per hectare in Kłodzko Poviat and constituted above 27 thous. of PLN where in Wrocław Poviat was lower almost 11 thousand PLN, and in Środa Śląska Poviat down almost 15 tys. of PLN (table 3). The the lowest value of investments was noted in Wrocław Poviat in are group over 100 ha (1,861.48 PLN/ha).

Together with in the growth of the area of farm average value of investment in count on 1 ha falls – but the area group 30-50 ha was exception Środa Śląska Poviat, where the value of investment per 1 ha was over 2 thousands of PLN. Average value of investments per 1 ha in selected poviats were comparable – the highest in Kłodzko Poviat – 3,692 PLN, than Środa Śląska Poviat 3,508 PLN and Wrocław Poviat 2,808 PLN.

4. Conclusions

The majority of farms before modernization programme possessed at least one machine to the agricultural production. Farm producers were equipped first of all in basic machines to the plant production purposes. The significant quantity of farms was forced in agricultural tractor from average power compartment. The tractors of Polish and Czech production were dominated. The majority of studied farms were equipped in cereal combine harvester both national and foreign. Farms from the region of intensive agriculture, in the larger scale undertook modernization workings than farms from the Kłodzko region. The directions of modernization transformations were determined by: direction of led activity, the size of farm, location and the size of standard gross margins. The average value of investment per one farm was higher in the region of intensive agriculture, than in the Kłodzko region. However the value of investment per 1 ha in Kłodzko Poviat was higher than both in Wrocław Poviat and in Średzki Poviat.

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AGROFORESTRY – A SUSTAINABLE LAND USE FOR THE FUTURE OF EUROPEAN AGRICULTURE

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Keywords: agroforestry, sustainable agriculture, multifunctional agriculture, intercropping

Summary

Agroforestry means land-use systems and practices, where woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The trees may be single or in groups inside parcels (silvoarable agroforestry, silvopastoralism, grazed or intercropped orchards) or on the limits between parcels (hedges, tree lines) (EURAF 2012).

Decline of traditional agroforestry systems in Europe was caused mainly by increased mechanization leading to removal of trees, maximising productivity through monocultures, a reduction in the agricultural work force limiting viability of labour-intensive systems, farms consolidation, favouring single crop systems by CAP Policy, wooded area were ineligible for subsidy payments (Eichhorn et al. 2006).

Possible functions of traditional as well as modern agroforestry systems for Europe under temperate climate conditions may include: soil protection against erosion, sustainable utilization of marginal lands, reduction of nutrients and pesticides leaching losses, biodiversity regulation, microclimate modification and climate resilience, carbon sequestration, products diversification, enhancement of agricultural landscapes. Agroforestry plays important role in both mitigation and adaptation to climate change (EURAF 2012, Mosquera-Losada et al. 2012).

Systems incorporating belts of biomass crops like short rotation willow coppice can be the source of energy every 2nd-4th year, while other systems with trees growing slower may deliver wood as a by-product of management practices including thinning and pruning.

The key issue for optimal production in agroforestry systems is optimization resource capture by maximizing positive interactions and minimizing negative ones (Smith et al. 2012). The recommended measure of productivity of intercropping systems is the Land Equivalent Ratio (Federer et al. 1982) that has been defined as a measure of efficiency of an intercropping. The LER compares land areas required under single cropping to give the yields obtained from the component crops of the mixture. Values greater than one indicate intercropping to be more efficient than sole cropping in terms of land use, while values less than one indicate a loss in efficiency due to intercropping.

Productivity of agricultural crops and trees is affected by appropriate choice of tree genotype, spatial design of the system (distribution of trees, orientating tree rows in north-south direction to optimize light availability for crops) and management practices (for example thinning and pruning of branches and roots controlling trees density influence on light penetration and quality of timber). Distances between the tree rows should be adapted to facilitate use of machines. Wide planting distances between trees within row allows higher diameter increment and better quality of wood. It is possible also to use free space within the row to sow plants attracting pollinating insects or herbs, fruits, vegetables etc.

Long-term studies are needed to optimize agroforestry systems design and maximize positive interactions under different conditions. Particular attention should be paid to nutrient use of neighbouring crops and water uptake. Due to complexity of the system, multidisciplinary approach is needed. Close cooperation between forestry and agriculture specialists may be necessary. Adoption of agroforestry is affected severely by farmers' awareness, high initial investment and a lack of financial incentives. Moreover, intercropping is excessively labour-intensive. However, appropriate management of these systems, supported financially by EU and regional policies may increase crop growth and yield and diversify agricultural production in a sustainable manner.

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IMPACT OF DIFFERENT SCENARIOS RELATED TO THE NEW COMMON AGRICULTURAL POLICY ON FARM INCOME IN WALLONIA

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Keywords : Wallonia, Common Agricultural Policy, scenarios, farm income.

1. Introduction

The Common Agricultural Policy (CAP) has been reformed several times since the treaty of Rome in 1958 [Ledent, Burny 2002]. For the period 2014-2020 at the European level, a new CAP had to be agreed upon by the 27 Member States and the EU parliament. Discussions were launched in 2010 and several proposals were made.

In Belgium, as agricultural policy is regionalized, the Walloon Minister for Agriculture decided to support academic research in order to assess the possible impact of different scenarios on farm income, and so to help the regional authorities to take decisions when the EU legislation would be adopted, giving a large set of possibilities to the Member States/regions.

So, different scenarios were defined with the partners of the administration, including farmers' unions, and their impacts on farm income were calculated.

2. Material and methods

The data used to calculate the impact of different scenarios come from the Integrated Management and Control System [Service public de Wallonie 2013] implemented by the regional administration of agriculture and from the Farm Accounting Data Network.

The scenarios are based on the different options proposed by different actors - the Commission [EU Commission 2011], the EU Parliament [EU Parliament 2013] and Member States.

The calculations are made on several hypotheses. To estimate the available amount for direct payments in Wallonia in 2020, it was supposed a) that the share of Wallonia within the Belgian envelope remains the same, so 54%, and b) that the amount available in 2013 is reduced by 11.2%, according to the proposal of the EU Commission. So, the amount available for direct payments in Wallonia is supposed to reach €270 million.

In order to estimate the eligible area, the area declared by farmers who have direct payments rights in 2011 was added to the area of farmers who

produce only fruits and vegetables and/or had vineyards, with no direct payment right in 2011.

The proposition of the EU Parliament concerning direct payments ceilings is implemented: a reduction of 20% between €150,000 and €200,000, 40% between €200,000 and €250,000, 70% between €250,000 and €300,000 and 100% over €300,000 .

The different scenarios are compared to a Scenario 0, status quo 2013.

In the reference scenario, the amount of the direct payments is calculated for each farm in 2013, before the implementation of the reform. The single payment is granted on an historical basis and the suckling cows premiums remain coupled.

The scenarios integrate the following alternatives [Terrones Gavira, Burny, Lebailly 2013]:

- with the maintenance of the coupled premiums for suckling cows or their incorporation into the decoupled payment;
- with an additional payment for the 30 first hectares or for the 50 first hectares;
- with an additional payment being equal to 25% of the basic payment or to 50% of the basic payment.

3. Results

The results are presented in table 1.

Table 1. Impact of different scenarios on the amount of direct payments granted to Walloon farmers in 2020 compared to the references scenario (2013)

Scenario	1	2	3	4	5	6	7	8	9	10
Suckling cow premium	witch premium (12 % of direct payments)					without premium				
Number of ha witth additional payment	0	30		50		0	30		50	
Amount of the additional payment	0	25% *DP	50% *DP	25%* DP	50% *DP	0	25%* DP	50%* DP	25%* DP	50%* DP
LOSSES										
50 % or more	4%	3%	3%	3%	3%	4%	5%	4%	5%	4%
From 30 to 50 %	16%	15%	14%	15%	14%	16%	14%	13%	14%	14%
From 20 to 30 %	16%	15%	14%	15%	15%	14%	14%	13%	14%	13%
From 15 to 20 %	8%	8%	7%	8%	7%	7%	7%	7%	7%	7%
From 10 to 15 %	7%	7%	7%	7%	7%	7%	6%	6%	6%	6%
From 5 to 10 %	7%	6%	6%	6%	6%	6%	6%	6%	6%	6%
From 0 % to 5 %	5%	5%	6%	6%	6%	5%	5%	5%	5%	6%
TOTAL	62%	60%	58%	60%	59%	60%	57%	54%	58%	56%
STATU QUO	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 1 – cont.

GAINS										
From 0 to 10 %	8%	9%	9%	8%	9%	9%	9%	9%	9%	9%
From 10 to 20 %	6%	6%	6%	6%	6%	6%	6%	7%	6%	7%
From 20 to 30 %	5%	5%	5%	5%	5%	4%	4%	5%	4%	5%
From 30 to 50 %	5%	6%	6%	6%	6%	6%	6%	6%	6%	6%
50 % and more	13%	15%	16%	14%	15%	16%	17%	19%	17%	18%
TOTAL	38%	40%	42%	40%	41%	40%	43%	46%	42%	44%

It appears that compared to the "status quo" scenario, all scenarios have a significant impact on the direct payments received by Walloon farmers. In general, around 60% of Walloon farmers will get lower direct payments, while around 40% will get higher direct support.

For the majority of the farmers, gains or losses will be limited. However, some farmers, from 3% to 5% according to the scenarios, could loose more than 50% of their direct payments, while others, from 13 to 19%, will gain more than 50%.

4. Conclusions

The new Common Agricultural Policy will have a significant impact, positive or negative, on the direct payments granted to Walloon farmers, and so on their income, whatever choice is made by the regional authorities, according to the "menu" proposed to the Member States. So, the final decision will be difficult to take, as some farmers could register an important decline of their profitability. It seems that there is a consensus to try to have as small changes as possible, but some negative impacts are unavoidable, mainly for farmers who were most favored in the previous period (2007-2013).

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THE COMMON AGRICULTURAL POLICY TOWARDS 2020

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Keywords: Common Agricultural Policy, direct payments, green payment, 2014-2020 budget period.

1. Introduction

The Common Agricultural Policy (CAP) defined in the Treaty of Rome and implemented since 1962, has always been under reform, mainly in 1992, 1999, 2003 and 2009. However, after the last enlargements and the international financial crisis, a new reform was needed for the budget period going from 2014 to 2020. The first ideas were launched by the EU Commissioner for Agriculture, M. Dacian Ciolos, in 2010. After three years of discussions, the political agreement between the Council of Ministers, the EU Parliament and the Commission was reached in June 2013 [Agra Europe 2013]. So, this paper presents the main decisions of this agreement.

2. Material and methods

This paper is based on official documents from the EU Commission, the EU Parliament, the Walloon regional administration for agriculture,... concerning the different proposals and the political agreement. A lot of actors also expressed their opinions on such a controversial topic.

3. Results

Three main topics are dealt with: direct payments to farmers, rural development, and the Unique Common Market Organization.

3.1. Direct payments

A new scheme for direct payments from the first pillar of the CAP was agreed upon (figure 1).

Compulsory measures for the whole EU	Optional measures (MS Choice)
- Basic payment	- Additional payment for the first ha
- Green payment	- Coupled payments
- Young farmers payment	- Payments for less favoured areas

All payments depend on cross-compliance

OR

Simplified payment for small farmers (MS Choice)

Figure 1. New scheme of the direct payments for 2014-2020

For all Member States (MS) or regions within them, the direct payments paid to the farmers from the first pillar must include at least three parts: the "green" payment, a payment to young farmers (in addition to the financial support for young farmers from the second pillar of the CAP) and the basic payment (the amount available for the basic payment is equal to the "national envelope" for direct payments reduced by the other payments in the new scheme). In addition the MS (or the regions within them) have also the possibility, if they choose so, to include:

- an additional payment for the first hectares of each farm (in order to support the smaller farms):
- to maintain some coupled payments (like the premium for suckling cows);
- a payment for less favoured areas (in addition to the financial support from the second pillar).

Of course, the amounts spent for these optional payments reduce equally the basic payment, as the "national/regional envelopes" have to be respected.

With this new scheme, the CAP becomes friendlier to the environment: the "green payment" will represent 30% of the national/regional maximum amount for direct payments in each MS/region [Département des Politiques Européennes et des Accords Internationaux du Service public de Wallonie 2013]. In order to get the green payment, farmers will have to prove that they respect some conditions additional to cross-compliance: crop diversification, maintenance of permanent pastures and to manage a minimal area of ecological interest. There are several ways of implementation and the MS/regions have the choice among several options.

Organic farming automatically gives the right to the green payment [EU Commission 2013]. Where NATURA 2000 is implemented, its measures have the priority. The MS can also consider some measures as equivalent to the "greening" measures, like environmental certification and agro-environmental measures (no double payment!).

The payments for young farmers [Clisson 2013] can represent a maximum of 2% of the maximum amount for direct payments at the national/regional level. Young farmers are farmers under 40, and the financial support can be granted for five years. There are several ways to calculate this payment, the choice being let to the MS/regions. So, the total expenses can vary according to the method.

The basic payments will be granted to farmers who applied for direct payments in 2013 and the number of eligible hectares in 2015. The mean value is the amount available for basic payments at the MS/regional level divided by the number of eligible hectares.

In order to support smaller farms, an additional payment can be granted to a given limited number of hectares. Up to 30% of the total amount of direct payments can be used for this purpose. The MS/regions are free to

implement this payment or not, and to implement it according to the method they have chosen.
Another optional payment is the additional payment for the less favoured areas. If the MS/Regions decide to implement it, they can use as much as 5% of the total amount for direct payments.

The last option for the MS/regions is to keep some coupled payments. in such a case, they can use as much as 2% of the total amount of direct payments for proteaginous crops and 13% for other productions. It is even possible to use a larger share of direct payments, with the agreement of the Commission. In Wallonia for example, the premiums for suckling cows represent 20% of the direct payments.

Between 2014 and 2020, the EU budget for the CAP will decline by 11% in constant terms (EURO 2011) [EU Commission 2013]. In addition, as large differences are observed, concerning the mean level of direct payments per hectare, not only between the MS, but also within the MS (when historical references are used), a measure of convergence has been decided : when a country has a mean direct payment below 90% of the EU mean, or when a farmer has a mean basic payment per ha lower than 90% of the MS/regional mean, one third of the difference will have to be compensated and supported by the countries (between MS) or the farmers (within MS/regions) who are above the mean.

The MS/regions also have the possibility to implement a special regime for small farms [EU Parliament 2013]. All direct payments can be replaced by an amount from 500 to 1,250 €. The total expenses cannot exceed 10% of the national/regional amount for direct payments.

3.2. Rural development

Six priorities and measures are proposed to the MS/regions:
- knowledge transfer and innovation;
- competitivity improvement;
- promotion of market chain organization and risk management;
- to protect agricultural and forestry agrosystems;
- to reduce the production of CO_2;
- to promote social integration and economic development.

In addition, agro-environmental measures must represent at least 30% of the total budget for rural development, and LEADER at least 5%.
Measures are implemented within a multi-fund strategic scheme.

3.3. The Unique Common Market Organization

The disappearance of the milk quotas is confirmed for 2015, while the disappearance of sugar quotas is foreseen for 2017. However, intervention measures will be maintained.

The producers' organizations and inter-professional organizations are encouraged, as they have to play a more important role in the management of the market.

A financial reserve is created from the direct payments amount in order to face eventual crises, like price collapse.

4. Conclusion

The new CAP leads to a better equity between the MS and within the MS (convergence of direct payments). It is also "greener" than before, as 30% of the direct payments are linked to the respect of additional measures in favour of the environment. It could also be simplified with the implementation of the regime for small farmers, though the new scheme for direct payments is more complex than before. The stress is also put on young farmers, as they are less and less numerous.

It is also observed that many important choices are let to the Member States/regions, so that the "Common" Agricultural Policy is less "Common" than before.

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DEVELOPMENT OF ORGANIC FARMING IN WALLONIA: PAST, PRESENT AND PERSPECTIVES

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Keywords : Wallonia, organic farming, development plan.

1. Introduction

Organic farming is today fully recognized as an alternative to conventional agriculture and its problems (water and air pollution, large use of pesticides and possible impacts on human health, vegetal and animal diseases, overproduction, etc.) and is clearly supported by the Common Agricultural Policy and its "greening".

Belgian (and Walloon) agriculture is an intensive one, with a high "labour force/agricultural area" ratio and high yields thanks to good soils, but also the use of large quantities of inputs like fertilizers and pesticides.

However, organic farming increased in importance during the last years and the Walloon regional government has just launched a development plan in June 2013. So, this paper aims to analyse the evolution of organic farming in Wallonia and to present the goals and the measures of the new development plan.

2. Material and methods

The data concerning organic farming and its products come from the national farm census organized every year on May 15, from statistics delivered by the regional Walloon administration, from consumer surveys, a survey among organic cereals producers, and the interprofessional organization "Bioforum Walloniei".

The official development plan for organic farming decided by the Walloon government is also taken into consideration.

3. Results

3.1. Production

The number of organic farmers in Wallonia (figure 1) and the agricultural area devoted to organic farming (figure 2) sharply increased during the recent past [Bioforum 2013]; In 2012, there are nearly 1,100 organic farmers, managing nearly 55,000 ha. Both represent around 8% of the total in Wallonia.

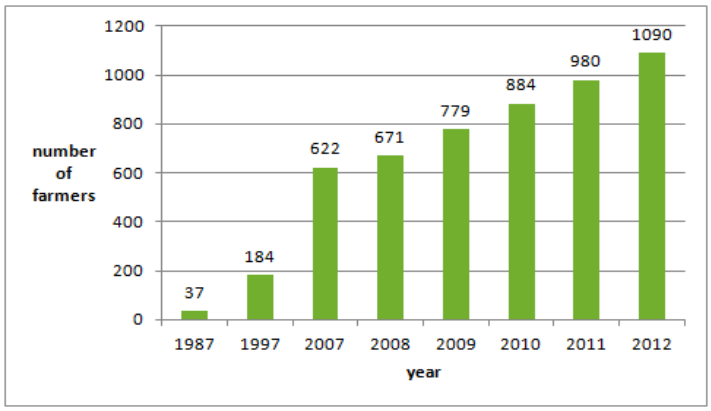

Figure 1. Evolution of the number of organic farmers in Wallonia (1987-2012)

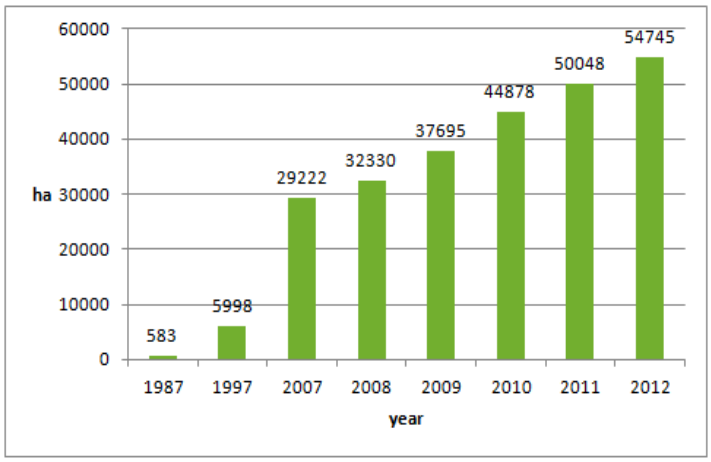

Figure 2. Evolution of the area (ha) devoted to organic farming in Wallonia (1987-2012)

The most important area devoted to organic farming is used for meadows (43,000 ha), on which cattle is raised, before general crops (mainly spelt, wheat and barley). Vegetables are not very important from the production point of view (372 ha in 2012).

According to a survey among organic farmers [Debode, Schiepers, Burny 2013], their mean age and the size of their farms are the same as for conventional agriculture. They are not newcomers but turned to organic farming in order to increase their self-sufficiency for the feedstuff and to be more independent from inputs providers. The financial support is also an important factor to convince the farmers.

3.2. Financial support

In Wallonia, the financial support for organic farming [Service public de Wallonie, Direction générale de l'Agriculture, des Ressources naturelles et de l'Environnement 2013] is significant (table 1).

Table 1. Financial support for organic production in Wallonia (€/ha)

Classification of crops	From 0 to 32th ha	From 33th to 64th ha	From the 65th ha	Area in conversion (2 years)
- Group 1 Meadows and forage	275	150	75	150
- Group 2 Fallow	275	150	75	150
- Group 4 Other annual crops	450	325	150	150
	From 0 to 14 ha	From the 15th ha		
- Group 3 Horticulture	750	450		

Prices paid to farmers for organic products are higher than for conventional products, but sometimes the products are sold as conventional ones, because the market for a given organic product is too small (bovine meat for example). And yields are significantly lower. So, the financial support is really important to reach an acceptable level of profitability.

3.3. Consumption

For food products, the market share of organic products reached 1.9% in 2012 in Belgium. The market share is very variable according to the products : 9% for eggs, 5% for vegetables, 3% for bread, and only 0.7% for meat. Nearly 60% of the total expenses are devoted to vegetal products.

The percentage of purchasing households is also highly variable: 60% for vegetables, but only 9% for poultry meat.

Supermarkets are still the main place where consumers buy organic products (44%), before specialized shops (31.5%). Direct sales (5%) and local markets (4%) are far behind.

3.4. The regional development plan

In June 2013, the Walloon government approved a development plan for organic farming [Cabinet du Ministre wallon de l'Agriculture 2012].

The measures which will be implemented include:

- coordination of the actors, from farmers to consumers;
- creation of a specialized research unit within the Walloon Centre for Agricultural Research;
- improvement of communication;
- strengthening of extension services;
- to support promotion activities
- continuation of the financial support to farmers through the 2014-2020 period;
- to support direct sales;
- to support cooperatives and food chain building;

- to build up teaching activities.

The development plan precise quantities targets for 2020:
- to reach 14% of the agricultural area
- to increase the number of organic farmers to 1,750:
- to double the number of organic products processing enterprises and so reach 500 units;
- to increase the value of organic products sales of the processing enterprises from 222 million € in 2009 to 500 million €;
- to increase the share of organic products in the households food expenses to 3.0%.

4. Conclusions

Organic farming has significantly developed during the last years in Wallonia, notably thanks to the financial support from the public authorities. In 2013, the regional government decided to even strengthen the public support through a series of specific measures which will be implemented in order to reach quantitative targets in 2020. The market for organic products has increased and will probably continue to expand. So, organic farming will probably play a more important role in Walloon agriculture, though there are economical (prices for consumers, profitability for farmers) and technical (lower yields, pests, etc.) limits.

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BIOLOGICAL CROP PROTECTION USING AUTOGYRO-MOUNTED SPRAYING SYSTEMS

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Keywords: autogyro, biological crop protection, maize, European corn borer

1. Introduction

Maize belongs to the most popular grain crops, and its acreage is constantly growing. In 2011, in Poland maize fields covered 333,328 ha, to rise up to 539,300 ha in 2012. Production output can reach 3 Million tons [GUS 2012]

Intensification of maize production implies growing pest risks. One of the most important maize pests is the European corn borer (*Ostrinia nubilalis Hbn*), feeding on all maize organs above ground (tassels, ears, leaves, stalks etc.) [Bereś 2012; Bereś, Prószyński 2008; Bereś, Lisowicz 2005] (Fig. 1, Fig.2). The European corn borer damages the plants by cutting vascular bundles. The quality of grain is seriously affected. Mechanical damage to plants is followed by the attack of phytopathogenic fungi, and contamination of grains with mycotoxines.

Fig. 1 The worm of the European corn borer

Fig. 2. Maize ear damaged by the worm of the European corn borer

The pest easily affect new territories [Bereś, Konefał 2010], and local damages of up to 90% of plants have been reported not only in the south-

west Poland, but also in south-east regions formerly free from corn borer [Bereś 2012].

One of the methods of the European corn borer control is a biological method [Bereś Pruszyński 2008; Matyjaszczyk et al. 2010] that consist in introducing Trichogramma (*Trichogramma sp.*) that are endoparasitoids of the borer's and other pest lepidopterans' eggs.

The aim of research was to assess the applicability of autogyro as a means of airborne biological control of the European corn borer.

2. Material and methods

A biological insecticide called TrichoLet® containing larvae of *Trichogramma evenenscens* can be applied from the air, as was proven by the success of airborne introduction of Trichogramma conducted by the Czech manufacturer of this insecticide [Zbiorowe Biocont Laboratory 2011]. This gave the rationale for testing autogyros as the carriers of the biological spraying systems for maize crop protection in Poland.

The autogyro [Zbiorowe 2010] (Fig. 3) is an ultralight aircraft equipped with a free spinning rotor to develop lift, and an engine-powered propeller to provide thrust. The autorotation of the unpowered rotor is caused by the air flow generated by the movement of the machine.

Fig. 3. Autogyro

The autogyro needs a relative short runway for takeoff and landing, and this can be a piece of flat grassy field. The autogyro can fly with the speed of

100km/h and is easily maneuverable; which is an asset if compared with the tractor.

The tested autogyro was equipped with the insecticide applicators – containers mounted on the ends of the boom in the distance of 7 m from each other (Fig. 4). The applicators were filled with the larvae of Trichogramma in parasitized eggs of moths and the vehicle substance.

To define the settings for the application (height of flight and swath width to provide adequate distribution of the larvae), preliminary tests were conducted above the runway: the containers filled solely with the vehicle substance were emptied over rows 25 collector boards covered with glue. The boards' size was 15 by 21 cm, and they were placed on the ground in row with 1 m spacing. The test was repeated eight times for two dosing speeds. Additionally, there were three tests with different autogyro flight speed, each repeated twice. The volume reaching the target and the uniformity of distribution were estimated on the basis of the amount and distribution of the material glued to the collector boards.

Fig.4. Autogyro equipped with Trichogramma application system

3. Results

Maize plantations are usually large, which justifies using airborne treatments and the autogyro is an option worth considering – with its modest needs towards runway length and quality (compared with airplanes) and ease of operation (compared with helicopters). Due to relatively low flight speed and maneuverability, it seems also applicable in the case of precision treatments on small areas.

Another practical asset of the autogyro as a spraying system carrier is its efficiency - compared with wheeled machines. For instance, a tractor with a spraying system can treat 10 ha per hour (assuming swath width of 20 m).

The autogyro set of the same swath width could spray about 100 ha per hour, including the time for refueling and loading the pesticide, maneuvers over the field, and flight to the field and back.

The flight height established during test flights was 18 m, and the optimal flight speed was found to be 100 km/h with the efficiency of 80 ha/h. Two containers were enough to treat 80 ha with the right amount of the pesticide.

4. Conclusions

The proposed method of corn borer control, if compared to traditional treatments, is considered an improvement as it uses a biological pesticide instead of chemicals, and a quick and efficient application method by means of an autogyro. The short time of application is not without meaning as this pest appears suddenly, and its eggs hatch time is short.

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APPLICABILITY OF EXPERIENCE FROM LABORATORY SCALE EXPERIMENTS TO DEVELOP A MORE SUSTAINABLE VIRGIN OLIVE OIL INDUSTRIAL PLANT

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Keywords: virgin olive oil extraction process, emerging technology, ultrasound, sustainable plant engineering solutions, scale up techniques.

1. Introduction

The European Union through the "*Integrated pollution prevention and control*" directive defines the obligations with which industrial and agricultural activities with a high pollution potential must comply. The aim is to prevent or reduce pollution of the atmosphere, water and soil, as well as the quantities of waste arising from industrial and agricultural installations, to ensure a high level of environmental protection. Moreover, within the last decade, the public's demands for adequate quantities of good-quality food and for sustainability throughout the food chains stimulated the study and application of promising new and emerging food technologies [Clodoveo, Hachicha, 2013]. In this scenario, ultrasound (US) is an emerging technology that has already found application in the food industry or related sectors. Industrial applications in the virgin olive oil extraction process (VOO) are not still developed. At the same time, energy costs have risen considerably, rendering a lot of conventional processes more expensive and time consuming. The entire VOO process, which has changed very little over the last 20 years [Clodoveo, 2013 a], is subject to strict environmental regulations. These regulations and the changes in the VOO worldwide market determined higher production costs in the developed countries such as the European ones, pressing the VOO producers to improve both the product quality and the extraction process in order to increase their incomes. One of the essential challenges of VOO industrial plant manufacturing sector is to design and build advanced machines in order to transform the discontinuous malaxing step in a continuous phase and improve the working capacity of the industrial plants [Clodoveo, Durante, La Notte, 2013]. In fact, the current uninterrupted extraction system is not totally so structured. Considering the current continuous extraction system, it is composed by a series of apparatuses able to work in continuous mode [Clodoveo, 2012;

Amirante, Catalano, 2000]. However, it is clear that the weakest link of the chain in the VOO extraction process to perform a continuous process is the malaxation [Amirante, Cini, Montel, Pasqualone, 2001; Clodoveo, 2013 b]. So actually, the malaxation represents the bottleneck of the continuous extraction process. In fact, a bottleneck is a stage in a process that causes the entire process to slow down [Clodoveo, 2012].Currently the system used to guarantee continuity to the process, without interrupting the activity of the machines upstream and downstream of the malaxer, consists in placing several malaxing machines in parallel, with an heavy economic investment. Oil mills not equipped with plural malaxers arranged in parallel actually operate discontinuously and do not fully exploit the working capacity of the metal crusher and of the decanter. One of the crucial factors causing such lengthy malaxing times is the time period needed for the freshly crushed olive paste to reach the process temperature (27-32°C). This period has a length on average equal to at least one-third of the total malaxing time, as the olive paste outlet from the crusher may have temperatures comprised between 18 and 26°C, depending on the temperature of the working environment and the type of crusher employed [Amirante, Cini, Montel, Pasqualone, 2001; Clodoveo, 2012]. The malaxer is a heat exchanger characterized by a low overall heat transfer coefficient [Clodoveo, 2012] because the ratio (r) between machine surface area (S) and its volume (V) is very disadvantageous (r = S/V). So, it is important to find an innovative technology able to improve heat-exchange reducing the duration of this batch process and the investment costs due to the numerous malaxers usually placed in parallel. Recent researches at laboratory scale demonstrated that US is an emerging technology able to increase the environmental sustainability, improving VOO extraction yields and quality. US are characterized by thermal and mechanical effects: The mechanical effect of ultrasounds is mainly due to cavitation phenomena [Clodoveo, 2013 b]. Cavitation phenomenon is the formation, growth and implosion of gas bubbles at high negative pressure, which promotes the release of minor compounds from the plant tissue by disrupting the cells. The thermal effect of ultrasound occurs as kinetic energy from the ultrasound waves is absorbed by a medium. Absorption is a mechanism that represents that portion of ultrasonic wave that is converted into heat. During malaxation, the conventional heating method required about 25 minutes to warm up the olive paste until the process temperature. Instead, US treatment (35 kHz–150 W) reduced the pre-heating time until about 10 minutes [Clodoveo, Durante, La Notte, Punzi, Gambacorta, 2013]. This result demonstrated that US is a time saving technology. US reduced significantly the pre-heating stage of the malaxation: the industrial application of this technology could represent the first step toward a continuous malaxing phase. However before developing

an innovative device we should consider the effects of the merging technology on the product quality and on the process sustainability. Analytical data [Clodoveo, Durante, La Notte, Punzi, Gambacorta, 2013] demonstrated that the main parameters legally established (acidity, peroxide value, and specific extinction coefficients (K_{232} and K_{270})) to evaluate VOO quality were not affected by the US treatment. Moreover, as previously mentioned, cavitation phenomena are responsible for the disruption of cell tissues releasing minor compounds. In fact the increasing of sonication time determined the increment of tocopherols, carotenoids and chlorophylls. The mechanical effect on olive paste is clear also observing the oil yields that improved as sonication time increased. The present paper analyses the strategy to develop an industrial and industrial plant starting from the laboratory scale experiment. The reduction of the duration of malaxation could be the first step towards the development of a sustainable and continuous process. In fact, over the advantages that could arise from a continuous process, it is important underline that the US technology of the process is characterized by a high energetic efficiency. So, the aim of this paper is to propose a series of technical ideas to design an innovative device placeable in an already existent VOO extraction plant, in order to increase the performance of the industrial plant, increasing the quality and the quantity of VOO guaranteeing a higher sustainability of the process. Moreover a swot analysis will be developed in order to stimulate the VOO plant manufacture sector to invest time and money in the scaling up of the tested technology. Some principles that should be considered during the design project to build a prototype of the innovative plant are also suggested. In the next future, it would be of great interest to assess the effects of the ultrasound technology in a full scale VOO extraction process. The aim of this study is to objectively and rationally uncover the strengths and weaknesses of the application of US in the VOO extraction process, opportunities and threats present in the environment, the resources required to carry through, and ultimately the prospects for success. The two criteria applied to judge feasibility are cost required and value to be attained.

2. Material and methods

SWOT analysis

Lozano and Valles [2007] state that "*SWOT analysis*" is widely recognized and it constitutes an important basis for learning about the situation and for designing future procedures which can be seen necessary for thinking in a strategic way. This useful method is very simple and everybody can use it without having advanced knowledge or external technical support. This study draws information from the previous research activity and from the information collected interviewing the managers of the

five main VOO industrial plant manufacturers in order to evaluate the commercial appeal of the new product. This method identifies the strengths, weaknesses, opportunities and threats of the introduction of an innovation in a well-known process. Firstly, the strengths of an innovation may be the advantages and the benefits arising from a new choice. Secondly, the weaknesses of the innovation could be obstacles that should be avoided in order for the innovation can respond sufficiently to designed goals. Thirdly, it seeks to identify the opportunities associated with the introduction of the innovation and finally, the method detects the threats that will be faced by the implemented plan from external factors.

3. Results

Is it easy to scale-up this technology?

Ultrasonic liquid processing can be described by the following parameters: pressure, temperature, viscosity, concentration of solids and US signal waveform [Patist, Bates, 2008]. The result, or outcome, (e.g., percentage improved extraction yield and/or rate) is a function of:

1) specific energy, the energy input per volume treated material (in kWh/m^3);
2) power intensity - the actual power output *per* surface area of the US probe (in W/cm^2),

where, the specific energy input is the product of power output (here measured in kW) and the time of exposure (here measured in hours). Both specific energy and power intensity are independent of scale and thus any ultrasonic process will be scalable using these two parameters.

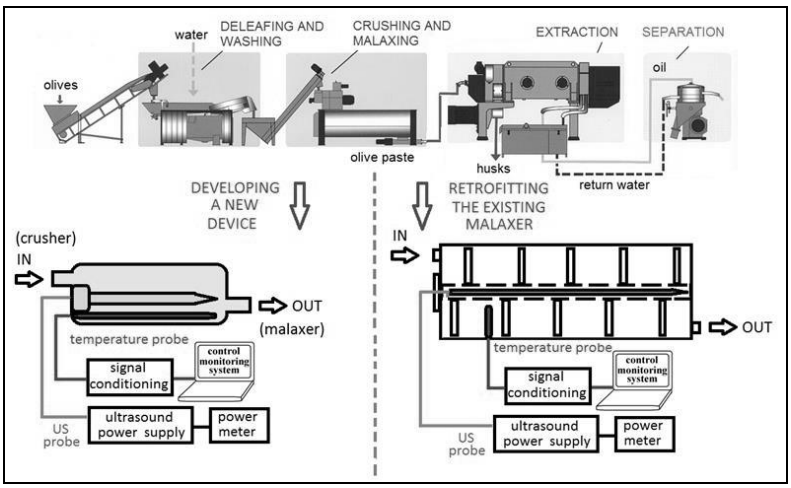

Figure 1. Hypothesis for the US technology scaling up in a VOO industrial plant.

At the light of this observation that ultrasound is an easy scalable technology, the full scale innovative ultrasound equipment for the VOO extraction plant should guarantee:

- *high work capacity*;
- *high energetic efficiency and high oil yield*;
- *low costs*;
- *easy adjustability*;
- *sustainability*.

These conditions seem to be well satisfactory by the US technology.
The scaling up of this technology can be realized following to hypothesis: retrofitting the existing malaxer introducing an ultrasound probe or developing a new ultrasound device placeable between the crusher and the malaxer [Clodoveo, 2013 b]. The new ultrasound device (Fig. 1) could be an ultrasonic reactor that consists of a holding tank and a *sonotrode* (US probe). In order to reduce the duration of sonication treatment it is also possible to combine a heat exchanger with the ultrasonic reactor [Clodoveo, Durante, La Notte, 2013; Clodoveo, 2013 a]. The heat exchanger can give rise to the faster attainment of the malaxation temperature. Ultrasound can enhance the effects of the heat exchanger by inducing acoustic cavitation, acoustic streaming, and fluid particles oscillations that are responsible for improving heat transfer [Legay, Gondrexon, Le Person, Boldo, Bontemps, 2011].

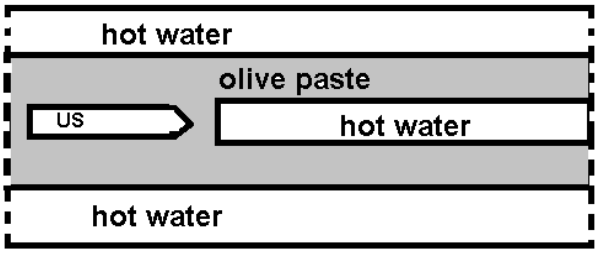

Figure 2. Sectional view of an innovative ultrasonic heat exchanger named "sono-exchanger", consisting of concentric tubes coupled with an US probe.

The sono-exchanger can consist of same concentric tubes (Fig. 2). The olive paste can flows in between two service channels, and is heated from the inside and outside at the same time. This heat exchanger can be coupled with a ultrasonic probe to treat the olive paste.

Is it convenient to scale-up this technology?

The opportunity to scale up the US in the VOO process is described using the SWOT analysis as reported in table 1.

Table 1. SWOT analysis: Evaluation of the opportunity for the ultrasound technology scaling up in the VOO process.

STRENGTHS	**WEAKNESSES**
Continuous process Energy saving Time-saving Higher VOO yields Higher concentration of minor compounds Good sensory properties of VOO Enzyme inactivation No negative effects on treated products	Poor information relative to their negative effects (absent or not studied?) Still commercially immature technology – many large-scale VOO plant manufacture companies don't believe in its advantages Large-scale production could present some other drawbacks compared to those found in laboratory experiments No pre-existing market model to use as a commercialization benchmark
OPPORTUNITIES	**THREATS**
Green process development Easy scalability Fast return of investment Continuous process development Consumer trends towards food in antioxidants Subsidies and policies could turn this technology economically feasible High commercial attractiveness of the product and high level of differentiation	Low VOO price and uncertain future Low profitability leading to low R&D investments Market and societal acceptance still unclear Innovative ultrasound technology might be constrained or delayed by mismatch with established regulatory standards

4. Conclusions

This paper aims to explore the opportunities of scaling up an ultrasound technique applied to virgin olive oil extraction plants. Many encouraging results have been demonstrated the goodness of the idea to perform an ultrasound treatment on olive paste, transforming the current malaxing batch process in a real continuous process. The social, economic, and environmental consequences of an innovative process are an integral part of the cost and benefit analysis. Also if the benefits of the employment of an energy saving technology cannot always be estimated easily, examining the SWOT analysis it is clear that this innovation can be successful because the benefits are major than the costs. The SWOT analysis confirms the applicability of this innovative technology to a full scale plants, and some hypothesis about the design of a new device which should overcome traditional malaxer have been proposed.

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INFLUENCE OF AGROECOLOGICAL FACTORS ON THE BIOLOGICAL VALUE OF SELECTED VEGETABLE SPECIES

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Keywords: vegetable, agronomic factors

1. Introduction

Agronomic factors, environmental conditions and genetic features of species affect the structure and yields of vegetable crops as well as their biological value. One of the key factors influencing the amount and quality of the crop is a soil, its type, acidity, and richness in macro-and micronutrients. The production of vegetables should be located on soils of high microbial culture. Temperature and precipitation during the growing season are the climatic factors, the variability of which has the greatest impact on yield of vegetables and their biological quality. For the growth of a plant, the proper temperatures at certain stages of its development are also required [Poniedziałek, Stokowski 1997]. Important issues in the cultivation of vegetables are pests and diseases. When they are not controlled they destroy on average 30% of vegetable crops and impair their quality. Plants infected by pathogens and pests contain substances harmful to the health especially mycotoxins secreted by fungi. A proper protection of plants can significantly improve the biological value of crops. Intensive research on the protection of vegetables is carried out [Mrówczyński, Wachowiak 2006]. Another problem is the contamination of soils. In industrial areas elevated concentrations of heavy metals, mostly zinc, copper, iron, lead and cadmium, have been observed. Heavy metal concentrations exceeding their permissible limits are found in vegetables coming from crops located near the emitters of these metals. Heavy metals present at excessive concentrations in the nutrient medium have destructive impact on plant organisms at various levels. Water stress caused by an excess of metals is the beginning of all other abnormalities observed in plant physiological processes and metabolism. Water stress and hence reduced transpiration may indirectly affect the photosynthesis by reducing the level of CO_2, which is available for this process. Plant photosynthetic system is particularly sensitive to heavy metals. The light is one of the most important environmental factors determining the processes of morphogenesis and influencing the crop yield and quality. It affects both the plant growth and photosynthesis process. The reduction in light intensity causes the etiolation of shoots, weak or lack of flowering, which consequently leads to the decrease in crop yield. The amount and intensity of the light at the end of the ripening period has a

considerable effect on the content of ascorbic acid. The cultivation of vegetables creates a need for continuous enrichment of the soil with micro and macroelements [Ociepa-Kubicka, Ociepa 2012; Sady, Smoleń 2004]. Their availability determines the yield and quality of crops, is responsible for vegetable health and resistance to pests and diseases, and their normal development. Nitrogen fertilization induces an increase in nitrate concentration, and consequently an increase in the content of very harmful nitrite in vegetables. However, this effect is clearly dependent on the species and harvest time. Increased doses of nitrogen fertilizer reduce the level of vitamin C in potato tubers. At extremely high doses of nitrogen (200 kg N / ha) the decrease in vitamin C content by 30 % in the comparison to the control tubers is observed. High doses of potassium may also reduce the vitamin C content. Phosphorus fertilizer does not affect ascorbic acid level. Of all nutrients plants take the largest quantities of potassium. It plays three main functions in the plant: it regulates water balance, is an activator of more than 60 enzymatic reactions and increases the resistance of plants to various abiotic and biotic stresses. Potassium deficiency leads to the increase in the content of nitrogen, calcium and magnesium, and potassium excess results in phosphorus content increase and significant reduction of the content of calcium and magnesium. Potassium ions play a balancing role in the transport of NO_3^- ions, and activate protein synthesis. In the absence of potassium simple nitrogen compounds, including toxic nitrosamines, accumulate in plants [Rożek 2000].

2. Conclusions

The content of macro- and micronutrients is dependent on the amount of rainfall, soil conditions, applied agricultural technology and plant variety.

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THE COMPARISON OF THE NOZZLE INSPECTION METHODS: NOZZLE FLOW VS. SPRAY TRANSVERSE DISTRIBUTION - THE METHODOLOGY AND THE FIRST RESULTS

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Keywords: nozzle inspection, nozzle flow, transverse distribution, methodology

1. Introduction

Polish national procedure for the inspection of field crop sprayers in use allows two methods of evaluation of the nozzles working during the inspection of the field crop sprayers. Only three countries (Poland, Portugal and Sweden) use both methods (measurement of nozzle flow and transverse distribution) [Wehmann 2012]. Measuring only nozzle flow is carried out in four countries, and in the majority of countries only measurements of the transverse distribution of the spray are carried out, with the coefficient of variation CV% as a measure of accuracy.

The comparison of the nozzle inspection methods have not been carried out in a direct way. Therefore, it is not known which of these methods is more rigorous, and if both methods could achieve the same results. In order to compare the stringency and time-consuming of both inspection methods, the methodology of comparative tests have been elaborated.

2. Materials and methods

The elaborated methodology [Godyń 2013] describes how to compare and criteria for the evaluation of methods of inspection nozzles in field crop sprayers.

In all studies, three types of Lechler nozzles were used (utilized before for less than one hour) flat fan standard (LU 120-03) at 3 bar, flat fan air-injector (ID 120-03) and Twin flat spray air-injector compact nozzles (IDKT 120-03) at 4.5 bar. During the tests the electronic spray patternator SPRAYER TEST 1000 (PESSL Instruments, Austria) have been used. The trials on the groove patternator (STABEN - "mechanical") are planned to be done soon. The nozzle flow has been measured by SCHACHTNER (set of 20 scaled burets of nominal capacity 2000 ml and accuracy 20 ml) and ball flow-meter LURMARK.

For each of the method the time of removing and assembling nozzles or changing positions of nozzle bodies was measured and assumed as a common time for further calculations. For each of the evaluated method the

time of each action was measured and the results of the study during the test were noted (CV%, mean nozzle flow rate, the number of the burets with 15% deviation from the mean and each nozzle flow rate). The gathered data allows the calculation of average time of the inspection of one nozzle depending on the type of the nozzle and the method used as well as binary and linear assessment of the test result.

The binary assessment expressed if the sprayer/nozzle inspection would be passed or not. The linear assessment expressed a percentage of fulfill the inspection criteria (e.g. CV% or the maximum deviation from the nominal value of nozzle flow rate).

Example: For limit value of CV% or flow rate deviation = 10% (linear assessment = 100%):

- *if measured CV% / deviation = 5% - the binary assessment is 1 (passed), the linear assessment is 50%*
- *if measured CV% / deviation = 15% – the binary assessment is 0 (not passed / failed), linear assessment is 150%.*

The comparison of the means for the linear assessments obtained for each nozzle type or inspection method answers whether the compared methods are equally "rigorous".

The repeatability of measurements was evaluated using the coefficient of variation for repetitions and by the statistical analysis (the “weight” of the factor "Repetition").

3. Results

The measurements of the transverse distribution uniformity were done by means of the electronic patternator SPRAYER TEST 1000 for the field crop sprayer Krukowiak with the 12 m long boom. The most uneven transverse distribution of the spray was measured for standard nozzles LU-120-03 (mean binary assessment = 0, all repetition failed; mean linear assessment = 104.55%) and the most equal for the air-injector ID-120-03 nozzles (binary = 1; linear = 64.08%). The CV% value for the first repetition of the IDKT nozzles (10.74%) clearly differed from three others (< 8.8%), therefore binary assessment achieved 0.75 (one failed) and linear one = 92.00%. A possible reason for such a difference was elimination of the spraying on to the spray line by one of the nozzles, noticed after the first measurement.

The average time of a single measurement (one position of a scanner) for standard nozzles was 36.5 seconds in comparison to 32.6 seconds for the air-injector nozzles. The mean test time of a single nozzle depended on the flow rate of the nozzle and the flow was pressure dependent. In this study, the 3.0 bar pressure was used for the standard and 4.5 bar for the air-injector nozzles (acc. to the Regulation of Ministry of Agriculture concerning sprayers inspection).

Average time of the assembling one nozzle was 29.06, 12.53 for disassembling and 1.53 seconds for rotating a nozzle body. The results of measurements will be used to simulate full inspection time for the method with all nozzles removed from the boom and/or for booms longer than 12 m or equipped with more than one set of the nozzles.

4. Conclusions

When the study will be finished it will be possible to answer which inspection method is more time-consuming or more restrictive. Preliminary analysis of the data obtained for a single measurement method shows the significance of a nozzle type in the final assessment of the evaluated method. Research goes on.

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TENSILE AND IMPACT PROPERTIES OF THIN FILM MADE FROM THERMOPLASTIC STARCH

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Keywords: thermoplastic starch, tension, impact properties

1. Introduction

The serious environment pollution due to the usage of packaging materials encourages producers to look for environmental friendly solutions. Most of researches are focused on oil substitute – based plastics by biodegradable materials. Starch is completely biodegradable in soil and water. It is also very cheap and possible to extract from many natural sources like potatoes, corn, rice or rye.

The thermoplastic starch is obtained after disruption of crystal structure of macromolecules by using high temperature and pressure [1].
These features testified that starch is one of the most promising raw materials for production of elastic and rigid packaging.

In order to use this material, it must meet the requirements of clients and producers with regards to static, dynamic, creep and stress relaxation strengths and other material properties.

Starch can be processed to mouldable thermoplastic form at high temperatures under shearing force loading. During processing the semicristaline structure is lost and molecules partly depolymerized. To improve elasticity and other mechanical properties, some cold plasticizers, like glycerol, alcohol, glucose and others, could be add during processing [2]. The aim of this work is to study different thin film strength parameters obtained from tensile and impact test.

2. Material and methods

Thermoplastic starch foils were prepared by the extrusion method with the film by blowing method from starch granulates. The main component of starch granulate was potato starch mixed with glycerol. It was done by the extrusion cooking process. Additionally, two kinds of additives were used: polyvinyl alcohol and keratin. Four different extruder screw rotation, ranging from 40 rpm to 70 rpm, were used. Samples were stored for two days in room at solar light, temperature 21^{o} C and three values of relative air humidity: 55%, 91% and 99%. Fresh and stored samples were tested under tensile and impact loading conditions.

3. Results

Some selected results of investigations are presented below.

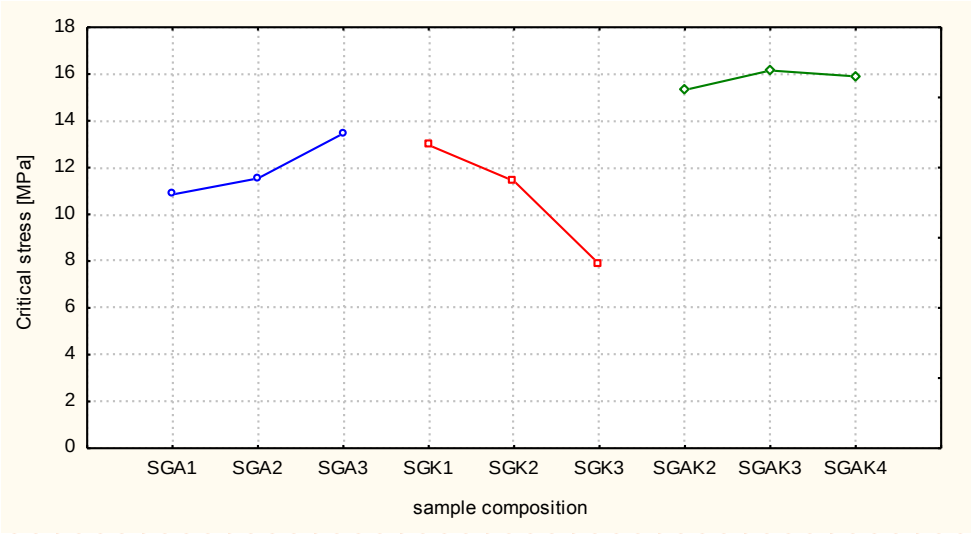

Figure 1. Influence of sample composition on mean values of Young modulus

Symbols mean: SG – potato starch with 20% glycerol, A1, A2, A3 additive of polyvinyl alcohol in amount of 2%, 5%, and 10%. K1, K2, K3 – additive of keratin in amount of 0,5%, 1,0%, 1,5%. AK1 – two additives 1% of polyvinyl alcohol and 1% keratin. AK2 – 2% of polyvinyl alcohol and 1% keratin. AK3 – 3% of polyvinyl alcohol and 1% keratin.

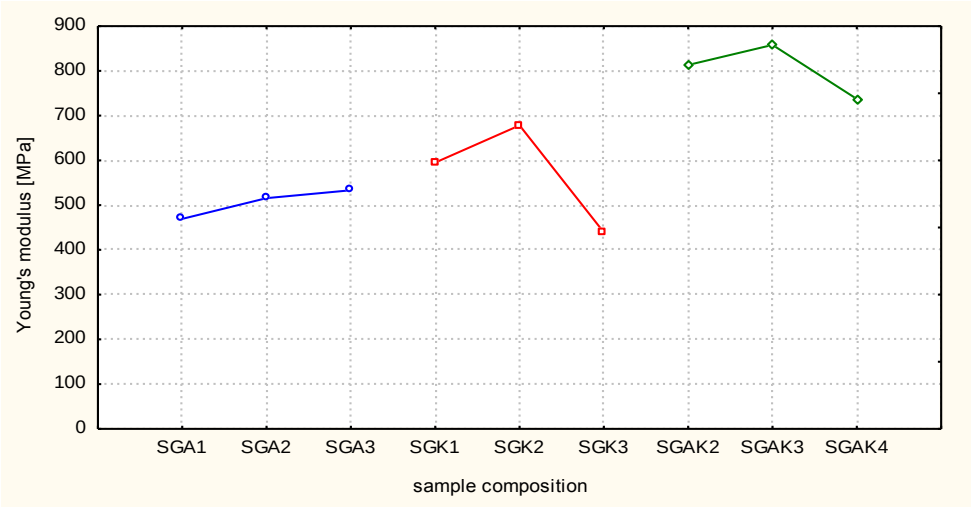

Figure 2. Influence of sample composition on critical stress

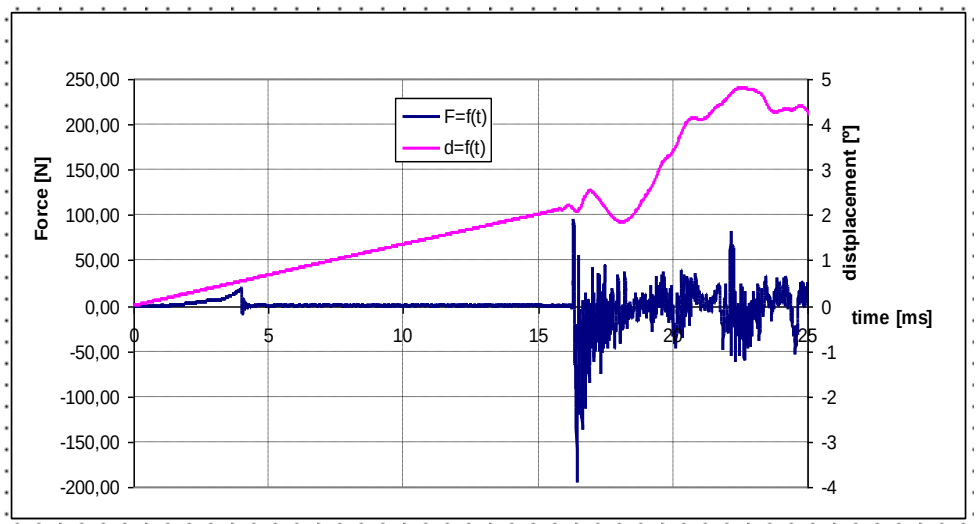

Figure 3. Force response and impactor displacement in terms of time for SGAK 2 sample starch 55% of air relative humidity.

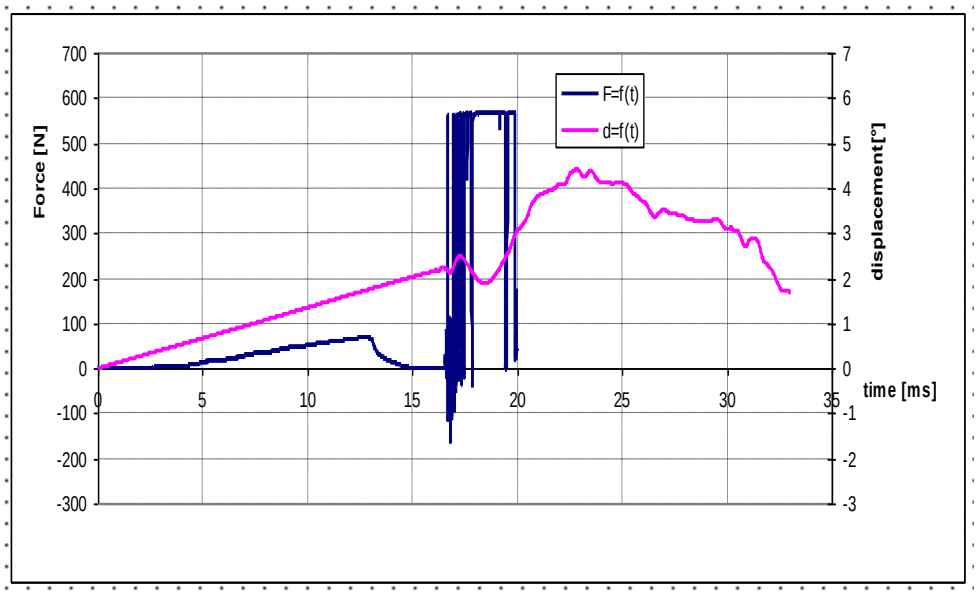

Figure 4. Force response and impactor displacement in terms of time for SGAK 2 sample stored in 91% of air relative humidity.

4. Conclusions

Results of experimental showed that additives have strong influence on mechanical properties of samples. The value of Young modulus for samples with polyvinyl alcohol and keratin was higher than for samples with only alcohol or keratin. Simultaneously, for that sample composition the highest

value of critical stress on the lowest value of critical strain were obtained. It could imply that mixture of additives make film more crispy. In tensile test was started that sample failure tool place reader after exceeding the constant value of strain but not stress. Ambient air humidity had also strong influence on mechanical properties in all tests. The samples stored at higher relative air humidity were characterized by the low value of Young modulus and critical stress but high value of critical strain. The samples with the additives of polyvinyl alcohol shored larger resistance to cracking during impact than other samples.

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ANALYSIS OF STUDENTS' MOTIVATION AND PREDISPOSITION FOR INTRODUCING INFORMATION TECHNOLOGY TOOLS FOR TEACHING MATERIALS SCIENCE

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Keywords: materials teaching, educational software, CES EduPack

1. Introduction

The phenomenon of systematic worsening of learning outcomes of Materials Science among students of Agricultural and Forestry Engineering, Management and Production Engineering, Transport, Environmental Engineering and Safety Engineering at the University of Life Sciences in Lublin, became the motivation to implement the computer methods in materials selection. The best educational software applied to different levels of education is Cambridge Engineering Selector - CES EduPack developed at the University of Cambridge. Previous studies on the use of IT by students of Agriculture show their good IT skills and widespread use to search for information on the internet [Lorencowicz, Kocira 2009, 2010, 2012], [Sołowiej, Nalepa, Neugebauer 2007]. Teachers doubt about the computer skills of students and their knowledge of English.

2. Material and methods

The purpose of the analysis was to check the motivation and predispositions of students for learning Materials Science with application of computer software in English. Surveys were carried out in a group of 221 students of Agricultural and Forestry Engineering, Management and Production Engineering, Transport, Environment Engineering and Safety Engineering at the University of Life Sciences in Lublin. The survey included 17 questions about the level of English, computer skills, motivation to learn Materials Engineering, use of IT in the classroom, access to computer at home and personal questions.

3. Results

The analysis shows that 56% of the students assessed their computer skills as good or very good (Fig. 1) and 62% of them correctly answered the survey questions about computer skills (Fig. 2).

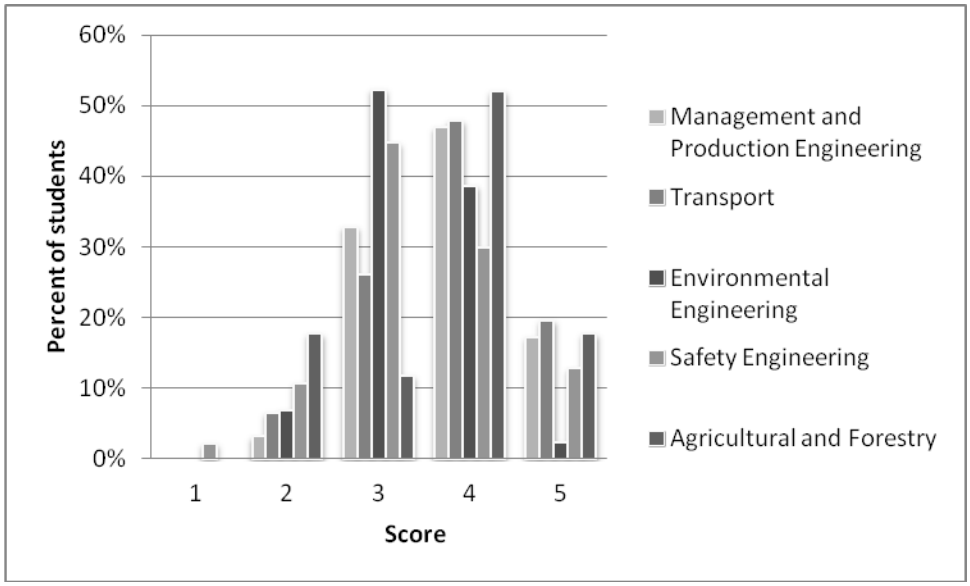

Figure 1. Subjective assessment of computer skills.

The highest score was in group of Agricultural and Forestry Engineering as 70% of them assessed their computer skills as good or very good. Only 55% of this group answered correctly the questions while 70% students of Environmental Engineering answered correctly.

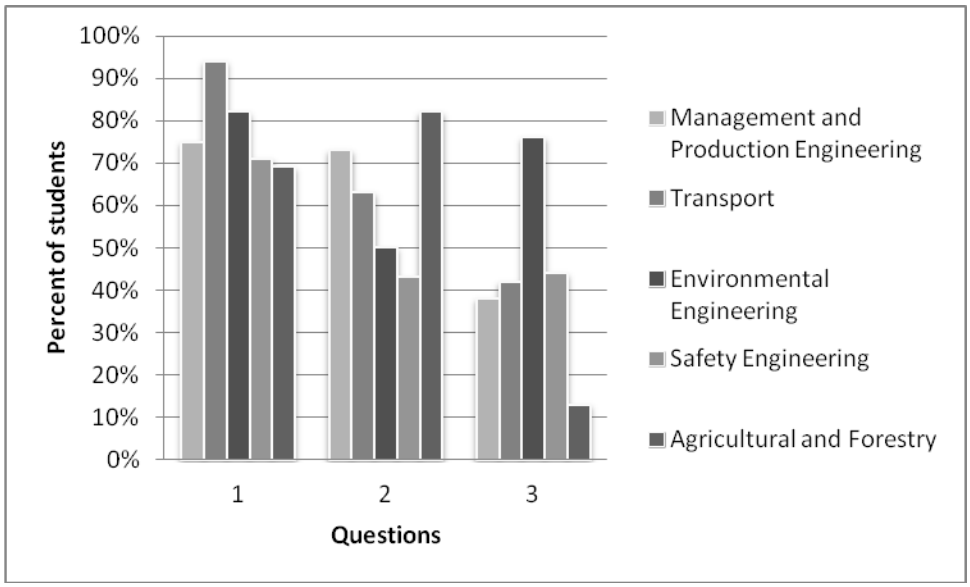

Figure 2. Correct answers to the questions of computer skills.

Seventy-five percent of students are also interested in learning about materials selection by using the computer, but where the language of

software is English only 30% would like to participate in classes (Fig. 3). Only 1 student of Agricultural and Forestry Engineering said "yes" and 41% of this group said "I do not know".

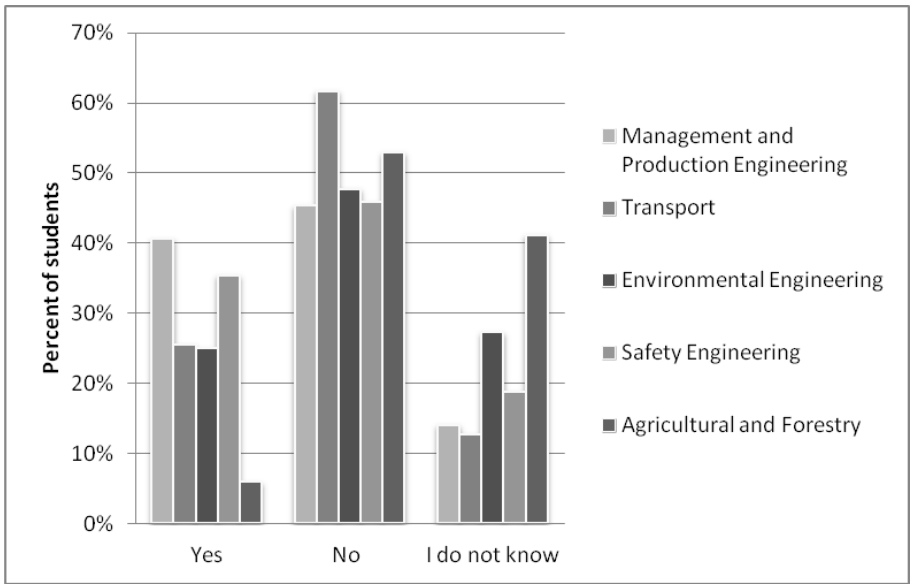

Figure 3. Students who want to use a computer program in English to learn Materials Science.

Students had doubts about understanding information in English and 71% of them assessed their English at 3 (out of 5) or worse (Fig. 4).

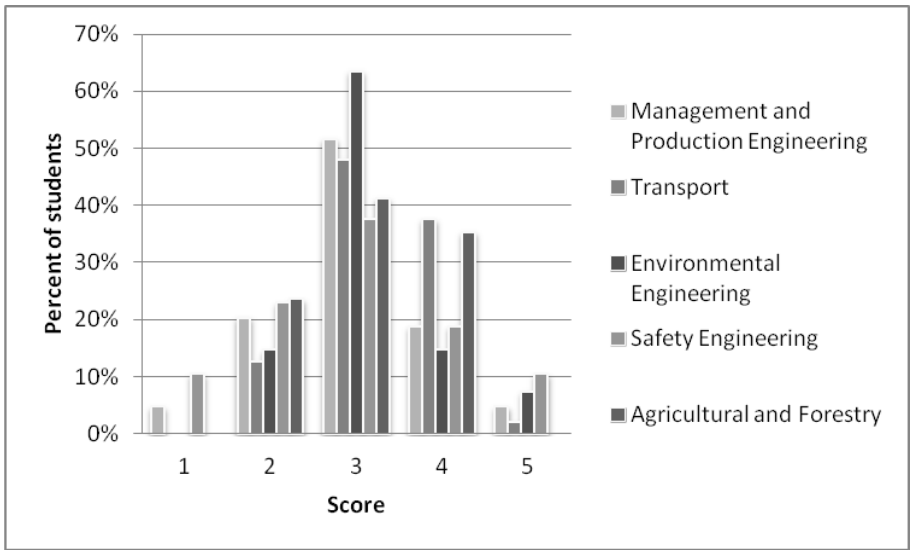

Figure 4. Subjective assessment of English.

4. Conclusions

The study shows that over 55% of students assessed their computer skills as good or very good and correctly answered the questions. Students are interested in the subject of materials science, but only 30% of respondents would like to use computer program in English in learning. Students assessed their English at medium or lower level and were concerned that they did not understand the message. This points to the need to experimental verify the accuracy of the concerns of respondents, and when confirmed, to take remedial action.

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APPLICATION OF GREEN ALGAE AND CYANOBACTERIA SECONDARY METABOLITES IN CORN BIOMASS FOR ECO-ENERGY PRODUCTION

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Keywords: microalgae, *Cyanobacteria*, corn, plant growth, metabolic activity

1. Introduction

Literature data indicate that diazotrophic *Cyanobacteria* and microalgae can have beneficial influence on higher plants growth and development. Plant growth can be stimulated not only due to additional dose of atmospheric nitrogen supplied by diazotrophic *Cyanobacteria*, but also by a wide spectrum of organic compounds, including plants hormones, amino acids, extracellular polysaccharides, proteins and others, which are synthesized by these organisms. Microalgal and cyanobacterial strains affected the several physical and physiological properties of soil and plants and also influence on number and composition of other microorganisms. There is an increasing worldwide interest in the use of *Cyanobacteria* and microalgae for improving plant development, although there is only a small amount of data on this subject [Karthikeyanb et al. 2007; Grzesik, Romanowska-Duda 2009; Tan et al. 2010].

The aim of the presented research was to test the influence of green algae *Chlorella* sp., and Cyanobacteria: *Anabaena* sp. PCC7120 and *Microcystis aeruginosa* MKR0105 strains, applied to leaves, on growth and some physiological properties of corn plants.

2. Material and methods

Influence of three preselected monocultures: *Anabaena* sp. PCC7120, *Microcystis aeruginosa* MKR0105 (*Cyanobacteria*) and *Chlorella* sp. (green algae) on growth of corn (*Zea mays* L.) plants, cultivated in pots, was tested in the presented research. The plants were cultivated outside in container area, in 3 liter pots filled with the low quality soil and fertilized once with 1.0; 0.5 and 0.0 g/pot of YaraMila Complex (Yara International ASA), consisting all the micro and macro elements necessary for growth. The mentioned above green algae and *Cyanobacteria* strains were applied to corn plants three times, in three week interval during vegetation, as the cells re-suspended in water (500 000 cells x ml^{-1}). The first spray was made when the plant were 15 cm in height. The method of plant spraying with no damaged cells and re-suspended in water was chosen on the base of previous

experiments. They indicated that plant treatment with not damaged monocultures were slightly more beneficial than spraying of plants with the cells water homogenates and solutions (at doses of 1, 10 and 100 ppm) made from lyophilized, not homogenate cells [Grzesik et al. 2013; Pszczółkowska et al. 2013; Romanowska-Duda et al. 2013].

Height of plants, total shoot length, index of chlorophyll content SPAD and photosynthesis activity (net photosynthesis, stomatal conductance, intercellular CO_2 concentration, transpiration), were evaluated every four weeks during the vegetation. Activity of acid (pH 6.0) and alkaline (pH 7,5) phosphatase, total dehydrogenase, nitrogen reductase and electrolyte leakage from leaves were measured once during growing season.

3. Results and discussion

All three monocultures: *Microcystis aeruginosa* MKR0105, *Chlorella* sp. and *Anabaena* sp. PCC7120, applied as triple foliar sprays, significantly stimulated the growth and development of corn plants and also intensified selected metabolic processes. Effects of applications varied slightly depending on green algae and *Cyanobacteria* species and considerably on level of plant fertilization.

All the treatments significantly increased growth and biomass of corn plants, as to compare to control. Spraying the plants with monoculture of *Microcystis aeruginosa* MKR0105 was slightly more beneficial in increasing growth than with *Anabaena* sp. PCC7120 and *Chlorella* sp.. The more intensive growth was associated with the increased physiological activity in plants. The used green algae and *Cyanobacteria* increased activity of acid (pH 6,0) and alkaline (pH 7,5) phosphatase, total dehydrogenase, photosynthesis (net photosynthesis, stomatal conductance, intercellular CO_2 concentration, transpiration), index of chlorophyll $_{a+b}$ content in leaves and decreased cytomembrane permeability (electrolyte leakage).

The applied doses of complex fertilizer YaraMila greatly influenced the plant growth and its biomass production. Corn fertilized with a dose of 1g/pot was the highest, and the lowering fertilizer dosages down to 0.5g and 0.0g/pot decreased plant height and their biomass respectively. Applied monocultures of green algae and *Cyanobacteria* caused the intensification of plant growth, independently of level of fertilization. Although, the higher increase in biomass production was in case of plant fertilized with 0.5g YaraMila/pot, slightly lower with 1g and much lower when the fertilization was not used.

The results show a great potential of *Microcystis aeruginosa* MKR0105, *Chlorella* sp. and *Anabaena* sp. PCC7120 as a new source of bio-fertilizers and bio-stimulating chemicals for growth stimulation of corn plants under condition of optimal fertilization and also in case of lower content of macro

and micro elements in soil. This indicate that ecological application of the evaluated monocultures of green algae and *Cyanobacteria* can reduce the amount of the used synthetic fertilizers, helping to minimize contamination of the environment and simultaneously it improves the corn plant growth and their biomass for eco-energy production.

4. Conclusions

Suspended in water monocultures of *Microcystis aeruginosa* MKR0105, *Anabaena* sp. PCC7120 (*Cyanobacteria*) and *Chlorella* sp. (green algae), applied as triple foliar sprays, significantly stimulated the growth and development of corn plants, and also intensified selected metabolic processes, independently of the level of used synthetic fertilizers. Ecological application of the evaluated monocultures of green algae and *Cyanobacteria* can stimulate corn biomass for eco-energy production and reduce the contamination by synthetic fertilizers in the environment.

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OPERATING COSTS OF FIXED ASSETS USED IN THE HOP PRODUCTION

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Keywords: hop production, fixed assets, operating costs

1. Introduction

By the end of the twentieth century, Poland was the fifth largest in the world and the third largest in Europe hop producer and the situation on the hop market was developing fairly favourably [Zaorski 2002]. Since 2001 the position of Poland as a hop producer has been falling, and the hop area has been constantly decreasing. In addition, frequent difficulties with selling the raw hop material have been occurring. Even those growers who own high-yielding plantations and sell the raw hop material without much difficulty, rarely decide to increase the acreage.

2. Material and methods

Hop production is a specialized production and requires the layout of substantial financial resources for the infrastructure that consists, among others, of the hop field, hop dryer and heater, humidifier of dried hop and a hop storehouse. In hop growing specialized machines are used, such as: stationary hop harvester, hop platform, bine cutter, hop cultivator, specialized sprayer and a packing press [Migdal, Zaorski 1996]. Hop farmers incur direct costs and indirect costs such as: depreciation, interest on capital, insurance and storage costs that translate into high annual costs borne by the hop grower to maintain in operation the fixed assets on the farm. Hop production is also very labour-intensive, especially in times of workload such as spring work on the plantation and hop harvesting.

The aim of this work is to isolate groups of the fixed assets used in hop production, conduct an economic analysis and assess the cost of exploitation of fixed assets on the hop farm [Hołaj, Zaliwski 1999].

3. Results

Fixed assets are property production elements and are directly involved in the processes of hop production. In the current hop market situation in Poland, hop growers rarely make farm investments to modernize the existing capital assets and those investments that are made have a limited scope. In accordance with the financial requirements fixed assets can be divided into the following groups [Hołaj 2008]:

- arable lands, along with the hop field construction,
- farm buildings and facilities,
- machinery and technical devices,
- means of transport,
- other fixed assets.

It is assumed that as fixed assets the property production elements of value exceeding 3 500 PLN are considered.

4. Conclusion

Over recent years the unit prices of the hop-production fixed assets mentioned above have been increasing systematically, while the prices of raw hop material have been stagnating. This led to a general decrease of the profitability of hop production.

Prices of selected fixed assets were acquired from the documentation of the Agricultural Experimental Station "JASTKÓW" Ltd. – a hop farm with 60 years of tradition, counted among the largest hop producers in the country.

5. References

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BEST MANAGEMENT PRACTICE TO REDUCE SPRAY DRIFT IN FIELD CROPS

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Keywords: spray drift, field crops, spray boom, liquid pressure, boom height

1. Introduction

Spray drift is a major environmental problem when applying pesticides in agriculture. It poses risk of environmental contamination, may damage neighboring crops, reduce control efficacy and hence lead to economical loss for the farmer [Nuyttens et al, 2011; Holownicki et al., 2006; D., Van de Zande et al., 2005]. In recent years many different spray drift reducing techniques (SDRT) were developed and implemented in practice. The implementation of the SDRTs requiring investment in new equipment may be very costly; however, there are also available low-cost methods of drift mitigation based on application of coarse spray, less prone to drift. Use of air-inclusion nozzles is one of the most effective ones, though it still costs money. Meanwhile a great potential of drift reduction, very often ignored by the applicators, is still in sprayer adjustment as recommended by best management practice (BMP), including lowering the boom height, decreasing spray pressure, slowing down travel velocity or increasing nozzle size.

The objective of the presented study was to determine the effect of spray application parameters of field crop sprayer, adjusted according to BMP rules, on spray drift. The obtained results may be used for classification of such adjustments as SDRTs.

2. Material and methods

In the field experiment a reference field crop sprayer was used (12 m boom; flat-fan nozzles 120-03). The effect of boom height and liquid pressure during spray application in field crops were evaluated according to the ISO Standard 22866 [ISO, 2005]. The sedimentation drift was measured 30 m downwind from the grass field sprayed with water solution of fluorescent tracer Brilliant Sulfo Flavine (BSF) at a concentration 0.3% (Fig. 1). The treatments were carried out at travel velocity 6.0 $km \cdot h^{-1}$ as combination of three boom heights (0.35; 0.5; 0.75 m) over the field and three spray pressures (0.15; 0.3; 0.5 MPa). Ground deposit was measured on horizontal collectors made of synthetic filter cloths, of 0.1x1.0 m, placed on

the downwind edge of the field. The collectors were placed in four lines (replications) at distances 1, 2, 3, 4, 5, 7.5, 10, 15, 20, 25 and 30 m from the last nozzle. The spray was applied 5 times on the area 60 m long and as wide as the sprayer boom. After the treatment the collectors were washed down and the BSF concentration in the extracted liquid was measured by spectrophotometer (Perkin Elmer LS 55). Meteorological conditions were recorded during the spray drift measurements.

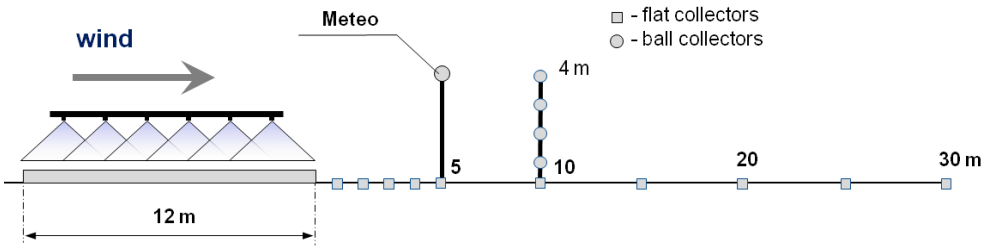

Fig. 1. Layout of experiment.

3. Results and conclusions

The results confirmed a previous study reporting significant influence of boom height on spray drift [Nuyttens et al., 2007]. The treatments with the boom height 0.35 m reduced drift by 50% compared to the standard recommended height 0.5 m (Fig. 2).

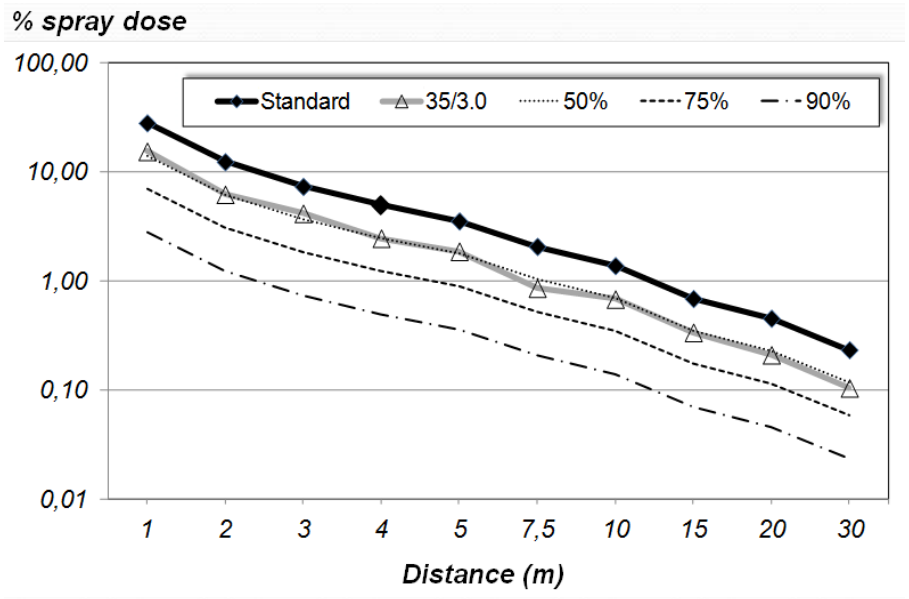

Fig. 2. Sedimentation drift – flat fan nozzles LU 120-03, spray boom height 0.35 m

However, the significant increase of spray drift by 75% was measured for boom height 0.75 m and liquid pressure 0.3 MPa at average wind velocity 2.4 m/s. The decrease of spray pressure from 0.5 to 0.15 MPa decreased by 50% the spray volume deposited on the downwind non target area (Fig. 3).

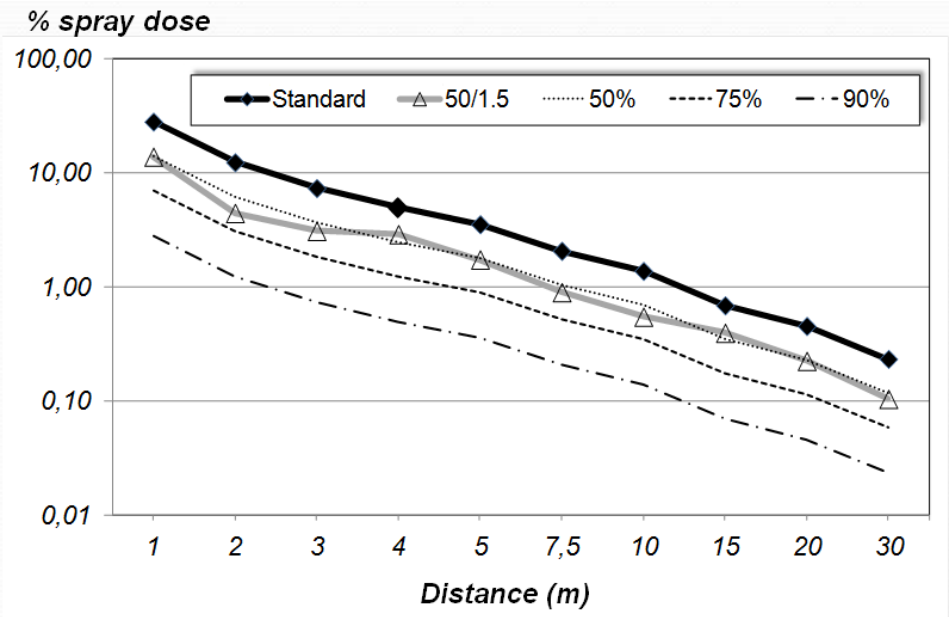

Fig. 3. Sedimentation drift – flat fan nozzles LU 120-03, pressure 0.15 MPa.

The combination of boom height 0.35 m and low pressure 0.15 MPa resulted in spray drift reduction by almost 75%. The results showed that proper adjustment of sprayer as recommended by Best Management Practice can be considered as an inexpensive and very effective method of spray drift reduction. The effect of drift reduction may be enhanced by simultaneous modification of more than one parameters.

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STUDY OF THE PRECISION OF THE GUIDANCE SYSTEM AUTOTRAC FROM JOHN DEERE – PART 1: MATERIAL AND METHOD

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ABSTRACT

The main objective of the study was to determine the actual precision of the AutoTrac Guidance System according to different correction signals proposed in Belgium by John Deere: StarFire 1 (SF1), StarFire 2 (SF2) and RTK. The second objective was to observe the evolution of this precision in function of the return time between two passes in the field. Finally, the study aimed at fixing the limits of use of each correction signal. A theoretical case (specific tool especially designed for the trials) and a practical case (precision seeder for sugar beet) were studied on fully equipped tractor John Deere 6830. The observed precision of the correction signals was equal or better than the one announced by the manufacturer.

Keywords: GNSS, guidance system, tractor, actual precision, Belgium

1. Introduction

The use of guidance systems by satellites experiences an increasing demand from farmers. Automated steering also interests farmers more and more because it largely facilitates control on field and improves comfort of the operator as well as the precision of work.

Principal works for which automated steering is strongly required are the sowing and the plantation of traditional cultures like cereals, corn, beets and potatoes (Freycon, 1996). The precision sought for this work varies from 1 to 10 centimeters pass to pass according to the culture but also according to the working width of the tool. The possibility of increasing the daily working period by carrying out work in night condition plays a considerable part in the choice of this system (Dana, 2000).

The Research Unit Agricultural Machines and Facilities underwent a study in collaboration with Cofabel, the Belgian importer of John Deere, on the Guidance System AutoTrac.

The main objective of the study was to determine the actual precision of the Guidance System AutoTrac in function of the different correction signals proposed in Belgium by John Deere: StarFire 1 (SF1), StarFire 2 (SF2) and RTK. By actual precision of the Guidance System, we understand, the working precision of the machine measured directly in the field. Therefore

the actual precision can be considered as the global driving precision of the combination tractor-machine that the user could obtain (Huyghebaert et al, 2007). The second objective was to observe the evolution of this precision in function of the return time between two passes in the field. The return time was the necessary time to go from one point in a parcel to the edge of the field and come back. This time was a function of the field length and could influence the driving precision of the guidance system (Adamchuk and al, 2008; Beguyot et al, 2004). Finally, the study aimed at fixing the limits of use of each correction signal with the AutoTrac.

2. Material and methods

2.1 Vehicle and Correction Systems

The equipment used during the trials are one tractor John Deere 6830 equipped with an integrated Guidance System AutoTrac, the new receptor STARFIRE 3000 and the interface GREENSTAR 2630. AutoTrac is a system of power-assisted steering allowing the operators to release the wheel while the machine (tractor, motorized vehicle…) follows the virtual guidance line. The new receiver STARFIRE 3000 is able to collect the signals from GPS and GLONASS constellations of satellites. The receiver accepts all the correction signals proposed by John Deere: SF1, SF2 and RTK. The tractor is mounted with "650/65" and "540/65" tires.

The 3 correction signals StarFire 1 (SF1), Star Fire 2 (SF2) and RTK, proposed by John Deere in Belgium, have been used and tested during the trials:

- Star Fire 1 (SF1) is a dGPS correction signal which has an announced precision of ± 30 cm pass to pass for 95% of the working time.
- Star Fire (SF2) is also a dGPS correction signal with an announced precision of ± 10 cm for 95% of the working time. This signal is subjected to a paying subscription.
- RTK correction signal has an announced precision of ± 2 cm. This system requires to invest in base station positioned near the field (< to 10 km).

2.2 Protocol and Method of Measurement

All the trials have been realized in the field in actual conditions. However, they can be divided in two parts: the "theoretical part" realized without machine and the "practical part" realized with a precision seeder for sugar beet.

For the "theoretical part", a specific tool especially designed for the trials (Huyghebaert et al, 2008) has been mounted on the three-point linkage of the tractor (Figure 1). This tool consists of a mono-disc of great diameter maintained in contact with soil by means of a spring system. The work of the

disc had no stabilization effect as the working depth was not greater than 5cm. The sideways movement of the three point hitch was locked using the provided John Deere blocks. The distance between two small furrows of adjacent passes reflected the actual precision of the Guidance System (Figure 1). The main parameters studied during the theoretical part of the trials were: the tractor speed (6 km/h), the working width (3 m), the correction signals (StarFire 1 and 2), the return time between two passes of the tractor (5 min, 12 min and 20 min), and the driving mode (straight or curved line) (Huyghebaert & Dubois, 2009). For each combination of the parameters, 4 return passes have been operated and 18 measurements of the actual distance between two passes have been realized through 3 repetitions. Finally 864 measurements were carried out for the various test configurations.

Figure 1. View of the mono-disc and the furrows in the field

The « practical part » of the study, has been realized with a farmer of the sugar beet seeding (working width of 2.70 m). The tested parameters were the guiding mode (straight line), the tractor speed (6 km/h) and the correction signals (StarFire 1, StarFire 2 and RTK). Time between two passes was function of the length of the field and can vary from 5 to 16 minutes. The parameters were less numerous because the farmer rules and constraints had to be followed. Finally it was possible to produce 180 measurements for the SF1, 296 measurements for the SF2 and 99 measurements for the RTK correction signal. Spacing measurements were taken between the first sowing line and the last sowing line of the previous pass (Huyghebaert et al, 2008) (Figure 2).

The farmer used a combination of machines: on the front side of the tractor a roller tiller and a light cultivator, on the back side of the tractor, a rotary tiller followed by the mechanical seed drill. To avoid an unspecified slip of the back machines, the arms of the lifting device were blocked.

Figure 2. View of the back side of the tractor with the seed drill and the spacing measurement

3. Conclusions on the Part 1

The material specially developed for the "theoretical part" (mono-disc, see figure 1) allows generating measurement of the working precision of the guiding system in actual conditions. Even the trials named "theoretical" have been realised in field, in real conditions taking into consideration the actual environment that the user have usually to face. In this way, the results give really the actual precision of the guiding system and correction signal.

The "practical" part has been realised directly with a user during the sugar beet seeding campaign. This series of trial allow validating the results obtain during the "theoretical" part and also to learn about the problems the user has to face when using such guiding system in a practical way.

The results of the trial are described in the part 2.

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STUDY OF THE PRECISION OF THE GUIDANCE SYSTEM AUTOTRAC FROM JOHN DEERE – PART 2: RESULTS AND DICUSSIONS

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ABSTRACT

The main objective of the study was to determine the actual precision of the AutoTrac Guidance System according to different correction signals proposed in Belgium by John Deere: StarFire 1 (SF1), StarFire 2 (SF2) and RTK. The second objective was to observe the evolution of this precision in function of the return time between two passes in the field. Finally, the study aimed at fixing the limits of use of each correction signal. A theoretical case (specific tool especially designed for the trials) and a practical case (precision seeder for sugar beet) were studied on a tractor John Deere 6830 fully equipped. The observed precision of the correction signals was equal or better than the one announced by the manufacturer.

Keywords: GNSS, guidance system, tractor, actual precision, Belgium

1. Introduction

The problem has been introduced in the part 1. The material and the methods developed for the realization of the trials have been also described in the part 1.

All the trials have been realized in the field in actual conditions. However, they can be divided in two parts: the "theoretical part" realized without machine and the "practical part" realized with a precision seeder for sugar beet.

2. Results

The overall precision of a Guidance System depends on several factors as the precision of the signal, the configuration of the vehicle and the machines, the field and ground conditions. During the trials, these factors have been taken into consideration and optimized where possible.

3.1 Theoretical Trials with the mono-disc

The distance between each pass has been measured and compared to the theoretical width (3 m). The distribution of the distance between two passes permitted to characterize the precision of the AutoTrac system used in different ways.

The Table 1 gives the characteristics of the driving precision of the AutoTrack guidance system used in straight line mode of functioning. Each result corresponds to 72 observations.

Table 1. Characteristics of the straight line driving precision of the AutoTrack used with the correction signal SF1 and SF2, in function of the return time.

Return time (min)	5		12		20	
Correction signal	SF1	SF2	SF1	SF2	SF1	SF2
Average distance between two passes (m)	3.00	3.02	3.01	3.01	3.01	3.00
Mean of the absolute deviations from the theoretical distance (m)	0.04	0.04	0.06	0.04	0.09	0.03
Maximum observed deviation (m)	0.18	0.14	0.22	0.10	0.33	0.12
Maximum deviation for 95 % of the time (m)	0.13	0.11	0.13	0.09	0.24	0.07

The global precision of the guidance system was better or in accordance with the precision announced by the manufacturer. The maximum observed deviation for 95 % of the working time was lower than 30 cm for the correction signal SF1 and was around 10 cm for the SF2.
On average the results don't show a significant difference between the two signals of correction (SF1 and SF2). The average distance between two passes is practically the same for both signals whatever are the return times.
However the mean of the absolute deviations, the maximum observed deviation and the maximum deviation for 95% of the working time increase with the return time for the correction signal SF1 and remain constant for SF2.

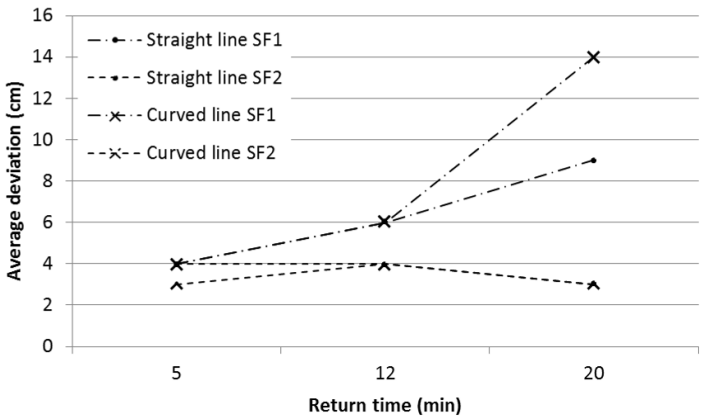

Figure 1. Evolution of the average deviation of the AutoTrack guidance system used with the correction signal SF1 and SF2, in function of the mode of functioning and the return time.

The results obtained in curved line mode of functioning underwent the same analysis and shows the same trends. However, the mean of the absolute deviations increases more in function of the return time for the curved line mode than the straight line mode (Figure 1).

3.2 Practical Trials during Sugar Beet Sowing

The working width of the drill seeder was 2.70 m. The three correction signals (SF1, SF2 and RTK) have been tested. As the trials have been realized in practical conditions, the return times differ from one correction signal to another.

As the precision of the SF1 correction signal was lower, the farmer used the tracers of the seeder to visualize when the AutoTrack guidance system left the right trajectory. When the tractor deviated more than 10 cm from the right trajectory, the farmer took back manually the control, replaced the tractor in the right track and recalibrated the guidance system. Two parcels of different length (350 m and 600 m) have been sowed using SF1 as correction signal. It allowed generating on average two different return times (10 min and 16 min). The results of the precision given by the guidance system using SF1 correction signal during sugar beet sowing are given in the table 2.

Table 2. Guidance precision of the AutoTrack used with the correction signal SF1, in function of the return time (practical trials – sugar beet sowing).

Average return time (min)	10	16
Mean of the absolute deviations from the theoretical distance (m)	0.05	0.08
Maximum observed deviation (m)	0.15	0.20
Maximum deviation for 95 % of the time (m)	0.12	0.16

As observed during the “theoretical trials”, the deviations tend to increase with the return time. The maximum observed deviation and the maximum deviation for 95 % of the time seem to be lower, but these results are non-comparable to SF1 results of the “Theorical trials”, due to the regular recalibration that the farmer had to proceed during this work. These interventions are supposed to produce a too optimistic pass to pass accuracy for SF1.

The trials realized with the correction signal SF2 didn’t ask to recalibrate the system. Also two parcels of different length have been sowed permitting to generate on average two different return times (12 mm and 16 min). The results of the precision given by the guidance system using SF2 correction signal during sugar beet sowing are given in the Table 3.

Table 3. Guidance precision of the AutoTrack used with the correction signal SF2, in function of the return time (practical trials – sugar beet sowing).

Average return time (min)	12	16
Mean of the absolute deviations from the theoretical distance (m)	0.04	0.04
Maximum observed deviation (m)	0.15	0.16
Maximum deviation for 95 % of the time (m)	0.08	0.11

Ninety percent of the observed deviations are within the range of ± 5 cm whatever the time between two passes is. Considering 95 % of the time, the maximum observed deviations reach ± 8 cm and ± 11 cm following the return time. For the rest of the time (5%), the observed deviations never exceed ± 9 cm and ±12 cm respectively for a return time of 12 and 16 minutes.

The RTK correction signal allows for centimetric accuracy. Before the trials (24 hours), the RTK base station has been located at the edge of the field so as to reach a high precision. The field was shorter and allows generating only a return time of 5 minutes. The results of the precision given by the guidance system using RTK correction signal during sugar beet sowing are given in the table 4.

Table 4. Guidance precision of the AutoTrack used with the correction signal RTK for a return time of 5 minutes (practical trials – sugar beet sowing).

Average return time (min)	5
Mean of the absolute deviations from the theoretical distance (m)	0.02
Maximum observed deviation (m)	0.07
Maximum deviation for 95 % of the time (m)	0.05

The average observed deviation reach 2 cm. Sometimes, we observed deviation reaching 7 cm but that applies in fact only to very few measurements.

Thanks to the high precision of the RTK correction signal, we carried out a skip pass, which means that we skipped voluntarily passes in order to improve the half-turns at the end of line. This practice kept the same level of precision as in normal work.

3.3 Discussion

The “theoretical trials” with the mono-disc showed that the Guidance System AutoTrac generates on average the same driving precision whatever the dGPS correction signal is SF1 or SF2. However the variability of the observed deviations is much more restricted when the Guidance System is adjusted with the correction signal SF2. That reflects the stability of this signal. This observation is confirmed by the independency of the correction done by the SF2 regarding the return time.

The importance of the return time on the driving precision has been highlighted during the practical trials (sugar beet sowing). When using the SF1 correction signal the farmer had to recalibrate regularly the system to keep an acceptable driving precision. In the parcel of 600 m length (average return time of 16 minutes), the user needed to recalibrated so many times that he decided to take back manually the control of the tractor. For the parcel of 350 m length (average return time of 10 minutes), the user proceeded differently. He recalibrated the system at the end of the line during the half-turn. In this way, the Guidance System kept the course adequately.
The use of SF2 as correction signal did not require any recalibration during all the sowing day even with a period of time between two passes of more than 20 min.

4. Conclusions

The automatic steering of the tractor is more and more used by farmers. It gives a great comfort to the operator, it is easy to use and can fit to numerous agricultural works (ploughing, sowing, planting, spraying, etc.). Its limits of use are strongly linked to the requested precision by these applications. The driving precision of a Guidance System is a function of its different components: the correction signal, the tractor configuration, the soil and field conditions, etc.

The study aimed at determining the actual precision of the Guidance System AutoTrac in function of the different correction signals proposed in Belgium by John Deere: StarFire 1 (SF1), StarFire 2 (SF2) and RTK.
The observed precision of the free correction signal SF1 is better than the one announced by the manufacturer. Following the observations made in practical conditions, the maximum deviation is around 15 cm with a return time of 12 minutes. This correction signal could be advised for works of great width requesting a lower precision than the seeding.
The correction signal SF2 fits totally to the precision announced by the manufacturer. The maximum observed deviation is lower than 11 cm. The great advantage of this correction signal is that it didn’t ask a re-adjustment during the day which is time consuming. The level of precision given by this correction signal allows the realization of the most of the works, from the seeding to the harvesting.

The RTK was the signal which gave the best precision and regularity. The maximum observed deviation was lower than 5 cm. This correction signal needs nevertheless the use of a base station.

THE USE OF INTEGRATED PLANT PROTECTION AGAINST ELATERIDAE IN POTATO FOR REDUCING LOSS OF QUALITY TUBERS

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Keywords: click beetle, effectiveness, forecasting, monitoring, pheromone traps, wireworms

1. Introduction

In the recent years, a locally growing population size of wireworm in agricultural fields with various plants such as vegetables, horticultural and ornamental plants has been observed [Erlichowski 2007, 2009; Pusz et al. 2013]. The scope of the research covered observation of four species of click beetles: *Agriotes lineatus* (L.), *A. obscurus* (L.), *A. sputator* (L.) and *A. ustulatus* (L.), which are the most dominant species in Poland. Click beetles were monitored in years 2010-2012 by YATLORf or VARb3 pheromone traps with synthetic sexual pheromone. The purpose of the research was determining the dependence between the catches dynamics and the location of traps in fields with potatoes, sugar beet, corn and grasses in eight municipalities in three voivodships (zachodniopomorskie, warmińsko-mazurskie and wielkopolskie).

2. Material and methods

The experiment was conducted in Poland, in the Wielkopolska Region, in Winna Góra (52°12'N, 17°27'E) and Słupia Wielka (52º13'N, 17°13'E) (municipality of Środa Wlkp.), during the 2011-2012 time period; in the Zachodniopomorskie Region, in Bonin (53°36'95''N, 15°39'71''E) (municipality of Łobez) and Laski Koszalińskie (54°08'25''N, 16°04'57''E) (municipality of Biesiekierz) during years 2010-2012; and in Warmia and Mazury Region in Barczewko (53°50'12''N, 20°41'43''E), in Łęgajny (53°49'N, 20°38'E) (municipality of Barczewo) and Garzewko (53°50'45''N, 20°16'49''E) (municipality of Jonkowo). Observations were provided on sugar beet, corn, potatoes and perennial grasses. Hungarian pheromone traps YATLORf or VARb3 type with Hungarian pheromone dispensers for catching males of *Agriotes lineatus* L., *A. obscurus* L., *A. ustulatus*.L. [Tóth et al. 2002] we used for Agroties spp. (click beetles) presence. Traps were placed on plantations in the third decade of April in a distance of approximately 3-5 m from the field edge - 1 trap per plantation. The average size of the field was from 1 hectare (corn, potato, grass, and

sugar beet) up to 1.6 hectare (sugar beet). The floors were checked systematically 2-3 times a weeks and the population size of caught males was recorded for each individual species. The dispensers were exchanged every 4-5 weeks, while the floors – as necessary. The monitoring of click beetles with the use of pheromone traps were maintained by the third decade of July.

Statistical analysis

Firstly, the normality of distributions for studied traits was tested using the Shapiro-Wilk normality test [Shapiro and Wilk, 1965]. A one-way analysis of variance (ANOVA) was carried out to verify the hypothesis about lack of differences between years for observed trait: numbers of *A. lineatus*, *A. obscurus*, *A. sputator* and *A. ustulatus*. A one-way ANOVA was carried out to verify the hypothesis about lack of differences between locations for observed traits. Mean values and standard deviations of observed traits were calculated [Kozak et al., 2013]. The variability of numbers of *A. lineatus*, *A. obscurus*, *A. sputator* and *A. ustulatus* classified by years and locations was presented in the form of a box-and-whisker diagrams (boxplots). All calculations for data analysis were performed using a statistical package GenStat 15 [GenStat, 2007].

3. Results

First click beetles *A. lineatus* species were caught on plantations in early May with the exception of 2011 year (Bonin) and 2012 year (Kretomino, W. Góra) where first click beetles were observed in the third decade of April. The maximum of the species were observed usually in May and June, while at W. Góra 2011 the peak was observed in July. In the years 2010-2012 the most numerous species of *A. lineatus* were caught in Bonin – 404 individuals (2011), W. Góra – 323 individuals (2011) and Słupia Wielka – 258 individuals, and in 2010 in Bonin – 250 individuals (Table 1).

Table 1. Number of *A. lineatus* click beetles caught in pheromone traps in different places in 2010-2012

Location	Crop plant	Number of click beetles caught in:		
		2010	2011	2012
Barczewko	potato	-	-	-
Boguchwała	potato	-	-	-
Bonin	potato	250	404	-
Kretomino	potato	-	-	110
Laski Koszalińskie	potato	-	-	-
Łęgajny	corn	-	-	-
Słupia Wielka	grasses	-	258	81
Winna Góra	sugar beet	-	323	67

The most numerous *A. obscurus* species were caught in Bonin (2010 - 137 individuals; 2011 - 343 individuals; 2012 - 157 individuals) and Łęgajny (2011 - 117 individuals), Barczewko (2011 – 466 individuals) and Słupia Wielka (2011 - 63 individuals) (Table 2).

Table 2. Number of *A. obscurus* click beetles caught in pheromone traps in different places in 2010-2012

Location	Crop plant	Number of click beetles caught in:		
		2010	2011	2012
Barczewko	potato	-	466	51
Boguchwała	potato	-	-	-
Bonin	potato	137	343	157
Kretomino	potato	-	-	-
Laski Koszalińskie	potato	-	-	-
Łęgajny	corn	-	117	-
Słupia Wielka	grasses	-	63	17
Winna Góra	sugar beet	-	1	17

Thanks to monitoring provided by using pheromone traps the presence of both species of the click beetles in sugar beet, potato, corn and grasses were observed. The biggest population size was recorded for *A. obscurus* and *A. lineatus* (Table 2, 1).The smallest population size was recorded *A. sputator* and *A. ustulatus* species. The Elateridae species dominance was observed during the 2011-2012 season.

Results obtained from the analysis of variance indicated that the years were a statistically significant factors ($p < 0.05$), that varied the population size of *A. lineatus* (Table 3). The longest number was observed in 2011, while maintaining most of ones variability. On the *A. lineatus* individuals were observed in the last year of study (2012). However, the number of occurrence of other click beetles did not affect the period of study ($p > 0.05$) (Table 3).

Table 3. Mean squares from analysis of variance for click beetle: *A. lineatus*, *A. obscurus*, *A. sputator*, *A. ustulatus*

	A. lineatus		*A. obscurus*		*A. sputator*		*A. ustulatus*	
	For years							
Source of variation	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares
Years	2	20180*	2	6439	1	78,6	1	18,164
Residual	25	4167	37	3693	6	113	6	5,292
For locations								
Source of variation	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares	Degrees of freedom	Mean squares
Locations	3	4359	4	6158	1	37,8	1	6,125
Residual	24	4848	35	3500	6	1,3	6	5,292
*p <0,05								

The correlation between the population size of the adult of four species of click beetles was assessed on the basis of correlation coefficients. The correlation between the population of *A. lineatus* and *A. obscurus* were statistically significant (r = 0.6197, p = 0.0012) (Table 4, 5).

Table 4. Mean values and standard deviations (s.d) for number of *A. lineatus* click beetle

Year	2010		2011		2012		2010-2012	
Location	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.
Barczewko	*	*	*	*	*	*	*	*
Boguchwala	*	*	*	*	*	*	*	*
Bonin	62.5	80.19	101	118.21	*	*	81.75	95.75
Kretomino/Bonin	*	*	*	*	27.5	20.47	27.5	20.47
Laski_Koszalinskie	*	*	*	*	*	*	*	*
Legajny	*	*	*	*	*	*	*	*
Slupia Wielka	*	*	64.5	48.39	20.25	22.16	42.38	42.11
Winna Gora	*	*	80.75	99	16.75	17.29	48.75	74.15
Mean	62.5	80.19	82.08	85.83	21.5	18.75		
$LSD_{0.05}$	Year: 54.28. Location: 82.96							

Table 5. Mean values and standard deviations (s.d) for number of *A. obscurus* click beetle

Year	2010		2011		2012		2010-2012	
Location	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.	Mean	Stand. dev.
Barczewko	*	*	116.5	132.98	12.75	16.15	64.62	103.76
Boguchwala	*	*	*	*	*	*	*	*
Bonin	34.25	41.44	85.75	84.93	39.25	52.1	53.08	61.34
Kretomino/Bonin	*	*	*	*	*	*	*	*
Laski_Koszalinskie	*	*	*	*	*	*	*	*
Legajny	*	*	29.25	40.45	*	*	29.25	40.45
Slupia Wielka	*	*	15.75	11.95	4.25	4.65	10.0	10.41
Winna Gora	*	*	0.25	0.5	4.25	4.35	2.25	3.58
Mean	34.25	41.44	49.5	79.19	15.12	28.69		
$LSD_{0.05}$	Year: 50.27. Location: 69.34							

4. Conclusions

The periodic changes in the intensity of the seasonal harmfulness of Agriotes species have a great influence on plant protection. The need for introducing constant monitoring of the abundance of *A. lineatus* and *A. obscurus*, for the purpose of signalling the presence of the discussed pests, is justified. In conclusion, wider use of pheromone traps, regular field observations for monitoring the pests, and monitoring weather conditions, should improve decision making and eliminate differences involving the chemical control.

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THE EFFECTIVENESS OF SELECTED BIOLOGICAL COMPOUNDS IN THE CARROTS AND PARSLEY SEED PRODUCTION

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1. Introduction

The effective, from January 2014, rules concerning the protection of plants by integrated methods oblige to reduce chemical compounds and replace them by biological preparations. In the production of horticultural crops, especially vegetable seed production, a major problem is the lack of biological agents, as well as the limited number of research indicating the phytotoxic effects of this compounds on forming, aging, health and quality of reproduced seeds. It concerns particularly the economically important plant species, including carrots and parsley [Gruszecki 2006, Dorna 2007, Dorna *et al*. 2008, Janas 2013].

Seed production of carrots and parsley is difficult and creates a lot of problems. The seeds of these species, and especially parsley, generally exhibit low germination caused by the high occupation of pathogenic microflora. Most of pathogens of the mentioned vegetable species seeds move from seeds to plants, causing difficulties in controlling infectious diseases. Poor germination results in low and uneven plant emergence and in reduced yield of crops and seeds, in the first year of cultivation [Tylkowska, Binek 1996, Nowicki 2002, 2002a, Wagner *et al*. 2003, Farrar *et al.* 2004, Irzykowska *et al*. 2007].

The used seed dressings and fungicides for plant protection are not always effective and many of them will be withdrawn and not allowed in protection of integrated or organic crops. Therefore, the efficient biological agents and methods are sought to improve the health and quality of seeds or plants.

2. Material and methods

The study was performed in 2010-2012 in the experimental field of the Institute of Horticulture in Skierniewice. The material for the study were plants and seeds of carrot (*Daucus carota* L.) and parsley root (*Petroselinum sativum* L.), obtained from plants grown organically. In the cultivation of the mentioned species, the biological agents with different mechanisms of action

and different methods of their application were tested. Then, the quality of the reproduced seeds and their contamination by microflora were evaluated.

Experiments were carried out in a randomized blocks, with 3 replications. The plots area was 9.2 m^2. Seeds of the mentioned above species were sown in 45x30 cm spacing, according to agricultural terms specific to each species. For research were selected: biostimulator Tytanit (ecological complexones of titanium), Biojodis –soil improver and plant growth stimulator (based on active iodine), Goëmar Goteo -fertilizer (based on sea algae), Physpe - biopesticide (based on laminarine). These preparations were used before sowing as the seed treatments and as foliar sprays of plants, as recommended by manufacturer. Then, their effects on plant health and the reproduced seeds and their quality and yield, was determined. Energy of germination and germination of seeds was assessed on Jacobsen germination tables, in accordance with ISTA rules.

Health of the seeds was studied by two methods: artificial culture using the potato dextrose PDAs medium and test on filter paper using the seed freezing. The seeds were incubated for 7 days, before assessing of their occupation by the micoflora.

3. Results

In the first year of production, application of Tytanit to the carrots and parsley seeds and plants caused the highest increase in yield of roots, as to compare to control and other treatments. The very good results were also obtained in case of parsley after application of the biological compound Physpe and in carrots treated with Tytanit (Tab. 1, 2).

Table 1. Effects of biological compounds on plant growth and root yield of parsley cv. Berlińska

Biological compounds	Weight of 1 plant [g]	Weight of root [g]	Yield of roots [kg 100 m^{-2}]	Average root length [cm]	Root diameter [cm]
BIOJODIS	326bc	269bc	196,4bc	19,0b	17,7b
TYTANIT	437a	374a	273,0a	19,5b	20,0ab
GOEMAR GOTEO	375b	310b	226,3b	20,7ab	21,8a
PHYSPE	403ab	342ab	249,7ab	24,0a	21,2a
Control	283c	233c	170,1c	19,4b	17,2b

Treatments with these compounds resulted in higher weight of roots, their length and diameter, as to compare to the other objects and control. In the second year of cultivation (in which the seeds were formed), the yield and quality of parsley seeds were significantly increased by Tytanit and Goëmar Goteo treatments, while in carrots by Physpe and Biojodis applications. The

obtained results confirm studies of Janas [2013], in which the biological compounds were used in dill and fennel –the plants of the same botanical family (*Apiaceae*) as carrots and parsley. The high efficacy of biological agents used in parsley seed production by integrated method was also noted by Janas *et al.* [2006], while in carrot crops by Dorna *et al.* [2008].

Table 2. Effects of biological compounds on plant growth and root yield of carrot cv. Amsterdamska

Biological compouns	Weight of 1 plant [g]	Weight of root [g]	Yield of roots [kg 100 m^{-2}]	Average root length [cm]	Root diameter [cm]
BIOJODIS	78b	61b	44,5b	14,5b	8,4b
TYTANIT	121a	111a	81,0a	16,9a	11,1a
GOEMAR GOTEO	64bc	57b	41,6b	14,9b	8,4b
PHYSPE	60bc	49bc	34,8bc	10,8c	7,3
Control	54c	48bc	35,0bc	12,6bc	7,9b

4. Conclusions

In the carrots and parsley seed production a different biological compounds, exhibiting different mechanisms of action are recommended: bio-stimulators Tytanit, Biojodis and Physpe and these affected the yield - Goëmar Goteo. Bio-stimulators stimulate plant resistance to stress and diseases. The mentioned biological compounds caused the improved quality of seeds and resulted in an increased seed yield and stimulation of growth and development of plants.

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ANALYSIS OF PHYSICOCHEMICAL PROPERTIES OF RAW MATERIALS OF AGRICULTURAL AND INDUSTRIAL ORIGIN

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Keywords: rape oil, glycerin, chlorophyll, lipids, fatty acids, MONG

Abbreviations: MONG - monoglyceri des/diglycerides/triglycerides/methyl ester/other organics

1. Introduction

Proper management of the resources of a country should follow the fundamental motto "*Nothing can be wasted",* therefore all products created as a result of human activity should be utilised to the maximum possible extent, without causing any negative effect on the natural environment. Among the great variety of raw materials with a broad spectrum of applications we can distinguish rape seeds and all kinds of products of their processing, namely oils, technical glycerine, distilled glycerine, or MONG which is a by-product of its purification. Rapeseed (*Brassica napus* L) is one of the most important crop plants used for the production of both edible and industrial oils and glycerine in Poland as well as in Europe [Kachel-Jakubowska et al. 2011, Gupta et al. 2007; Casséus 2009; Bhattacharjee 1991; Singh et al. 2007; Brauer, Röbbelen 1989]. Due to its high levels of essential linoleic acids (ω-3 fatty acids), monounsaturated fatty acids, polyphenols, phytosterols, that oil contains tocopherols having excellent nutritional value and thus becomes indispensable in human diet. Due to its mild aroma and its typical characteristic taste, it is used primarily as salad oil, in margarines and other edible fats [Guderjan 2007].

The elimination of dyestuffs from the oil causes not only an improvement of its colouring but also an increase in the stability of the product obtained, especially in the case of cold pressing of oil [Krygier et al. 1996, 2000; Dąbrowski et al. 1987]. However, the removal of chlorophyll accumulated in the seeds is important as – under the effect of temperature and other factors – it undergoes oxidation and hydrolysis, which causes the loss of proper colouring of the seeds, affecting the final colour quality of refined oil [Daun 1987; Gruszecki 1999; Jerzewska et al. 1986; Strobel et al. 2005].

As a result of increased production of bioesters, the biocomponent added to diesel fuel, excess amounts of glycerine are produced, classified as a by-

product. The producers and importers of fuels, obligated by the biofuel laws, must add them both to petrol and diesel fuels. The production of every 10kg of biodiesel generates about 1kg of glycerine (so-called glycerol) [Sabourin-Provost 2009]. Glycerine is non-toxic and non-irritant, biodegradable and suitable for recycling, and it is very stable under typical storage conditions and compatible with numerous chemical substances. These properties permit its use as a desiccant, a plasticiser, as an agent softening the skin, as a thickener, lubricant, a sweetener, and an antifreeze. Thus it is used as a component in cosmetics, personal hygiene cosmetology, medical products, and food products [Ash and Ash, 2004]. However, all of those branches are not capable of utilising all the glycerine produced, and therefore both in Poland and abroad (Brazil, Great Britain) research has been initiated on the possibility of using glycerol as a fuel for engines. Such a fuel could be used in diesel engines.

2. Objective of the study

The objective of the study was to examine physico-chemical properties of selected rape oils and rape oil by-products.

The following parameters of rape oils delivered by different providers were evaluated: lipid content, fatty acids profile and chlorophyll content. Calorific value was evaluated for rape oil by-products such as distilled glycerine, technical glycerine and MONG fraction.

3. Materials and methods

Experimental material originated from Trzebinia Refinery S.A (Bodaczów). The 30mL samples of industrial rape oil as well as five-liter samples of distilled glycerine, technical glycerine and MONG fraction were used. Rape seeds were collected at random from the resources provided by 17 different contractors from Lublin area according to the PN-EN ISO 542/1997 standard and stored under laboratory condition at the temperatures between 19-22^{0}C and the humidity between 60-70%. All the rape seed samples consisted of a mixture of different varieties of winter seeds collected by individual supplier. Samples of rape oil-by products such as distilled glycerine, technical glycerine and MONG fraction were obtained from the Trzebinia Refinery S.A, Orlen Group.

Rapeseed oil was pressed on laboratory pressing stand using a HYBREN 6 worm extruder equipped with micrometric mesh strainers. The process of pressing started after stabilization of the press temperature. After pressing of c.a. 1.5 kg of raw material the temperature of extruder reached 70^{o}C (TP6 laser pyrometer).

Chlorophylls *a* and *b* as well as carotenoids were determined spectrophotometrically in the freshly pressed oil using a double-beam Varian

Model Cary 300Bio spectrophotometer. Samples of oil were diluted 5 times in acetone and the spectrum measured between 350 and 700 nm. Concentrations of chlorophylls and total carotenoids from 3 independent measurements were calculated according to the procedure of Lichtenthaler and Buschmann [Lichtenthaler and Buschmann, 2001].

The values of heat of combustion of the oil was evaluated with means of LECO AC 600 type calorimeter.

The measurement consisted in the perfect combustion of the 1 g (+/- 0.0002 g) standardised samples in bomb calorimeter pressurised with 3 MPa oxygen. The internal atmosphere was saturated with water. The measurements were conveyed in three independent repetitions, and the reading was done after ca. 5 min. after the process stabilized (according PN-86/C-04062).

Fatty acids content was determined with means of gas chromatograph Varian 450-GC, supplied with Galaxie™ Chromatography Data System. Statistical analysis included mean values, standard deviations (S.D.) as well as the data correlation matrices. All the calculations were done with means of Statistica 6.0 by Statsoft.

4. Results and discussion

Preliminary analysis of selected results revealed that the calorific value of rapeseed oil varied within the range from 9194 to 9847 kJ/kg, the calorific value of technical glycerine was 1806 kJ/kg, that of distilled glycerine was 1703 kJ/kg, and of MONG - 1134 kJ/kg.

The content of the particular saturated fatty acids in samples of oil was in the range from 5.20% to 7.70% of the total acids content. The level of unsaturated acids was in the range from 92.32% to 95.08% of total acids content. In technical glycerine the presence of saturated fatty acids was noted at the level of 59.5%, while in distilled glycerine the whole, i.e. 100% of the total acids content, was constituted by saturated fatty acids. The content of 83.92% of the total acids content was noted for MONG.

On the basis of the research performed it can be concluded that the raw materials under analysis are characterised by all the parameters that make them interesting from the viewpoint of both the agriculture and the industry.

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ORGANIZATION AND TECHNIQUE OF AGRICULTURAL CROP PROTECTION IN IRAQ

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Keywords: crop protection organization, Iraq, crop protection techniques

Introduction

The agricultural sector is still a major source of livelihood for the poor and food insecure and is the largest source of rural employment in Iraq. The sector's contribution to GDP (agriculture is the second contributor after oil revenues), declined from about 9 percent in 2002 to 3.3 percent in 2008 and 3.6 percent in 2009. However, it still provides 20 percent of employment. The population of the country is about 32 million of which one third resides in rural areas and depends upon agriculture for their livelihoods. The population growth rate is about 3 percent of the national level [FAO 2011].
The total area of Iraq is 39,547,800 ha and the total cultivated area is 3,187,211 ha, more than half of it is planted with wheat crop [Ministry of Agriculture 2013] (table 1).

Table 1. Arable land in Iraq: base and its use

Description	**The area in ha** (percentage of cultivated area %)
Total land area	39,547,800
The cultivable area	12,533,773
Cultivated area	3,187,211
Orchards area	254,076
Wheat	1,728,624 (54.23%)
Barley	712,382 (22.35%)
Maize	151,453 (4.75%)
Rice	79,691 (2.50%)
Sorghum	38,296 (1.20%)

Plant protection organizations in Iraq

The Plant protection organization in Iraq, which is affiliated to the Ministry of Agriculture, is covered by the General Authority for Plant Protection. It was originally established in 1928, and in 1969 it was named the Plant Protection Directorate within the Ministry of Agriculture and Agrarian Reform. In 1979 it became the General Authority for Plant Protection, and in

1990 it was discontinued and became a section within the Authority for Agricultural Services. In 1992 it was reconstituted as The General Authority for Plant Protection and has been operating since then.

The projects of the investment plan of the General Authority

1. Project to thwart and control the agricultural pests.
2. Project of beneficial insects.
3. Project of development of agricultural quarries in Iraq.
4. Project of development and rehabilitation of the agricultural aviation in Iraq [Ministry of Agriculture in Iraq website 2013].

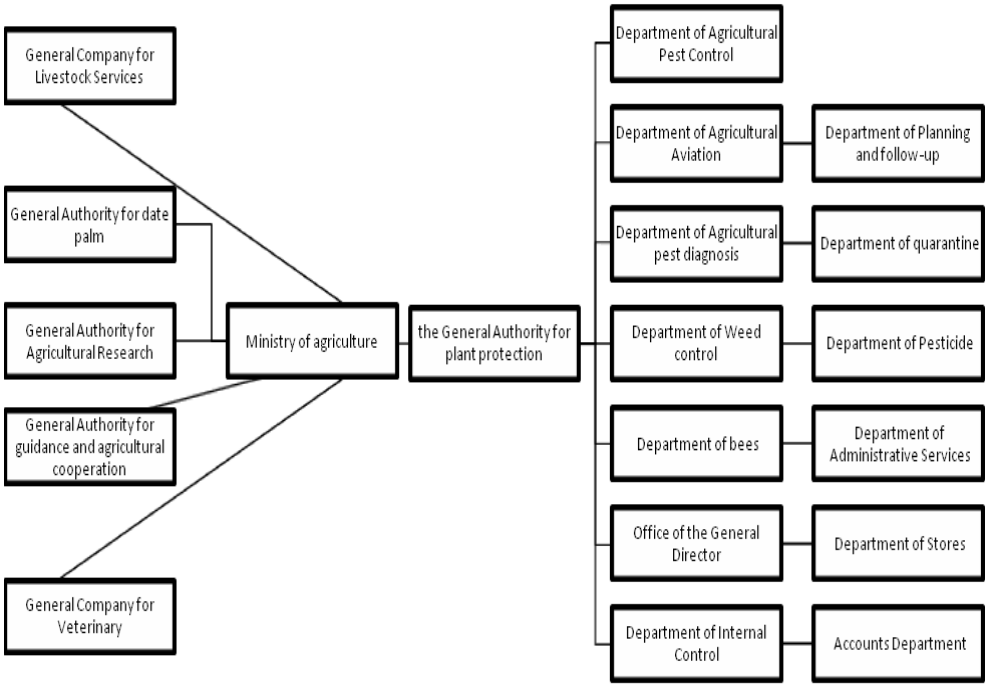

Fig. 1. Plant protection organizations in Iraq

The plant protection techniques and equipment used in Iraq

1. Spraying from helicopters - The helicopter contains one tank on each side, and this method is mainly used for orchards' area (254,076 ha) of date palm.
2. Spraying from an airplane,
3. Spraying equipment: - on tractors (400 – 600 litres); - spraying equipment mounted on vehicles (pick up); - sprayers pulled by people with canister sizes up to 100 litres and it takes the movement from a one piston engine; - spraying equipment mounted on the person's back.

There are different types of sprayers used to protect the crop. Most of the protection process is done by the General Authority for Plant Protection.

The national campaign

- Date palm control campaign: The government of Iraq organizes a free national campaign carried out by the Ministry of Agriculture - General Authority for Plant Protection - Department of Agricultural Aviation to combat the lesser date moth (Batrachedra amydraula) and dubas bug (Ommatissus lybicus) on the date palm every year .It usually takes place at the beginning of April or May for the Spring generation and in September for Autumnal generation in every year.
- Wheat weeds control campaign: The process of controlling wheat weeds starts at the beginning of October, the control process starts with conducting field trips to the wheat fields and doing the necessary surveys for the fields using the wooden box to calculate the density of the weeds to see what kinds of weed is spreading, this is done through special forms prepared for this purpose [General Authority for Plant Protection 2012].

Pesticide registration procedure

In Iraq a new pesticide should be registered before being used. To register a new pesticide the person or the company who imports the pesticide needs to fill in the pesticide registration form and provide some documents and certificates. The pesticide registration procedure requires the following:

1. Provide a required document, for example the certificate of pesticide registration in the country in which this pesticide was produced and certificates of chemical and physical analyses.
2. Provide general information about the pesticide and the company which produced it.
3. Provide data about the active ingredient.
4. Provide data on formulated products.
5. The toxicity of the active ingredient and end use product.
6. Fate in plants and residues in target crops.
7. The assessment of consumer risk.
8. Environmental fate and ecotoxicology.
9. Biological properties and target pests and crops.
10. Mode of action (how the pesticide influences on the disease).
11. Uses and recommendations.
12. Crop tolerance and compatibility.
13. Safety handling.
14. Storage and disposal.
15. Type of container and packaging materials.

16. Fill in the form of pesticide producer company which contains general information about the company, information about the research and production divisions in the company and control laboratories.
17. All the forms, documents and certificates should be provided to the national committee for pesticide registration and approval – Ministry of Agriculture [Ministry of Agriculture in Iraq website 2013].

Conclusions

The General Authority for Plant Protection continues to secure the provision of pesticides for control campaigns and give support to state-owned companies that produce pesticides, and continue to provide free control campaigns as well as the database of all diseases that infect plants and the results of each campaign and its efficiency.

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COMPARISON OF THE QUALITY OF SEEDING THE HERMAPHRODITA RUSBY SEEDS BY S071 KRUK SEEDER IN LABORATORY AND FIELD CONDITIONS

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Keywords: precision seeding, seeding quality

1. Introduction

Properly performed act of seeding is one of the major factors determining the volume and quality of the yield. Economic justification behind the application of this seeding method is based on the fact that it allows to reduce to a minimum the amount of the sown seeds and thus lower the seeding costs.

Hermaphrodita Rusby, in America commonly known as Virginia fanpetals, was brought to Poland in the fifties of the previous century and since then has been used as a raw material providing energy. This plant belongs to the family of Malvaceae. Virginia fanpetals can be reproduced generatively through sowing seeds but also vegetatively. The growth and development of this plant is basically undisturbed in our climate. Prior to establishing a plantation of this plant, the most advantageous reproduction method should be chosen. It was observed that 1 or 2 year old seeds germinate easily in humid and not crusty soil but the initial growth of seedlings is very slow and the plantation requires intensive weed control.

Most frequently applied method of Virginia fanpetals reproduction is sowing seeds while which it is crucial to properly and carefully arrange individual seeds on a specified unit of surface and keep the same sowing depth for all of them.

2. Material and methods

In the laboratory conditions the Virginia fanpetals seeds were sown onto a sticky tape of the research stand. Then distances between them were measured on 1-meter measurement sections in 5 repetitions and percentage of single, duplicate and skipped plants was calculated. Single plants were considered those between which the distance was bigger than half of the average real distance and smaller or equal to 1.5 of the average real distance. Duplicated plants were considered those which grew at distances smaller or

equal to the half of the average real distance. Skips were considered distances bigger than 1.5 of the average real distance.
Then the following was calculated:

- percentage of single plants expressed as a quotient of the number of single plants and overall number of plants grown on all measurement sections,
- percentage of duplicated plants expressed as a quotient of the number of such plants and overall number of plants grown on all measurement sections,
- percentage of skips expressed as a quotient of the number of skips and overall number of skips on all measurement sections.

In the field conditions the precision of the Virginia fanpetals seeds distribution in a row was determined after the germination process was completed. In order to do that distances between plants were measured on 5-meter measurement sections in 5 repetitions for each peripheral speed of the seeder sowing disk. Classification of the obtained results was carried out following the methodology applied in laboratory research.

The obtained research results were made subject to further statistical analysis based upon a variance analysis and multiple confidence intervals of T-Tukey at an assumed significance level of $\alpha = 0.05$.

3. Research results

The research results are presented in table 1.

Table 1. Results of testing the quality of sowing Virginia fanpetals seeds with S071

Seeder operating speed ($m\ s^{-1}$)	Peripheral speed of the sowing disk ($m \cdot s^{-1}$)	Single plants (%)	Duplicated plants (%)	Skips (%)
	Laboratory tests			
0,8	0,42	$59,9^{a}$	$26,5^{a}$	$13,6^{a}$
0,8	0,36	$67,4^{b}$	27^{a}	$5,6^{b}$
0,8	0,23	$79,5^{c}$	$12,7^{b}$	$7,8^{b}$
	Field study			
0,8	0,42	$35,6^{d}$	$42,4^{c}$	22^{c}
0,8	0,36	39^{d}	$42,6^{d}$	$18,4^{d}$
0,8	0,23	$41,6^{e}$	$36,8^{e}$	$21,6^{e}$

Different letters provided in the indexes mean that at the examined speeds of the sowing dick, significant differences occurred between single and double plants sown and skips at the level of $\alpha = 0,05$.

Statistical analysis of the results showed significant differences between the shares of single plants, duplicated plants and skips obtained at the examined seeding disc speeds in the laboratory and field conditions.

4. Conclusions

1. Significant influence of peripheral speed of the seeder's sowing disk on percentages of single, duplicate and skipped plants was observed.
2. Negative correlation of simple regression of shares of single, duplicated and skipped seedlings shows that the shares decreased as the peripheral speed of the S071 Kruk seeder sowing disk increased.
3. Most advantageous ratios related to the distribution of the seeds in a row were obtained at the peripheral speed of the sowing disk of 0.23 $m \cdot s^{-1}$.
4. At the examined peripheral speeds of the seeder sowing disk, the ratios indicating the distribution of the seeds in a row obtained in laboratory conditions were better than the ones obtained in the field conditions.

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ANALYSIS OF DURABILITY FEATURES OF PELLETS USED IN POWER GENERATION

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Keywords: pellet, straw crushing

1. Introduction

One of the most modern and ecological fuels is pellet composed of cylinder-shaped granules 10-50 mm long and 4-25 mm in diameter. Its production involves the usage of waste materials such as: sawdust, woodchips, corn straw, rape straw and other energy-related plants. It is made through crushing and compressing of half-products under very high pressure. The process also causes the calorific value of the product to condense and thus we obtain a fuel of very good physical and chemical properties.

Pellet shows very low humidity of 8-12% only. In the combustion process we obtain neutral balance of CO_2 emission – the same as in the case of wood. Besides the ash generated in the wood granulate combustion process may be used as fertiliser. The calorific value of pellet, according to DIN 51731 ranges between 4.9 to 5.4 $kWh \cdot kg^{-1}$. When pellet combustion properties are compared to the analogical parameters obtained in the process of coal or various oil fraction combustion, significantly lower emission of harmful dust and gas is observed.

2. Research material and methodology

The research material was obtained from URSUS S.A. Company situated in Dobre Miasto. Examined were pellets made of various kinds of straw such as: wheat, rye, maize, rape and olive. In order to determine the humidity of the examined pellets, gravimetric method was applied, compliant with the procedures described in norm [PN-93Z-15008/02].

After agglomeration, a durability test was conducted to check a pellet's resistance to crushing by INSTRON 4302 apparatus connected to a computer and equipped with a load cell strain gauge of the pressure force of F=1kN; the sweep speed was 25 $mm \cdot min^{-1}$. The pellet samples of every pellet type were subject to uniaxial crushing. The samples were selected at random (6 repetitions for each rotation speed of the gauge) during the process of their condensation on the ring granulator at different gauge speeds, such as: 25, 38 and 45 $revs \cdot min^{-1}$.

3. Research results and analysis

In order to estimate the impact of the type of material used to make pellets and the rotation speed of the granulator gauge on the force of crushing pellets, a bifactor analysis was carried out involving variance and interaction. Besides, based on the Tukey procedure, simultaneous comparisons of average crushing forces applied to different straw types used for different types of pellets were conducted. The pellet crushing durability test was carried out at three rotation speeds of the granulator gauge (25, 38, 45 revs·min^{-1}).

The highest value of the crushing force was observed for pelleting maize straw and olive waste while the lowest for wheat straw and slightly higher for rape straw. The values of these forces were similar for all examined rotation speeds of the gauge.

In order to find out whether the type of straw and gauge rotation speed have important impact on the crushing force at the predefined gauge speeds of 25, 38 and 45 revs·min^{-1}, a bifactor analysis involving variance and interaction was conducted.

Table 1. Analysis of the variance of the pellet crushing force at the gauge speeds of 25, 38 and 45 revs·min^{-1} for the examined straw types with the humidity of 16%.

Source of variance	Degrees of freedom	Sum of squares	Average squares	Value of F_0	$P(F>)F_0$
Gauge rotation speed	2	0.6028	0.3014	0.50	0.6090
Examined material	4	771.6949	192.9237	319.47	<.0001
Gauge rotation speed * Examined material	8	11.2416	1.4052	2.33	0.0274
Error	75	45.2915	0.6038	-	-
Total	89	828.8311	-	-	-

The straw type significantly impacts the value of the crushing force at all examined gauge rotation speeds. On the other hand, the gauge rotation speed does not significantly impact the crushing force in case of all straw types. Besides, at the significance level of α=0.05 no significant impact of the interaction between the gauge rotation speed and the examined material used for pellets was observed.

4. Conclusions

1. The research showed that the value of the crushing force depends on the type of material used for pellet production.
2. Based on the conducted research, it can be stated that the granulator gauge rotation speed, at the level of α=0.05 did not significantly impact the value of the crushing force for the obtained pellets.

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THE DEFINING OF THE LIQUID DECOMPOSITION IN A FLAT-FAN NOZZLE

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Key words: flat-fan nozzle, volume stream, decomposition, flux density

Introduction

Flat fan sprays and their modifications are widely-used elements in crop-sprayers and especially in field crop-sprayers. It results from a number of advantages, mainly a simple and enduring construction and therefore, an immense reliability, easy installation and dis-assembly on a field beam and mostly, a low price. A crucial disadvantage of this spray is an uneven layout of the liquid in the spray.

In this respect, they are not so good as swirl-type or pneumatic sprays that are characterized by an even density of watering (Prywer 2003). The uneven crop-spraying causes that more of a chemical substance is used which results in negative ecological effects (Kowalik 2012). It may be prevented by a precise spraying with a little amount of a chemical substance of a larger concentration (Koo, Kuchlman 1993). To obtain the desired work effects of flat fan sprays it is necessary to get to know the influence of construction parameters on the evenness of the stream and the possibility of its modeling.

The subject and the aim

The subject of the research is a flat-fan spray and its hydro-mechanic features. The aim is the defining of the decomposition of the stream density and the speed of liquid flux in any point of a spray nozzle.

Method

The initial speed in the cylindrical part of the spray nozzle has been defined from the definition of the stream volume (Orzechowski and others, 1997) according to the following dependency:

$$v = \frac{Q}{A} \ [m \cdot s^{-1}] \qquad (1)$$

where:

Q - the flow $[m^3 \cdot s^{-1}]$ -value defined as the result of measures

A - a cross-section area of cylindrical channel of the nozzle $[m^2]$;

The parameters of the liquid (Q1, V1) at the beginning of the flux through the nozzle have been calculated from the movement continuity equation:

$$Q_1 = A_1 v_1 = A\ v = Q \quad [m^3 \cdot s^{-1}] \tag{2}$$

$$v_1 = \frac{A}{A_1} V \quad [m \cdot s^{-1}] \tag{3}$$

where:
A_1 - the surface of liquid flux perpendicular to its direction (perpendicular to the spray axis) [m^2];

The values of the stream volume in the remaining points of the nozzle have been defined according to the dependency:

$$Q_n = Q_{n-1} - 2\Delta Q_n \quad [m^3 \cdot s^{-1}] \tag{4}$$

where:
Q_{n-1} - the value of the stream volume in the point n-1 preceding the n-point[$m^3 \cdot s^{-1}$]. The initial value of the stream Q is known;
$2\Delta Q_n$ - the amount of the liquid with which the stream volume was diminished as a result of its flux through the surface F_n between the points n-1 and n with the speed v_{n-1} [$m^3 \cdot s^{-1}$];
F_n is a surface of the part of nozzle projection on a surface perpendicular to the spray axis.

$$\Delta Q_n = F_n v_{n-1} \quad [m^3 \cdot s^{-1}] \tag{5}$$

$$Q = 2 \sum_{i=1}^{n} \Delta Q_i \quad [m^3 \cdot s^{-1}] \tag{6}$$

The speed of the liquid flux through the surface perpendicular to the spray axis and the speed of the liquid flux in the point n equals:

$$v_n = \frac{Q_n}{A_n^*} \quad [m \cdot s^{-1}] \tag{7}$$

The research results and analysis

The changeability of the parameters in the nozzle of the flat fan spray is presented in the figures 1 and 2. It shows that both the speed and the amount of the liquid coming out of the nozzle changes depending on the location of the flux in relation to the spray axis. The closer the flux spot to the spray axis

is, the more of the liquid ΔQ_n appears. It is caused by a greater speed with which the liquid comes out and the bigger surface of the flux.

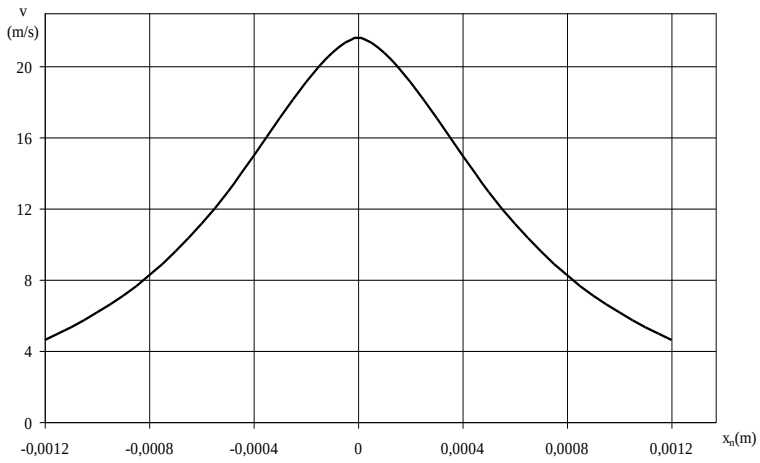

Fig. 1. The layout of the flux liquid speed from a flat-fan nozzle

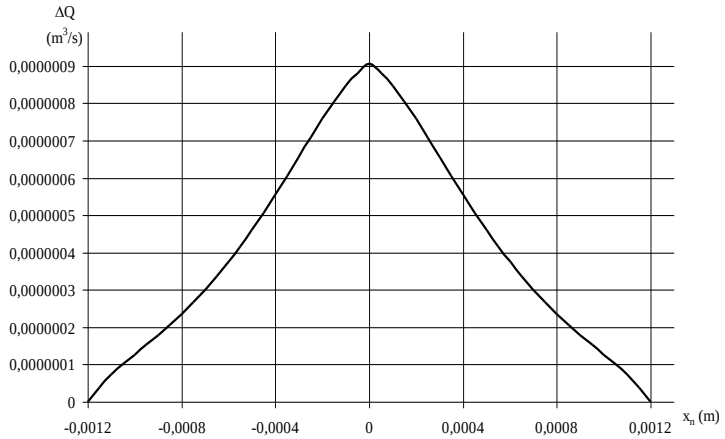

Fig. 2. The layout of the stream volume density in a nozzle

Analyzing pattern no 5 it must be stated that changing the values of its components we can change the amount of the liquid coming out in any point of the nozzle, that is, we may alter the flux density.

Conclusions

1. The speed of the liquid flux from the flat-fan spray is different and changes from a minimal value at the end of the nozzle to the maximal value in its central part.
2. The amount of the liquid coming out of the flat-fan spray depends on

the flux point. In the center of the nozzle a large part of the liquid comes out while in the extreme external parts the flux is minimal.

3. Modeling the shape of the nozzle we may alter the layout of the density of the liquid flux, and thus, we may affect the evenness of the spraying.

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INFLUENCE OF THE CHEMICAL PROPERTIES OF THE PLANT BIOMASS OF AGRICULTURAL ORIGIN ON ENERGY INTENSITY OF ITS COMPACTION

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Keywords: chemical properties of the biomass, compaction energy consumption, plant biomass

1. Introduction

Plant biomass as a renewable, environmentally friendly energy source has a constant interest. It is recommended for energy use of biomass of waste and surplus from conventional agricultural crops, such as cereal straw and other plants and grasses of permanent grassland and wasteland [Świętochowski et al. 2011].

These raw materials, in its original condition, unprocessed, are diverse not only in terms of physical characteristics (moisture, density) but also chemical characteristics [Denisiuk 2009; Rybak 2006; Wandrasz and Wandrasz 2006]. Shares of individual chemical elements in solid fuels, which include biomass, are different and depend on the type of fuel and its degree of coalification. With the increase in the degree of metamorphism increases significantly the carbon content, and a decrease in the oxygen and hydrogen content decreases slightly. The quantities of nitrogen and sulfur in practice depend on the carbon content of the fuel, and the other elements present in minor amounts of biomass in the form of a mineral substance [Kowalczyk-Juśko 2009; Rybak 2006; Wandrasz and Wandrasz 2006]. It should also be noted that the quantitative differences in chemical composition occur not only in the biomass of different species, but also can occur inside a single species. This causes the quality of the habitat and agricultural practices carried out [Świętochowski et al. 2011]. Hence, plant biomass is a difficult material to energy use in the unprocessed and it is difficult when compacted.

Based on literature data you can get information on range of parameters of the compaction process of biomass, including energy intensity and, as well as its chemical composition [Denisiuk 2009; Rybak 2006; Wandrasz and Wandrasz 2006]. There are no elaborations which take into account the relationships between energy intensive compaction plant biomass of agricultural origin and her chemical properties.

2. Material and methods

The following types of straw were selected for the study; winter wheat, triticale, rye, buckwheat, cereal mixed.

Acquired material shredded device H-111, which is equipped with a sieves with openings of 3 mm. Then, samples were taken for further laboratory tests that define the content of:

- water - gravimetric method according to PN-EN 14774-2:2010;
- carbon, hydrogen - IR absorption method according to CEN / TS 15104:2006;
- nitrogen - measuring automatic analyzer according to CEN / TS 15104:2006;
- sulfur - automatic measurement of IR analyzer according to PN-G-04584: 2001;
- chlorine - Eschki method according to PN-ISO 587:2000 p.7.2.1.

The agglomeration of particulate materials so proceeded with the compactor with a fixed flat-sided matrix with a thickness of 25 mm and a diameter of 8 mm holes. The rotational speed roller compaction was 11.67 rad·s^{-1}, and was transferred to the drive roller of an electric motor with a capacity of 7.5 kW for team toothed gears.

The research on energy intensive process of compaction test plant materials used measuring system, which included a measure of Lumel N14, coupled with computer recording, which was determined using energy expenditures.

The statistical analysis of test results acquired to determine average values, standard deviations, and Pearson correlation coefficients was performed, as well as ANOVA test. The significance of differences between mean values determined using Tukey's test. The level of significance α=0.05.

3. Results

Selected results are presented in Table 1.

In terms of research, statistical analysis showed significant differences between the averages in each group of raw materials. The test Tukey most often pointed to following homogeneous groups: grain and straw mixture of winter wheat as well as winter wheat and rye (Table 1).

Table 1. Selected chemical properties of the material subjected to compaction and energy expenditures
(a-c homogeneous groups; α = 0.05)

Parameter	The straw species	Moisture [%]	Carbon [%]	Hydrogen [%]	Nitrogen [%]	Sulfur [%]	Chlorine [%]	Energy expenditures [kWh·kg^{-1}]
Average	triticale	15.35	46.64	5.83 a	1.07	0.12 a	0.093	0.275 a
	cereal mixed	14.09 a	46.98 a	5.85 a, b	0.59	0.06 b	0.028	0.275 a, b
	winter wheat	14.03 a, b	47.00 a	5.79 a, b	1.19	0.12 a, c	0.082	0.270 a, b, c
	buckwheat	14.49	44.40	5.56	0.88 a	0.13 a, c	0.123	0.190
	rye	13.85 b	47.94	5.92	0.85 a	0.07 b	0.018	0.265 c
Standard deviation	triticale	0.06	0.06	0.03	0.02	0.02	0.001	0.002
	cereal mixed	0,07	0,04	0,03	0,01	0,03	0,002	0.003
	winter wheat	0.02	0.07	0.02	0.01	0.02	0.001	0.002
	buckwheat	0.07	0.02	0.02	0.02	0.02	0.002	0.002
	rye	0.05	0.03	0.03	0.02	0.01	0.001	0.004

For the examined raw materials statistical analysis results showed negative linear trend between energy expenditures and: water content, total sulfur and chlorine. Positive linear trend between energy expenditures and: contents of carbon, hydrogen, and nitrogen. Wherein the coefficients of correlation expenditures energy and: carbon, hydrogen and chlorine are significant $p<0.05$.

4. Conclusions

Under the test conditions the lowest power consumption occurred during compaction buckwheat straw was determined for the least amount of carbon and hydrogen, and the largest chlorine-and sulfur. This parameter for other raw materials was about 45% higher. Cross-shareholdings between the considered chemical composition meant that among the examined species of straw, buckwheat straw biomass was the most favorable material properties to agglomeration.

Comparing the results with literature data it can be concluded that, at the test conditions of participation was comparable [Denisiuk 2009; Rybak 2006; Wandrasz and Wandrasz 2006].

The content of the test material under consideration of water, carbon, hydrogen, nitrogen, sulfur, and chlorine is a factor in determining its suitability for energy purposes. Nevertheless, the large variation in the elemental composition of organic matter, as well as their impact on the process of compaction of individual fuels of agricultural origin, indicates a need for further research in this area and to make them public.

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COMMODITY PRODUCTION AND LABOUR INPUTS IN ECOLOGICAL FARMS

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Keywords: ecological farm, commodity production, labour inputs

1. Introduction

In Poland, as in other EU Member States, intensive development of ecological farming has been observed since the end of the 90's of the previous century [Tryburski, Żakowska-Biemas 2007].

Dynamic development of ecological farming in Poland, after EU accession in 2004, gave rise to the need of carrying out research and analysis concerning the agriculture branch. Getting information on production and economic situation of ecological farms and their competitiveness has become crucial, especially because the number of agricultural producers interested in the production of ecological methods raises systematically [Kowalska 2010; Nachtman, Żekało 2011]. Huge diversity of factors shaping the functioning of such farms should be taken into consideration when assessing activity of agricultural farms [Kowalski et al 2012]. Effective use of human labour resources and obtained production results constitute these factors.

2. Material and methods

The objective of the paper was to assess commodity production in the global production of the researched ecological farms in the aspect of incurred labour inputs. The scope of the study covered research carried out in 50 ecological farms with a certificate, located in the Southern Poland. The study was carried out within the development grant No 12 016510 'Innovative impact of technology and IT support of management on of production efficiency in organic farms".

The collected information was obtained on the basis of a guided survey carried out with farm owners. Information concerned 2011 and the collected data allowed, inter alia, determination of the sowing structure, the obtained crops and the incurred labour inputs in the researched farms. Farms were divided into four area groups on account of the size of the agricultural land area: I group - to 5.00 ha (12 farms), II group - from 5.01 to 10.00 ha (17), III - from 10.01 to 20.00 ha (12), IV - above 20.00 ha (9).

3. Results

Participation of commodity production in the global plant and animal production (with division into plant and agricultural land groups) was presented in tables 1 and 2; whereas, labour inputs were presented in table 3.

Table 1. Participation of commodity production in the plant global production (at the average for plant and agricultural land groups) [%]*

Group	Area of agricultural land [ha]	Plant and agricultural land group					
		Grain	Root	Fodder crops	Vegetables	Herbs	Orchards and plantations
I	3.33	53.3	60.8	97.5	77.1	100.0	92.7
II	6.90	36.5	54.2	57.3	88.6		55.9
III	15.05	88.5	67.1	80.0	97.1	100.0	66.7
IV	31.80	24.2	62.5	0.3	25.0		
Total	12.48	55.5	58.6	68.7	84.5	100.0	75.1

*- for facilities, where a specific product occurs

Table 2. Participation of commodity production in the animal global production in the product assortment *

Group	Parameter	Milk		Meat		Eggs	
		PG**	PT**	PG	PT	PG	PT
		ths ltr	%	tons	%	ths	%
I	average	4.6	58.5	0.8	44.4	5.1	41.3
	standard deviation	3.1		0.7		6.5	
II	average	11.5	62.4	1.5	63.9	6.3	66.4
	standard deviation	14.6		1.2		7.4	
III	average	37.1	80.2	4.2	62.7		
	standard deviation	26.6		3.2			
IV	average	78.3	93.7	5.0	58.6		
	standard deviation	36.6		1.8			
Total	average	29.8	71.8	2.6	58.4	5.8	55.3
	standard deviation	36.0		2.4		6.8	

*- for facilities, where a specific product occurs;
** - PG – global production, PT – commodity production

Table 3. Labour inputs in plant and animal production (plant and agricultural land groups) [manhour·ha^{1}]

Group	Parameter	Grain	Root	Fodder crops	Vegeta-bles	Herbs	Grass-lands	Orchards and planta-tions	Animal produc-tion
I	average	41.9	287.0	58.2	1107.5	30.9	35.4	654.9	262.7
	standard deviation	23.2	388.6	127.3	2079.7	107.1	44.8	828.0	222.5
II	average	27.4	272.6	71.3	462.7	-	31.5	439.6	195.3
	standard deviation	23.2	355.6	119.5	1131.7	-	49.6	1326.9	137.6

Table 3 - cont.

III	average	23.6	107.1	28.9	269.6	9.4	8.1	105.8	74.8
	standard deviation	24.6	116.1	31.1	621.6	32.7	7.8	155.4	88.2
IV	average	31.7	104.4	24.0	43.6	-	13.7	-	70.5
	standard deviation	20.2	81.1	11.8	130.8	-	6.1	-	44.6
To-tal	average	30.8	206.1	49.4	495.7	9.7	23.6	332.0	160.1
	standard deviation	23.4	294.5	94.6	1273.1	54.5	37.5	892.5	160.1

4. Conclusions

Participation of commodity production in total plant production was varied and was within 55.5% for grains to as much as 100% for specialistic crops such as herbs. Whereas, in animal production, participation of commodity production for milk is at the average of 71.8%, 58.4% for meat and 55.3% for eggs.

Labour inputs for plant production were high and amounted to respectively: 30.8 manhour·ha^{-1} grains, 206.1 manhour·ha^{-1} root plants (potatoes) and 495.7 manhour·ha^{-1} vegetables. Organization of field works related to manual loading and unloading of pressed straw, manual harvesting of potatoes after a potato spinner and manual harvesting of vegetables decisively influenced such a high level of labour inputs. Labour inputs in animal production were at the average of 160.1 manhour·ha^{-1}.

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DRIFT REDUCTION RATE OF THREE ANTIDRIFT NOZZLES USED FOR SPRAY APPLICATION IN BARLEY

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Key words: barley, reduction rate, drift-reducing nozzles, standard nozzles, drift

Abstract

We have done experiments on a field of barley where we have studied a possibility of lowering the drift FFS with using the antidrift nozzles. After applying, we have measured a share of spray deposit on the distance of 0, 1, 2, 5 and 10 meters away from the edge of the field using the fluorescent tracker. All measurements have been done in four repetitions. We have compared a perimeter of skidding with standard nozzle (Lechler LU 120-03) and three antidrift nozzles (Lechler ID 120-03, Albuz AVI – TWIN 110-03, and AGROTOP Turbodrop HiSpeed 110-03) with a deposit of 250 liters of spray deposit on hectare. A share of spray deposit that was skid lowered with the distance from the edge of the field with all measured distances. The smallest drift was achieved with the nozzle HS. The size of the droplets significantly influenced the part of the drift where the drift was the biggest with the nozzle LU (VMD = 185). When using different types of nozzles with similar sizes of droplets and approximately same speeds of wind in the time of deposit the drift is the same. Antidrift nozzles lowered the drift for 70–85% on all measured distances.

FARMERS COLLABORATION – A FACTOR IN THE DEVELOPMENT OF SUSTAINABLE AGRICULTURE

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Keywords: farmers collaboration, machinery costs, labour management

Introduction

The definition of the sustainable agriculture covers not only the ecological and technological aspects but also economic and social. As one of many definitions of sustainable agriculture [SAI] states: "Sustainable agriculture is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species." Those aspects are especially important in case of small, family farms with area of a few hectares and economic value of a few ESU. Without doubt, farmers' collaboration, in terms of planning and realization of work activities, would improve the economic results of farms as well as quality of life for farm families.

Forms of collaboration in mechanization

Proper realization of many agricultural activities requires access to many machines and equipment, which in general is very expensive. It is quite normal that in case of small farms with small areas and low income it is not possible to keep own machinery. One of the possible solutions is collaboration between farmers. In most cases, farmers collaborate with each other both formally and informally, using a variety of methods for work organization and to settle costs and efforts. It is typical in countries with majority of small, few hectares, farms but also in case of bigger farms, even with areas of hundreds of hectares [de Toro and Hansson 2004, Lorencowicz 2005].

The possible solutions for farmers' cooperation can be classified as follows [Landers 2000, Theunissen 2002, Wesche 2004, Witney 1988]:

- machinery syndicates - both formal and informal groups,
- machinery rings,
- machinery co-operatives,
- neighbours' cooperation – both in terms of contract work and work exchange.

Farmers' collaboration has a lot of advantages and contributes to the following:

- savings in cost of mechanization,
- reduction of investments outlays
- improvement in access to new technologies
- specialization, both in terms of work done and type of production
- attain additional income

It can also create more free time for farmers which can be spent with their families or used for professional development.

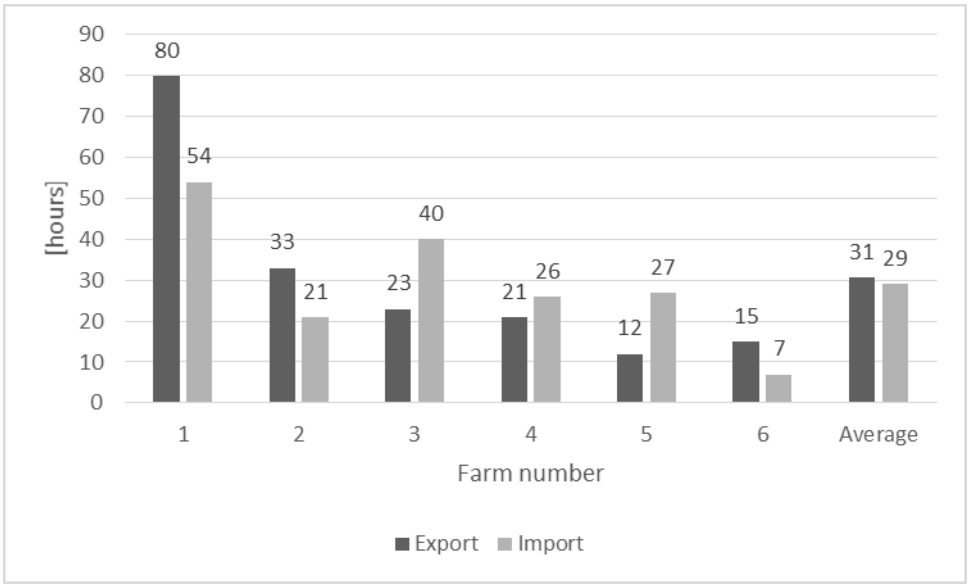
Case study

Analysis was performed for 6 selected farms in Lublin Province [Pawluk 2007]. Farm owners were members of the same family and cooperated with each other in an informal way for many years. It was mainly neighbours' cooperation, settled in monetary terms. However, there were also settlements by exchange of work and agriculture products. The farms under consideration were diverse in terms of arable areas and technical equipment (Tab. 1). The agricultural areas varied from 8.57 ha (the smallest farm) to 76.47 ha (the biggest farm).

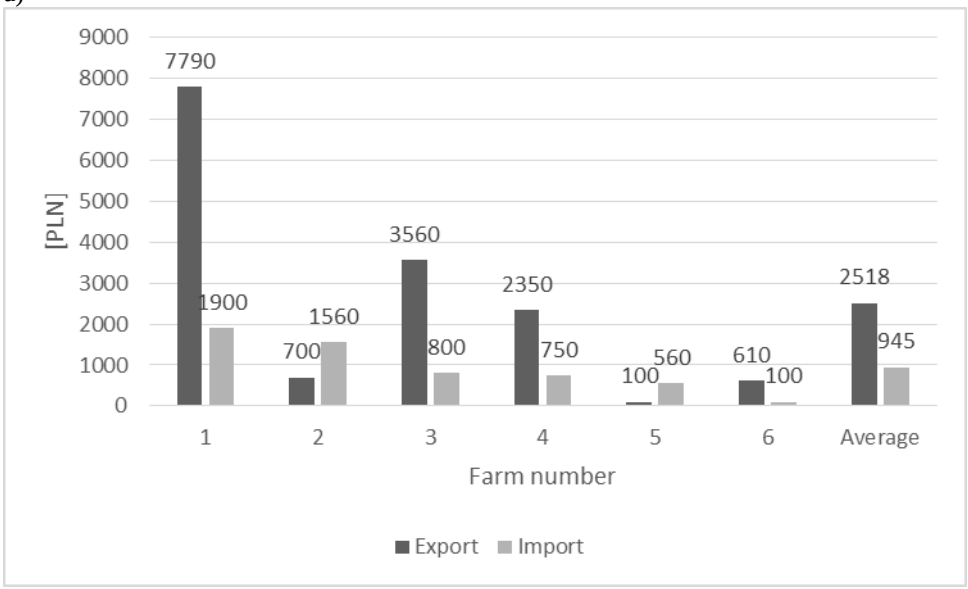
Table 1. Characteristics of selected farms

Item	Farm Number							
	1	2	3	4	5	6	Average	Total
Arable area [ha]	76.47	47.00	18.73	16.30	13.15	8.57	30.04	180.22
Value of machinery [thousands of PLN]	1,905.7	964.6	109.2	183.8	188.4	205.9	592.9	3,557.6
Value of machinery per ha [thousands of PLN/ha]	24.921	20.522	58.30	11.277	14.325	24.030	16.818	X
Tractor power saturation [kW/ha]	2.7	3.0	1.2	2.1	2.6	2.6	2.5	X
Machinery average age [year]	10.2	21.7	17.3	23.5	19.8	19.0	18.7	X

The total value of machineries varied from PLN 0.11M to PLN 1.9M. Tractor power saturation was on average 2.5 kW/ha. The machinery was relatively old as the average age was almost 19 years and it varied from 10.2 to 21.7 years. The above indicates low investment ability of the farms.
The number of contract work done by a particular farm depended on its work and machinery capacity and varied between 16 hrs. to even 80 hrs. per year (Fig. 1a). The yearly income varied between PLN 1,000.00 to even PLN 7,790.00 (Fig. 1b).



a)



b)

Figure 1. For selected farms (a) Export and Import of work hours (b) Income and Cost of contract work

The analysis of the operation cost of the machinery used in farmers' collaboration showed its reduction due to the increase of machines use during a year. Such reduction reached even 62% in case of a combine harvester.

Conclusions

Farmers' collaboration is an important form of satisfying technological needs in case of fragmented agriculture; at the same time it reduces the costs and outlays. It allows the farms to fulfil the requirements for sustainable agriculture improving, at the same time, the quality of life for farm families. According to farmers under investigation, the most important factor in favour of collaboration was lack of own equipment and, in case of elderly farmers, limited possibility of own work. Despite relatively low economic gain and frequent use of non-monetary forms of settlements, the farmers' collaboration practised throughout the years afforded proper operation of the farms and protected their owners in case of lack of technical means.

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RESONANCE PUMP FOR APPLICATION IN DESERT AREAS

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Keywords: resonance vibrating pumps; spring suspension system; solar power

Introduction

Pumping water in the desert and remote countryside in the absence of electricity has always been a great engineering challenge. A cheaper and easy means for solving this problem is to use a resonance vibrating pump. Although these pumps were primarily invented and used for many decades in oil industry they could be used for pumping ground water from deep wells for agricultural applications.

Resonance Pump

Resonance pumps, known formerly as sonic pumps, were invented in the early fifties of the 20^{th} century and since then were used for pumping crude oil from as deep as 2000 m, as well as water from 30 to 150 m [1]. Unfortunately these pumps are almost unknown today as they have been superseded by submersible centrifugal, screw, and rod-pumps. However, the current generation of pumps is electrically powered, which restricts their use in the non-electrified regions in the desert and semiarid areas of Africa, Middle East, and central Asia.

Resonance pump utilizes the resonance vibrations of one degree-of-freedom oscillating system. The pump is powered by a mechanical shaker consisting of two counter rotating offset masses and as the name suggests operates in resonance [2].

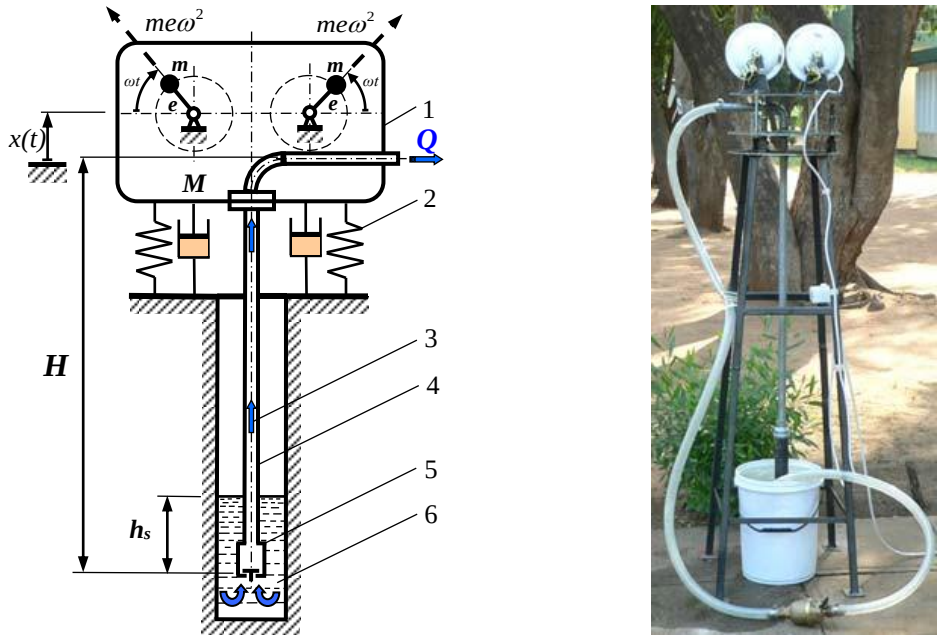
Fig. 1,a shows the dynamic model of a low frequency sonic pump furnished with a spring loaded poppet valve whereas Fig. 1,b shows the physical model of the pump [3]. Apart from the mechanical shaker, the pump entails a valve which is attached to the bottom end of the oscillating pipe and submersed at a depth of h_s under the water level in the well. The pump is modelled as one degree-of-freedom oscillating system and for simplicity of the analysis it is assumed that both the pipe and the water column (*WC*) in the pipe are solid bodies.

The theoretical analysis of the dynamic model yielded the following expression for the flow rate of the pump in litres per minute [4]:

$$Q = 250\pi d_v^2 X_{rel} n \qquad (m^3/min)$$

where,

X_{rel} - is the stroke of the virtual reciprocating pump (m),
d_v - is the inlet diameter the foot valve (m), and
n - is the angular speed of the shaker (rev/min).



(a) (b)

Figure 1. (a) The dynamic model of a sonic pump: 1 – dual shaft shaker, 2 – spring suspension system, 3 – water column (*WC*) in the pipes 4, 5 – spring-loaded poppet valve, and 6 – aquifer of the well. (b) The physical model of the pump.

The actual model of the pump developed (Fig. 1b) had the shaker composed of two small AC motors intended for ceiling fans, which were set to rotate in opposite directions and synchronized by employing timing belt rubber gears. The amount of the unbalanced mass per motor was m = 0.176 kg offset at a radius of 0.0895 m. One of the motors was passive and the other one active, delivering 60 W power output at 360 rpm. An electronic control device was used to vary the speed of the active motor to achieve resonance in the oscillating system [4].

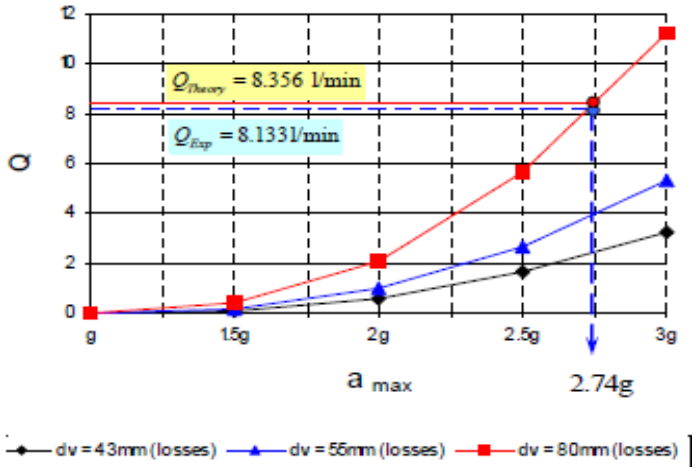


Figure 2. Comparison between theoretical and experimental flow rates for 3-inch valve

Fig. 2 shows the theoretical predictions of the flow rate for 1.5, 2, and 3-inch valves versus different accelerations of the oscillating system [4]. In this figure the point of the experimental flow rate is shown, obtained with a 3-inch valve without a strainer, at frequency of 5 Hz, amplitude 21.4 mm, acceleration 2.74g m/s^2, and a depth of pumping H = 1.65 m, considering the fluid losses in the pipe system.

Solar Powered Sonic Pump

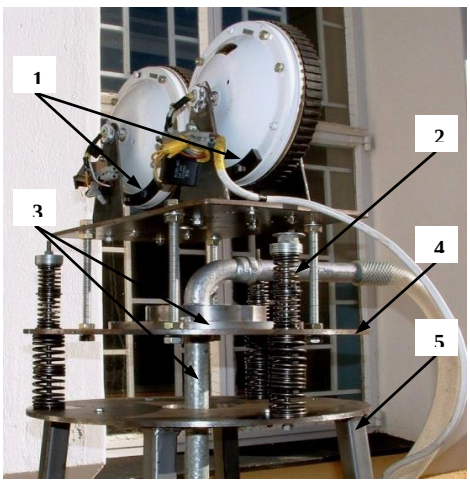


Figure 3. Sonic pump assembly: 1-offset masses of the shaker, 2-spring suspension system, 3-oscillating pipes with the additional mass connected to the oscillating plate 4, and 5 is the supporting stand.

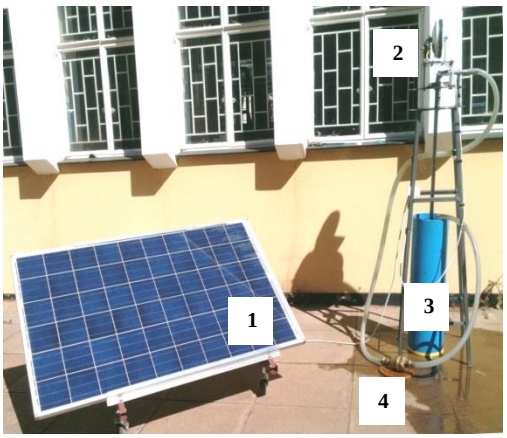


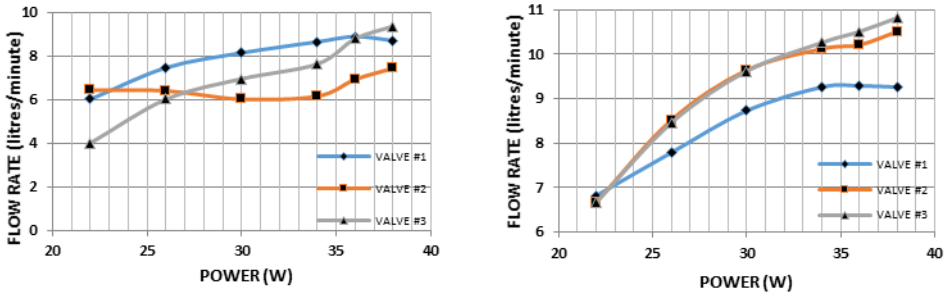
Figure 4. Side view of the solar powered sonic pump where: 1- solar panel 230W 80V, 2 - sonic pump, 3- source of water (well), 4 - water meter "C-PHB 3122" of 2.5 m^3/h water metering capacity.

For the experimental analysis of the resonance pump powered by solar power the following modifications to the original model (Fig. 1b) were done:

- *Increasing* the offset masses of the shaker to improve the shaker unbalance to a 0.0408 kgm;
- *Installing* a new set of springs for the pump suspension system providing large resonance amplitudes of the oscillating system. As seen in Fig. 3 a special spring assembly was designed to provide large amplitudes at low resonance frequency. The total stiffness of the spring suspension system was set to be 29227 N/m in order to get a shaker resonance speed of 320 rev/min, or pump resonance frequency 5.33 Hz, corresponding to a total oscillating mass of 25.21kg.

The photovoltaic power supply unit consists of a polycrystalline solar panel, charge controller, DC-AC inverter and a Power & Energy monitor. All equipment was mounted upon the supporting frame of the solar panel for mobility and easy tracking of the sun during the experiments. In addition there were two silver-calcium batteries, connected in parallel maintaining the power supply when there was no sun energy.

The Power & Energy Monitor used in the experiments measured voltage, amps, watts, volt-amps, frequency and the power factor in the AC grid and had a maximum current measuring capacity of 15A. The measurements were predominantly done for the power consumption of the pump at different power setups when assessing the flow rate of the pump. Examples of the results are presented in Fig. 5 (a & b), for 1.5″ and 2″ valves respectively



a) b)

Figure 5. Relationship between the flow rate and the input power for (a) 1.5 inch and (b) 2 inch valves.

Conclusions

Resonance pumps are suitable for pumping water from deep boreholes (200 meters and more) in the deserts and remote areas. These pumps possess good efficiency, have a simple and reliable design, and are easy to maintain in practice. They can pump water mixed with sand and other hard particles, can be employed in boreholes of very small diameters (4″), their flow rate is controlled by changing the excitation force in resonance, they are self-

priming pumps, and can be powered by a small engine or solar power. The vibrating pumps are ideal for rural water applications in the developing countries of Africa, Asia and Latin America.

Experimental results proved that the theoretical modeling and analysis was correct and suitable for the pump. They also confirmed that pump achieved desirable flow rate in operating at a particular depth. It was also proved that the resonance pump can be successfully powered by solar energy and is more effective than the original model.

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PREVENTION OF HARMFUL ORGANISMS DEVELOPMENT IN POLAND IN THE LIGHT OF INTEGRATED PLANT PROTECTION REQUIREMENTS

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Keywords: integrated plant protection, prevention methods, Poland

1. Introduction

Integrated Plant Protection will be obligatory in Poland, as well as in all European Union member states, from the 1st of January 2014. According to the general principles of Integrated Plant Protection laid down in the Directive 128/2009 of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, non-chemical methods should have priority over chemical plant protection. Among non-chemical methods of pest control particularly important is prevention.

2. Material and methods

The main purpose of the analysis was to assess the importance and scale of use of individual prevention methods in Polish agriculture with the regard to the most important agricultural crops.

The analysis was based on the data of Polish Central Statistical Office, Ministry of Agriculture and Rural Development and literature.

3. Results

The prevention of harmful organisms can be achieved especially by:

— crop rotation,
— use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing),
— use, where appropriate, of resistant/tolerant cultivars and standard/certified seed and planting material,
— use of balanced fertilisation, liming and irrigation/drainage practices,
— preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment),
— protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilisation of ecological infrastructures inside and outside production sites.

Polish agriculture is not homogenous. It is characterized by small average farm area which amounts to about 10.5 ha of agricultural land [1], however more than half of the farms produce exclusively or mainly for their own

needs. The owners of these farms see their production as a source of food for their family and a way of family expenses reduction. These farms, holding a relatively small area, make use of traditional production methods, with low use of mineral fertilisers, chemical plant protection products and commercial feeds [2]. There are over 1.2 million farms with the area below 10 hectares in Poland (fig. 2), but together they possess only 21% of the sown area in Poland (fig. 1). On the other hand to the significantly less numerous group of farms with the area exceeding 20 hectares belongs over 45% of the total sown area in Poland [3].

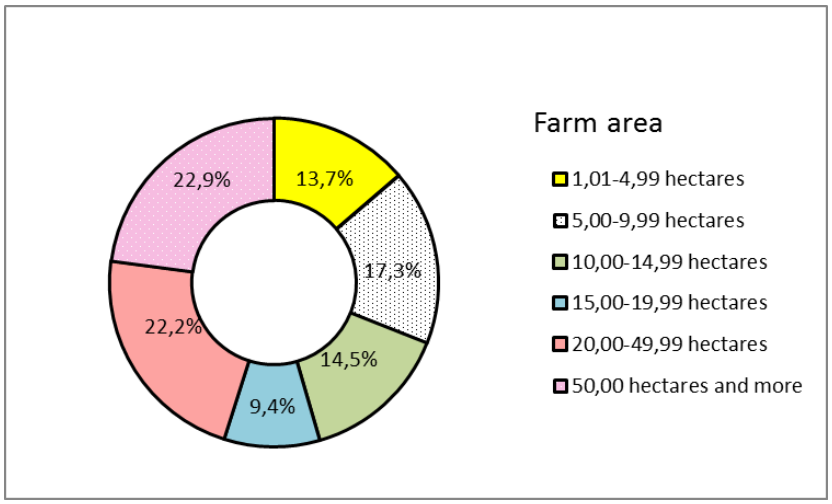

Figure 1. Share of sown area in Poland according to the farm size in 2011
Source: Central Statistical Office 2012

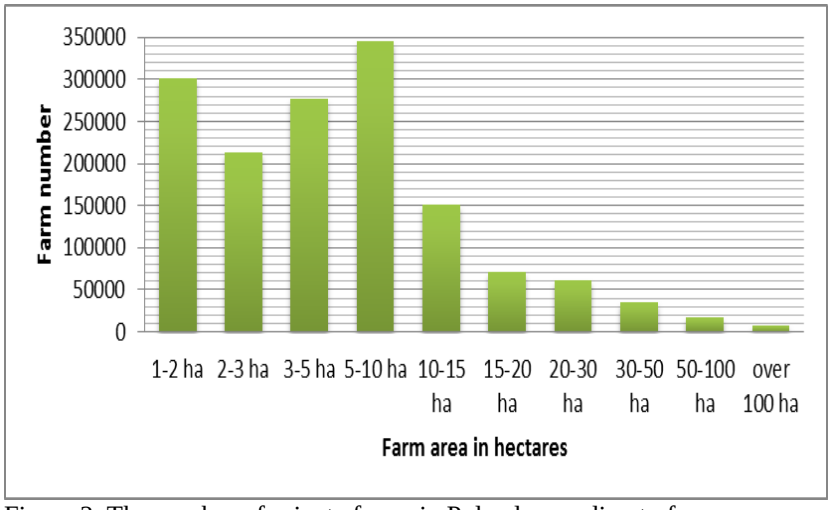

Figure 2. The number of private farms in Poland according to farm area.
Source: Central Statistical Office 2012

The farmers themselves are also diversified group. About 20% of farmers have elementary education only, but mainly the owners of the smallest farms belong to this group. Over ¼ of heads of farms with the area over 100 hectares has higher agricultural education [4]. The highest share of farms with commodity production is located in Kujawsko-Pomorskie and Wielkopolskie provinces while the lowest in Podkarpackie and Małopolsie provinces.

4. Conclusions

From the point of view of fulfilling the requirements of Integrated Plant Protection the small farms belonging to poorly educated farmers are often forward the big farms with specialised production run by farmers with higher education [5]. It is not the result of the farmers' special efforts, but rather of making use of traditional cropping systems. Probably some of the farmers are even not aware that following the methods used by their parents and grandparents they successfully fulfil the most recent European Union requirements.

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EFFECT OF A PLOUGH WITH FURROW SLICE CRACKER ON THE CRUSHING DEGREE IN THE SEEDBED USING A NEW APPROACH OF IN-SITU AIR PERMEABILITY MEASUREMENT

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Keywords: mouldboard plough, furrow slice cracker, air permeability

1. Introduction

One of the main task of the secondary tillage is to prepare a seed bed for the different crops according their specific requirements. Ploughing with a mouldboard plough for primary tillage is often used for formation of a plant residue-free surface. On heavy soils the formation of bare furrows after ploughing leads to cryoturbation (loosening of the soil through freezing of the soil water) during winter. For seeding of winter crops (cereals, rapeseed, etc.) on heavy soils, the time window for ploughing and seed bed preparation could be too small because the optimal time is limited through the suitable soil water content. For supporting of soil loosening and drying on heavy soils, ploughs can be combined with a furrow slice cracker (Figure 1). According farmer experiences the furrow slice cracker can substitute the secondary tillage (seedbed preparation) on light soils (e.g. sandy loam).

Figure 1. 4 furrow reversible mouldboard plough (Vogel&Noot®; 4x45 cm) with mounted furrow slice cracker (Kerner®)

The aim of the investigation was to analyze the effect of the furrow slice cracker (Figure 1) in heavy soils on the loosening and compaction degree in the seedbed. For measuring the loosening and compaction degree of the seedbed a new approach (in-situ air permeability) was used. Additional the moisture situation after the seedbed preparation was measured.

2. Material and methods

The investigations were carried out on 2. and 3. October 2012 on a arable farm in Kleinfrauenhaid (Province of Burgenland; mean precipitation of 600 mm) on a sandy clay soil [1]. The used tractor for ploughing was Deutz Agroton 135 MK3 (130 kW). The field (length 327 m) with the previous crop (winter cereal) was separated in stripes with a width of each 5 m. Three long plots where ploughed (25 cm) on 2 October with the furrow slice cracker and three without the furrow slice cracker. On 3 October the seedbed preparation and seeding was done with a combined power harrow-seeding machine (Vogel&Noot/Gaspardo, 3 m). Three soil parameters (pneumatic conductivity, water tension and moisture content) are measured immediately after the seedbed preparation and seeding process. This was done with a combined field measurement PL-300 ([2], figure 2). The pneumatic conductivity describes the waterfree pore space of the soil and is a function of water content. A defined air flow is generated using a measurement chamber in the soil volume investigated. The rate of flow is determined from the drop in pressure through a calibrated two stage measurement throttle in the PL instrument. The pressure difference above the soil volume is recorded by a further pressure sensor and supplies the pressure gradient of this flow. The pneumatic conductivity is calculated from these test parameters using the DARCY equation and shown in the instrument display. The PL-300 also has connections for an electronic soil tensiometer and a moisture probe so that soil moisture tension and/or soil moisture may be recorded parallel to each other. The data of all connected sensors as well as the calibration data of the measurement chambers and a marking of the measurement point are saved and managed by a microcomputer within the instrument (UGT, 2012). The measurement of the soil conductivity was done with the ring-camber (height: 6.1 cm, diameter: 7.2 cm). Before the field measurement was started, the calibration was done with a calibration throttle. The measurements were done with the measuring throttle 2, which is suitable for soils with low permeability (1.5....0.03 cm/s). From each variant (mouldboard plough without mounted furrow slice cracker; mouldboard plough with mounted furrow slice cracker) 16 randomly measurements were carried out. One measurement of the three parameters took about 10 min.

Figure 2. Field measurement (UGT®) of soil moisture content (TDR-moisture probe), water tension (tensiometer) and PL-300 measurement chamber for homogenous flow according to DARCY with integrated pressure probe.

3. Results

The furrow slice cracker supports mechanically the loosening process during the turning of the furrow. The result is that the soil is cracked in more aggregates with a changed surface/volume ratio. After one day the seedbed preparation was done and the effect of the soil parameters were measured. The results (Table 1) show that the mechanically cutting of the soil furrow increased the drying process of the soil. The mean soil moisture content of 14.38 % is statistically significant lower than without using the furrow slice cracker. The water tension was not changed. It must be mentioned, that water tension measurements are very sensitive and error prone.

The mean pneumatic conductivity show significant difference in the compactness of the seedbed. After ploughing with mounted furrow slice cracker and seedbed preparation (power harrow), the soil aggregates are more compacted than without the mounted furrow slice cracker. The mean measured pneumatic conductivity was significant smaller. This measured effect was also confirmed by the sinking effect, if you are going on the prepared seedbed. The sinking is deeper on the seedbed, where the plough was not combined with the furrow slice cracker.

Table 1. Mean values (N=16) with standard deviation for the top soil parameters after ploughing and seedbed preparation.

	Mouldboard plough **without** mounted furrow slice cracker	Mouldboard plough **with** mounted furrow slice cracker
Soil moisture (Vol. %)	$19.75^{A*} \pm 8.11$	$14.38^{B} \pm 5.18$
Water tension (kPa)	$80.22^{A} \pm 1.70$	$79.53^{A} \pm 4.08$
Pneumatic conductivity (10^{-3}cm/s)	$21.99^{A} \pm 7.31$	$13.02^{B} \pm 4.55$

*different letters indicate statistically significant differences (α=0,05); T-Test

The first results show also, that the measurement approach of the pneumatic conductivity with the PL-300 measurement chamber is suitable for measuring the compactness of the seedbed. Further investigations in combination with other physical soil parameters (bulk density, soil penetration resistance etc.) are necessary to get detailed view of the physical properties of the seedbed.

4. Conclusions

Mouldboard ploughing in combination of the furrow slice cracker is used to support the crumbling effect. Farmer experiences on light soils (e.g. sandy loam) show, that the seedbed preparation process can be omitted. Results of the carried out investigation on heavy soils show, that the increased amount of smaller aggregates improves the field drying process. After seedbed preparation, the top soil has lower moisture content, if a furrow slice cracker was used in ploughing.

Also the compactness of the soil after the seedbed preparation was higher, which could be confirmed by results of the soil permeability measurement.

The parameter "pneumatic conductivity" was a plausible and reliable parameter to describe the physical properties of the seedbed.

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POLISH AGRICULTURAL MACHINERY MARKET 2000-2012

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Keywords: agricultural machinery, market, production, import, export

1. Introduction

According to VDMA [2013] estimates, in 2012 the world production of agricultural machinery amounted to € 91 billion [VDMA 2013]. This was an increase of 13% compared to the previous year (€ 80.2 billion) – fig.1. In Europe (EU 27) the volume of the agricultural machinery market compared to 2011 increased by 5.5% to € 25.7 billion, what is the volume of the market in year 2008 [VDMA 2012]. The last two years show steady recovery of this sector of industry after decline in sales in 2009 and 2010, which was a result of the global financial and economic crisis.

After accession to the EU, Poland has become an increasingly significant shareholder in the European market for agricultural machinery. Currently, Poland is the largest market of agricultural machinery in the central European region (EU'12 - entry 2004 and 2006) with a volume of €1.5 billion in 2012. This value gives Poland the fifth position in the EU'27 market after Germany (€5.4 billion), France (€4.8 billion), UK (€2.3 billion) and Italy (€1.9 billion) [VDMA 2013].

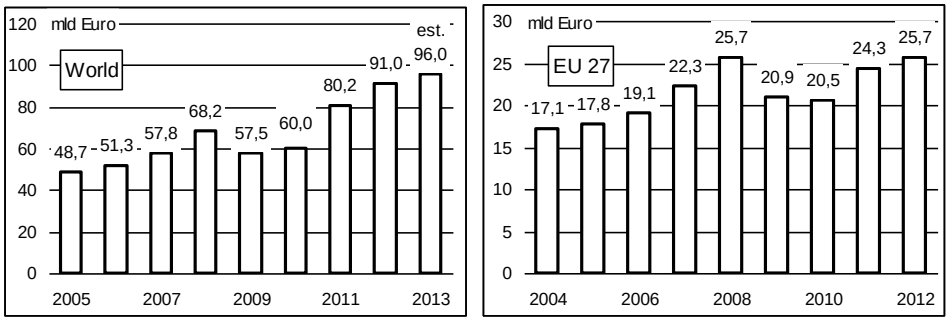

Figure 1. Worldwide agricultural machinery production and market volume in the European Union

Source: [VDMA 2006, 2008, 2010, 2012, 2013]

In the global economy, changes and trends in the world and EU market of agricultural machinery also affect the Polish market of agricultural tractors and machines. The aim of this study is to analyze the Polish market of agricultural machines and tractors within years 2000-2012. The analysis includes market volume, expressed in monetary units and for some types of equipment in pieces.

2. Material and methods

The market of agricultural machinery is determined as the sum of supplies from domestic production and imports, less export (Market = Production + Import – Export). Such defined volume indicates a change in the value of domestic agricultural resources of mechanization means and is slightly smaller than the actual demand (purchase of equipment) by the value of exports of used equipment. The analysis does not include the market value of trade between farmers.

The analysis was based on the following data:
Central Statistics Office (Production of industrial products - years 2000-2012, Bank of foreign trade data), Agency for Restructuring and Modernisation of Agriculture (Reports on the activities), publications of IERiGZ concerning the market of production means for agriculture, estimations of VDMA (German Association of Machinery and Equipment Manufacturers), own market unpublished data.

3. Results

In the years 2000-2012 the market of the agricultural machines and tractors in Poland increased at current prices more than three times, reaching in 2012 PLN 7.03 billion (€1.67 billion) - Figure 1 and 2. The breakdown of sales of agricultural equipment in 2009 by 23%, compared to 2008, was due to the global financial crisis, affecting the purchasing power and willingness to invest in agriculture. In real terms, taking into account the annual price index of agricultural machinery, the domestic market for agricultural equipment increased in the period 2000-2012 nearly 2-fold.

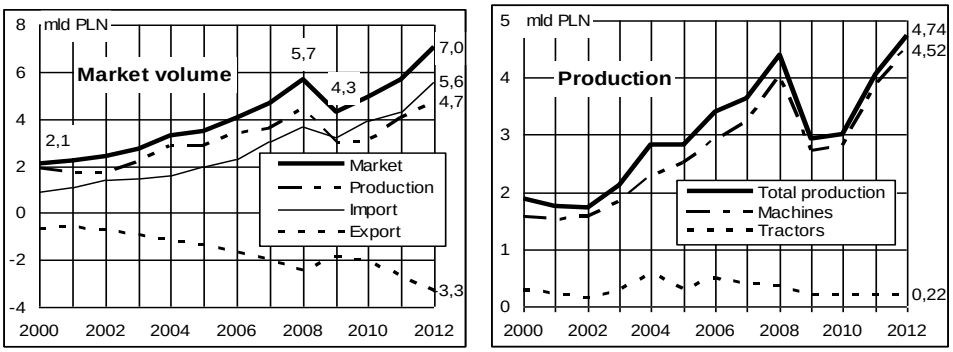

Figure 2. Volume of Polish market and production of agricultural machinery
Source: Own estimations based on data of GUS [2000-2012, 2001-2013]

The main sources of funding for investment in modernizing farms were EU development programs, including SAPARD and also rural (2004-2006) and scrotal (2004-2006) development programs. In the last years the demand

for agricultural equipment was driven mainly by means of the program Rural Development Programme for 2007-2013. In subsequent years, the demand for agricultural machinery will depend on the shape of the EU Common Agricultural Policy in the 2014-2020 financial perspective.

In the years 2000-2012 the highest growth rate was characterized by the import of agricultural machinery - 6.4-fold increase in the current prices, and the smallest domestic production, which value in the analyzed period has increased in current prices only 2.5-fold – figure 2. The value of exports increased more than 5-fold.

Poland is a net importer of agricultural equipment. In the years 2000-2012 the value of imports amounted to PLN 34.5 billion, while the value of exports only to 21.4 billion PLN. The negative balance in foreign trade of agricultural machinery is 13.1 billion PLN. In 2000, the share of imports in the supply of agricultural equipment for the domestic market was 42%, whereas in 2012 as 84%.

In the years 2000-2012 the value of production of agricultural mechanization means increased 2.5-fold, including the increase of agricultural machinery by 2.9-fold. The value of tractors production increased by 2004 to 580 million PLN, and then decreased in 2012 to about 220 million PLN. Compared to the year 2000, this represents a reduction of 36%. In real terms the value of production of agricultural machines and tractors increased during this period only 1.5-fold.

It can be seen in the period 2000-2012 a significant increase in the production of various types of machinery, for example: combine harvesters-threshers (4.08-times), agricultural trailers (4.54-times), field seeders (2.84-times) and other machines – table 1. A large part of this production goes to foreign markets. As mentioned above, significantly decreased the production of tractors, from 7,195 units in 2000 and 8,510 units in 2004 to just 3,539 units in 2012 (a decrease of 51%).

Table 1. Production of selected agricultural machinery in Poland (in pieces)

Specification		2000	2004	2006	2012	2012/2000	2012/2004	2012/2006
Tractors total,		7195	8510	6720	3539	0,49	0,42	0,53
of which of an engine power:	59 kW and less	6207	6805	5120	1482	0,24	0,22	0,29
	more than 59 kW	977	1705	1600	2057	2,11	1,21	1,29
Ploughs		5323	6134	6682	9580	1,80	1,56	1,43
Field seeders		2182	2315	2883	6199	2,84	2,68	2,15
Mowers		6226	5068	5786	10004	1,61	1,97	1,73
Combine harvester-threshers		441	821	1215	1798	4,08	2,19	1,48
Sprayers		6702	11759	11950	11703	1,75	1,00	0,98
Trailers		2648	3647	5970	12028	4,54	3,30	2,01

Source: Own estimates based on GUS [2001-2013] and IERiGZ [2001-2013]

However, it is worth paying attention to more than double the production of tractors with an engine power of more than 59 kW.

The Polish market of agricultural tractors has changed over the years. According to data from the Central Statistical Office [GUS 2001-2013] in years 2000-2012 supplies of tractors for the domestic market increased more than two-times from 11.2 to 23.3 thousand units. Particularly significant is a 16-fold increase in the supply of new imported tractors, while nearly two-fold decrease in supply of imported used tractors. Deliveries of tractors from Polish producers decreased by 3.5-fold. In the years 2000-2012 the sale of tractors in Poland amounted to 211.491 items, including 57% imported new ones, 26% of imported second-hand tractors and 17% of new tractors from domestic production.

Table 2. Supplies of agricultural tractors on Polish market, in thousand pieces

Specification	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Total supplies, of which:	11,2	9,8	12,1	14,1	13,5	13,2	18,4	22,0	22,5	14,5	18,2	18,6	23,3	211,5
Import of new tractors	1,2	2,0	3,4	4,8	5,5	7,1	10,2	13,3	15,1	10,0	13,9	14,4	19,5	120,5
Import of second hand tractors	3,5	5,3	7,5	6,6	3,6	3,4	5,0	5,4	4,8	2,7	2,8	2,7	1,9	55,1
Sales of Polish new production tractors*	6,4	2,5	1,2	2,7	4,5	2,8	3,2	3,3	2,6	1,8	1,5	1,5	1,8	35,9

Source: Own estimates based on GUS [2001-2013] and unpublished data
** Sales of Polish tractors = production of Polish tractors diminished by exported ones*

The economic situation in agriculture as well as on the market of agricultural machinery and the globalization of this segment of economy have undoubted impact on the condition of Polish producers of agricultural equipment. Due to the above factors in the last 18 years (1995-2012) the number of employees in polish agricultural machinery industry dropped from approximately 35,800 in the year 1995 to 16,300 in the year 2000 and to almost 14,000 in the year 2012. Respectively, the number of companies in agricultural machinery industry dropped from 123 to 98 and 70 ones.

Detailed analysis of the relationship between the market value of agricultural equipment in Poland in the years 2000-2012 and macroeconomic factors shows that the growth and volatility of the market depends largely on: the availability of preferential loans, investment subventions from EU programs of rural development and farm modernization, agricultural incomes, the current situation shaped by agricultural procurement prices of

cereals, maize, rapeseed, milk. In-depth analysis of this issue will be the subject of a separate publication.

4. Conclusions

In years 2000-2012 Polish market of agricultural machinery has increased above three-times to 7.03 billion PLN. This value gives Poland the fifth position in the EU'27 market and the first position in the EU'12. Since 2000, gradually increases the share of imports in the supply of agricultural machinery and currently stands at 84%.

Domestic production of various types of agricultural machines is also increasing, but at a slower rate than the market of mechanization means of agriculture. It was found a significant increase in a production of combine harvesters-threshers, agricultural trailers, field seeders and other machines. On the other hand production of tractors has diminished above 2-times.

These changes have an impact on the improvement of agricultural equipment with modern mechanization means (see results of the National Agricultural Census 2010) as well as on a state of Polish industry of agricultural machines and tractors.

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MATHEMATICAL MODEL OF TOTAL STATIC DISTRIBUTION OF MINERAL FERTILIZERS

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Keywords: spread, mineral fertilizers, centrifugal spreaders

The aim of this study was to investigate the effect of selected parameters of construction and operating centrifugal spreader on the total static distribution of mineral fertilizers with different physical properties (urea, ammonium nitrate, ammonium sulfate). On the basis of the results from stationary researches the determination was made of the distribution parameters of fertilizers in the polar coordinate system with center located at the point of disc rotation, fig. 1.

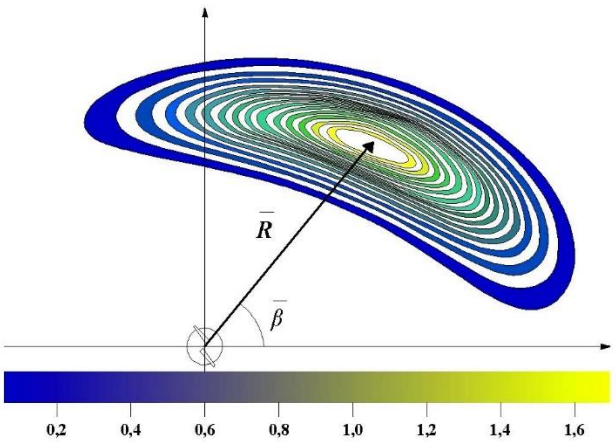

Fig. 1. Determining the parameters of the spread area in the polar coordinate system

The parameters of this area are the mean angle of spread ($\overline{\beta}$) and mean radius of spreading fertilizer ($\overline{R}$), which was calculated by the following equation (Koko and Virin, 2009, Coetzee and Lombard 2011):

$$\overline{\beta} = \sum_{i=1}^{n}\sum_{j=1}^{m} f_{ij}\beta_{ij} \tag{1}$$

$$\overline{R} = \sum_{i=1}^{n}\sum_{j=1}^{m} f_{ij} r_{ij} \tag{2}$$

where:

f_{ij} − mass fraction of particles in the collector tray, g

β_{ij} − angle of the ij-th collector of particles in the collector tray, °

n − number of rows of trays,

m − number of columns of trays,

r_{ij} − radius of the ij-th collector of particles in the collector tray, m.

Based on the calculated parameters of the tested fertilizers spread area and statistical analysis of the results (mean, standard deviation) a probability density was proposed of the normal distribution of two variables (in the absence of traffic centrifugal spreader). It can be a useful function for modeling mineral fertilizer spread process by centrifugal spreaders. The form of this function is as follows:

$$Q_i = \frac{m_i(t)}{2\pi\sigma_r\sigma_\beta} \cdot \exp\left[-\frac{\left(r(t) - r_i^m(t)\right)^2}{2\sigma_r^2} - \frac{\left(\beta(t) - \beta_i^m(t)\right)^2}{2\sigma_\beta^2} \right] \tag{3}$$

$$Q_L(m_L, \overline{R}_L, \overline{\beta_L}, t) = \frac{m_L(t)}{2\pi\sigma_{R_L}\sigma_{\beta_L}} \cdot \exp\left[-\frac{(R_L - \overline{R_L})^2}{2\sigma_{R_L}^2} - \frac{(\beta_L - \overline{\beta_L})^2}{2\sigma_{\beta_L}^2} \right] \tag{4}$$

$$Q_P(m_P, \overline{R}_P, \overline{\beta_P}, t) = \frac{m_P(t)}{2\pi\sigma_{R_P}\sigma_{\beta P}} \cdot \exp\left[-\frac{(R_P - \overline{R_P})^2}{2\sigma_{R_P}^2} - \frac{(\beta_P - \overline{\beta_P})^2}{2\sigma_{\beta_P}^2} \right] \tag{5}$$

$$Q_{total} = Q_L(m_L, \overline{R}_L, \overline{\beta_L}, t) + Q_P(m_P, \overline{R}_P, \overline{\beta_P}, t) \tag{6}$$

where:

Q_L, Q_P – total static distribution spread for left and right disc, kg·s^{-1}·m^{-1}·(°)$^{-1}$

Q_{total} – total static distribution spread for two discs, kg·s^{-1}·m^{-1}·(°)$^{-1}$

$m_L(t), m_P(t)$ – mass flow rate for left and right disc, kg·s^{-1}

$\overline{R_L}, \overline{R_P}$ – mean radius for left and right disc, m

$\overline{\beta_L}, \overline{\beta_P}$ – mean angle for left and right disc, °

$\sigma_{R_L}, \sigma_{R_P}$ – standard deviation of radius of spread area for left and right disc, m

$\sigma_{\beta_L}, \sigma_{\beta_P}$ – standard deviation of angle of spread area for left and right disc, °.

Experimental studies made it possible to develop a model of the interactions between parameters of the total static distribution (spread of

fertilizer) and some of the operating parameters that can be the basis for carrying out computer simulations. Sample test results and regression based on the studied traits (S – angle setting of the vanes, V – rotational speed of the disc, G - density of the fertilizer, FP - powdery fraction) for ammonium sulfate are shown in figures 2-4.

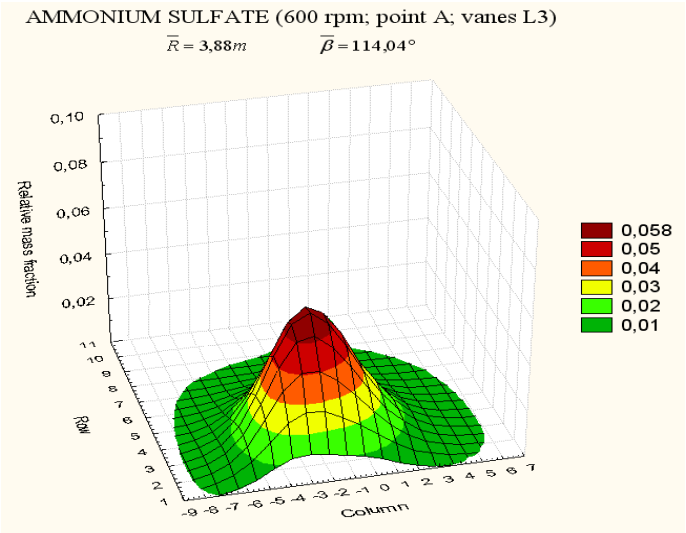

Fig. 2. Total static distribution of ammonium sulfate and the calculated mean values of radius ($\overline{R}$) and angle ($\overline{\beta}$) of the spread area

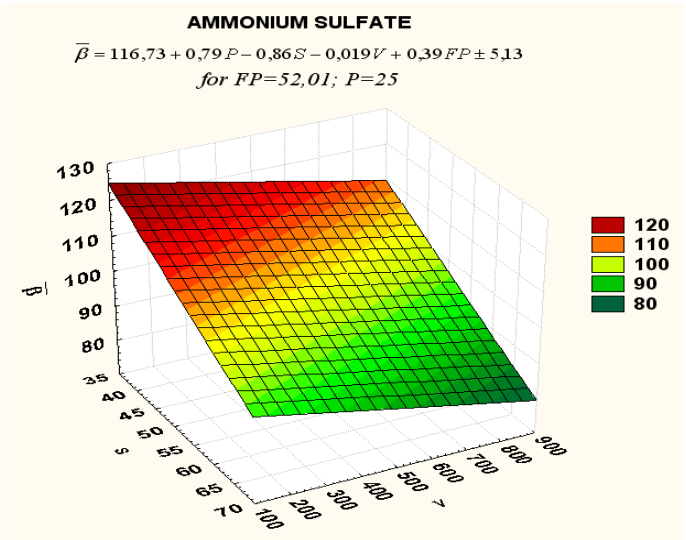

Fig. 3. Relationship of mean angle versus rotational speed of the disc and vanes setting for ammonium sulfate

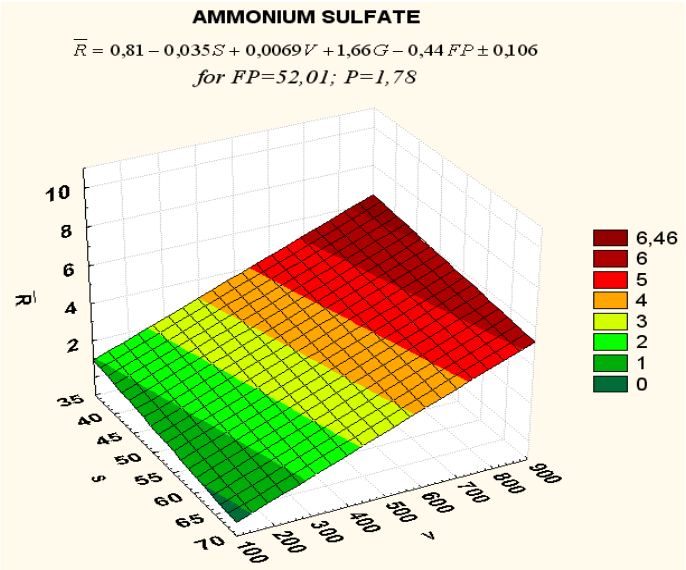

Fig. 4. Relationship of mean radius versus rotational speed of the disc and vanes setting for ammonium sulfate

Based on the developed mathematical model of mineral fertilizers total static distribution, the optimization can be achieved of the construction and setup work elements of centrifugal spreaders. Knowledge of the physical properties of mineral fertilizers and construction and operating parameters of fertilizer spreaders also allows for the development of spread tables.

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SUSTAINABLE DEVELOPMENT OF TECHNOLOGY IN AGRICULTURE TAKING INTO ACCOUNT RESTRICTIONS CONCERNING ENVIRONMENT CONDITIONS IN CATTLE BREEDING SYSTEMS

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Keywords: sustainable development, renewable energy, cattle breeding, manure disposal, harmful gases, biogas production

1. Introduction

Rational development of technology in agriculture connected with animal production is very close to some vastly important parameters as: genetic progress, EU requirements for well-being of animals living in restricted area, existing limitations of environment protection and general expectations for the quality of a final product. It is proved that exhausted air from cattle barns contains quite harmful components as: ammonia, methane, hydrogen sulfide, nitrous oxide, germs and dust.

The goal of the present research is to evaluate the influence of different factors on sustainable development of agriculture technology based on the manure and odor management in cattle barns. Moreover the utilization of manure as a raw material for energy production was also taken into consideration.

2. Material and methods

The scope of research is technical and economic analysis of two cattle barns located on family farms with high – V level of mechanization. Both barns had loose housing systems, but one of them had litter on the cattle stalls, but another one had no litter at all and rubber mats used. To utilize natural manure and also biomass residue on the farms, it was proposed development of biogas installation to obtain additional energy production directly on the farm [Romaniuk et al 2012].

Besides that some tests concerning harmful gases concentration inside the barn according to EU regulations were provided.

3. Results

Principal objective of this study was to determine the influence of environment condition elements on the inputs and animal welfare.

In both of the cattle barns relative humidity of air exceeded the optimum. Average relative air humidity inside the cattle barns tested, ranged from 60.1 to 77.12%, whereas the particular readings oscillated within 26.4–99.9%.

Average concentration of carbon dioxide in all the cattle barns did not exceed 1000 p.p.m., what is recognized as the comfortable conditions. Particular CO_2 concentrations, varying from 280 to 2900 p.p.m., were comprised within standard accepted limits. Average ammonia concentration in tested objects was situated in the range from 3.39 to 8.72 p.p.m., what does not exceed allowable limits.

Generation and usage of agricultural origin energy, give some chances to diversify and increase the agricultural incomes and rural energetic security, as well as to improving the environment protection in the country side.

Considering the needs to diversification of energy sources, the agricultural biogas plants give the chance to ensure energetic security. Agricultural biogas plants of the power 100–500 kW, when using 50–70% of natural manure from the own farm, are economically feasible.

4. Conclusions

Average ammonia concentration in tested objects was situated in the range from 3.39 to 8.72 p.p.m., what does not exceed allowable limits.

Also particular CO_2 concentrations, varying from 280 to 2900 p.p.m., were comprised within standard accepted limits.

Generation and usage of agricultural origin energy, give some chances to diversify and increase the agricultural incomes and rural energetic security, as well as to improving the environment protection of agriculture land.

Provided experiments have proved that it is possible to obtain the following results:

- Reduction of greenhouse gases by about 20 percent
- Improvement of effectiveness of energy utilization by about 20 percent (lower usage of original energy),
- Increase of usage renewable energy sources in a total energetic energy balance on a country scale by about 20 percent.

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SELECTED ISSUES OF THE TDR BASED MEASUREMENT OF THE SOIL APPARENT DIELECTRIC PERMITTIVITY ORIENTED TO THE EVALUATION OF SOIL MOISTURE

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Keywords: TDR, soil water content, dielectric permittivity

1. Introduction

Water status monitoring defined as the spatial and temporal registration of the water properties that decide about the processes under consideration, is the basic instrument in natural research (in industrial processes, too). Increasing demands of water management result in the continuous development of its tools. Monitoring of water status is accomplished using digital systems.

The most difficult are the electric measurement of soil water potential and soil water content; therefore they are the subject of permanent research. The method successfully verified for soils can be also applicable for other porous agricultural materials because their structure is usually not as complex as soil.

In majority of practical situations the status of water is described only by one variable – water content. Soil water content seems to be the most difficult water status variable to determine because the response of available moisture sensors is not dependent only on soil water content, but also on soil salinity, temperature and texture. Thermogravimetric methods enable to determine the amount of water in the soil sample on the mass or volume basis in the direct way and they are the most popular. These methods are very laborious, time consuming and require the laboratory equipment. Time Domain Reflectometry (TDR) technique for soil water content and electrical conductivity [1, 2] has become popular since the publication of Topp *et al.* [5].

The key feature of the applied measurement method is its selectivity, *i.e.* the lack of sensitivity of the conversion function (calibration) on the influence from the factors other than the measured one. Proper selectivity liberates the user from frequent, specific for each soil, *in situ* calibration measurements.

A water molecule has a permanent dipole moment of 1.87 D, which is extremely big value as compared to other molecules in natural world. This polarity is the reason that dielectric permittivity of water is much higher than

permittivity of soil solid phase (the relative dielectric permittivity of pure water in the electric field of frequency below about 20 GHz and 18ºC temperature is 81, while the relative dielectric permittivity of solid phase is 4÷5 at the same conditions). The dielectric permittivity of soil strongly depends on its water content, therefore it may be concluded that electric measurement of soil moisture should be based on the measurement of its dielectric permittivity.

In the case of materials conducting electric current, such as moist soil, the selective electric measurement of moisture on the base of dielectric permittivity is complicated because soil has features of dielectric and conductor simultaneously. The soil dielectric permittivity, ε, is a complex quantity:

$$\varepsilon = \varepsilon' - j\left(\varepsilon_d'' + \frac{\sigma}{\omega\varepsilon_0}\right), \tag{1}$$

where: ε' is the real part of the relative complex dielectric permittivity of the soil, ε_d'' is negligible contribution from the soil dielectric loss connected with dielectric polarization (mutual friction of permanent and induced dipoles), ρ (g cm^{-3}) is dry bulk density of soil, σ (S m^{-1}) is the electrical conductivity of electrolyte, ω (s^{-1}) is electric pulsation of external field stimulating the sensor, equal to $2\pi f$, f (Hz) is frequency of electric field, ε_0 (Fm^{-1}) is dielectric permittivity of vacuum and $j=\sqrt{-1}$. Practically ε' depends solely on soil moisture, θ, and soil dry bulk density, ρ. The imaginary part depends on electrical conductivity of the soil, σ, as well as the frequency of electric field, f. The bigger the value of the imaginary part (practically the bigger the value of soil electrical conductivity), the more visible are conductive features of the soil. Considering that the electrical conductivity of soils reaches values of 1 Sm^{-1}, the electric method of moisture measurement should apply the electric field of frequency not lower than 1 GHz.

2. Time domain reflectometry application in dielectric moisture measurement

The principle of measurement of electromagnetic wave propagation velocity in soil (or other porous materials) is presented in Fig. 1.

A section of transmission line, called the sensor, is constructed from two parallel, non-isolated metal rods. Another transmission line (for example coaxial line), called the feeder, connects the ending of the sensor with an electric voltage pulse generator. The voltage step traveling along the feeder reaches at instant t_1 the beginning of the sensor and propagates further in the

soil to reach the sensor ending at the instant t_2. There is a discontinuity of impedance (feeder impedance differs from the sensor impedance) at the feeder/sensor connection, and a part of energy of the pulse is reflected at the instant t_1 and returns to the generator. The remainder continues to propagate further (in the soil) to reach the end of the sensor at the instant t_2 and reflects again towards the generator because of the impedance rise at the end of the sensor.

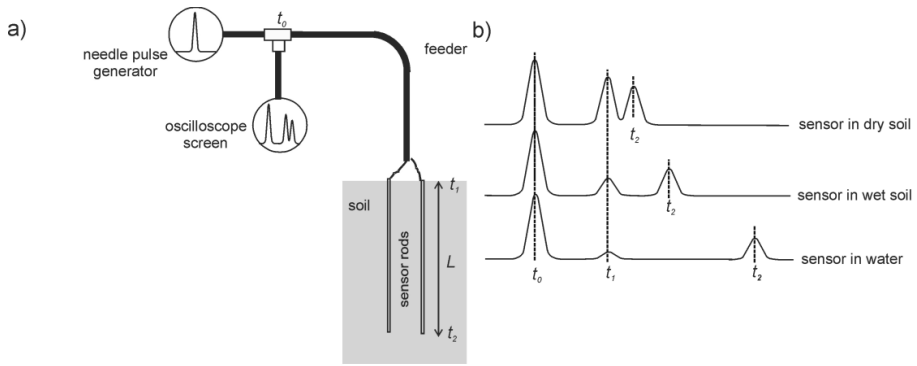

Figure 1. Principle of the reflectometric measurement of soil moisture: a) basic components of the system, b) the pulse and its reflections as seen on the screen of the oscilloscope.

Figure 1b shows the picture of the pulse and its reflections as is recorded on the screen of an oscilloscope connected to the feeder. The initial pulse reaches the T-adapter at the instant t_0, propagates further and is subjected to the reflections at the instants t_1 and t_2. The higher the soil moisture, the higher is the dielectric permittivity, ε, and the smaller propagation velocity, v, of the pulse in the soil, and the longer the time interval $t_2 - t_1$.

The dielectric permittivity, ε, is calculated from the measurement of the propagation velocity, v, of electromagnetic pulse in the examined medium, which is equal to the velocity of light in vacuum, c, divided by the square roots of the dielectric permittivity, and magnetic permeability, μ. Assuming that for majority of considered materials $\mu = 1$, the formula for the electromagnetic wave refractive index, $\sqrt{\varepsilon}$, can be written as:

$$\sqrt{\varepsilon} = \frac{c}{v} = \frac{c}{2L}\, t\,, \tag{2}$$

where, L is the length of the sensor rods, t is the time necessary for the pulse to travel the double length of the sensor rods. It has been found that the dielectric permittivity, ε, of examined soils and other porous materials depends on volumetric water content, θ, and density, ρ [3]. A new formula

for determination of moisture from dielectric permittivity and density has been derived as:

$$\theta = \frac{\sqrt{\varepsilon} - 0.819 - 0.168\rho - 0.159\rho^2}{7.17 + 1.18\rho} \tag{3}$$

Figure shows comparison of the soil moisture measurement results carried out by reflectometric method, θ_{TDR}, with the ones by thermogravimetric method, θ_{grav}, for 61 different mineral and organic soils of densities in the range $0.086<\rho<1.78$ g cm^{-3} [3]. Small scatter of data proves the TDR method of soil moisture measurement to be satisfactory. This method has been also proved in applications to grain and wood.

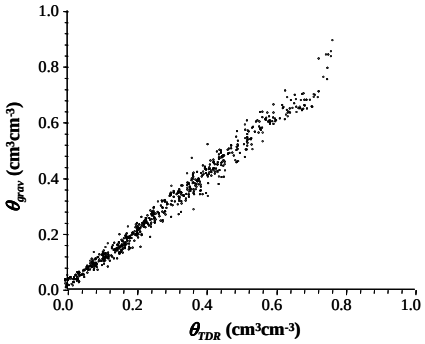

Figure 2. Comparison of soil moisture data obtained using TDR, θ_{TDR}, with data obtained using the oven-drying method, θ_{grav}, for samples having bulk densities $0.086 < \rho < 1.78$ g cm^{-3}. $\theta_{TDR} = 0.0001 + 1.00\ \theta_{grav}$, $R^2 = 0.9801$, SD = 0.028 (SD is standard deviation).

3. Outlook

TDR meters provide reliable, accurate and selective measurements of water content and salinity of soil and other materials. The Institute of Agrophysics developed hand-held and laboratory TDR devices, commercially available from an independent company (www.e-test.eu) [4].
The Laboratory of Dielectric Spectroscopy in the Institute of Agrophysics PAS is currently working on an improved version of the TDR moisture meter under a research project "TDRUPGRADE" funded by the National Research and Development Centre (NCBR). The purpose of the research is to increase the accuracy of moisture measurement for soils of low water content or high salinity. The measurements in these conditions are subject to large errors due to the strong attenuation of the signal and the finite resolution of the time measurement of the reflectogram. The project also includes numerical simulations and the results can be used in the future to develop a new prototype TDR device. The scientists from the Institute of Agrophysics offer

their expertise and the measurement TDR equipment that can be tailored to specific applications in agriculture engineering.

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TECHNOLOGY OF SOIL BIOREMEDIATION AND CONVERSION OF CONTAMINATED PHYTOMASS INTO USABLE ENERGY FORMS

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Keywords: ash, biomass, decontaminate, energy, heavy metals, phytomass

1. Introduction

One of the places characterized by soil pollution in Slovakia is Ružín dam on the River Hornád. Heavy metals get into the soil as a result of water erosion and also from factories.

According to the data from 2002 (Brehuv, et al. 2002) the amount of deposited silt on Ružín dam was 7 000 000 m^3. The annual deposit of silt is approximately 225 000 m^3.

The examinations of pollutants content (Brehuv, et al. 2002) showed that as a result of sedimentation the soil on the river bottom was contaminated with heavy metals beyond the limits (Bouček 2005). Therefore, it is advisable to search for the ways of soil disinfection in the interest of environment protection.

2. Material and methods

The aim of the study was soil remediation by means of *amaranthus* cultivation with the possibility of using thus produced phytomass for energy production.

The research on soil remediation is justified since the extraction of sedimentary soil increases the capacity of a water reservoir. The repeated cultivation of *amaranthus* should decrease the soil contamination to the permissible limit.

The first stage was the examination of the soil contamination level and possibilities of its disinfection. A decision was taken to use the biological method for soil remediation. The plant used in the examination was *amaranthus*.

3. Results

The analysis of heavy metals content in the soil before sowing and after harvesting of *amaranthus* is presented in Table 1.

The examination results indicate the increased level of heavy metals in the soil before sowing of *amaranthus*. The data shown in Table 1 imply a decrease in the soil contamination after harvesting of *amaranthus*.

Table 1. The content of heavy metals in the soil before sowing and after harvesting of *amaranthus*

Examined element	Heavy metals content [mg*kg^{-1}]		Difference [%]	Limit values of detrimental elements
	Before sowing of *amaranthus*	After harvesting of *amaranthus*		
As	50,00	25,90	48,20	25,00
Cu	321,00	300,00	6,54	60,00
Hg	1,24	1,18	5,08	0,50
Pb	66,00	30,10	54,39	70,00

The comparison of the examination results showed that the content of heavy metals in the plants grown in the contaminated substrate was higher than in the plants from the disinfected substrate, which proves that *amaranthus* has the ability to accumulate heavy metals. The analysis of the examination results implied that if the plants are harvested for energetic purposes, they need to be harvested together with the roots. Otherwise, if only the aerial parts of the plants were harvested, the roots would die and recontaminate the soil.

The content of heavy metals in ash is the evidence of the transportation of pollutants from the soil through a plant as a transitory material, and eventually the contamination of ash – the product of biomass burning.

4. Conclusions

The examinations proved that *amaranthus* is a plant which is capable of accumulating heavy metals. It was also found that a considerable amount of heavy metals was accumulated in the plants roots, which implies that the plants need to be harvested together with the roots.

Contaminated plants can be processed into power engineering fuel. The energy potential is comparable to the one of cereal straw or wood. The technology of processing of the aerial parts of plants is comparable to the technology of processing of fodder plants (Duraník 2010).

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LIFELONG LEARNING – AN ESSENTIAL ATTRIBUTE FOR ENGINEERING GRADUATES

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Keywords: *lifelong learning, self-directed learning, graduate attributes*

Introduction

Lifelong education which is precursor of lifelong learning (LLL) grew out of the notion that education is a continuous aspect of life. That aspect of education is especially important in science and engineering as their boundaries are continuously shifting by advances of science and its technological implications. The pace of progress seems faster with true revolutions occurring in less than a generation forcing engineers to evolve in both technical and non-technical knowledge if they are to keep abreast with the actual requirements posed on them by the society.

There are attempts to formulate learning policies taking into consideration the importance of 'skills and knowledge for life'. One of such very influential examples may be Organization for Economic Cooperation and Development (OECD)-based lifelong learning policy [1].

LLL started as an idea in Denmark 150 years ago when Grundtvig, the Danish scholar and priest, introduced the concept of liberal education and the folk high schools [2]. The concept was political as the aim was to improve the general knowledge of all citizens, in order to equip them to participate fully in public life [2].

It is impossible to find one, universally accepted, definition of LLL. In fact, there are several definitions depending on the framework set by the author, the audience, objective and circumstances in which the definition is given. Some definitions consider LLL as a process required for an employee to change areas of employment in order to advance in a career or adapt to a new setting of employment; whereas other definitions view LLL as continuing or distance learning. However, for the purpose of engineering education at the university level, it is convenient to consider LLL skills as the ability to acquire new knowledge throughout graduate life, i.e., learning beyond conventional schooling resulting in both professional and personal development. Because engineering education is often based on a set of

competences required by the profession, it is the responsibility of university curricula and academic staff to develop LLL skills in their graduates.

Lifelong learning in engineering

The mutual recognition of engineering qualifications and professional competence by various countries [3] has brought the concept of LLL to foreground. All three international accords, the Washington Accord – for engineering degree programmes, the Sydney Accord – for engineering technologists and the Dublin Accord – for engineering technicians, recognize the need and importance of LLL for graduates. In case of engineering degree programmes the attribute is formulated as follows [3]:

> *Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.*

The requirement of LLL skills is also embedded in the graduate knowledge profile [3], which requires 'engagement with selected knowledge in the research literature of the discipline' in the context of depth of knowledge required for solving complex engineering problems.

On the other hand, the cognitive perspective of engineering education considers LLL as a form of self-directed learning. The process of self-directed learning refers to the ability of students to identify goals for learning, access relevant information, assess their learning and make necessary modifications to improve their progress by own initiative rather than something controlled outside the learner by a teacher, trainer, or instructional designer such as in a formal educational arrangement [4].

In view of the importance of new technologies and growing demands on the engineering profession, the capacity to undertake lifelong learning should be considered as the most important aspect of the professional (soft) skills for graduate engineers. The lifelong learning concept is no longer some additional, i.e. optional, training after graduation but these are all activities covering the entire active life of a graduate [5,6].

Need to re-engineer curricula

In the last few decades the university education has gone through enormous transition. It is due to two major factors; one of them is the fact that university education has now become a norm rather than exception and has finally stopped being the privilege of only elite group of people. That dramatically increased the student population and also the diversity of students. The second factor is the aspiration of countries to create or to transit towards 'knowledge society' [7]. That created a general movement towards the society in which the ability to learn tomorrow is as important as the ability to learn today. Those two factors fit perfectly the concept of LLL

which has main pillars, namely, widening participation and learning throughout life.

The traditional engineering (or science) curricula, still used in their original form at many universities, do not support lifelong learning skills. The academics see engineering curricula as highly structured and linked in sequential serial courses [8]. However, are they really linked and connected? Academics see those courses as 'building blocks' to successfully deliver everything an engineer should know. How do we know that the curriculum is not a set of separate and unrelated stumbling blocks? Also, since there is no block dedicated to LLL how do we then ensure that it makes a part of the curriculum?

The paradigm shift from traditional curricula based on teaching toward curricula based on learning and acquisition of particular skills, or competences (including LLL), is an on-going response of programmes to the demands posed by globalization of economy, advancement of information and communication technologies and the associated social and cultural changes. It is now recognized that the new curricula should be driven by clear learning objectives rather than material to be covered. The goal of university education should be attaining higher level skills and knowledge, as well as generic skills and knowledge, lifelong learning skills included.

Furthermore, the OECD's framework of key competences for 'knowledge society' define teaching and learning as a process in which not only skills and knowledge are acquired but also particular values, motivations, attitudes and dispositions that are deemed necessary for continuous, reflecting and autonomous learning are to be nurtured [1]. Therefore the design of new curricula requires change in the teaching philosophy and teaching strategies in order to meet these expectations.

Need to change teaching philosophy and teaching approach

In order to boost and encourage LLL skills, teaching and learning philosophy should change from teaching students to facilitating student learning. The shift towards student-centred learning can be regarded as the single most important step towards transforming universities to 'lifelong learning universities'.

Student-centred learning refers to pedagogies focused on the learner and what is learned, rather than on the teacher and what is taught [9]. The primary reason for project-based learning (PBL) is a need to adapt to a changing world. The argument is that students should strive in an environment centred on learning instead of on teaching. Student-centred learning offers an attractive alternative to traditional education by shifting the focus of education from 'what staff teaches' to 'what students learn'. The emphasis moves from the result to the process and the lecturer transforms

from the classroom main actor and a dictator to an advisor and mentor. It is pictorially described as a shift of a lecturer from a '*sage on the stage to a guide on the side'* [10]. The other element of the "student-centred" feature of PBL is that the student, at least partially, determines the goals. It creates an environment of self-directed learner thus contributing to the development of LLL skills.

Student-centred instructional methods which emphasise the student's responsibility for learning include all active learning approaches. Methods are mainly based on the concept that students learn by creating their own version of reality rather than following the versions delivered to them by the instructor. Such approaches include peer learning (both cooperative and collaborative learning), as well as project and problem based learning.

Several activities within a course can also help in developing LLL skills [11]. Those include the following:

- use new technologies - incorporate extensive online resources to support students in all aspects of their learning;
- create independent study resources – that can include both virtual and real facility for independent study;
- employ assignments that require initiative in search of information and encourage the student to assess the quality of information;
- enhance communication skills – encourage, develop and maintain communication between staff and students and also between students themselves';
- develop teamwork activities - emphasise small group learning, especially for laboratory experiments and project work.

Conclusions

The ever changing reality of engineering practice requires that graduates of engineering are equipped with professional skills and are committed to lifelong learning in order to face the new challenges both in terms of knowledge and possible changes in job profile. LLL skills provide engineers with the ability to acquire those elements of knowledge that were omitted in the course of their formal education and keep updating their knowledge through concern for acquiring other relevant skills.

Lifelong learning is the continuous building of skills and knowledge throughout the life of an individual. It should start as early as possible in the learning process and such skills should be introduced and initiated during teaching. Lecturers should not be mere instructors who deliver knowledge but rather guides and encourages students to acquire knowledge and reflect on their learning. The reflection on the learning process is an important part of the learning experience.

The emphasis and successful attaining of LLL skills during university education has two imperatives; curriculum and staff. The curriculum should be flexible and not restrictive in terms of mode of delivery and time of study. The staff should be involved, motivated and committed to teaching with readiness to experiment with non-traditional methods of teaching.

Although structure (curriculum) is an important factor, it is human aspect (staff) which is the key factor in the successful development of students' lifelong skills.

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POSSIBLE TECHNICAL SOLUTIONS AND COST OF SPATIALLY VARIABLE MINERAL FERTILIZATION AVAILABLE TO POLISH FARMERS

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Keywords: variable mineral fertilization, costs, breakeven area

1. Introduction

Application of spatially variable fertilization should be preceded by economic analysis as the economic benefits have to be offset against the cost of specialist equipment for introducing precision farming techniques [Godwin et al., 2003]. Introduction of the site specific management technologies involves not only considerable expenses, as the necessary equipment is concerned, but also costly acquisition of information on the field conditions, inevitable for performing the field operations in spatially variable mode. It is than fully justified to ask a question on what conditions it is profitable, especially in relation to the farm size. The farm breakeven area depends on many factors, among them on used technologies, cultivated plants and also on the prices of agricultural products and machines.

2. Material and methods

The presentation includes available technical solutions of spatially variable mineral fertilization that can currently be used by Polish farmers and the related costs. Some systems for precision farming, comprising hardware, software and available (possible) custom services offered to the Polish farmers, were set up and for each of them the breakeven area for spatially variable mineral fertilization was determined. Calculations were made on the basis of annual costs of maintenance per hectare, considering the range of areas between 50 and 500 hectares, and on the savings of fertilizers, obtained as a result of using variable rate application (VRA) in wheat, rape and corn production.

Calculating the annual costs of maintenance it was assumed that the price of the fertilizer spreader equals to the difference between conventional one and adapted to VRA performance, and also that the farmer owns already a computer (either desktop or laptop). The determined costs are net costs expressed in euro (EUR).

Calculation of the annual costs was made according to the generally accepted method [Goć i in. 1992; Rataj 2005].

Depreciation K_a was determined as follows:

$$K_a = \frac{C_m}{T_a} \quad \text{(EUR yr}^{-1}\text{)} \qquad (1)$$

C_m – the equipment price (EUR)
T_a – time of depreciation (yrs)

Time of depreciation of the specialist equipment for precision farming was assumed to be the same as the machines on which it is installed. According to Ammann [2008] this time amounts to 12 years (or 1800 hectares) for fertilizer spreader and 12 year for the tractor (or 10 000 hrs).

Costs of sheltering and insurance of the precision farming equipments were omitted, as the specialist equipment and the machine create one unit, the dimensions of the machine are not changed and the insurance is voluntary.

For calculation of the cost of maintenance K_n per year (eq. 2), k_n = 2.0 and 3.5% of the initial capital cost was assumed. This does not apply to the software.

$$K_n = \frac{k_n C_m}{100} \quad \text{(EUR yr}^{-1}\text{)} \qquad (2)$$

Introduction of a modern equipment and software requires farmers to go through training to learn how to operate it. Such trainings are sometimes provided by dealers as free of charge, thus these costs were not considered.

The cost of capital was calculated according to eq. (3), where k_{op} is the annual interest rate of 4%.

$$K_{op} = \frac{0{,}5 k_{op} C_m}{100} \quad \text{(EUR yr}^{-1}\text{)} \qquad (3)$$

Based on the above described methods, two variants of the costs calculations were prepared: for 12 and 5 yrs of depreciation time.

The overall annual maintenance costs for the considered systems were then expressed per hectare for a range of arable land between 50 and 500 hectares, assuming that it can be managed by the system. The calculated costs were increased by the costs of custom services per hectare, if they were included in the proposed system. Relations between unit costs of the system

overall maintenance in EUR·ha^{-1} and the land area in hectares, were presented on the chart.

3. Results

Determination of the breakeven areas was made graphically. They represent the points where curves of the annual cost per unit area intersect the lines representing the obtained benefits per unit area, arising from spatially variable spreading of nitrogen, phosphorus and potassium, in rape, wheat and corn production (Fig. 1 a, b).

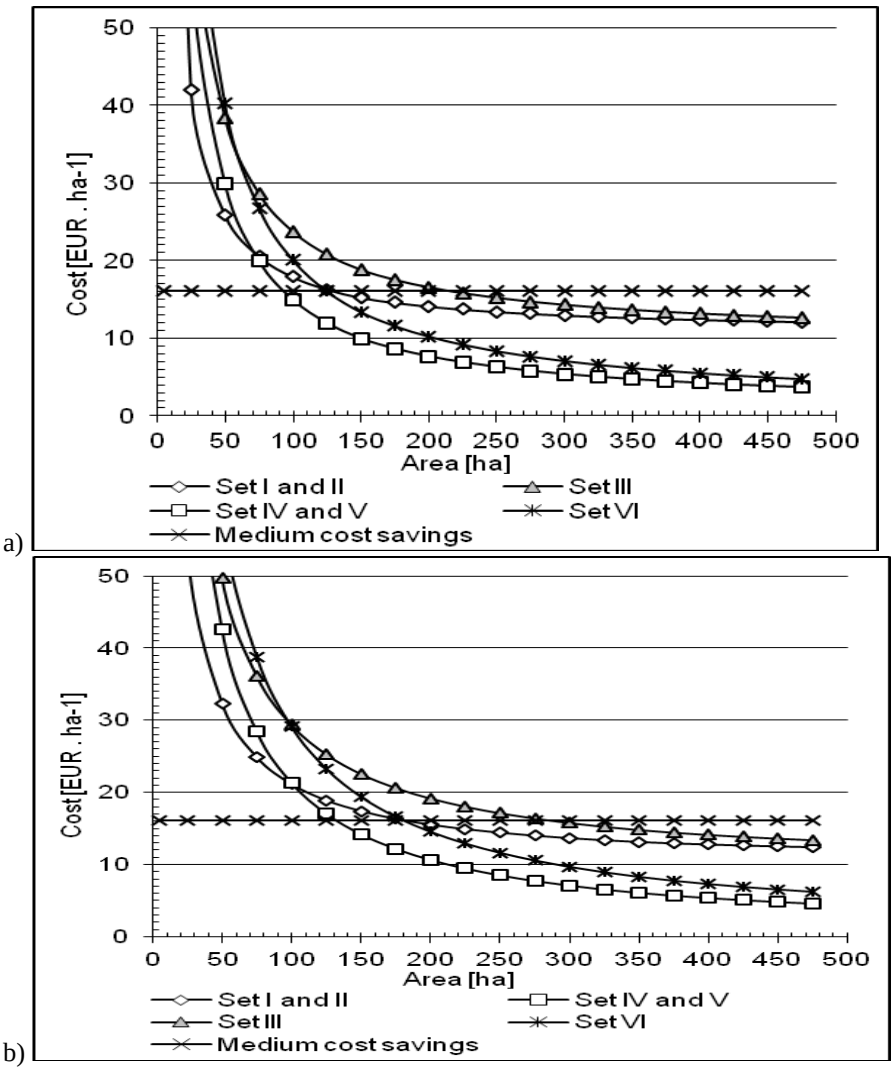

Figure 1. Determination of the breakeven areas for six different systems of precision farming, assuming: a) 12 years of depreciation b) 5 years of depreciation

The average benefits amounted to 16,14 EUR·ha^{-1}. It must be stressed that the costs of depreciation and maintenance were calculated in accordance to the assumed yearly use, thus with the increasing area the time of utilization in years shortened and the depreciation costs increased adequately. The systems I, II and III included costs of soil examination on macro elements contents and preparing the application maps, carried out as custom service. As a result, the overall maintenance costs of those systems did not fall below 12 EUR·ha^{-1} even at 500 hectares of the arable land (Fig. 1 a, b).
At the average savings on fertilizers, the breakeven area in the case of systems I and II amounted to 125 and 175 hectares (Fig. 1 a) for 12 and 5 years of exploitation respectively (Fig. 1 b). The biggest breakeven area was obtained for the system III – 210 and 280 hectares for 12 and 5 years of use respectively. According to the carried out calculations, the best results would be achieved by using the systems IV and V, with 90 and 130 hectares as economically justified area. Results for the system VI are similar as those obtained for systems I and II.

4. Conclusions

Application of variable fertilization based on maps prepared by the custom service is profitable in the case of having high benefits from using VRA. When the average savings, as a result of using VRA, amounts to net 16 EUR·ha^{-1}, then it justifies introduction of the VRA equipment on farms having above 90 hectares of arable land (Fig. 1 a). On farms of more than 300 hectares of area, each of the presented system for variable fertilization will be profitable.

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MAINTENANCE COSTS OF TECHNICAL RESOURCES IN FAMILY FARMS RECEIVING EUROPEAN UNION SUBSIDIES

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Keywords: family farm, maintenance costs, usage costs

1. Introduction

Scientific and technological development as well as the development of farms is connected with an increase in the investment expenditure and also an increase in the maintenance costs of technical resources resulting from the tear and wear of machines and appliances. In the process of making decisions concerning each type of production, costs constitute one of the main factors as they decide not only the quantity of production but also its range or structure. Malaga-Toboła and Tabor [2004] as well as Karmowska [2008] stated that the use of machines has a considerable influence on the value of changeable costs and their share in the structure of maintenance costs. The level of usage costs of means of mechanisation can serve as an indicator of a current engagement of agricultural technology in the production process. The economic condition of agricultural farms does not always allow investment from their own resources. Therefore, there arises the need to use available support sources, which nonetheless is connected with contributing one's own financial resources [Wasąg 2011]. A profitable farm generating profits from its business activity can provide such opportunities,

2. Material and methods

In the years 2004–2009 70 agricultural farms were studies in the Biłgoraj County which used EU subsidies for technical modernisation. In order to determine maintenance costs of technical resources, the group of farms under study was divided according to the amount of subsidy, to the area of the arable land, to the economic size unit (ESU) and to the income of the farm.

The level of maintenance costs of means of agricultural mechanisation was calculated by means of the calculation method taking into account actual investment inputs made by the farms under the study. The costs of maintenance of mechanical resources include usage costs (variable costs) and maintenance costs (fixed costs). Maintenance costs (depreciation, taxes, garage costs, farmers' TPL insurance for machines, crops and buildings and farmer Insurance at KRUS was determined by calculation [Muzalewski 2008].

The structure of maintenance costs includes the usage costs of technical resources, which includes petrol and grease costs, electricity charges, spare parts, repair materials, repair charges, etc. The presented cost group enables the evaluation of the current engagement of technology in the agricultural production process. Usage costs were included into the analysis as a turnover resources factor with respect to agricultural technology. The input side also includes the level of engagement of production turnover resources. Labour costs are not included in the input part because in individual farm sit is impossible to determine it once and for all.

3. Results

The group of farms based on the amount of subsidies, the highest maintenance costs were found in the category of farms up to 50 thousand PLN (2.82 10^3 PLN · ha^{-1} AL) and 50–100 thousand PLN (2.72 10^3 PLN · ha^{-1} AL). Growth of subsidy, AL area, and economical size unit meant decreased maintenance costs per one hectare of AL. Though, an increase in the income of a farm resulted also in an increase in the maintenance costs. Intensity of the organisation of production was high in the economically largest farms and also with respect to their size (from 510 to 950 pts).

Usage costs in the farms under study were over 20% of maintenance costs and with an increase in the amount of subsidy, size of arable land, economical size unit and the income of a farm they decreased gradually. Investment purchases of means of mechanisation per one ha of AL were the highest in farms with the smallest area. The calculating method of determining maintenance costs can lead to high tax deductions for depreciation and to agricultural technology to be treated as a renewable resource of production on a farm. The study found that the relation of usage costs to the replacement value of technical resources increased with an increase of the area (1.7–3.8%) and the economic size of farms (2.1–3.3%). A low level of relation of these costs is another argument confirming the existence of a high burden on the studied farms by the value of technical machines when they are rarely used. In studied farms with a rate of mechanisation costs against replacement value 32.8 thousand PLN · ha^{-1} AL. and the assumed annual investment input at about 5% (1.64 10^3 PLN · ha^{-1} AL) of this value, replacement time for a set of machines is 20 years (32.8 : 1.64 = 20 years).

4. Conclusions

The analysis showed that investment purchases constitute on average 24.8% of the replacement value of means of mechanisation, and their largest

share us in farms with an area of 50–70 ha AL (58.2%) and amount of subsidy 100–150 thousand PLN (48.9%). These indicators are especially important as the mean replacement time of some agricultural machines in Poland in family farms is 25 years and more [Wójcicki 2001]. The group ordered according to the amount of subsidies showed that greatest maintenance costs in the category of 50 thousand PLN and 50–100 thousand PLN. With a growth of the amount of subsidy, area of AL and the economic size unit saw a simultaneous increase in the maintenance costs.

One of the prerequisites for EU subsidies is making one's own contributions (ca. 50 %), which undoubtedly is an obstacle for some agricultural farms. In such cases there is the need for some of them to obtain a commercial or bridge loan (public support excluded) for agricultural investment. Following the studies, it was found that especially farms with small areas do not have sufficient income to obtain invest. A more profitable solution would be to give advance payments towards the realisation of undertakings or to provide state guarantees to bank loans.

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A SHEET AUDIT MODEL FOR THE LOGISTICS PROCESSES OF THE SUPPLY SPHERE OF A COMPANY

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Keywords: logistics audit, procurement process, farms

1. Introduction

The logistics audit is a method of verification of the discrepancy between the declared state of a real implementation or functioning of logistics systems and to assess their effectiveness [Twaróg 1998]. The logistics audit is a systematic and independent examination to determine whether activities related to the quality of the logistics system and their results comply with planned findings and whether these findings are implemented effectively and allow the achievement of the objectives particularly in terms of cost, use resource and customer service [Twaróg 1996]. The organization of the supply process is designed to minimize costs while maintaining the proper levels of supply and inventory. The purpose of the supply process is therefore the maximum protection for any material requirements for farms at a minimum cost of logistics services. It is about ensuring the availability of raw materials, materials and means of production which maintains the company in the production readiness [Wojciechowski 1999]. A procurement logistics is a system of management of the flow of materials from suppliers to production area on an acceptable price, in the right quantity, at the right time, quality and location.

The purpose of this study was to develop a model of the auditory sheet for the evaluation of logistics processes in the sphere of supplying agricultural enterprises. The development of a sheet audit model in supply sphere is part of an integrated audit methodology of logistic processes in agricultural enterprises which includes outside the sphere of supply other spheres such as: storage, production and distribution. Developed sheet will be a tool used in the audit methodology of logistic processes in relation to the all means of production and services purchased by company. The sheet will allow to verify and evaluated and express of recommendations to improve the efficiency of logistics processes in supply sphere. The advantage of the model is that possibility of registration of all activities and procedures in the procurement process, while of the analysis, evaluation and recommendations shall be subject only of logistics activities. As the main criterion in divide of activities for logistics and non-logistics activities the purpose implementation of actions was selected. In the logistics of agricultural

production the purpose of the tasks typically logistic is the implementation of logistics function for handling operational processes, e.g. to provide all the means of production, means of supporting the storage area or directly from the supplier to the manufacturing process such as supplier selection, the implementation of the orders, loading, transporting and unloading for sowing seed, fertilizer, etc. However non logistics tasks are directly related to the achievement of the objectives of production such as sowing seeds into the soil.

The need to develop tools useful for the implementation of audits of logistics is due to a significant share of logistics costs in total costs of activity in farms. Results of a pilot study carried out in a number of selected agricultural enterprises showed that the share of logistics costs in total costs of production remained at a relatively high level compared to other industries and businesses in the range of 35% - 42% [Wajszczuk, 2005]. In addition, there are no tools for evaluation and control of logistics processes implementation in the sphere of supplying agricultural enterprises, the lack of improvement systems in the sphere of procurement the means of production, waste of the means of production, inflated production costs resulting from poorly planned supply, unreliable supplier causing overdue deliveries.

2. Material and methods

The study was conducted in 10 agricultural enterprises. To the study was used deliberately chosen multibody enterprises, leading production of mixed, about varying shape of field and area of more than 500 ha of arable land (criterion important because of the complexity of the logistics processes). The deliberately choice will let for the knowledge of supply systems of agricultural enterprises of various production profiles, supplying various types of production. Collecting information takes place through direct interviews with those responsible for the sphere of enterprise supply. In addition, we examined documentation orders and purchases. Interview include a description of all the procedures for the procurement process on the individual means of agricultural production and the purchase of services. To applied the studies of the technique of mapping processes. Process mapping is a analysis technique allows shows the process by means of map of processes. Resulting from the use of this technique, the organization's business process maps are models reflect reality [Ciesielski 2009]. Maps of processes visualized make it possible to assess processes, the extent of losses, errors and situations that need improvement. The main purpose of creating these maps is to describe business processes in order to simplify, eliminate and improve in such a way that products and services are cheaper,

better and faster achievable [Christopher, 2000; Hunt, 1996]. Benefits include process maps [Peppard and Rowland, 1997]:

- maps of processes often further explain the process better than words, therefore, should be widely used in the organization, which gives the opportunity to evaluate processes, losses and situations that need improvement,
- when mapping, the workers begin to better understand the tasks and problems of others as well as their contribution to the processes,
- often during the mapping process are evident imperfections, that by finding ways to improve the business, are eliminated.

The scope of research concerned the mapping procedures in the area of procurement, verification of existing procedures and their evaluation. In order to identify specific changes in supply has been made to map the entire process including all means of production and services purchased in the process. For this purpose, has been inspected all procurement processes for both livestock, crop and other activities within the agricultural enterprises. Furthermore, in order to develop of sheets detailed analysis made including:

- methods of market analysis of suppliers,
- procurement system,
- suppliers, delivery terms, payment terms,
- negotiating with suppliers,
- the supply contracts,
- transport conditions.

3. Results

The developed sheet model contains the main areas of the supply process, material requirements planning, supplier selection, ordering and purchasing, organizing supplies supply (transport), warehousing, inventory and assessment of the structure of waste management. The purpose of the sheet is to obtain information about all the activities and practices implemented in the supply process. The data contained in the sheet are all purchased production inputs.

The first element is a sheet audit description of the actions of the process. Deliberately chosen set of questions is designed to accurately describe each action carried out in the process. Description of the measure allows for the development of criteria for evaluating the success of the action. On this basis, using the ID of the supply process are analyzed in terms of specific tasks relevant set of evaluation criteria. The criteria are qualitative or quantitative. To assess the audit sheet model is shown in Table 1.

Table 1. A audit sheet model for logistics processes of sphere of supply - some examples

A description of all actions ……...					
The process ID of the supply	**Product**	**Evaluation criterion**	**Verification**	**Registry errors**	**Recommendations**
Actions					
Subprocess 1 - Material requirements planning					
Analysis of demand	Fodder	Method of analysis	Positive	No	No
Making plans of supply		Planning accuracy	Negative	Generation of surplus inventory	changes in the planning system
Subprocess 2 - Selecting suppliers					
The collection offers of supply	Mineral fertilizers	Number of offers	Negative	poor market analysis, too high prices	Collecting more offers
Selection of suppliers		Critria for selection	Positive	No	No
Subprocess 3 - Placing orders and purchase					
Frequency of the orders	Spare parts	Level of inventory	Positive	No	No
Orders tracking		On time delivery	Negative	Delay in delivery	Change of supplier
Subprocess 4 - The supplies organization					
Costs of transport	Diesel	Index, measure	Positive	No	No
Timely deliveries		No downtime	Positive	No	No
Subprocess 5 - Storage					
Structure of inventory	Seed	Index, measure	Positive	No	No
Storage time		Index, measure	Positive	No	No
Subprocess 6 - Waste Management					
Segregation of waste	Plant protection products	Documentation, utlization procedures	Positive	No	No

With the presented model can be assessed each activity within the sub-processes in the supply process. Taking into account the specificity of purchase and consumption of each of the means of production can be based on the evaluation criteria to verify the correctness of the action in the subprocess. Positive verification completes the evaluation, and verification of negative results in the formulation of the registry errors and consequently move to the formulation of recommendations.

4. Conclusions

The developed sheet audit model for the sphere of supply logistics processes will be an important component of the overall logistics process audit model for agricultural enterprises.

The potential benefits from the use of tools in the form of a sheet audit in the methodology of the audit logistics processes include:
- identify errors and omissions in purchasing procedures,
- assess the effectiveness of negotiating the terms of delivery,
- possible savings in the consumption, storage, transport means of production,
- increase the timeliness of delivery,
- favorable discounts and loyalty programs,
- lower storage costs by planning and implementation of on-time delivery,
- avoid downtime caused by e.g. equipment failure,
- obtaining the optimal purchase price,
- evaluation of the optimal batch size.

In further studies, after the development of a comprehensive audit model of logistics processes will be verified sheets audit sphere of supply.

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PROJECT OF AN AUTOMATIC SYSTEM FOR SOIL MOISTURE REGULATION USING TDR TECHNIQUE

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Keywords: irrigation system, moisture stabilization, time-domain reflectometry

1. Introduction

Soil moisture is one of the most important factors determining the energy consumption of applied agrotechnical measures as well as agricultural output (Abayomi et al., 2012, Farooq et al., 2012).

Even small decrease of soil moisture may increase mechanical impedance of soil reducing root growth rate and increase soil resistance to agricultural machinery (Whalley and Clark, 2011).

Plant water use, which is almost proportional to crop yield (Dmowski and Chmura, 2006), is strongly dependent on soil moisture. The knowledge of the effect of soil moisture deficit on photosynthesis rate is important in face of increased growing season droughts predicted by climate-change scenarios (Vico and Porporato, 2008). New deficit and partial root zone irrigation techniques may help to improve efficiency of plant water use (Nardella et al., 2012). However, these techniques require precision in watering level both in time and on the spatial scale. The drought induces a chain of plant reactions including non-linear changes in root hydraulic conductance. Depending on drought duration root hydraulic conductance initially decreases as an effect of water channels activity and later increases due to the increased suberization of the root endodermis (Lipiec et al., 2013). The proper evaluation of physiological plant reaction on water deficit should be made on the level and duration of water shortage. Studies on the impact of precisely controlled water deficit on plant growth and functioning is important due to a high potential of irrigation in increasing crop yields and the cost of typical irrigation techniques. The growth chamber experiments with the controlled plant environment include the regulation of the soil water availability for plants. This allows for precision measurements of the biomass distribution between the root and shoots that is strongly dependent on the availability of soil water (Mann et al. 2013).

2. Materials and methods

The project of an automatic soil moisture regulation system was based on laboratory multichannel reflectometric TDR/MUX E-Test moisture meters (Skierucha et al., 2006, Skierucha et al., 2012). These devices enable selective measurements of soil volumetric water content with the accuracy of ±2% of the measuring range. The moisture regulation system consists of a PLC (programmable logic controller) connected to a personal computer and a precision flowmeter with the water dosing resolution of 0.013 mL and the flow range from 5 to 250 mL/min (Fig. 1). The PC controls the electrovalves according to the moisture readings from the TDR meters. This enables dosing of given amounts of water with a frequency set by the user or a selected algorithm. The feedback allows to maintain chosen soil moisture for any length of time independently of diurnal variations or the long-term water intake by the root system of a studied plant. It is also possible for the user to simulate drought of the chosen intensity or excessive moisture conditions for a given period of time. The designed system can regulate moisture in up to 128 objects, providing that the total dose of the irrigation water for all objects does not exceed 15 litres per hour.

The system is able to record the dosages of the irrigation water, moisture content and electrical conductivity of the soil. It is also possible to upgrade the system by adding additional sensors for soil temperature and matrix potential. The designed system provides immediate notifications in the case of malfunctions occurring because of water shortages or excessive leakage from the studied object (text message or email).

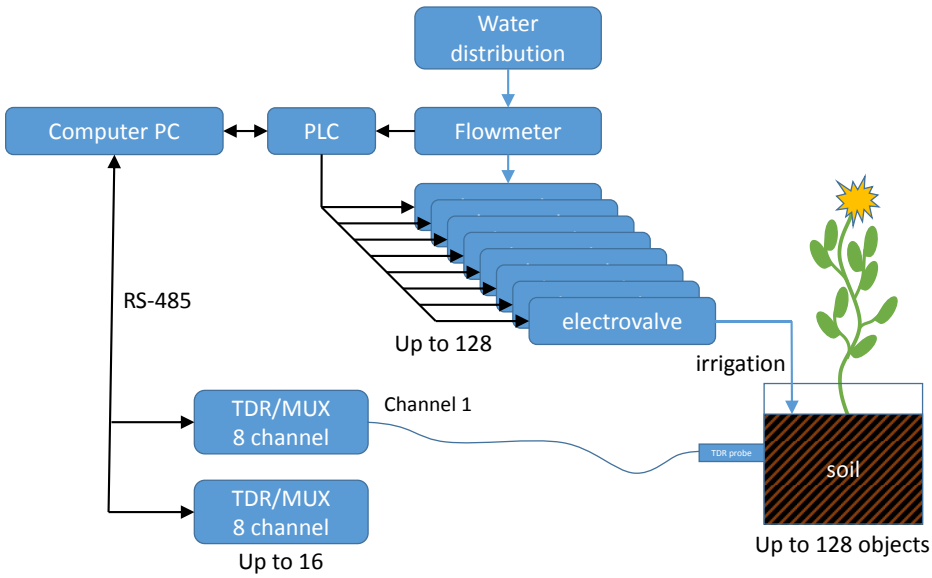

Figure 1. The scheme of the automatic system for soil moisture regulation

3. Strengths and weaknesses of the project

The described project of the moisture control system uses the time-domain reflectometry (TDR) to measure soil moisture content. This technique is the most popular nowadays because of its selectivity and high measurement speed. The TDR probes consist of two parallel acid resistant steel rods which are inserted into the soil. This method is very reliable and easy to use. Thanks to the time-domain signal analysis and the usage of the internal frequency references, the soil moisture stabilization uncertainty can be as low as 0.1%. The application of a flowmeter with extremely low flow rates and high resolution allows precise dosage of water, which would lessen the sensitivity of the system to any possible overshoot or oscillations of the controlled value.

The system can be also used in research requiring control of soil matrix potential, as well as in the cases where the temperature corrections of measured parameters of a tested object are necessary. However, such versatility requires substantial financial resources because of the high cost of the TDR system elements and the flowmeter. The adjustment of the control algorithms (PID – proportional-integral-derivative controller) to the stability and accuracy demands of the user could also be a problem. It is possible to average the measured quantity over several probes at the expense of reducing the number of the objects. However, controlling the system by the PC allows for flexible modifications of the software according to the specific demands of a given experiment.

4. Summary

The proposed system will facilitate research requiring soil moisture stabilization and control. There is a possibility of further development of the control algorithms which are essential to the control accuracy, e.g. predictive algorithms.

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CONVENTIONAL AND ORGANIC CROP PRODUCTION - RISKS FOR FARMERS HEALTH

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Keywords: organic dusts, organic and conventional crops, health

1. Introduction

Farmers in relation to the specific of their work are exposed to a variety of factors harmful to their health. It is divided into: physical, chemical and biological factors. Among the physical factors may be mentioned: noise, vibration, high physical stress related to work, climate and UV radiation. Among chemical agents should be replaced pesticides. The occupational biohazard agents include inorganic and organic dusts. Organic dust contains macro-and micro-organisms and their metabolites such as toxins, allergenic substances in its composition. Biological occupational risk factors can be divided in terms of the nature of their harmful effects on the human body to: pathogens, allergens, biological toxins, carcinogens and biological vectors carrying infectious diseases. According to the Directive 2000/54/EC of the European Parliament and of the Council biological occupational hazard classified into four groups depending on the degree of risk. Biological agents from first group are the least harmful and unlikely there is to cause human disease. However in the fourth group there are biological agents that causes severe human diseases and is a serious hazard to workers, is present a high risk of spreading to the community. There is no available effective prevention and therapy.

Among the sources of occupational biohazard factors include: dust, human and animal excreta, sewage, waste and animal and vegetable products. These factors can be transmitted in many different ways such as: air-dust, airborne droplets, oral, skin and mucous membranes, and the sting e.g. ticks.

Conventional farming uses measures of industrial production, including fertilizers and chemical pesticides while organic farming rejects any chemical fertilizers for organic fertilizers. According to data the Inspection of Agricultural and Food Quality in recent years, organic farming in Poland is growing rapidly. Continued support of the European Union in this area and the growing interest in organic products are the factors that determine the development. In the first half of 2012, the increase in the number of organic producers was reported in all 16 provinces.

The aim of this research project was to assess the exposure of farmers to organic dusts in organic and conventional cereal crops. It was evaluated potential ability of fungi and their metabolites of inhaled organic dust to cause respiratory diseases

2. Material and methods

In 2012, as part of the project assessed the degree of colonization by fungi samples taken from grain rye, settled dust collected during threshing combine harvester and soil taken from the crop of rye, coming from organic and conventional farms in the Province of Lublin. That assessment was made used the method of plate dilution on media Malt Agar (MA) and Potato Dextrose Agar (PDA). Selected isolates were classified according to the BioSafety Level classification.

3. Results

Less contaminated with mold, thereby constituting a lower risk to the health of farmers are organic crops. Organic dust is the most contaminated microbiologically. The greatest difference for microbial contamination was observed in soil samples. In general, reported higher levels of fungi was in samples from conventional farms compared to organic farms about: 7.5% for samples of dust, 1.5% for samples of grain, 58.9% for soil samples. These results are presented in Table 1.

Table 1. Mean values of CFU/g (Colony Formin Unit per gram) for molds isolated from samples of dust, grains of rye and soil for two different strategies for agriculture

Dust		**Grains of rye**		**Soil**	
Organic Farming	Conventional Farming	Organic Farming	Conventional Farming	Organic Farming	Conventional Farming
Average: **3065** x 10^3 CFU/g	Average: **3313** x 10^3 CFU/g	Average: **27,475** x 10^3 CFU/g	Average: **27,9** x 10^3 CFU/g	Average: **50,075** x 10^3 CFU/g	Average: **121,975** x10^3 CFU/g

In organic farming does not apply to common antifungal preparations and plant protection products, which are the basis of conventional farming in the fight against weeds and pests, however, correctly sized for this type of cultivation of cereals better deal with threats such as mould.

Most commonly isolated fungi from samples (regardless of the strategy of agriculture) were: Alternaria alternata, Aspergillus versicolor, Aureobasidium pullulans, Cladosporium macrocarpum, C. oxysporum, C. herbarium, Fusarium poae, F. tricinctum, Paecilomyces variotii, Penicillium citreo-viride, P. expansum, P. glabrum, P. lilacinum, Gonatobotrys sp.

Classification of Biosafety Level (BSL) is the scale of potentially pathogenic fungi for humans and animals, and distinguishes three hazard classes represented by different species of fungi. Most frequently occurring fungi mostly belong to the BSL-1 class causing a non-invasive or mild

danger. Some fungal isolates has been included in BSL-II class that is particularly dangerous for people with immune deficiency, in whom can cause opportunistic infections.

4. Conclusions

Years of research conducted at the Institute of Rural Health have shown that exposure to organic dust can lead to many respiratory syndromes, such as diseases of allergic (extrinsic allergic alveolitis - EAA - alveolitis allergica, bronchial asthma, allergic rhinitis, allergic conjunctivitis, allergic dermatitis), immunotoxic related diseases (organic dust toxic syndrome - ODTS, "sick building syndrome"), nonspecific diseases, chronic bronchitis. Health statistics show that the most of occupational diseases reported by Polish farmers is caused by pathogens present in organic dusts. In Poland, lung diseases are more common in farmers than in the rest of the population, just as in other countries.

Results of this study indicate that organic farming is less contaminated by mould, and therefore are less hazardous to the health of farmers. In addition, organic products have better nutritional values.

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EVALUATION OF ENERGY CONSUMPTION AND QUALITY OF SOLID BIOFUELS PRODUCTION FROM PLANT RAW ATERIALS*

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Keywords: plant raw materials, solid biofuels, energy consumption, production quality

1. Introduction

Environmental problems associated with the operation and the depletion of fossil fuel resources, as well as with the issue of pollution, contribute to the growing use of renewable energy sources. In the current situation of energy production from conventional fuels more and more attention is paid to issues associated with the protection of the environment. They result from a growing environmental awareness of societies and a desire to counteract the hothouse effect and global warming. A significant reduction in the quantity of emitted substances considered to be particularly harmful to the environment, can be obtained during the use of biomass for energy purposes. Energy production from biomass should be done, however, without detriment to obtaining adequate resources of food and feed [Denisiuk 2007, Kołodziej and Matyka (red.) 2012].

Plant biomass and, in particular, straw of cereals and other crops in the original form takes a lot of transport and storage space and has a low calorific value per volume unit. In this situation, it should be appropriately processed to improve its energy efficiency. Therefore agglomeration of plant raw materials through briquetting and pelleting is pursued, thanks to which increased mass and energy concentration is obtained per volume unit of this biofuel type and its distribution and usage is significantly improved [Frączek (red.) 2010, Mani at al. 2006, Niedziółka and Szpryngiel 2011, Stolarski at al. 2008],

2. Material and methods

The aim of the work was evaluation of energy consumption and quality of pellets and briquettes made of selected plant raw materials. Studies included measurements of energy consumption in the agglomeration process of plant raw materials. Before the measurements, plant raw materials were chopped by using the station chaff cutter of theoretical cutting length of 20 mm and

then on the chopper equipped with sieves of 6 mm holes. Relative humidity of plant raw materials was determined by weight-dryer methods according to standard PN-EN 15414-3:2011.

In the process of compacting the chopped plant raw materials used was a pelleting machine with a fixed one-sided flat matrix and rollers powered by a 7.5 kW electric engine and a screw briquetting press. The power of the compacting screw came from a 4.5 kW electric engine, and the heating of the compacting chamber from the electric heaters of 3 kW.

The volume of energy outlays was set using the converter of power, time and Lumel 3000 electricity type working with the computer. The converter-recorded data included: instantaneous and idling power consumption of devices and compaction process, as well as the duration of the compaction process. Energy consumption measurements were carried out after the adopted temperature by the compaction. Measurements of the total electricity consumption in the heating chamber and during the compaction process there are also using the three-phase linear meter.

The obtained power results converted per unit mass of produced pellets or briquettes. The obtained results have been testing statistical analysis based on an analysis of variance and Tukey test, with 95% confidence interval in STATISTICA 6.0.

3. Results

Figure 1 shows the results of tests of mechanical durability of pellets produced from the various raw materials. The pellets of lowest mechanical durability are made of wheat straw (82.6%) while slightly higher mechanical durability present those of rape straw (87.8%) and meadow hay (90.7%).

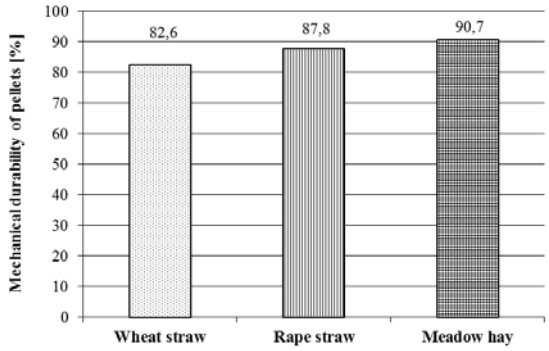

Figure 1. Mechanical durability of pellets produced from plant raw materials

Figure 2 shows the results of tests of briquettes mechanical durability, depending on the kind of used plant raw materials and the temperature in the

compacting chamber of briquetting press. The lowest mechanical durability is that of the rape straw briquettes (52-75%) while that of meadow hay and wheat straw briquettes is slightly higher, 55-75% and 60-80% respectively.

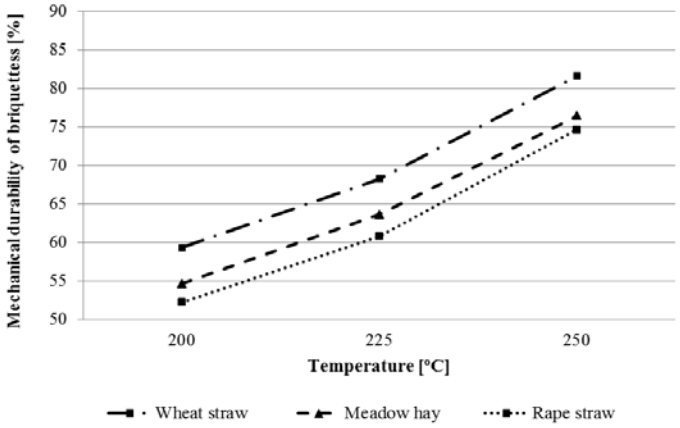

Figure 2. Mechanical durability of briquettes depending on the compaction temperature

An analysis of variance showed that plant raw materials used in studies ~~of~~ significantly affect energy consumption during the process of pelleting. Statistically significant differences were found in the case of energy consumption in the production of pellets for all agglomerated plant raw materials (table 1).

Table 1. The average values of the energy consumption during the pelleting process

Kind of raw material	**Wheat straw**	**Rape straw**	**Hay meadow**
Energy consumption [kWh·kg^{-1}]	0,153^{A}	0,145^{B}	0,176^{C}
Standard deviation	0,0068	0,0035	0,0032

Statistically significant differences were found in the case of energy consumption of briquetting process for all agglomerated plant raw materials. Also, statistically significant differences were found in the case of energy consumption during production of briquettes at the temperature of 200, 225 and 250°C (table 2).

Table 2. The average values of the energy consumption during the briquetting process

Kind of raw material	**Wheat straw**	**Rape straw**	**Hay meadow**
Energy consumption [kWh·kg^{-1}]	0,137^{A}	0,159^{B}	0,168^{C}
Temperature [°C]	**200**	**225**	**250**
Energy consumption [kWh·kg^{-1}]	0,162^{A}	0,151^{B}	0,140^{C}

4. Conclusions

1. Statistical analysis showed significant differences in the case of mechanical durability of pellets produced from tested plant raw materials. Best results in terms of mechanical durability of pellets were obtained when meadow hay was used to produce them while in case of wheat straw the results were a bit worse.
2. Analysis of variance showed that both the plant raw material and the temperature have a statistically significant influence on briquettes mechanical durability. The lowest durability briquettes have been reported in the case of compacting rape straw at a temperature of 200°C (52%) and highest when compacting wheat straw at a temperature of 250°C (83%).
3. By analyzing the results of the study it was found out that the energy consumption of the production process of both pellets and briquettes depends on the kind of the agglomerated plant raw materials and adopted temperature in the compacting chamber of briquetting press.
4. The smallest energy consumption during pelleting occurred for rape straw, while larger for wheat straw about 5.5% and of meadow hay about 21.4%. In turn during briquetting the smallest energy consumption occurred for wheat straw, and larger for rape straw about 16.0% and hay meadow about 22.6%.
5. The unit energy consumption during the briquetting process was reduced with increasing temperature in the compacting chamber. With increasing temperature from 200 to 250°C, the reduction in energy consumption ranged from 13 to 15% for wheat and rape straw and about 20% for hay meadow.

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REPRODUCTION OF MECHANIZATION MEANS ON FARMS IN LOWER SILESIA

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1. Introduction

One of the most essential questions in the area of agriculture farm management is technical armament of the work that means it's mechanization. This irreversible in present-day times process of the substitute of the alive work for work objectivizes except many advantage connected mainly with the improvement of efficiency, the quality and economic threat resulting from the high capital absorption of mechanization processes decrease of the difficulty of work carries especially in individual farms [Muzalewski et al. 1997, Pawlak 2010]. This is highly connected in the report to received products with the price of mechanization means, and also the costs of their exploitation whose level determines first of all the degree of their utilization. The rationality of the reproduction process of these centres gathers in relationship with this essential meaning.
Having this on the attention, the analysis of the reproduction of the mechanization means in the studied population of farms was the aim introduced in the study.

2. Material and methods

The investigation was conducted in the period of 3 years – since 2008 till 2010. Source materials came from individual farms laid in the most farm intensive subregions of Lower Silesia.
The investigations were conducted in 100 farms with plant production profile chosen in the purposeful way. In this farms the accounting processes was introduced with special advisory AG persons for book – keeping in purpose to count final economic efficiency for whole farm and identify mechanization costs. Moreover, the detailed stock-taking of possessed assets was executed and conducted interviews with owners relating to activity investment.
The average surface of studied farm carried out 46.65 ha of which 46.24 ha was utilised agricultural area. This surface was about four times larger in comparison with average surface of the individual farm on Lower Silesia passed by Main Statistical Office and three the times larger in the relation to

Niven data from ARMA The minimum surface of studied farm is 2.08 ha, and maximum 170.36 ha. The division was executed for studied community on 6 area groups: to 10.00 ha (6); 10.01-15.00 ha (19); 15.01-30.00 ha (19); 30.01-50.00 ha (18); 50.01-75.00 ha (17); over 75 ha (100). The number of farms was signed in compartments.

3. Results

The production of cereals predominated in studied farms, which made up 74.28% of all sowings, the winter rape occupied 20.20 %, and the root plant less than 5%. The number of mechanization assets was noted down as 24 in the whole studied community of farms. The average indicator was 2.09 tractors per farm. In most cases farms possessed 2 tractors somewhat connected to 44% of cases, 1 tractor in 25% of cases and 3 tractors in 28% of cases. In every three farms utilized 4 tractors. For tractor covered surface over 22 ha. Combine harvesters were in the possession of 70% of farms and for each of them 48 ha of cereals fells the machine on this type of similar technologically plants. The average age of possessed equipment is 17 years, of what 13 years was used in studied farms. Foresee more far of its use by next 11 years, what consists on period of durability carrying out together 28 years.

The conducted analysis of machine investments showed, that in the smallest group of farms no investment purchases were noted. In the next area groups in 30% of cases was noted investment processes and in group over 75 ha of UAA about 50% of units undertook investment. The considerably smaller number of farms sold possessed machines. The sale of machines joined with new equivalents purchase most often. The total 58 machines were bought and 20 sold. Tractors, ploughs and cereal combine harvesters predominate among machines bought. Special attention was noticed to purchase of tractors over 80 HP tractors. Details are presented in table 1-3.

Table 1. Sale and purchase of machinery in the analysed sample of farms

Area group (UAA)	Sale of machinery			Purchase of machinery			Balance of investments [PLN/ha]
	Number of farms	Total average value [PLN]	Average value of the 1ha [PLN]	Number of farms	Total average value [PLN]	Average value of the 1ha [PLN]	
< 10 ha	-	-	-	-	-	-	-
10.01-15.00 ha	2	13250.00	1174.35	6	32676.67	2834.72	-1660.37
15.01-30.00 ha	3	5800.00	254.08	5	22208.57	940.09	-686.01
30.01-50.00 ha	6	8362.50	239.55	6	42800.00	1007.45	-767.9
50.01-75.00 ha	2	5750.00	90.85	6	60700.00	1028.92	-938.07
> 75.00 ha	4	34000.00	351.44	10	125427.05	1116.40	-764.96

Source: own study

Table 2. Specification of purchased machinery in the analysed sample of farms

No.	Specification	< 10 ha UAA	10.01-15.00 ha UAA	15.01-30.00 ha UAA	30.01-50.00 ha UAA	50.01-75.00 ha UAA	> 75.00 ha UAA	Total
1.	Tractors until 80HP	-	-	2	1	-	-	3
2.	Tractor above 80 HP	-	2	-	3	3	3	11
3.	Grain combine-harvesters	-	1	1	-	-	2	4
4.	Ploughs	-	1	-	3	3	2	9
5.	Cultivators	-	1	-	-	-	1	2
6.	Grubbers	-	1	-	1	-	1	3
7.	Seed drills	-	-	-	1	1	1	3
8.	Tilling and sowing sets	-	-	-	-	-	1	1
9.	Plant setters	-	-	-	-	1	-	1
10.	Fertilizer broadcasters	-	-	1	-	-	1	2
11.	Sprayers	-	-	1	-	-	-	1
12.	Disc harrows	-	-	-	1	1	-	2
13.	Subsoilers	-	-	-	1	-	-	1
14.	Rollers	-	-	-	-	1	2	3
15.	Tilling sets	-	-	1	1	-	1	3
16.	Trailers	-	-	-	-	2	3	5
17.	Potato graders	-	-	1	-	1	-	2
18.	Cross augers	-	-	-	-	1	-	1
19.	Appetizer for package of corn	-	-	-	-	-	1	1
20.	Total	-	6	7	12	14	19	58

Source: own study

Table 3. Specification sales of machinery in the analysed sample of farms

No.	Specification	<10 ha UAA	10.01-15.00 ha UAA	15.01-30.00 ha UAA	30.01-50.00 ha UAA	50.01-75.00 ha UAA	> 75.00 ha UAA	Total
1.	Tractors until 80HP	-	2(1w*)	1(1w)	1	1(1w)	1(1w)	6
2.	Tractor above 80HP	-	-	-	1(1w)	-	1(1w)	2
3.	Grain combine-harvesters	-	-	-	-	-	2(1w)	2
4.	Sugar beet combines	-	-	-	2	-	-	2
5.	Ploughs	-	-	-	1(1w)	1(1w)	-	2
6.	Seed drills	-	-	-	1 (1w)	-	-	1
7.	Precise seeders	-	-	-	1	-	-	1
8.	Fertilizer broadcasters	-	-	2 (1w)	-	-	-	2
9.	Cultivators	-	-	1	-	-	-	1
10.	Trailers	-	-	-	1	-	-	1
11.	Total	-	2	4	8	2	4	20

Source: own study
**- w – exchange for newly purchased*

On the basis of gained information relating to the investment activity of studied farms - the analysis of the level of reproduction of mechanization

assets and the real possibilities of investment in farms was conducted. In this purpose the calculation of investment cash balance of farms in individual area groups and confront calculated values with investment expenses in the studied period was done. The disposal cash for family purposes in the reference to the surface of 1 ha, as the sum of the isolated unit of farm income and isolated level of the amortization was calculated. Final cash was diminished about the parity payment of work accept the monthly net payment on the level of PLN2200 (according to Main Statistical Office as average in national economy in the period of the analysis) and taking under the consideration the potential of work force in farms.
The level of disposal money for investment was established by this method. In all area groups (except first group, where the investment wasn't noted) the widened reproduction of mechanization assets was visible (Table 4).

Table 4. Possibilities of farms surveyed population recovery of machinery

Area group (UAA)	The value of the average depreciation of machinery [PLN/ha]	Agricultural income [PLN/ha]	Disposal cash for family [PLN]	Charge of standard work [PLN/ha]	Investment Cash [PLN]	Capital expenditures [PLN]
Up to 10 ha	1709.51	-1115.68	593.83	5808.00	-5214.17	-
10.01-15.00 ha	973.90	-407.84	566.06	2376.00	-1809.94	1660.37
15.01-30.00 ha	766.22	-170.34	595.88	2376.00	-1780.12	686.01
30.01-50.00 ha	719.15	97.66	816.81	1584.00	-767.19	767.90
50.01-75.00 ha	517.73	463.06	980.79	792.00	188.79	938.07
over 75.00 ha	488.27	411.35	899.62	528.00	371.62	764.96

Source: own study

4. Conclusions

In all area groups of farms under investigation, except the smallest group, the investment activity was noted down in the area of mechanization assets. This activity had the character of widened reproduction. The positive level of investment cash appeared only in 2 the largest groups but it did not let cover the whole of investment expenses. It could testify the developmental character of these individuals probably. In the remaining groups the investments were realized in spite of the lack of covering resulting from incomes what takes very sceptical opinion of next investments in the context of the considerable number of investment and possessed until now farm equipment.

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KEYWORDS INDEX

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