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Intensity and labour consumption of integrated production in horticultural farms

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Abstract

The paper presents economic efficiency of work in the horticultural production in the selected farms which carry out the integrated production. At the average, one man-hour was paid 0.09 PLNk·man-hour-1. Taking into consideration the use structure in the investigated objects, the intensity of production organization was determined. The production was varied (it was within the intensity range of 213-393 points) and the differences resulted directly from the participation of the grain cultivation area and currant plantation in particular farms. A field work mechanization degree is, inter alia, a factor that influences the labour inputs level. Thus, an annual use of farm tractors was also determined. It was 400 hours. The paper covers farms associated in the formalized producer's group.

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Keywords: machinery park; sustainable agriculture; optimisation; agricultural technology; agricultural software.

1. Introduction

Labour, as one of the production factors, is an essential element which influences effectiveness and competitiveness of agricultural farms which produce under any system, also in the sustainable one. A relation in the

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Polish agriculture between land and capital is assessed as a sufficient, whereas a relation between work and capital as well as work and land, due to too high work resources, is negatively evaluated (Pepliński et al. 2002; Tabor and Prusak 2008). The research studies, which have been carried out so far (Szeląg-Sikora 2013; Sikora 2014) show that there is no clear substitution dependency between live and objectified labour in the crop production. It results from the fact that at an irrational organization of production processes, technical and technological innovations do not release high labour surpluses.

The integrated agriculture is defined as a farming method, which enables realization of economic and ecological aims through a conscious use of modern production techniques, systematic facilitation of management and introduction of various forms of biological progress in a manner which favours realization of these purposes (Perini and Susi 2004; Die Lage der Landwirtschaft in der Europäischen Union). In the Polish conditions, which should be emphasised, agriculture is integrated in the initial stage of development. Presently, approximately 2 million of individual farms existing in our country, with varied levels of farming: from primitive, extensive farms to modern, well-equipped with machines with a reduced labour consumption (Sawa, 2009). The integrated farming has the biggest number of properties of the sustainable production, at the same time it is a form of alternative farming, it consists in harmonious combination of the conventional and ecological farming (Figuski and Lorencowicz, 2008; Cupiał and Szeląg-Sikora, 2014). A rational mechanization of production processes is an essential element of efficient functioning of integrated farms (Alvarez and Arias, 2004). The state of the research studies on implementation of the integrated farming systems is advanced in many countries of Western Europe. For example, according to Dutch scientists, an integrated farm may obtain a 94% income of the income of a conventional farm (Helander and Delin, 2005). In Germany, introduction of the integrated system is carried out by, inter alia, the Crop Protection Institute in Stuttgart. Average surface of such an integrated farm is 17 ha (Musshoff and Hirschauer, 2008). The nature, size and production results of the German integrated farms may be an example for the Polish agricultural objects. The integrated agriculture research system similar to the German one, is carried out in Switzerland, however, implementation takes place in a considerably bigger number of farms, which form a network of farms with the controlled production system. Also in Great Britain, France, Denmark and Norway, macro-field experiments concerning the selected technological elements (e.g. crop rotation, reduction of agri-chemical products use, labour inputs, etc.) of the integrated agriculture are carried out (Mézière et al., 2013).

According to Woś (2001), efficiency is a factor determining the position of the Polish agriculture on account of economy sectors. He lists economic weakness of farming as one of the reasons of the current agriculture depreciation in the system of inter-branch flows, and consequently low ability of accumulation and investing. Disadvantageous agrarian structure of the Polish farms (especially in the Southern Poland) translates not only into their low competitiveness but also determines their efficiency of farming by too slow modernization process of the technical back and by this to also low labour efficiency and high production costs. Also, according to Kożuch (2000) relatively low efficiency of the Polish agriculture is in a considerable degree a result of fragmented agrarian structure, which makes fast increase of the labour efficiency, production efficiency and farmers' abilities to absorb technical and technological progress impossible. Moreover, full mechanization is in small farms the most frequently economically unjustified. The only way for its introduction is a common purchase of specialist equipment at a considerable participation of the EU funds in its funding.

The labour inputs often determine a production orientation and intensity in agricultural farms and the investment activity of farms is mainly oriented at the reduction of difficult working conditions and improvement of production profitability. Knowing labour resources, assets and production potential of a farm, they may be rationally modernized and developed, according to the sustainable development of principles (Kocira and Parafiniuk, 2010).

2. Objective, data and methodology

Research in the form of a guided survey was carried out in 2015 in 9 farms associated in the horticultural group. These are initial research studies with respect to the integrated farming. Detailed tests are going to be carried out in all member farms of the group.

The objective of the paper was to assess the economic efficiency of work and intensity of horticultural integrated production. To fully perform the assumed objective of the paper, firstly the land use structure, labour consumption of particular cultivation treatments were determined (harvesting, cultivation and treatments in orchards). Then, the

gross final production as a reference point for compensation for the incurred labour inputs was calculated and based on the Kopeć's method (1968) the intensity of production of the investigated farms was assessed. The paper also includes basic information concerning the quantity of the equipment of the machinery park as well as the annual use of farm tractors.

Calculation methods:

Intensity of the plant production organization is determined by multiplying participation of each plant in the sowing structure by a relevant intensity coefficient and then the obtained numbers of points are summed up:

$$I_R = \sum_{i=1}^{n} u \; x \; s \tag{1}$$

where:

I_R – plant production intensity,

u – percentage share of the cultivation surface of a given crop in agricultural land,

s – conversion factor of the crop intensity for particular groups of plants (points) acc. to Kopeć.

Average conversion factors for the following group of crops are assumed for calculation of the production intensity level: grains 1.0; orchards 2.5; berries plantations 5.0 (Gębska and Filipiak 2006 after Ferenc et al., 1998).

Table 1. Production intensity distribution (points)

Level of intensity	Intensity of production in points
Extensive	>200
Low-intensive	200-250
Medium-intensive	250-300
High-intensive	300-350
Very high-intensive	<350

(Gębska and Filipiak 2006 citing Ferenc et al., 1998)

Economic labour efficiency (EWP) informs on the production value generated in the time unit by one man or a group of people. Economic labour efficiency was determined for the entire farm according to a pattern quoted after Gębska and Filipiak (2006):

$$EWP = P/NP \qquad (\text{kPLN} \cdot \text{man-hour}^{-1}) \tag{2}$$

where:

P – gross final production (kPLN·ha^{-1}AL),

NP – labour inputs (man-hour).

Gross final production – constitutes a sum of the obtained plant and animal production value.

Plant and animal production value included:

- value of the main product,
- value of the side product (only in case it was the subject of the market exchange),
- domestic use value,
- subsidies to a product or to its cultivation area (these could be subsidies from the state budget ot the European Union budget within Common Agricultural Policy).

Value of production in case of particular activities of plant production was calculated for 1 ha of AL of cultivation or for 1 LU.

3. Results

Farms covered by the scope of research were oriented at plant production which was almost exclusively horticultural. Among trees cultivated by farmers there were apple trees, pears, plums, cherries and currant bushes. Only two farmers from the investigated group had, except for horticultural crops, small cultivations on arable lands

were wheat was sowed (2). The research show that apple trees had the highest participation in the stocking structure and it was at the average for all 80.3%. Almost parallel on the second position were currant bushes - 7.2% and plum trees 6.8% of the stocking surface area.

Table 2. The structure of the land use and the organization intensity in the investigated farms

Specification		Farms									
		Average	1	2	3	4	5	6	7	8	9
		(ha)									
Orchards and plantations		3.8	5.5	2.7	3.5	5.3	2.1	2.9	3.7	5.0	3.5
including:	Apple trees	3.1	4.5	2.4	3.5	5.0	1.5	2.0	1.7	5.0	2.5
	Pear trees	0.1	-	0.1	-	-	0.5	-	-	-	-
	Plum trees	0.2	-	0.1	-	-	0.1	0.5	1.3	-	-
	Cherry trees	0.1	-	0.1	-	0.3	-	0.2	0.3	-	-
	Currant	0.3	1.0	-	-	-	-	0.2	0.4	-	1.0
Arable land (grains)		0.1	-	0.9	-	-	0.4	-	-	-	-
Total agricultural land		**3.9**	**5.5**	**3.6**	**3.5**	**5.3**	**2.5**	**2.9**	**3.7**	**5.0**	**3.5**
		(points)									
Intensity of production organization		**279**	**341**	**213**	**250**	**250**	**226**	**284.5**	**304**	**250**	**393**

The analysis, which was carried out, shows that the intensity level decreases along with the increase of the grain sowing area (minimum value of 213 points) and raises in case of currant plantations (maximum value of 393). According to a five-degree scale the plant production organization intensity was at the level of 279 points, which acc. to Kopeć's scale, corresponds to the medium intensive level of the production organization intensity.

The average final gross crop production (table 3) for the investigated horticultural farms was 21.2 kPLN·ha^{-1}AL. The maximum final gross crop production with reference to agricultural land was reported in farm no. 1 i.e. 24.0 kPLN·ha^{-1}AL, and no. 8 i.e. 24.0 kPLN·ha^{-1}AL. It should be noticed that those farms carried only a horticultural production as well as they had the biggest areas of orchards and currant plantations in comparison to other investigated objects. The minimum gross production was on the other hand reported in the farm no. 5 i.e. 19.2, whose acreage of orchards was the lowest.

Table 3. Economic balance of the economic efficiency of work

Specification	Farms									
	Average	1	2	3	4	5	6	7	8	9
	(kPLN·ha^{-1}AL)									
Gross final production	21.2	24.0	20.2	20.0	23.5	18.4	19.2	22.2	24.0	19.1
	(man-hour·ha^{-1}AL)									
Labour input	228	163	249	247	195	249	263	254	182	250
including: harvest	88	55	96	99	70	109	114	104	61	108
treatments and cultivation	140	108	153	148	125	140	149	150	121	142
	(kPLN·man-hour^{-1})									
Economic labour efficiency	**0.09**	**0.15**	**0.08**	**0.08**	**0.12**	**0.07**	**0.07**	**0.09**	**0.13**	**0.08**

A guided survey collected source information based on which labour consumption of the conducted production in particular farms with reference to 1 ha of AL was determined (Table 3). Time of harvest, cultivation and treatment was specified. In case of horticultural production it included cutting and winter formation, mineral fertilization, mechanical mowing, summer cutting and forming, sprouts thinning, spraying of interrows, spraying of trees and planting.

The research, which was carried out, shows that farms no. 6 and 7 incurred the highest labour inputs, respectively for the farm no. 6 - 271 man-hour·ha^{-1}of AL, and for the farm no. 7 256 man-hour·ha^{-1} of AL. Such circumstances resulted from the distribution of production and lack of orientation on the specific one group of

plants. Farms 1, 4 and 8, which were oriented at production of specific fruit and which had the biggest areas of orchards and plantations from among the investigated farms, were defined by lower labour inputs with reference to 1 AL and in a farm no. 1 it was only 171.3 man-hour·ha^{-1}AL. In the remaining farms 2, 3, 5, 9 labour time inputs were at a similar level of approx. 250 man-hour ·ha^{-1}AL.

Achieving possibly the highest labour efficiency is a notable effect of agricultural production. Comparing the investigated objects on account of the value of the discussed factor, the most advantageous results were obtained in the first farm, where one man-hour was compensated with the gross final production value at the level of 0.15 PLN k and the lowest (almost doubled) value was obtained in farms 5 and 6 i.e. 0.07.

In order to define the investigated farms, the quantity equipment of the machinery park was analyzed (table 4). The presented results prove that the investigated objects had indispensable machines used for maintenance of orchards and plantations. On the other hand, there were no machines or tools for grain cultivation (which occurred in the use structure), because in farms, where these crops occurred, farmers declared that they use mechanization services.

Each investigated farm had 2 pcs·farm^{-1}. At the average 0.8 pcs·farm^{-1} of a tractor with 6kN towing class was per a farm and 0.7 pcs·farm^{-1} of 9 kN class. A producer group was responsible for the collection of fruit from farms, however, despite this, almost all farms were equipped with trailers and platforms for transport of fruit to the collection center. Fork lifts used for the so-called internal transport were only in 3 farms (1, 4 and 5). The remaining farmers used lifts mounted on tractors. Farmers had at the average 0.4 pcs·farm^{-1} of fertilization machines. All farms were equipped with sprayers, machines, which are the basic element of equipment in horticultural farms, but farmers from the farm no. 2 and 7 had 2 pcs·farm^{-1} each of these machines. Similarly, all farms were equipped with mowers which help to keep order in an orchard. At the average, 1.11 pcs·farm^{-1} was per one farmer.

Table 4. The number of machines in the machinery park and annual use of farm tractors

Specification	Farms									
	Average	1	2	3	4	5	6	7	8	9
Farm tractors	1.4	2.0	2.0	1.0	1.0	1.0	2.0	1.0	2.0	1.0
including: 6 kN class	0.8	-	1.0	-	1.0	-	2.0	1.0	1.0	1.0
9 kN class	0.7	2.0	1.0	1.0	-	1.0	-	-	1.0	-
Fork lifts	0.3	1.0	-	-	1.0	1.0	-	-	-	-
Trailers and platforms	0.9	1.0	-	-	1.0	1.0	2.0	1.0	1.0	1.0
Fertilizer distributors	0.4	-	-	-	1.0	-	1.0	1.0	-	1.0
Sprayers	1.2	1.0	2.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0
Mowers	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
Annual use of tractors in agriculture farm	(hour·year^{-1})									
	400	400	432	500	700	343	216	500	281	448
	(kPLN·ha^{-1}AL)									
	105.3	72.7	160.0	142.9	132.1	163.3	74.5	135.1	56.2	128.0

Average level of annual use of tractors in the investigated group was 400 hours·year^{-1}. A farmer from farm no. 4 used a tractor most intensively - at the average 700 hours·year^{-1}, and in the farm no. 6, which had 2 tractors, the use of machines was only 225 hours·year^{-1}. When referring the working time to the calculation unit of 1 ha of AL, at the average for the investigated farms, this index was 105.3 hours·ha^{-1}AL and for all objects it was within 72.7-163.3 hours·ha^{-1}AL. Big differences occurred as a result of the size of the owned area of orchards and plantations and the lack of proportional differences in case of an hourly use of agricultural farms in particular objects.

4. Summary and conclusion

To conclude it should be emphasized that the integrated production is a developing farming system. It complies with the sustainable agriculture principles which include the newest achievements of science and agricultural technique and has to ensure competitiveness of fruit, vegetables and other produces on the market and facilitate their sale. However, as every agricultural production it generates many inputs including the labour consumption. The analysis which was carried out proves that the investigated farms had average labour inputs at the level of 228 man-hour·ha^{-1}AL. Each farm aimed at obtaining a relevant farming effect, inter alia, through obtaining appropriate financial compensation for the time devoted for realization of particular production processes. The obtained value of economic labour efficiency index was at the level of 0.09 kPLN·man-hour^{-1}, it is an example of effective

management in the investigated farms, since it indicates the relations between possible financial effects i.e. gross final production value and production labour consumption. The use of farm tractors, which as assumption, cooperate with the so-called cooperating machines (sprayers, mowers, etc.) are a indirect factor, which may influence the level of incurred labour inputs. In farms covered by these investigations, the value of this index was at the average within 216-700 hours·year^{-1}).

From the point of view of the rational farm management, the production organization is vital; the production organization intensity index, which for the investigated objects was at the average of 176 points, reflects this element of the production process.

The results presented in the paper are the effect of initial research of the project; extension of the research group and the substantive scope is planned to answer, inter alia, the question whether the integrated agriculture may be competitive for a conventional farming and how much the production processes in the mentioned production systems differ and what are those differences. Among many factors, the following factors should be analyzed: owned land resources, production trend, production intensity, production concentration level, owned technical equipment and human factor including ability for strategic management and creativity within enterprise. Since it is assumed, that the increase of consumers' awareness enforced actions in order to produce food which is safe for health and protects environment, the integrated agricultural production is a system which meets requirements of the sustainable production.

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