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Factors supporting the use of technical means and production efficiency in peasant holdings

MONOGRAPH

edited by Józef Kowalski

Compiled by:
Elżbieta Budyn, PhD, Eng.
Paweł Kiełbasa, PhD, Eng.
Prof.Józef Kowalski, PhD, Eng.

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Reviewers:
Prof. Rudolf Michałek, regular member of the Polish Academy of Sciences
Prof. Jan Pawlak, PhD, Eng. Institute of Technology and Natural Sciences in Falenty - Warsaw Branch

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Statistics editor
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Translated by Katarzyna Wójcik

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Contents

SYMBOLS

C_p – fuel price [PLN·l^{-1}],
C_c – machine price [PLN],
E_c – total amount of accumulated energy [MJ],
E_{s1} – amount of energy accumulated in GU [MJ·GU^{-1}],
E_m – energy accumulated in the used machines and devices E_m [MJ·year^{-1}],
E_{bud} – energy accumulated in buildings and facilities [MJ·year^{-1}],
E_n – energy from direct energy carriers [MJ·year^{-1}],
E_p – energy constituting an equivalent of man labour [MJ·year^{-1}],
E_s – energy accumulated in materials and raw material [MJ·year^{-1}],
E_{su} – amount of energy accumulated in GU compensated from EU funds [MJ·GU^{-1}],
F_p – surface area of a building [m^2],
G_e – fuel consumption [l·h^{-1}],
i – 1 man hour work cost [PLN],
i_1 – number of work hours of people employed in the production process
K_a – amortization costs [PLN·year^{-1}],
K_{ec} – operation costs of tractors and machines [PLN·ha^{-1}]
K_k – costs of storage, insurance, registration [PLN·year^{-1}],
K_r – amount of direct and target subsidy to GU [PLN·GU^{-1}],
K_s – total production cost of GU [PLN·GU^{-1}],
K_u – amount of direct and target subsidy [PLN·ha^{-1}],
K_{uj} – maintenance cost [PLN·h^{-1}],
K_a – cost of use [PLN·h^{-1}],
K_c – total production cost from 1 ha [PLN·ha^{-1}],
K_{r1} – amount of direct and target subsidy [PLN·GU^{-1}],
K_{s1} – total production cost [PLN·GU^{-1}],
m – mass of a tractor (machine) [kg],
m_1 – consumption of energy carriers [kg], [kWh],
n – number of man hours [man hour·ha^{-1}],
n_1 – conversion yield [GU·ha^{-1}],
Pz – installed capacity [kW·ha^{-1}AL],
Pn – nominal power of tractors, forklift trucks, delivery trucks [kW],
r_1 – index of repair costs during service life,
r – coefficient of correlation,
r^2 – coefficient of determination,
S – area of AL in a farm [ha],

T	–	service life [years],
T_1	–	normative time [h·year^{-1}],
w	–	index of the accumulated energy consumption for machines and tractors [MJ·kg^{-1}],
W_r	–	annual use [h·year^{-1}],
WT	–	use during the service life [h],
W_{RK}	–	EU compensation index of production costs,
W_{RE}	–	EU funds compensation index from energy accumulated in a product [%],
W_{07}	–	exploitation capacity of an aggregate [ha·h^{-1}],
W_{rz}	–	real use during a year [h·year^{-1}],
V	–	coefficient of variation [%],
x	–	index of energy consumption accumulated in materials and raw materials [MJ·unit^{-1}],
x_{rbh}	–	index of energy accumulated in labour – 42 MJ·man hour^{-1},
x_n	–	index of the accumulated energy consumption for an energy carrier [MJ·kg^{-1}], [MJ·kWh^{-1}],
y	–	index of the accumulated energy consumption in buildings and station roofs [MJ·m^{-2}·year^{-1}],
q	–	raw material consumption [unit·ha^{-1}],
σ	–	mean standard error,
*	–	unit – [kg, item, l, m^2,….],
*x_n	–	index of the accumulated energy consumption in 1 kg of ON [MJ·kg^{-1}].

1. THE EUROPEAN UNION FUNDS SUPPORTING THE POLISH AGRICULTURE COMPARED TO OTHER FACTORS

1.1. Introduction

Poland's accession to the EU structures in 2004 enabled development of the country but also influenced the increase in competitiveness also within agricultural production. Therefore, agricultural enterprises of high modernity potential, such potential that their products would be of high quality, attractive price and would be desirable at the market, can face up to competition.

In 2000 the Council of Ministers of the Republic of Poland issued a report on advantages and costs of integration with the EU [2000 Report], which covers support of multifunctional development of rural areas concerning: raising productivity of agriculture, improvement of agricultural structure, reshaping unprofitable farms into modern and efficient, optimisation of employment in the agricultural sector, introduction of technical progress, changes in the production structure, increase of the agricultural products quality and improvement of natural environment condition.

Within the reform of joint agricultural policy, the EU abandoned the support of production for funding a farmer. It is a system of simplified compensation subsidies for the area and not for the production. This, on the other hand makes the amount of subsidies independent from the size of the present area.

This direction of evolution of the Common Agricultural Policy [CAP] is advantageous for the Polish agriculture because it leads to direct influence on farmers' incomes, abandoning funding through prices for the benefit of direct payments, the consequence of which is moving the burden of supporting agriculture from a consumer to a tax payer.

The union expenses on financing agriculture and rural areas come from the European Fund for Orientation and Agricultural Guarantee and mechanisms of Common Agricultural Policy referred to the agricultural market are administered in Poland by the Agency of Agricultural Market [Polish: ARR].

Supporting Polish farmers with the EU funds may influence renovation of the machinery park in farms. However, what is efficiency of subsidies in the aspect of technical modernisation? This question has not been answered yet.

Presently, the Polish agriculture is financially supported by many types of the EU programmes. Amounts of subsidies which result from them are really high and amount to over PLN 12 billion only in case of direct subsidies in 2012. [Direct subsidies (on-line) 2012]. Therefore, correct allocation of this sum between particular beneficiaries, i.e. agricultural producers and owners of farms, is an activity which considerably influences further functioning of our agri-food sector. Simultaneously, effects of influence and mutual relations of particular economic and production factors with subsidies are significant.

1.2. Conditions of farming efficiency

Achievements of the scientific and technical progress enable introduction of machines and devices of a new generation, which lead to the growth of agricultural production [Kowalski et al. 2002]. However, the price of a new generation machine is prohibitive for a producer when referred to the equivalent of the agricultural product. Therefore, the only alternative possibility of meeting the market requirements is using the EU aid funds [Pawlak 1999].

The influence of using the structural funds (Sectoral Operational Programme) on modernization of the machinery park in farms and advantages from the European Union aid programmes give possibilities of fast modernization of the machinery park as a result of a 50-65% refund of the incurred costs for the purchase of agricultural machines, because the quantity of the machinery park is satisfactory, but obsolete machines, in many cases, are not suitable to be aggregated with new generation tractors, which are purchased in the first place [Szeląg-Sikora et al. 2007]. Therefore, selection and use of tractors may also considerably influence the production costs. As a result, the analysis of the changes dynamics in the structure of the machinery aprk should be taken into consideration, which is emphasised by many authors, inter alia by Kocira [2006].

Karwowski [1998] states that the machinery park structure has a great significance in decreasing the production costs and especially it is justified by energy demand, power and number of tractors, the share of which in direct production costs is 30-70%.

Whereas, decrease of the operation costs of farm equipment is rational when the quality and quantity selection of this equipment includes natural and organisational conditions. Moreover, selection of the most appropriate forms of using the equipment for particular conditions of agricultural production, ensuring its rational use, should take place. Consequently, the production costs may be lowered. While, exchanging the old equipment with more energy saving and introduction of multifunctional aggregates of new generation operated by a highly qualified staff should be a condition for modernization of a consumer. Inter alia Pawlak [1999] and Wójcicki [2007] point out the above.

Wójcicki [2005] also claims that in order to assess the material and energy inputs incurred in a particular farm on agricultural production determining present costs of this production and the obtained agricultural income, the level of remuneration for the farmer's and his family's work, all components of the production thrust should be thoroughly analysed. Effects of the final and commodity global production and inputs on production estimated in money units allow determination of the economic efficiency of the farm activity and the unit production costs [PLN·GU^{-1}]. Similarly, the obtained production effects and incurred material and energy inputs, estimated in energy units [MJ] allow determination of the energy efficiency of farm production activity and the unit energy consumption of the obtained global and final agricultural production [MJ·GU^{-1}]. Therefore, one may conclude that the analysis of the energy inputs gives a possibility of determination of the minimum sizes of the accumulated energy consumption streams in agricultural produce and this may translate into optimal production costs.

Other authors state in their papers that Polish farmers, who want to compete with farmers from the so-called "Old EU", from the moment of accession to the European Union must change the farming system by applying efficient machines of new generation and suitable knowledge is necessary for their correct exploitation. This fact is emphasised inter alia by Michałek [2004]. However, one should remember that although our farmers have belonged to it for many years, they are not treated equally to farmers of the "Old EU" and receive considerably lower subsidies.

Malaga-Toboła [2007] also sees this problem and states that realisation of structural funds depending on the level of education of farmers within the Rural Areas Development Plan and the Sectoral Operational Plan significantly influences the size of the obtained structural funds and the form of their use. Farmers with higher and high school education use the EU funds for modernization of a farm, changing them into ecological, eventually investing in agri-tourism.

As a result of farm modernization and as a consequence of this, a better use of means and lowering the production costs, improvement in agricultural sector should occur and this will be a factor for the increase of producers' incomes and as a result will stimulate improvement of a financial condition of agricultural families. A similar opinion is shared by Barwicki [2007]. Moreover, this author states that in conditions of high supply of scientific and technical information and the use of aid means, the producer should be equipped with tools and a proper information system ensuring a suitable access to information, facilitating science development and progress of practice within sustainable agriculture.

Inner balance between production factors and production processes is a condition for correct organization and farms operation. Therefore, meeting criteria and tasks of the sustainable farming requires considerable skills, high knowledge resources, access to information and documentation kept systematically. Current monitoring and analysis of the collected information enables introduction of changes and modification which influences improvement of the farming efficiency. Pre-accession programme SAPARD was very useful in this case. It enabled, inter alia, acquisition of tractors and technical equipment by farmers with preferential conditions. However, in order to use this programme it was necessary [cit. Baum 2007] to inter alia:

– posses soil and agricultural maps of particular fields with information on soil reaction and content of alimentary components,
– maintenance of field cards and reports on animal herds turnover,
– drawing up fertilization plans including balance of the basic alimentary components and organic substances.
– maintenance of the influence and expenses register.

Meeting the above conditions is a condition for the increase of farming efficiency. Since, the growing significance of informative technology in agricultural mechanization and development of agricultural engineering is supposed to enable the use of precise farming, provide new technologies of production, energy from renewable energy sources and include requirement of progressing civilization and utility forms of using machines. European producers of agricultural machines have to react flexibly to the market demand, introduce innovations concerning products and processes, lower the production costs. This fact is especially emphasised by Pawlak [2007].

Many authors, including inter alia Wanke [2007] emphasises that plant and animal production development and the increasing diversity of requirements for agricultural machines in food and agricultural processing farms and companies forces out constant modernization of technical equipment, which must be adjusted to tasks and must be characterised by the operation costs adjusted to economic possibilities.

Influence of the technical equipment on the effects of the family farm activity and mechanization inputs - related to the maintenance and use of technical means, frequently called operation costs of machines may be assessed in the most advantageous way by the use of calculation methods or calculation-balance methods. These methods are applied at the determination of the gross mechanization costs, i.e. a process which should be required by a service provider from a service receiver. While, at assessing self-costs, resulting from the annual activity of family farms, the use of balance-calculation methods is recommended, where the remaining costs (inputs) of maintenance and the use of the machines set are added by calculation to the mechanization costs resulting from the incurred costs (expenditures) [Wójcicki 2007].

Current research prove that costs incurred on mechanization amount to 35–60% of the total production costs of a farm. In order to determine the share of mechanization costs in the total cost Kowalski et al. [2005] calculated the rate, which is a ratio of the mechanization costs to the total production costs. While, they reported in their research that along with the increase of the surface area of farms, the share of mechanization costs in their total value increases. It results, inter alia, from the increase of technical infrastructure in bigger farms and the possibility of decreasing the mechanization costs is viewed in the decrease of the value of the machinery park calculated into 1 ha of AL and the increase of its annual use. The above mentioned authors prove that the influence of the diversity of agrarian structure on the indexes of technical fittings level, that is: the area of arable land; power installed [kW·ha^{-1}AL]; replacement value of the machinery park [thousand PLN·ha^{-1}AL] and the age and the service life of tractors [years], is crucial. One should admit that referring to the assessment criteria, there are strict relations proving rationality of farm owners actions at modernization of tractors and machinery parks. However, in majority of farms, completing machines takes place rather by deduction than based on scientific methods including priority conditions.

Determining measures of assessment of economic and technical conditions of farms, Szeląg-Sikora [2008] analysed the level of intensity of agricultural production organisation on one hand and the standard gross margin obtained from this production on the other hand. She compared meters in the aspect of their interdependance and their influence on the level of indexes which characterise the machinery park. The researched farms (180 facilities) were divided into area groups:

I – to 6 ha AL,

II – 6.1-10 ha AL,

III -area 10 ha of AL.

Moreover, she included classes of economic sizes of farms expressed in ESU (European Size Unit, where 1 ESU equals to Euro 1,200) in the analysis. II area group farms obtained the most advantageous results, where the machinery park was of the highest replacement value and the power installed and was strongly correlated with high intensity of production organization. Summarising her research, the author states that there are cause and effect relations between intensity of production organization and economic results of this production. Simultaneously, equipment with the machinery park of low-commodity farms (those, where the gross standard margin reached the level lower than 4 ESU) was lower in comparison to farms of other economy size classes - from III to VIII. The most advantageous situation in the aspect of the obtained gross standard margin was reported in the facilities of three last economic sizes. These farms reached the highest annual use of farm tractors and machines [Szeląg-Sikora 2009]. The above results may be very useful at searching for solutions limiting the use of technical means in agriculture.

Kocira [2005] also dealt with the use of farm machines in farms of different economic sizes. The researched farms were grouped according to the European Size Unit (ESU). He also determined that low use of machines in farms of small economic size and the analysed group of machines and tools were characterised by low annual use amounting in some case to few hours.

Sawa et al. [2007] investigated balance of agricultural production in farms of varied economic size. The accepted balance effects: economic, social and ecological constituted a basis for the assessment. The following were accepted as the assessment ratio: gross standard margin ratio, intensity of the farm production organisation, net commodity production and the work load. It was found that the accepted criteria of balancing the agricultural production process are met only by farms of the economic size above 16 ESU.

Szeląg-Sikora [2009] carried out the research in agricultural farms of Małopolskie voivodeship of the area above 70 ha of AL and the grain production trend, setting out indexes presenting the level of the production which was carried out and its notable final effect in the form of the value of the obtained standard margin. A high index of technical infrastructure was reported in this research, especially in farms of 78 ha area while the best economic effects of farming, expressed with the value of standard margin was obtained by the biggest farm (550 ha). The same, according to the author, proves that possessing proper land resources seems to be the most significant condition of obtaining suitable profitability of a farm.

At low land resources, a high profitability may be obtained through production intensification. And this in the plant production department is possible mainly through cultivation of vegetables and fruit. Except for high crops, horticultural production requires high work inputs. In relation to the variety of cultivated plants, they are 10 to 20 times higher than for grains calculated into the area unit. Mechanization of the most labour consumption works related to collection, cultivation and protection of plants and preparation for sale plays a crucial role in the development of vegetable and fruit production. Collection of horticultural produce requires the highest handwork inputs. For vegetables they constitute approximately 50% and for fruit 40-85% of total work inputs. Therefore, horticultural practice expects from agro-engineering drawing out and popularization of the mechanized technologies and concepts of precise agriculture the best include principles of the sustained development and play a decisive role in the development of horticultural production. Taking the above into consideration, Hołownicki [2006] indicates the necessity of extensive interdisciplinary research works integrating the newest achievements of electronics and computer techniques with biological research.

Tabor [2006; 2008] carried out research concerning comparison of technical equipment and the use of production capacities of machines which are included in the equipment of a farm of the varied area of orchards. For the assessment of production capacities, the author evaluated the rate of using capacities, which constitutes a quotient of the machine use to the machine use in the service life. As a result, he states that the rate of using production capacities grows adequately to the increase in the plantation area which seems to be logical, however, it is satisfactory only in case of sprayers - at the average it is 12.5%. To conclude, the author emphasises that the highest use of production capacities is characteristic for fruit farms of the highest area (area 10 ha) and the speed of exchange of the fixed means which get worn increases along with the increase of the area of an orchard plantation. As a result, the rate of exchanging fixed means in specialistic farms is considerably higher than in traditional farms. Similar research concerning the use of the production means in fruit farms was carried out by Kowalczyk [2008 a, b]. The author reports that the quality condition of equipment in the researched farms is satisfactory, however it is advanced in age and the average age of equipment decreases along with the increase of production intensity which is a positive phenomenon and may prove a better financial situation and consequently – higher potential of reproduction of the tractor-machinery park of farms specializing in orchard production.

The increase in the share of orchard cultivations in the area of arable land of farms causes considerable increase of the total production costs. However, analysis of indexes of production cost-effectiveness and profitability of farms proves that the value of global production and the family income exceeds the incurred production costs which allows to say that the fruit production is profitable and fruit farms are profitable [Kowalczyk 2006].

Interesting results concerning efficiency of farming were obtained by representatives of Lublin Center [Sawa et al. 2000] proving that efficiency of the incurred labour inputs is related to the organization of agricultural production. Extensive specialistic farms and highly intensive farms show the highest coefficients of efficiency with reference to the level of the net commodity production. In case when farms are characterised by the average level of production organisation it influences the decrease of indexes with reference to the level of the net commodity production. Farms incurring high inputs of labour and objectified labour per each hectare of AL do not obtain respectively high production effects. The reason for this situation may be found in limited inputs on productive circulating assets which consequently may result from too high investment in technical means in comparison to the accepted production organisation.

Spatial division of farms directly influences costs, therefore spatial concentration of farms at a simultaneous increase of the production acreage and specialization should favour the decrease of the production costs. Flow of the capital from the EU funds decreases own inputs incurred on measures and raw materials for agricultural production and allow adjustment of the machinery park to the production requirements. As a result the purchase of machines from aid programmes allows decrease of costs of their exploitation (resulting from investing lower own financial means), and consequently real production costs. *It also influences modernization of the machinery and tractor park, which is old in majority of cases.*

Purchase of the mechanization means for a farm results from the investment decision, taken by a farmer, the effects of which, he will face in the future. Therefore, it is so significant to carry out economic analysis including mechanization costs of a farm. A percentage relation of the value of direct material and energy inputs and services (without own labour) to the value of the obtained standard margin, i.e. market, potentially commodity production may constitute an approximate index of the technological efficiency of grain production and other plants production. If the index starts to exceed 50–60% it is a signal that mechanization effects decrease and efficiency of the applied technology decreases and agricultural income allotted for reproduction and development investment may be also decreased.

Information on exploitation costs of machines and ability of their calculation are indispensable for the assessment of profitability of particular production activities in farms. Information on technical and exploitation machines parameters and forms of credit aid at its purchase is also a condition necessary at taking rational decisions on the equipment of farms with new machines, on alternative selection of services and selection of the most advantageous forms of mechanization [Kurek 2007].

One of the forms of supporting agricultural production are direct payments ensuring a proper level of agricultural incomes without the necessity to increase produce prices for consumers - Fedyszak-Radziejowska [2003] concludes when assessing agricultural policy of the EU with reference to the country and agriculture.

Polish farmers were included into a simplified system of direct payments which consisted in granting a financial support proportionally to agricultural land of a farm. A farmer who receives direct subsidies should carry out agricultural production according to environmental requirements, requirements of food safety and welfare of animals. In Poland, farmers who apply for subsidies are obliged to meet the requirements of good agricultural culture according to the environment requirements, which required the use of modern technologies of cultivation at the use of new generation machines. The scope of requirement, on which direct subsidies will depend, will gradually increase in the following years. One is sure changes in the payments system take place and will take place. As it was emphasised, Poland uses a simplified system concerning direct payments, which is in accordance with the Common Agricultural Policy reforms direction.

According to the Accession Treaty, new Member States can, upon the consent of the European Commission complete the level of direct subsidies up to 30% level of the support applied in the EU as on 30th April 2004. Pursuant to article 143(2) R.1782/2003 new member states may, within national means, aid the selected operations allowing realization of significant elements of the national policy if they are compatible with the EU provisions. Every year, Poland provides the European Commission with such a support programme – which is carried out from the national means in order to obtain acceptance for the method of supporting particular production orientations and the maximum amounts of support in particular sectors [Support programme (on-line) 2012].

Farmers' joining producers' groups, which also aim at the increase of potential of activity at the market and obtaining financial means for modernization of the machinery park and joint producers' investments, constitute a path enabling the use of expensive modern machines. Organising agricultural producers has also a formal meaning because a part of instruments of the market intervention within the Common Agricultural Policy is based on the producers' groups.

For example, it was determined that within the fresh fruit and vegetables market, organizations of fruit and vegetables producers are supported by the following:
- financing the operational fund of these organizations;
- supporting initially recognized producers' groups for covering the costs related to formation of such a group, administrative activity and financing investment costs;
- paying out compensations for not allotting fruit and vegetables for sale [Szumski 2007].

In case of the processed vegetable market, the aid is directed to tomato producers, who supply tomatoes to the food processing industry through the initially accepted producers' group or accepted organization of fruit and vegetables producers.

Maintaining strong and stable position of a fruit farm in the conditions of free market economy requires constant improvement of all stages of fruit production. Apple orchards should be oriented towards cheap production of fruit of great quality. It is believed that there is much more to do in the technique of protection and care of orchards since full mechanization of the whole process of fruit production and especially cutting tree crowns, thinning and cropping is weak. All machines, which have been produced so far, do not meet all the agro-technical requirements. Constant decrease of inputs on fruit production is a basic condition of maintaining profitability in modern fruit growing.

Farmers joining the producers' groups, which also aim at the increase of potential activity at the markets and obtaining financial means for modernization of the machinery park and joint producers' investments constitute a path enabling the use of expensive modern machines. As it was mentioned above, better production planning and adjusting it to the recipients' demands and lowering production costs in a farm through joint purchase of production means constitutes a main advantage from the membership in the producers' group. Joint use of equipment, preparing products for trade and arrangement of their sale, better access to information and greater investment possibilities due to combining capitals are also advantages [Producers' groups (on-line) 2012].

Agricultural machines and devices constitute indispensable element of equipment of a modern farm. Combined properly with energy sources they form machine aggregates which enable mechanization of numerous farming activities. Diversity of works performed in farms is great. Therefore, agricultural machines and devices must include a wide range adjusted to performing works in different production processes.

Each farm, aiming to obtain higher incomes is forced to invest in new, more efficient production means which are carriers of scientific and technical progress. It results from the fact that biological progress interacts with the technical progress - except for the growth of the cultivated plants yield since it leads to the decrease of losses and products damage.

Introduction of technical progress is very expensive and requires incurring considerable financial inputs on purchase and modernization of technical infrastructure in the form of a machinery park and farm infrastructure. Therefore, a machinery park, which has been rationally adjusted to the potential and profile of the farm production and suitably used, influences production effectiveness [Michałek 2005]. Thus, financing implementations and modernization of the machinery park from the EU funds is significant.

Maintaining strong and stable position of a farm in the conditions of free market economy requires constant improvement of all stages of production. Many authors indicate this fact, including Sikora [2006].

Numerous data from the subject literature prove that the current knowledge on the subject of the impact of funds from the EU means on agricultural production and especially on technical infrastructure of farms is not full and is considerably limited to legal acts. There is no information on what are notable economic effects of these operations. Theoretically significant meaning and possibility of inflow of the EU financial means to producers were presented in the literature review of the subject. There is no full recognition of the degree of impact of these means on the modernization of technical infrastructure of farms and on the degree of impact on the farming efficiency. All quoted authors barely prove the actual state, what should be done and what requirements a producer should meet to obtain a subsidy. However, there is no paper concerning a complex analysis of farming in relation to the trend and plant production scale of farms.

Orienting the research to relations which take place or could take place between a production trend and its size in farms and the degree of technical fittings as well as answering the question "how do the degree of use of financial means and the EU subsidies influence the changes in these relations, seem to be especially important.

Plant production in the South Macro-region is based mainly on the strongly fragmented agrarian structure. Thus, searching for organizational-structural solutions which enable the use of technical means acquired at the financial support of the EU is necessary. One of the basic ways enabling the above is orienting towards production intensification. This, on the other hand is guaranteed by vegetable and fruit production. Simultaneously, taking into consideration a target area polarization of farms in our macro-region, one should consider bigger farms, which are characterised with weaker production intensification. They cover grain production farms.

In the literature there is no synthetic and complex study on the problem which was emphasised in the chapter herein. Especially there are no practical indexes for farmers resulting from scientific research but informing on the exact needs of directions of organizational changes of production in a farm - changes, the purpose of which should be the improvement of farming efficiency in a particular farm of particular economic and environmental conditions. These informations should concern inter alia, relations which will occur if one or few among factors influencing this efficiency change. A practical aspect resulting from the research carried out in our research Centre within this scope is supposed to constitute one of the main assumptions of this publication.

2. ASSUMPTIONS AND THE RESEARCH AREA

2.1. Research assumptions

When carrying out the research, the authors accepted two basic research aims.

The first research plan was based on the assumption that the European Union funds compensate energy inputs accumulated in an agricultural product, costs of its production and technical fittings depending on the production trend.

Therefore, it seems logical that subsidizing agricultural production in the form of direct subsidies and target funds (considerably) influences efficiency of agricultural production.

Taking the above assumptions into consideration, a work hypothesis was formulated, which says that the ***EU funds (target and direct) differently compensate the production costs and energy inputs on the yield unit in farms of fruit, vegetable and grain production.***

The next hypothetical assumption is that the EU target funds are not uniformly used by owners of different types of farms for modernization of the machinery park.

Recognizing, by application of two research methods, in what degree the EU funds compensate energy inputs accumulated in a product and the costs of its production and what is their share in modernization of the machinery park depending on the agricultural production orientation, is a scientific issue.

In order to compare the European Union subsidies share in the compensation of the energy accumulated in the agricultural product and the production costs, a comparative analysis was carried out with the use of the original compensation index from the European Union means of the energy and costs inputs per a conversion unit.

Moreover, prof. Wójcicki's opinion [2000, 2001, 2005] who claimed that the cost method and energy inputs method are equally efficient and compatible in this type of research and as a result they may be applied interchangeably, was verified with the use of this index. Simultaneously, there are no studies verifying the above mentioned methodological assumptions. It also concerns comparative research in the system of the production trend. And they constitute one of the main methodological assumptions of our study.

The second purpose of our research was based on a conviction that each farm is a unit, in which many factors influence the final production effect. While mutual relations of these factors change in the organized manner. Therefore, the value change of one logically influences changes of the remaining values. This assumption also constitutes a work hypothesis.

In order to explain the accepted hypotheses and to solve a scientific issue, detailed research assumptions were formulated and they covered:

1. Analysis of resources and production in a farm:
– assessment of labour force resources,
– equipment of a farm in the form of fixed means,
– the use of fixed means,
2. Analysis of costs and accumulated energy consumption and share of the EU subsidies:
– in the production costs,
– in the energy input accumulated in the product.

Searching for mutual relations between the assumed technical, economic and production factors, a comparative analysis of inputs and costs as well as production effects in the form of agricultural income was carried out.

Assuming a future increase of the energy aspect significance in the agricultural production, two methods of the results analysis were accepted: cost and energy analysis. An assumption was made that the method of the accumulated energy consumption is also an efficient research method of agricultural production profitability because the accumulated energy consumption (energy inputs) means energy consumption on the production of the discussed product. In this case of the agricultural product it must be considered in the system of energy carriers stream, materials and production processes, reproduction of the fixed means and labour force.

According to Wójcicki [2000, 2001, 2005], inputs on agricultural production are determined in physical units (dt), in money units (PLN) or in comparable contractual agricultural units (GU) or in energy units (kWh, MJ). Investigating energy consumption and energy and economic efficiency, calculating agricultural products and means for its acquirement into contractual grain units (1GU = 1 dt of grain) and into energy units expressed in multiplicity of joule (MJ) enables estimation of inputs and effects of agricultural activity not only in money units (PLN) but also in grain (GU) and energy units (MJ).

The research was carried out in 99 farms of Małopolskie and Opolskie voivodeships of the total area of arable land of 4,117.4 ha. These voivodeships are similar concerning topography and climate. Therefore, conditions of the research area were accepted as the same.

Farms were divided into three groups according to the production trend:
I Group - grain production
II Group - vegetable production
III Group - fruit production

When qualifying an object for the research, equipment of the machinery park was taken into consideration and the use of the EU funds as well as carrying out fruit production within one of three production trends. A farm production trend was determined according to the obligatory methodology within agricultural economics [Jabłonka et al. 2006].

As a result of this qualification regime, 33 farms were selected for each production trend: grain, vegetable and fruit production.

Research concerning fruit production included only plantations of apple orchards, because regardless a cultivar, these plantations have similar technologies of care, protection and collection. Moreover, they are a dominating crop in this production trend. According to Walterska [2008] apple orchards constitute 66% of fruit cultivations in Poland and in 2006 Polish production constituted as much as 19.6% of total production of apples in the EU. While, Makosz [2011] claims that production of apples is highly profitable at the crop of 30 t from one hectare with participation of approx. 75% of apples of high quality.

There is a tendency to increase the acreage of cultivation of apple orchards. According to BGŹ data [2012], number of fruit farmers cultivating apple trees on the area of over 10 ha increased by 48%. The above arguments determined that farms producing apples were selected for the research.

Using empirical data, correlation and regression account quantifying it for the deve-
lopment of regression model equations which indicate, in case of significant correlation relations, which economic and production effects may be obtained along with the change of one of factors determining their size, were applied. The results obtained within this scope may be helpful for farmers - producers who decide to change a profile of production in their own farms.

2.2. Description of the research area

Polish agriculture is characterised with the fragmented agrarian structure and high number of farms of the area from 1–5 ha (table 2.1). On the country's scale, farms from this group cover 55.2% area of arable land. The problem of fragmentation in Małopolskie voivodeship, where the area of small farms includes as much as 84.7 of arable land, seems to be worse. This situation is much better in Opolskie voivodeship, where farms of area from 1–5 ha constitute 46.3%. Opolskie voivodeship is also characterised by high percent of farms from the group of the area from 5–15 ha (30.9%). Their share is higher than in Małopolskie voivodeship of 16.8% and lower than the national value by1.4%. However, it should be emphasised that the number of farms of the area above 15 ha in Opolskie voivodeship is high and relatively covers 20.6% of arable land. Extremely different situation is in Małopolskie voivodeship where these farms take up only 1.21% of arable land.

Table 2.1. Structure of individual farms of the area above 1 ha of arable lands according to the area groups [%]
Tabela 2.1. Struktura gospodarstw indywidualnych o powierzchni powyżej 1 ha użytków rolnych według grup obszarowych [%]

Administrative unit	Total number of farms [items]	Area group according to the area of arable land [ha]								
		1-2	2-5	5-10	10-15	15-20	20-30	30-50	50-100	100 and more
1	2	3	4	5	6	7	8	9	10	11
Poland	1,558,413	21.9	33.3	22.5	9.8	4.6	3.9	2.3	1.1	0.5
Małopolskie voivodeship	163,056	38.8	45.9	12.2	1.9	0.6	0.4	0.1	0.1	0.01
Opolskie voivodeship	28,479	18.6	27.7	20.4	10.5	6.4	6.3	3.0	3.0	1.9

Source: Powszechny Spis Rolny 2010-KSOW
www.ksow.pl/fileadmin/user.../Raport_z_wyników_PSR_2010.pdf

A small area of farms is a consequence of high fragmentation of the acreage of arable land in this voivodeship, which causes that a small area of arable land is per one tractor when every farmer strives to have his own tractor (tab. 2.2). As a result, in Małopolska region, only 5.0 ha of AL is per one tractor and the average area of a farm is 3.81 ha of AL. A situation in Opolskie voivodeship is much better: 18.06 ha of AL per one farm and 6.9 ha of AL per one tractor. On the country's scale, the situation is indirect with indication to more advantageous relations of AL hectares to tractors (9.5 ha·tractor^{-1}).

The mentioned indexes for the researched voivodeships are varied and present extremely different production conditions for farms in the south and south-east macro-region. These conditions are much worse for Małopolska region. This is also visible when compared to the national scale. Data included in table 2.3 presents also considerably higher equipment with tractors in farms of the researched voivodeships in comparison to the national average.

Table 2.2. Selected agricultural sizes for Poland and the investigated voivodeships [ha]
Tabela 2.2. Wybrane wielkości rolnicze dla Polski i badanych województw [ha]

Administrative unit	Average area of individual farms above 1 ha AL	Area of AL per 1 tractor
1	2	3
Poland	9.76	9.5
Małopolskie voivodeship	3.81	5.0
Opolskie voivodeship	18.06	6.9

Source: Powszechny Spis Rolny 2010-KSOW
www.ksow.pl/fileadmin/user.../Raport_z_wyników_PSR_2010.pdf

Table 2.3. The area of sowing and orchards for Poland and the investigated voivodeships [%]
Tabela 2.3. Struktura zasiewów oraz sadów dla Polski i badanych województw [%]

Administrative unit	Total		Grain	Leguminous	Industrial	Fodder crops	Potatoes	Orchards	Vegetables
	[thousand ha]	[%]	[%]						
1	2	3	4	5	6	7	8	9	10
Poland	10,427.7	100	73.3	0.5	11.2	8.3	3.7	2.4	3.0
Małopolskie voivodeship	303.2	100	68.0	0.6	7.8	7.8	11.6	2.3	4.2
Opolskie voivodeship	462.8	100	70.1	0.4	22.7	3.5	2.0	0.3	1.4

Source: Powszechny Spis Rolny 2010-KSOW
www.ksow.pl/fileadmin/user.../Raport_z_wyników_PSR_2010.pdf

In the area of sowing in Małopolskie voivodeship, similarly to the national conditions and as in case of Opolskie voivodeship, grains cultivations prevails. Share of grain cultivation in this voivodeship amounts to 68% in sowing and is lower from the national value by 5.3%. This voivodeship has a relatively high percent of arable land under potatoes cultivation (11.6%) and vegetables cultivation potential which is three times higher than in Opolskie voivodeship (table 2.3).

2.3. Description of the researched districts

Characteristics of districts, where the research was carried out is as follows:

I Group

A grain production trend

- Baborów (Opolskie voivodeship, Głubczycki province),
- Branice (Opolskie voivodeship, Głubczycki province),
- Kietrz (Opolskie voivodeship, Głubczycki province),
- Gdów (Małopolskie voivodeship, Wieliczka province),
- Dobczyce (Małopolskie voivodeship, Myślenice province),

Baborów –rural district in Głubczycki province is located in the south part of Opolskie voivodeship in Nizina Śląska. It is an agricultural - industrial district. The area of the commune is 12,796 ha out of which 75% are very fertile soils of I, II and III class. Cultivations of grains, beetroots and rapeseed prevail. Number of citizens is 3,459. In majority, the district citizens work in agriculture in their own farms or in the neighbouring farms of big area [Charakterystyka Gminy Baborów (on-line) 2012].

Branice - district is located on Głubczycki plateau in the south part of Opolskie voivodeship. Plain land. There are 7,767 citizens in the district. It is a region with a typical rural structure with fertile soils (97.3% in class I-III) and advantageous climate. Therefore, agriculture is a dominating branch of economy. Arable land area is 10,800 ha including 4,800 ha of arable land of individual farms in the number of 300. Grain prevail in the cultivation - 63%, root crops (14%) and rapeseed (19%) [Charakterystyka Gminy Branice (on-line) 2012].

Kietrz - a district is located in the south part of Opolskie voivodeship. There are 11,776 citizens. It is a rural district. Arable land of 6,853 ha area constitute 49% of the arable land area. Arable lands are distinguished by high index of soil evaluation (mainly II and III class) which favours cultivation - wheat-beetroot complex. Grain constitute 53% in the structure of sowing, while root crops - 21%, rapeseed - 6% and 21% others. Majority of citizens earns their living from agriculture, working in their own individual farms or in three Agricultural Production Cooperatives (Chruścielów, Nowa Cerekwia, Wojnowice) or in the Agricultural Complex [Charakterystyka Gminy Kietrz (on-line) 2012].

Gdów –this district is located within Pogórze Wielickie and Pogórze Wiśnickie [Wielickie and Wiśnickie Foothills]. II and III class lands constitute 89% of AL including the area of 6,873 ha and grasslands, which cover 1,563 ha. Grains dominate among crops, which include 3,613 ha (79%) and root crops of area 841 ha constitute 18% of agricultural land. It should be emphasised that fruit production develops in the district (407 ha) and vegetable cultivation in the ground (30 ha). High fragmentation is visible in the agrarian structure – average area of a farm is 3.2 ha and the number of farms below 2 ha constitute as much as 86% of the total number. Big farms above 10 ha constitute 1% of all farms [Charakterystyka Gminy Gdów (on-line) 2012].

Dobczyce –the total area of the district is 6,663 ha including arable land which constitutes only 52% of the area (3,464 ha). III and IV class soils dominate (90%). The commune is characterised by high fragmentation of farms, including a prevailing number of farms under 1 ha (1,193). There are 983 farms of the area from 1–5 ha and only 57 from 5–10 ha. There are even less farms above 10 ha – only 9. The average area of the whole group is 2.12 ha. Grains constitute 72% and root crops 25% in the structure of sowing. Meadows and pastures take 32% of arable lands and orchards 2%. Population (13,562 citizens) mainly works outside the agriculture [Charakterystyka Gminy Dobczyce (on-line) 2012].

II Group

A vegetable production trend

- Koniusza (Małopolskie voivodeship, Proszowicki province),
- Koszyce (Małopolskie voivodeship, Proszowicki province),
- Nowe Brzesko (Małopolskie voivodeship, Proszowicki province),
- Pałecznica (Małopolskie voivodeship, Proszowicki province),

Koniusza – this district is located on the area of Wyżyna Krakowsko-Częstochowska [Krakowsko-Częstochowska Upland] and its area constitutes 8,800 ha and arable land constitutes 91.6% (8,065 ha). It is an agricultural district - farmers specialize in vegetables cultivation, which is favoured by fertile soil of mainly I and II class. On the south of the district, cabbage vegetables, cucumbers and tomatoes are cultivated, while onion, carrot, parsley and paprika in the north. Grains and root crops occur in the structure of sowing except for vegetables. The district is inhabited by 8,673 people, who in majority work in the field. Farms are fragmented and the fact that 35.9% of the total number of farms within the area range up to 2 ha, 34.6% are farms of area between 2-5 ha while only 3.1% are farms within the range of 10-15 ha and only 0.6% of farms of AL area above 15 ha proves the high scale of fragmentation. Small farms and very small farms constitute 70.5% of the total number, while bigger farms above 10 ha constitute only approx. 4%. The average size of a farm in the territory of Koniusza District is 3.40 ha [Charakterystyka Gminy Koniuszowa (on-line) 2012].

Koszyce – this district is located on the north-east end of Małopolskie voivodeship along the left side of Vistula River. Its administrative area is 6,600 ha, number of people - 5,870. Agriculture is a dominating source of income for the citizens of the district. The total area of arable land amounts to 5,819 ha, including arable land - 4,800 ha. There are 1,421 farms on its territory and their average area is 3.9 ha. Grains cultivation has the highest share in the plant production (it takes 58% of the sowing area). Increase of the area of maize cultivation for seeds has been reported in the recent years (385 ha). Vegetables take up 7% of arable land. Tobacco - 175 ha, rapeseed - approx. 40 ha and beetroot - approx. 30 ha takes a considerable area from among cultivations of industrial plants. Koszyce district owns very good soils. Mainly these are black soils, brown soils, fen soils and limestone soil - over 73% of soils belongs to the soil evaluation classes from I to III. Therefore, production potential is high, which favours vegetables cultivation [Charakterystyka Gminy Koszyce (on-line) 2012].

Nowe Brzesko – is an agricultural district, which is inhabited by 5,778 people, the majority of whom are employed in their own farms. The number of farms of the area above 1 conversion ha amounts to 1,415. There are very good and good soils of I, II and III classes on the territory of the district. Chernozem soil constitutes 40%, loess on the clay and loam base constitute 54.5%, river alluvial soils constitute 5.5%. Advantageous lie of the land, a long vegetation period (approx. 220 days), favourable climatic conditions, a balanced level of precipitation and solar days causes that conditions of the efficient production are very favourable. The district area takes up 5,435 ha, out of which arable land (4,701 ha) constitutes 86.5%. Grain cultivation constitutes almost half of 3,844 ha of arable land and vegetables - 220 ha. Moreover, potatoes (460 ha), fodder beetroots (370 ha) and vegetables (220 ha) are cultivated [Charakterystyka Gminy Nowe Brzesko (on-line) 2012].

Pałecznica – is a typical agricultural district, and arable land constitutes the majority of its area (4,800 ha). Soils of high classification (I, II, III class) favour development of agriculture. They are recognised as degradated chernozems formed from loess, brown soils and black soils formed from alluvial formations. On account of the agricultural character of districts, majority of citizens from among 3,695 is employed in agriculture. Grains, vegetables, root crops and tobacco are the main crops. Climatic and soil conditions which occur there and location far from industrial pollutions predispose the district to ecological farming (organic food production). Presently, farmers from Pałecznica concentrate on the vegetable production, especially production of root vegetables - onion, potatoes, beetroot and parsley. It seems to be certain that processing of vegetables located on its territory is an opportunity for a district [Charakterystyka Gminy Pałecznica (on-line) 2012].

III Group

Fruit production trend

- Laskowa (Małopolskie voivodeship, Limanowski province),
- Łososina Dolna (Małopolskie voivodeship, Nowosądecki province),
- Chełmiec (Małopolskie voivodeship, Nowosądecki province),
- Łącko (Małopolskie voivodeship, Nowosądecki province),
- Raciechowice (Małopolskie voivodeship, Myślenicki province).

Laskowa – there are 3,820 ha of arable land in the district,which constitutes 53% of the total area (7,248 ha) of arable land. In the total area of arable land, agricultural land constitutes 47% (1,809 ha) grassland as much as 45% (1,720 ha), orchards (291 ha). The average area of a farm is 3.7 ha. 7,605 people inhabit the district, mostly working on their own farms. 1,016 people out of 1264 run agricultural activity. Production has a comprehensive, non-specialised character in majority of them. Grains prevail in the structure of crops - 956 ha (53%), root crops 375 ha (21%), orchards 291 ha (16%) root vegetables 20 ha (1.0%), and others 167 ha (9%) [Charakterystyka Gminy Laskowa (on-line) 2012].

Łososina Dolna –it is a rural district located in the central fragment of Karpaty Mountains on the east ends of Beskid Wyspowy. Its surface is 8,431 ha and arable land constitutes 54% of this area (4,553 ha). Climatic and soil conditions favour the fruit production development. Uphills which surround the district are covered with colourful mosaic of fruit orchards (over 1,000 ha of orchards) including 650 ha of apple orchards producing apples of the highest quality: Jonagold, Szampion, Idared. Pear and plum orchards, as well as gooseberry, strawberry, currant and vegetables plantations spread out on smaller areas. 50% of the district citizens out of 9,420 deal with agriculture [Charakterystyka Gminy Łososina Dolna (on-line) 2012].

Chełmiec – the district owns areas of high natural and landscape values since it is located at the foothill of picturesque Beskid Wyspowy. Its area of 11,270 ha is characterised by a small advantage of arable land, which constitute 55.9% (6,300 ha) in the total area of the district. The agricultural land area constitutes 85.5% (5,353 ha) of arable land and forests take up 28.4% of the total area. 76.6% of people out of 24,610 citizens maintain themselves from farming. 4,287 households functions, including 2025 farms of the area above 1 ha, the average area of a farm is approx. 3.3 ha. There are only seven farms within the area range above 10 ha. There are 948 farms within the range of 1-2 ha and this group constitutes 46.8%. Next groups of farms within the range 2-3 ha and 3-5 ha include respectively 22.5% and 21.0% of the total number. Grains - 56.1% prevail in the structure of crops, potatoes constitute 15.9%, red clover takes up 13.5% of the total area of crops. Orchards take up the area of 514 ha and grasslands 397 ha [Charakterystyka Gminy Chełmiec (on-line) 2012].

Łącko – it is called a capital of the orchards' land. Majority of orchards is located on slopes of approx. 15 degree deviation which results in the most advantageous distribution of annual temperatures. Apples from Łącko were included in the List of Traditional Products on 18th October 2005. An application was also filed to enter them on the List of Products of the Protected Geographic Marking. Polish authorities positively reacted on it and decided on 2 July 2007 to transfer it to Brussels where it is presently examined by the European Commission. The total area of the district is 13,295 ha inhabited by 14, 709 people. Arable land includes 6,730 ha out of which 3,110 ha is covered by agricultural land. Total area of orchards is 1,010 ha and orchards and pastures include the area of 2,610 ha. The district soils are weak – V and VI soil evaluation constitute 62% and IV class with small enclaves of III and II class includes the remaining 38% of the area of arable land [Charakterystyka Gminy Łącko (on-line) 2012].

Raciechowice – the district is located on the border of Beskid Wielicki and Beskid Wyspowy. The district area takes up 6,100 ha, out of which arable land (3,885 ha) constitutes 64%. Relatively clear air and non-polluted water and soil are properties which favour the development of the agricultural production. There are 6,011 citizens. There are 1,533 individual farms in Raciechowice district. The average area of a farm is 2.4 ha. Intensive establishing of orchards started here in the 50's of the previous century. At the moment, there are 1000 ha of orchards including 80% of apple orchards. This district is one of the biggest orchard centres in Małopolska, which produces approximately 2.0–40 thousand tonnes of fruit every year. Apples production is a basic trend, – plums, pears, black and red currant production is a complementary production. Good conditions with majority of soils of III and IV class occur on the big area. Agricultural land include the area of 1,908 ha (48%), orchards constitute 26% of arable land, meadows and pastures 1304 ha (34% of AL). Forests and forest land 844 ha and the remaining land 228 ha constitute a complementation to the total area of the district [Charakterystyka Gminy Raciechowice (on-line) 2012].

3. APPLIED RESEARCH METHODS

3.1. Research methodology

Selection of farms was deliberate. The research was carried out in the form of the guided survey with farm owners, enabling filling the questionnaire in the most objective and clear manner. The collected information, due to the specificity of the calculation method, concerned all production processes carried out in the production year 2009 and the information concerning the use of subsidies from the European Union means.

When starting the research with the guided survey, the scope of problems and questions including conditions and indexes of production activity of farms was assumed.

Land as the production factor

Land in agro-business enterprises plays two basic functions - it is a production place and production measure. It constitutes a factor of a special kind because it has its own production potential and at a correct agro-technology its value may increase. In agro-technology, impact of land is directly proportional to the degree of modernity of the applied technologies and management.

Labour force resources

Human resources play in the production process, at least three functions: they initiate it, realize and consume its effects. Therefore, these resources influence a dynamics of development in a decisive degree. Both amount as well as the quality of the labour force resources is significant. Well selected number of workers and their qualifications has the basic meaning in the correct functioning of each type of an enterprise. The following assumptions were made after Toczyński [2006] for the assessment of selection and staff needs:

– A fully-fit unit of labour force is a fully-fit man in the age 18-65 and a woman in the age of 18-60 years.
– A full-time employee is a fully-fit unit of labour force, who worked a normative number of hours in a year (2,120 hours).
– Labour consumption of production is the amount of human work which is necessary to produce one unit of a product. Labour consumption of agricultural production stands for the number of man hours necessary to perform the whole productive cycle per 1 ha [man hour·ha $^{-1}$].

In the EU system, labour inputs are measured in the Annual Work Units - AWU).

In Poland, it was accepted that 1 AWU, i.e. 1 person working 8 hours daily by 265 days. In other EU countries these conversion factors are different (the highest 1 AWU=2,200 hours in 6 countries and the lowest – 1 AWU-1800 hours in 4 countries [Toczyński 2006].

Equipping an enterprise with the fixed means

Capital is a selection and a condition of material goods and financial resources of an enterprise, used for further multiplication. Fixed and turnover means are its basic elements.

Buildings and facilities, machines, technical devices and tools, transport means, perennial plants and basic flock belong to the fixed means in agro-businesses.

The following groups are distinguished within the fixed means:

a) Production:

production means are means which participate in the production processes or enable their management, e.g. tractors, barns, cowsheds, etc.,

b) Non-productive:

non-productive means serve for satisfying people's needs, e.g. residential buildings, social buildings, buildings related to the health service, etc.

The fixed means used in the business activity, active and temporarily excluded from exploitation are subject to the process of wear and tear that is they gradually loose their value. The amortization system is related to the consumption and reproduction process of the fixed means. According to Wieczorek [2002] it has a triple aspect in the enterprise operation:

1) Cost:

Amortization of the transferred consumption values of the fixed means on costs which allows costs planning and prices and their analysis.

2) Balance:

Amortization is a sum of current amortization of the fixed mean and allows decrease of its value.

3) Financial:

Amortization enables return of money for acquisition of the fixed mean for a price of the products produced with its use. Therefore it is a source of creating a fund for financing reproduction of the consumed fixed means.

Detailed questions from a questionnaire concerned:

- a farm owner (age, sex, education, learnt profession, farm qualifications etc.),
- general characteristic of a farm (area, the use structure, sowing structure etc.),
- equipment with buildings and facilities,
- balance of plant production,
- equipment of a farm with cars, tractors, machines and devices,

– expenditures related to the purchase of energy carriers and agricultural and non-agricultural raw materials,
– labour consumption,
– EU subsidy,
– purpose and allocation of direct subsidies and target funds,
– participation in trainings from the pre-accession period.

3.2. Calculation methodology

3.2.1. Calculation qualification of the material

Based on the obtained information, qualification and the initial processing of the research questionnaires was carried out in order to adjust the stored data to formation of a computer base. A computer data base allowed systematic verification of entries introducing corrections. They were stored and then subjected to analysis which required a multiple data transformation, sorting, elimination and completion. Excel software was used for this purpose.

Based on the prepared spreadsheet calculations of the selected indexes, characterising material and capital resources, efficiency of production and calculation of the accumulated energy necessary for production of the final agricultural products were carried out.

A real yield was calculated into GU for full comparative analysis of energy accumulated in the agricultural product and costs.

Based on these data cost values and economic indexes were calculated and calculations of energy consumption inputs accumulated in the agricultural products were carried out. It allowed answering the question in what degree the EU funds compensate costs and energy inputs on agricultural production depending on the production trend, degree of technical utilities and accumulated energy consumption and also comparison of the research efficiency of the applied methods.

Moreover, a standard error of arithmetic mean was determined as a basic statistics describing interdependence between oceans of two measures of variability dispersion in a given sample. In order to determine the impact of the production trend on the measured parameters, analysis of variance with Duncan test was used.

Statistical inference was carried out on the significance level of α=0.05.

Hypothesis on regularity of distribution of the researched properties was verified with Kołmogorow Test λ at the significance level of 0.05. Results of the test proved that there are no bases to reject a hypothesis on the regularity on the standard distribution.

Searching for statistically significant interdependence of the researched factors and calculated indexes characterising production and inputs as well as costs and economic effects of managing the investigated units, a correlation calculation was used. The obtained coefficients of correlation for the most significant of them, from the point of view of the assumed research objective, were placed in the results analysis.

Trends in the form of equations and graphs of simple regression were also determined for them.

Methods of economic and energy analysis of the researched farms were used in calculations:

a) costs method

b) accumulated energy consumption method

3.2.2. Cost method

The following were the values and economic indexes which were determined and used for calculations:

Direct costs included the materials, raw materials and components used in the production process.

The following costs were included in the direct costs of plant production:

– costs of seedlings
– purchased fertilizers,
– plant protection substances,
– specialistic costs.

Labour costs (K_r) were calculated according to the formula:

$$K_r = i \cdot n \;\; [\mathrm{PLN \cdot ha^{-1}}] \tag{1}$$

where:

i – *1 man hour work cost [PLN],*
n – *number per 1 ha.*

Methodology of calculating exploitation costs of machines was accepted according to the obligatory methodology developed by Michałek and Kowalski in the Kraków Centre [Kowalski 2002]

Exploitation costs of tractors and machines **(K_{ec})** constitute the sum of maintenance and use costs:

$$K_{ec} = K_{uj} + K_{u\dot{z}} \;\; [\mathrm{PLN \cdot h^{-1}}] \tag{2}$$

where:

K_{uj} – *maintenance cost [PLN·h^{-1}],*
K_{uj} – *use cost [PLN·h^{-1}],*

The following were included in the maintenance costs:

Amortization costs (K_a)

$$K_a = \frac{C_c}{T} \text{ [PLN·h}^{-1}\text{]} \tag{3}$$

where:

C_c – purchase price according to the replacement value of the investment mean [PLN],

T – service life [years],

Storage, insurance and registration cost (K_k) was accepted on the level of 2% annually in comparison to the purchase price of a machine [KPODR 2011]:

$$K_k = \frac{2 \cdot C_c}{100 \cdot T} \text{ [PLN·year}^{-1}\text{]} \tag{4}$$

Including all positions, a unit cost of machine maintenance per 1 hour of work (K_{uj}) was calculated with the use of the following formula:

$$K_{uj} = \frac{K_a + K_k}{W_r} \text{ [PLN·h}^{-1}\text{]} \tag{5}$$

where:

K_{uj} – unit maintenance costs per 1 hour [PLN·h^{-1}],

K_a – amortization costs [PLN·$year^{-1}$],

K_k – storage, insurance, registration costs [PLN·$year^{-1}$],

W_r – annual use [h·$year^{-1}$].

The use costs constitute the second group of technical means exploitation. It includes costs of repair, fuel and smears as well as auxiliary materials.

Costs of repair (K_n) was calculated out of the following dependence:

$$K_n = \frac{C_c \cdot r_1}{WT} \text{ [PLN·h}^{-1}\text{]} \tag{6}$$

where:

C_c –machine price [PLN],

r_1 – index of the repair price in the service life [Grześ 2005],

WT –use during the service life [h],

Fuel and smears costs (K_p) constitute a dominating position in the use costs of tractors and self-driving machines. Their value was calculated according to the following formula:

$$K_p = 1{,}1 \cdot G_e \cdot C_p \;\; [\mathrm{PLN{\cdot}h^{-1}}] \tag{7}$$

where:

G_e – fuel consumption*[l·h⁻¹]*,
C_p – *fuel price [PLN·l⁻¹].*

Unit costs of use ($K_{uż}$) per 1 hour of work were calculated from the sum of particular component costs:

$$K_{uż} = K_n + K_p \;\; [\mathrm{PLN{\cdot}h^{-1}}] \tag{8}$$

Resources of the installed capacity in the machinery park (Pz) in a farm constituting the capacity of tractors, forklift trucks, delivery trucks, per an area unit of AL [Kowalski et al. 2002], was calculated from the formula:

$$P_z = \sum P_n \cdot S^{-1} \;\; [\mathrm{kW{\cdot}\ ha^{-1}AL}] \tag{9}$$

where:

Pn –*nominal power of tractors, forklift trucks, delivery trucks [kW],*
S - *surface area of AL used in a farm [ha AL].*

Percentage index of compensation from the EU means of production costs (W_{RK})

$$W_{RK} = \frac{K_{r1}}{K_{s1}} \cdot 100 \;\; [\%] \tag{10}$$

where:

K_{r1} – *amount of direct and target subsidy to GU [PLN·GU⁻¹],*
K_{s1} – *total production cost of GU [PLN·GU⁻¹].*

The above values (K_{r1}, K_{s1}) were calculated according to the formula:

$$K_{rl} = \frac{K_u}{n_1} \;\; [\mathrm{PLN{\cdot}GU^{-1}}] \tag{11}$$

where:

K_u – *amount of direct and target subsidy [PLN·ha⁻¹],*
n_1 – *amount of GU in the yield of 1 ha [item]*

and:

$$K_{sl} = \frac{K_c}{n_1} \;\; [\mathrm{PLN{\cdot}GU^{-1}}] \tag{12}$$

where:

K_c – *total cost of production of 1 ha [PLN·ha⁻¹].*

Methods of calculation of indexes and statistical values jointly with the analysis of variance and correlation and regression relations were based on a computer packet STATISTICA [Statistica packet (on-line) 2011].

3.2.3. Accumulated energy consumption method

The values presented in table 3.1. were accepted for calculation of the accumulated energy consumption citing Pawlak [1989] and Wójcicki [2000]

Table 3.1. Units of energy consumption accumulated in the agricultural production
Table 3.1. Jednostki energochłonności skumulowanej w produkcji rolniczej

Production means group	Production means type	A unit of reference of the index	Index of accumulated energy consumption [MJ]
1	2	3	4
Direct energy carriers	Diesel oil	[1 kg]	48
Material and raw materials	Mineral fertilizers	[1 kg]	55
	Protection measures (active substance)	[1 kg]	300
	Manure	[1 kg]	0.2
	Seed potato	[1 kg]	2.5
	Vegetables seedlings	[100 items]	1.5
	Grain for sowing	[1 kg]	7.5
	Seeds	[1 kg]	30
Investment means	Machines and tractors	[1 kg]	110
	Spare parts for repair	[1 kg]	80
	Buildings	[1 $m^2 \cdot year^{-1}$]	100
	Umbrella roofs	[1 $m^2 \cdot year^{-1}$]	25
Work	People	[1 man hour]	42

Source: Pawlak, 1989, Wójcicki 2000

The following energy streams constitute the full energy consumption of production of the considered farms:
– energy from energy carriers,
– energy included in raw materials and materials,
– energy included in machines, devices and buildings,
– energy constituting equivalent of live labour.

Energy accumulated in machines, devices and buildings was divided into elementary components:

Energy accumulated in the used machines and devices (E_m) [according to IBMER Anuszewski, Pawlak 1979, Wójcicki 2002]:

$$E_m = \frac{m \cdot w}{T} \quad [MJ \cdot year^{-1}] \tag{13}$$

where:

m – *mass of a tractor (machine) [kg],*

w – *index of the accumulated energy consumption for machines and tractors [MJ·kg^{-1}],*

T –*service life [years],*

Energy accumulated in buildings and facilities (E_{ibw}):

$$E_{ibw} = \frac{y \cdot F_p}{T} \text{ [MJ·year}^{-1}\text{]} \tag{14}$$

where:

F_p – *area of a building [m^2],*

y – *index of the accumulated* energy consumption of buildings and station roofs [MJ·m2·year–*1*],

T –*service life [years],*

Energy from direct energy carriers (E_n):

$$E_n = m \cdot x_n \text{ [MJ·year}^{-1}\text{]} \tag{15}$$

where:

m – *wear of the energy carriers [kg·year^{-1}], [kWh·year^{-1}]*

x_n – *index of the accumulated energy consumption for an energy carrier [MJ·kg^{-1}], [MJ·kWh^{-1}]*

Energy constituting equivalent of live labour (E_p):

$$E_p = i \cdot x_{rbh} \text{ [MJ·year}^{-1}\text{]} \tag{16}$$

where:

i_1 – *number of labour hours of people employed in the production process [man hour·year^{-1}],*

x_{rbh} – *index of energy accumulated in labour – 42MJ·man hour^{-1}.*

Energy accumulated in materials and raw materials (E_S):

$$E_S = q \cdot x \text{ [MJ·year}^{-1}\text{]} \tag{17}$$

where:

q – *raw material consumption [unit·ha^{-1}]*

x – *index of the accumulated energy consumption [MJ·unit^{-1}]*

Final energy consumption accumulated (E) in agricultural production was calculated from the following formula:

$$E = E_{im} + E_{ibw} + E_n + E_p + E_s \quad [\text{MJ}\cdot\text{year}^{-1}] \tag{18}$$

where:

E_{im} – *investment energy consumption related to the use of machines and devices [MJ·year^{-1}],*

E_{im} – *investment energy consumption related to the use of buildings and facilities [MJ·year^{-1}],*

E_n –*energy from direct energy carriers [MJ·year^{-1}],*

E_p –*energy constituting an equivalent of man labour [MJ·year-1],*

E_s –*energy accumulated in materials and raw materials [MJ·year-1],*

We refer the final energy consumption accumulated depending on methodological needs to different units, the most frequently to: 1 hour of work, 1 ha of AL, 1 GU, 1 year, 1 tonne of a product.

A percentage index of compensation of energy accumulated in the product from the EU means was calculated from the following formula:

$$W_{RE} = \frac{E_{su}}{E_{s_1}} \cdot 100 \ [\%] \tag{19}$$

where:

W_{RE} – *index of compensation from the EU funds of energy accumulated in a product [%],*

E_{su} –*amount of energy accumulated in GU compensated from the EU funds [MJ·GU^{-1}],* [MJ·GU-1],

Es_1 –*amount of energy accumulated in GU [MJ·GU^{-1}].*

$$E_{su} = \frac{K_{r1} \cdot x_n}{C_p \cdot 1{,}16} \ [\text{MJ}\cdot\text{GU}^{-1}] \tag{20}$$

where:

Kr_1 – *amount of subsidy from the EU means to 1 GU [PLN·GU^{-1}],*

x_n – *index of energy consumption accumulated in 1 kilo of DO [MJ·kg^{-1}],*

C_p – *price of 1 l of DO [PLN·l^{-1}],*

$C_p \cdot 1.16$ – *price of 1 kilo of DO [PLN·kg^{-1}].*

Amount of a subsidy from the EU means to 1 GU (K_{r1})

$$K_{r1} = \frac{K_u}{n_1} \ [\text{PLN}\cdot\text{GU}^{-1}] \tag{21}$$

where:

K_u – *amount of a direct and target subsidy [PLN·ha^{-1}],*

n_1 – *amount of GU in the yield of 1 ha [item].*

4. DESCRIPTION OF THE RESEARCHED FARMS

4.1. The surface area and structure of crops as well as equipment of the machinery park

The total area of arable land is varied depending on the production trend. Table 4.1. presents the area characteristics of the researched farms.

Table 4.1. Area description of the investigated farms
Tabela 4.1. Charakterystyka obszarowa badanych gospodarstw

Production trend	Number of farms	Specification							
		Total area [ha]	Number of fields	Average area of a field [ha]			Average area of farms [ha]		
				Average	Min	Max	Average	Min	Max
1	2	3	4	5	6	7	8	9	10
Fruit production	33	251.0	163	1.54	0.32	5.3	7.6	1.2	28
Vegetable	33	656.9	209	3.1	0.24	38.7	19.9	4.8	66.6
Grain	33	3209.5	150	21.4	1.0	68.2	97.3	23.5	170.2

Source: author's own study

The highest cultivation acreage of farms of the grain production trend – 3,209.5 ha where research included farms of the area of arable land from 23.5 ha to 170.2 ha was reported. The average area of cultivation of this kind of farm amounted to 97.3 ha. Runners of the researched farms constituted 150 fields and the average area of a field is 21.4 ha. The smallest field was 1.0 ha and the biggest was 68.2 ha.

The area of arable land of farms of the grain production trend, exceeded few times the area of cultivation of the remaining two production trends. It should be mentioned that the area of vegetable cultivations was two times higher than the average area of orchards.

The above relations are considerably conditioned with the fact that diversity of the cultivation area is a result of specificity of particular plantations both with reference to plants type and variety as well as agro-technology. A degree of the production intensity and availability of work force is significant here.

The structure of sowing in the researched farms of grain, vegetable fruit production trend was presented in figures 4.1, 4.2, and 4.3 but figure 4.3 presents a percentage area of cultivation of apples cultivars.

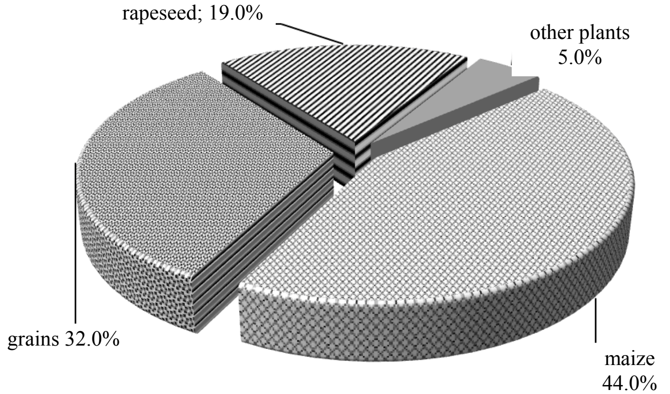

Fig. 4.1. Percentage area of sowing in crop production farms
Rys. 4.1. Procentowa struktura zasiewów w gospodarstwach o kierunku produkcji zbożowym

Source: author's own study

In grain production farms, maize dominates (44%) and cultivation of four basic (remaining) grains includes 32% of land. High percentage index of rapeseed cultivation (19%) is not without meaning, either.

The vegetable production trend characterizes considerable fragmentation of cultivation acreage and this is caused by a varied production of different vegetables depending on their type and variety. Often the cultivation area of a particular variety is below 0.5 ha. The total area of arable land of the vegetable production farms amounts to 656.9 ha (tab. 4.1), and the average area of a field is 3.1 ha, the smallest is 0.24 ha and the highest 38.7 ha. Farms of the AL area from 4.8 ha to 66.6 ha were investigated. Vegetables cultivation takes up 45% of the agricultural land area. Grain cultivations constitute 2% of smaller areas; the remaining crops constitute 12% of the area.

It should be mentioned here that this production trend on account of agro - technical requirements (rotation) is characterised by the highest fragmentation of production.

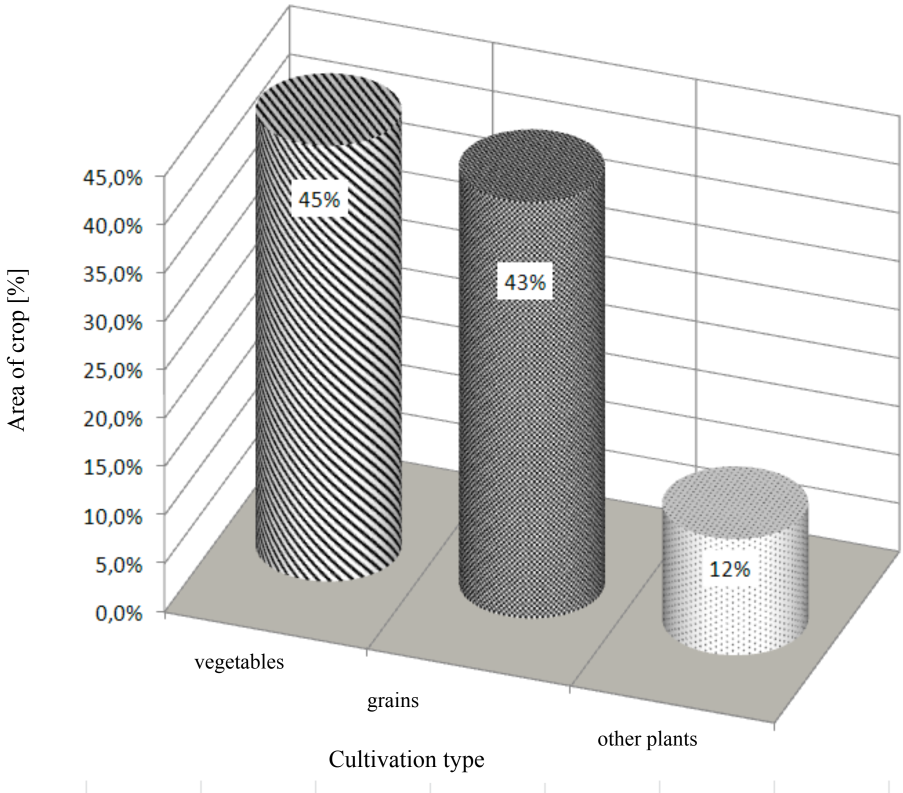

Fig. 4.2. Percentage description of field crops in vegetable production farms
Rys. 4.2. Charakterystyka procentowa upraw polowych w gospodarstwach o kierunku produkcji warzywniczym

Source: author's own study

For the assessment of the production activity of fruit farms, the research was carried out in facilities of the area from 1.2 ha to 28.0 ha. The average area of these farms was 7.6 ha and the number of allocated plantations of the orchard (163) is considerably conditioned by cultivated apple varieties. In the researched apple orchards the following varieties dominate: Szampion (31%) and Jonagold (25%).

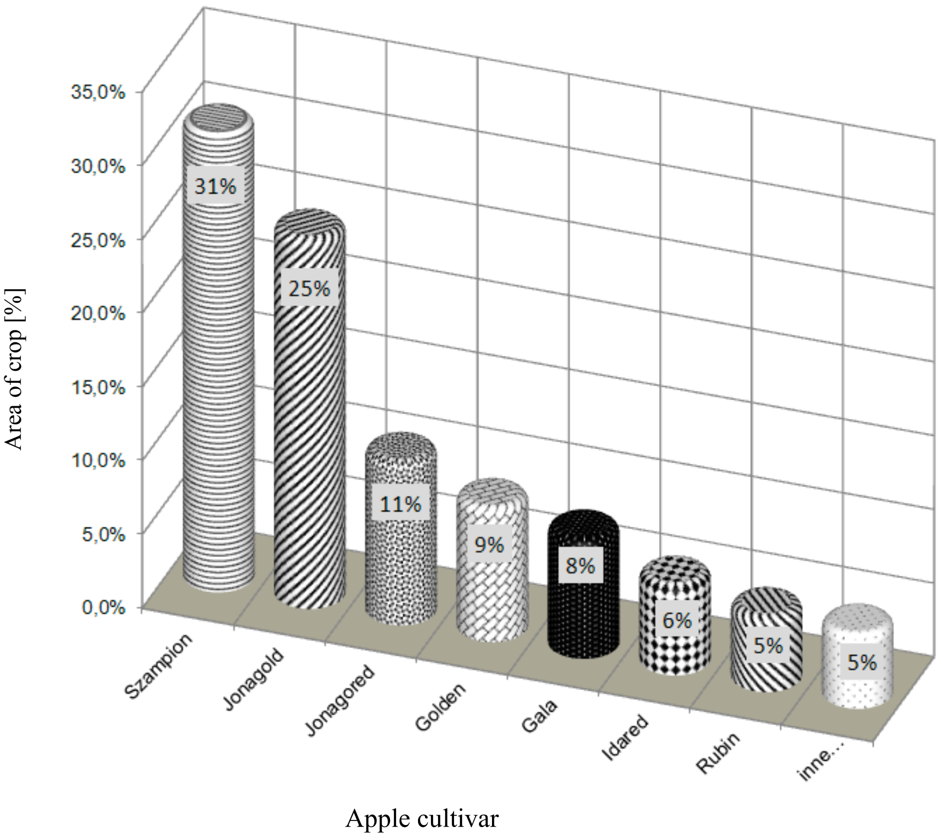

Fig. 4.3. Percentage area of apple tree varieties cultivation
Rys. 4.3. Procentowa powierzchnia upraw odmian jabłoni

Source: author's own study

Table 4.2 presents the actual in the research year (2009) characteristics of the machinery park structure. The presented data prove that structure, trend and the production size determined the structure and the size of the machinery park in the investigated farms.

The biggest number of tractors per one farm was in the grain production farms (3.4 item·farm^{-1}), and the lowest in the orchard farms (2 item·farm^{-1}), not much more tractors were in facilities producing vegetables (2.2 item·farm^{-1}). While, in reference to the number of tractors per 100 ha of AL reverse relations occurred. The highest number of tractors 26.5 item per 100 ha of AL was reported in the orchard farms, which inter alia results from smaller areas of plantations in comparison to farms of the two remaining production trends. Here the assessed index was on the level: for the grain trend –

3.6 item·100 ha^{-1} for the vegetable trend – 11.5 item.·100 ha^{-1}. These values prove agro-technical specificity of the investigated agricultural production trends and at the same time confirm the rightness of the research subject.

Table 4.2. Description and structure of the machinery park in the investigated farms (2009)
Tabela 4.2. *Charakterystyka* i struktura parku maszynowego w badanych gospodarstwach (rok 2009)

Specification	Production trend														
	Fruit production					Vegetable					Grain				
	Age [years]			Items per		Age [years]			Items per		Age [years]			Items per	
	Average	Min	Max	Farms	100 ha	Average	Min	Max	Farms	100 ha	Average	Min	Max	Farms	100 ha
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Tractors	19.5	4	34	2.0	26.3	15.7	5	42	2.2	10.9	15.9	2	29	3.4	3.5
Combines	-	-	-	-	-	-	-	-	-	-	14.7	2	30	1.1	1.1
Other harvesting machines	-	-	-	-	-	16.1	5	34	6.1	30.5	28.7	27	29	1.2	1.3
Forklift trucks	22.3	5	29	1.1	14.5	17.2	3	26	0.7	3.5	-	-	-	-	-
Side cars	14.2	3	29	1.0	13.1	18.6	10	18	1.3	6.5	22.2	11	41	2.2	2.3
Loaders	-	-	-	-	-	20.5	12	29	1.0	5.0	26.8	22	29	0.4	0.4
Spreaders	-	-	-	-	-	19.0	11	30	1.0	5.0	30.0	37	30	0.1	0.1
Aggregates	-	-	-	-	-	14.1	5	35	6.5	32.5	16.5	2	30	3.5	3.6
Sievers and dibbers	-	-	-	-	-	19.4	5	54	2.2	10.9	17.1	5	38	2.3	
Sprayers	16.8	5	30	1.0	13.1	9.3	5	26	1.3	6.5	11.8	2	31	1.0	1.0
Fertilization machines	11.2	4	29	1.0	13.1	21.1	5	30	2.5	12.5	12.7	2	29	1.6	1.6
Green forage harvesting	13.6	3	29	1.0	13.1	17.2	7	28	0.7	3.5	15.2	8	27	0.5	0.5
Stationary aggregates	-	-	-	-	-	11.2	4	14	0.7	3.5	15.0	5	23	0.6	0.6

Source: author's own study

Consequence of the above is also *a distribution of the value of conversion capacity installed in tractors per 100 ha of AL (production trend: fruit - 1066.5 kW·100 ha^{-1}, vegetable - 436.7 kW·100 ha^{-1}, grain 319.3 kW·100 ha^{-1}). It should also be mentioned, that the grain production farms are equipped with combines (1.1item.·100 ha^{-1}) of the capacity* *value of 116.7 kW·100 ha^{-1}. In total, these two trends possess the unit power almost at the same level.*

No explicit diversity of the average age of tractors has been noticed between the investigated farms of a different agricultural production trend. The lowest average age of tractors was 15.7 years and it was reported in farms of the vegetable production trend and the highest 19.5 years is the age of tractors in the fruit production farms. Age of tractors which constitute equipment of the machinery park of the grain production farms is similar to vegetable farms and amounts to 15.9 years. A minimum age of tractors 2-5 years results mainly from the purchase with the use of the EU funds. While, the oldest tractor - 42 years was reported in vegetable farms and despite its age was technically efficient.

Tractors structure in the researched farms according to the System of Farm Machines was presented in table 4.3. It was reported that *the biggest number of small tractors (class 6 kN) is owned by vegetable farms. It is conditioned mainly by after - cultivations technologies of vegetables, where tools of considerably low resistance powers and spacing of interrows requires the use of narrow tyres. While, the grain farms are equipped with tractors of high capacity of 14 class and higher kN. It is related to the cultivation and sieve technology on relatively big areas. Therefore, aggregates are relatively heavier. However, these farms posses by approx. half less capacity per 100 ha of AL in comparison with the remaining.*

Table 4.3. Structure of tractors in the investigated farms
(classification of tractors according to SMR)
Tabela 4.3. Struktura ciągników w badanych gospodarstwach
(klasyfikacja ciągników wg SMR)

Class [kN]		Production trend								
		Fruit production			Vegetable			Grain		
		item·farm^{-1}	kW·100ha^{-1} AL	item·100 ha^{-1}	item ·item^{-1}	kW·100 ha^{-1} AL	item·ha^{-1}AL	item·farm^{-1}	kW·100ha^{-1} AL	item·ha^{-1}AL
1	2	3	4	5	6	7	8	9	10	11
6	<30 kW	0.5	142.4	6.8	0.9	149.1	4.8	-	-	-
9	31-50 kW	0.8	375.8	10.5	1.0	196.7	5.0	1.3	60.2	1.4
14 and above	>50 kW	0.7	548.3	9.2	0.3	89.8	1.2	2.1	259.1	2.2
Tractors Total		2.0	1,066.5	26.5	2.2	436.7	11.0	3.4	319.3	3.6
Combine harvesters		-	-	-	-	-	-	1.1	116.7	1.1

Source: author's own study

All investigated farms posses a machinery park adequate to the production trend. Only in case of vegetable farms, producers use the outside services at grains harvesting. While grain farms which do not posses drying rooms, do not store grain only sell it directly to storages equipped with suitable devices.

According to the possibilities of use of different programmes of the EU subsidies for the purchase of machines upon Poland's accession to the EU structures in 2004, farmers started to purchase tractors and machines quite decidedly, modernizing the same the machinery park. Thus, a question of why the average age of tractors and machines is full of age (above 18 years old) arises. It results from many factors. Including, inter alia, that "the old" tractor is complementary to the second one - the new one. It is also, a consequence of human mentality - attachment and attitude "I may need it someday". Sometimes it really comes in handy. However, economic factor is a basic factor. Farmers can not afford to buy new and at the same time expensive machines. Purchased goods at the EU aid cover huge needs only in a small degree.

4.2. Employment, age and the producers' education level

Age and education of farm owners is a significant factor in the production line, especially in agricultural production line, which is emphasised by Michałek in his research [2004].

Profession of a farmer is an interdisciplinary profession, because a farmer must have knowledge of economic efficiency, and knowledge on the new generation machinery park equipped with electronic sub-assemblies based mainly on GPS technologies and computer controlling of technological processes (precise agriculture), except for widely understood agro-technical knowledge in order to achieve a good financial result in his farm. The above scope of knowledge is strictly related to the age and level of education of staff which manages the farm [Peszek 2011]. Number relations of the age groups of farm owners in the production trends system is presented in table 4.4.

Table 4.4. Farm owners' age according to the production orientation
Tabela 4.4. Wiek właścicieli gospodarstw wg kierunku produkcji

Age groups [years]	Production trend					
	Fruit production		Vegetable		Grain	
	Number	[%]	Number	[%]	Number	[%]
1	2	3	4	5	6	7
21-45	18	54.5	17	51.5	13	39.4
46-55	11	33.3	10	30.3	10	30.3
56-65	4	12.1	6	18.1	10	30.3

Source: author's own study

As it results from the data included in the table, over 50% of farmers were reported in the age group between 21 to 45 years in fruit and vegetable production farms. While in the second age group (46-55 years) number of farmers in all three researched production trends is similar and constitutes approximately 30% of the total number. Grain production representatives (30.3%) constitute the third age group, while 12.1% of fruit producers and 18.1% of vegetable producers.

Overpopulation of rural areas in South Poland is a significant demographic aspect of this region. Therefore, analysis of the employment size with reference to the area unit is significant within searching for solution. This contrary is strictly related to the degree of production mechanization on the one hand and on the other with the production intensification degree. Table 4.5 includes data concerning the size of the unit full and part-time employment.

Tabela 4.5. Liczbowa i procentowa struktura zatrudnienia w odniesieniu do powierzchni 1 ha uprawy w zależności od kierunku produkcji
Table 4.5. Number and percentage structure of employment referred to 1 ha area of crop depending on the production trend

Production trends	Full time			
	employment		part-time employment	
	Number	[%]	Number	[%]
1	2	3	4	5
Fruit production	0.51	60.7	0.33	39.3
Vegetable	0.25	56.8	0.19	43.2
Grain	0.033	62.3	0.022	37.7

Source: author's own study

Fruit production is the most difficult for full mechanization due to activities, which must be performed manually because their mechanization is unbelievably expensive and sometimes impossible. Tree crown prunning, buds thining or fruit collection, especially delicacies fruit may be an example. 0.51 employee is employed full time at the average per 1 ha of plantation and 0.33 is employed part-time (seasonally) in the researched fruit farms. Employment in the vegetable production is 0.25 people per 1 ha full time and 0.19 people part-time. 2,120 man hour·year^{-1} were accepted as full time citing Toczyński [2006].

A vegetable production technology is also highly labour consuming. However, it may be more mechanized in comparison to technologies of fruit production. Moreover, in vegetable farms in about 40 percent of cultivations, on account of their rotations, grain cultivations occur, which may be and often are highly mechanized. Thus, employment per 1 ha in the investigated vegetable farm is lower in comparison to fruit farms.

In grain farms a unit employment in comparison with previous is by about 10 times lower and amounts totally to 0.053 of employed per 1 ha AL It is a level of employment similar to the one occurring in the highly mechanized big-area farm enterprises.

For comparison in the Farm in Kietrz of 7 thousand ha area of the plant- farm production trend, the size of employment per 1 ha is 0.042 people (Informator KR Kietrz).

From the above, it is clear that grain farms belong to labour saving and should function on the areas related to deficiency of human work force.

In the research papers of many authors [Kowalski et al. 2002, Peszek 2011, Michałek et al. 1992] an assumption is made that the level of education should influence economic effects of farmers management relatively to its degree.

Persons with farm vocational education constitute the most numerous group (from 42% to 50%) among the investigated group of farmers (table 4.6) It seems to be a result of the education system which was in use to the 90's of the previous century, where except for farming vocational schools, courses in "farm training" were carried out. They constituted the base for obtaining the farmer status with all consequences along with a possibility of inheriting a farm.

Table 4.6. Educational status of farm owners according to the production orientation
Tabela 4.6. Poziom wykształcenia właścicieli gospodarstw wg kierunku produkcji

Education	Production trend					
	Fruit production		Vegetable		Grain	
	Number	[%]	Number	[%]	Number	[%]
1	2	3	4	5	6	7
Farming vocational education	14	42.4	17	51.4	15	45.4
Other vocational education	4	12.1	3	9.1	3	9.1
High school farming education	8	24.2	10	30.3	11	33.3
Other high school education	4	12.1	2	6.1	1	3.1
Higher farming education	2	6.1	1	3.1	3	9.1
Other higher education	1	3.1	0	0	0	0

Source: author's own study

Approx. 36% of responders have high school agricultural education and it is similar to all three production trends. While, 3.1% to 9.2% of responders have higher education. The last represent the biggest grain farms

Farmers use different forms of knowledge completion. More than seventy percent of responders in the researched farms reported participation in the training financed from the European Union means. The remaining producers also took part in the training, however, they paid for the training from they own means or it was financed from other source.

4.3. The amount of crops and the production size

Conversion of the real yield into grain units (GU) was used for analysis of the yield amount of plants cultivated in the researched farms. This method is commonly used in the research of agricultural and economic sciences. Amount of physical unit yield (dt) and GU was presented in table 4.7.

Table 4.7. Actual yield (dt) and per GU (according to Woermann)
Tabela 4.7. Plon rzeczywisty (dt) i w przeliczeniu na JZ (wg Woermanna)

Plant	Actual yield [dt·ha^{-1}]			Conversion factor per [GU]	Conversion yield [GU·ha^{-1}]		
	Production trend				Production trend		
	Fruit	Vegetable	Grain		Fruit	Vegetable	Grain
1	2	3	4	5	6	7	8
Winter barley	-	30.5	71.6	1.00	-	30.5	71.6
Spring barley	-	37.1	39.4	1.00	-	37.1	39.4
Spring wheat	-	40.9	46.8	1.00	-	40.9	46.8
Winter wheat	-	58.3	60.7	1.00	-	58.3	60.7
Rye	-	-	47.5	1.00	-	-	47.5
Oats	-	-	26.1	1.00	-	-	26.1
Mixture of grain	-	-	41.2	1.00	-	-	41.2
Maize	-	75.4	78.7	1.00	-	75.4	78.7
Grains straw	-	18.5	24.5	0.15	-	2.8	3.7
Grasslands	-	524.6	-	0.015	-	7.9	-
Tobacco	-	25.7	-	2.00	-	51.4	-
Rapeseed	-	-	31.9	2.00	-	-	63.8
Sugar beetroot	-	513.6	479.0	0.25	-	128.4	119.7
Beetroot	-	338.3	-	0.25	-	84.6	-
Potatoes	-	308.2	120.6	0.15	-	46.2	18.1
Carrot	-	354.9	-	0.15	-	53.2	-
Parsley	-	186.2	-	0.15	-	27.9	-
Garlic	-	296.4	-	0.30	-	88.9	-
Onion	-	307.5	-	0.30	-	92.3	-
String bean	-	226.8	-	0.30	-	68.0	-
Celery	-	283.3	-	0.25	-	70.8	-
Cauliflower	-	233.6	-	0.30	-	71.0	-
Red cabbage	-	652.3	-	0.15	-	97.8	
Chinese cabbage	-	581.5	-	0.15	-	87.2	-
White cabbage	-	592.9	-	0.15	-	88.9	-
Savoy cabbage	-	545.9	-	0.15	-	81.2	-
Paprika	-	228.3	-	0.15	-	34.2	-
Parsnip	-	254.4	-	0.15	-	38.2	-
Fruit (apple)	223.0	-	-	0.38	84.7	-	-
Average amount GU·ha^{-1} ($\bar{x}$)					84.7	60.6	61.0
Standard mean error ($\sigma_{\bar{x}}$)					3.29	5.22	4.31

Source: 43. Zarządzenie NR 11/08 Prezesa Agencji Nieruchomości Rolnych z dnia 31.01. 08

Actual amount of yield of 27 plants cultivated on agricultural land, grassland and crops of apple orchards is not different than the amount of the yield presented in the research of Małopolski Center of Agricultural Concultancy in Karniowice [2009].

The highest conversion yield (GU) from 1 ha was reported on the plantation of apple orchards (84.7 GU) and the value of the mean standard error ($\sigma_{\bar{x}}$ *=3.29JZ) proves slight dispersion between cropping of the selected plantations despite high number of 163 fields.*

The obtained numerical data prove that orchard farms give decisively the highest number of grain units from one hectare. As a result they should be included in the group of the most intensive on account of production. This fact should be significant in the agriculture development programmes in the Macroregion of the South Poland. The fact, that the vegetable trend, considered as intensifying considerably the production on account of labour consumption in the size of the subject index proved to be the least advantageous, should be taken into account in these programmes.

Since, in case of vegetable production, the lowest conversion yield amounting to 60.6 $JZ \cdot ha^{-1}$was reported. Relatively high value of the error ($\sigma_{\bar{x}}$=5.22 $JZ \cdot ha^{-1}$) is a derivative of the varied crop rotation (23 plants). Similar dispersion of the amount of the conversion yield of a plant ($\sigma_{\bar{x}}$=4.31 $GU \cdot ha^{-1}$) was reported in case of the grain production trend. The average yield for this trend was similar to the yield of vegetable farms and amounted to 61.0 $GU \cdot ha^{-1}$. Difference between the average values of yield achieved the values only of 0.4 $GU \cdot ha^{-1}$. Therefore, it is insignificant, which is confirmed by the analysis of variance and lies in the limit of error. The highest value of the conversion yield was reported in case of sugar beetroot cultivation but a very small area of cultivation of this plant, both in case of the grain trend (0.3%) as well as the vegetable trend (1.7%) did not influenced significantly the increase of the average value of yield.

5. COSTS AND ENERGY CONSUMPTION OF AGRICULTURAL PRODUCTION

5.1. Analysis of energy consumption accumulated in a product

The study assumes inter alia a hypothesis that energy consumption of production, calculated with the use of rolling costs may constitute a significant index of assessment of activity of farms production. Indexes developed by prof. J Pawlak and Z.Wójcicki in IMBER [Pawlak 1989, Wójcicki 2000], set forth in methodology were applied for calculations. Analysis of the energy consumption includes four streams. A stream of energy carriers, and within them liquid fuels (DO, fuel oil and fuel) should be included in the most crucial among them.

The results presented in table 5.1 prove that *the highest unit consumption of fuel occurs in farms of orchard plantations, at the consumption of 202.64 kg·ha^{-1}, chemical protection - at least several treatments in a season is the most energy consuming on account of consumption of energy carriers. In case of vegetable farms consumption of liquid fuels is lower and amounts to 108.29 kg·ha^{-1}* and is related to inter alia inputs of the objectified labour at mechanical plant harvesting, high number of cultivation treatments, including mechanical methods of interrow cultivation, eliminating the use of herbicides on account of ecological requirement towards the yield. Almost two times lower unit consumption of fuel in comparison to the orchard trend proves explicitly that production of vegetables is decisively the most advantageous on this account. Simultaneously, *approx. 50% lower fuel consumption in comparison with the third trend - grain was reported. Relatively high fuel consumption with reference to the grain cultivation trend, amounting to 154.93 kg·ha^{-1} results from big areas of fields and the use of machines for cultivation and seeds sowing, aggregated with tractors of high capacity, and relatively high energy load of harvesting grains with combines.*

When analysing a subject stream of energy, insignificant share of electric energy consumption in accumulative inputs should be emphasised in case of the grain and vegetable production trends. Per 1 ha of AL it is respectively 220 and 1,142.4 MJ. As a result, only in case of the fruit production, liquid fuel significantly accumulatively increases energy consumption of production per 1 hectare. Consumption in this case is mainly related to after-crop processing. Therefore, accumulatively, the accumulated energy consumption reaches at the average the value of approx. 5,500 MJ·ha^{-1} for the vegetable production trend. It is almost two times higher and reaches values of more than 10,500 MJ·ha^{-1}for the fruit production trend. While for the grain production trend, accumulative value of the accumulated energy in carriers amounts to approximately 7,500 MJ·ha^{-1}. Therefore, it gives the average value of the compared remaining production trends.

It is worth noticing that electric energy inputs in this case are rather symbolic. They are only12.94 kWh·ha^{-1}. It should be however emphasised that big area of fields in farms of this trend, the use of high efficient machines, small number of cultivation treatments causes that the unit consumption of fuel is considerably lower in comparison to fuel consumption in the fruit production despite a high energy consumptive technology of grain harvesting.

Table 5.1. Energy consumption accumulated in energy carriers
Tabela 5.1. Energochłonność skumulowana w nośnikach energii

Production trend	Energy carriers				Total
	Fuel		Electric energy		
	[kg·ha^{-1}]	[MJ·ha^{-1}]	[kWh·ha^{-1}]	[MJ·ha^{-1}]	[MJ·ha^{-1}]
1	2	3	4	5	6
Fruit production	202.64	9,726.5	87.18	959.0	10,685.5
Vegetable	108.29	5,198.1	20.13	221.4	5,419.5
Grain	153.85	7,385.0	12.94	142.4	7,527.3
Average	154.93	7,436.5	40.08	440.9	7,877.4

Source: author's own study

The fact of low fuel consumption in vegetable production (108.29 kg·ha^{-1}) should be taken into consideration at forecasting sowing structures because only orienting production to less intensive plants and the use of bigger machines without rationally simplified cultivation technologies will not give energy saving effects. And it is more and more expensive and will finally decide on the efficiency of management not only in agriculture.

Average values of the accumulated energy consumption in raw materials and materials were presented in table 5.2. When analysing the obtained quantity material, one may notice reverse relations and proportions between the compared production trends as in case of the first stream (energy carriers).

Generally, the highest energy inputs with reference to 1 ha of AL occurred in case of the vegetable trend - obtaining average value of 19,544.6 MJ·ha^{-1}. In case of the fruit trend, this index was lower by approx. 38% and in case of grain trend by approx. 20%.

In the fruit production trend in this stream, plant protection substances dominated (6,906.9 MJ·ha^{-1}), while in the remaining two production trends the highest energy inputs were incurred on mineral fertilizers: vegetable - 16,660.9 MJ·ha^{-1}; grain – 14,165.6 MJ·ha^{-1}. High consumption of chemical substances for protection of orchard plantations is economically justified because it stimulates the increase of fruit trees yield. And this is achieved by minimizing losses which occur from destructive activity of illnesses and pests. However, one should remember that from the point of view of ecology, the chemicalization effect may be considered as harmful.

Table 5.2. Energy consumption accumulated in raw materials and materials
Tabela 5.2. Energochłonność skumulowana w surowcach i materiałach

Production trend	Raw materials and materials							Total
	Sowing material		Organic fertilizers		Mineral fertilizer		Plant protection substances	
	[MJ·ha^{-1}]	[kg·ha^{-1}]	[MJ·ha^{-1}]	[kg·ha^{-1}]	[MJ·ha^{-1}]	[kg·ha^{-1}]	[MJ·ha^{-1}]	[MJ·ha^{-1}]
1	2	3	4	5	6	7	8	9
Fruit production	-	-	-	96.8	5,324.4	23.0	6,906.9	12,231.3
Vegetable	819.7	4,200.0	840.0	325.2	16,660.9	4.1	1,224.0	19,544.6
Grain	835.3	28.6	5.7	257.6	14,165.6	2.4	729.3	15,735.9
Average	827.5	2,114.3	422.9	226.5	12,050.3	9.8	2,953.4	15,837.3

Source: author's own study

Huge diversity of production trends proves the size of human labour inputs calculated in man hours and in MJ of the accumulated energy consumption of this labour. Cumulative number data from this scope are included in table 5.3. Values presented there explicitly prove that unitarily (with reference) to 1 ha of labour consumption and energy consumption of fruit production is over two times higher in comparison to the vegetable trend - otherwise considered as labour consumptive and capital-saving.

Table 5.3. Energy consumption accumulated in man labour
Tabela 5.3. Energochłonność skumulowana w pracy żywej

Production trend	Accumulated energy consumption	
	[man hour·ha^{-1}]	[MJ·ha^{-1}]
1	2	3
Fruit production	411.98	17,303.3
Vegetable	174.81	7,342.0
Grain	26.21	1,100.7
Average	204.33	8,582.0

Source: author's own study

Results of the subject inputs at comparing horticultural trends with the grain trend are extremely different. In the last example inputs are over 6 times lower than in comparison to vegetable and over 15 times lower as in case of comparing it with the fruit production.

This last trend generates high inputs of man hours amounting to 411.98 man hour·ha^{-1}. The following treatments mainly compose these inputs: prunning of crowns, manual buds thinning and their cropping. All these activities are difficult to be mechanized.

It should be emphasised that in order to avoid losses, production activities must be carried out by highly qualified employees. In case of vegetable production, labour inputs amounting to 174.81 hours per one hectare in comparison to the previous trend are moderate - 2.5 times lower. Despite the fact that many activities are possible for mechanization, commodities production of vegetables requires direct contact with a plant from planting to cropping - to which the after-crop processing and preparation of crop for distribution is included. All these activities are labour consuming, generating high inputs of labour in comparison to the grain trend. Since, the grain production is fully mechanized and in this case labour inputs are low and constitute only 26.21 man hour·ha^{-1} which gives the average energy consumption amounting to 1,107.7 MJ·ha^{-1}. The accumulated energy consumption of live labour of fruit and vegetables production trend amounts respectively to: 17,303.3 MJ·ha^{-1} and 7,342.0 MJ·ha^{-1}.

The presented numerical values showing the amount of inputs for production resulting from the stream of human labour explicitly prove one-trend agricultural production in the South Poland which is characterised by great fragmentation of the agrarian structure and overpopulation of a country. Besides animal production, it should be:

- **the fruit production trend on weaker soils in the region of uphills including favourable micro-climate,**
- **the vegetable trend on strong soils and near urban centres.**

The highest value (table 5.4) of the accumulated energy consumption in machinery aggregates and buildings was reported in farms of the vegetable production trend (10,697.6 MJ·ha^{-1}), and almost two times lower in case of the fruit production (4,607.1 MJ·ha^{-1}) and in the grain production (3,982.6 MJ·ha^{-1}).

The above numerical data prove that the fruit trend and especially the vegetable trend except for high energy consumption are also capital consuming. However, it should be emphasised that at high number of protection treatments (the fruit production) and mechanized cultivations (vegetable) and at lower efficiency of aggregates, high value of the accumulated energy consumption in this stream can be logically justified.

As it results from the data included in table 5.4 in the investment energy consumption the main share is for machines and devices. In its total average value (6,429.1 MJ·ha^{-1}) the share of technical devices is approximately 96% and of buildings and facilities is slightly over 3.6%. The vegetable trend presents the highest share of the last - 4.1% and the fruit trend is the lowest and it reached 2.8%. According to the above, minimizing the accumulated energy consumption in farms one should especially take into consideration machines and devices. At the same time, the obtained results prove that the storage base in the investigated objects is rather poor. And this disables farmers to sell produce in the period of the most advantageous prices on the market.

Table 5.4. Energy consumption accumulated in mechanisation and construction means
Tabela 5.4. Energochłonność skumulowana w środkach mechanizacji i budownictwa

Production trend	Mechanization means	Buildings	Total
	[MJ·ha^{-1}]	[MJ·ha^{-1}]	[MJ·ha^{-1}]
1	2	3	4
Fruit production	4,480.2	126.9	4,607.1
Vegetable	10,273.6	424.0	10,697.6
Grain	3,853.5	129.2	3,982.6
Average	6,202.4	226.7	6,429.1

Source: author's own study

Total energy consumption accumulated in yields calculated into grain units for all three agricultural production trends was presented in table 5.5. The highest value of the total accumulated energy in the amount of 710.2 MJ·JZ^{-1} was reported in the vegetable production trend at the value of error of 8.32 MJ·JZ^{-1}. While, its lowest value in the product amounting to 464.9 MJ·JZ^{-1} (at the standard error of $\sigma_{\bar{x}}$ =4.84 MJ·JZ^{-1}) occurred in case of the grain production trend.

Table 5.5. Total energy consumption accumulated in produce
Tabela 5.5. Całkowita energochłonność skumulowana w produkcie płodów rolnych

Energy consumption stream	Production trend								
	Fruit production			Vegetable			Grain		
	[MJ·ha^{-1}]	[MJ·JZ^{-1}]	σ[MJ·JZ^{-1}]	[MJ·ha^{-1}]	[MJ·JZ^{-1}]	σ[MJ·JZ^{-1}]	[MJ·ha^{-1}]	[MJ·JZ^{-1}]	σ[MJ·JZ^{-1}]
1	2	3	4	5	6	7	8	9	10
Energy carriers	10,685.54	126.1	3.22	5,419.5	89.5	3.06	7,527.3	123.5	2.78
Materials and raw materials	12,231.29	144.4	3.82	19,544.6	322.8	4.64	15,735.9	258.1	3.47
Live labour	17,303.27	204.3	4.31	7,342.0	121.3	3.73	1,100.7	18.1	0.90
Investment	4,607.12	54.4	2.95	10,697.6	176.7	2.89	3,982.6	65.3	1.69
Total energy consumption	44,827.22	529.2	7.22	43,003.7	710.2	8.32	28,346.5	464.9	4.84

Source: author's own study

When comparing extreme values of this index it can be noticed that accumulated energy consumption of the grain unit in the yield of the vegetable trend is higher than its equivalent of the grain trend by 245.3 MJ·JZ^{-1}. Practically, it may be said that the difference is substantial. A slight difference of the accumulated energy consumption converted into the GU between the fruit trend and the grain

trend needs to be emphasised – the grain trend has a lower index only by 12%. It is a precious indication for technological systems designers of Małopolska region for future.

When assessing total energy consumption converted into 1 ha of AL a significant fact is noticed. That is, the value of this index (for the fruit trend 44,827.22; for the vegetable trend 43,003.7 MJ·ha^{-1} AL) is at a similar level - insignificant difference amounting to approx. 4%. Simultaneously, a significant difference between the above values and the unit energy consumption referred to 1 ha of AL is noticed in case of the grain production trend. This value constitutes only 63.24% of its equivalent for the fruit production trend. From the statistical point of view, it should be emphasised that production of 1 GU is the most energy consuming in the vegetable production and the least in the grain production. While, loading with energy inputs of one hectare is the highest in the fruit production. The fact that the grain trend is the most advantageous in both subject indexes should be considered as symptomatic.

When assessing component sizes of energy streams, the highest share in total inputs of materials and raw materials is reported. It does not concern the fruit production trend (tab. 5.6).

This stream in the fruit production trend includes 27.29% of the total energy inputs in case of the vegetable production - 45.45%. In case of the grain production trend it includes 55.51% of the total energy consumption.

Table 5.6. Percentage share of energy consumption streams accumulated in the total energy consumption [%]
Tabela 5.6. Procentowy udział strumieni energochłonności skumulowanej w energochłonności całkowitej [%]

Stream of energy consumption	Production trend		
	Fruit production	Vegetable	Grain
1	2	3	4
Energy carriers	23.84	12.60	26.55
Materials and raw materials	27.29	45.45	55.51
Live labour	38.60	17.07	3.88
Investment	10.28	24.88	14.05
Total energy consumption	100.00	100.00	100.00

Source: author's own study

The percentage share of energy carriers in the total inputs for two trends is on a similar level and constitutes: 23.84% (fruit production trend) and 26.55% (grain production trend). A subject index in case of the vegetable production decisively diverge from them. In the vegetable production trend it is only 12.6%.

When analysing data included in table 5.6 a considerable diversity of energy inputs resulting from labour consumption of production processes is noticed.

A very high share of human labour in the total energy consumption is noticed in technologies of the fruit production - as much as 38.6%. At the same time, a minimum share of this stream in case of the grain production trend of 3.88% needs to be emphasised.

5.2. Analysis of the production costs

Average costs of materials and raw materials calculated into the area of one hectare of arable land and GU of yield was presented in tables 5.7 and 5.8.

Table 5.7. Unit costs and their structure of materials and raw materials per 1 ha
Tabela 5.7. Jednostkowe koszty i ich struktura materiałów i surowców w przeliczeniu na powierzchnię 1 ha

Production trend	Sowing material		Mineral fertilizers		Organic fertilizers		Protection substances		Total costs
	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]
1	2	3	4	5	6	7	8	9	10
Fruit production	0.0	0.0	472.13	3.0	0.0	0.0	3,573.70	19.8	4,045.80
Vegetable	1,140.30	26.5	1,280.00	3.6	182.60	43.0	364.80	25.9	2,967.60
Grain	228.90	29.2	1,049.40	7.4	3.43	16.9	223.24	31.5	1,504.97

Source: author's own study

Agricultural production costs constitute a basic element of the assessment of management efficiency. Financial inputs on materials and raw materials are one of the basic elements of these costs.

Farmers geared towards the fruit production incurred the highest financial inputs on materials and raw materials calculated into 1 ha of AL in the researched number of farms - it was PLN 4,045.80. Vegetable farms incurred decisively lower values; they were PLN 2,967.60 per 1 ha. The lowest costs on this account were reported in the grain trend - only PLN 1,504.97 - they were only two times lower in comparison to the vegetable and 2.7 times lower than the fruit production. Protection means for fruit plantations, which constitute 88% of their total value influenced the high value of material costs in the fruit production. In case of the vegetable production trend high costs of the sowing material and seedlings material - 38.4% as well as mineral fertilizers - 43.1% were reported. While, in the grain production trend, costs of mineral fertilizers constitute a dominating position - as much as 69.7%.

A slightly different relation may be noticed when comparing subject costs referred to the calculation yield (table 5.8). *As it results from the data included in a table, the costs of production of GU in fruit farms as well as vegetable is on a similar level fluctuating around the value from approx. PLN 48 to 49.* The above proves that the price and the value of fruit and vegetables sale will decisively influence the agricultural income, and not the same production cost. *It decisively differs from the* *above subject costs in case of the grain production trend. Here it is two times lower and amounts to the average of PLN 24.68.*

Table 5.8. Unit costs of materials and raw materials per a grain unit of a yield [PLN·GU^{-1}]
Tabela 5.8. Jednostkowe koszty materiałów i surowców w przeliczeniu na jednostkę zbożową plonu [zł·JZ^{-1}]

Production trend	Sowing material	Mineral fertilizer	Organic fertilizers	Protection substances	Total
1	2	3	4	5	6
Fruit production	-	5.57	-	42.19	47.76
Vegetable	18.83	21.14	3.02	6.02	49.01
Grain	3.75	17.21	0.06	3.66	24.68

Source: author's own study

Operation costs of aggregates and labour per 1 ha of AL and the grain unit of yield were presented in tables 5.9 and 5.10.

Operation costs of aggregates and labour costs should be recognized as the most important from the point of view of agricultural engineering. Since, they are included in main components deciding on the effect of managing. Simultaneously, constituting mutual substitutes they decide on the substitution of human labour with objectified labour. Moreover, quantity and quality relations, inter alia, prove degree of technical progress represented in the assessed work technologies and production systems.

Table 5.9. Unit costs of aggregates operation and labour per 1 ha
Tabela 5.9. Jednostkowe koszty pracy agregatów i robocizny w przeliczeniu na powierzchnię 1 ha

Production trend	Amortization		Repairs		Interests		Garage and insurance		Fuel and energy		Total costs of exploitation		Labour		Total costs	
	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]	[PLN·ha^{-1}]	V [%]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fruit production	560.8	21.2	482.2	36.1	28.1	24.5	86.9	24.6	1,245.6	13.4	2,403.6	17.3	4,119.8	5.9	6,523.2	12.9
Vegetable	705.7	32.4	618.4	33.3	16.6	36.0	14.1	32.4	630.7	10.8	1,985.4	15.9	1,748.1	11.7	3,733.5	18.7
Grain	367.6	35.7	322.0	48.7	9.8	53.1	20.1	48.2	843.3	24.6	1,562.8	19.2	262.1	6.7	1,824.9	15.8

Source: author's own study

Unit costs of the aggregates operation and the human labour involvement, presented in table 5.9. prove huge diversity of both amount of money inputs on the assessed components of costs at comparing production trends as well as their mutual relations within these trends.

In total, the highest financial inputs per 1 ha of AL are incurred by fruit farms. Total amount of costs amounts here to as much as PLN 6,523, out of which fruit farmers allot PLN 4,119 for labour, which constitutes 63% of the total value of the subjective costs.

A farm oriented to the vegetable production incurred costs per a unit of the area by approx. 43% lower. Their accumulative value oscillated around the value of 3,700 PLN·ha^{-1} AL. Also in this case manual works have an enormous share - they include almost 47% of total costs. Farmers of this trend allotted 1,985 PLN·ha^{-1} AL for mechanized works. *Therefore, it is an index by approx. 400 PLN·ha^{-1} lower in comparison to fruit farms. Nevertheless, operation costs of two trends shall be considered as very high.*

Financial inputs on mechanization means operations and labour should be assessed differently in case of the grain production trend. Here, unit costs of mechanized works are lower by approximately PLN 400 in comparison to vegetable farms and by approx. PLN 800 in comparison to fruit farms. Since, they amount to 1,562 PLN·ha^{-1}AL. Thus, difference is clear and significant. Nevertheless, extreme disproportion in human labour input, reaching multiple, should be emphasised. Thus, in comparison to the vegetable trend, labour consumption for the grain trend is approx. seven times lower and in comparison to fruit facilities six times lower (tab. 5.9).

In the authors' opinion, the unit costs of aggregates operation and labour referred to the obtained yield in the form of the grain unit are more useful for the assessment of management efficiency. Data concerning this index were presented in table 5.10.

Table 5.10. Costs of mechanisation means operation
and labour per a yield unit [PLN·GU^{-1}]
Tabela 5.10. Koszty pracy środków mechanizacji
i robocizny na jednostkę przeliczeniową plonu [zł·JZ^{-1}]

Production trend	Amortization	Repairs	Interests	Garage and insurance	Fuel and energy	Total operating costs	Labour	Total costs
1	2	3	4	5	6	7	8	9
Fruit production	6.62	5.69	0.33	1.03	14.7	28.37	48.63	77.01
Vegetable	11.65	10.21	0.27	0.23	10.42	32.78	28.87	61.66
Grain	6.03	5.28	0.16	0.33	13.83	25.63	4.30	29.93

Source: author's own study

Data included in table 5.10 show that the operation cost of mechanization means per 1 GU is varied within the range from PLN 25.63 (grain) to PLN 32.78 (vegetable). Differences are significant but not shocking. While, a considerable difference occurs in case of labour costs. And they finally diversify the sum of these two costs cathegories (tab. 5.10)

When analysing the total costs in the discussed table, one may find that the highest financial inputs on the production of 1 GU is incurred by fruit farms - 77.0 PLN·GU^{-1}. Production of 1 GU in vegetables requires investing PLN 61.66 (by 20% less) and in the grain farms PLN 29.93 (by over 61% less than in the fruit farms).

Labour involves 48.63 PLN·GU^{-1} in production of apples - it constitutes 63% of total positions, in the vegetable production respectively: 28.87 PLN·GU^{-1} and 46%. Subjective indexes decisively diverge from two previous in case of the grain trend, where costs of producing a grain unit are over two times lower than in comparison to vegetables and one and a half times lower in comparison to fruit.

Labour involves 63% of these costs in fruit production, 46.8% of vegetable production and only 14.4% in case of the grain trend.

The presented value concerning particular components gave a possibility of determining production costs covering all components in the investigated facilities. Data concerning unit costs per 1 ha of AL and 1 GU of production were presented in table 5.11.

Table 5.11. Total unit costs per 1 ha and one grain unit
Tabela 5.11. Jednostkowe koszty ogółem w przeliczeniu na powierzchnie jednego hektara i jednej jednostki zbożowej

Production Trend	Unit costs along with coefficients of variation			
	[PLN·ha^{-1}]	V [%]	[PLN·GU^{-1}]	V [%]
1	2	3	4	5
Fruit production	10,569.06	10.8	124.74	5.6
Vegetable	6,701.11	16.7	110.65	17.4
Grain	3,329.82	10.7	54.67	10.1

Source: author's own study

When analysing values presented in the table, mutual relations between the assessed trends for particular components may be generally confirmed. Fruit producers incur decisively the highest costs both with reference to one hectare as well as to the grain unit (10,569 PLN·ha^{-1} and 124.74 PLN·GU^{-1}). Decisively lower production costs calculated into 1 ha of AL are incurred by vegetable producers. While, calculating it into the grain units of production, one may notice that the difference with the previous trend is not so big - however, it is significant. In this case, the cost is 110.67 PLN·GU^{-1}. The grain trend of production should be assessed as the most advantageous on account of the amount of unit costs. Both on account of the reference point to the area as well as the production unit. Here, total costs referred to one hectare are two times lower in comparison to vegetable farms and almost three times lower as in the fruit production. In this case they amount to only 3,329.12 PLN·ha^{-1}. The grain unit cost is PLN 54.67. Thus, it is two times lower than in the vegetable farms and approx. 2.5 times lower in the fruit production.

The presented costs analysis clearly ranks the compared production trends. In this case, the fruit production trend is the least advantageous and the grain production trend is the most advantageous. However, a final assessment will include also the other side that is revenues and incomes. Since, one should bear in mind, that the market value of the grain unit is different for fruit, vegetables or other agricultural produce. This will be analysed in the further part of this study.

The production cost of 1 GU - one decitonne of grain amounting to PLN 55 should be emphasised in this place. Calculating the above value per one tonne of grain we receive a value similar to the grain price on the market. Therefore, one may state that revenues from the sale (in the reference year) cover only the production costs.

Values of the coefficient of variance of the obtained results presented in all tables of this chapter explicitly emphasize that variance in majority of cases is low. Thus, one may subject these results to a further statistical "processing".

6. REVENUES AND AGRICULTURAL INCOME

An agricultural farm as an enterprise from the point of view of production organization at the multi-trend production may be and often is a unit which is organizationally complicated. And this in most cases is a restraint for the correct work organization and as a result disables optimization of production which brings maximization of profits.

In the current analysis of results, pressure was placed on inputs and costs while incomes were omitted. Comparative values of incomes resulting from the sale of produce and agricultural products were placed in table 6.1 and the analysis of variance was presented in tables 6.2 and 6.3. "Agricultural income" was accepted as a criterion in the analysis of this economic category. Since it includes all material components of costs except for practically "virtual" expenses resulting from, inter alia, the ground income.

Numerical values characterizing the agricultural revenue and income in the researched farms with reference to the area of 1 ha and a conversion unit of yield (GU) were presented in table 6.1. Targeted and direct subsidies were added to the product value. Analysis of these subsidies will be carried out in the next section.

Table 6.1. Revenues and agricultural income per the area unit [PLN·ha-1] and the production grain unit [PLN·GU-1]
Tabela 6.1. Przychody i dochód rolniczy na jednostkę powierzchni [zł·ha-1] i jednostkę zbożową produkcji [zł·JZ-1]

Production trend	Revenues		Agricultural income	
	[PLN·ha^{-1}]	[PLN·GU^{-1}]	[PLN·ha^{-1}]	[PLN·GU^{-1}]
1	2	3	4	5
Fruit	29,364.85	364.00	18,759.79	221.88
Vegetable	21,815.62	360.28	15,114.51	249.00
Grain	4,486.46	73.58	1,156.63	18.97

Source: author's own study

The highest revenue in the amount of 29,364.85 PLN·ha^{-1} was reported in fruit production farms. A similar observation was made in relation to the agricultural income, which in fruit farms was18,795.73 PLN·ha^{-1}. The lowest agricultural revenue and income was reported in case of grain production, respectively: revenue - 4,486.46 PLN·ha^{-1} and income – 1,156.63 PLN·ha^{-1}. The amount of revenue in vegetable production farms amounted to 21,815.65 PLN·ha^{-1} and the agricultural income – 15,114.51 PLN·ha^{-1}.

When converting the agricultural revenue and income into grain units a slightly different order in the agricultural income was reported. Its highest value per the grain unit was reported in case of vegetable farms where it was PLN 249.0. In fruit farms the agricultural income was slightly lower and amounted to 221.9 PLN·GU^{-1}. In grain farms its value was very low. Since it was only 18.97 PLN·GU^{-1}

The results presented above prove that if we refer the obtained indexes to the area unit, a situation in fruit farms is decisively better in the subject matter. It concerns both the amount of revenue per 1 ha of AL and the agricultural income. A slightly worse situation is in the above indexes in case of the vegetable production trend. Here, the indexes are a bit lower: 25% and approx. 20%. However, when calculating income into the production unit, a difference is small - since it is only 10% but in this case it is for the benefit of the vegetable production. Thus, a final economic effect prefers a vegetable production.

Decisively, they diverge in minus from the previous value of the revenue and income for the grain trend. Since here, revenues from one hectare are 6.5 times lower in comparison to fruit farms and the obtained incomes referred to the GU of production are as much as 13 times lower. Therefore, differences are huge. However, to confirm a statistical significance of difference on this account between the compared production trends (especially horticultural trends) analysis of variance with Duncan test was carried out.

The analysis of variance with Duncan test for agricultural revenue and income referred to the production unit was presented in tables 6.2 and 6.3.

Table 6.2. Analysis of variance with Duncan test (F=11.62) for revenue per GU
Tabela 6.2. Analiza wariancji z testem Duncana (F=11,62) dla przychodu na JZ

Production trend	1	2	3
Fruit (1)	X	X	*
Vegetable (2)	X	X	*
Grain (3)	*	*	X

*- significant difference (α=0.05)

Source: author's own study

From the data included in tables, statistically significant differences between the investigated factors result. High content of F test authorizes to state that both in case of the agricultural revenue and income there are significant differences between the horticultural and grain production trend. While, lack of significance of differences was reported only between the fruit and vegetable trend in the comparative analysis for the revenue.

Table 6.3. Analysis of variance with Duncan test (F=14.85) for agricultural income per GU
Tabela 6.3. Analiza wariancji z testem Duncana (F=14,85) dla dochodu rolniczego na JZ

Production trend	1	2	3
Fruit (1)	X	*	*
Vegetable (2)	*	X	*
Grain (3)	*	*	X

* - significant difference (α=0.05)

Source: author's own study

Moreover, with the use of analysis of variance and Duncan test it was verified whether elements of costs and agricultural incomes of the investigated farms differ within the production trends and between them. 12 composing factors were statistically analysed and it was found at the high F value within 24.36-284.69 that in 69 cases out of 72 possible combinations, average values differ statistically. No statistically significant differences between the average values of material and raw material streams costs in case of the fruit and vegetable production trends were reported. In case of energy consumption of direct energy carriers no significance of differences between the average values of the vegetable and grain production trends was reported. Whereas in the energy consumption of the investment inputs no statistically significant differences were reported between the fruit and grain trend.

7. THE EUROPEAN UNION FUNDS' SHARE IN ENERGY CONSUMPTION AND THE PRODUCTION COSTS OF VARIOUS TYPES OF FARMS

7.1. Amount of a subsidy for the purchase of equipment in 2004-2009

Purchase of tractors and machines with the use of a subsidy from the EU means in 2004-2005 was presented in table 7.1.

The grain production trend farms invested the most, where the total amount of a subsidy was 5,370.0 thousand which gives a subsidy in the amount of 162.7 thousand per one farm at the amount of a subsidy of 16.8 thousand $\cdot farm^{-1}$ in the fruit production trend and 47.6 thousand$\cdot farm^{-1}$ in the vegetable production farm. All the researched objects preferred purchase of tractors (18 items in the fruit trend - PLN 401.0 thousand, 21 items in the vegetable trend - PLN 825.8 thousand and in case of the grain trend 42 items – PLN 2200.5 thousand of a subsidy).

Table 7.1. The amount of the European Union fund for the purchase of tractors and machines by the investigated farms in 2004-2009
Tabela 7.1. Wielkość dofinansowania unijnego przy zakupie ciągników i maszyn przez badane gospodarstwa w latach 2004-2009

Specification	Production trend					
	Fruit		Vegetable		Grain	
	By quantity	By amount [thousand PLN]	By quantity	By amount [thousand PLN]	By quantity	By amount [thousand PLN]
1	2	3	4	5	6	7
Tractors	18	401.0	21	825.8	42	2,200
Cultivation aggregates	-	-	57	401.5	18	216.0
Seeders and distributors	6	10.8	6	79.0	36	442.5
Sprayers	16	105.9	12	35.8	9	150.0
Combine harvesters	-	-	-		21	2,361
Others	16	35.1	21	227.4	-	-
Total	-	552.8	-	1,569	-	5,370
Amount$\cdot$farm $^{-1}$	-	16.8	-	47.6	-	162.7

Source: author's own study

It is noticed that from the remaining machine groups particular trends included purchase of machines suitable for the applied technologies; the fruit production trend objects bought 16 sprayers (19% of a subsidy), vegetable objects bought 57 cultivation aggregates (26% of a subsidy) and the grain farms bought 21 grain combine harvesters (44% of a subsidy).

7.2. The European Union subsidies' share in the compensation of the energy consumption accumulated in a product and the production costs

One of the main purposes of the presented scientific issue is a detailed comparative analysis of the EU funds calculated into the compensation of the accumulated energy in the agricultural products in relation to the production trend. For this purpose, a percentage index W_{RE} was developed, which constitutes the amount of the energy accumulated in the GU [$MJ \cdot GU^{-1}$] compensated from the EU means and referred to the total amount of energy accumulated in the GU [$MJ \cdot GU^{-1}$], and also the cost index which is a quotient of the total amount of the direct and target subsidy to the GU [$PLN \cdot GU^{-1}$] and the production costs of the GU [$PLN \cdot GU^{-1}$].

In tables 7.2, 7.3, 7.4 the amounts and share of the EU subsidies in the compensation of the energy and cost inputs in the production depending on its trend were presented. Tables include the unit data of indexes calculated per 1 ha of AL and 1 GU of production and values of the percentage index of compensation (W_{RK} and W_{RE}).

Table 7.2. Share of the European Union subsidies in the compensation of energy and costs inputs in the fruit production
Tabela 7.2. Udział dotacji unijnych w rekompensacie nakładów energetycznych i kosztowych w produkcji sadowniczej

Subsidies	Index of subsidies							
	Energy				By costs			
	[$MJ \cdot ha^{-1}$]	[$MJ \cdot JZ^{-1}$]	[%]	W_{RE} [%]	[$PLN \cdot ha^{-1}$]	[$PLN \cdot GU^{-1}$]	[%]	W_{RK} [%]
1	2	3	4	5	6	7	8	9
Direct	2,346.94	27.71	77.66	5.24	448.20	5.29	71.32	4.24
Target	675.02	7.97	22.34	1.51	128.91	2.13	28.68	1.71
Total	3,021.96	35.67	100.0	6.74	577.11	7.42	100.0	5.95
$\sigma_{WRE}, \sigma_{WRK}$	-	-	-	1.39	-	-	-	1.21

Source: author's own study

According to the data presented in tables 7.2, 7.3, 7.4 direct subsidies constitute a basic amount of the total subsidy to the agricultural production. It amounts to PLN 448 at the average per one hectare in the fruit production, PLN 518 in the vegetable production and PLN 598 in the grain production. The least advantageous situation on this account is in the fruit production and the best in case of the grain production. Targeted subsidies for the analysed trends are respectively: 128.91 PLN·ha^{-1} in the fruit production, 140.54 PLN·ha^{-1} in the vegetable production and 116.27 PLN·ha^{-1} in case of the grain production. It gives their total share in the EU subsidy on the level of: 28.68%; 21.47% and 16.20%.

Table 7.3. Share of the European Union subsidies in the compensation of energy and costs inputs in the vegetable production
Tabela 7.3. Udział dotacji unijnych w rekompensacie nakładów energetycznych i kosztowych w produkcji warzywniczej

Subsidies	Index of subsidies							
	Energy				Cost			
	[MJ·ha^{-1}]	[MJ·GU^{-1}]	[%]	W_{RE} [%]	[PLN·ha^{-1}]	[PLN·GU^{-1}]	[%]	W_{RK} [%]
1	2	3	4	5	6	7	8	9
Direct	4,858.46	80.17	82.72	11.30	518.46	8.56	78.53	7.32
Target	1,015.27	16.80	17.28	2.36	140.54	2.34	21.47	2.74
Total	5,873.73	97.00	100.0	13.66	659.00	10.90	100.0	10.75
σ_{WRE}, σ_{WRK}	-	-	-	3.37	-	-	-	4.03

Source: author's own study

Low costs of targeted subsidies, despite considerable investing of producers in modernization of the machinery park result from accepting in calculations distribution of subvention for the period of 15 to 17 years. It results from the assumed average service life of tractors and machines [Wójcicki 2005] because logically a subsidy for the targeted purchase influences a long term subsidy to the production and should not be considered only for the year of purchase for calculation of costs or compensation of the accumulated energy carriers in the product.

The presented numerical values prove that in the accumulated value of a subsidy both with reference to the area unit as well as the production unit the most advantageous situation occurs in the grain trend, where the total amount per one hectare reached PLN 714 and per the production grain unit it is PLN 17.7. ***A slightly worse situation occurred in vegetable farms, respectively PLN 659 and PLN 10.90. The situation in the fruit production is the least advantageous. Subsidies were on the level of 577.17 PLN·ha^{-1} and 7.42 PLN·GU^{-1}.***

Values of the inputs compensation index emphasise clearly this diversity. This index amounts to only 5.95% in case of the fruit production costs and in the vegetable production 10.75% and as much as 21.46% for the grain farms.

According to the above, the EU subsidies and funds prefer extensive production trends. Whereas, the higher is the production intensity degree the lower is the EU support. Therefore, one may conclude that the agricultural policy of the

unified Europe prefers farms of great area which minimize financial and goods inputs and the production size. In this place a question arises: "Should it be like that?" and "Should the EU agricultural policy aim there"?

Analysis of the subject indexes in the compensation system of the energy inputs, calculated with the rolling account, pictures relations and proportions similar to the cost indexes. It should be emphasised that a synthetic index of compensation of a subsidy in the energy aspect even more strongly pictures diversity between the compared production trends. Since, for the fruit production it is 6.74%, for the vegetable production 13.66% and for grains it is as much as 23.42%. According to the above in case of the grain trend, energy equivalent of the production compensation from the EU means covers the accumulated energy inputs almost in one fourth.

Table 7.4. Share of the European Union subsidies in the compensation of energy and costs inputs in the grain production
Tabela 7.4. Udział dotacji unijnych w rekompensacie nakładów energetycznych i kosztowych produkcji w kierunku zbożowym

Subsidies	Index of subsidies							
	Energy				Cost			
	[MJ·ha^{-1}]	[MJ·GU^{-1}]	[%]	W_{RE} [%]	[PLN·ha^{-1}]	[PLN·GU^{-1}]	[%]	W_{RK} [%]
1	2	3	4	5	6	7	8	9
Direct	5,557.39	91.10	83.72	19.61	598.14	9.80	83.80	17.96
Target	1,080.29	17.71	16.28	3.81	116.27	1.90	16.20	3.49
Total	6,637.68	108.81	100.00	23.42	714.41	11.70	100.00	21.46
σ_{WRE}				1.91				2.59

Source: author's own study

Results presented in tables and the analysis of variance with Duncan test which was carried out (table 7.5) confirm the rightness of the working hypothesis that the share of the EU funds compensating the energy costs and inputs on the agricultural production depending on the production trend is varied.

Table 7.5. Analysis of variance with Duncan test concerning compensation factors from the European Union means of energy accumulated in a product and costs
Tabela 7.5. Analiza wariancji z testem Duncana odnośnie wskaźników rekompensaty ze środków unijnych energii skumulowanej w produkcie i kosztów

Production trend	Fruit	Vegetable
Fruit	X	*
Vegetable	*	X
Grain	*	*

* significant difference (α=0,05)

Source: author's own study

A compensation index is a percentage interpretation of the EU subvention to the agricultural production. In case of costs, determination of the index is understandable for the authors. Whereas, in case of the accumulated energy consumption, this method gets slightly complicated because a grant is expressed by money measure [PLN] and the energy accumulated in the product by energy units [MJ]. Therefore, in order to obtain energy units, the EU subsidy was calculated into equivalent purchase of the particular amount of DO. Such a methodical solution was accepted because DO is among other carriers, a significant factor in the agricultural production and its changing price may be precisely averaged which cannot be said about other materials or raw materials.

Application of this index in the cost and energy version gives information on what degree the agricultural production is financed from the EU means (direct and target subsidies) and in what degree the energy inputs are compensated depending on the production trend.

Average values of energy (W_{RE}) and cost (W_{RK}) indexes presented graphically (fig. 7.1 and 7.2) reflect a degree of compensation of the energy costs and inputs, differ statistically in all combinations of the research system and at the same time confirm the assumed working hypothesis that the EU subsidies compensate the production costs and the energy inputs per a yield conversion unit not in the same degree.

One-factor analysis of variance was carried out for the assessment of the significance of differences between the average values of indexes W_{RE} and W_{RK} in order to verify the statement that methods of the accumulated energy and the production costs may be interchangeably used to assess the production parameters of agricultural farms (tab. 7.6). Analysis of variance and Duncan test in one case proved a statistically significant difference between the energy index value and the cost index value. This observation concerns the accumulated energy compensation index and the compensation index of the yield cost of the vegetable production trend (table 7.6). *Thus, a statistically significant conclusion can be made, which says that the compared methods may be applied interchangeably in scientific research.*

Table 7.6. Analysis of variance with Duncan test for comparison of the applied methods of assessment of the European Union funds share in agricultural production
Tabela 7.6. Analiza wariancji z testem Duncana dla porównania zastosowanych metod oceny udziału funduszy unijnych w produkcji rolniczej

Production trend	W_{RE} [%] Fruit	W_{RE} [%] Vegetable	W_{RE} [%] Grain
Orchard W_{RK}	X	X	X
Vegetable W_{RK}	X	*	X
Grain W_{RK}	X	X	X

** - significant difference (α=0.05)*

Source: author's own research

It seems that a high number of plants of completely different botanical features, different cultivation and crop technologies and also of the varied amount of the actual yield (from few dozens dt to few hundred dt from one hectare) is a factor that could influence the lack of significance of differences in case of the vegetable production trend. This huge number of data processed with the method of calculating the weighted average could influence the obtained averaged values for W_{RE} and W_{RK}.

Graphic interpretation of the average values of the results of the analysis of variance for the cost and energy index of the compensation of the EU subsidy for the unit calculation yields of the researched production trends were presented in figures 7.1 and 7.2.

The values presented in the figures explicitly confirm that the grain production farms are privileged in the EU grants and – as it was found earlier – compensation from the EU funds in 23.42% for W_{RE} and 21.46% for W_{RK} covers the production costs. The situation in case of the vegetable production is quite advantageous, where W_{RK} amounts to 10.06% and W_{RE} – 13.06%. Situation for fruit farmers is the least advantageous. These indexes reach only approximaly 6% for them.

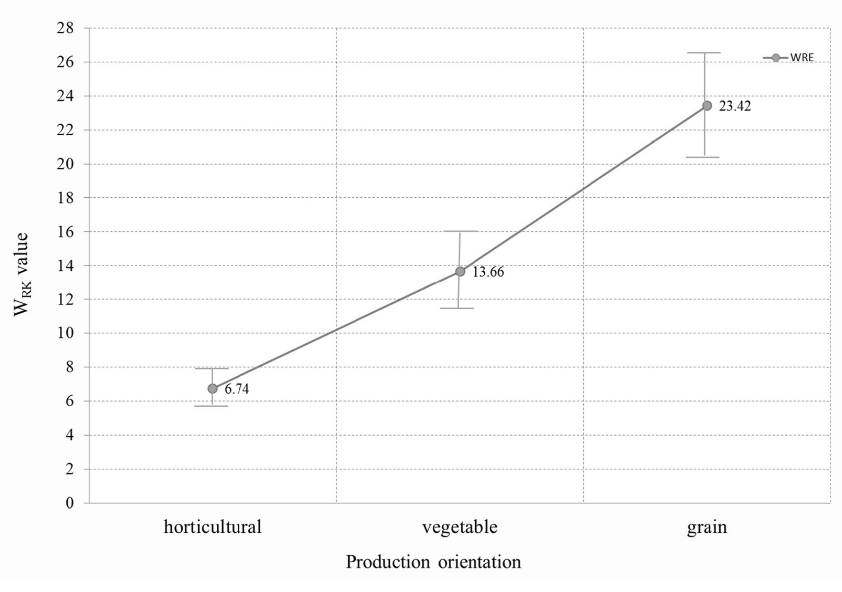

Fig. 7.1. Graphic interpretation of the results of analysis of variance for the cost coefficient of compensation W_{RK}
Rys. 7.1. Interpretacja graficzna wyników analizy wariancji dla kosztowego współczynnika rekompensaty W_{RK}

Source: author's own study

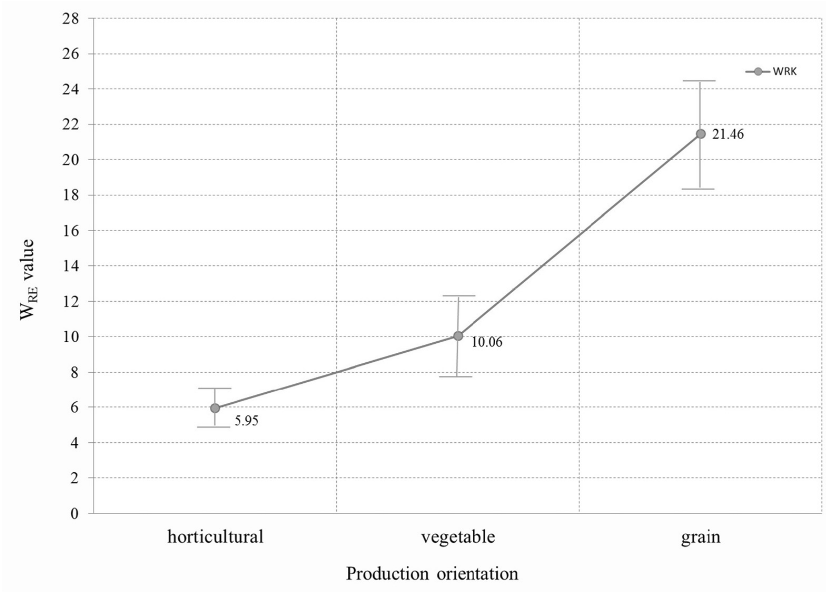

Fig. 7.2. Graphic interpretation of the results of analysis of variance for the energy coefficient of compensation W_{RE}
Rys. 7.2. Interpretacja graficzna wyników analizy wariancji dla energetycznego współczynnika rekompensaty W_{RE}

Source: author's own study

Figures 7.3, 7.4, 7.5 and 7.6 present compensation indexes of the energy costs and inputs from the EU means on the production of particular plants cultivated in the researched vegetable and grain farms. The analysis does not concern orchard farms, where mono-culture of the apple tree variety exists. Clearly significant differences occur for W_{RK} of the vegetable trend. For the grain trend, significant differences of the average values for W_{RK} of sugar beetroot and the remaining ten plants occurred. A similar observation was made for the index W_{RE}.

Values of coefficients W_{RK} and W_{RE} for plants in the crop rotation in the vegetable production farms are varied (figure 7.3. and 7.4). In this case, sugar beetroot is characterised by high compensation coefficients amounting to 37% and grain - within 19% for maize to 28% of spring wheat. In case of sugar beetroot, high sugar subsidy influenced the high index, while in case of grain – low cost end energy inputs on production and relatively low yield.

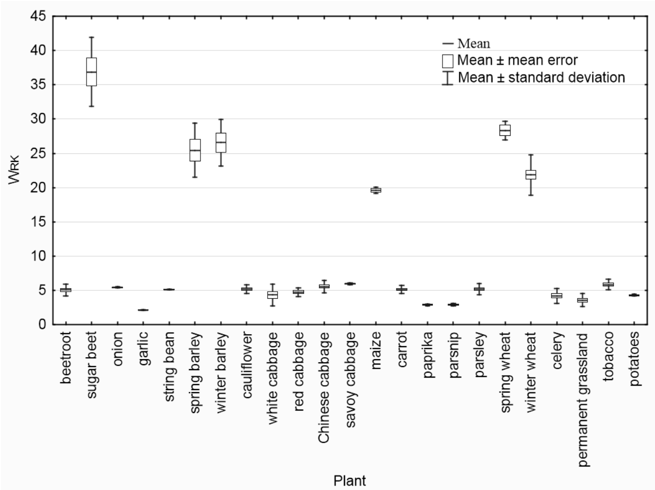

Fig. 7.3. Description of the cost coefficient of the European Union funds W_{RK} for the crops production in vegetable farms
Rys. 7.3. Charakterystyka kosztowego współczynnika dopłat unijnych W_{RK} do produkcji upraw w gospodarstwach warzywniczych

Source: author's own study

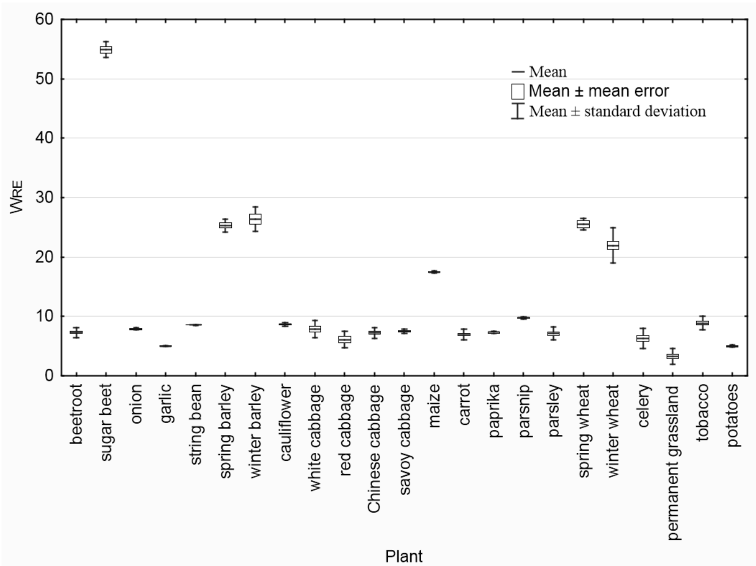

Fig. 7.4. Description of the energy coefficient of the European Union funds W_{RE} for crops production in vegetable farms
Rys. 7.4. Charakterystyka energetycznego współczynnika dopłat unijnych W_{RE} do produkcji upraw w gospodarstwach warzywniczych

Source: author's own study

It was noticed that the average values of the standard error and the average values of standard deviation are lower in case of coefficient W_{RE} than in case of coefficient W_{RK}. Increased distribution of the average values in case of the cost coefficient, especially in the grains production (which also occurred in vegetable farms) could have been caused by varied costs of combine harvesting of grains. As it was mentioned above, grains cultivation was carried out here from services, the prices of which are not the same and differ on account of a service provider. In the grain production trend farms, grain harvesting was carried out with own combines and here the average dispersion values are low. In this case the energy method seems to be more precise in comparison to the cost method.

In the production of the vegetable trend farm, the results presented in figures 7.5 and 7.6 are confirmed considerably and picture and characterize subject indexes for the grain production trend.

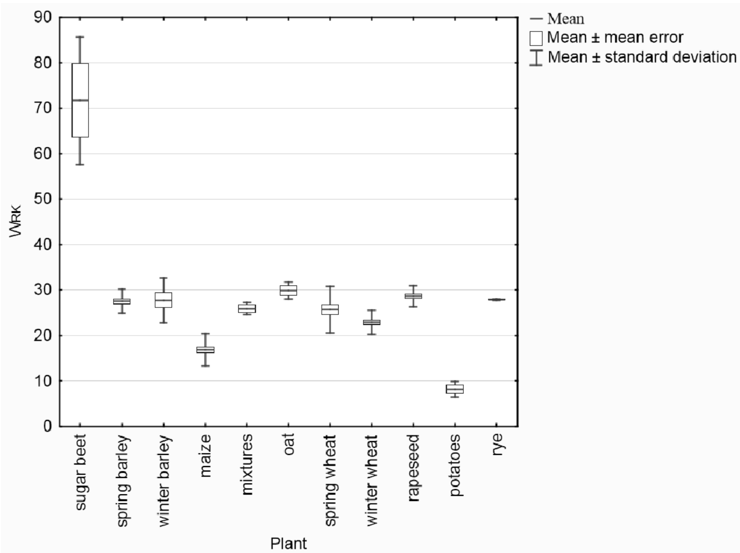

Fig. 7.5. Description of the cost coefficient of the European Union funds W_{RK} for the crops production in grain farms

Rys. 7.5. Charakterystyka kosztowego współczynnika dopłat unijnych W_{RK} do produkcji upraw w gospodarstwach zbożowych

Source: author's own study

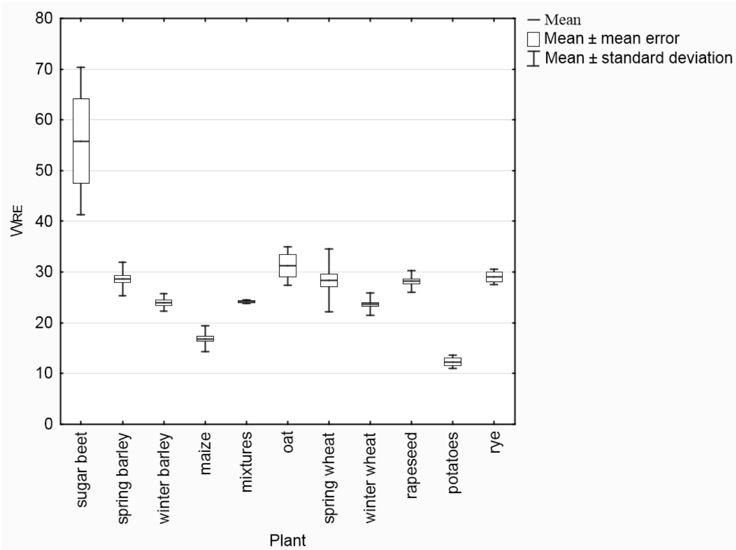

Fig. 7.6. Description of the energy coefficient of the European Union funds W_{RE} for the crops production in grain farms
Rys. 7.6. Charakterystyka energetycznego współczynnika dopłat unijnych W_{RE} do produkcji upraw w gospodarstwach zbożowych

Source: author's own study

When analysing numerical data included in these figures, one should state that in case of the grain trend high values of W_{RK} and W_{RE} indexes were reported. In case of sugar beetroot the value of W_{RK} amounts to approx. 72% and W_{RE} – 56%. The lowest values of W_{RK} and W_{RE} were reported in case of potato production (respectively 9 and 11%). Values lower than the average researched feature were also reported in maize cultivation - 18%.

8. MUTUAL INFLUENCE OF THE SELECTED FACTORS AND THE PRODUCTION EFFECTS - DESCRIBED WITH A CORRELATION AND REGRESSION CALCULATION

8.1. Correlations

For the analysis of mutual influences in the initial stage, 15 categories of data were accepted. For clarity, verbal analysis of correlation was carried out only for 10 the most important selected features. It was: area [ha], aggregates operation [PLN·ha^{-1}], inputs of live labour [PLN·ha^{-1}], total costs [PLN·ha^{-1}], revenue [PLN·ha^{-1}], agricultural income [PLN·ha^{-1}], W_{RK} [%], live labour input [MJ·ha^{-1}], energy input [MJ·ha^{-1}] and W_{RE}[%].

Matrixes for particular production trends were placed in tables 8.1, 8.2 and 8.3.

Simultaneously, it should be emphasised that the matrix with fifteen fraction variables was subjected to full assessment of the correlation account. The obtained results of correlation from and between the remaining factors may constitute additional source of information and were presented in the annex (annex 1).

Coefficients of correlation between the researched properties presented in table 8.1 for facilities of the orchard trend prove that the selection of properties for the analysis of correlation was proper since out of 45 calculated coefficients of correlation the dependence proved to be insignificant only for five. These were the searched solutions between live labour costs, agricultural revenue and income and the operation costs of aggregates. In this place, searching for correlation relations in the research assumptions was thus logically justified. However, it turned out that other factors (variables) more intensely influenced every above explanatory property. Insignificant correlation relations occurred also in searching for relations between the agricultural income and energy inputs and the total costs. Considering high variability of economic, environmental and socio-demographic conditions of the researched farms, the obtained coefficients of correlation should be found high. It gives an opportunity to lay out trends of mutual relations in the form of line regressions.

Table. 8.1. Coefficients of correlation between the selected features and components of the costs and energy consumption balance accumulated in fruit farms
Tabela 8.1. Współczynniki korelacji pomiędzy wybranymi cechami oraz składnikami bilansu kosztów i energochłonności skumulowanej w gospodarstwach o kierunku sadowniczym

Specification	Area [ha]	Operation of aggregates [PLN·ha^{-1}]	Live labour input [PLN·ha^{-1}]	Total costs [PLN·ha^{-1}]	Agricultural revenue [PLN·ha^{-1}]	Agricultural income [PLN·ha^{-1}]	W_{RK}[%]	Live labour input [MJ·ha^{-1}]	Energy input [MJ·ha^{-1}]	W_{RE}[%]
Area [ha]	XXX	-	-	-	-	-	-	-	-	-
Operation of aggregates [PLN·ha^{-1}]	-0.65*	XXX	-	-	-	-	-	-	-	-
Live labour input [PLN·ha^{-1}]	-0.61*	0.24	XXX	-	-	-	-	-	-	-
Total costs [PLN·ha^{-1}]	-0.68*	0.67*	0.68*	XXX	-	-	-	-	-	-
Agricultural income [PLN·ha^{-1}]	-0.64*	0.12	0.81*	0.53*	XXX	-	-	-	-	-
Agricultural income [PLN·ha^{-1}]	-0.40*	-0.21	0.59*	0.10	0.90*	XXX	-	-	-	-
W_{RK}[%]	0.74*	-0.45*	-0.66*	-0.83*	-0.70*	-0.39*	XXX	-	-	-
Live labour input [MJ·ha^{-1}]	-0.61*	0.24*	1.00*	0.68*	0.81*	0.59*	-0.66*	XXX	-	-
Energy input [MJ·ha^{-1}]	-0.86*	0.73*	0.70*	0.80*	0.64*	0.34	-0.71*	0.70*	XXX	-
W_{RE} [%]	0.84*	-0.48*	-0.66*	-0.75*	-0.76*	-0.50*	0.96*	-0.66*	-0.81*	XXX

*- significant coefficient of correlation (α=0.05)

Source: author's own study

When assessing correlation relations between the area of arable land of the researched farms and the remaining factors a basic regularity is reported. Namely, along with the increase of the area values of all remaining factors decrease - all coefficients are negative. Both coefficients of both cost (W_{RK}) as well as energy (W_{RE}) compensation constitute an exception. These coefficients correlate positively with the area while negatively with the remaining factors. From the point of view of utility, the increase of the orchard area in the researched farms was strictly related to the decrease of the inputs amount and economic effects calculated into the area unit. *Thus, the increase of the fruit production intensity along with the decreasing area of orchard occurs. As a result of levelling differences of the farmer's income from the whole farm- smaller farms are economically forced to intensify the production. And it* *gives a possibility to obtain incomes from the farm on the level similar to the incomes obtained from bigger facilities.*

A vegetable production trend gives similar trends of correlation relations between the researched features to the previous one. Moreover, a correlation coefficient is reported on the similarly high level (tab. 8.2).

Table. 8.2. Coefficients of correlation between the selected features and components of the costs and energy consumption balance accumulated in vegetable farms
Tabela 8.2. Współczynniki korelacji pomiędzy wybranymi cechami oraz składnikami bilansu kosztów i energochłonności skumulowanej w gospodarstwach o kierunku warzywniczym

Specification	Area [ha]	Operation of aggregates [PLN·ha^{-1}]	Live labour input [PLN·ha^{-1}]	Total costs [PLN·ha^{-1}]	Agricultural revenue [PLN·ha^{-1}]	Agricultural income [PLN·ha^{-1}]	W_{RK}[%]	Live labour input [MJ·ha^{-1}]	Energy input [MJ·ha^{-1}]	W_{RE}[%]
Area [ha]	XXX	-	-	-	-	-	-	-	-	-
Operation of aggregates [PLN·ha^{-1}]	-0.65*	XXX	-	-	-	-	-	-	-	-
Live labour input [PLN·ha^{-1}]	-0.69*	0.69*	XXX	-	-	-	-	-	-	-
Total costs [PLN·ha^{-1}]	-0.76*	0.77*	0.93*	XXX	-	-	-	-	-	-
Agricultural revenue [PLN·ha^{-1}]	-0.61*	0.41*	0.87*	0.77*	XXX	-	-	-	-	-
Agricultural in-come [PLN·ha^{-1}]	-0.50*	0.25	0.77*	0.62*	0.98*	XXX	-	-	-	-
W_{RK}[%]	0.87*	-0.68*	-0.84*	-0.87*	-0.82*	-0.72*	XXX	-	-	-
Live labour input [MJ·ha^{-1}]	-0.69*	0.69*	1.00*	0.93*	0.87*	0.77*	-0.84*	XXX	-	-
Energy input [MJ·ha^{-1}]	-0.86*	0.87*	0.88*	0.90*	0.67*	0.53*	-0.85*	0.88*	XXX	-
W_{RE}[%]	0.92*	-0.64*	-0.75*	-0.78*	-0.71*	-0.62*	0.97*	-0.75*	-0.84*	XXX

*- significant coefficient of correlation (α=0.05)

Source: author's own study

Thus, conclusion is identical in the verbal analysis as in the previous production trend. However, the fact that the agricultural income insignificantly correlates here with the operation costs of the aggregate should be emphasised. Thus, on this account, vegetable farms prove more significant relations of economic indexes in comparison to orchard farms.

Table. 8.3. Coefficients of correlation between the selected features and components of the costs and energy consumption balance accumulated in vegetable farms
Tabela 8.3. Współczynniki korelacji pomiędzy wybranymi cechami oraz składnikami bilansu kosztów i energochłonności skumulowanej w gospodarstwach o kierunku zbożowym

Specification	Area [ha]	Operation of aggregates [PLN·ha^{-1}]	Live labour input [PLN·ha^{-1}]	Total costs [PLN·ha^{-1}]	Agricultural revenue [PLN·ha^{-1}]	Agricultural income [PLN·ha^{-1}]	W_{RK}[%]	Live labour input [MJ·ha^{-1}]	Energy input [MJ·ha^{-1}]	W_{RE}[%]
Area [ha]	XXX	-	-	-	-	-	-	-	-	-
Operation of aggregates [PLN·ha^{-1}]	-0.55*	XXX	-	-	-	-	-	-	-	-
Live labour input [PLN·ha^{-1}]	-0.45*	0.68*	XXX	-	-	-	-	-	-	-
Total costs [PLN·ha^{-1}]	-0.37*	0.92*	0.82*	XXX	-	-	-	-	-	-
Agricultural revenue [PLN·ha^{-1}]	0.06	0.42*	0.43*	0.56*	XXX	-	-	-	-	-
Agricultural income [PLN·ha^{-1}]	0.18	-0.04	0.26	0.11	0.82	XXX	-	-	-	-
W_{RK}[%]	-0.22	0.14	0.66*	0.25	0.12	0.38*	XXX	-	-	-
Live labour input [MJ·ha^{-1}]	-0.45*	0.68*	1.00*	0.82*	0.43*	0.26*	0.66*	XXX	-	-
Energy input [MJ·ha^{-1}]	-0.43*	0.63*	0.95*	0.78*	0.50*	0.39*	0.70*	0.95*	XXX	-
W_{RE}[%]	-0.01	-0.08	0.38*	-0.01	-0.12	0.17	0.85*	0.38*	0.31*	XXX

*- significant coefficient of correlation (α=0.05)

Source: author's own study

Situation of correlation relations of the subject factors in case of farms of the grain production trend is slightly different. Here, one may observe considerably weaker correlation relations between them (table 8.3). Simultaneously, considerably higher number of insignificant coefficients occurred. They constitute one third of all variants of the hypothetically assumed relations.

Lack of significant correlation relations of the final assumed economical effect - that is the agricultural income - with the majority of the remaining nine factors - should be emphasised. Significant but weak correlation relations occurred only in case of W_{RK} (r=0.38), live labour inputs in MJ (r=0.26) and energy inputs in MJ (r=0.39).

From among significant relations high positive coefficients of correlation between the following should be emphasised:

– the production costs (PLN) and operation costs of the aggregate (PLN) (r= 0.92), live labour inputs in PLN (r=0.82) and energy inputs in MJ (r=0.78),
– costs summation (PLN) and energy inputs summation in MJ (r=0.78),
– energy inputs (MJ) and live labour inputs (r=0.95), the total costs in PLN (r=0.78) and the operation costs of mechanisation means in PLN (r=0.63).

The above correlation relations are logical and do not require special interpretation. *However, a positive coefficient between operation costs of the mechanisation means and live labour inputs calculated both in PLN and MJ must raise some doubts (table 8.3). In this case it seems that there is no substitution of the live labour with the objectified labour – calculated by amount and by energy. The only explanation of the above should be a very low work consumption of production of these farms on one hand, and irrational growth of the value of the purchased agricultural equipment with the increase of the AL area on the other hand. As a result, a significant growth of value and exploitation values of modern agricultural equipment was obtained at the decreasing efficiency of its use*. Simultaneously, employment reduction, which is low, does not go hand in hand with the above. The growth of targeted subsidies for a farm in this production trend along with the increase of the area significantly influences this situation.

Moreover, attention is also paid to very similar or equal amounts of coefficients of correlation between factors of the same category but at different measure units (PLN; MJ). High coefficients of correlation in these cases confirm the thesis, which was explained in the previous sub-sections, on possibilities of interchangeability (depending on needs) of the cost research method with the method of the accumulated energy consumption.

8.2. Regressions

The obtained results presented in the previous sub-section prove high correlation relations expressed with both strength of these relations (high indexes) as well as the number of significant correlations. Regression relations of the researched factors in the orchard production were presented graphically in figures 8.1 and 8.2.

As it was mentioned before, out of fifteen compared factors, 10 the most significant from the substantial point of view were selected for analysis. Statistical analysis in this sub-section will be carried out for every trend separately according to the order of the generally assumed work: orchard, vegetable and grain.

Very significant correlation relations of the arable land area with the remaining factors for orchard farm explicitly indicate trends of changes of predictors.

The farm area along with the increase of the area of orchards results in the decrease of:

– ***operation costs of agriculture mechanisation means from 5,262 PLN·ha^{-1} in smaller farms (absolute term) along with the increase of the orchard area of 1 ha, the decrease of costs amounts to approx. PLN 230 - for the coefficient of determination r^2=0.42, (fig. 8.1),***
– ***live labour costs - from 5,800 PLN·ha^{-1} in the smallest farms, increase of the area by 1 ha gives the decrease of costs by PLN 149 – r^2=0.37 (fig. 8.2),***
– ***total production costs - from 14,876 PLN·ha^{-1} in the smallest farms along with the increase of the area by 1 ha, their value decreases by PLN 336 r^2=0.47 (fig. 8.3),***
– ***live labour inputs in MJ·ha^{-1}– from approx. 24,000 MJ·ha^{-1}, along with the increase of the area by 1 ha, the input gets lower by 627 MJ for r^2=0.37 (fig. 8.4),***
– ***total inputs of the accumulated energy calculated into cultivation of 1 ha of orchards from 67,695 MJ in the smallest facilities, along with the increase of the area per one hectare inputs decrease by approx. 5,026 MJ (fig. 8.5)***

The trends presented below and statistically confirmed prove significant relations of the growth of the orchards area in farms with the improvement of economic and energy indexes. ***Regression equations obtained from the calculations indicate what positive economic or energy effects fruit farmers can expect when increasing the orchard area. Relatively high coefficients of determination, proving high probability (as for such type of research) of realization of the assumed aim at taking up decisions, should be emphasised.***

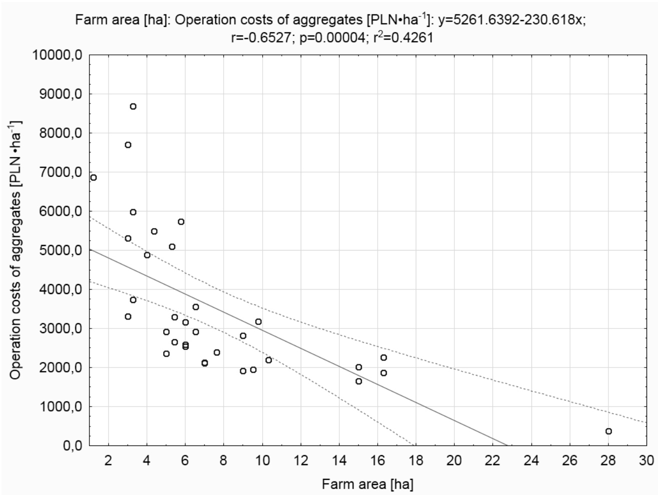

Fig. 8.1. Impact of the fruit farm area on the operation costs
of the agriculture mechanisation means
Rys. 8.1. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym
na koszt pracy środków mechanizacji rolnictwa

Source: author's own study

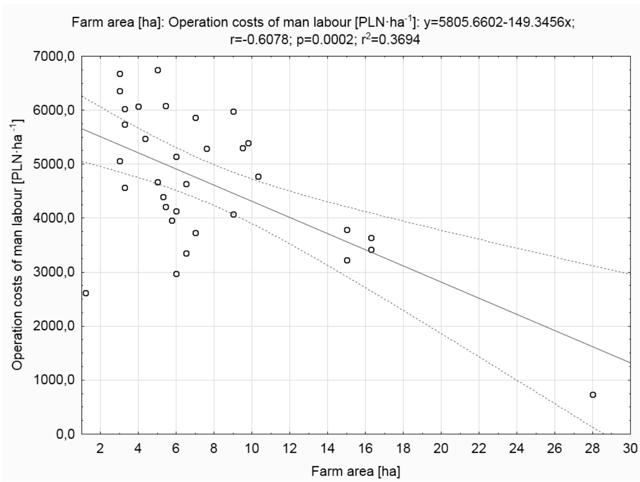

Fig. 8.2. Impact of the fruit farm area on the live labour costs
Rys. 8.2. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym
na koszt pracy żywej

Source: author's own study

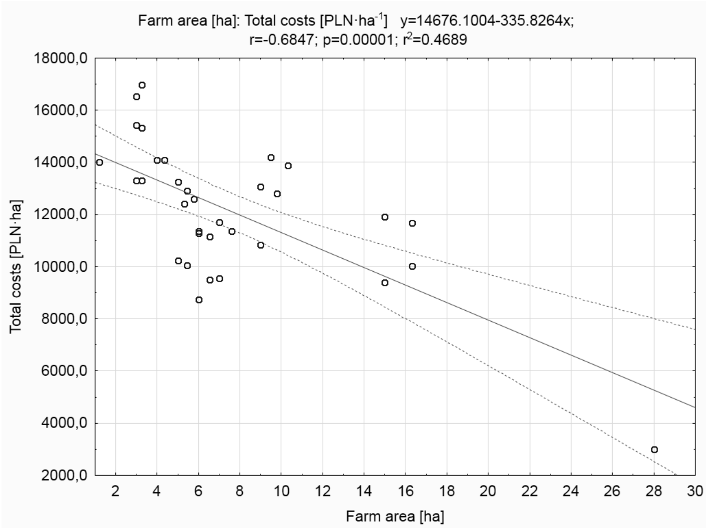

Fig. 8.3. Impact of the fruit farm area on the total production costs
Rys. 8.3. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym na koszty produkcji ogółem

Source: author's own study

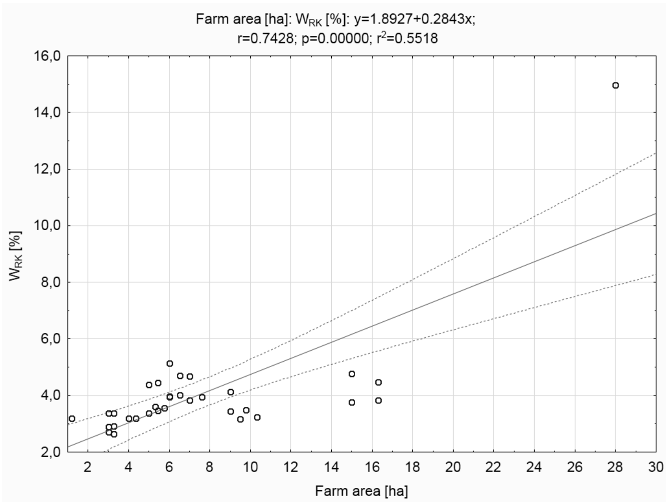

Fig. 8.4. Impact of the fruit farm area on W_{RK}
Rys. 8.4. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym na W_{RK}

Source: author's own study

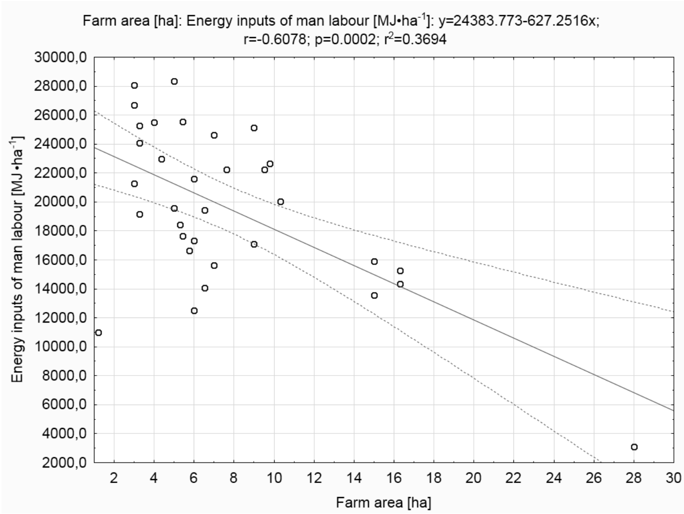

Fig. 8.5. Impact of the fruit farm area on the energy input of live labour
Rys. 8.5. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym na nakład energetyczny pracy żywej

Source: author's own study

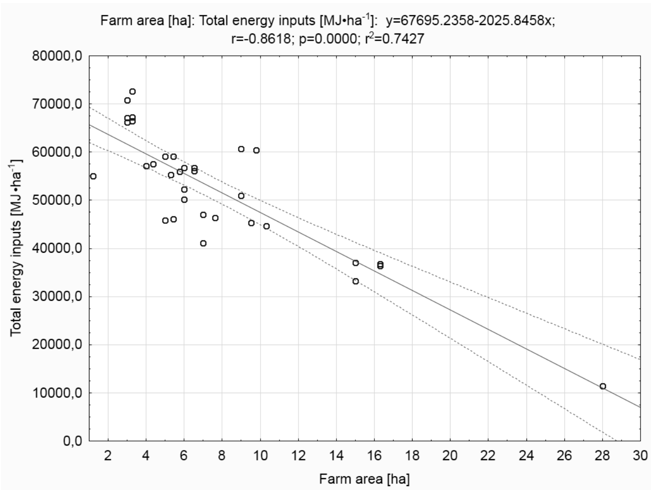

Fig. 8.6. Impact of the fruit farm area on the accumulated energy input
Rys. 8.6. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym na nakład energii skumulowanej

Source: author's own study

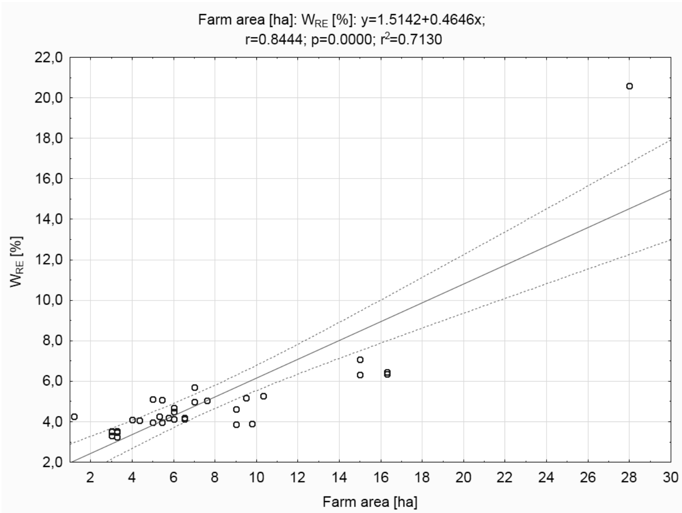

Fig. 8.7. Impact of the fruit farm area on W_{RE} index
Rys. 8.7. Wpływ powierzchni gospodarstwa o kierunku produkcji sadowniczym na wskaźnik W_{RE}

Source: author's own study

Plots and regression equations presented in figures 8.4 and 8.7 and illustrating relations of also orchard areas with indexes of compensation of the EU subsidies have rather informative character. Since, they prove that along with the increase of the orchard area in a farm, a percentage input of the EU subsidies clearly increases. Along with the increase of the area by 1 ha it increases by 0.2843% for W_{RK} and by 0.4648% for W_{RE}. Thus, one may assume that big fruit farms use the EU compensations and subsidies to a higher extent. Along with the decrease of the area, subsidies for a farm are clearly decreased. It is especially visible in case of W_{RE}. Influence of agricultural aggregates operation on the selected factors at significant correlation relations were presented in figures 8.8 to 8.11.

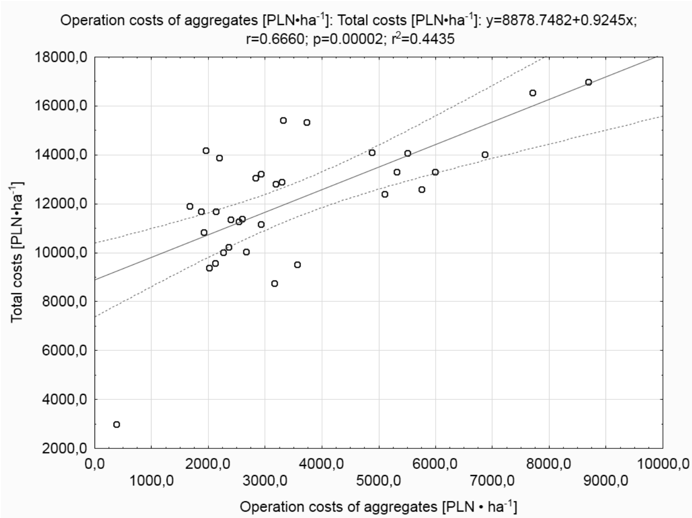

Fig. 8.8. Impact of the operation costs of the agriculture mechanisation means on the total costs in fruit farms

Rys. 8.8. Wpływ kosztów pracy środków mechanizacji rolnictwa na koszty ogółem w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

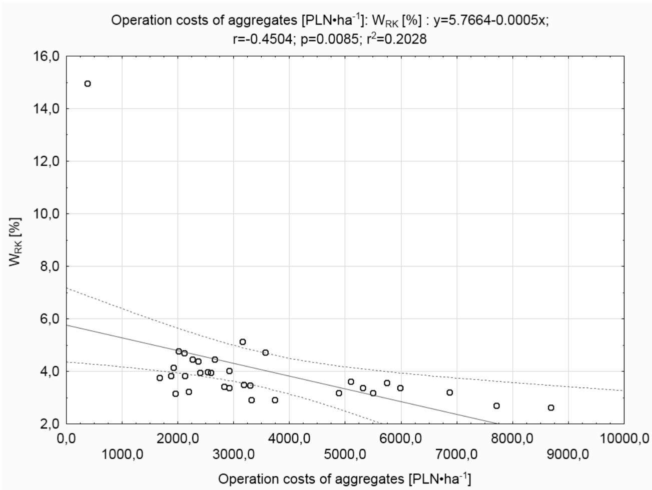

Fig. 8.9. Impact of the operation costs of the agriculture mechanisation means on W_{RK} index in fruit farms

Rys. 8.9. Wpływ kosztów pracy środków mechanizacji rolnictwa na wskaźnik W_{RK} w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

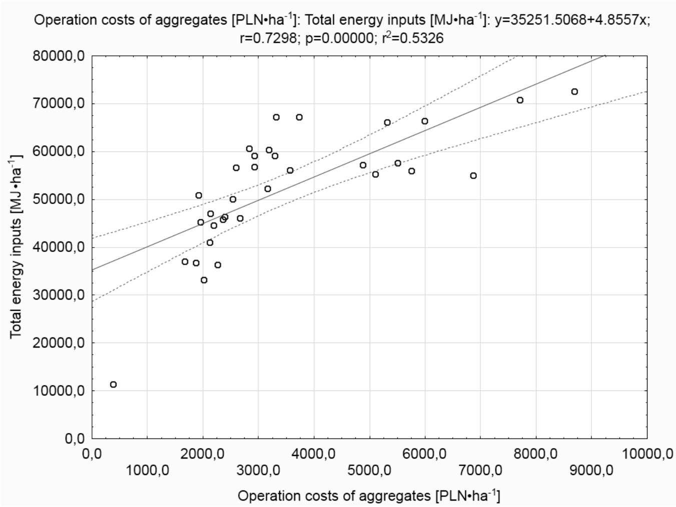

Fig. 8.10. Impact of the operation costs of the agriculture mechanisation means on the accumulated energy input in fruit farms
Rys. 8.10. Wpływ kosztów pracy środków mechanizacji rolnictwa na nakład energii skumulowanej w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

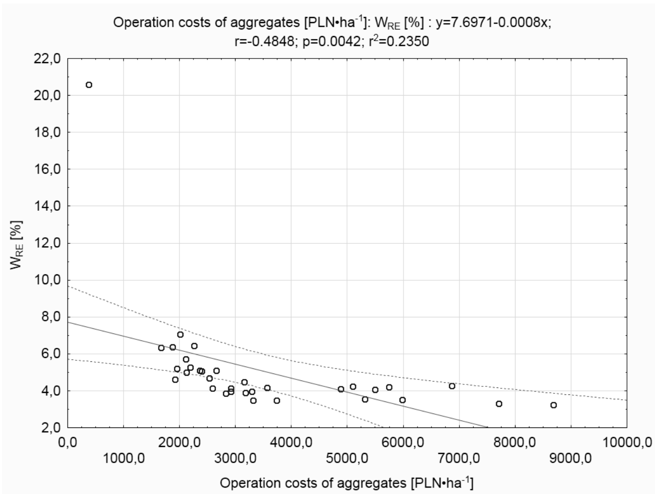

Fig. 8.11. Impact of the operation costs of the agriculture mechanisation means on W_{RE} index in fruit farms
Rys. 8.11. Wpływ kosztów pracy środków mechanizacji rolnictwa na wskaźnik W_{RE} w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

According to the data included in pictures, the operation costs of agricultural mechanisation means:

- ***Have a considerable and significant impact on the total production costs in a farm. The minimum values of the aggregates operation costs - below one thousand PLN are related to the total costs on the level of approx. 9 thousand PLN. The increase of these costs of every one PLN increases the total costs by PLN 0.9245 r^2=0.44 (fig. 8.8),***
- ***Similar trends may be noticed in case of mutual relations with energy inputs. Here, the increase of costs within 1,000 to 9,000 PLN·ha^{-1} gives the increase of inputs within 35,000 MJ·ha^{-1} to 80,000 MJ·ha^{-1}. Coefficient of determination in this case is high and amounts to 0.53 (fig. 8.10),***
- ***They prove significant but low degree of the negative impact of the operation costs of aggregates on the indexes W_{RK} and W_{RE}. Along with the increase of the operation costs of machine aggregates, subject indexes decrease slightly.***

Results of the research concerning correlation and regression relations between live labour costs and the total costs and the agricultural income seem to be significant from the substantial point of view. The above relations include data included in figures 8.12 and 8.13.

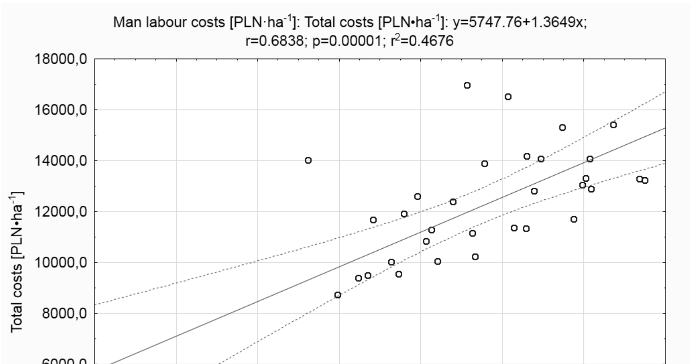

Fig. 8.12. Impact of costs of the live labour on the total costs in fruit farms
Rys. 8.12. Wpływ kosztów pracy żywej na koszty ogółem w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

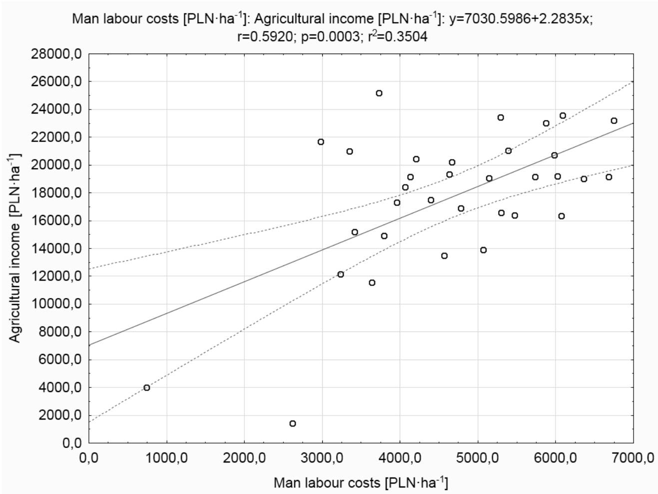

Fig. 8.13. Impact of costs of the live labour on the agricultural income in fruit farms
Fig. 8.13. Wpływ kosztów pracy żywej na dochód rolniczy w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

When analysing data presented in these figures, it should be determined that the mutual positive relations between categories of both types of costs (fig. 8.12) prove a considerable impact of labour costs on the total costs thus on the final results of farming. According to the data presented in the data figures, the increase of costs of human labour up to 7 thousand PLN·ha^{-1} results in the increase of the total costs of production from approx. 6 thousand PLN·ha^{-1} to approx. 14 thousand PLN·ha^{-1}. High coefficient r^2=0.49 should also be emphasised here.

It should be assumed from the above that the human labour costs considerably influence the total costs of fruit production.

Numerical data included in figure 8.13 confirm the considerable influence of the live labour costs on the final effect of farming. They picture relations between labour costs (PLN·ha^{-1}) They prove that the increase of labour costs by PLN 1 per one hectare results in the increase of the agricultural income by as much as 2.2835 PLN·ha^{-1}. Simultaneously, the increase of the unit costs of human labour from approx. 1000 PLN·ha^{-1} to up to approx. 7 thousand PLN·ha^{-1} results in the increase of the agricultural income calculated into one hectare of an orchard within approx. PLN 8 thousand to approx. PLN 22 thousand.

The above numerical data confirm explicitly the conclusion that the increase of the intensity of farming, measured with the units of labour inputs give an opportunity for a farmer (a fruit producer) of effective and parity farming in case of the fragmented agrarian structure of farms. Numerical data presented in figure 8.14 describing relations between the amount of the total production costs referred to one hectare and the total accumulated energy inputs in the investigated facilities include relations mentioned in the previous chapters in the form of a mathematical formula. As it results from the regression equation the increase of costs by 1 PLN·ha^{-1} gives the increase of the energy inputs per this hectare by 3.8387 MJ. Very high coefficient of determination (r^2=0.64) proves the significance of the above relation.

Regression relations concerning mutual relations between the selected factors for the group of vegetable farms were included in figures 8.16 to 8.18. Out of many significant correlation relations placed in table 8.2 for the verbal analysis, only those which are described by a relatively high coefficient of relation were selected. And only those substantially significant from the point of view of the assumed research purposes were analysed.

Similarly, as in case of the analysis related to the fruit production trend, for vegetable facilities, the area of arable land proves to be one of the most important factors deciding on the efficiency of farming.

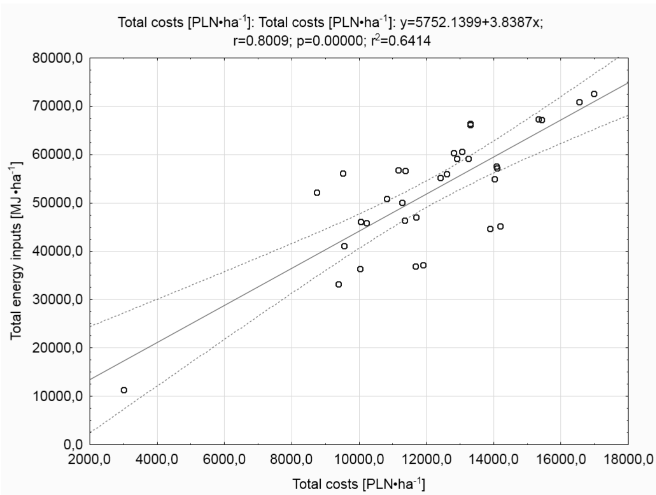

Fig. 8.14. Impact of the total costs on the accumulated energy input in fruit farms
Rys. 8.14. Wpływ kosztów ogółem na nakład energii skumulowanej w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

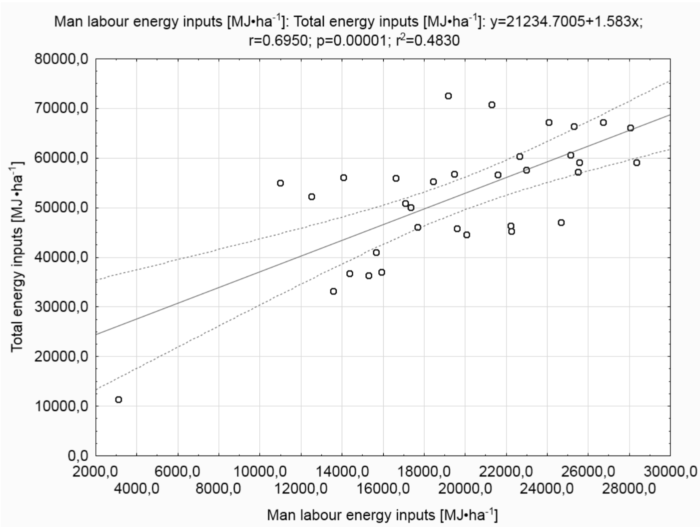

Fig. 8.15. Impact of the size of the live labour energy stream on the accumulated energy input in fruit farms
Rys. 8.15. Wpływ wielkości strumienia energii pracy żywej na nakład energii skumulowanej w gospodarstwach o kierunku produkcji sadowniczym

Source: author's own study

Taking this factor into consideration, significant correlation relations with all the remaining factors accepted for the analysis with the correlation account were reported (correlation matrix table 8.2).

The equations prove that in vegetable farms:

- ***The unit operation cost of agricultural aggregates intensively decreases its value along with the increase of the AL area. In the analysed area scope of farms, its value decreases within from approx. 3,200 PLN·ha^{-1} up to approx. 1,200 PLN·ha^{-1}. The increase of the AL area by 1 ha causes the decrease of costs by approx. 46 PLN·ha^{-1}. These relations were confirmed at the level of significance 0.0001 and the coefficient of determination equal to r=0.50 (fig. 8.16),***
- ***A similar significance and the coefficient of correlation may be reported by assessing regression relations of the area with the human labour costs (p=0.0001; r^2=0.58). In this case, unit live labour inputs are within the range from approx. 3,700 PLN·ha^{-1} for facilities of the area of approx. 5 ha up to approx. 1,200 PLN in facilities above 50 ha of AL. The increase of the area by 1 ha should result in the decrease of labour costs per one hectare by approx. PLN 60 (fig. 8.17),***

– ***Predictors presented above significantly influenced the total costs of production. Equation and regression plot is the result (fig. 8.18). The results show that also in this case at the significance level p=0.0001 and r^2=0.62 the correctness of concluding is highly probable. The total costs per 1 ha of AL according to the presented regression equations along with the increase of the area by approx. PLN 162. A wide spectrum of differences of these costs between the biggest farms and the smallest should be emphasized here - it is within the range from approx. PLN 4.5 thousand for the biggest and to approx. PLN 12 thousand for the smallest (fig. 8.18).***

The production costs, except for revenues are the main component of the agricultural income and at the same time influencing its amount. Data included in figure 8.19 present the relations between the amount of this income and the area of a vegetable farm. Also here, the level of significance is high p=0.0005. Whereas, the coefficient of determination is slightly lower (r^2=0.36). However, one should bear in mind that the coefficient of relation is 0.60. And such a coefficient in economic research should be considered high.

As it results from the regression equation and plot, the highest incomes will probably occur in small facilities - up to approx. PLN 20 thousand. Along with the increase of the area by approx. 1 unit ha - the agricultural income decreases its value by approx. 370 PLN·ha^{-1}. In case of the facilities of the biggest areas, they prove 4 times lower index amounting to approx. PLN 5 thousand PLN·ha^{-1} (fig. 8.19).

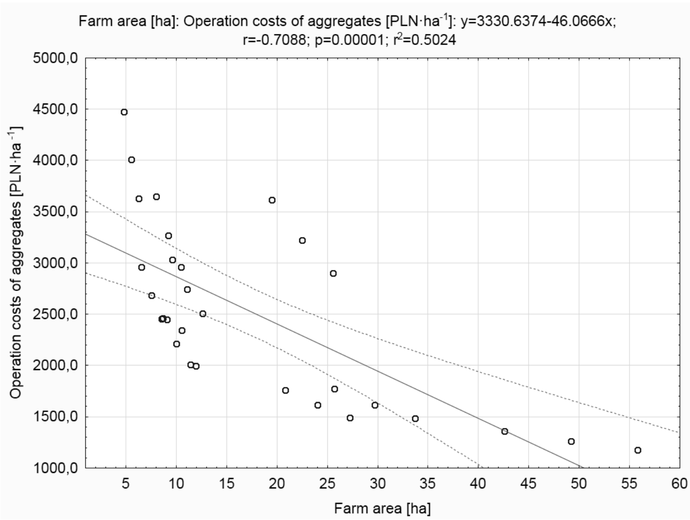

Fig. 8.16. Impact of the vegetable farm area on the operation costs of agriculture mechanisation means

Rys. 8.16. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na koszt pracy środków mechanizacji rolnictwa

Source: author's own study

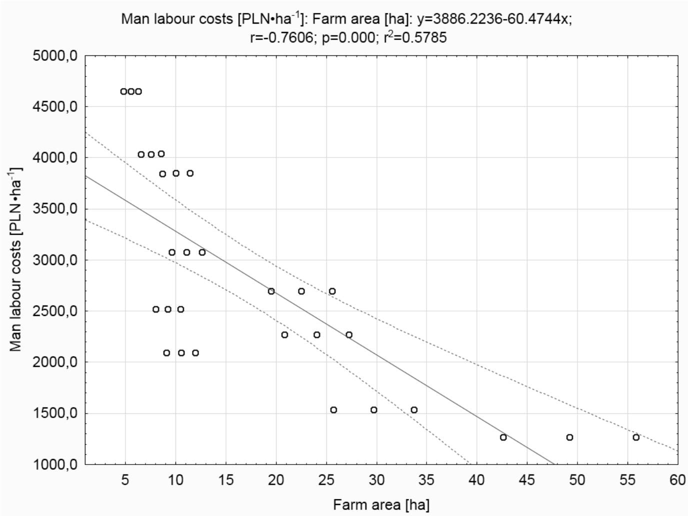

Fig. 8.17. Impact of the vegetable farm area on the live labour costs
Rys. 8.17. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na koszt pracy żywej

Source: author's own study

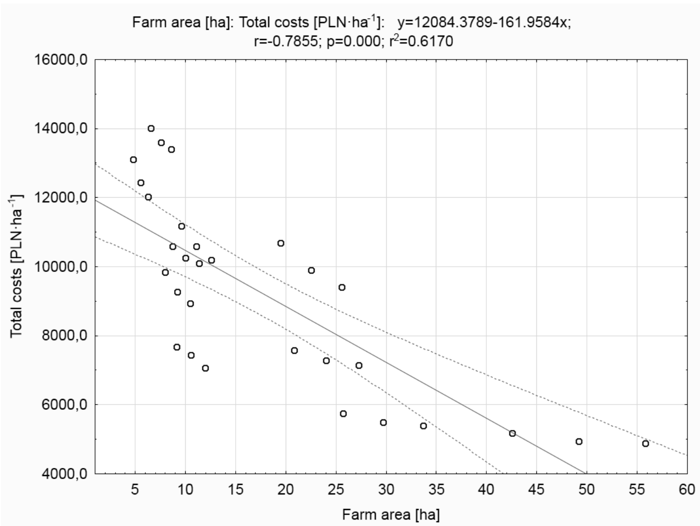

Fig. 8.18. Impact of the vegetable farm area on total costs
Rys. 8.18. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na koszty ogółem

Source: author's own study

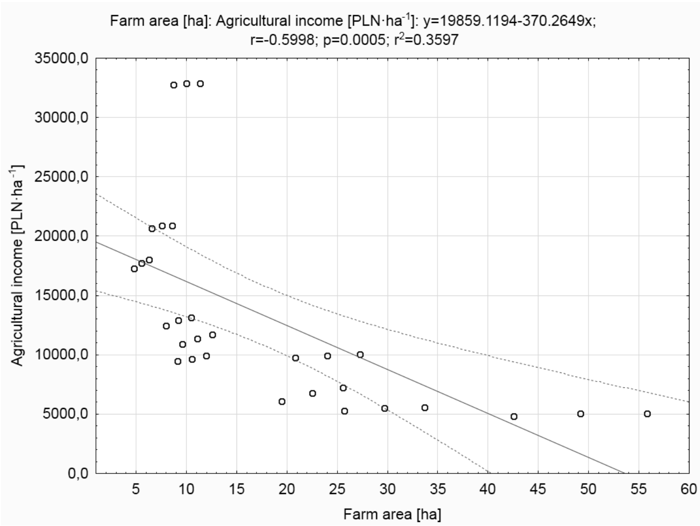

Fig. 8.19. Impact of the vegetable farm area on the agricultural income
Rys. 8.19. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na dochód rolniczy

Source: author's own study

Data concerning mutual relations between the area of a farm and the EU compensation indexes presented in figure 8.20 and 8.23 prove that farms of the vegetable production trend similarly as in case of fruit farms obtain the increasing indexes along with the increase of the area proportionally to its area. High level of significance and coefficients of determinations should be especially emphasised (fig. 8.20 and 8.23).

The remaining relations: between the area of a farm and the size of live labour inputs expressed in MJ·ha^{-1} and the total accumulated energy inputs are included in the data presented in figures 8.21 and 8.22. When analysing them, similar conclusions as in previous cases can be drawn (except for W_{RK} and W_{RE}).

They can be generalized in the following way:

– ***the increase of the area significantly and considerably (expressed with multiplicities) decreases the amount of energy inputs,***
– ***unit live labour inputs are within the range from approx. 5 thousand MJ·ha^{-1} in the biggest facilities to approx. 15 thousand MJ·ha^{-1} (according to the regression equation) in the smallest facilities (fig. 8.21),***
– ***total accumulated energy inputs are within the range from approx. 20 thousand MJ·ha^{-1} to approx. 65 thousand MJ·ha^{-1} in small farms,***
– ***the level of significance and very high coefficients of determination (higher than the previous) prove very strict relation of the compared features.***

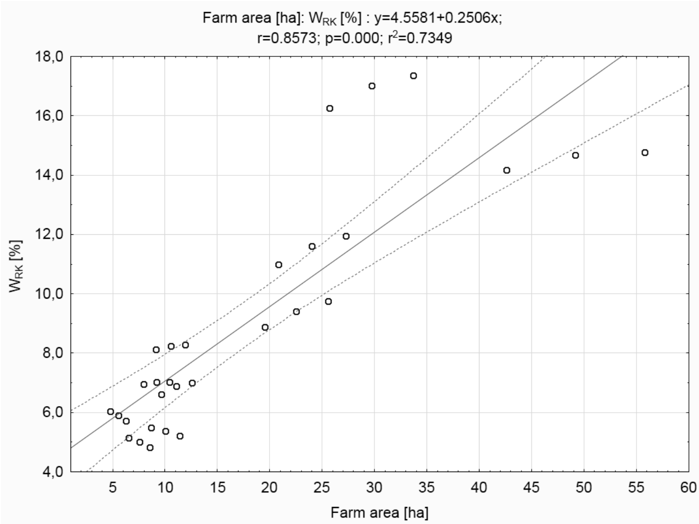

Fig. 8.20. Impact of the vegetable farm area on W_{RK} index
Rys. 8.20. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na wskaźnik W_{RK}

Source: author's own study

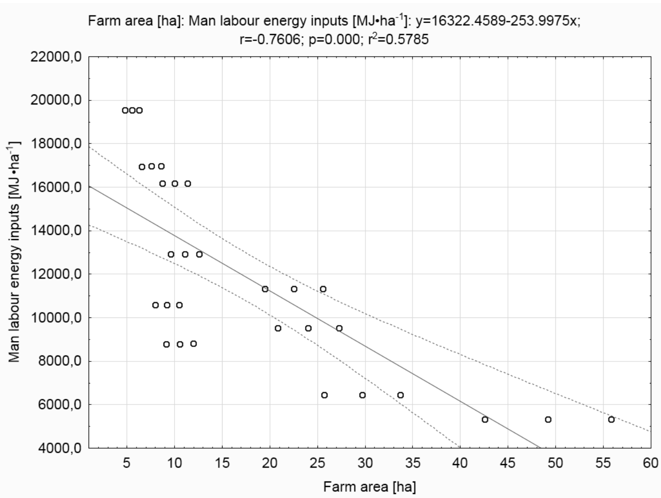

Fig. 8.21. Impact of the vegetable farm area on the live labour stream
Rys. 8.21. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na strumień energii pracy żywej

Source: author's own study

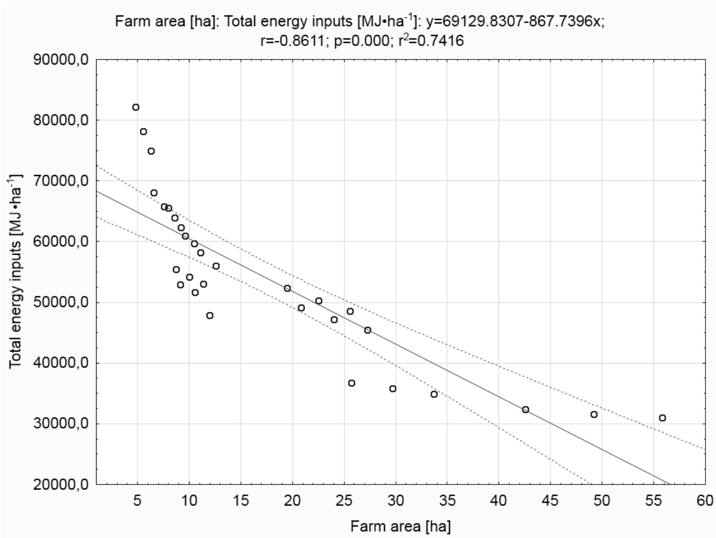

Fig. 8.22. Impact of the vegetable farm area on the accumulated energy input
Rys. 8.22. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na nakład energii skumulowanej

Source: author's own study

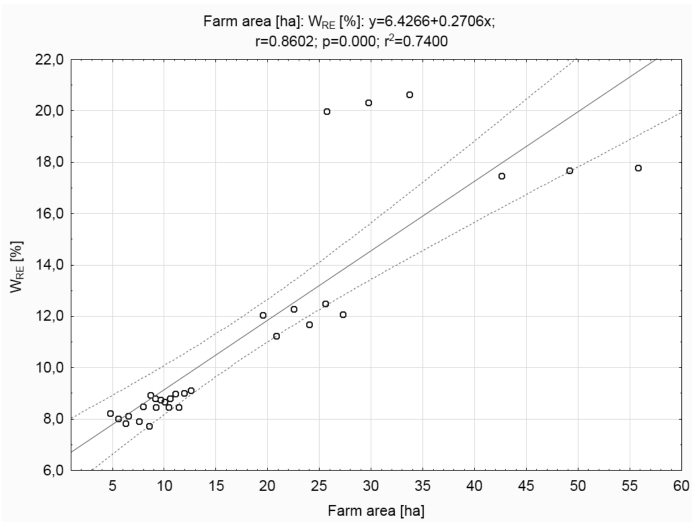

Fig. 8.23. Impact of the vegetable farm area on W_{RE} index
Rys. 8.23. Wpływ powierzchni gospodarstwa o kierunku produkcji warzywniczym na wskaźnik W_{RE}

Source: author's own study

Out of many remaining correlation relations determined as a result of empirical research and equations of regression calculated on their basis - described with a plot, the relations between the following should be emphasized:

- the aggregates operation costs and the total costs in PLN·ha^{-1} (fig. 8.24),
- the operation costs of agricultural mechanisation means in PLN·ha^{-1} and the total accumulated energy inputs in MJ·ha^{-1} (fig. 8.25),
- live labour means and the total costs in PLN·ha^{-1} (fig. 8.26),
- live labour means and the agricultural income in PLN·ha^{-1} (fig. 8.27),
- live labour costs in PLN·ha^{-1} and the total accumulated energy inputs in MJ·ha^{-1} (fig. 8.28),
- total costs and the agricultural income in PLN·ha^{-1} (fig. 8.29),
- live labour inputs in MJ and the agricultural income (fig. 8.30),
- the accumulated energy inputs in MJ and the agricultural income in PLN·ha^{-1} (fig. 8.31),
- live labour inputs in MJ and the total accumulated energy inputs in MJ·ha^{-1} (fig. 8.32),

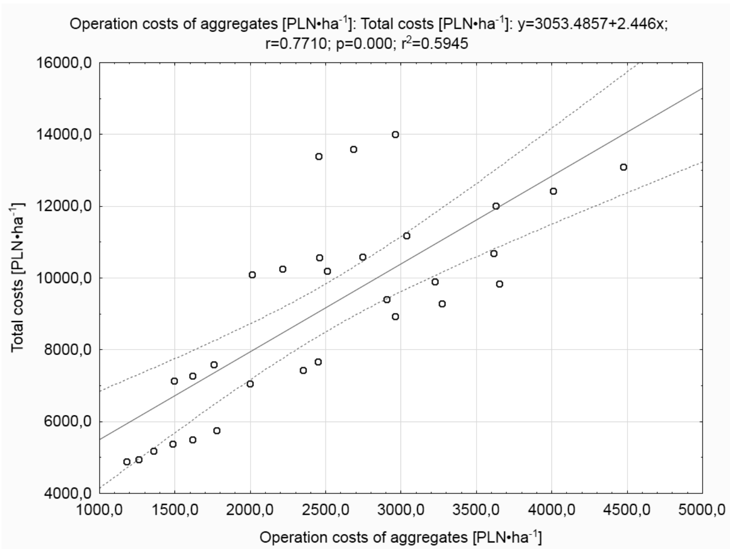

Fig. 8.24. Impact of the operation costs of the agriculture mechanisation means on the total costs in vegetable farms
Rys. 8.24. Wpływ kosztów pracy środków mechanizacji rolnictwa na koszty ogółem w gospodarstwach o kierunku warzywniczym

Source: author's own study

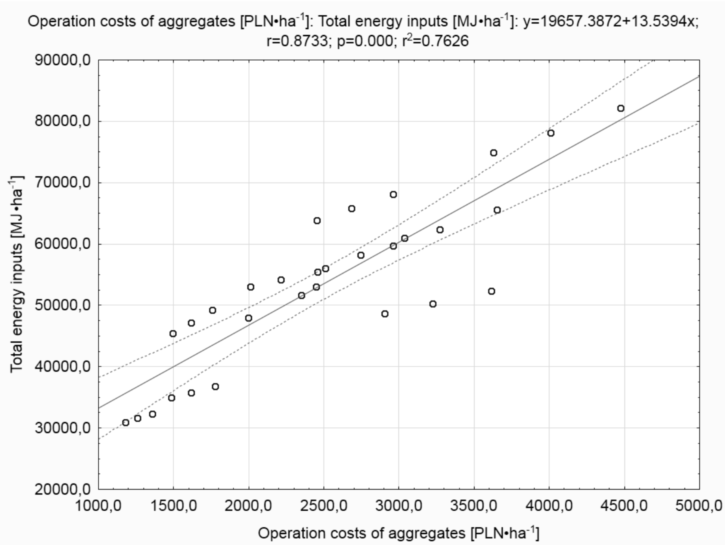

Fig. 8.25. Impact of the operation costs of the agriculture mechanisation means on the accumulated energy input in vegetable farms
Rys. 8.25. Wpływ kosztów pracy środków mechanizacji rolnictwa na nakład energii skumulowanej w gospodarstwach o kierunku warzywniczym

Source: author's own study

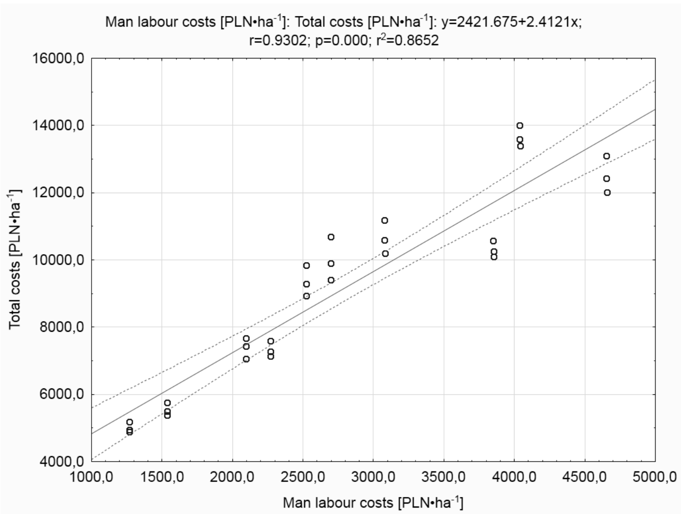

Fig. 8.26. Impact of the live labour costs on the total costs in vegetable farms
Rys. 8.26. Wpływ kosztów pracy żywej na koszty ogółem w gospodarstwach o kierunku warzywniczym

Source: author's own study

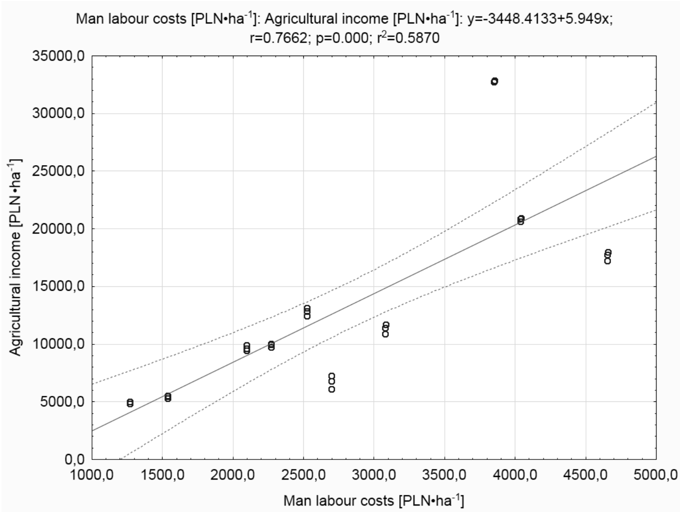

Fig. 8.27. Impact of the live labour costs on the agricultural income in vegetable farms
Rys. 8.27. Wpływ kosztów pracy żywej na dochód rolniczy w gospodarstwach o kierunku warzywniczym

Source: author's own study

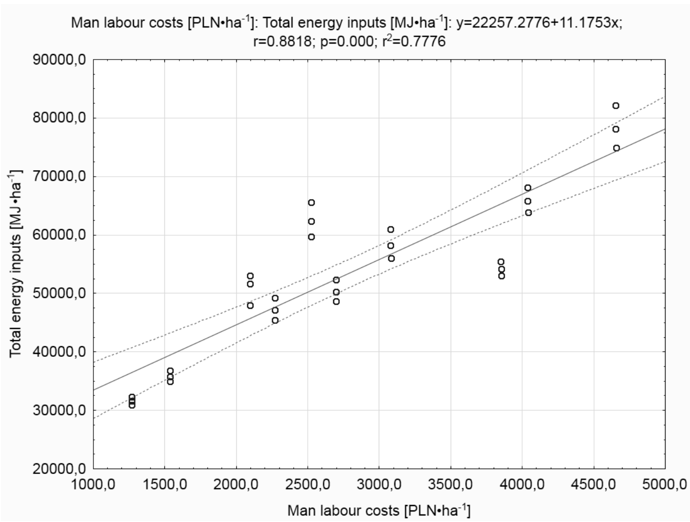

Fig. 8.28. Impact of the man labour costs on the accumulated energy input in vegetable farms
Rys. 8.28. Wpływ kosztów pracy żywej na nakład energii skumulowanej w gospodarstwach o kierunku warzywniczym

Source: author's own study

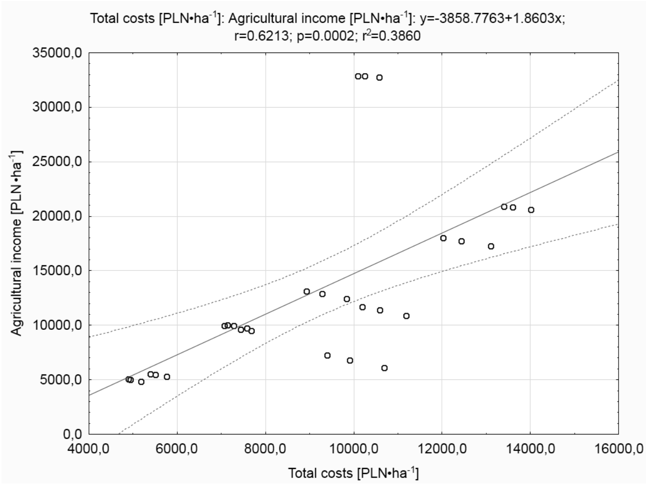

Fig. 8.29. Impact of the total costs on the agricultural income in vegetable farms
Rys. 8.29. Wpływ kosztów ogółem na dochód rolniczy w gospodarstwach o kierunku warzywniczym

Source: author's own study

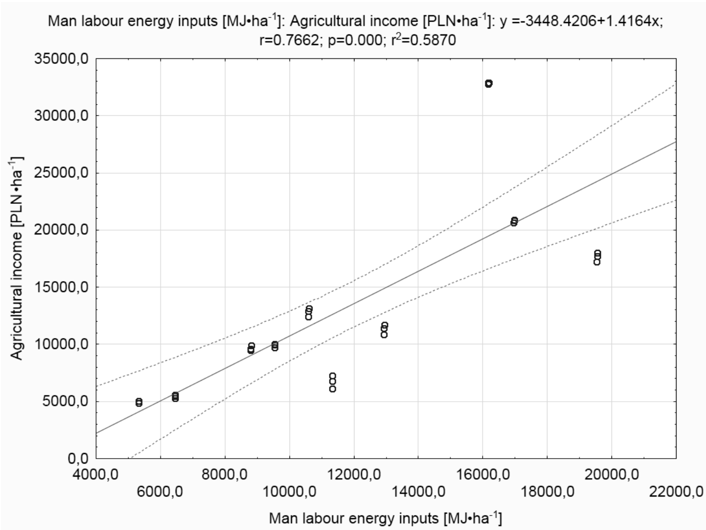

Fig. 8.30. Impact of the live labour energy stream on the agricultural income in vegetable farms
Rys. 8.30. Wpływ strumienia energii pracy żywej na dochód rolniczy w gospodarstwach o kierunku warzywniczym

Source: author's own study

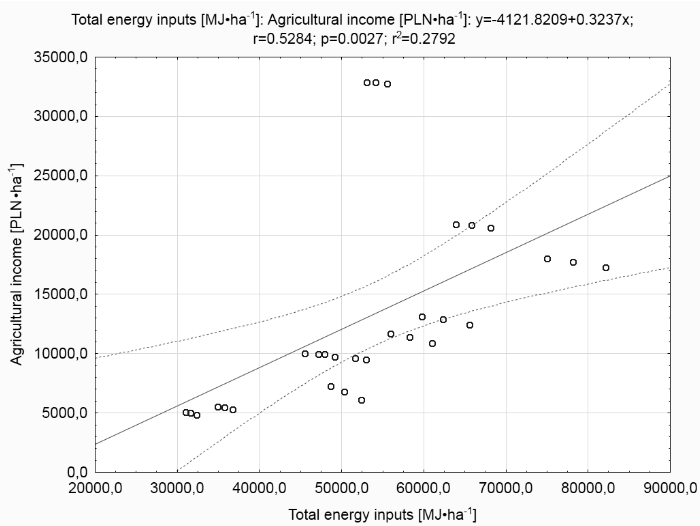

Fig. 8.31. Impact of the accumulated energy input on the agricultural income in agricultural farms
Rys. 8.31. Wpływ nakładu energii skumulowanej na dochód rolniczy w gospodarstwach o kierunku warzywniczym

Source: author's own study

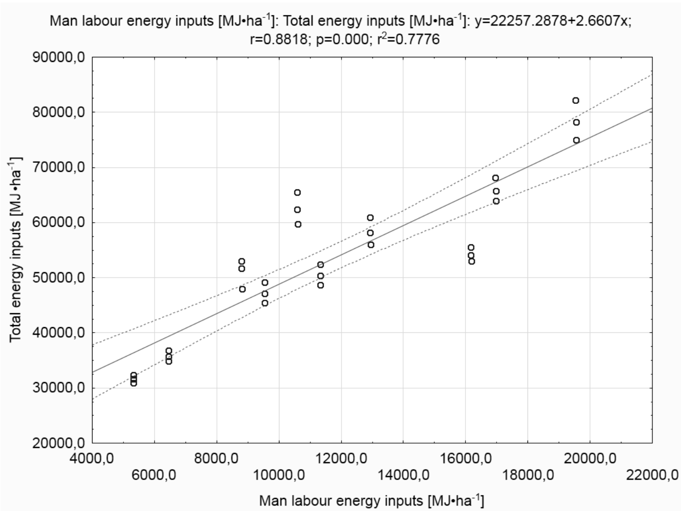

Fig. 8.32. Impact of the live labour energy stream on the accumulated energy input in vegetable farms
Rys. 8.32. Wpływ strumienia energii pracy żywej na nakład energii skumulowanej w gospodarstwach o kierunku warzywniczym

Source: author's own study

The data presented in figures, describing significant and crucial dependencies have one property in common. Namely, the increase of the independent variable is accompanied by the increase of the value of the explained variable. Moreover, in all cases the level of significance of the mutual relations is very high and is within the range from 0.0001 to 0.0027. At the same time, the established coefficients of determinations in majority of cases are very high and are within r^2=0.58 to r^2=0.86. Coefficient of determination for two variants of regression between the following, constitute en exception:

- ***values of the total costs (PLN·ha^{-1})and the obtained agricultural income (PLN·ha^{-1}) r^2=0.39,***
- ***the accumulated energy inputs (MJ·ha^{-1}) and the obtained agricultural income (PLN·ha^{-1}) r^2=0.28.***

In case of mutual relations of the above two pairs of variables, there are the reason and result relations statistically confirmed with a high coefficient of correlation and a very high significance. However, a percentage of statistically confidentally explained events for a predictor with values of the independent variable reaches only the amounts of approx. 40% in the first case and approx. 30% in the second case. Therefore, in this case the certainty of concluding may be slightly limited.

At the relation between the total production costs and the agricultural income, reasons for disturbances of the mutual relations should be searched for in other remaining factors, which oppositely influence both costs as well as finally the agricultural income. It is visible in figure 8.29 where from the remaining investigated facilities, three are distinguished - of very high unit incomes exceeding 33 thousand PLN·ha^{-1}. Removing thess facilities would cause a very significant increase of the coefficient of determination. Simultaneously, however, it would disable a reader, who analyses results, to state that there are facilities, which may obtain considerably more advantageous economic results. They indicate that at the average financial inputs amounting to approx. 10 to 11 thousand PLN·ha^{-1} one may obtain unit incomes which are 2.5 times higher in comparison to other facilities in the same costs range. The presented equation and the single regression plot indicate that at a low level of the incurred costs (4 to 5 thousand PLN·ha^{-1}), the agricultural income from one hectare amounts to only approx. 5 thousand PLN·ha^{-1}. Investing in the vegetable production (materials and raw materials, energy carriers, human labour and fixed means) give a significant and noticeable financial effect. When assessing approximately a four-time increase of the production costs at a rational farming gives an opportunity of over 5-times unit decrease of the agricultural income - over 25 thousand PLN·ha^{-1}.

Data included in the plot and in the equation of figure 8.32 presenting changes of the relation between the total energy inputs (in MJ·ha^{-1}) and the agricultural income (in PLN·ha^{-1}) confirm the previous interpretation of results basing on the costs. Moreover, the increase of all inputs, calculated into energy units gives the agricultural income of the similar relation of its amount. Also in this case the three facilities mentioned above distinguish. Thus, in this case, interchangeability of using both methods in the research: the costs and the accumulated energy method may be emphasized here. Equations and the regression line, presenting the influence of the live labour inputs expressed in MJ on the accumulative value put into the energy production confirm the costs relations. Live labour also here decisively influence the total energy inputs (r^2=0.77).

When searching for regression relations between the selected factors at the economic and energy assessment of business activity of grain production farms it is reported that the effects of functioning considerably differ from the results of the previously analysed trends. Therefore, the obtained results should be viewed from the other perspective. Basic factors, decisively diverging from the previous and influencing the farm results are mainly as follows:

– the area of arable land exceeding at the average 13 times and 5 times the area of farms in the previous production trend,
– very high degree of mechanization of the production technology,
– low employment in agriculture resulting from the low unit labour force inputs.

The obtained results prove inter alia, significant correlation relations (as it was previously mentioned, in the previous sub-section) between the area of a farm and the costs and energy consumption of live labour and the total energy costs - at the significance at the level of 0.01 and 0.02. Correlation coefficients are on the level of r=0.39 and r=0.43. Labour costs in farms of the area within the range from approx. 10 ha to approx. 240 ha of AL are within the range from approx. 210 PLN·ha^{-1} to approx. 290 PLN·ha^{-1}. As a result it should be reported that along with the increase of the farm area of this trend by 1 ha of AL labour costs decrease and it amounts to only PLN 0.34. A unit decrease is minimal (fig. 8.33).

Similar relations may be reported for subject trends calculating the human labour per MJ. Here, the increase of the area by a unit causes decrease of the energy inputs by 10.4062 MJ (fig. 8.34).

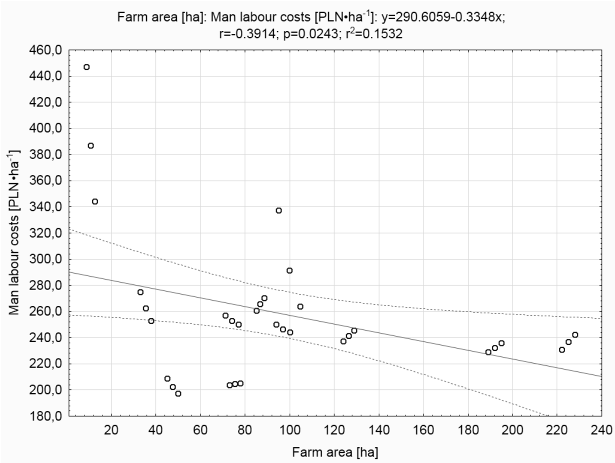

Fig. 8.33. Impact of the grain farm area on the man labour cost
Rys. 8.33. Wpływ powierzchni gospodarstwa o kierunku produkcji zbożowym na koszt pracy żywej

Source: author's own study

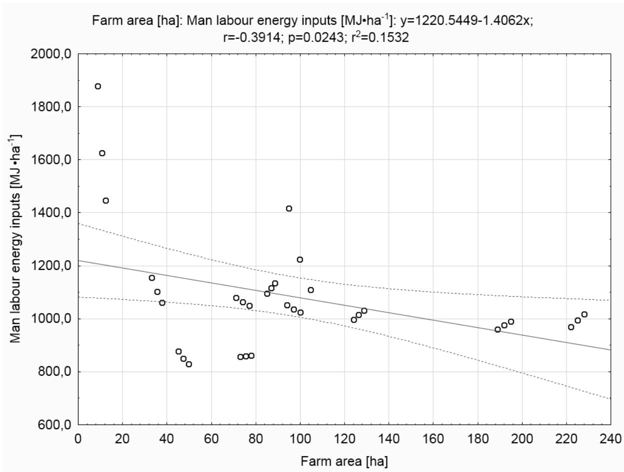

Fig. 8.34. Impact of the grain farm area on the live labour energy stream
Rys. 8.34. Wpływ powierzchni gospodarstwa o kierunku produkcji zbożowym na strumień energii pracy żywej

Source: author's own study

The above relations and trends are confirmed by the data presented in figure 8.35, and characterising the total accumulated energy inputs. Here, energy included in materials and raw materials mainly decides on the amount of energy inputs and its absolute value calculated into one hectare is significant. ***It can be concluded from the above analysis, that the degree of grain farms mechanisation is very high and does not depend on the farm area. Thus, further introduction of technology progress may not give an economically measurable effect. However, one should remember that the purpose of introduction of this progress is to obtain economically non-measurable effects and non-economical effects. And these effects may be obtained by introduction of modern and ergonomic equipment.***

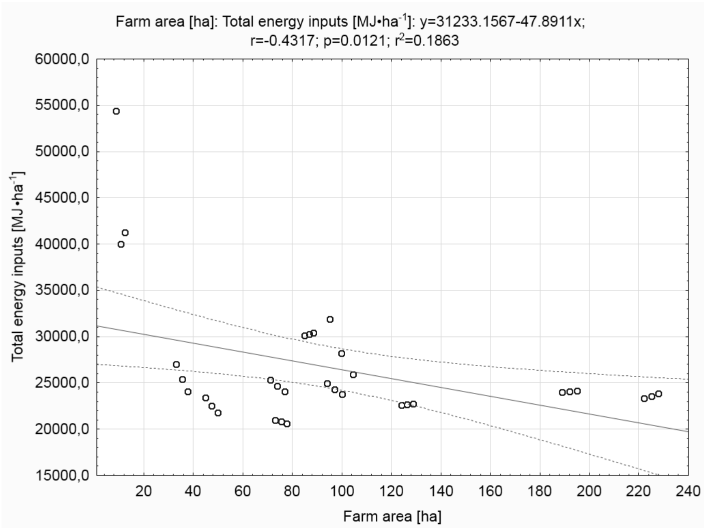

Fig. 8.35. Impact of the grain farm area on the size of the accumulated energy
Rys. 8.35. Wpływ powierzchni gospodarstwa o kierunku produkcji zbożowym na wielkość energii skumulowanej

Source: author's own study

From the point of view of agricultural engineering, numerical values presented in figure 8.36 concerning the grain production trend illustrating the influence of the operation costs of the agricultural mechanisation means on the total production costs constitute the most essential element of the subject analysis. The presented numerical values prove at the highest significance level and the coefficient of determination r^2 close to the unity that along with the decrease of the operation costs by PLN 1 per one hectare, the increase of the total costs by 1.3057 PLN·ha^{-1} should be assumed (fig. 8.36). Similar relations, however with a slightly lower degree of certainty, may be reported at the analysis related to the above operating costs of agricultural mechanisation means with the total inputs in energy units (fig. 8.37).

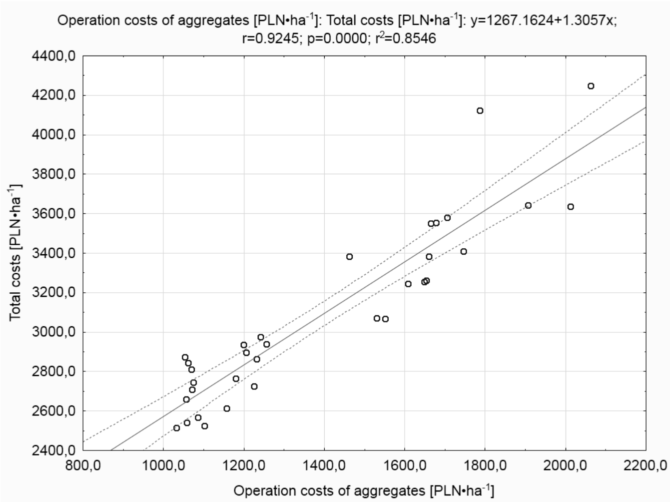

Fig. 8.36. Impact of the operation costs of the agriculture mechanisation means on the total costs in grain farms
Rys. 8.36. Wpływ kosztów pracy środków mechanizacji rolnictwa na koszty ogółem w gospodarstwach o kierunku zbożowym

Source: author's own study

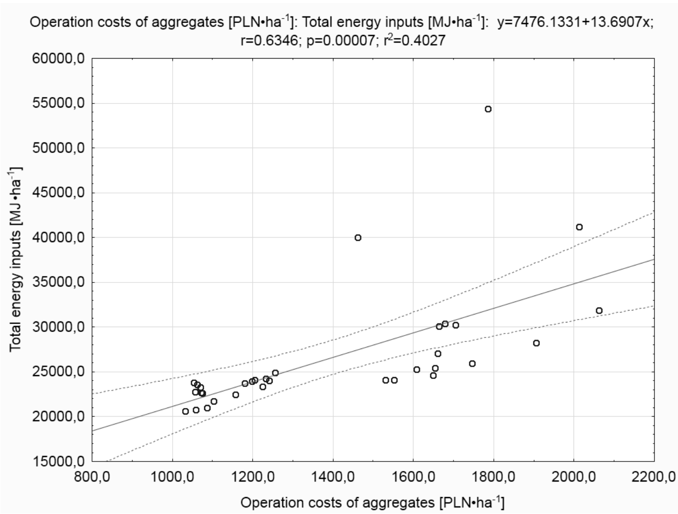

Fig. 8.37. Impact of the operation costs of the agriculture mechanisation means on the accumulated energy input in grain farms
Rys. 8.37. Wpływ kosztów pracy środków mechanizacji rolnictwa na nakład energii skumulowanej w gospodarstwach o kierunku zbożowym

Source: author's own study

Labour consumption of technological processes is also strictly connected to the production costs. Data presented in figure 8.38 show their relations with the total costs. The presented values as in the previous case indicate a growing trend for the total costs at the increase of the labour costs. ***Along with the increase of costs of human labour by PLN 1, one should expect the increase of the total production costs as much as by PLN 6.9839 at the coefficient of determination close to 40% (fig. 8.38). The above shows that human labour has only an insignificant impact on the accumulative agricultural production costs in grain farms.*** From the logical point of view, out of the remaining factors, materials and raw materials and the objectified labour should be distinguished.

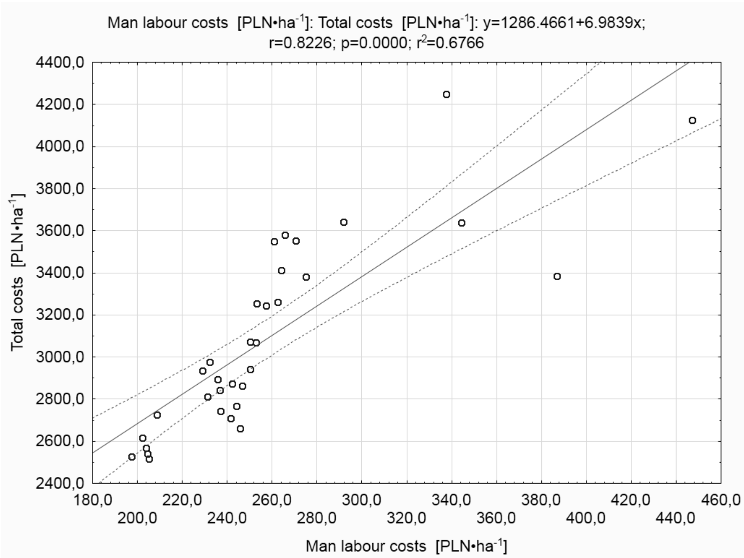

Fig. 8.38. Impact of the man labour costs on the total costs in grain farms
Rys. 8.38. Wpływ kosztów pracy żywej na koszty ogółem w gospodarstwach o kierunku zbożowym

Source: author's own study

Data presented in figure 8.39 referring to the accumulated energy consumption prove a similar trend to the above. However, here we observe even higher significance of results and the coefficient of determination is similar to the unity and amounts to 0.90. Therefore, one may assume that the increase of money inputs for paying for the labour force by 1 PLN·ha^{-1} gives the increase of the energy inputs by 123.1735 MJ·ha^{-1}.

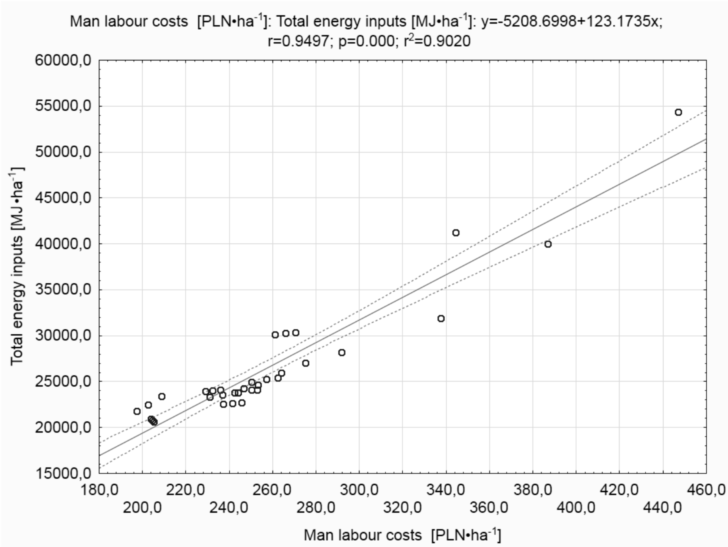

Fig. 8.39. Impact of the live labour costs on the accumulated energy input in grain farms
Rys. 8.39. Wpływ kosztów pracy żywej na nakład energii skumulowanej
w gospodarstwach o kierunku zbożowym

Source: author's own study

Straight lines and regression equations presented in figures 8.40 and 8.41 describing the impact of the sizes of the live labour inputs expressed in MJ·ha^{-1} on the total production costs and the total energy inputs indicated an explicitly high degree of mutual relations of the human factor with the subject predictors. In both cases the level of significance is really high, also for very strong correlation relations (r^2=0.68 in the first case – fig. 8.40 and r^2=0.90 in the second case – fig. 8.40). Thus, one may conclude with high probability that the increase of the energy inputs related to human labour inputs by 1 MJ·ha^{-1} raises the production costs by 1.6628 PLN·ha^{-1} and the accumulated energy inputs by as much as 29.32276 MJ·ha^{-1}. The above facts also confirm that the human labour both in the costs system as well as the energy system constitutes a marginal part of the total costs and inputs.

The numerical data presented in section 7 and 8 and their analysis in the numerical meaning and in the aspect of mutual correlation and regression relations at the simultaneous indication of the significance of differences between the key values of results allowed economic and energy assessment of functioning of peasant holdings in the conditions of dynamically changing farm system in the country. The obtained results except for the epistemological values, in the authors' belief, prove many utilitarian aspects. We would like to draw attention of the decision makers within the agricultural policy as well as farmers– producers to these results.

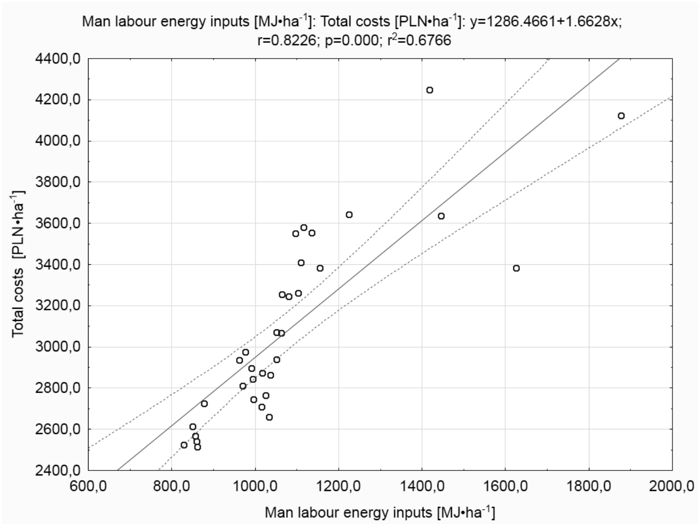

Fig. 8.40. Impact of the live labour energy stream on the total costs in grain farms
Rys. 8.40. Wpływ strumienia energii pracy żywej na koszty ogółem w gospodarstwach o kierunku zbożowym

Source: author's own study

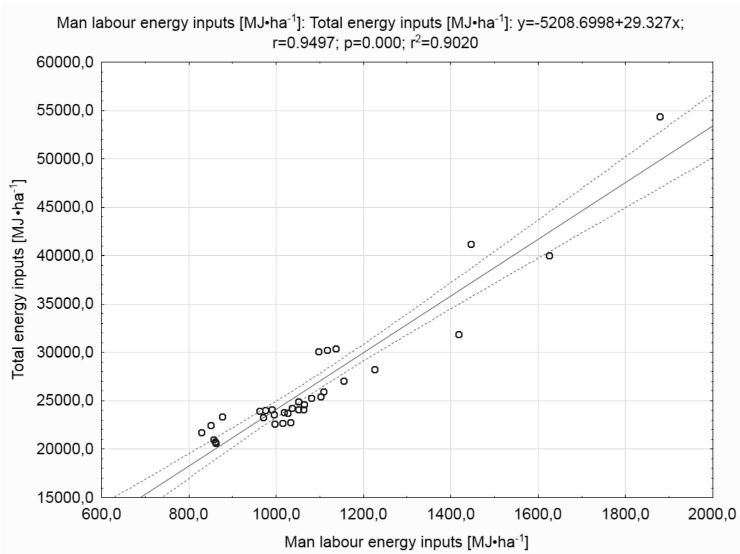

Fig. 8.41. Impact of the live labour energy stream on the accumulated energy stream in grain farms
Rys. 8.41. Wpływ strumienia energii pracy żywej na nakład energii skumulowanej w gospodarstwach o kierunku zbożowym

Source: author's own study

9. SUMMARY AND CONCLUSIONS

The assumptions presented in the study, working hypotheses as well as the aim and the scope of the paper were carried out and verified through the field research in 99 farms of the South Macro-region. The collected results were statistically developed with the methods adequate to the assumed research objective and scope. Simultaneously, additionally the original percentage coefficient of compensation of the EU subsidy in the cost (W_{RK}) and the energy version (W_{RE}), developed within a doctorate thesis [Budyn 2012] was applied. The obtained results explicitly confirmed usefulness of the developed method for this type of research.

Methodology aspect was based also on the analysis of results with two independent methods: the cost and energy analysis. The obtained results in all aspects confirmed compatibility and interchangeability of these methods. Since, the accumulated energy consumption method developed in the 70's of the previous century has become in the recent years in the age of economic crisis, connected strictly with the increase of prices of the energy carriers, a very valuable as useful as the cost method.

The obtained results presented in the paper in the form of the numerical data allowed carrying out the following:

– a verbal analysis of the obtained results,
– searching for statistically significant differences of the obtained results between the assumed variants of the production trend and the size of the EU subsidies,
– assessment of the correlation relations between the selected production factors (10 properties) the most significant from the substantial point of view, and
– in case of significant correlation relations (in the number of 81.5% out of 135 combinations and variants), searching for trends of these relations through determination of equations and plots of the simple regression.

In order not to obscure the image of the results, correlation and regression relations of the most important results from the substantial point of view, were selected for the substantial analysis. Such, that can presently and ultimately allow economic and energy assessment of peasant holdings functioning in the conditions of the dynamically changing economic systems in the country and agriculture within them.

The following should be emphasised beside the conclusions, opinions and statements, presented in the previous sections placed in the research results:

1. The investigated farms met the criteria qualifying them to the particular production trend. It should be also mentioned that the production groups differed on account of the area. The area of the researched farms was from few hectares in the orchard production trend to few hundred in the grain production trend.

2. ***The assumed working hypothesis stating that the EU subsidies compensate the production costs and the energy inputs per a conversion unit of yield was empirically confirmed. Application of the compensation coefficients from the EU means of the cost and energy inputs on the agricultural production allowed precise explanation of this research hypothesis. The highest value of the compensation coefficient was reported in the grains production trend and the lowest in the fruit production.*** Analysis of variance with Duncan test and values of the correlation coefficients confirmed credibility of the research results and rightness of the operational hypothesis. Average values of the energy (W_{RE}) and cost (W_{RK}) indexes, reflecting the degree of the costs and energy inputs compensation differ statistically in all combinations of the research system.
3. ***Moreover, a next hypothesis, that the EU targeted funds are not used in the same degree by owners of different types of farms was also confirmed. Since, the cost diversity of the obtained EU targeted funds on the machinery park modernization was reported. Farms producing grains obtained the highest sum (PLN 162.7 thousand per 1 farm). Vegetable farms obtained almost four times lower sum and fruit farms obtained ten times lower sum in comparison to grains farms.***
4. Confirmation of both accepted hypothesis should be identified with the full realization of the objective of the study.
5. Results concerning the amount of EU grants and subsidies, which were presented in the paper, calculated both with reference to one hectare as well as the GU of production, explicitly prove that the agricultural policy of the united Europe prefers bigger farms, minimizing financial and goods inputs ***as well as minimizing the production size. This fact is confirmed explicitly by the developed compensation indexes of a subsidy*** W_{RK} ***and*** W_{RE} ***(section 4.7) developed in the presented dissertation. Thus, it should be concluded that the grain production trend farms - of the biggest area of AL are on the very privileged position in comparison to the investigated facilities.***
6. The stream of materials and raw materials with the energy and cost method determines high production costs and the inputs of energy accumulated in a product. Therefore, when taking up a decision on the quantity use of doses, one should consider not only a high yield but also the cost and energy inputs, which may be decreased using the precise agriculture technology, recommended by the integrated agriculture.
7. ***The amount of inputs for production resulting from the stream of human labour explicitly proves one-trend agricultural production in the South Poland which is characterised by great fragmentation of the agrarian structure and overpopulation of a country. The results show that the fruit production trend should be preferred on weaker soils and in the region of foothills considering favourable micro-climate and the vegetable production on strong soils and close to the city centres.***

8. No statistically significant difference between average coefficients of the cost and energy method of the percentage degree of the production compensation from the EU subsidy was reported. Thus, from the point of view of changing fuel and raw materials prices, it seems that the accumulated energy method may be in some cases a more effective method that the cost method. The research results with the accumulated energy method in a product are clear for all recipients not related to time and geographical location of the research region and the market economy in some sense.
9. ***The EU subsidies were an essential factor in the modernization of the machinery park. Majority of targeted subsidies was directed for the purchase of tractors and combine harvesters and secondly for the purchase of specialistic tools and machines depending on the production trend.***
10. ***From the point of view of utility, the increase of the cultivation area and at the same time of AL in the researched farms was strictly related to the decrease of the inputs amount and the economic effects calculated into the area unit. Thus, the increase of the production intensity along with the decreasing AL area occurs. And this results in levelling the differences of the farmer's income from the whole farm when comparing the efficiency of farming of small facilities with the big ones.***
11. ***When assessing the correlation relations between the area of arable land of the researched farms and the remaining factors, one can notice one basic regularity in all the production trends, that is, along with its increase values of all the remaining factors decrease - coefficient of correlation are negative.*** Both coefficients of the cost (W_{RK}) as well as the energy (W_{RE}) compensation constitute an exception. These coefficients correlate positively with the area. While negatively with the remaining factors.
12. ***Statistically significant relations of the area of crops in farms with the improvement of the economic and energy indexes were confirmed. Regression equations obtained from calculations indicate what positive economic or energy effects farmers can expect when increasing the farm area.***
13. ***High value of coefficients of determination prove that the total production costs and energy inputs in a farm have a considerable impact on the human labour costs and the operating costs of agricultural aggregates.***

However, in case of the grain production trend, there is no statistical confirmation that the increase of the objectified labour inputs causes the decrease of the costs and energy inputs included in the human labour. This fact may indicate:
- over-investing of a farm with technical means,
- lack of possibility of the employment reduction,
- improper organization of work in a farm.

14. ***Considering the final effect of his activity, a farmer organizing the production processes in a farm must aim at optimization of mutual relations between factors analysed in the paper herein. The presented results should facilitate him in taking up a proper decision.***

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Streszczenie

Osiągnięcia postępu naukowo-technicznego umożliwiają wprowadzenie maszyn i urządzeń nowej generacji, które prowadzą do wzrostu produkcji rolniczej. Jednak cena maszyny nowej generacji jest ceną zaporową dla producenta, jeżeli odniesie się ją do ekwiwalentu produktu rolniczego. Dlatego jedną z najważniejszych alternatyw sprostania wymogom rynku jest skorzystanie z unijnych funduszy pomocowych. Plan badawczy oparto na złożeniu, że fundusze unijne zróżnicowanie rekompensują nakłady energii skumulowanej w produkcie rolniczym, koszty jego produkcji i uzbrojenie techniczne w zależności od kierunku produkcji. Biorąc pod uwagę powyższe założenie postawiono hipotezę roboczą, że fundusze unijne (bezpośrednie i celowe) zróżnicowanie rekompensują nakłady energetyczne i kosztowe na produkcję rolniczą kierunków produkcji. sadowniczego, warzywniczego i zbożowego. Badania prowadzono w 99 gospodarstwach województwa małopolskiego i opolskiego, o łącznej powierzchni użytków rolnych 4117,4 ha. Dobór gospodarstw był celowy. Badania przeprowadzono w formie wywiadu kierowanego z właścicielami gospodarstw. Zebrane informacje ze względu na specyfikę metodyki obliczeniowej dotyczyły wszystkich procesów produkcyjnych prowadzonych w roku produkcyjnym 2009 oraz informacji dotyczącej skorzystania z dofinansowań ze środków Unii Europejskiej. W obliczeniach zastosowane zostały metody analizy ekonomicznej i energetycznej badanych gospodarstw. Dla porównania udziału dotacji unijnych w rekompensacie nakładów energii skumulowanej w produkcie rolniczym i kosztów produkcji przeprowadzono analizę porównawczą przy zastosowaniu opracowanego, autorskiego wskaźnika rekompensaty ze środków unijnych nakładów energetycznych i kosztowych na jednostkę przeliczeniową. Wskaźnik W_{RE}, jest ilorazem ilości energii skumulowanej w JZ [$MJ \cdot JZ^{-1}$] zrekompensowanej ze środków UE i obliczonej całkowitej ilości energii skumulowanej w JZ [$MJ \cdot JZ^{-1}$]. Wskaźnik kosztowy stanowi iloraz sumy dopłaty bezpośredniej i celowej do JZ [$zł \cdot JZ^{-1}$] i kosztów produkcji JZ [$zł \cdot JZ^{-1}$]. Odnotowano w badanych kierunkach produkcji zróżnicowanie kwotowe pozyskanych unijnych funduszy celowych na modernizację parku maszynowego. Najwyższą kwotę pozyskały gospodarstwa o zbożowym kierunku produkcji (162,7 tys. zł na 1 gosp.). Prawie czterokrotnie niższą kwotę pozyskały gospodarstwa kierunku warzywniczego i dziesięciokrotnie niższą w stosunku do kierunku zbożowego pozyskały gospodarstwa sadowniczego kierunku produkcji. Zastosowanie współczynników rekompensaty ze środków unijnych nakładów koszto-

wych i energetycznych na produkcję rolniczą, pozwoliło na precyzyjne wyjaśnienie hipotezy badawczej, że dotacje unijne niejednakowo rekompensują nakłady na produkcję rolniczą w zależności od jej kierunku. Najwyższą wartość współczynników rekompensaty odnotowano w zbożowym kierunku produkcji, a najniższą w produkcji sadowniczej. Analiza wariancji z testem Duncana potwierdziła wiarygodność wyników badań i słuszność postawionej hipotezy roboczej.

Równocześnie przeprowadzona analiza wzajemnych oddziaływań piętnastu czynników produkcji, dla porównywanych kierunków produkcji gospodarstw przy pomocy rachunku korelacyjno-regresyjnego, pozwoliła na wskazanie ewentualnych kierunków ich przemian. Rolnik organizujący procesy produkcyjne w gospodarstwie musi dążyć do optymalizacji wzajemnych relacji miedzy czynnikami przeanalizowanymi w naszym opracowaniu. Pomocnymi w tym powinny być proste i równania regresji. A te są uwiarygodnione współczynnikami determinacji. Przedstawione wyniki powinny więc ułatwić podejmowanie trafnych decyzji.

FACTORS SUPPORTING THE USE OF TECHNICAL MEANS AND PRODUCTION EFFICIENCY IN PEASANT HOLDINGS

Summary

Achievements of the scientific and technical progress enable introduction of machines and devices of a new generation, which lead to the growth of agricultural production. However, the price of a new generation machine is a prohibitive price, if it is referred to an equivalent of an agricultural product. Therefore, the only alternative of meeting the requirements of the market is using the European Union aid funds. The research plan was based on the assumption that the European Union funds compensate energy inputs accumulated in an agricultural product, costs of its production and technical fittings depending on the production orientation. Taking into consideration the above assumptions it was operationally hypothesised that the European Union funds (direct and targeted) variously compensate the energy and costs inputs on the agricultural production of the fruit, vegetable and grains production. The research was carried out in 99 farms of Małopolskie and Opolskie voivodeships of the total arable land area of 4117.4 ha. Selection of farms was deliberate. The research was carried out in the form of a guided survey with farm owners. The collected information, due to the specificity of the calculation method, concerned all production processes carried out in the production year 2009 and the information concerning the use of subsidies from the European Union means. Methods of economic and energy analysis of the researched farms were used in calculations. For comparison of the European Union subsidies share in the compensation of the energy accumulated in an agricultural product and the production costs, a comparative analysis was carried out with the use of the original compensation index from the European Union means of the energy and costs inputs per a conversion unit. Index WRE, is a ratio of the amount of the accumulated energy in GU [MJ·GU-1] compensated from the EU means and the calculated total amount of the energy accumulated in GU [MJ·GU-1]. The costs index constitutes the ratio of the direct and targeted subsidy sum to GU [PLN·GU-1] and the production costs GU [PLN·GU-1]. In the examined production orientations, sum diversity of the obtained targeted funds for modernisation of the machinery park was reported. Farms producing grains ob-

tained the highest sum (PLN 162.7 thousand per 1 farm). Vegetable farms obtained almost four times lower sum and fruit farms obtained ten times lower sum in comparison to grain farms. The use of compensation coefficients from the European Union means of the costs and energy inputs on the agricultural production allowed precise explanation of the research hypothesis that the Union subsidies differently compensate inputs on the agricultural production in relation to the orientation. The highest value of the compensation coefficients was reported in the grain production trend and the lowest in the fruit production. Analysis of variance with Duncan test and values of the correlation coefficients confirmed credibility of the research results and rightness of the operational hypothesis.

ANNEX

Annex 1

Correlation matrixes for the selected factors

Correlations within the group (analysis of the whole) Group: trend: vegetables. Marked coefficients of correlation are significant with p<0.5000

	Area	Materials and raw materials PLN/ha	Operation of aggregates PLN/ha	Labour input man-hour PLN/ha	Total costs PLN/ha	Agricultural income PLN/ha	Revenue PLN/ha	Subsidy PLN/ha	WRK	Direct energy carriers MJ/ha	Raw materials and materials MJ/ha	Live labour MJ/ha	Investment inputs MJ/ha	Total energy input MJ/ha	WRE
Area	1.00000	-0.6341	-0.6511	-0.6869	-0.7629	-0.6149	-0.5007	0.4435	0.8693	-0.6496	-0.7075	-0.6869	-0.8035	-0.8650	0.9188
Materials and raw materials PLN/ha	-0.63413	1.0000	0.4081	0.7060	0.8626	0.6664	0.5332	-0.2904	-0.7208	0.5948	0.7262	0.7060	0.2817	0.6111	-0.6300
Operation of aggregates PLN/ha	-0.65109	0.4081	1.0000	0.6934	0.7710	0.4126	0.2527	-0.0526	-0.6810	0.6276	0.6687	0.6934	0.8396	0.8733	-0.6396
Labour input man-hour PLN/ha	-0.68693	0.7060	0.6934	1.0000	0.9302	0.8708	0.7662	-0.1086	-0.8409	0.6826	0.8640	1.0000	0.5429	0.8818	-0.7516
Total costs PLN/ha	-0.76291	0.8626	0.7710	0.9302	1.0000	0.7735	0.6213	-0.1925	-0.8717	0.7357	0.8793	0.9302	0.6041	0.8975	-0.7824
Agricultural income PLN/ha	-0.61489	0.6664	0.4126	0.8708	0.7735	1.0000	0.9771	-0.2134	-0.8221	0.3880	0.8527	0.8708	0.2589	0.6704	-0.7150
Revenue PLN/ha	-0.50067	0.5332	0.2527	0.7662	0.6213	0.9771	1.0000	-0.1865	-0.7202	0.2353	0.7614	0.7662	0.1160	0.5284	-0.6158
Subsidy PLN/ha	0.44351	-0.2904	-0.0526	-0.1086	-0.1925	-0.2134	-0.1865	1.0000	0.4949	0.0422	-0.0664	-0.1086	-0.2162	-0.1578	0.6188
WRK	0.86927	-0.7208	-0.6810	-0.8409	-0.8717	-0.8221	-0.7202	0.4949	1.0000	-0.5681	-0.8049	-0.8409	-0.6384	-0.8522	0.9652
Direct energy carriers MJ/ha	-0.64956	0.5948	0.6276	0.6826	0.7357	0.3880	0.2353	0.0422	-0.5681	1.0000	0.6047	0.6826	0.6712	0.7991	-0.5537
Raw materials and materials MJ/ha	-0.70749	0.7262	0.6687	0.8640	0.8793	0.8527	0.7614	-0.0664	-0.8049	0.6047	1.0000	0.8640	0.4731	0.8309	-0.7010
Live labour MJ/ha	-0.68693	0.7060	0.6934	1.0000	0.9302	0.8708	0.7662	-0.1086	-0.8409	0.6826	0.8640	1.0000	0.5429	0.8818	-0.7516
Investment inputs MJ/ha	-0.80350	0.2817	0.8396	0.5429	0.6041	0.2589	0.1160	-0.2162	-0.6384	0.6712	0.4731	0.5429	1.0000	0.8563	-0.7249
Total energy input MJ/ha	-0.86495	0.6111	0.8733	0.8818	0.8975	0.6704	0.5284	-0.1578	-0.8522	0.7991	0.8309	0.8818	0.8563	1.0000	-0.8377
WRE	0.91883	-0.6300	-0.6396	-0.7516	-0.7824	-0.7150	-0.6158	0.6188	0.9652	-0.5537	-0.7010	-0.7516	-0.7249	-0.8377	1.0000

Correlations within the group (analysis of the whole) Group:trend: grains. Marked coefficients of correlation are significant with p<0.5000

	Area	Materials and raw materials PLN/ha	Operation of aggregates PLN/ha	Labour input man-hour PLN/ha	Total costs PLN/ha	Agricultural income PLN/ha	Revenue PLN/ha	Subsidy PLN/ha	WRK	Direct energy carriers MJ/ha	Raw materials and materials MJ/ha	Live labour MJ/ha	Investment inputs MJ/ha	Total energy input MJ/ha	WRE
Area	1.00000	0.20405	-0.55395	-0.44579	-0.37252	0.06332	0.17923	-0.36592	-0.21810	-0.10825	0.24767	-0.44579	-0.58388	-0.42906	-0.01082
Materials and raw materials PLN/ha	0.20405	1.00000	0.38622	0.63694	0.70235	0.58562	0.30672	0.40537	0.19314	0.72656	0.87131	0.63694	0.33766	0.61098	-0.00274
Operation of aggregates PLN/ha	-0.55395	0.38622	1.00000	0.67707	0.92447	0.42052	-0.03776	0.41599	0.14133	0.71036	0.34978	0.67707	0.52376	0.63459	-0.07617
Labour input man-hour PLN/ha	-0.44579	0.63694	0.67707	1.00000	0.82257	0.42674	0.25782	0.86895	0.66348	0.58040	0.64028	1.00000	0.86263	0.94972	0.37593
Total costs PLN/ha	-0.37252	0.70235	0.92447	0.82257	1.00000	0.55525	0.11217	0.54034	0.24656	0.82844	0.63141	0.82257	0.59194	0.77739	-0.01063
Agricultural income PLN/ha	0.06332	0.58562	0.42052	0.42674	0.55525	1.00000	0.82108	0.29080	0.11845	0.60386	0.74732	0.42674	0.26372	0.49666	-0.12146
Revenue PLN/ha	0.17923	0.30672	-0.03776	0.25782	0.11217	0.82108	1.00000	0.38175	0.37865	0.14686	0.58246	0.25782	0.28635	0.38877	0.17486
Subsidy PLN/ha	-0.36592	0.40537	0.41599	0.86895	0.54034	0.29080	0.38175	1.00000	0.92678	0.22371	0.49919	0.86895	0.94303	0.91121	0.64292
WRK	-0.21810	0.19314	0.14133	0.66348	0.24656	0.11845	0.37865	0.92678	1.00000	-0.03667	0.30339	0.66348	0.79707	0.70020	0.84555
Direct energy carriers MJ/ha	-0.10825	0.72656	0.71036	0.58040	0.82844	0.60386	0.14686	0.22371	-0.03667	1.00000	0.63647	0.58040	0.22005	0.51409	-0.18276
Raw materials and materials MJ/ha	0.24767	0.87131	0.34978	0.64028	0.63141	0.74732	0.58246	0.49919	0.30339	0.63647	1.00000	0.64028	0.40873	0.67907	0.02179
Live labour MJ/ha	-0.44579	0.63694	0.67707	1.00000	0.82257	0.42674	0.25782	0.86895	0.66348	0.58040	0.64028	1.00000	0.86263	0.94972	0.37593
Investment inputs MJ/ha	-0.58388	0.33766	0.52376	0.86263	0.59194	0.26372	0.28635	0.94303	0.79707	0.22005	0.40873	0.86263	1.00000	0.93382	0.42358
Total energy input MJ/ha	-0.42906	0.61098	0.63459	0.94972	0.77739	0.49666	0.38877	0.91121	0.70020	0.51409	0.67907	0.94972	0.93382	1.00000	0.31169
WRE	-0.01082	-0.00274	-0.07617	0.37593	-0.01063	-0.12146	0.17486	0.64292	0.84555	-0.18276	0.02179	0.37593	0.42358	0.31169	1.00000

Correlations within the group (analysis of the whole) Group: trend: orchard. Marked coefficients of correlation are significant with p<0.5000

	Area	Materials and raw materials PLN/ha	Operation of aggregates PLN/ha	Labour input man-hour PLN/ha	Total costs PLN/ha	Agricultural income PLN/ha	Revenue PLN/ha	Subsidy PLN/ha	WRK	Direct energy carriers MJ/ha	Raw materials and materials MJ/ha	Live labour MJ/ha	Investment inputs MJ/ha	Total energy input MJ/ha	WRE
Area	1.00000	0.16487	-0.65273	-0.60777	-0.68474	-0.64050	-0.39560	0.02526	0.74285	-0.77161	-0.37109	-0.60777	-0.62497	-0.86181	0.84437
Materials and raw materials PLN/ha	0.16487	1.00000	-0.31931	0.01914	0.32541	0.06825	-0.08846	-0.13624	-0.31352	-0.32805	-0.05787	0.01914	-0.06562	-0.13389	-0.12164
Operation of aggregates PLN/ha	-0.65273	-0.31931	1.00000	0.23925	0.66597	0.11797	-0.20646	0.21287	-0.45035	0.68220	0.32887	0.23925	0.85880	0.72981	-0.48478
Labour input man-hour PLN/ha	-0.60777	0.01914	0.23925	1.00000	0.68383	0.80781	0.59196	-0.40064	-0.65996	0.58167	0.10032	1.00000	0.13111	0.69501	-0.66006
Total costs PLN/ha	-0.68474	0.32541	0.66597	0.68383	1.00000	0.52697	0.09957	-0.12175	-0.82622	0.60382	0.25559	0.68383	0.64854	0.80089	-0.74634
Agricultural income PLN/ha	-0.64050	0.06825	0.11797	0.80781	0.52697	1.00000	0.89813	-0.38340	-0.69731	0.54553	0.30541	0.80781	-0.03064	0.64350	-0.75899
Revenue PLN/ha	-0.39560	-0.08846	-0.20646	0.59196	0.09957	0.89813	1.00000	-0.38589	-0.38891	0.32628	0.22532	0.59196	-0.37143	0.33902	-0.50246
Subsidy PLN/ha	0.02526	-0.13624	0.21287	-0.40064	-0.12175	-0.38340	-0.38589	1.00000	0.04338	-0.06655	0.14297	-0.39898	0.13060	-0.08597	0.01810
WRK	0.74285	-0.31352	-0.45035	-0.65996	-0.82622	-0.69731	-0.38891	0.04338	1.00000	-0.59705	-0.26181	-0.65996	-0.41050	-0.71488	0.95977
Direct energy carriers MJ/ha	-0.77161	-0.32805	0.68220	0.58167	0.60382	0.54553	0.32628	-0.06655	-0.59705	1.00000	0.04438	0.58167	0.49418	0.72232	-0.65386
Raw materials and materials MJ/ha	-0.37109	-0.05787	0.32887	0.10032	0.25559	0.30541	0.22532	0.14297	-0.26181	0.04438	1.00000	0.10032	0.26096	0.60492	-0.42168
Live labour MJ/ha	-0.60777	0.01914	0.23925	1.00000	0.68383	0.80781	0.59196	-0.39898	-0.65996	0.58167	0.10032	1.00000	0.13111	0.69501	-0.66006
Investment inputs MJ/ha	-0.62497	-0.06562	0.85880	0.13111	0.64854	-0.03064	-0.37143	0.13060	-0.41050	0.49418	0.26096	0.13111	1.00000	0.64210	-0.42247
Total energy input MJ/ha	-0.86181	-0.13389	0.72981	0.69501	0.80089	0.64350	0.33902	-0.08597	-0.71488	0.72232	0.60492	0.69501	0.64210	1.00000	-0.80934
WRE	0.84437	-0.12164	-0.48478	-0.66006	-0.74634	-0.75899	-0.50246	0.01810	0.95977	-0.65386	-0.42168	-0.66006	-0.42247	-0.80934	1.00000

Annex 2

Developed tables of variations with Duncan test

Analysis of variance (analysis of the whole). The underlined effects are significant with p □0.5000

	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
Area	5.945439E+03	2	2.972719E+03	6.126925E+03	93	66	45.1226	0.000000
Materials and raw materials PLN/ha	1.327600E+08	2	6.637998E+07	1.141440E+08	93	1227355	54.0838	0.000000
Operation of aggregates PLN/ha	7.362898E+07	2	3.681449E+07	1.405349E+08	93	1511127	24.3623	0.000000
Labour input man-hour PLN/ha	3.234060E+08	2	1.617030E+08	8.873833E+07	93	954176	169.4688	0.000000
Total costs PLN/ha	1.397101E+09	2	6.985504E+08	4.497698E+08	93	4836234	144.4410	0.000000
Agricultural income PLN/ha	1.164910E+10	2	5.824549E+09	4.190854E+09	93	45062945	129.2536	0.000000
Revenue PLN/ha	4.813949E+09	2	2.406975E+09	2.823289E+09	93	30357950	79.2865	0.000000
Subsidy PLN/ha	1.507923E+06	2	7.539615E+05	2.873292E+06	93	30896	24.4035	0.000000
WRK	8.270271E+03	2	4.135136E+03	1.784568E+03	93	19	215.4962	0.000000
Direct energy carriers MJ/ha	8.872467E+08	2	4.436234E+08	5.059989E+08	93	5440848	81.5357	0.000000
Raw materials and materials MJ/ha	1.238897E+09	2	6.194487E+08	1.534138E+09	93	16496110	37.5512	0.000000
Live labour MJ/ha	5.704895E+09	2	2.852447E+09	1.565367E+09	93	16831902	169.4667	0.000000
Investment inputs MJ/ha	1.628244E+09	2	8.141222E+08	2.752272E+09	93	29594326	27.5094	0.000000
Total energy input MJ/ha	1.502231E+10	2	7.511153E+09	1.190349E+10	93	127994517	58.6834	0.000000
WRE	7.030820E+03	2	3.515410E+03	1.148392E+03	93	12	284.6877	0.000000

Area		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.049983
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.049983	0.000106	

Materials and raw materials PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.966396
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.966396	0.000106	

Operation of aggregates PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.002179	0.006108
	Grains {2}	0.002179		0.000106
	Orchard {3}	0.006108	0.000106	

Labour input man-hour PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000106
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000106	0.000106	

Total costs PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000109
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000109	0.000106	

Agricultural income PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000198
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000198	0.000106	

Revenue PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.006343
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.006343	0.000106	

Subsidy PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.001016	0.012691
	Grains {2}	0.001016		0.000106
	Orchard {3}	0.012691	0.000106	

WRK		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000178
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000178	0.000106	

Direct energy carriers MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.595511	0.000106
	Grains {2}	0.595511		0.000106
	Orchard {3}	0.000106	0.000106	

Raw materials and materials MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000106
	Grains {2}	0.000106		0.511387
	Orchard {3}	0.000106	0.511387	

Live labour MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000106
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000106	0.000106	

Investment inputs MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000107
	Grains {2}	0.000106		0.238324
	Orchard {3}	0.000107	0.238324	

Total energy input MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.899089
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.899089	0.000106	

WRE		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0.000106	0.000106
	Grains {2}	0.000106		0.000106
	Orchard {3}	0.000106	0.000106	

Area		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,049983
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,049983	0,000106	

Materials and raw materials PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,966396
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,966396	0,000106	

Operation of aggregates PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,002179	0,006108
	Grains {2}	0,002179		0,000106
	Orchard {3}	0,006108	0,000106	

Labour input man-hour PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000106
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000106	0,000106	

Total costs PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000109
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000109	0,000106	

Agricultural income PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000198
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000198	0,000106	

Revenue PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,006343
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,006343	0,000106	

Subsidy PLN/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,001016	0,012691
	Grains {2}	0,001016		0,000106
	Orchard {3}	0,012691	0,000106	

WRK		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000178
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000178	0,000106	

Direct energy carriers MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,595511	0,000106
	Grains {2}	0,595511		0,000106
	Orchard {3}	0,000106	0,000106	

Raw materials and materials MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000106
	Grains {2}	0,000106		0,511387
	Orchard {3}	0,000106	0,511387	

Live labour MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000106
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000106	0,000106	

Investment inputs MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000107
	Grains {2}	0,000106		0,238324
	Orchard {3}	0,000107	0,238324	

Total energy input MJ/ha		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,899089
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,899089	0,000106	

WRE		Vegetables {1}	Grains {2}	Orchard {3}
	Vegetables {1}		0,000106	0,000106
	Grains {2}	0,000106		0,000106
	Orchard {3}	0,000106	0,000106	