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MODERNIZATION OF AGRICULTURE VS SUSTAINABLE AGRICULTURE

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Abstract

The paper shows the correlation between the need to modernise agriculture and sustainable development. Modernisation of agriculture aiming only at increasing the efficiency of production, if implemented in accordance with the principles of sustainable development, enabled reduction in the negative external effects. Modernisation of agriculture is supposed to ensure productivity growth without imposing any threats to the natural environment and the well-being of animals, reduced impoverishment in rural areas as well as to ensure food security, growth in the profitability of farms, improvement to the efficiency of use of natural resources. Therefore, in the near future, the agriculture – environment relation will be subject to change taking into account, on the one hand, concern about the natural environment, and, on the other, pressure on increasing the efficiency of production. The above challenges will be addressed by the need to implement efficient and, at the same time, environmentally-friendly production technologies and relevant legal instruments which oblige agricultural producers to protect the natural environment.

Key words : *modernisation of agriculture, production technologies, sustainable development*

INTRODUCTION

Modernisation of agriculture is a process of transforming agriculture from traditional labour-based agriculture to technology-based agriculture [25]. It is one of the fundamental issues in agricultural policies, particularly in countries, where agriculture is less developed. We can see that in many countries agriculture is a sector of economy which keeps a greater distance than the remaining sectors from modern solutions in the areas of: production technology and organisation, implementation of modern technological and IT solutions as well as management methods, but also with regard to the utilisation of the institutional setting. The speed and the scope of the creation and implementation of modernisation of farms ensure their permanent competitive edge. We can also see that low-income countries are burdened with primitive technologies, which is both a reason for, and a consequence of low incomes [3]. Therefore, the modernisation process and technological change are regarded as the driving force behind economic growth. As a result of an appropriately implemented process of modernisation of farms, the effectiveness of management improves, the working conditions improve and, finally, the level of satisfaction from the performed work increases. However, inappropriately designed or inappropriately implemented modernisation may bring unfavourable effects.

MATERIALS AND METHODS

The aim of this study is to demonstrate the correlation between modernisation of agriculture and sustainable agriculture.
The research was based on mass statistical data from the World Bank and the Main Statistics Office in Poland. In the study, the following research methods were applied:
1. 1. critical and cognitive analysis of the theoretical frameworks found in the literature,
2. analysis of mass statistical data.

RESULTS AND DISCUSSIONS

Modernisation of agriculture is a continuing process and it is the essence of progress in

agriculture and in rural areas. Constant creation and implementation of new technologies is used as a standard reference in differentiating modern agriculture from traditional agriculture [23]. Agriculture in economically developed countries has changed significantly thanks to broadly understood progress. Implementation of new solutions in the organisation of farms and of new production technologies has increased production volumes, decreased employment levels in agriculture and lessened the burdensomeness of work as well as has brought a better quality of products and has decreased the environmental nuisance of agriculture. Beside the increase in the effectiveness of management in agriculture, technological progress contributes to the reduction in the level of risk of management [16].

Modernisation of production methodology in agriculture through implementation of new technological solutions follows from the presence of the so-called "technology treadmill" [3, 8, 10]. This results in a constant need to keep up with technological progress, or even the need to spearhead this race. When new technology is being implemented in agricultural practice, the first farmers – innovators are those who benefit most. The advantages of being "the first" are related to the possibility of increasing agricultural income. This is a consequence of decreasing individual costs of production with the market price typical of the old technology. With time, the economic gains obtained by innovators attract new farmers who hope to achieve similar effects. However, when most farmers introduce new technological solutions, supply of a given product increases. The low flexibility of food demand and the higher price flexibility of supply often lead to price reductions. A case in point is the data describing real prices of selected agricultural products in Poland in the period 1990 – 2011. During the restructuring and modernisation of Polish agriculture, a decrease in real prices was observed (Fig. 1). Similarly, J.P. Chavas [7], analysing the evolution of real prices of agricultural products on the maize, milk and wheat market in the USA over the past 100 years, reported a persistent downward trend.

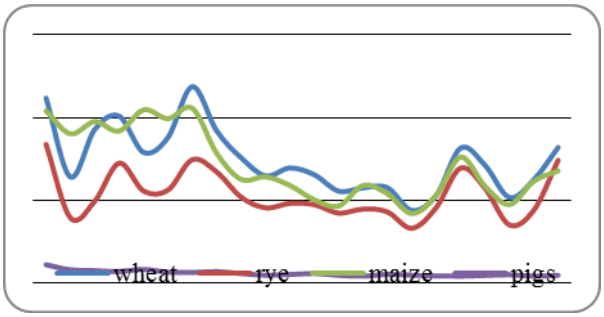
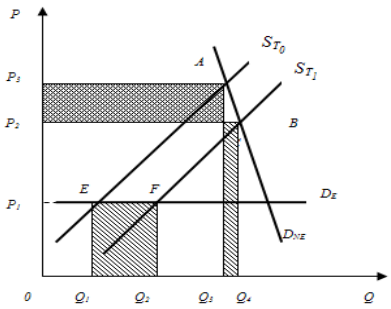


Fig. 1. Real prices (PLN) on the wheat, rye and maize market in Poland in the period 1990 – 2010 (constant prices in 2010)
Source: author's own data based on statistics from the Main Statistics Office in Poland

As a result, the main beneficiaries of the modernisation of agriculture are consumers and not agricultural producers (Fig. 2). The area of field Q_3Q_4BC indicating the advantages of the growth in production when new technology is being used is smaller than the area of field P_2P_3AC indicating reduction in the advantages on the part of producers resulting from price decreases. Only in the case of producers who experience endlessly elastic demand are higher profits arising from technological change wholly attributable to producers (Fig. 2).



ST_0 – aggregate supply in the case of old technology; ST_1 – aggregate supply in the case of new technology; D_E – perfectly elastic demand; D_{NE} – inelastic demand

Fig. 2. Technological change vs. producers' gains in the case of inelastic and perfectly elastic demand
Source: author's own data

The majority of agricultural products show low price flexibility of demand and it is for this reason that in the long run agricultural producers seem not to benefit from technological progress. Agricultural producers adapting new technologies which reduce

individual costs, and increase productivity. New technologies cause a transfer of aggregate supply, as a result of which prices go down. In the end, farmers may face a situation which is worse than that existing prior to the technological change [3, 8, 10, 12]. Empirical data suggest that an increase in well-being resulting from technological progress in agriculture is captured" as consumer surplus resulting from lower prices and not as producer surplus [1, 12, 20].

The importance of agricultural progress results from its effects, including, above all: (i) quantitative increase in production, (ii) reduction in individual costs of production and (iii) increase in production potential. The benefits of farms arising from the modernisation of production methods consisting in the implementation of broadly understood technological progress in the short term lead to an increase in agricultural income and/or a decrease in demand for factors of production. However, in the long run, due to the technology treadmill mentioned above, the benefits are difficult to maintain. Because of the low flexibility of demand for agricultural products, the benefits are obtained mainly by food consumers. In the long run, technological progress does not always lead to an increase in agricultural income. After a certain kind of innovation is commonly introduced, all farms may have lower profitability than prior to this change. Despite this effect, however, farms are doomed to permanent modernisation. Ignoring this process may result in an even greater reduction in income than in the case of continuous implementation of modernisation.

Industrialisation and modernisation have significantly changed agriculture, shifting it towards new technologies which enable production of a substantial number of products in the most effective way possible. This has caused a substantial increase in the concentration and specialisation of production, changed the structure of factors of production, caused a reconstruction of agrarian structures as well as has created a new organisation of production processes. Over the past few decades, modernised agriculture, thanks to an increase in the volume of agricultural production, has brought the possibility of feeding an increasingly greater number of people worldwide as well as famine reduction [2, 3, 5, 6, 7, 18, 19, 24, 26]. However, the industrialisation and modernisation processes have upset, in many respects, the ecological balance. Industrialised agriculture has caused a radical decrease in the number of farms and employment levels in agriculture, reflected in greater migration from the countryside and the growing problem of overt and covert unemployment. Modernisation of agriculture may also equal a greater threat to the natural environment, lowering of the quality of food products and increased social costs of production [4]. In connection with the above, apart from the many benefits related to the modernisation of agriculture, we may witness undesirable ecological as well as social and cultural effects, and those related to food consumption, particularly in the case of an inappropriately implemented modernisation of agricultural production (Fig. 3).

The direction of the development of agriculture which has been pursued so far and which has been based on the criterion of microeconomic effectiveness (aimed at maximising economic gains) has been subject to criticism.

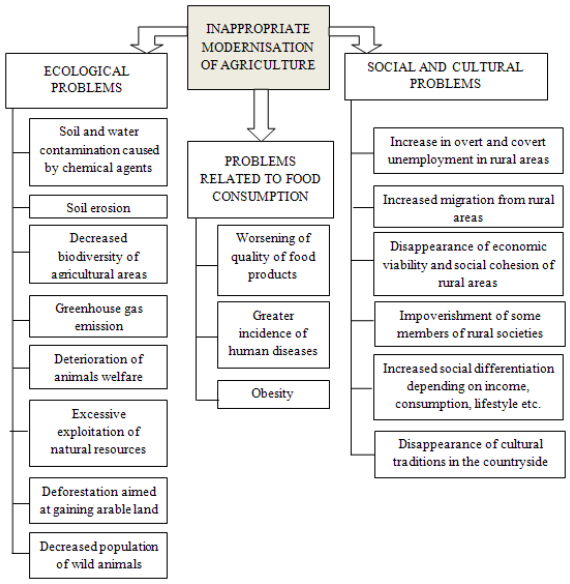


Fig. 3. Inappropriate modernisation of agriculture vs. social and cultural as well as environmental problems
Source: author's own data

The dominance of economic goals, including the pursuit of the maximisation of profit, leads to an upset ecological and social balance. Private and economic understanding of the rationality of conduct usually does not correspond to general social (global) rationality. What is beneficial to individual entities, i.e. on the microeconomic scale, is not always beneficial to all, that is on the macroeconomic scale. For this reason, it is necessary for one to seek a compromise, taking into account both the producer's interests and the interests of society. Figure 4 shows a theoretical model which enables the determination of a social optimum. This model entails a comparison of economic gains with the costs of environmental nuisance. The producer's optimum is at N_2, where the volume of production results in the maximum profit (marginal profit equals zero). At the same time, social costs, such as, for instance, soil erosion, elution of nitrates, disappearance of species, poorer product quality, deterioration of the well-being of animals and growing environmental pollution. The social optimum N_1 is found at the intersection of the marginal gains and the marginal social costs. Thus, it is the optimal level of intensity of production, taking into account not only the producer's interests, but also ecological and ethical goals. The goal of sustainable agriculture is to ensure the possibility of attaining the greatest gains possible, both private and ecological. At the same time, the level of the achievable private goods in the case of sustainable agriculture is lower, but it allows one to achieve social benefits (public goods).

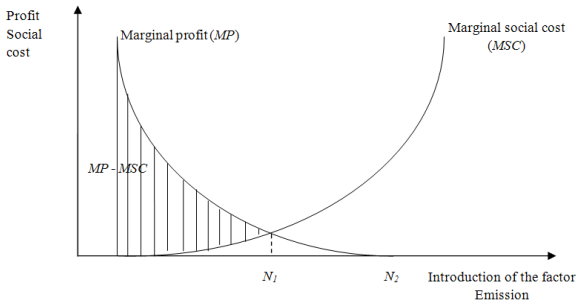


Fig. 4. Determination of the social optimum from the point of view of an individual producer depending on environmental nuisance

Source: author's own data based on: [17, 22]

An essential question arises here: do the regulations and restrictions related to environmental protection or the well-being of animals lead to increased individual production costs, decreased individual efficiency, reduced agricultural income and, as a consequence, reduced effectiveness of management? The idea of constant conflict between environmental goals and economic goals stems from the static view on environmental regulations, where products, technologies, processes and consumers' needs are constant. In this static vision economic entities minimise individual production costs, while environmental protection regulations inevitably increase these costs. However, over the past few decades, the competitiveness paradigm has been shifted from the static model towards the dynamic one. In the dynamic model, the new paradigm is based on innovativeness. Appropriately designed environmental protection regulations may lead to innovations which can balance the costs related to compliance with these regulations. Environmental protection regulations should aim at improving the effectiveness of the management of resources, rather than focus on limiting pollution. Such a policy promotes both ecology and competitiveness of economic entities [21].

The necessity of sustainable development in agriculture is motivated by the dissatisfaction with the present state of affairs, but it also follows from the benefits arising from the implementation of modern, environmentally-friendly technological solutions. Drastic changes which have occurred in agriculture over the past 100 years have resulted from external stimuli and they have been a response to social needs. It is difficult to agree with the claim that science and technology are by nature anti-environmental [26]. Studies by Y. Hayami and V.M. Ruttan [13] as well as Z. Griliches [11] have demonstrated that technologies have evolved and have been adopted in response to external stimuli. In situations, where new production technologies harmed the natural environment, this was

often a result of the absence of legal regulations or the lack of incentives promoting harm prevention. The reasons behind this state of affairs can be found in misguided policies, dysfunctional institutions and a dysfunctional control and management system. An exceptionally high number of negative external effects related to the modernisation of agriculture can be seen in developing countries, particularly in the south [9].

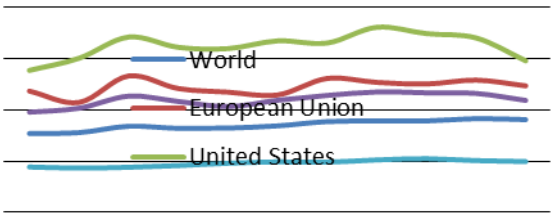


Fig. 5. Global grain crops in the period 2002 – 20012 (Hg/ha)
Source: author's own data based on statistics of The World Bank

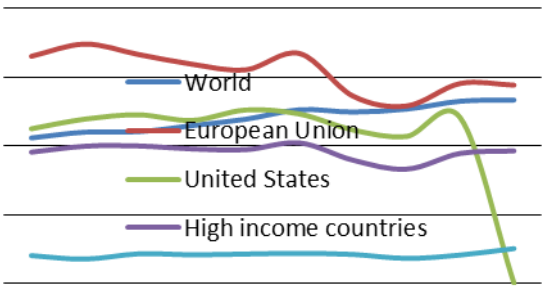


Fig. 6. Consumption of mineral fertilisers [kg/ha of arable land] in the period 2002 – 2009
Source: author's own data based on statistics of The World Bank

A vital role in ensuring sustainable development of agriculture is played by present-day research which enables mitigation of many unfavourable external effects related to modern agriculture. A case in point is that of grain crops in the period 2002 – 2012 (Fig. 5), which show an upward trend both globally and in individual regions (global growth by 17.7%, EU 4.3%, USA 6.8%, high-income countries 11.7%, low-income countries 12.0%). At the same time, consumption of mineral fertilisers showed varied trends (Fig. 6). Worldwide, an increase by 26.1% in the consumption of fertilisers was reported; however, a significant rise in the consumption of mineral fertilisers was observed in low-income countries (25.2%). On the other hand, in countries like the USA, consumption of mineral fertilisers grew by 7.8%, while high-income countries recorded a mere figure of 0.9%. In the EU, consumption of mineral fertilisers decreased during the period under analysis by 12.7%, with an increase in the level of crops by 4.3%. This may indicate that, especially in rich countries witnessing social pressure on environmental protection, one implements production technologies which enable reduction in the negative effect on the natural environment and maintenance of high production efficiency. Concern about the natural environment should lead to technological change oriented both towards "repairing" the environment and preventing the negative impact that agriculture has on the natural environment. Priority should be given to production technologies which ensure increased efficiency and sustainable use of natural resources.

What is also significant is the search for optimal technological solutions taking into account local conditions of agricultural production. The variety of environmental and climate conditions as well as social and economic conditions suggests that technological solutions must be diversified in space and time as well as adjusted to the specific conditions of a given location. Uniform solutions to production problems which occur in agriculture are impossible. Development of strategies which promote initiative and enterprise among farmers, facilitate adaptation of new technologies and, further, facilitate farmers' application of knowledge and practical skills in the development of new technological solutions is a key challenge for scientists, political decision-makers and local activists.

One of the ways in which problems related to the modernisation of agriculture can be solved, consisting in the need to combine an increase in the effectiveness of production with the reduction in the harmful effect of agricultural production on the natural environment, is the application of high-precision technologies. They are technologies

which enable the application, from the very beginning, of the exact number of means of production according to the real needs of animals and plants, taking into account variable environmental conditions. Comparing the profitability of different production technologies in agriculture, M. Khanna and D. Zilberman [15] demonstrated that high-precision technologies lead to an increase in income, reduction in variable costs and less environmental nuisance, but, at the same time, that they also contribute to an increase in constant costs. The possibility of using these technologies depends on whether an increase in efficiency, reduction in the use of means of production and reduction in environmental pollution are greater than the increase in constant costs. Whether net positive results are obtained depends on the level of acceptance of high- precision technologies. One of the reasons why these technologies are not so commonly adopted, which is socially optimal, is the fact that environmental pollution does not affect directly the farms that generate it. The main reason for environmental protection problems in agriculture is the fact that producers do not take into account in their economic calculations the social costs related to their production choices. This, in turn, results in the lack of interest in investments in production technologies limiting the negative impact on the environment as well as excessive use of means of production in the applied technologies (e.g. excessive irrigation, excessive use of chemicals) [26]. In this situation, it is necessary to implement legal solutions which enforce environmental protection as well as an increase in prices of agricultural products or an increase in prices of means of production, thus contributing to greater economic effectiveness of investments in high-precision technologies. An additional factor which brings about the need to take into account ecological aspects in decisions related to production is the growing ecological awareness of consumers. Obtaining information about the pro-environmental activity of economic entities may increase demand for its products and, at the same time, force these entities to take initiatives aimed at self-regulation and limitation of activities which harm the natural environment [14].

CONCLUSIONS

What matters in the development of agriculture is the search for sustainable agricultural systems taking into account not only economic and social goals, but also ecological ones. This task is a difficult enterprise because the goals often exclude each other. On the one hand, one strives to achieve a high rate of production efficiency growth, but on the other, there is a need to ensure just distribution of income and to take into account environmental aspects when making economic decisions. Identification of potential areas of conflict enables one to seek a compromise as well as to pursue a relevant development policy and design its instruments. One should also reject the notion that economic growth is permanently linked to degradation of natural resources, while the lack of growth equals preservation of these resources.

Modernisation of agriculture which aims only at increasing production efficiency, if it is implemented in accordance with the principles of sustainable development, will enable one to limit the unfavourable external effects. Development of agriculture based on the industrial model encounters obstacles related to the finiteness of natural resources and the capacity of the environment in terms of the consequences of the anthropogenic impact. Another factor which limits the industrial development model is the pressure to include external effects in the economic calculations in agriculture alongside the "rights" of farm animals as well as the social and cultural consequences, such as those related to the viability of rural areas.

REFERENCES

[1]Baland, J.M., Kotwal, A., 1998, The political economy of underinvestment in agriculture. Journal of Development Economics, Vol. 55, pp. 233 – 247

[2]Ball, V.E., Bureau, J.Ch., Nehring, R., Somwaru, A., 1997, Agricultural Productivity Revisited. American

Journal of Agricultural Economics 79 (November 1997), pp. 1045 – 1063
[3]Barrett, C.B., Carter, M.R., Timmer, C.P., 2010, A Century–Long Perspective on Agricultural Development. American Journal of Agricultural Economics 92 (2), pp. 447 – 468
[4]Batie, S.S., 1989, Sustainable development: challenges to the profession of agricultural economics. American Journal of Agricultural Economics, Vol. 71, no. 5, pp. 1083 – 1101
[5]Brennan, J.P., 1984, Measuring the contribution of new varieties to increasing wheat yields. Review of Marketing and Agricultural Economics 52 (December), pp. 175 – 195
[6]Byerlee, D., 1996, . Modern varieties, productivity and sustainability: recent experience and emerging challenges. World Development 24 (April), pp. 697–718
[7]Chavas, J.P., 2011, Agricultural Policy in a uncertain world. European Review of Agricultural Economics, Vol 38(3), pp. 383 – 407
[8]Cochrane, W.W., 1958, Farm Prices: Myth and Reality. Minneapolis, University of Minnesota Press
[9]Davis, C.G., Langham, M.R., 1995, Agricultural Industrialization and Sustainable Development: A Global Perspective. Journal of Agricultural & Applied Economics No. 27 (1), July, Southern Agricultural Economics Association, pp. 21 – 34
[10]Gardner, B.L, 2002, American Agriculture in the Twentieth Century: How it Flourished and What it Cost. Cambridge, MA: Harvard University Press
[11]Griliches, Z., 1957, Hybrid corn: an exploration in the economics of technological change. Econometrica, Vol. 25, No. 4, pp. 501 – 522
[12]Hardaker, J.B., Anderson, J.R., Dillon, J.L., 1984, Perspectives on assessing the impacts of improved agricultural technologies in developing countries. Australian Journal of Agricultural Economics, Vol. 28, Nos 2 and 3 (August/December), pp. 87 – 108
[13]Hayami, Y., Ruttan, V.M., 1985, Agricultural Development: An International Perspective. Johns Hopkins University Press, Baltimore
[14]Khanna, M. , 2001, Non-Mandatory Approaches to Environmental Protection. Journal of Economic Surveys, Vol. 15, Issue 3, pp. 291 – 324
[15]Khanna, M., Zilberman, D., 1996, Incentives, precision technology and environmental protection. Ecological Economics, Vol. 23, Issue 1, pp. 25 – 43
[16]Kim, K., Chavas, J.P., 2003, Technological change and risk management: an application to the economics of corn production. Agricultural Economics, No. 29, pp. 125 – 142
[17]Marks – Bielska, R., 2011, Chosen aspects of sustainable development in Poland with particular focus on agriculture. Management theory and studies for rural business and infrastructure development. 2011. Nr. 2 (26). Research papers, pp. 160 – 168
[18]Master, W.A., Bedingar, T., Oehmke, J.F., 1998, The impact of agricultural research in Africa: aggregate and case study evidence. Agricultural Economics 19 (September), pp. 81 – 86
[19]Matejková, E., Qineti, A., Serenčéš, R., 2008, Macroeconomic aspects of the development of Slovak regions in the post-accession period. Agricultural Economics – Czech, nr 54 (8), pp. 367 – 375
[20]Minten, B., Barrett, C.B., 2008, Agricultural Technology, Productivity and Poverty in Madagascar. Word Development Volume 36, Issue 5, pp. 797 – 822
[21]Porter, M.E., van der Linde, C., 1995, Toward a New Conception of the Environment-Competitiveness Relationship. The Journal of Economic Perspectives, Vol. 9, No. 4, pp. 97 – 118
[22]Reisch, E., Zeddies, J., 1983, Einführung in die landwirtschaftliche Betriebslehre. Volume 2, 2nd Edition, Stuttgart: Verlag Eugen Ulmer
[23]Schultz, T.W., 1964, Transforming Traditional Agriculture. Yale University Press, New Haven
[24]Solow, R.M., 1957, Technical Change and the Aggregate Production Function. Review of Economics and Statistic 39, pp. 312 – 320
[25]Wu, Z.-I., 2011, Research on Harmony between Agricultural Modernization and regional Economy Developmentin China. Asian Agricultural Research, 3(3), pp. 6 – 10
[26]Zilberman, D., Khanna, M., Lipper, L., 1997, Economics of new technologies for sustainable agriculture. The Australian Journal of Agricultural and Resources Economics, 41:1, pp. 63 – 80