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Boosting the competitiveness of agricultural production in Hungary through an innovation system

The final versions of the European Union's (EU) support schemes and funding instruments for the 2014-2020 budgeting period have not yet been prepared. What is final, though, is that the ten-year Lisbon Strategy which aimed at strengthening the competitiveness of the EU ended in 2010. In addition to three priorities (smart, sustainable and inclusive growth), the recently launched Europe 2020 Strategy has set five headline targets to be reached, one of them being an increased investment in research and development. This is evidently a difficult challenge owing to the limited economic capacity of individual EU Member States. A considerable share of agricultural production activities are performed by small- and medium-sized enterprises and farmers who face difficulty in reaching the level of concentration need to gain market advantage. Consequently, it is imperative to establish a system that can maintain close connections with producers and improve innovation activities. Without such a system, a significant growth of added value cannot be foreseen in Hungarian agriculture. This paper describes a technology development system that incorporates three elements (measurement of inputs in space and time, market-focused technology development and a self-teaching information system for farmers) and that could be used in rural development, primarily in the area of agricultural production. While developing the system, we relied on experience gained from the operation of previous agricultural production systems and also considered the specific local conditions with the aim of offering a potential solution to meeting the objectives of the Europe 2020 Strategy.

Keywords: cooperation, farmers, markets, public goods

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Introduction

The driving force behind the formation of agricultural production systems capable of development has always been the challenges and opportunities emerging in agricultural markets. The 1867 Compromise established a huge food market in the Austro-Hungarian Monarchy. For Hungary this led to an unprecedented agricultural development which established a system consisting of medium-sized and large estates where mechanisation played a key role. This in turn fostered the rapid development of the domestic farm engineering industry leading to a growing need for knowledge and a deeper understanding of production. As a result, the role of agro-education institutions considerably strengthened and by the end of the century (due to the efforts of Darányi Ignác, then Minister of Agriculture) a research network was established, the traces of which can still be seen today (Romány, 2002). These institutions later functioned as knowledge transfer centres. At the turn of the 19-20th century, agriculture played a crucial role in national economies, including that of Hungary.

During the interwar period the activity of the food market was not only maintained at the pre-war level but it grew stronger, consequently boosting agricultural production. This market-driven development was fostered both by the development of local trade (market system) that had the capacity to fully supply the domestic demand and by the birth of internal trading formations (the so-called Ants Cooperative) based on purchasing activities. The increase in demand brought about by the strengthening economy laid the foundations for sustainable growth. Under the influence of market-focused production development based on the further growth of mechanisation and a stable knowledge transfer system, smaller estates could also benefit from the changes (in the following years the majority of farmers running a family estate emerged as the so-called 'kulaks').

The post-war era introduced many political constraints which also influenced ownership structures, the use of land and the method of production. As a result of the market pull, a suitable production system was built, primarily under the auspices of Dimény Imre, Minister for Agriculture and Food. The system was basically a production solution (production system) built along agricultural supply chains which in turn were based on integrators. In addition to providing inputs and professional advice based on continuous learning, it also played an important role in processing. It was the responsibility of the integrators to provide the inputs and also to gather and understand the experience gained from the production process i.e. a kind of autodidactic system took shape which monitored the expectations of the market of the mid-20th century (Dimény, 1975; Dimény *et al.,* 2004). Similar integrators (such as KITE, IKR etc.) are well known across the world in expert circles. The operation of the system required in-depth knowledge, thus the number of research institutes and universities increased. However, their high quality work was basically limited to responding to orders. As a result, a number of institutes with expert staff were established but they had neither the initiative required by further changes nor the research capacity that could have been realised in production.

By the beginning of the 21st century both the production structure and the market had undergone considerable transformation and Hungary has not yet found a production system that is suitable to meet the new challenges. Takács *et al.* (2008) and Takács and Baranyai (2010) analysed competitive virtual large estates, identified the factors hindering their development and conducted model-based investigations. Today, almost every country is characterised by the diversity of agricultural producers and estates while the most pronounced change in the past decade has been the formation and increasingly significant role of vertically integrated agricultural supply chains (Csáki, 2012).

Based on the extrapolation of the historical trends above, the present study outlines an autodidactic production system which is adapted to the present situation and prevailing conditions. It incorporates three elements: measurement of inputs in space and time, market-focused technology development and a self-teaching information system for farmers.

At present there are great market opportunities but the risks are perhaps even greater. Although the agricultural industry is still productive, it has become more fragile owing to the profit optimisations stakeholders wish to achieve at a future time and to the fact that they have been losing ground in the domestic market. This situation calls for the more active participation of researchers. Since the relationship between producers and input suppliers is to a large extent determined by space, input users are tightly controlled by a network of agents representing manufacturers and traders while their relationship is defined by the efforts of traders to maximise profits. This is unfortunate since producers have few opportunities to review the full supply portfolio and make use of the most favourable offers by comparing all the offers available on the market (e.g. minimum purchase price, best quality, etc.).

Dimény (1975) states that 'the technical development of agriculture rests on four pillars, namely biological, chemical, technical and human factors, among which technical includes mechanisation and architecture, too'. The total annual turnover of inputs (pillars) amounts to an estimated HUF 4-600 billion. On the one hand, experience suggests that the pressure exerted on the input side generates a profit margin of about 15-20% for traders and this is basically financed by producers, thus reducing the possibility for the latter to realise that profit for themselves. On the other hand, the annual subsidies allocated to the agricultural industry are mostly used by those who purchase produce at depressed price levels. Consequently, the profit realised by the agrarian sector is small and this prevents the increase in production. It is of crucial importance to improve the position of farmers and to exploit the opportunities emerging in the field of output sales. These issues also constituted the core objectives of our research. The model we developed offers a way out of that deadlock by improving the purchasing options available for agriculture, thus offering a chance to increase production.

Methodology

Economic growth is generated by continuous technical-economic innovation which is based on basic and applied research (Husti, 2009). Research (basic and applied), development, production and market together form the agricultural production system. If this connection cannot be formed within a specialty, the completed research result cannot be utilised. The essence of our method lies in the fact that in the course of research and development we concentrate on the products and services instead of focusing on the activities of various professional fields (such as research in mechanisation). The core objective of our system is to establish the ground for competitive production. The 'bridge' between the basic research and production is provided by the sector research institutes in each country. Consequently, the main task of research activities conducted in various professional fields is to improve the marketability of production and to increase added value. The organisations for applied research involved in various stages of the production process perform their activities and solve research problems with the aim of fostering success in the market. Besides the institutions conducting basic research related to arising hypotheses, farms experimenting with the realisation of research findings also play a key role (Figure 1).

This model is both a research and a production management system. The results we present observe the complexity of agricultural production including the differences in the use values of inputs applied in various fields, the characteristics of biological processes, the necessary cooperation of several different professional fields and the dynamic nature of the food market. The production management system spontaneously creates horizontal development directions as several segments may be identical in the course of the development that occurs along agricultural supply chains and activities, the management of which is then performed in a similar way. The fact that research findings are realised by the producers guarantees that R&D activities are useful and take the right direction. The research thus realised in the production process ensures its success in the market while the successful technologies introduced in this way set a 'spontaneous' example to other producers. The system has horizontal and vertical connections with the research and development centre and, ideally, each producer receives the production information that is relevant for them.

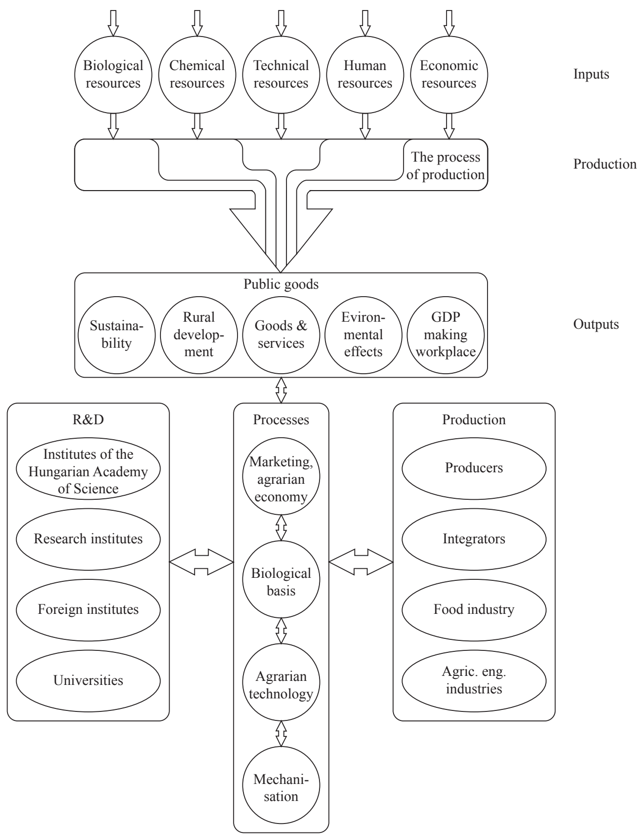

Figure 1: A model of production with the market-focused technology development system.

Results

Measurement of inputs in space and time

In order to foster efficient sustainability and economic production, we must be aware of the use value of technology which also influences the value indicators of public goods as external effects (Zheng Zhou *et al.,* 2005). The efficiency of agricultural production influences public goods as well, the value indicators of which are reflected in the environment, human health etc. Thus the analysis of the use value of inputs is given priority since these tend to change depending on the given production and utilisation conditions. Only by being aware of the multidimensional nature of use (technological) values are we able to select the most favourable input which may lead to the optimisation of utilisation (and technology).

In addition to the growth of private goods, one of the main aspirations of the new European agricultural policy is to produce more public goods and facilitate the creation of a liveable, developing rural area. By reducing and eliminating harmful environmental effects, available resources and a healthy life can be sustained. The case of public goods can be best served through innovation taking place by uniting active research, development and successful marketing activities. For example the appropriate production and use of bio-energy have favourable effects that go beyond the boundaries of the industry. The profits thus potentially available for producers are further increased by the development and improvement of trade in public goods (e.g. by reducing the emission of greenhouse gases, commercial profit and income can be realised).

The idea of utilising the local knowledge of inputs also constitutes a fundamental principle in Integrated Crop Management (ICM) (Lancon *et al.,* 2007). ICM is a system of crop production which conserves and enhances natural resources while producing food on an economically viable and sustainable foundation. It is based on a good understanding of the interactions between biology, environment and land management systems. ICM is particularly appropriate for small farmers because it minimises dependence on purchased inputs and makes the fullest possible use of indigenous technical knowledge and land use practices (Ángyán *et al.,* 2003). Since this model does not focus on technical inputs or the values defined by the common good, we need to concentrate on these issues.

Market-focused technology development

It is important that all hypotheses formulated during basic research as well as tasks carried out during applied research are linked to market-focused technology development, in other words, should directly serve agricultural production. As with chemicals and seed grains, technical and technology systems represent one of the inputs of agricultural production. Food safety, among other issues, can be effectively enhanced through the continuing improvement of agricultural technology (Popp and Molnár, 2010).

The innovation system defines the starting aims and tasks then continuously corrects them (Figure 2). So a 'self-teaching' structure has been prepared which always approximates the optimal solution. The squares with Arabic numbers symbolise the certain work-boards which carry out the above-mentioned analysis. The Roman numerals show the tasks-groups with consortium members. The first (1) group, where the market analysis takes place, should be underlined. The suggested way to start a research project is as follows:

- A coefficient is estimated (0-1 scale) which represent the value in use of the analysed expected research result (E);
- A similar coefficient is calculated which represents the difficulties of solving the process (K);
- The decision number (D) can be formed by: D = E K;
- The decision should be made by this 'D' level. If:
  - $D \leq 0.5$ the planned R&D programme is dropped;
  - $0.5 < D \leq 0.7$ detailed analysis of the estimated coefficients is conducted;
  - $0.7 < D \leq 1$ the programme is agreed.

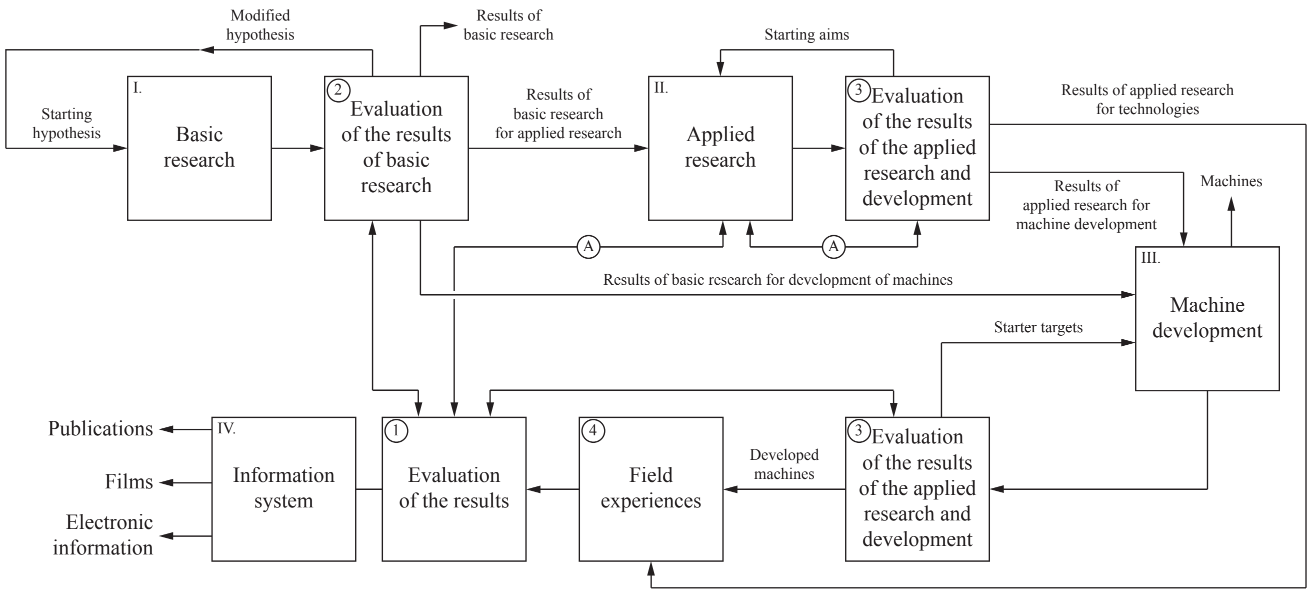

Figure 2: Managing and quality assurance system of the cooperation

Source: Redrawn from Dimény *et al.* (2004)

The method has contributed to the competitiveness of open-field vegetable production in Hungary. In the frame of machine development the main domestic invention is a special foil tuner maker and remover with salvation pipe layer. There have been excellent results in fresh green pepper technology development through which income per hectare has been significantly increased. The development of sweet corn production technology has contributed to a doubling of the yield in the last decade. So this part is the biggest in the Hungarian and European sweet corn production.

'Self-teaching' information system for farmers

A crucial element of the optimal operation system is the development of 'self-teaching' information technology (IT) consisting of traditional areas (e.g. training, professional advice, publications etc.) and electronic solutions. The central part of this development is a new digital information database that can also be conceived as a trade and production system in agriculture observing the following stipulations:

- Producers are perceived as being autonomous and equal persons and organisations who shall be empowered to make the best possible decisions and whose decisions relating to production are not restricted;
- Market relationships are a determining factor, thus activities and production shall meet the conditions defined by the market;
- The system shall also comply not only with the demands of the market but also with all of the other conditions that regulate its operation (e.g. environmental protection provisions, subsidies). Nevertheless, these basic conditions shall define only the conditions of operation and not the way the system operates;
- The system shall also act and think in the interest of the producer, providing opportunities for more successful production instead of imposing constraints with the aim of realising market benefits in each segment of agricultural production (regardless of the size of the estate, the production system, etc.).

The new IT gathers offers for its users (producers) and assists them with writing purchase and sales tenders thus forcing suppliers and buyers to compete. The number and circle of individuals offering supply may gradually increase since the system counts on new players entering the market. This leads to strengthened competition and an increase in the number of products being offered together with an improvement in their quality. Although the stakeholders of both the supply and demand markets will inevitably face competition in this system, they can also gain benefits since in this way the demand and supply markets of input products become more transparent, offering the possibility of systematic planning and a simple identification of market players which leads to more efficient trading activities. Through the information system, accurate data can be accessed about the use of inputs including their characteristics related to time, quality and quantity. The use and sales of quality products are guaranteed by quality management and standards while the faster flow of information leads to a reduction in costs. By embracing the full spectrum of producers, the system also provides the conditions for efficient information flow.

The users of the system may belong to different branches of the industry (plant production, livestock breeding or mixed farms). With the help of the system farmers may jointly indicate their intention to purchase input material regardless of their size and location. The information system motivates producers to cooperate. With the involvement of an increasing number of producers the coordination of production intensity may take place at a significantly higher, more extensive level. Cooperation may involve the harmonisation of their joint use of technical tools and a more efficient access to funds while the techniques of accessing market information would also improve. The joint coordination of research – development – innovation management tasks embracing a wider production structure provides a common ground for the application of innovation systems. Porter (2000) defined a cluster as a 'geographic concentration of inter-connected companies and institutions working in a common industry'. The cluster-based economic development model represents a synergy, a dynamic relationship and a network not only between the companies that comprise a cluster but also the successful partnering of the stakeholders in a knowledge-oriented system (Lagendijk and Charles, 1999; Gergely, 2006). The cluster organisations are not typical but some initiations have already started in Hungary.

Cooperative solutions facilitate the application of cutting-edge technological solutions and the results of innovative developments. At the same time the joint use of various types of machinery may improve the efficiency of the purchase and use of machines.

The external information transfer is based on GIS structures (e.g. land registration, animal registration systems) that cover the whole country and which also maintain the traditional forms of information provision (e.g. displays, training). The maintenance of the system would not involve additional costs since the research tasks of small- and medium-sized agricultural enterprises and their funding are mostly the responsibility of the state. On the other hand, the funds spent on these tasks could be more efficiently used since the operation of the system can be permanently monitored and its results can be easily measured.

Discussion

The system we have defined as market-focused technology development focuses on the marketing activities of the agricultural industry and on increasing the success of agricultural products. Phillips (2001), Kok *et al.* (2003) and Zheng Zhou *et al.* (2005) have also analysed market-driven production and market-oriented product development. The objectives of the system we have developed are as follows: inducing competition between input suppliers, increasing supply, loosening rigid trading structures, fostering the optimisation of mechanisation (investments, maintenance, etc.) and ensuring the possibility of appropriate technology development.

Within the framework of the system, the use value of inputs is important, i.e. what produce quality can be reached by using specific machines and how do these machines affect the environment and the sustainability of production (in the case of technical inputs)? The system also enables us to gain valuable knowledge that enhances the development of technologies and the investigation of environmental sustainability. By becoming aware of use values, Hungary will be able to exploit its domestic conditions and capacities, leading to a competitive advantage. The potential yield could be further increased by using both the innovation opportunities driven by the market and the research opportunities generated by innovation. The most important consideration in the field of agricultural innovation is not restricted to research but it also involves the task of making the end product or a rural development service more successful through the cooperation of various professional fields. Thus, the task is to conduct basic and applied research in each field such as mechanical engineering, the results of which can be directly utilised on the market. Successful innovation can be achieved through the cooperation of universities, research institutes and producers in the course of performing each production and rural development task.

On the basis of the results of the last decade it can be established that the developed system can be effective in the Hungarian environment. The self-teaching information structure guarantees that the solution we have worked out opens the door to the intensive development of Hungarian agriculture. By reducing the distorting effects of the funding system, innovation takes on a more important role which is efficiently supported in several fields by the system (e.g. investments, optimisation of operation, reduction of costs, enhanced research activities). By introducing an up-to-date IT solution Hungary can make better use of its unique agricultural potential, providing a competitive edge for its agricultural production and food industry which in turn would have a favourable effect on the domestic input production. Production-based research leads to the birth of new technologies and machines.

Our innovation development method can be successfully applied to systems developed for arable lands, livestock breeding, energy production and rural development. The biggest beneficiary of the system is the rural area since this is where the greater part of agricultural and food production takes place and where most environmental resources are found.

As far as the international scene is concerned, the model integrates the main production trends developed outside Hungary. It contains the logical elements of the integrated agricultural production concept but it does not limit the creation of the system to a single field. Instead, it offers a solution that involves the option of spatial transformation. It fits well into the Living Lab (Eriksson *et al.,* 2005) model but, in addition, it provides for the optimisation of the stakeholders both in the field of research and implementation. The modelling module of the system is easily extendable offering the option to build into the system the advantages of organic production. Consequently the system provides a unique solution which integrates the main international agriculture development trends (e.g. market-oriented technology development programmes). Furthermore, with the harmonisation of funding systems, the optimisation of the incentives of various sizes become more precise and professionally grounded, which may contribute to the optimisation of European Union and national funding.

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