INNOVATIONS IN THE AGRICULTURAL SECTOR

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Abstract

The aim of this paper is to show the impact and significance of innovation in agriculture. Its economic development takes place when innovation solutions based on knowledge and modern technologies are implemented and intensified. Innovations in agriculture encompass a number of operational fields: resource management, soil protection, cultivation processes, biodiversity protection, ecological cultivation and production of bioenergy. The demand for agricultural innovations in different localities may vary, therefore there is a need to bring together the local requirements through utilisation of a multitude of possibilities in a variety of ways, adjustment adaption capability and conditions of a particular rural environment. There is also a need to emphasise the strong integration of innovations in agriculture with other sectors of the economy, which is translated into the acquisition of new solutions and the introduction of innovations that encourage adjustment and the capability to cooperate as well as the application of modern technologies in the economy. Innovative activities that solve problems become the main stimulant to a dynamic economy in agriculture, allowing the most beneficial implementation of its potential.

This article has been divided into three parts, in the first, the author conducts a theoretical deliberation on the agricultural sector. The second part presents the conditions for innovation processes in this sector and the third, 'Innovative tendencies in the development of agriculture', includes the areas of innovative change in agriculture.

Key words: Innovations, new technologies, agriculture, local area

Introduction

The achievement of an adequate level of agricultural development requires implementation of resources and tools that allow constant advancement. Innovations are considered to be the main factor for this development. The introduction of innovations in agriculture gives the opportunity to improve the lives of rural communities. It allows more efficient production of competitive products and, as a consequence, improves farmers' income as well as that of other rural residents. It also sustains and, to a degree, creates new employment places, which is particularly important as unemployment is one of the most pressing issues in rural areas. It is

becoming a common belief that innovations ensure an effective impact on: the opportunity to catch up with this existing development lag of the local environment, companies, fulfilling peoples' needs and raising the competitive advantage of each farm holding. As a consequence, innovations are regarded as more and more significant constituents of the pro-development process and one of the main resources for achieving agricultural goals.

The importance of innovations in agriculture draws attention to the issue of development directions to put it into practice. Agricultural operations require, in order to achieve their objectives of both acquiring innovative solutions in the current areas of operations as well as introducing and developing new production trends, which are the basis for the required transformations resulting in improvement of innovative principles. Implementation of the set predevelopment objectives requires an adequate direction and effective implementation based on, for example, indispensable infrastructure. Thanks to this, it is possible to achieve effective economic structures and the development of entrepreneurship under the particular conditions of an individual local communities. Thus, the objective of this paper is the presentation of the impact and importance of innovations in agriculture, seen as the factor allowing solutions to existing problems. Innovations in the agricultural sector allow the adaptation of this sector to the development process and the structural changes occurring in the global economy.

Innovations in agriculture

The dynamic developments in the World economies is reflected in all types of activities. They stem from new scientific challenges and new technologies which facilitate transformations for achieving a business's goals. Facing these challenges requires modernisation of operations conducted by companies across all economic sectors. It is innovations that through the spread and adaptation of knowledge have been regarded as the main drive of economic development. It is becoming a widely held belief that companies able to activate their knowledge, technologies and unique experiences (products and services) or the innovative methods for their creation and attracting customers with their offers have found themselves in the most favourable position [Tidd, Bessant, 2013].

In agriculture, just like in other sectors of the economy, it is advisable to carry out modernisation with the introduction and spread of innovative ventures. Innovations in this sector include new knowledge, technology in agricultural production, processing and the introduction of solutions for economic and social processes. Agriculture is not a

homogeneous sector, consisting of a variety of production chains such as plant cultivation, rearing animal and market gardening. Here, innovations refer to new and improved seed types, tissues, vaccines, cultivation, rearing, equipment and techniques. They also encompass the application of quality standards, organisational restructuring, improvement of management and sales to new buyers and markets [Pomareda, Hartwich, 2005].

It is worth emphasising the territorial aspect of the innovation process [Zajda 2013]. This emphasises the possibilities coming from a particular environment and its stimulating abilities for the implementation of innovations. It is particularly true in the area of agricultural activity, which displays strong territorial bonds and is organically linked to the features of the land where it is conducted. Innovations in local scale agriculture is understood as operations that have yet to be introduced in a particular locality. It means that what is regarded as the norm in one area in another is considered as innovation. Therefore innovations can be regarded as new methods, habits and devices used to perform new tasks or solution to problems that arise in a particular area [Sunding, Zilberman, 2000]. Innovativeness is defined as the ability to constantly transform knowledge and ideas into new products, processes and systems that serve the achievement of a company's goals [Lawson, Samson, 2001]. Some of these are in fact viable only for a particular sector, others are of a more universal nature, having sometimes a significant impact on the whole economy, such as electricity applications or modern IT and communication technologies [Tidd, Bessant, 2013]. Therefore, innovations in agriculture often stem from innovative sources in other sectors (among others, earlier and later links of the supply chain).

The market approach to innovativeness is a new way to solve a client's problems, and innovations are seen as goods or services which in an innovative way fulfil the needs highlighted by clients, regardless of the fact whether it takes place based on previously known methods or new scientific achievements or not. It is essential that the client receive a solution which in a new (previously unknown) manner meets their needs [Raźny, 2013]. It is also assumed [Rajalahti, et. al., 2008] that innovation is not a science or technique but the application of all types of knowledge in order to achieve the desired social and economic results. Innovations are usually not a complete novelty but rather a creative copying of, most frequently, a local nature. Indeed, innovations though perceived as referring to major changes are unusually focussed on many minor improvements and the constant process of modernisation. Innovative activity is effective when it refers to pre-existing solutions. It is a kind of adaptive function whose aim

is to stabilise reality. The success of innovative operations must be linked to the current technology available [Masarek, 2013].

Therefore, there are a few levels of innovativeness, usually regarded as three fold [Innovation, 2009]:

- First level – copying ideas from other regions;
- Second level – combining a few known elements in order to arrive at a new solution;
- Third and highest innovation level – creating a brand new idea.

The first two levels occur most frequently. In most successful cases they are not based on new inventions, but utilise pre-existing ones [Rajalahti, et. al., 2008]. They are mainly the answer to market demands or a need for a solution to a particular problem and are linked with a practical applicability in a particular reality.

It is assumed that innovations in agriculture should to a greater degree answer business needs rather than just be technological inventions [Raźny, 2013]. The key to creating and introducing a profitable innovation is a business model which considers predominantly the problems of interested parties as well as the cost and income accounting. The market will not accept a new type of fertiliser if it is too expensive or machinery if overcomplicated. The development of the agricultural sector is dependant to a significant degree on how effectively knowledge is generated and applied in various ways which facilitate innovations, this is knowledge that enables overcoming the complex, volatile and multi-faceted problems occurring in agriculture.

Innovations in agriculture are therefore perceived as new knowledge and widely understood technology, applied in management processes in agriculture, production, processing as well as sales. However, they signify different ideas in different contexts, which makes it difficult to discuss one definition. Innovation (particularly concerning development of agricultural areas) is seen not only as a technological process or a popularisation of research results, as innovation must generate tangible results and be practical [Innovation, 2013]. As a result of the application of innovations by farmers or processing and distribution personnel, agriculture is able to produce/sell desirable products of improved quality, generate higher income, boost competitive advantage and bring about social benefits.

Conditions for innovative processes in agriculture

Today's agriculture is determined by many aspects which direct demand for concrete innovative activities. Most of all one should highlight:

- Significant structural diversification of agriculture, which affects need diversification for both new knowledge and technologies. There are spatial conditions for agricultural innovations specific to a particular place or time, while many innovations of a more global nature are adjusted to the needs and local reality of the users.
- Changes occurring in the agriculture sector under the influence of the far-reaching transformations in the economy trigger the need for innovative solutions. These are particularly noticeable in the aspect of changes linked to supply chain creation. Within these chains, production, processing and sales of agricultural product processes are coordinated. The relationship between the links of the supply chain become increasingly formalised, and the arrangements cover a wider scope of ideas, space and time.
- The narrowing of production specialisation undergoes changes over time, following customers' requirements concerning quality, level of processing, changes in norms and health and safety as well as the introduction, processing and distribution of agricultural products which leads to a share increase of products of a fairly high and ever increasing unit value. Therefore, new solutions must keep up with the increasing client requirements and demands.

As a consequence, one can assume that innovation advancement in agriculture is determined by the following development trends [Rajalahti, et. al., 2008]:

- The development of agriculture is increasingly driven by markets not production
- Production, trade and consumption of agricultural products is ever more dynamic and evolves in an unpredictable manner
- The structure of agriculture is undergoing significant changes
- The development of agriculture is increasingly occurring in a globalised environment, having an impact on national and local interests
- The rapid growth of ICT transformed the opportunities to avail of knowledge gained in different places for other goals
- Knowledge, information and technologies are, to a greater degree, generated, channelled distributed and applied by more numerous, varied (multi-faceted and diversified) flow links.

Attention should be drawn to the tight bond between agriculture and other sectors of the economy. Agriculture gears itself to provide for these sectors, acquires their modern solutions and introduces innovations that facilitate adjustment to the needs coming from modernisation introduced in

these sectors. Innovations are frequently the result of problem solving based on personal experiences using available equipment, relying on technologies coming from other sectors. These a highly dependent on other sectors of the economy. As a result, they may come from institutions that are not connected with the agriculture sector, for example ICT or biotechnology.

The local context must also be emphasised. The innovation process is based on the convergence of factors and economic capability. The main factor for innovation induction is potential demand, which requires the support of technical capabilities and knowledge ensuring technical resources for new solutions. The factors behind the success of an innovative offer are not regarded as universal but specific and dependant on a wide range of technological and market features [Tidd, Bessant, 2013]. Drawn from experience is the fact that the main challenge in most cases of successful innovation is not the creation of the invention but the ability to adapt and apply it. This demands the search for new sources of inspiration for innovativeness. Expansion of access to knowledge through the development of the potential of communication channels and the scope for mutual contact, encourage the spread and adaption of information. Making modern media commonplace along with a tangible reduction of access costs, stemming from new network routes and modern electronic transfer lines, generate clear results. Obstacles created by distance decrease along with the spread of wireless transfer technology, which impacts the scope and speed of innovation processes.

Innovative directions in agricultural development

Innovations in agriculture focus on striving to achieve a range of benefits. This does not only concern increased yield and production, more efficient fruiting plants of greater flexibility but also a more selective application of plant protection chemicals, reduction of environmental impact, boosting plant resistance, reduction of the emission of greenhouse gases and improvement of the natural capital.

Most innovations in agriculture are linked to cultivation, fertilisers, plant protection substances, fodder, supplements, veterinary medicaments as well as agricultural machinery. The advancement in biological sciences and information technology is a vital source for innovation. The most talked about, yet controversial, are changes in biotechnology, in the production of genetically modified crops in particular.

It is worth emphasising the characteristic signs of innovation which can be observed in individual aspects of their introduction to agriculture. They are

multifarious in regard to subject matter, level of innovativeness as well as expected results.

In reference to plant production, one can point to a wide range of stimuli facilitating the implementation of change in the cultivation of agricultural products. These include, seeds of a higher quality, more efficient fertilisers and the introduction of ecological products. This is not linked to impressive transformation and the conducted changes are considered minor improvements. Radical innovations concern the implementation of more significant change such as GMO seeds, the trend for ever greater plant attributes to utilise water and fertiliser more efficiently and be more pest resistant, which generates greater opportunities for producers. Other important innovations in agriculture include soil cultivation, in precision agriculture in particular. This cultivation technique, which precisely selects plants for particular conditions, focuses on the ultimate usage of resources in order to improve the quality and quantity of crops while reducing the cost of production. This limits the application of fertilisers and pesticide, prevents soil degradation and boosts efficiency, as the plants can avail of water and fertilisers more effectively and are more pest resistant. Modern systems of so called closed loop are applied here, which include environmentally friendly agricultural and technological practices, including satellite imaging and information technology. The development of computerisation and satellite technology generate a new huge potential for precision cultivation. It is undoubtedly the future of agriculture, especially as it impacts the improvement of the quality of the environment.

A similar goal is the introduction of new ideas based on so called ‘effective microorganisms’, namely a choice of bacteria cultures whose aim is to sustain or reinstate the natural balance in cultivation. Ecological processes are applied here to supplement soil fertility. This speeds up the biological regeneration of soil causing the humus layer to grow more quickly. This does not replace fertiliser but increases the process of restoring its optimal state [Miernik, 2013].

Introduction of GMO plants is a controversial area of innovations. Their aim is to boost profitability of production and be resistant to natural pests. The controversy regarding their application stems from the anxiety about the possible negative impact on consumer health and the dangers they pose to unmodified organisms (however, research generally refutes this). The fact remains that GMO cultivation generates clear economic benefits through significantly higher yields, time, fuel and machine savings, reduced chemical usage, energy consumption, water consumption, increased nutritional value of plants, the possibility of producing new, cheaper bioproducts (especially

industrial) as well as the improvement of some quality features. Increased profits follow, as well as the improvement of the profitability of agricultural production and, consequently, a more favourable competitive advantage for producers.

Other innovative impacts linked to modern crop protection products boost plant development through an increase in plant resistance to unfavourable conditions, especially soil pollution. They are primarily applied in intensive and monoculture farming.

One modern innovative direction is the practice aimed at the development and sustainability of biodiversity. Contemporary highly intensive agricultural practices negatively affect biological diversity of the cultivated environment. Specialisation (monocultures) and intensification of a number of production methods, fallow land growth and the marginalisation of traditional agricultural and environmental practices requires counteraction in the form of modern innovative solutions. These allow a compromise between maximisation of the current economic effects of agricultural businesses and the need for the sustainability of biodiversity which means adding value and strengthening the local natural heritage, giving a foundation for the continuity of ecosystems [Hermon, 2014]. Biodiversity ensures therefore a higher adaptability to changing conditions and risk resistance.

A partial set-aside solution may serve as an example of the introduction of new economic practices beneficial for biodiversity. For instance the cultivation of alfalfa enables lengthened blooming, thanks to which beneficial insect attraction is increased. Making alfalfa fields of seven metre rotation strips where harvesting is forbidden is a low cost alternative for the creation of a set-aside strip. Such conduct has led to an increase in insects, butterflies and birds [Rural, 2009]. Similar effects are generated through leaving soil to lie fallow, which serves as a habitat and food source for ground-nesting birds.

Sweden is the leader in its engagement in biodiversity protection. A group of farmers set aside on their fields so called ‘nesting windows’- unsown areas allocated for nesting, limit pesticide use along the fields, adjust mowing patterns and introduce water sources [Rural 2009].

Biodiversity has a positive impact on innovative solutions in agricultural production. First of all, it is a major reason for undertaking diversified eco-cultivation. Ecological practices draw from a variety of local cultures, their ethical values and beliefs. On a global scale, they appear varied and multi-faceted as they are based on local adaption solutions. Ecological agriculture is driven by consumer demand for natural food, free from

chemical additives. Undoubtedly, this generates a positive developmental impetus and favours the biodiversity of plant species. It seems however that this direction of food production may only be of a niche nature, as it requires adherence to a number of rigorous environmental conditions of production and more importantly, is highly restricted by high production cost demand and, as a consequence, price, which is an extremely sensitive area for the modern consumer.

Another direction in the search for innovative solutions for agricultural production is working towards the utilisation of renewable resources of an organic origin for energy production in a more beneficial manner based on technical advancement. Many types of bio-refineries are being utilised in order to achieve this goal. They allow industrial use application of such resources for alternative fuel production, thanks to the processing infrastructure. Agriculture for energy may become an area which will witness a strong stimulus for the development of innovative agricultural energy and ecological technologies [Marks-Bielska, Bielski, 2013].

The foundation of this is the agricultural production of biomass applied in the production of biofuels and biogases. A big advantage of this type of agricultural production is the possibility to use fallow land for cultivation. Biomass may be transformed into liquid fuel through a technological process which requires the implementation of renewable energy production technology in small companies neighbouring agricultural businesses. A company producing bioethanol may produce from plant and agricultural waste a few thousand litres of bioethanol. In addition, it offers employment of a relatively high standard, which seems yet another innovation in the area of the improvement of the local labour forces' qualifications. What remains after bioethanol production is used to produce fodder for livestock [Supporting, 2009]. Groundbreaking methods of using plants which were previously not regarded as resources are being investigated. For instance Jatropha - an oily shrub with inedible berries which may be grown on soils unsuitable for edible crop cultivation. From its seeds a vegetable oil can be produced for use in the production of eco biofuel [Innowacje, 2007].

In order to produce biogas in modern biogas plants, not only are all sorts of biomass resources used based on energy plant cultivation such as wood, tree leaves, straw, hay, waste after vegetable cultivation (primary biomass resources) but also all kinds of organic waste and sewage (secondary biomass resources) from agricultural farms and the agrifood industry, which may be fermented into gas. This allows the utilisation of many byproducts according to the above mentioned groundbreaking

system of ‘closed loop’ whose aim is to minimise or even eliminate waste. It is believed that long term energy agriculture will transform the Polish countryside into one of the great innovation areas [Marks-Bielska, Bielski, 2013].

Innovations in agricultural areas may also be linked to local resources. An area may possess resources which could be utilised in an innovative manner [Zajda, 2013]. It usually goes along with their unique nature stemming from their origin, including manufacturing culture, coexistence with nature, uniqueness and rarity of materials as well as their ecological and health qualities. In agriculture this mainly concerns natural resources rather than economic ones. Unique resources are particularly valuable and their innovative aspect strengthens this feature. More common resources may be used in a nonstandard way reflecting the uniqueness of a particular territory. Their innovative dimension is gained by usage either according to a specific trajectory or a general one but with specific aspects [Zajda, 2013].

The former above mentioned group includes particularly high quality soil, especially beneficial hydro conditions or qualities of the climate coming from natural features of the environment facilitates the utilisation of these strongpoints. For example, for plant production whose cultivation requires unique conditions, e.g. certain flower types and herbs that are key ingredients in the production of cosmetic, perfumes or medicine, this gives them their uniqueness.

In the case of commonplace resources, innovativeness entails for example the cultivation of certain plants, and, in particular, their processing based on technologies specific for that region, thereby accentuating the good points of these products. Based on the region’s image, the product gains its unique quality, making it distinctive through association with the said area. For instance „Ser Koryciński” (cheese), „Olej Kujawski” (oil), „Kropla Beskidu” (mineral water), and „Miód Wrzosowy z Borów Dolnośląskich” (heather honey). These products are associated with a particular place and its appeal, and serve as examples of an innovative approach using our image of a particular region.

Summary

Agriculture has at its disposal a wide range of possibilities for innovative activities. The uniqueness of a situation (own potential and external conditions) translates into a variety of development possibilities, directs local agriculture along separate, specific paths that depend on economic conditions and economic potential as well as efficient management.

Transformations occurring in the market economy demand an increasing level of agricultural production development based on crop quality and boosting value added, as well as greater adjustment to the overall level of economic development in the country and obtaining a more beneficial and comparable economic standing. The answer to these challenges is in developing innovations in agricultural production based on the utilisation of harmoniously linked areas of operations together with adequate support. Innovative activities are highlighted which rely mainly on the transfer of knowledge facilitating the solution to current problems, coming up with new, competitive, high quality products well adjusted to the local environmental conditions, agricultural tradition and customer preferences, including entrepreneurs. There are a number of innovative possibilities both within agriculture itself and agricultural services whose introduction may result in market success.

Innovations are the answer to the market changes occurring, offering better development possibilities for the future. The stronger and more advanced the economy, the more developed the partnership of the companies that create it, which in effect, generates a more solid foundation for strengthening development trends. It is advisable to create capable constellations of agricultural companies and service institutions, ways of cooperating and monitoring tools. These should be linked to the conditions of the environmental context. The impact of these conditions on the development possibilities of agricultural activities through separate companies requires particular attention. One should consider mainly the state and possibilities of technical infrastructure improvement. There is also a call for groundbreaking solutions, better adjusted to the reality of organisational practices and tools implemented in business. Only the utilisation of modern and innovative change ensures the sustaining of effective economic structures and the development of entrepreneurship in agriculture. This will strengthen the adjustment to market conditions and boost competitiveness of companies operating in that sector of the economy.

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