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## 1.5. AGRICULTURAL INNOVATION AND SITE SPECIFIC FARMING

**Summary**
One special frame of technological development in agriculture is precision farming technology. The national and international researches handle a lot with the effects of precision farming technology like a possible method of innovation. At the same time the diffusion of this technology is very slow from the practical appear in 1990. The obstructive factor of adjudge the spread of precision farming technology is that the definition of the farm which apply this is hard. Because of the application of the different technology elements are dependent on plant, soil, weed-coverage and management. The adaptation of the site specific technology like a new innovation in the process demands an extra investment in one hand and in the other hand necessitates precise work from everybody which goes together with change of approach. The aims of this study to examine that in which condition will be viable the adaptation of the precision farming technology and what kind of factors make faster the spread of the technology. The other question is that which element of the technology called innovation and what are the effects of these on the profitability.

**Keywords**: innovation, site-specific treatment, profitability, cost-efficiency

### Introduction

The permanent economic development of the enterprises is the key factor of the competition. Everybody agree with that the innovation is the basic of economic development, but the meanings of innovation are not uniform among the operators of the market. The scientists, the users, the politics, the costumer and the ordinary people use the innovation in different context. In many cases, innovation means something novelty or new establishment product or process or technology. In fact, the innovation is more than a new technology or methods. The innovation should not be totally scientific newest things or an earlier unknown things. The widest used definition of innovation is the following: “implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in-business practices, workplace organization or external relations.” (Oslo Manual, 2006, p.46)

#### *Changes in the definition of innovation*

Over time, the nature and landscape of innovation have changed. Schumpeter was the first who said that the innovation is not only engineering invention. According to Schumpeter (1939), the innovation has an economic part too. The innovation contains

the newest combination of resources, new financing form, or the entrepreneur. The innovation is more than a unique or casual operation. It is the series of the interaction methods and process. (Morton, 1972) In the first edition of the Oslo Manual in 1992, the focus was on technological product and process innovation in manufacturing. The second edition of the Oslo Manual published in 1997, which expanded coverage to service sectors too. The non-technological innovation appeared in the second edition. The scope of innovation expanded to include two new types: marketing and organisational innovation. The latest version of the Oslo Manual is published in 2006 which was the third edition of its. These editions were the basic of surveys about the nature and impacts of innovation e.g. European Community Innovation Survey (CIS) made by Eurostat in every second year. The questionnaires of this survey are a good example to show the changes of the meaning of innovation over time.
The types of innovation in the EU innovation survey have expanded. In the beginning, it was only two kind of innovation (production and process). This two types have remained in each later survey but the meaning expand with some elements. For example in the beginning the innovation meant things which are developed by the own enterprises. In 2006, the innovation which are made by own or other enterprises are also fit to the meaning of product innovation. In 2012 the service (insurance, educational, consulting) were put to the list of product innovation. In the meaning of process innovation, we can see the same change. The organisational or managerial changes were not be included in innovation type until 2006. In this time, it was a part of process innovation, but in the CIS 2012, it became an individual type. The first appear of the marketing innovation was in the CIS 2006 and lessen with the routine changes in marketing methods in 2012. Table 1 summarizes changes in the definition of innovation in CIS.
The increasing of the research and development expenditure in business enterprises sector are national tendencies. The EU average is 1.3% of GDP. The V4 countries show different growth in innovation activities. Hungary spends around 1% of the GDP for R&D, Poland and Slovakia spend 0.4% of GDP for innovation. (Eurostat, 2015)
The innovation of a nation's economy is based on R&D activities- particularly in business enterprises – can be influenced by government regulation, e.g. taxation. Thanks to the EU-accession and the global financial crisis there are many direct and indirect tax system element have appeared for encouraging R&D activities. In the future, a positive improvement in tax allowances would be needed for innovative enterprises. (Illés et al., 2011; Illés et al., 2013, Hustiné Béres et al., 2014)

### *Agricultural innovation*

The task of technical development is to pass the rewarding results of the R+D activities. In the area of agricultural innovation is very high-pressure problems are the technical or process developments. (Husti, 2008) Because of the specialty of agriculture the process of the agricultural innovation has unique form (Husti, 2011):

- more complex and less suggestible than the industrial production,
- natural and agro-climatic conditions have a great effect of the agricultural production,

***Table 1: Changes in the definition of innovation in CIS***

| Type | CIS 3 | CIS 2006 | CIS 2012 |
|---|---|---|---|
| **Product innovation** | Good/service which either new or significantly improved. It should be new to your enterprise, but it does not necessarily to be new to the market. Selling innovation which produced and developed by other enterprises shall not be included. | Complete CIS 3 with the following: It does not matter if the innovation was originally developed by your enterprise or by other enterprises. | Complete CIS 2006 with the following: A service is usually intangible such as insurance, educational courses, consulting, etc. |
| **Process innovation** | Includes new and significantly improved production technology, methods of supplying services and of delivering products. It does not matter if the innovation was originally developed by your enterprise or by other enterprises. Organisational or managerial changes shall not be included | Complete CIS 3 with the following: Exclude purely organisational or managerial changes. | Complete CIS 2006 with the following: Put the organisation innovation in separate part. |
| **Organisational innovation** | - | Implementation of new or significant changes in firm structure or management methods that are intended to improve your firm's use of knowledge, the quality of your goods/services of the efficiency of work flows. | Complete CIS 2006 with the following: including knowledge management, work-place organisation. It must be the result of strategic decisions taken by management. Exclude merges or acquisitions |
| **Marketing innovation** | - | Implementation of new/significantly improved designs or methods to increase the appeal of your products or to enter new market. | Complete CIS 2006 with the following: exclude seasonal, regular or routine changes in marketing methods. |
| **Innovation activities** | - | Include acquisition of machinery, equipment, software, licenses, engineering work, training when they are specifically undertaken to develop/implement a product/process innovation. | Complete CIS 2006 with the following: Include all types of R&D activites |

Sources: own construction based on Community Innovation Survey's questionnaires

- natural and agro-climatic conditions have a great effect of the agricultural production,
- the time of the treatment is very important in biological and agro-technical point of view,
- the work time are different in the peak time (for example in harvest period),
- the innovation are different in time and in place.

The agricultural-technical developments never are self-interest. These developments should always be lead with production aims. The prime aim for agricultural-technical development is to the results of research put into practice. The agricultural innovations eventuate the higher profitability and economic growth, (Kapronczai, 2011) and shall be considered as an important tool of increasing competitiveness of agricultural enterprises (Illés and Dunay, 2014). The agricultural innovation includes chemical innovation (in fertilizer, in pesticides, in herbicides), technical innovation (in machinery and equipment) and biological innovation (in hybrids, in seeds). (Husti, 2011) In the practice the research of agricultural technical development materialize in the production technology. One of the well examined parts of the agricultural technical development is the precision farming technology.
The aim of this paper to show the precision farming technology in the different aspects of innovation, like process-, organizational-, environmental-, product- and marketing-innovations.

## Precision farming technology as realization of agricultural innovation

Beyond the traditional technology innovation a new business-model, a new organizational form, a new design or marketing-strategy are also mean innovation for companies. The most wide spread innovation type are the product and technical innovation. The practice can also speak about environmental innovation, marketing innovation, organizational innovation. (Schumpeter, 1939; Magyar Innovációs Szövetség, 2010)
Under innovation, the inputs and the yield of the agricultural enterprises are change. The precision farming technology is a kind of production and management methods which able to handle the homogeneity of production condition and thanks to this it fit to the expectation of the agricultural innovation.

### *Technological innovation and precision farming technology*

According to Oslo Manual (2006), a process/technology innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products.
The agricultural technology innovation based on four pillars. These pillars are the biological, chemical, technical and human factors. (Dimény, 1975) The agro-technical developoment can not be self-intrest, it should be fit with economical and ecological

criteria. (Dimény, 1992) In this aspect the precision farming technology is the base of the sustainable agriculture. There are numerous researchers examined the correlation between the sustainability and precison farming technology. The latitude of this paper not allows to spead about in detail. (Weiss, 1996; Lambert and Lowenberg-DeBoer, 2002; Székely et al., 2000; Takács-György, 2008; Takács, 2008; Schmuk et al., 2009; Lencsés, 2013; Lencsés et al., 2014)
The appearance of global positioning system in the agricultural make possibilities for taking out the field-average treatment and handle the heterogeneity of the production factors (field, nutrients, etc.). In precision farming technology, the treatments are based on maps or on-line sensors. The treatment unit called management-zone and usually not bigger than 3 hectares.
The two technical methods of precision farming technology are the on-line and the off-line way. In on-line way the inputs optimized according the sensors (for example N-sensor or infra-red camera) information in real-time. In the off-line way, firstly the treating maps should be generated before the treating. The advantages of both methods to optimized inputs according to field-heterogeneity, and thanks to this increase the profitability of the process with decrease the environmental harm of the agriculture.
In summary the precision farming technology squarely fit the meaning of technological innovation because it is a new way of plant production. Change the field-average treatment for the management-zone based treatment (in the process of planning, treating and monitoring).

***Organizational innovation and precision farming technology***

According to Oslo Manual (2006), an organizational innovation is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. Organizational innovations can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labor productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies.
The precision farming technology is not only a new plant production method. An aim of precision farming technology (beyond the variable rate treatment in zone-by-zone) is to simplify the decision process thanks to the precise information base and the higher reaction for heterogenic production factors. In short, precision farming technology is information and remote sensing based farm management system. This system able to identify, examine the varying field parameters and lead the treatment in field.
The precision farming technology is an electronically observer system which monitoring the site-specific treatment of inputs, the timing of treatment, the process and the staff. (Lowenberg-DeBoer and Boehlje, 1997)
The switch to precision farming technology demand changes of the conventional thinking about farming. Come to the front the intention of exactitude of treatment. There are not permissible the margin from the plan or the overlaps in the field-twist.

In the aspect of organizational innovation very important to speak about the knowledge and acceptance of the philosophy of precision farming technology both on the management-level and on the staff-level. The staff should be understand and use the new and mostly informatics based system. The information-based precision farming technology is decrease the time-input for example vocational training, teaching, monitoring.
In summary the precision farming technology is an organizational innovation because the adaptation of the technology is require the changes in the working process. The tasks and time-input change with making of maps, input registration, etc.

***Environmental innovation and precision farming technology***

Precision farming technology is an information-intensive technology which is a part of the agricultural technical development. Precision farming technology is a complex, contiguous process and purposeful innovation activities which gives rise to changes in quality and quantity of agricultural production. These changes define in resources, for example soil parameters, human resource, equipment, information-system, etc. Finally the plant production is happen in the higher efficiency way.
The precision farming technology is a kind of environmental innovation because the prime aim of the technology is to reduce the environmental impacts of plant production. According to Wolf and Buttel (1996) precision farming technology increases the efficiency of production, decrease the environmental pollution. The input (seeds, nutrition, herbicide, pesticides, etc.) optimization happened zone-by-zone. Thanks to this the redundant of inputs in the soil are reduce.

***Marketing innovation and precision farming technology***

According to Oslo Manual (2006), a marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales
In marketing innovation, the primary aim is the demand of consumer. Nowadays there are no differences between the consumer demand with the conventional and precision farming technology. The consumers do not knows which technology used for their product. The precision farming technology use the same quantify inputs like the conventional farming.
There are unproven the quality increase of yield with the precision farming technology. Otherwise, in social-level the demand for the fork-to-fork monitoring of plant production is increasing. With precision farming technology, huge amount of information could be realized about the production process. The society requires the decreasing of environmental damage, ecological sustainability. Both demand make true with precision farming technology.
In summary, precision farming technology does not mean marketing very novelty innovation for producer or user because the preparation or use of equipment not goes

to the changes in the market issue. But because of the seasonality of agricultural machinery market thanks to the subsidies policy (Medina et al., 2015) the marketing innovation is very important for the machinery producers. They should find a new promotion way to increase their selling.

***Product innovation of precision farming technology***

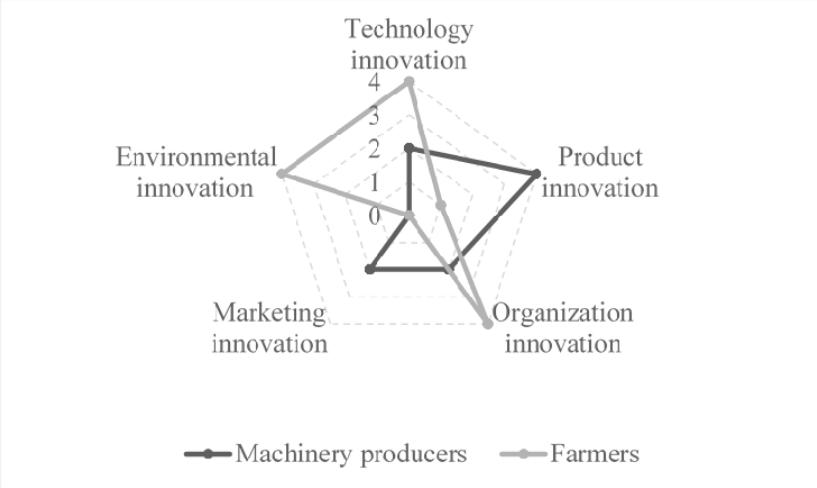
According to Oslo Manual (2006), a product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilize new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies.
The equipment for the site-specific production for the producer is a product innovation. Because the producers of equipment which able to implement the site-specific treatment in the practice. For this is necessary to make changes in the products, for example put GPS, board-computer on the tractor or put component which helps to variable rate treatment in for example the fertilizer.

## Conclusions

The condition of the successful innovation is the efficient information systems which react fast for the changes of micro and macro environment with quantity in the middle. Precision farming technology fit to these requirements. Thanks to the big amount of qualified information the system able to monitoring the production zone-by-zone.
The precision farming technology improve the productivity of labor, productivity of inputs, quantity and quality of yield with attentive the aspects the sustainability. These parameters are the key factors of agricultural innovation, so the precision farming technology is a tool of innovation.
The precision farming technology squarely fit the meaning of technological innovation because it is a new way of plant production. Change the field-average treatment for the management-zone based treatment (in the process of planning, treating and monitoring). The precision farming technology is an organizational innovation because the adaptation of the technology is require the changes in the working process. The tasks and time-input change with making of maps, input registration, etc. The precision farming technology does not mean marketing innovation for producer or user because the preparation or use of equipment not goes to the changes in the market issue. The switch to precision farming technology demand changes of the conventional thinking about farming. Come to the front the intention of exactitude of treatment. There are not permissible the margin from the plan or the overlaps in the field-twist.
Thanks to the precision farming technology the enterprises able to make products with less inputs or reach the higher yield with the same amount of inputs. The agricultural enterprises would be cost-efficiency and environmental friendly thanks to the site-specific treatment. In the agricultural practice the precision farming technology is require the new way of thinking about plant production.

For machinery producers the produce of precision farming equipment is a significant novelty because it should built in some IT equipment too. The use of IT equipment in agricultural machinery changes are needed in the process of building machines and it results a very high novelty, sellable products. The machinery producers need more employees who work in IT and develop the application and sensor mechanism and software of the machines. (Figure 2)

**Figure 2: Novelty of precision farming technology for machinery producers and farmers**




Notes: Scale of novelty:
0 – no novelty, 1 – minor novelty, 2 – significant novelty, 3 – high novelty, 4 – very high novelty
Source: own construction

In case of environmental innovation, it does not appear for the machinery producers but it has a very high novelty for the farmers who use the precision farming equipment. Because the farmers able to highly increase the environmental damage of their plant production with precision farming technology. The product of the farmers has less environmental damage but the market does not pay more money for this kind of product. Thanks to the precision farming, the fork-to-fork production became real but for the farmers the product with use precision farming technology has only minor novelty.

Machinery producers need to find different marketing communication methods for selling the precision farming equipment. Farmers can sell their product in the same way than earlier but they need to make lot of changes in their organization. The farmers need emlpoyees who are able to use the new information technology based machineries.

The novelty of precision farming technology for the machinery producers and farmers appear in different way, but it has some aspects, which mean a very high novelty for them. For the farmers there are three types of very high novelty innovations (technology, environmental and organizational innovations), while machinery

producers have only one kind of very high novelty innovation (product innovation) but the other type of innovation has a medium novelty. It should be highlighted that the area of the innovation in Figure 2 is almost the same in the case of machinery producers and a case of farmers, which shows its importance for both parties.

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