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MODERN LOGISTIC STRATEGIES IN AGRICULTURE

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Abstract This paper aims at presenting the consequences of implementing new technologies in agriculture. On the basis of pertinent literature the author has presented the economic and organisational effects which may be obtained as a result of implementing RFID and GPS in agriculture.

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1. INTRODUCTION. IMPLEMENTATION OF RFID AND GPS IN AGROLOGISTICS

Agrologistics is one of the youngest fields of logistics, which deals with creation and implementation of solutions optimising various types of flows (that is

to say the flow of information, goods, produce, financial means) in agriculture, horticulture, pomiculture and forestry. The main aim of agrologistics is to increase the productivity and competitiveness of entities or chains operating in the above mentioned fields. It also strives at reducing costs, increasing value of different objects, creating adaptation capabilities and general development capabilities of procurement, manufacturing and distribution. Within agrologistics we may distinguish precision agrologistics which takes advantage of the modern IT tools.

2. IMPLEMENTATION OF RFID IN AGROLOGISTICS

Agrologistics, similarly as other fields of logistics, is witnessing a ubiquitous implementation of RFID technologies. The aim of such implementations of RFID is to gain additional advantages such as the following ones:

- information is exchanged via radio waves thanks to which the identificator does not need to be 'physically visible' for the reader's aerial;
- RFID has the lowest percentage of error occurrence out of all technologies serving the purpose of automatic identification;
- radio tags may work in a wide spectrum of temperatures and are almost insensitive to present weather conditions;
- radio tags may be made of materials and in shapes adjusted to individual requirements of customers;
- radio tags may enable multiple recordation of data, modification of some part of data;
- radio tags are actually forgery-proof – their serial number is conferred by the manufacturer in the course of manufacturing process and cannot be changed, and the recorded information may be protected by a user's password.

Table 1 Selected applications of RFID technology in precision agrologistics; by the author on the basis of:

Application description	Examples	Source
identification and tracking (tracing) of the movement of containers, pallets, etc.	The Netherlands	www.ehow.com/about_5161645_definition-industrial-agriculture.html; www.intechopen.com/download/pdf/pdfs_id/13216 www.rfid.thingmagic.com/rfid-blog/bid/35678/Improving-Farming-with-RFID; www.idtechex.com/knowledge-
stock management in supply chains	France, USA	
gathering and storing information	USA	
identification of animals, contagious disease spread prevention (e.g. foot-and-mouth disease, BSE); optimisation of animal farming processes	Identification of farm animals e.g. in the cities of Łódź, Warszawa, Opole, Gdańsk (Poland), or the state of Louisiana (USA)	
identification and localisation of equipment, machinery, vehicles		
forest resources management	Cambium – Forstbetriebe, Forest Arboretum in	

	Syców Forest Inspectorate in Poland	base/en/nologon.asp www.agnet.org/library/pt/ www.rfid-info.pl/rfid-w-indentyfikacji-zwierzat.html; www.ncsa.illinois.edu/~kindr/papers/icpa04_paper1.pdf; www.agrologistiek.nl/downloads/Agro_folder_UK_06_web.pdf.
animal localisation and tracing	USA, Australia, Canada, Japan, Poland	
up-to-date monitoring of the humidity of hay, grain, seeds, etc.	Urbana – Illinois (USA)	
marking of farm animals which enables to trace the flow of meat from farms to slaughterhouses, meat processing plants and shops	China	
theft-protection	Horses in e.g. USA, France	
registration of results of races – camel races.	Australia	
registration of breeding of dogs, horses – very accurate genetic purity control and monitoring	USA	

At the same time it is possible to limit effectively the impact of some threats in particular in the field of data security by introducing additional protection (in some cases making the outside infiltration more difficult or even impossible). Moreover, the cost of single tags (due to the scale of implementation of the technology) has decreased significantly. In 2000 the cost of manufacturing one tag amounted to about 1US$ (Prater, Frazier, 2005, pp. 138). Right now it is calculated in cents.

An exemplary juxtaposition of the application of RFID in precision agrologistics may be found in Table 1. In accordance with the research, RFID technology implementation has enabled to:

- improve the accuracy of undertaken actions,
- improve the efficiency of undertaken actions,
- improve competitive advantage,
- optimise (shorten) delivery times,
- improve integration of automated systems,
- reduce all stock levels,
- reduce made errors,
- reduce warehousing costs,
- improve customer service quality (Schmitt & Michahelles, p. 27), and
- reduce operational costs by 1 up to 3 % (Basu & Siems, 2011, pp. 4-8).

Gaining all the above mentioned advantages leads to the constant improvement of competitiveness of given business entities. This is especially visible in precision agrologistics. The successful implementation of RFID as a tool used by JiT in this field (similarly, as in the case of manufacturing and warehousing) helps achieve intended goals and as a result helps gain new fields of operation. According to the international research, the implementation of RFID leads to constant in time and space increase in technological and organizational innovativeness. The research carried out by Gogan has revealed that, indeed, it is a practice considered as new to many firms. In addition RFID technology stands as an enabler for the

implementation of collaborative practices such as the collaborative planning, forecasting and replenishment or build-to-order practices (Gogan, 2007, pp. 423-435). Moreover, the new effects of RFID implementation are visible also in other respects. RFID influences products. The process innovation is related, on the one hand, to changes in the sequence of activities, and on the other hand to the emergence of new techniques or the improvement of the already existing ones to support the production of goods or rendering services (Wamba, 2011, pp. 4). Whole companies or even chains become more competitive and innovative (due to the requirements of any organizational innovation). A radical or breakthrough innovation can be defined as 'an innovation impacting significantly on a market and on the economic activity of firm in agrologistics market' (d'Oslo, 2005, p. 68). Moreover, radical innovation enables organizations to develop new products for which there is not yet any competition, largely redefine their business networks, and even change the rules of the game within agrologistics for their own profit (Garcia, 2002, pp. 137-154).

3. GPS IMPLEMENTATION IN PRECISION AGROLOGISTICS CONCLUSION

The practical implementation of GPS in agriculture brings many benefits. In accordance to the results of the research carried out by the European GNSS Agency the application of GPS-based solutions enables to gain the following benefits:

- improving precision of driving and operating different types of machinery and vehicles,
- constant tracing and tracking of available resources (e.g. water, feed and fodder, pesticides, fertilizers, etc.) and their more rational usage,
- performing all meteorological and geodesic measurements in a very precise way (among others complete identification of farmlands, the so-called geo-tracking),
- precise positioning of machinery, vehicles and equipment, cultivated crops, animals, etc., and
- improving the precision of undertaken actions.

All those elements contribute to the more precise performance of all activities in the right place, in the right way, at the right time and at the acceptable price. Right now (data from 2009) about 8% of agricultural machinery and equipment is equipped with GPS in the EU. In accordance with forecast in 2013 it will be 13%. Of course one must be aware that the application of GPS brings measureable results and benefits. Among the most important ones we may enumerate:

- decreasing by 2,36% the time, fuel and seeds/grains (in comparison with solutions not taking advantage of GPS) necessary for obtaining attained goals,
- decreasing by 14% the quantity of used fertilizers,
- increasing crop (on average by 3-13%),
- saving of 23% in the quantity of needed pesticides and crop protection products (Doruchowski, 2008, pp. 19-31),
- improving produce quality,
- decreasing the negative impact of agricultural production on natural environment (Holownicki, 2008, pp. 7-12),
- saving of 10-30% in production costs (Siennicki, 2011, p. 3),
- saving of 15-25% in required headland,
- saving of 20-30% in required work time, and
- saving of 100 – 300 euro per ha in costs (Auernhammer, 2001, pp. 36-40).

4. CONCLUSION

Concluding, it is worth emphasising that the application of RFID and GPS in agrologistics brings expected results especially if someone attaches importance to such elements as: clarity of the flow of information, produce and other goods, their easy localisation, tracing and tracking the route of materials (raw materials, component parts, produce, ready-made goods, etc.), limiting the risk of thefts of products and goods, increasing the efficiency of manufacturing or providing the desired quality level. By ensuring efficient and effective information flow, we may ensure that all four assumptions of JiT strategy will be met in an adequate degree. Moreover, the successful application (implementation) of both technologies brings additional value in the form of innovation. The incremental innovation is also a powerful tool for realizing the competitive advantage concerning productivity gain, through continued improvements (Garvin, 1988, pp. 121). RFID technology imposes the complete re-engineering of (for example) warehouse activities in agriculture, and facilities the emergence of new concepts such as the *intelligent process*, the *communicative objects*, which are entities capable of communicating and even interacting with their environment (Heiskanen, 2007, pp. 489-509). Moreover, in the packaging (especially in agrologistics) the use of *intelligent packaging* is revolutionizing the process through which the products pass from the manufacturer (for example agricultural farm) to the consumers (Berkhout, 2007, pp. 189).

Although no impact is recorded on the existing production processes, RFID and GPS technologies have been effected on JiT strategy because they help optimize for instance the management and circulation of automobile modules on production sites, and reduce the number of scraps (Poirier, 2006, pp. 98).

Although there are no ideal systems (systems ensuring zero stock, zero defects), but the effects gained in the case of GPS and RFID are significantly better than in the case of other strategies. It must be stressed here that the example given above refers to a very narrow application of JiT strategy (improvement of information flow by applying RFID and GPS). In a broader scope of application, coupling RFID and GPS technologies with the Internet or emerging networks (e.g, EPC network) allows for an extension of the concept of *intelligent object* and provides extra competitive advantages (Rundh, 2008, pp. 97-114).

But there is still a need to carry out further research into the basic assumptions of that strategy (zero stock, short order fulfilment cycles, low quantities of often replenished goods and high quality – zero defects) as well as its supplementing with enhancing elements such as RFID or GPS. The implementation of such modern technologies, on the one hand, helps decrease costs and, on the other hand, improves system operation. Not long ago, some solutions were impossible of implementation due to existing construction and technological limitations. Right now, new solutions in those fields (e.g. the increase in the range depending on the frequency of radio waves, from 6 meters in the case of passive tags without batteries up to 100 meters in the case of active tags) may be applied in more and more fields and scopes. Apart from applying those technologies in animal breeding (e.g. large farms in the USA, Brazil or Great Britain), management of machinery and equipment or identification of, tracking of and tracing the movement of containers, there are also opportunities and possibilities not exploited so far. What I have in mind here, is for instance the implementation of RFID in breeding some especially valuable (precious) animals, which may result from the imposed legal or business regulations (customer requirements) or monitoring hay humidity (or humidity of other produce e.g. grain, seeds). Moreover, the new applications resulting from changing legal regulations and the new scope of agrologistics also become available. One of the examples of such application may be found in plans of registration of wild animals (game).

Furthermore, the implementation of those technologies in new fields of agrologistics also brings economic benefits such as (i) increasing system efficiency even of 18% (total automation of some processes), (ii) minimising errors of 21% (in comparison with the error level before the implementation), (iii) decreasing information processing costs of 30% or (iv) improving asset exploitation of 2% (www.rfid-lab.pl/roi-i-npv-z-rfid).

Morover, the usage of those technologies in practice (for example in monitoring and tracking of cattle infected by the mad cow disease) helps minimize the propagation of the pathology (Bitko, 2006). This new approach supports all activities of the firms. As a result of this situation we may observe among others the reduction of risks connected with the emergence of new technologies (Chesbrough, 2003, pp.35-41). An organization can gain higher profit levels (Fredberg, 2008, pp. 25). Recently, agrologistics has also become the field of

interest of scholars in Poland (cf. Grzybowska et al., 2010, pp.53-66), (Bralewski et al., 2010, pp. 251-260).

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BIOGRAPHICAL NOTES

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