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MODERN METHODS OF LABELLING AND IDENTIFICATION USED IN AGRICULTURE

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Abstract: *This paper aims at describing and analyzing the role of modern methods of labelling and identification used in agriculture in the Information Age. It is an extremely crucial aspect, in particular due to the growing number of phytosanitary risks present nowadays or the need for development of sustainable agriculture. This paper includes the analysis of the national and foreign source literature concerning, on one hand, the analysis of various types of biological risks affecting modern agriculture and, on the other hand, characteristic demand for ecological and non-GMO food. In this aspect the application of various methods enabling easy and cheap labelling of both crops and animals (at the breeding stage) and also at the later stages of processing, storage and even distribution is extremely vital. The analysis of the source literature and case study were adopted in this paper as the research method. The following research hypothesis was put forward in this paper: "Is the application of systemic labelling enabling unambiguous identification of products necessary in the era of global phytosanitary risks and growing demand for ecological and healthy food?" Following the literature research and case study analysis it was possible to unequivocally prove the assumed hypothesis. Of course, only in the selected aspect of the efficiently conducted activities in the economic reality. On the basis of the conducted studies it was possible to come to the conclusions unambiguously proving that the application of systemic labelling in agriculture increases the efficiency of the conducted activity.*

This paper involved the review of selected source literature which may only constitute a prelude to pilot studies. Only a certain practical aspect was taken into account, which, on one hand, enables corroboration of the assumed hypothesis, but, on the other hand, does not form the basis for its generalization to cover the whole modern agriculture. As a consequence, it is advisable to continue the research in order to analyze the whole scope of agriculture worldwide and potential applications of systemic labelling in this scope.

Key words: *agriculture, sustainable agriculture, bar codes, two-dimensional codes, genetically modified food, RFID, biological threats, information system, Information Age, product identification.*

СОВРЕМЕННЫЕ МЕТОДЫ МАРКИРОВКИ И ИДЕНТИФИКАЦИИ ИСПОЛЬЗУЕМЫЕ В СЕЛЬСКОМ ХОЗЯЙСТВЕ

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Аннотация: *Целью данного исследования является определение и анализ роли современных методов маркировки и идентификации, применяемых в сельском хозяйстве, в эпоху информационных технологий. Это существенно важный аспект, особенно если учесть растущие фитосанитарные угрозы, встречаемые в настоящее время, при стремлении к развитию устойчивого сельского хозяйства. В своих пределах, данная работа включает анализ как отечественной, так и зарубежной литературы. С одной стороны анализ разнообразных биологических угроз наблюдаемых в современном сельском хозяйстве, а с другой стороны специфический «спрос» на экологические и свободные от генетических модификаций продукты. В связи с этим чрезвычайно важным является применение разнообразных методов предоставляющих возможность быстро и недорого производить маркировку, как растительных культур, так и животных, (начиная с этапа животноводства) так и в последующих этапах переработки, складирования или дистрибуции. В работе как метод исследования - принят анализ литературы и case study (тематическое исследование) и выдвинута исследовательская гипотеза: «Необходимо ли в эпохе глобальных фитосанитарных угроз и постоянно растущего спроса на экологическое и полезное для здоровья продовольствие применение системных маркировок обеспечивающих однозначную идентификацию изделий». В результате исследования литературы и анализа case study, удалось однозначно подтвердить принятую гипотезу. Конечно, только в выбранном аспекте действий эффективно проводимых в экономической реальности. На основе проведенных исследований, удалось сделать выводы, из которых однозначно следует, что применение системных маркировок в сельском хозяйстве повышает эффективность деятельности. В статье представлен только обзор выбранной литературы по данной теме, которая может стать основой к дальнейшим исследованиям. Учтен только практический аспект, который с одной стороны позволяет подтвердить выдвинутую гипотезу, но с другой стороны не дает оснований обобщить ее на все современное сельское хозяйство. Следовательно, исследования должны быть продолжены с целью проанализировать весь спектр сельского хозяйства в мире и возможных применений системных маркировок в этой области.*

Ключевые слова: *сельское хозяйств, устойчивое сельское хозяйство, штрих-коды, двумерные коды, генетически модифицированные продукты, RFID, биологические угрозы, информационная система, информационный век, идентификация изделия.*

Introduction: The way of running a farm in the broadly defined agriculture, has been changing nowadays. The changes mainly stem from the fact that, on one hand, new technologies appeared in the process of plant or animal breeding, and, on the other hand, new conditions appeared in the market. In case of the former (namely, state-of-the-art technologies applied in agriculture) significant changes were implemented in the last 30 years. Precision agriculture appeared (together with the development of up-to-date technologies aimed at very precise positioning – GPS or GLONASS or laser scanning) [McBratney 2005, pp.7-23]. Of course, the development of precision agriculture was possible thanks to the advancement not only in technical sciences, but also in broadly defined biological and social sciences. What is more, precision agriculture (as the sustainable development tool in this scope) was possible also as a result of other processes which took place in agriculture generally. We should take here into account certain recurrence observed by Bertschinger. In his view the agriculture development followed the pattern of a hyperbola curve, namely moved from the point in which the abundance of resources was accompanied by the scarcity of food, passed through the point of the balance between the demand and production, and finally reached the current situation, namely, the situation in which the present potential of agriculture allows us to have food surplus with consumption increase (caused inter alia by the global population growth, global growth of affluence of societies etc.) in line with the simultaneous resource conservation or even recovery [Bertschinge 2006, pp. 4-12]. Moreover, precision agriculture is a characteristic reaction to the need of sustainable agriculture development. It is an effective application of advanced technologies (such as inter alia: positioning, various methods of retrieving, processing and effective use of information/data) to reasonably manage agriculture production processes. This (namely, production process management) involves mainly managing the variability in the spatial scope (diversification of plants, animals and environment) and in the time scope (changes of variable traits and determinants with time). What is more, coordination in one place of both a very complex information system (of course in compliance with the rules of information society reinforced with various information instruments based on the use of wide area networks or "cloud" concept) and extremely precise machines and appliances (able to very precisely dose pesticides and other crop protection products or fertilizers) requires smooth and quick information exchange [Dorychowski pp. 19-31]. As a result of smooth operation of the systems of precision agriculture it is possible to obtain, with the previously assumed targets, quantifiable economic benefits such as lesser demand for fertilizers (with the assumed productivity level per hectare), e.g. in case of triticale – 20-80% depending on the cultivation and the chemical substance used [Czarnocki 2006, 287-298].

Considering new conditions existing in the market with respect to agriculture it should be underlined that, on one hand, we observe a constant growth tendency in demand for ecological non-GMO food, and, on the other hand, the increasing phytosanitary risks. In case of ecological non-GMO farming, this market sector is dependent on the social awareness and social affluence. The development of this sector is also determined by the state policy (or the policy of a union of states, e.g. European Union) reflected in inter alia various types of subsidies or restrictions (broadly defined legal regulations). In other words its development (of the ecological food sector) is possible (alongside the physically existing demand for these types of products) through various types of financial incentives as well as media creation of healthy nutrition model. In case of European Union the supply of ecological products does not meet the demand. As a consequence, ecological food is imported from non-EU countries [Komorowska 2009, pp. 183-187]. Increasing support of eco-friendly activities in agriculture offers a possibility of development of ecological production and in fact “self-sufficiency” of EU in the future.

Phytosanitary risks constitute another, currently very common, trend in agriculture. Such risks have been common from the dawn of the time. However, currently (in the information society, namely in the society in which the information is the most important asset to each entity) they are frequently observed on an international or even global scale. We live in a “global village” in which the access to the information is facilitated. An explicit growth tendency may be observed in this scope (concerning various biological risks) It started towards the end of the 90-ies of the previous century and it is still present. The most important risks include inter alia:

- BSE – Bovine Spongiform Encephalopathy – in UK cattle [Wales 2006, pp.187-195];
- dioxins in meat and eggs [Bernard 2002, pp.1-18];
- outbreak of bird and swine flu [Meghna 2009, pp. 833-841].

All the events resulted in serious food industry crisis and at the same time led to a new problem which should be effectively prevented in the future. One of the issues which should have been addressed included a question whether and how to label agricultural produce. What is more, it has to be emphasised that in the common globalization era and in information society such an hypothesis has to be widened. The following statement seems to be more accurate: Is the application of systemic labelling enabling unambiguous identification of products necessary in the era of global phytosanitary risks and growing demand for ecological and healthy food?

MODERN METHODS OF LABELLING AND IDENTIFICATION APPLIED IN AGRICULTURE: There are plenty of systems of labelling various products. However, in widespread globalization (affecting also the agricultural production), as well as the international (or even global) character of most of phytosanitary risks, what seems to be the most accurate solution is the application of global labelling of systemic nature. To depict the problem more precisely (with no local pandemic such as Bovine Spongiform Encephalopathy or bird or swine flue), in the USA only, in 2011 about 16.7 % of the population (that is more than 47.8 mln of people) went down with the diseases having their origins in food [Resemde-Filgo 2012, pp. 596-603]. What is more, the possibility of being affected by such detrimental events is still growing. This may be attributed to various reasons. However, the most important ones include prolonged supply chain in the agricultural and food production market (currently we observe more and more often the situation in which the food is produced in one continent and delivered to another continent or to another distant place of the world). In addition, this trend is intensified by various vegetation periods existing on the earth or changes in dietary styles of the population living in a given area [Śmiechowska 2014, pp125-132].

It should be noted that some countries have already had for some time legal regulations imposing the obligation to apply specific identification systems, inter alia in agriculture. European Union using this solution is one of the examples. In EU territory since 1 January 2005 regulations have been in force (inter alia Article 18 of Regulation 178/2002 of the European Parliament and Council dated 28 January 2002 and subsequent regulations), which unambiguously define the principles and requirements concerning food safety. This Regulation indirectly imposes the obligation to follow a unified labelling system to facilitate identification and tracking of the route of specific raw materials or products in the whole supply chain (namely from the moment they were obtained till the final distribution and sales). In order to meet so precise legal regulations it is necessary to apply one of a few potential technologies for their subsequent, in most cases fully automatic, identification. The most popular labelling system meeting those criteria consists in using bar codes. Automatic identification using this solution consists in reading the numerical data encoded in the form of white and black bars. Unfortunately, there is no one standard applicable in the world. Currently there are more than 400 types of bar codes. Most generally they are divided into one-dimensional, two-dimensional and hybrid codes. Their most valuable advantage consists in the possibility to easily, unambiguously and permanently label various types of raw materials and products produced in agriculture. Moreover, due to high popularity of bar codes, it is the easiest method of labelling used in automatic identification systems. The biggest disadvantage consists in no possibility of reloading new data later on (namely, after the encoding of the data under a given code), as well as huge restrictions with respect to the construction of the line for automatic identification (in most cases the data are read when the bar code is brought within the reach of the bar code scanner). It has to be underlined that this technology is still under further development and as a consequence, new solutions are invented which boost/introduce new functionalities. The appearance of QR codes constitutes a good example of this trend. In case of these codes there are big opportunities of boosting “the attractiveness” of this relatively outdated technology inter alia by giving the possibility for mobile phones equipped with relevant applications to read those codes [Mazur 2013, pp.192-206]. Another technology used for labelling is known as RFID. A typical system consists in this case of three components: a transponder, a transmitting and receiving antennae with a decoder and a programme layer (namely, IT system enabling the operation of the whole system). The transponder consists of a chip (equipped with memory) and an antennae for wireless communication. The transmitting and receiving antennae is a device which transmits or receives electromagnetic radiation properly decoded, in this way recording or reading the data. It is additionally equipped with a decoder which transforms the digital signal into a radio signal. The programme layer is responsible for physical transmission and for exchange, collection and processing of data. Radio-frequency identification (RFID) allows for remote reading of the data from transponders and for recording the data without the necessity for optic contact. It has to be emphasised that RFID technology streamlines the information flow through inter alia full automation of such processes as e.g. information creation, transmission (communication to the users), storage or processing. To sum up, RFID enables automation of information processes to a greater extent than bar codes. It accelerates those processes and reduces the probability of errors. Its biggest disadvantage consists in the implementation costs and, to some extent, costs of using the system [Preradovic 2010, pp.87-97]. Moreover, it is this technology that enables effective labelling and error-free reading in such complex breeding tasks as e.g. selection of animals for mating which fundamentally affects the production or economic indicators obtained in subsequent breeding (inter alia through storing precise information about the potential of genotypes used and effects of crossing them). Moreover, RFID technology lets us obtain and effectively use so-called Big Data effect (that is the system must give the possibility of fully automated data collection and further arrangement of the data in accordance with various identifiable algorithms). [Małopolska 2014, pp. 51-66].

Conclusions Summing up the above contemplations, we have to agree with Gębski that one of the basic needs of food consumers is safety [Gębski 2015, pp. 387-395]. What is more, unambiguous labelling used at each stage of the processes taking place in broadly defined agriculture (or also in food processing, transport, warehousing or subsequent distribution until it reaches the final consumer) contributes not only to the above mentioned safety (at least in issues concerning prevention of latest, global and constantly changing phytosanitary risks) but also to the quality of the offered agricultural products. In this respect we have to take into consideration such issues as non-GMO or ecological sustainable agricultural produce (this is due to inter alia higher production costs and lower yield by 20-30%), risks of various types of abuses by dishonest farmers or agents forming the whole supply chain (starting from the raw material suppliers) [Nowogródzka 2012, pp.54-64]. What is more, in some countries relevant legal regulations are indirectly imposed (European Union and so-called Hygiene Package, that is inter alia Regulations 852/2004, 853/2004 and 854/2004). This leads to the necessity of strict control of food and tracking of the food at each stage (starting from production and ending with distribution). To meet such boundary conditions unambiguous labelling is necessary as it enables: product identification, obtaining required information about the product (namely, detailed description), information about the raw materials used (e.g. fertilizers, plant protection products, fodders, mineral supplements, vitamins, antibiotics etc.) or full data concerning the whole technological process (understood in this case as animal breeding process or plant cultivation). In addition, it has to be emphasized that in many cases it is also necessary to add new data later on to the labelling system. As a consequence, it seems to be true that the assumed hypothesis is corroborated (namely, that the application of systemic labelling enabling unambiguous identification of products is necessary in the era of global phytosanitary risks and growing demand for ecological and healthy food). Moreover, in this case RFID seems to be more adequate in comparison with various types of bar codes. This results from the fact that this technology enables the addition of information at a later stage, and on the other hand, is more adequate for creating a fully automated system successfully using EDI and ICT. Of course we have to underline that the conducted research into the source literature may only constitute pilot studies and global conclusions may not be drawn on this basis. Moreover, the above mentioned trends (concerning inter alia more and more frequent phytosanitary risks and the increasing interest in non-GMO or ecological agricultural produce) form satisfactory basis for claiming that the research in this scope should be continued due to the growing number of phenomena to which they directly relate both nationally, internationally and also globally.

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