INNOVATION RISK IN AGRICULTURAL PRODUCTION

B. Kaczmarska, *Ph.D.*
Kielce University of Technology

Качмарська Б. Інноваційний ризик сільськогосподарської продукції
Сільськогосподарська продукція у великих обсягах характеризується подібними закономірностями, як і промислова продукція. До неї можна застосовувати такі самі методи менеджменту, наприклад, менеджмент ризику. Вже на етапі планування завдяки останньому можна передбачити і запропонувати заходи, які б нівелювали некорисні наслідки господарської діяльності. Наступна важлива проблема – це вплив продукції і продукційних процесів на навколишнє середовище. Вирішення зазначеної проблеми має високий пріоритет в країнах Європейського Союзу, де щораз більше продуктів підлягає процедурі оцінки. Ця оцінка триває впродовж цілого циклу життєдіяльності продукту і для її реалізації застосовується метода LCA. Така оцінка повинна застосовуватися для сільськогосподарської продукції уже на етапі планування, щоб зменшити вплив на навколишнє середовище.
Ключові слова: *менеджмент ризику, інноваційний ризик, аналіз LCA.*

Kaczmarska B. Innovation risk in agricultural production
A constant implementation of new solutions is inevitable at the present stage of economic development. This also applies to agricultural production, where innovation may relate to products, cultivation technologies, processing, and marketing activities. At the same time the environmental awareness of customers increases, which calls for producing ecological products with the application of environmentally-friendly processes. These issues are reflected in the documents of the International Organization for Standardization in ISO 1400.
The study emphasizes the need for risk management in the agricultural production process, as it is in industrial processes, and the use of the LCA (Life Cycle Assessment) methodology for assessing the environmental impact.
The comprehensive nature of the LCA methodology allows us to determine how to manage resources effectively, both in terms of ecology and economics. It also makes it possible to identify and prioritize environmental risks relating to a particular product or process in all its phases of the life cycle, which has a significant impact on risk management.
Key words: *risk management, innovation* risk, *the LCA methodology.*

Качмарська Б. Инновационный риск сельскохозяйственной продукции
Сельскохозяйственная продукция в больших объемах характеризируется подобными закономерностями, как и промышленная продукция. К ней можно применить такие же методы менеджмента, например, менеджмент риска. Уже на этапе планирования благодаря ему можно предвидеть и предложить мероприятия, которые нивелировали бы ненужные последствия хозяйственной деятельности. Следующая важная проблема – это влияние продукции и продукционных процессов на окружающую среду. Решение данной проблемы имеет высокий приоритет в странах Европейского Союза, где все больше продуктов подлежит процедуре оценки. Эта оценка сопровождает весь цикл жизнедеятельности продукта и для ее реализации используется метод LCA. Такая оценка должна использоваться для сельскохозяйственной продукции уже на этапе планирования, чтобы уменьшить влияние на окружающую среду.
Ключевые слова: *менеджмент риска, инновационный риск, анализ LCA.*

Introduction. Agricultural production is an example of a natural process, where the processes occur automatically, and changes of the production object occur due to natural forces. Human activities relate to the beginning of the production process and modification of conditions in order to obtain beneficial effects. Production executed by agricultural companies is subject to the laws of the market as it is while manufacturing other products. The well-known business slogan indicates the two main problems of any enterprise, namely customers and competition.

Hence the survival and development of an enterprise requires persistent activities aimed at acquiring customers and a constant struggle against competition. These two actions are the essence of quality management within the approach of E. Deming, who defined 14 quality management principles and divided enterprises into two groups. One group constituted of enterprises recognizing the significance of quality, while the other included enterprises falling out of the business [15, p. 45-115]. As a consolation Deming said that the survival of a company was

not obligatory. The Deming Wheel is a practical expression of actions conducive to the success of an enterprise through customer satisfaction and escaping the competition. The Deming Wheel describes the well-known PDCA cycle in the process of continuous development (Fig. 1).

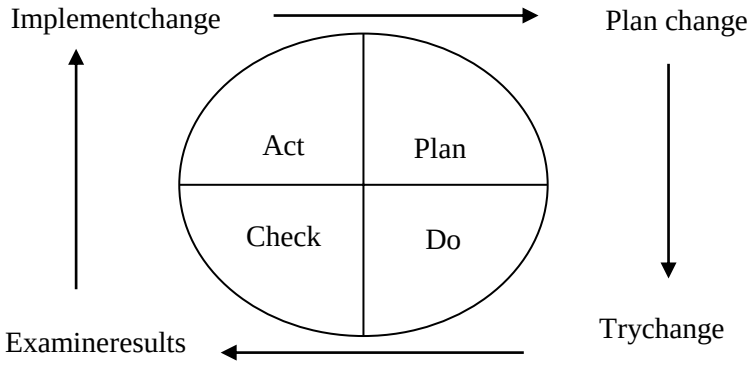

Fig. 1. **The process of continuous development cycle.**
Source: the author's study on the basis of [9, p. 937].

The beginning of this cycle is planning changes that in many cases relate to the product manufactured in the company and are innovative by nature. The planned changes are subject to verification by the market which is a place of trade. In ancient times, the market was a square where sellers and buyers gathered, and after negotiations called bargaining, from time to time transactions were completed.

The buyer walked away with the goods he purchased while the seller was left with money or received other goods in exchange. In general, sellers had to make a considerable effort to find and encourage buyers to purchase the goods they offered.

They made the effort to be attractive to the buyers of goods. The situation nowadays is very similar. The market in the shape of a distinct square is not as important as it used to be in the past, however the list of places where purchase transactions can be made has increased significantly.

These may be places where actually the seller and the buyer meet, such as various small and medium-sized shops, as well as huge shopping centres and commodity exchanges. They also may be virtual formations, for instance online shops and stock exchanges. Despite these changes the relationship between the seller and the buyer still occurs. It involves the subject of interest "what" and the manner of operation "how" (Fig. 2).

The implementation of changes is associated with the innovation risk, whose negative effects are demonstrated by the seller-buyer relationship.

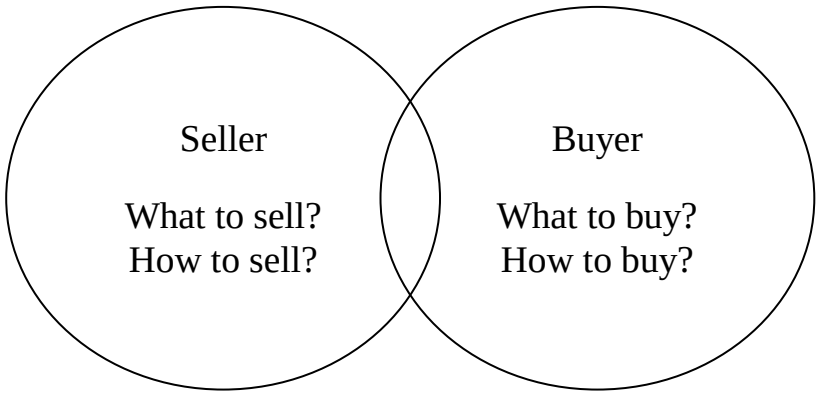

Fig. 2. **The relationship between the seller and the buyer.**

The activities within risk management aim at decreasing the level of possible negative effects. These actions should be completed, as in the case of industrial products, with an analysis of the degree of impact on the natural environment, using the LCA methodology.

Risk mitigation using the LCA methodology. The LCA methodology is described in many documents of the European Union and the specialist literature [7, p. 5480-5492], as an advanced instrument for managing risk in terms of the environment and as an instrument enabling identification and prioritization of environmental impacts and creating the basis for determining ways of mitigating them. Environmental impacts relate to products and processes and how they affect the environment in connection with the consumption of raw materials, emission of harmful substances, as well as producing waste. The principle, structure, guidelines and requirements with respect to life cycle assessment (LCA) were established by the International Organization for Standardization in ISO 14040, 14044, 14047 [16, p. 506-517].

The life cycle assessment tool is universal, and thus it can be widely applied to analyzes the risk of negative impact that products and production processes exert on the environment, as well as in comparative analyses of environmental impacts of two and more products or processes of similar nature.

The examples of application areas include:

–designing environmental protection management systems, through ecological life cycle assessment of manufacturing processes [3];

–modelling ecological hazards for various variants of technological processes, e.g. regeneration of components of agricultural machinery and devices [11, p. 65-70];

–ecological assessment of various products, on basis of the concept of sustainable development [2, p. 7-15];

–indicating relations between activities aiming at limiting environmental pollution, generated during the process of production, utilization, waste management and the demand for products identified as ecological [22, p. 16-21];

–identifying opportunities for improving environmental aspects of products at various stages of their life cycles (e.g. life cycle assessment of industrial water meters) [13, p. 71-74];

–characterizing or conducting the comparative evaluation of services or their selected unit processes over time (e.g. life cycle assessment of various scenarios of waste management) [20, p. 311-322];

–performing relative comparisons between products or processes on the basis of selected category indicators (e.g. environmental assessment of the technology of iron and steel metallurgy) [5, p. 5-13];

–decision making in industry, the service sector and organizations related to strategic planning, prioritizing, designing products and processes (e.g. life cycle assessment in the chemical industry) [10, p. 154-159];

–marketing activities relating to environmental statements, eco-labelling schemes or environmental products declarations (e.g. environmental car declarations) [12, p. 85-90].

Thus the life cycle assessment can become an instrument for selecting the best variant of product or process. Using it we can limit the risk related to the launch of new products and production processes. It should be part of the developing concept of extended responsibility of the producer, especially in agricultural production.

Risk management. The risk in the process of agricultural production can be defined as a possibility of occurrence of an event which has negative influence on obtaining the expected targets. Risk management is a series of actions aimed at reducing possible negative effects of the occurring adverse events. The following actions are performed as part of risk management:

- identification of hazards;
- assessment of risks arising from various hazards;

- determining the risk mitigation plan.

Identification of hazards can relate to various areas, which include:

- Finance – the risk of cost overruns.
- Time – delays in the implementation of tasks.
- Technology – problems arising from the improper cultivation technology.
- Innovation – problems with the implementation of innovative tasks.
- Engineering – malfunction of machinery and equipment.
- Nature – problems resulting from the natural environment.
- External – problems from the surroundings.
- People – problems arising from the employee behaviour and work safety.

The risk assessment is performed using the risk map, which binds together two parameters: the significance of the event for the project (Z; values 1-3-5-7) and the probability of its occurrence (P; values 1-2-3-4). The measure of risk is the product of these two parameters. The significance is often referred to the financial effects necessary to incur as a result of the event.

$$R = Z \cdot P$$

According to such a defined measure, the risk is greater in the case of high significance and high probability of occurrence of the event. Fig. 3 illustrates a risk map constructed according to the presented rules which account for the verbal description given in Table 1.

As part of risk mitigation certain preventive measures, which will reduce the level of high and medium risk, must be specified. Low risk does not require preventive measures, but only monitoring.

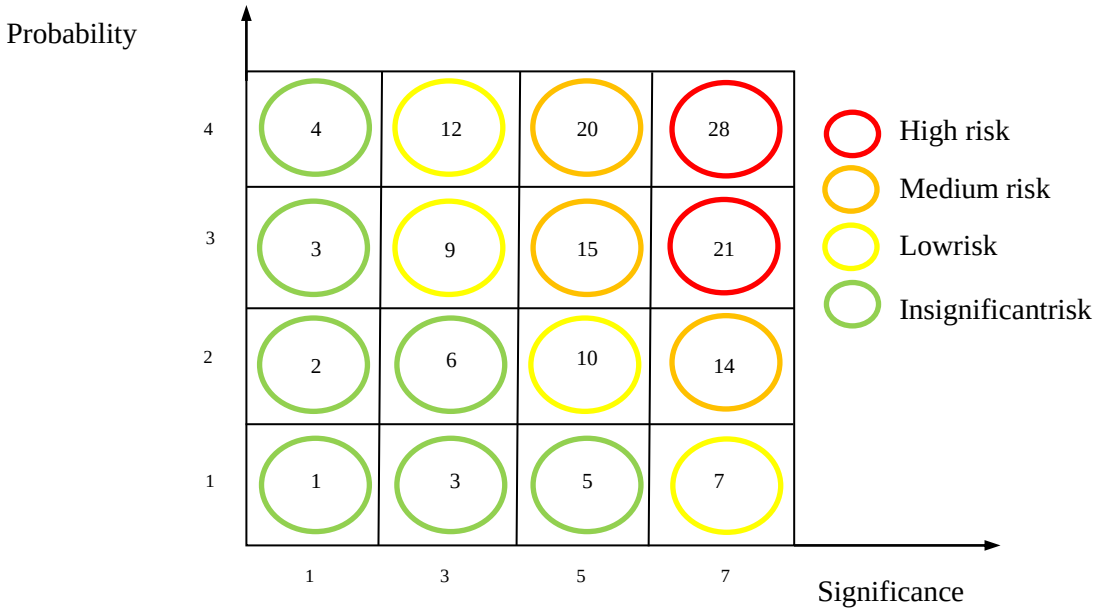

Fig. 3. **Risk map.**

Table 1

Risk measure

Risk measure R	Description	Share %
1-6	Insignificant risk	1-25
7-13	Low risk	26 -50
14-20	Medium risk	51-75
21-28	High risk	76-100

For example, an attempt to relocate the crop from other remote regions is associated with high probability of failure (P=4). Likewise, the use of new unverified technology of cultivation, use of new fertilizers and plant protection products, new machines for maintaining plants and harvesting.

If the new experimental cultivation covers a large area then the significance of failed crops is large (Z=7). High risk is the result (R=28), which requires presenting a plan of reducing the risk. The simplest measure is to reduce the experimental cultivation area, leaving the remaining part for the already grown products.

Thus the coefficient defining the significance of failure (Z=3) is curtailed, which reduces significantly the level of risk to low risk (R=12). Obviously, it is at the expense of smaller potential profits, which were to be provided by the new successful innovative cultivation on a large area. However, the acquired experience will allow us to reduce the probability of failure (P=2) in the following years, which will diminish the level of risk (R=14) to medium.

The impact on the natural environment. Systemic thinking, whose origins date back to the fifties of the 20th century, contributed to the change in perceiving human functioning in the natural environment. Thinking based on the idea that the environment is part of the economy was replaced by a reversed conviction that it is the economy which is part of the environment [6, p. 38, 182].

Thus, the economy and the associated human activities remain within the system which creates the natural environment called the ecosystem. From a global perspective the economy is the cause of considerable damage, often overshadowed by local success. The devastation is related to ecosystem and can be identified within three areas[1, p. 241; 6, p. 182-183; 21, p. 131]:

- devastation of non-renewable resources,
- devastation of the ecosystem,
- devastation of human health.

The main problem was to determine the standards and how to measure the indicated damage, which is a factor necessary for analyzing its impact on the entire system. The concept of energy evaluation was proposed in the case of non-renewable resources, i.e. the conversion of loss into energy [6, p. 183; 17, p. 370].

A more difficult thing was to find a measure for the two other types of damage. The method of estimating the damage throughout the life cycle of the product, represented by the ISO 14000 standards, has become the solution to this problem [18; 19].

Hence comes the LCA methodology (Life Cycle Assessment) allowing us to assess the overall impact of the product on the environment. It is also an instrument enabling designers to seek solutions diminishing the scale of such threads to the natural environment. This activity is called eco-design, according to which environmental aspects of the product are important indicators of how innovative the product is [4]. Eco-design relates also to agricultural production and should be used, in particular, in the case of implementing innovative solutions.

The LCA covers the entire life cycle of the product, taking into account all the factors related to it and affecting the natural environment [14, p. 7-48]. In other words, the LCA analysis examines the relationships between the product and the surrounding environment.

In the case of material goods these relationships are to indicate the degree of environmental impact within the four areas: materials, manufacture, utilization and disposal.

Environmental impact is due to consuming non-renewable resources, including energy or introducing harmful elements into the environment. The product is considered as part of the eco-system, so the analysis must account for even the most remote system constituents linked to the product (Fig. 4).

Materials – the impact on the environment throughout the entire production cycle of materials, considering the material resources used and the resulting waste, energy and the hazardous substances introduced into the environment.

In the case of agricultural production it involves the impact on the environment in the process of preparing seeds and seedlings, artificial fertilizers and plant protection products, water used for watering crops, waste as part of the plants not intended for consumption purposes.

Manufacture – the impact on the environment taking into account the machines and devices, energy, generated waste, and harmful substances introduced into the environment. In the case of agricultural production it involves the impact on the environment through the construction and use of machinery and agricultural equipment, use of fuel and electrical energy for producing agricultural produce and processing the produce into food products in a commercial form.

Utilization – the impact on the environment taking into consideration the energy consumed, supplies, and harmful substances introduced into the environment.

In the case of agricultural production it involves the impact on the environment in the process of processing commercial food products to a form suitable for direct consumption. These includes kitchen machines and appliances, energy, water, as well as waste arising in this process.

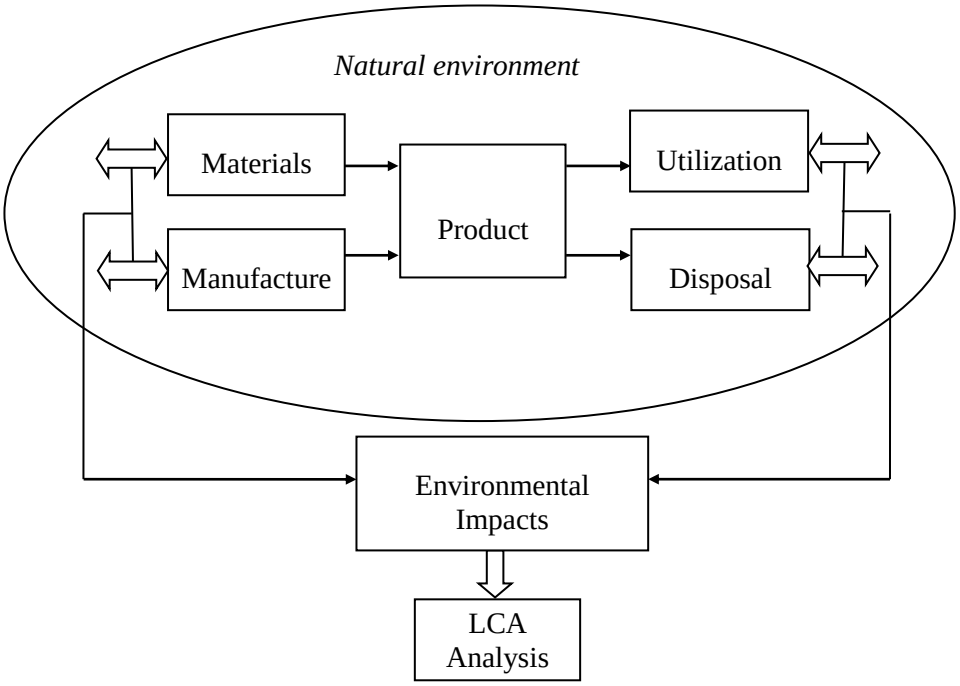

Fig. 4. **Relation: product – environment in the LCA methodology.**
Source: Kaczmarska B., Gierulski W., Designing Innovative Products in Terms of LCA, Structure and Environment, Architecture, Civil Engineering, Environmental and Energy, No. 3/2014, p. 48-55.

Disposal – the impact on the environment taking into consideration the energy consumed during the disposal process, recovery of materials as a result of recycling, and the introduction of harmful substances into the environment.

In the case of agricultural production it involves the impact on the environment after preparing the products for direct consumption, including machines and devices used for washing, water, energy and waste treatment. Determining the environmental impacts of the product is a very complex task, especially due to the necessity of accounting for a complete product life cycle compatible with the systemic approach.

The factors occurring in the case of agricultural production, indicated in the descriptions, do not include all the aspects of environmental impact and should be treated only as selected examples.

Summary. Agricultural production carried out on a large scale displays many similarities to the industrial production. Thus it is possible to use similar methods of management. The issue of risk management is an example. Thanks to risk management it is possible to predict and take measures to reduce the negative effects of adverse events already at the stage of planning the project.

Another important element is the impact of the product and production process on the

natural environment. It is a high priority issue in the EU states, where more and more products are subject to this kind of assessment.

It is the assessment within the entire product life cycle where the LCA methodology is applied. It seems that such assessment should also be applied to agricultural production already at the planning stage in order to diminish the negative impact on the natural environment. The study is a descriptive theory, because due to its limited volume it does not contain the research results.

REFERENCES

1. *Adamczyk. W., Ekologia wyrobów.(Ecology of Products), PWE, Warszawa 2004.*
2. *Adamczyk W., Nitkiewicz T., Rychwalski M,: Wykorzystanie metody LCA do ekologicznej oceny opon samochodowych, Gospodarka materiałowa & Logistyka, nr 3/2013.*
3. *Bajdur W., Idzikowski A., Salamon Sz.: Możliwości zastosowania ekologicznej oceny cyklu życia procesów wytwórczych w projektowaniu systemów zarządzania ochroną środowiska, http://www.ptzp.org.pl/files/konferencje/kzz/artyk_pdf_2010/7_Bajdur_W.pdf.*
4. *Burchart-Korol D., Ekoprojektowanie – holistyczne podejście do projektowania (Eco-design-holisticapproach to design). Problemy Ekologii (Ecological Issues), vol.14 no. 3, May-June 2010. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-article-BAR8-0005-0016/c/http www_bg_utp_edu_plartpe1-32010burchart.pdf.*
5. *Burchart-Korol D., Środowiskowa ocena technologii hutnictwa żelaza i stali na podstawie LCA, Prace Naukowe GIG. Górnictwo i Środowisko, Główny Instytut Górnictwa nr 3/2010.*
6. *Cempel C., Teoria i inżynieria systemów.(Theory and Engineering of Systems), Wydawnictwo Naukowe Instytutu Technologii Eksploatacji –PIB, Radom 2008.*
7. *Corominas Ll., Foley J., Guest J.S., Hospido A., Larsen H.F., Morera S., Shaw A.: Life cycle assessment applied to wastewater treatment: State of the art., Water Research 47 (2013).*
8. *Gierulski W., Kaczmarska B.: Designing Innovative Products in Terms of LCA, Structure and Environment, Architecture, Civil Engineering, Environmental and Energy, No. 3/2014.*
9. *Gierulski W., Sulerz A., Szmidt A.: Rozwój wyrobu z wykorzystaniem metodyki FMEA w procesie kształcenia studentów, w: Innowacje w zarządzaniu i inżynierii produkcji, T.II, (pod red.) R. Knosali, Oficyna Wydawnicza PTZP, Opole 2014.*
10. *Graczyk M., Ocena cyklu życia jako dobra praktyka promowania zasad zrównoważonego rozwoju na poziomie przedsiębiorstw, „Funkcjonowanie przedsiębiorstw w warunkach zrównoważonego rozwoju i gospodarki opartej na wiedzy”, Wydawnictwo Wyższej Szkoły Ekonomicznej w Białymstoku, Białystok2009.*
11. *Grudziński J.: Modelowanie zagrożeń ekologicznych w regeneracji części maszyn rolniczych, Inżynieria Rolnicza 7(105)/2008.*
12. *Gruszka A., Niegowska E., Zarządzanie środowiskowe: Komentarz do norm serii ISO 14000, Wydawnictwo PKN, Warszawa 2004.*
13. *Kłos Z., Kurczewski P., Kasprzak J., Środowiskowe charakteryzowanie maszyn i urządzeń. Podstawy ekologiczne, metody i przykłady, Wydawnictwo Politechniki Poznańskiej, Poznań 2005, cyt. za:Kulczycka J. i inni, Opracowanie metodyki LCA dla oceny projektów infrastrukturalnych, Kraków, 2008, str.71-74, https://www.ewaluacja.gov.pl/Wyniki/Documents/rimi_017.pdf.*
14. *Kowalski Z., Kulczycka J., Góralczyk M., Ekologiczna ocena cyklu życia procesów wytwórczych (LCA)(Ecologicalassessment of the life cycle of manufactureprocesses), Wydawnictwo Naukowe PWN, Warszawa 2007.*
15. *Latzko W. J., Saunders D. M., Cztery dni z Demingiem – nowoczesna teoria zarządzania. Wydawnictwo Naukowo-Techniczne Warszawa 1998.*
16. *Masternak-Janus A., Rybaczewska-Błażejowska M.: Ocena cyklu życia (LCA) – metodologia i możliwości zastosowania, [w:] Współczesne uwarunkowania rozwoju społeczno-gospodarczego Świat-Polska-Region Świętokrzyski; Politechnika Świętokrzyska, 2014.*

17. Odum H., Environmental Accounting, Energy and Decision Making, John Wiley, New York 1996.

18. PN-EN 14040:2009, Zarządzanie środowiskowe – Ocena cyklu życia – Zasady i struktura. (Polish standard: Environmental management-LCA-Priciples and Structure).

19. PN-EN 14044:2009, Zarządzanie środowiskowe – Ocena cyklu życia – Wymagania i wytyczne.(Polish standard: LCA-Requirements and Guidelines).

20. Schluchter W., Rybaczewska-Błażejowska M., Life cycle sustainability assessment of municipal waste management systems, Management nr 2/2012.

21. Szoege H.M., Sobolewska A., Analiza cyklu życia opakowań w handlu jabłkami waspekcie oddziaływania na środowisko naturalne, Roczniki Nauk Rolniczych, Seria G, T. 96, z. 4, 2009.

22. Zagajewska K., Hasiuk A.: Aspekty ekologiczne jako stymulatory sprzedaży samochodów, Systemy Zarządzania w Inżynierii Produkcji, 2011, Nr 3(3).

◄●►