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SUSTAINABILITY OF FOOD PRODUCTION CHAIN*

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A b s t r a c t: Based on the insight of into the comprehensive actual and current investigations in the area of food production chain suistanability in Europe and in the world, and comparative insight of situation in Serbia, this study presents structure of investigations which have to be realized in orgder to enable the creation of prerequisites for technological development of food production, as a significant and important branch of Serbian economy, applying sustainable principles from economic, social, and ecological points of view.

***Key words*:** *food production chain, sustainability, objectives*

Održivost lanca proizvodnje hrane*

S a d r ž a j: Na osnovu sagledavanja sveobuhvatnosti aktuelnih istraživanja u oblasti održivosti lanca proizvodnje hrane u Evropi i svetu i poredeći situaciju u Srbiji, ovaj rad predstavlja istraživanja koja će biti realizovana da se omogući stvaranje boljih preduslova za tehnološki razvoj proizvodnje hrane, važne i prosperitetne oblasti srpske ekonomije, primenjujući održive zahteve sa ekonomske, društvene i ekološke tačke gledišta.

***Ključne reči*:** *lanac proizvodnje hrane, održivost*

Introduction

The fundamental task of agriculture is the production of adequate quantities of high quality foods and raw materials of organic origin for the existing world population and its increase of of about 93 million people per year (*Kennedy,* 1993). Ever growing demands for food production impose the needs for more efficient managing of economic resources that such production follows. Management of agricultural resources is crucial for the survival of mankind, i.e. for the economic, cultural and social development of the society.

In Serbia, as a country with exceptional natural resources for agricultural production, production of food is one of the supports of technological development. Structure of natural resources, and also market capacities generated from demands of particular categories of products, caused locations of nearly 90% of food production in the structure of chain of production and processing in segments characterized with mass production and consumption. In the light of enviromental conditions and consumer habits in region of Balkans, the food production chain that could be considered as mass production, can be divided into:

- basic field crops and basic products of their processing (wheat, corn, sunflower, soy),
- mass-produced animal species and products of their processing (pigs, cattle, poultry).

High participation of the mentioned products in the gross production of agro-industrial sector, as well as high degree of exploitation of natural resources through the realization of the mass production of food, sets as imperative serious approach to the realization of all necessary activities in the shortest possible time. On the level of mass production of food, this should follow steps of sustainable technological development that are going to solve the existing problems, introduce necessary developmental solutions and provide conditions for strategic approach to projecting and managing this enormous

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segment of the agro-industrial which is, from the aspects of characteristics of natural resources and market demands, irreplaceable and obligatory. (*Meyer*, 2007).

Large volume of production, which is concentrated in the chain of mass production of food is, at the same time, a source of significant losses characterised by weak links in chains of production, processing and distribution. However, there are potential points of significant improvement and contribution to the national economy, environmental protection and competitiveness of this group of goods at the world market (*Rowe et. al.,* 2007).

Investigations and general practice in Serbia and in the world

Trends of investigations concerned with technological development of food production in Europe and world-wide evolved during the past several decades: beginning with investigations predominantly oriented to solutions aimed at production of adequate quantities of quality food that characterized first half of the last century; followed by studies oriented to improvements of food quality and safety during the last decades of 20th century, to the shift of focus on sustainability of food production chain as a whole at the beginning of the new millennium (*Risku and Maenpaa*, 2007).

The word „sustainability“ in its broadest sense, which is used in the present study, means „the production which ensures that demands of the inhabitants and the market set towards natural environment are achivable, without diminishing the capacities of the environment to satisfy the needs of future generations“, where sustainability of each system and also of system of the food production chain demands equal consideration of economic, ecological and social aspects of sustainability.

The structure of European technological platform „Food for life“ and priorities of investigations and the technological development that are there defined demonstrates the evident shift of focus of European investigations, as well as of European and even world processes of technological development from domains of development of new and improvement of the existing singular technologies to the trend of recognition of food production chain as the whole, from points of view of efficient management with tendencies in all segments and especially the trend of the all-including investigation and defining of all aspects of sustainability of food production chain and mutual interconnection and dependence of all of its segments. European technology platform FOOD FOR LIFE (http://etp.ciaa.be) is developed by teams of the most eminent European experts and it makes the basis for determining the structure of future activities in R&D projects, as well as in orientation of trends of technological developments in production of foods in general. Sustainable production of food, which is in the European technological platform stated as one of its principal aims, defines diversification of focuses of investigations on:

- development of sustainability of food production and distribution chains in Europe;
- elaboration of scenarios of future sustainable food production and provision systems;
- development of systems of sustainable production, preservation, packaging and distribution;
- ensuring sustainable primary production of food in Europe;
- development of consumers' understanding and their relations with sustainability in the food production.

On the basis of European technology platform FOOD FOR LIFE, in almost all European countries teams of the most eminent experts have defined, on multidisciplinary foundations, national technological platforms, where aspect of sustainability of food production chain was positioned in light of the existing problems and developmental potentials of each country.

In Serbia, there is awarness of the necessities of establishing technological development on the sustainable basis at the highest level, put together in the Strategy of Sutainable Development of the Republic of Serbia (http://www.odrzivi-razvoj.sr.gov.yu), which went through the public discussion phase and which is expected to be adopted soon. The text of this document does not apply directly on sustainability of chain of mass production of food, but deals with respect on the explained imperatives connected with natural resources, the place of mass production of food in national economy and its significance for each individual as consumer. High quality, applicable and all-including investigations in this domain will be necessary for the implementation of this strategy.

Protection and improvement of environment, as well as rational use of natural resources, apear as one of priorities of this startegy, what is, to a great degree, directly linked with the mentioned problems concerning mass food production chain. Insisting on protection and improvement of system of enviromental protection, decreasing pollution and pressures on the environment, use of natural resources in a way which will assure their availability for future generations indicate that establishing a system of protection and sustainable use of natural resources, including soil as starting resource of mass

production of food, will have unequivocal priority, but also the unequivocal necessity for intensive research activities.

Considering agriculture and production of foods, general objective of sustainable development is the creation of economically feasible and ecologically acceptable production, which is capable of entering the European market, including introduction of organic agriculture. Among many important priorities, Strategy of Sustainable Development of Serbia insists on the following priorities:

- investigations of potentials of renewable energy resources, with aims of their verification and more real balancing;
- defining the optimal approach to construction and/or reconstruction of the industrial infrastructure oriented to enviromental protection;
- introducing „cleaner“ production and improvements of energy and raw materials efficiency, with simultaneous decrease of quantities of wastes.

The degree of mutual effects of individual links in chain of mass production of food and their mutual interactions with market and with the environment is shown in Figure 1.

Chain of the mass production of food

Chain of mass production of food, perceived in the manner and with segments which have to be recognized, analyzed and synthesized as integral sustainable system is shown in Figure 2. On the basis of experiences of multidisciplinary and highly specialized team of researchers, conception of project named “Sustainability of chain of mass production of food” was realized, is on going and was accepted for financing by the Ministry of Science and Technological Development for the period 2008–2010. Within this project critical points are addressed, which represent objects of investigating activities that have to assure optimal effects on technological development, with respects of individual improvements, but also with respect of improvement of sustainability of chain of mass production of food as the whole.

The very first link in the chain of mass production of food is primary agricultural production. Optimization of conjunction between primary agricultural production and processing of primary agricultural products represents first focus point for realization of significant improvements of sustainability of mass production of food.

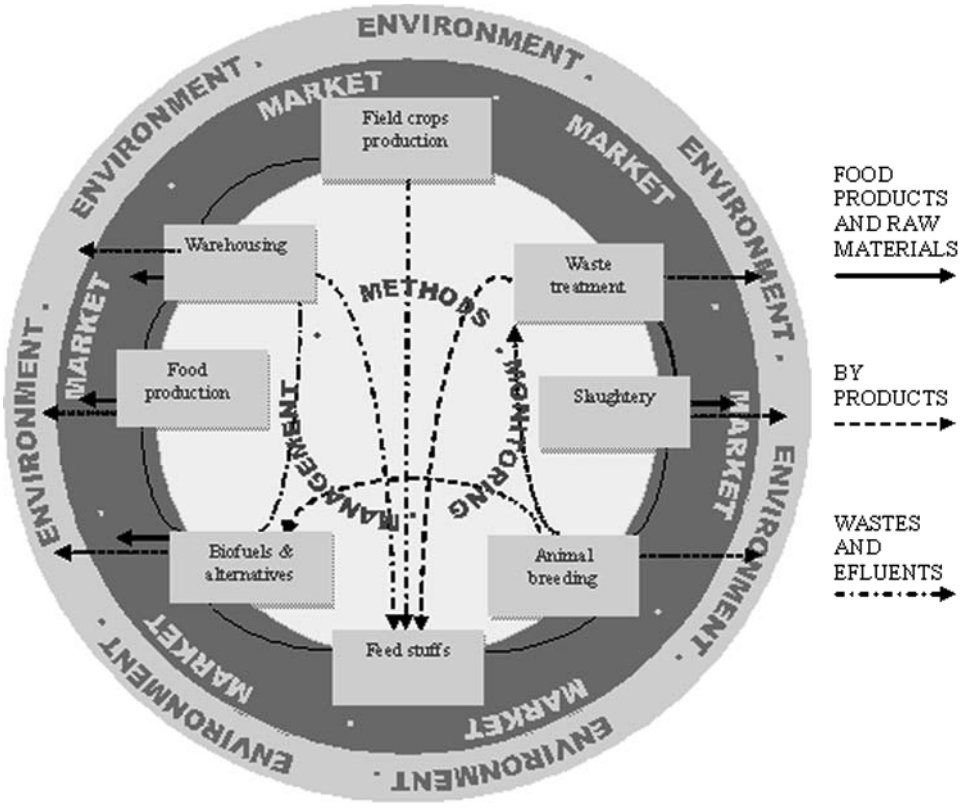


Figure 1. Large scale food production chain in the environment with flows of raw materials, by-products, products and wastes

Slika 1. Lanac masovne proizvodnje hrane u životnoj sredini sa šematskim prikazom tokova sirovina, sporednih i finalnih proizvoda

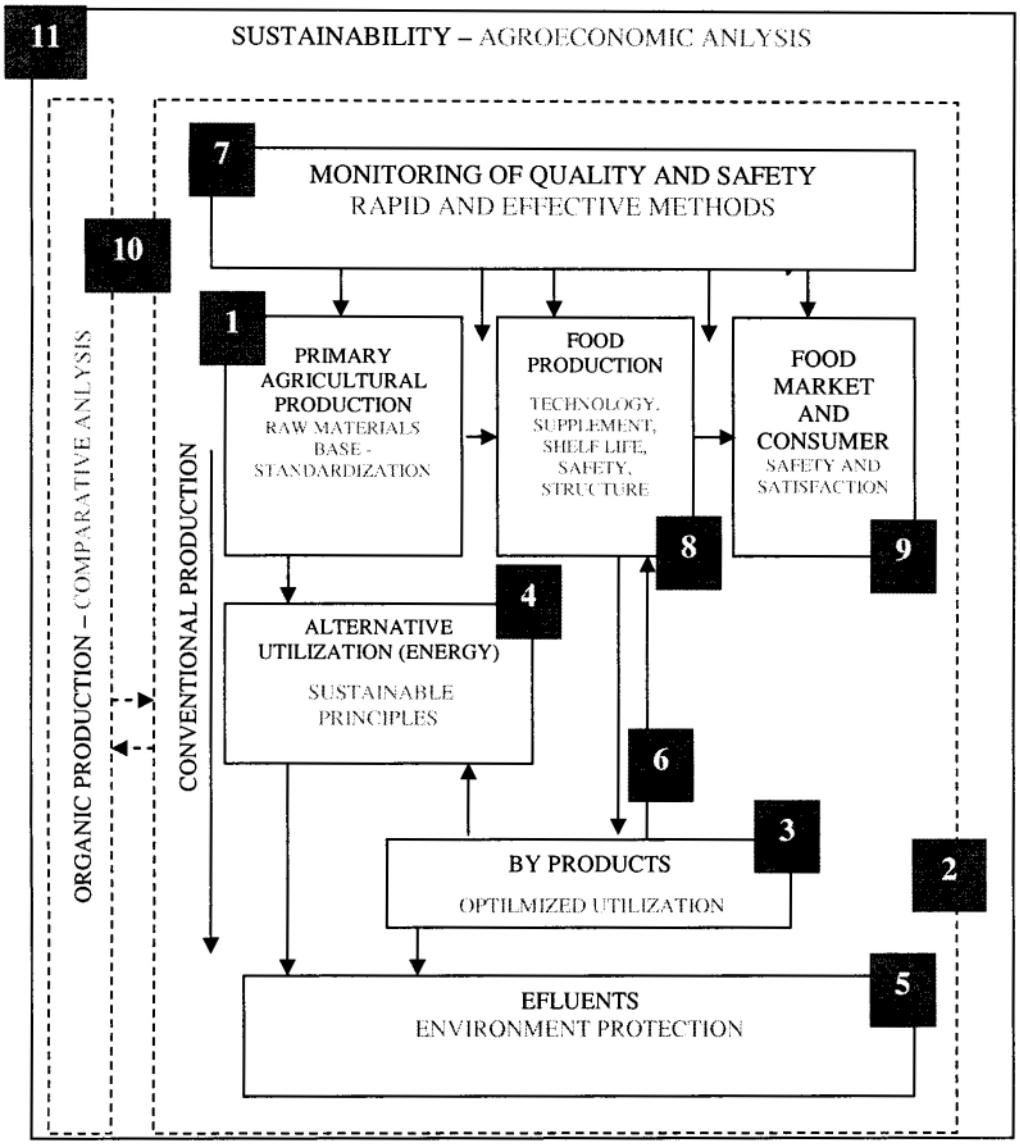


Figure 2. Large scale food production chain with focused critical points
Slika 2. Lanac masovne proizvodnje hrane sa fokusiranim kritičnim tačkama

Chain of mass production of food includes great losses, but also the huge possibilities for potential improvements in optimization of the use of by products that appear in primary agricultural production, as well as in plants for mass processing of foods (*Green and Foster*, 2005). Two directions of investigations are oriented to improvements of safety, and nutritive properties of animal feeds on one, and improvement of assortment and quality of products and by-products of slaughterhouse industry from the other side.

Sustainable management with the use of by-products, and especially of primary agricultural products for alternative purposes, meaning predominantly the production of biofuels which represents backbone of numerous investigations in the world, in this project are covered by investigational task AGRICULTURAL PRODUCTS AND BYPRODUCTS FROM PRODUCTION AND PROCESSING OF FOOD AS RAW MATERIAL IN ENERGY AND OTHER ALTERNATIVE FORMS OF PROCESSING, where they will be evaluated.

Important aspects of sustainability of mass production of food chain, which must be recognized through integral research of the effects of chain of mass production of food on the environment (*Henningsson*, 2004), effluents in the chain of mass production of food will be realized, through investigations of quantities and compositions of the most significant effluents, analyze of potential risks for the environment and development of sustainable solutions of registered problems on their macro level.

Sustainability of system of management, safety, quality and environmental protection processes

belonging to the chain of mass production of food, depends mostly on the availability of research methods (*Gerbens et. al.*, 2003), which enable realization of the corresponding parameter measurements during entire production, processing and distribution phases, with application of investigation methods, whose application is sustainable regarding efficiency of obtaining results, costs of the performed tests and scientific impact. In modern research, sustainable production of food is often connected with production of foods based on principles of organic production.

Intended investigations, focused on individual aspects of sustainability of mass food production chain, can be positioned in implementation of the obtained, results so that they veritably contribute to the technological development over integral contribution to sustainability of chain of mass production of food only after their mutual complementarities have been assured through agroeconomic analysis of model of sustainable chain of the mass production of foods.

Meat industry – part of the food mass production chain

Meat industry is an important link in the food production chain. Together with intensification of the production process and with production of the even larger quantities of meats, problems with dead animals and accumulation of slaughterhouse wastes also emerge (Table 1).

Solution of the problem of harmless removal of waste products of animal origin, are of exceptional economic importance, today, it is irreplaceable veterinary-sanitary and preventive usage in the suppression of catlle infections and zoonoses and special attention is paid to environmental protection and rehabilitation.

Table 1. Slaughter and Animal Wastes Quantities in Serbia in 2007 (Statistical Office of RS)
Tabela 1. Klanje stoke i količina animalnog otpada u Srbiji u 2007 godini (RZ za statistiku)

Origin of wastes	Slaughter	Wastes, metric tons
Cattle	491 000	21 990
Swines	6 553 000	47 068
Sheep	1 066 000	7 627
Poultry	45 942	27 565
TOTAL		**104 250**

Quantity of animal waste which appear in circulation of goods (raw meat, intestines, cured products, sausages, fat) as well as quantity of animal corpses which can be collected, should be added to this quantity. If the production of livestock and meat industry is not going to change drastically, there are 125.000 t of animal by-products annualy, or cca 496 t daily, which should be harmlessly removed.

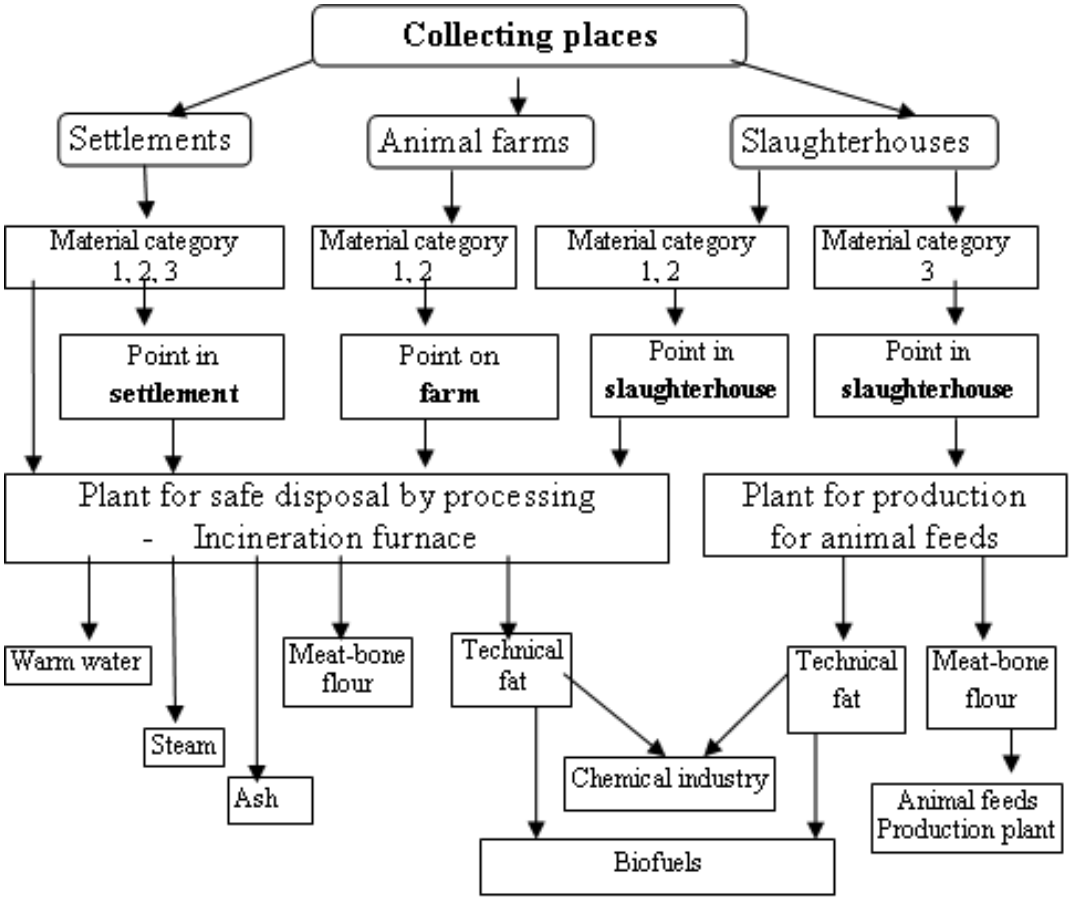
Importance of safe disposal of animal by products

Necessity of solution of safe disposal of animal by-products by their utilization with processing into animal feed and bioenergents, grows with the intensification of animal growing and the increasing of capacities of industrial slaughterhouses, construction of new small slaughterhouses, building of plants for meat processing and increasing of the volume of international trade of commercial animal products (*Okanović et al.,* 2006). Correct solution of safe disposal of animal by-products can be seen from three key aspects that should fulfill the technological solutions for solving of disposal of such materials by their processing, namely: from the epidemiologic--epizoothiologic aspect, with the aspect of environment protection, and the economic aspect.

According to *Ristić et al*., (1996; 2000), without any doubt, the newest and the best method of safe disposal of animal wastes is their technical processing in separate categories into products for chemical industry, bio-fuels and feed for specific animals.

Prerequisite for safe disposal of animal wastes, using one of the described methods is organized collection and delivery of raw materials. Modern disposal of waste materials demands orderly constructed plants with adequate capacities, which should assure permanent and continuous supply of raw materials. This confirms the importance of recognizing the raw materials fundaments for each object, i.e. organizing of epizoothiologically and economically acceptable region, which should enable obtaining adequate quantities of animal wastes leading to designing and construction of modern object for their safe disposal (*Okanović et al.,* 2008a).

In such collecting circle, organizing of collection of animal wastes represents a very delicate problem, from whose solution to a large extent depends the successful operation of the plant that is going to process such raw materials. This problem, in any case, has to take into consideration both, plant that proceses raw materials of animal origin or cattle-growing farms, and slaughterhouses that generate such raw materials. Also, important role in solving of the problem have local municipal communities. They are, according to the existing legislative rules on suppression of contageous diseases, obliged to organize safe disposal



Scheme 1. Organizing of collection, storage and safe disposal of animal waste.
Shema 1. Organizacija sakupljanja, skladištenja, i neškodljivog uklanjanja animalnog otpada

of animal wastes in their region. In other words, organizing the collecton of mentioned raw materials should be based on contractual linking of plants for safe disposal and processing of animal wastes and local municipal communities or their corresponding organizations (slaughterhouses, animal farms etc.) (*Ristić et al.,* 2003).

The emphasis on the necessity of transferring of animal wastes from the place where they were generated to the storaging place as fast as possible, is of grate importance, as well as the necessity of rapid performing procedure of their processing. This is very significant, not only from the epidemiologic-epizoothiologic aspect, or from environmental protection aspects, but also from the aspect of their technical processing. Namely, fresh raw materials are processed more easily with generation of lower quantities of waste gases and obtaining of better quality products (*Ristić et al*., 2007).

Safe disposal of the described animal waste (material Category 1) by combustion on high temperatures (over 850°C) enables obtaining of warm water or steam, as an energent for processing plant that use warm water or steam and ash as construction material for roads.

We shall mention only that, with the respecting procedures of blood collection and its technological processing, various articles for human use can be obtained, primarily products which are used as functional additives in manufacture of meat products. Special processing procedures enable their use as raw materials in pharmaceutical industry or for production of functional foods (*Matekalo-Sverak et al.* 2007).

On the other hand, industrial waste blood can be collected and processed using corresponding technological procedure in a plant for processing of other animal by-products, using special processing unit. Such a one procedure enables obtaining of feed with high protein content, which contains, mostly, high quantities of essential amino acids, vitamins and mineral substances, and, particularly, iron (*Okanović et al.,* 2008b, *Ristić et al.,* 2008).

Articles (meat- and bone meal and fat) obtained by processing of Category 1 of materials are suitable for use as fuel, i.e. as fuel for direct combustion in architecturally separated objects, respecting the corresponding legislative rules.

Conclusions

Economic and general development of the Republic of Serbia should be more based on the organized investigations and development that should produce permanent technological development through the improvement of the existing and creation of new technologies, as well as of new products, processes and services on sustainable foundations which implies their economic, social and above of all, ecological feasibility.

In order to achieve these goals is it necessary to concentrate on:

1. Multidisciplinary research oriented on solving realistic problems which represent brakes for technological development in numerous points of the mass production of food and the necessity of extraordinary large number of economy subjects;
2. Systematic investigations, integrated with all their interrelations and reservations, which assure that these goals are not going to be performed through partial skips in technological development, but through the sustainable solutions, which should bring long-lasting technological development and prosperity;
3. Focused investigations oriented above all on allready existing problems.
4. Agricultural and food industry by-products, if not valorized, are disposed on landfills, in waste disposal landfill, buried in arid terrains or in open water courses, thus contaminating the environment.
5. If all mentioned ecological and economical aspects are recognized properly, it becomes clear that organized solving of safe disposal of inedible by-products obtained from slaughtered or died animals by their technical processing is a valuable task. This contributes to prevention of spreading of contagious diseases, and rehabilitation of the environment and rational use of waste materials.
6. The most rational solutions of its disposal is its processing into feed, or raw materials for chemical industry and production of biofuels. Manufacturing of feed from sanitary safe raw materials is multiplay valorized, with assurance of the rational development of cattle growing and of protection of the environment. Application of biofuels contributes to reduction of oil consumption (i.e. of imports), reduction of emissions of detrimental gases, stimulation of sustainable development of rural regions.

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