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AGRICULTURAL ANSWER TO CLIMATE CHANGE - OPTIMIZING RESOURCES

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Abstract

Objective: Sustainable future is our task. Site-specific crop production is compatible with sustainability from ecological, economic and social aspects. The aim of the paper is to highlight the role of innovation in optimizing resource use in agriculture. That means the use of all items of precision technology matched with a form of farming technology that is appropriate for the environment. The question to be answered is: what solutions give enough income for farmers and keep the environment in good condition if the climate is changing, in the aspect of the "de-growth' theory developed by Serge Latouche. Methods: Based on content analysis a summarization is given in this paper on the 'de-growth theory'. The paper focuses on our former researches where the question was discussed as an economic question of farms, innovation and cooperation, taking into consideration attitudes and willingness to cooperate. Results: Site-specific farming is a holistic system, a technology that allows target-oriented treatments, thus managing the spatial and temporal variability within an ecosystem, by applying spot treatment applications, finding the optimum solutions, when the climate, water supply is radically changing with an increasing risk of production. And at the same time, the farmer has to be effective! How to combine the concept and practice of site-specific agriculture with sustainability in a changing word? The concept of site-specific farming meets with the following thoughts of the 'de-growth' theory: (1) Allows the efficient use of natural resources (Restructurer – restructuring factors of production). (2) Each farming strategy in which the farmers' cooperation is the base of efficient machinery use (Restructurer – restructuring of social relationships). (3) Each technology that reduces the human-health risk (Réduire – reduction) shows into the direction of 'degrowth'. Conclusions: Site-specific agriculture is and can be one of the solutions as good answer to climate change.

Keywords: *sustainable development renewal, site-specific agriculture, risk, answers 'de-growth theory' strategy, cooperation*

JEL classification*: Q01; Q55; P49*

1. INTRODUCTION

The sustainability of agricultural production is one of the most important issues of our time, and the agricultural innovation would be a very important aspect. The aim of sustainable agriculture is to define the balance between economic, social and environmental expectations, to establish both the ecologic and economic sustainability. All over the world the common challenges of the agriculture are to satisfy the growing food necessity on smaller and smaller agricultural area in view the avoidance environmental damage. One of the main tasks of society to find the appropriate answers, to use those technologies that fit both these requirements, in agriculture, too. [1-4]

To be successful in economy efficient resource use, strategic thinking and cooperation is required. Sustainable economy includes viable, developing agriculture, with competitive farms.

One of the key driving forces of this development is the farmer itself. Cooperation, sharing the resources helps to meet the requirements of sustainable economy.

The question arose: „What kind of business model do we need?" To find and adopt those farming activities, solutions and technologies that are suitable for effective production, ensuring the viability for the farmers by the product chain is one of the basic tasks of a sustainable economy. A safe food production and establishing the food security are tasks in which all actors in the food chain should be active involved. Higher is the need of thinking together, cooperation if we take into consideration climate change, growth of population, migration questions. More food we need less arable land we reach, less water with higher rainfall fluctuation we face – more questions arose. Really sustainable is the word? Kurt Vonegut, the writer said some when, good place is our planet, what pity it is we have not taken enough care of her. Let see, what kind of possibilities we have to give good answers?

The future of the agricultural production is to keep the input (artificial or natural) usage within a reasonable level and spread out only the amount which is necessary for the produced plant considering the heterogeneous conditions of the field and not more. Many new or rediscovered technologies have appeared against the harmful effects of the artificial chemical use of the agricultural production without yield loss or with yield similarity (for example ecological farming, mid-tech farming and precision farming technology). Among natural resources arable land is one of the key factors in agriculture and in the life of rural areas as well. Another key factor has become more important recently: the water and the question of irrigation. Without going deeply into the question of economy of resource limitation, here should be highlighted the need for increased efficiency both of land and water use. There is a paradigm change need in not only the economy but in our life as well. The so-called linear model of resource consumption, based on the "take-make-consume-dispose" pattern, does not meet the requirements of sustainability.

The limitation of natural resources, the contradiction between the need of today's generation for resources, goods, environment, the unlimited consumption and the need(s) of future generation was well-discussed in the last years in several literatures [5] Also important issues are the depletion of the nature and the pollution of the environment. The new thoughts of circular economy appeared in the last decade. [7-10] Main message of circular economy from the point of view of our topics is, that agriculture – the farm itself – should be considered as a holistic, regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops. In other words the artificial inputs are limited, but at the same time the optimal use should be meeting with the yield requirements. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and up cycling.

A safe food production and establishing the food security are tasks in which all actors in the food chain should be active involved. Questions of food safety, food traceability, environment pollution or the increasing food demand have been discussed from several aspects by agricultural economists. In our paper we highlight the role of site-specific plant production. [11-14]

Traceability guarantees the food safety from farm to fork. The materials and products flow must be linked with the professional information' flow along the entire chain and they must move together. Stakeholders who cannot suit the requirements based on food security, may drop out from the market. Here appears the role of site-specific – with more common words – precision agriculture (PA). [15]

Efficiency has a technical meaning: yield efficiency for the given land, soil and climatic conditions. Based on the analysis of production functions, can be stated that many inputs (variables) the farmer as a decision maker has no impact, so more information and knowledge is needed to adopt farming practice the eco-system.

The responsibility of agricultural production means to find the appropriate species, technologies from the point of view of agro-eco potential. The meaning of production efficiency is a term that is closer to economic efficiency and includes the questions of market (demand, price, subsidies etc.), farm facilities (property, ownership, size, market connections,

memberships, geographical localization, level of capital and machinery, management skills etc.). In this case the responsibility of agricultural production means to find the proper market where there is solvency and willingness of consumers to by the products at an equilibrant price. The task is not too easy to solve at the same time, but all managerial decisions should be made under the agro-ecological and economic circumstances. [16-19]

The term 'sustainable development' includes the current and long-term sustainable production and the controversies of environmental protection that assurance the right quality of life, and difficult to prevent, but rather tolerated conflicts. [20-23] The basic figure of sustainability includes three pillars: ecological, economic and social sustainability, based on the Brundtland Report. [24] What we add: the role of innovation in giving the appropriate answers to changes. (Figure 1)

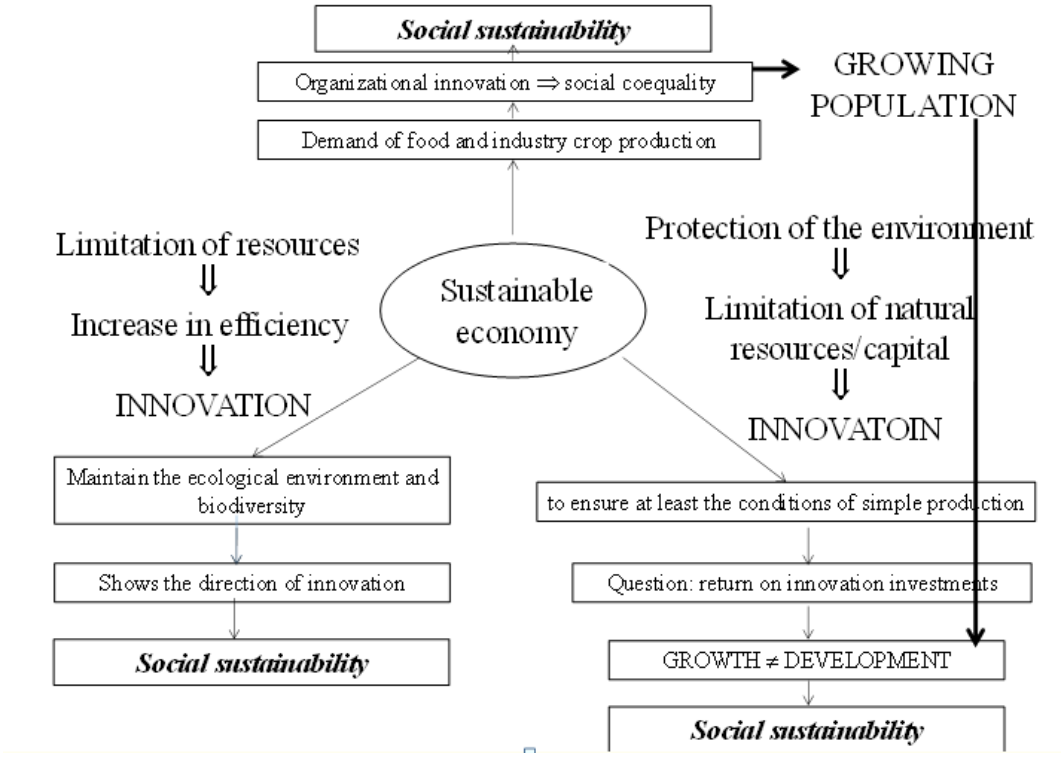

Figure 1. Sustainable economy in the context of innovation
Source: own construction [25]

Sustainability must include farming that adopts the new, innovative, more efficient technologies which allows the easy reproduction of assets needed for production. The future of the agricultural production is to keep the input (artificial or natural) usage within a reasonable level, to apply water saving technologies (not only in the case of irrigation, but land cultivation, amelioration, genetically transferred or modified species, etc.) and spread out only that amount of inputs which is really necessary for the produced plant considering the heterogeneous conditions of the field. [26-28]

Now we got to the stage of food channel participants. The responsible behaviour of all participants (producer, consumer and society) has to find a degree of intensity and technology of production matched with a form of farming technology that is appropriate for the environment (such as organic, conventional, integrated and precision (a further developed form of integrated) farming strategies.

Here should be highlighted the role of up-to-date technologies that allow to optimize the input use (i.e. seed, chemical, water). [29-31] To find the new ways of agricultural development and innovation it is also important to focus on sustainable economy that is nothing else than social sustainability.

2. MATERIAL AND METHODS

The aim of this paper is to define and highlight the characteristics of precision farming as an agricultural innovation, as one way of digitalization of agriculture in the aspect of the "de-growth' theory developed by Serge Latouche. [32-33]

With the method of content analysis, agricultural efficiency and sustainability are characterized from the point of view of precision technology as a potential answer to climate change, focusing on economic efficiency. Logical modelling was used to apply the 'de-growth' theory to agriculture.

3. RESULTS

How PA reduces the risk of production?

We should use such combination of the tools having plant protection effect that will allow the expected yield at a lowest cost, with the lowest environment and human burden. The tools of integrated plant production – here we are meaning wider aspect of production, including a lot of technological elements – we must combine. From economic point of view the direct items needs energy surplus to a system – increase the production cost, like chemicals, mechanical weed management, biotechnical tools, etc. –, while the indirect tools are integral parts of the whole technology (resistance species, protection of useful organism, etc.).

Based on the threshold principle, the treatment is needed when the potential economic loss due to the density of harmful organizations is equal or higher than the cost of treatment (direct tool, energy surplus). That is one role of plant protection: reducing the yield uncertainty, from this aspect it is a variable of yield uncertainty.

$$Y = f(V_1,...,V_n; V_{n+1},...,V_k; V_{k+1},...,V_m),$$

where

$V_1,...,V_n$ = decision variables (fertilizer, seed, several herbicides);

$V_{n+1},...,V_k$ = predetermined variables (soil conditions);

$V_{k+1},...,V_m$ = variables of yield uncertainty (dynamics of predetermined variables, dynamics of infection, weather, etc.). [based on 34]

From this context, on-line site-specific plant production can be considered as more than simple variable of yield uncertainty, it become a real decision variable of yield. [35]

Efficiency and sustainability in agriculture

By 'efficiency' we will consider the economic meaning that is connected to the question of sustainability. The principle of sustainability, the harmony must be achieved between the needs of society, population growth, the natural resources and environmental pollution in a sustainable society by the limitation of consumption, thrift in the use of inputs (materials, energy etc.). The definition of sustainability of the environment comes from the Brundtland Report. [36] Pearce and Atkinson's (1995) understanding is that the natural resources and human-made capital are complementary to each other in the production process, so that natural resources are creating the limiting factors to increasing production and, at the same time, they should be used rationally during production. [37] By the turn of the millennium, sustainability has a broader interpretation:

- Protection of natural resources;
- Food production (fitting to the increasing demand);
- Maintenance of viable rural communities;

- Improvement of human and animal health (conditions);
- Environment protection ('polluter pays' principle);
- Suitable subsidy system(s);
- Diversity of land use;
- Less harmful territorial usage;
- Local solutions in territorial land (resource) usage;
- More efficient institutional background to ensure the multifunctional territorial usage ('territorial cohesion policy').

During recent decades, the new paradigm of agricultural research and development has been built on the interaction of three factors: ecological sustainability, economic efficiency paired with equal opportunities, and mutual assistance of governmental and non-governmental sectors in order to improve the performance and profitability of farming systems. In the future we should extent the question of sustainability with the question: how to react to climate change?

Innovation in agriculture – mainly coming from machine and chemical industry, biotechnology, digitalization, managerial sciences, etc. – gives a good base for the farmers to extend their knowledge, practice and find the appropriate way,
that meet the three pillars of sustainability. The main characteristics of such agriculture are:

- up-to-date information and knowledge about facilities the farmer has (soil and weather parameters, technical efficiency, market prices, movements, etc.)
- appropriate technologies to the given circumstances (with wide assortment from ecological production to site-specific production or individual feeding);
- reduced use of water (drip and precision (planed) irrigation);
- energy saving systems and renewable energy use;
- optimization of chemical use (precision farming, site-specific usage if needed, based on field experiences and prediction of degradation, etc.);
- harmonized with the environment (wild animal protection, shelterbelts; preserving biodiversity, etc.)
- focus on quality production (including the questions of safety food), meeting the market need;
- importance of human capital, human skills (including the IT usage).

In other words, to be genuinely sustainable, agricultural production, land use should be sustainable from the point of view of land, soil, water, biodiversity (environment), from the economic point of view (how to be viable, competitive, giving enough income for the farmers, for the rural communities) and also sustainable in terms of social aspects ('Feed the world') (Figure 1).

Theory of 'de-growth' – how to implement it for agriculture?

This chapter is based mainly of the Authors' former scientific publications. [38-40] The wide expanded interpretation of sustainability and has strong connection to the new paradigm: 'de-growth'. This new theory connected to the question of a sustainable future in the economy came to mind at the very beginning of the 21st century. The main meaning of 'de-growth' is not unknown for society, it is a movement towards a sustainable future, combining ecological economics, anti-consumerist and somehow anti-capitalist thoughts. The roots of the movement go back to the antecedents: The Club of Rome report of 1971 entitled 'Limits to Growth'. Estimates suggest the population will exceed 9.2 billion in 2050 and this is projected to increase demand for food by 50-70 per cent, while the internal structure of consumption is evolving towards high quality food. The Earth's growing population generates increasing demand not only for the limited natural and artificial resources, especially food, energy, drinking water, but also for the liveable areas. To this must be added the question of migration due to climate change. For agriculture, the main task is not only to ensure food safety but safe food and viable rural areas as well. In maintaining the above-mentioned aims the economy, agriculture and environmental management all have a significant role. [40-45]

Decades before the (re)appearance of the moral economists, an etologist, Konrad Lorenz (1973), wrote his novel *Die acht Todsünden der zivilisierten Menscheit* (in English (1974): Civilized man's eight deadly sins). [46] The environmental, ecological and social processes the author is referring to have some economic consequences for business life: degradation of biodiversity, decreases in agricultural and rural areas have huge effects on individual enterprises, on production structure, technology, direction of innovation etc. To be successful participants of business life they need to give appropriate answers, trying to reach their optimal behaviour. On the other hand, the increase in consumption (the over-consumption itself) can be a leading force of economic development, but the question is: why increase the use of limited resources, what is the limit of the current usage? The limitation will increase the production cost, so many enterprises will leave the market if they will not meet the acceptance of the consumers. To be accepted, to keep them, trust is also an important factor. Business must change some moral attitudes (such as being altruist, paying more attention to environment and social responsibility etc.). All the thoughts and questions are beyond themselves and in strong connection with innovation, with the capability to be renewed.

Serge Latouche (2007) summarized the principles of 'de-growth' in his book 'Petit traité de la décroissance sereine' (in English: Farewell to growth). According to these principles, population growth is not the only cause of environmental problems. The allusion of this hides the ethical and moral questions which need common society action. In the view of Latouche, a revolution in culture and behaviour is need to 'de-growth'. Some of the latest economic trends content to these principles. The necessary steps for 'de-growth' are the following:

- Re-evaluate: in our age the individualist megalomania, a rejection of morality, a liking for comfort, and egoism is agreed and we feel it normal. [47 p. 220] It is necessary to go back to the old 'bourgeois' values of honour, public service, the transmission of knowledge, 'a good job well done', frankness and mutual trust, the respects for human rights, and nature and society. It is necessary to re-evaluate the idea of poor or rich and developing or developed.
- Reconceptualise: 'We must for instance and redefine the concepts of wealth and poverty; deconstructing the infernal couple of scarcity/abundance on which the economic imaginary is based, is a matter of urgency'. [48]
- Restructure: adapt the productive apparatus and social relations to changing values. Make equitable policies in production tools and social sources. For example, some car factories need to be converted to make products for recuperating energy through cogeneration. The question is how much does it cost and who will pay for it.
- Redistribute: it means the redistribution of access of natural heritage at the global, social, generational and individual levels. Direct effects of redistribution weaken the power of 'world consumer class' and especially the power and wealth of the big predators. It helps to solve the problem of distribution between North and South and pay back the earlier ecological debt. Thanks to the redistribution the developed countries can give an example and avoid the resistance of 'North' countries.
- Relocalise: producing on a local basis. Relocalization is an economic, political and cultural issue. Fortunately, there are more and more positive examples for growth of local economies. For example: direct marketing, short supply chains and local service nets. The free movement of ideas are not restricted but it is necessary to minimize the movement of physical resources. All production needs should be carried out at the local level. The 'Think global – Act local' philosophy is equivalent to the relocalize principle.
- Reduce: Reduce our habitual overconsumption and the incredible amount of waste. Think the products which goes together a social demand and artificial enkindle needs. Need to reduce the health risk and the prevention need to be placed in the foreground. Recommended to change the 'mass tourism' to regional travel.
- Re-use: we have to reduce conspicuous waste, fight the built-in obsolescence of appliances and recycle waste that cannot be re-used directly. The Olympic Basketball Stadium in London (2012) is a good example because it was the biggest temporary

building and after the Olympic Games it was dismantled and sub-divided for reuse elsewhere.

- Recycle: recycling is part of our everyday life. There are many good examples of it. For example, the parts refurbishing program for Peugeot. In this program the parts are renewed so that the price of service will be low but the quality is the same. Another example is the waste cloth which made from waste paper. The secondary use of biomass energy is also a good example.

These principles could lead our life to another society where free cooperation and self-imposed rules are not a utopia. Re-evaluation is emphasized because this is the basis for the other seven principles. Co-operation should be exchanged for the competitive methods in the business and everyday life too. Latouche does not use the term 'co-opetion' but his idea is equivalent to this. Egoism needs to be exchanged for altruism, and hedonism needs to be replaced by chivalry. It is necessary to change the aim of our life. The new aim will be the share of assets and not the getting of property. The tone could be on the social links and not on the consumption. To realize 'de-growth' it is very important to reduce consumption, recapture reasonable production and increase free time (and intelligent activities in the free time). According to Latouche, localization is a very important issue. His aim is to spread the ideology of local production and local consumption all over the world. Owing to the limitation, the concept of 'Consume less, share more' is only mentioned, without any discussion.

The main conclusions of the First International Conference on Economic Degrowth for Ecological Sustainability and Social Equity in Paris in 2008 and the so-called Barcelona Conference of 2010 must be added to the question of 'de-growth'. [49-50] T the first event the financial, social, cultural, demographic, environmental crisis caused by the deficiencies of capitalism, and the main principles of 'de-growth' were discussed.

At the second, the main focus was how to implement the 'de-growth' theory in society, in daily life. Some practical solutions are the following (not all are listed): promotion of local currencies, reforms of interest; transition to non-profit and small-scale companies; increase of local commons and support of participative approaches in decision-making; reusing empty housing and co-housing; elimination of mega infrastructures, transition from a car-based system to a more local, biking, walking-based one.

Some suggestions have become practice, such as the solutions of the sharing economy (Uber, Airbnb etc.), local currencies (including Soproni Kékfrankos and Balatoni Korona in Hungary) or the increase of local communities, but the conclusion of the conference after six years is that society has not had a big influence on the responsible economists and politicians.

Other authors, i. e. Fukuyama, Sedlaček highlight the importance of learning the new principles of economic cooperation. [51-52] The basis of cooperation is moral economy instead of benefit economy. [53] Transition from the economy of even more to the economy of enough is of the utmost necessity. The role of cooperation, to share resources, strengthen the market position with concentrated products is an important element of current agriculture and farming. [54-58]

Sustainability – based on the three pillars – means that the use of nowadays resources allows to satisfy the present need at a limited level and will serve for the futures generations. Sustainability does not contradict 'degrowth'. Here, in agriculture we need to produce safe food, to ensure food safety with preserving the earth, environment (soil, water, landscape, biodiversity) at the same time. The connection between the 'degrowth' concept and the use of new, innovative technologies in plant production is the ensured food production with less environment burden, less waste, somehow the strengthening of local production – local consumption.

Conclusion

"*Who wins*?" – the question arose. It can be stated that for all participants of the economy/agriculture and rural territories, the sustainable operation means today: appropriate

answers to changes, focusing on the future, finding new solutions, ways to reach and keep the consumers, at a viable farm size. Going back to thought of Latouche, site-specific plant production is a tool to meet the expectations of "de-growth" theory in agriculture.

Food security and safe food are non-separable questions from the climate change, the increasing demand of healthy water. Yes, the questions of food safety, food traceability, environment pollution or the increasing food demand have been discussed from several aspects by – agricultural – economists. In this paper, we tried to highlight the role of new solutions in plant production (i.e. site-specific plant production as innovation), as a potential, good answer to climate change. Based on some ideas coming from Serge Latouche, can be stated that changing the behaviour of farmers, consumers, all participants of food chain ('from farm to table') and of policy makers (governments), humanity is able – and should – to find such solutions – like precision farming – that is in line with the concept of sustainable intensification can contribute to sustainable food system.

We believe that it will not be possible to maintain a sustainable economy without strengthening the rural areas, helping farmers to find successful ways/strategies for being competitive, innovative and to cooperate with each other. Values, attitudes, networks, trust and openness are important to both individual and social utility coincidence that promotes the sustainability of being viable, competitive in wider meaning: future orientation, ability to renew (development, imitation, synthesis), economic/social cooperation.

To reach these goals, all individual farms should operate in an efficient way, that means at least to be of a viable size, so that revenue covers all the costs – including the personal/family income at the average social level – and ensures the necessary investments. By 'viable size', we mean that farming size (at certain production structure and yield level) when the given economic environment allows at least such income to be reached that covers all the production costs, including the necessity investment and ensuring the satisfactory standard of living for the farmer. The basic principle of a real market requires from a farm to reach the viable size without subsidies.

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