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ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2005
Volume 8
Issue 3

Topic:
Economics

Szarek S. 2005. DEFICIENCIES IN THE LAW OF DIMINISHING RETURNS Part I, EJPAU 8(3), #03.
Available Online: http://www.ejpau.media.pl/volume8/issue3/art-03.html

DEFICIENCIES IN THE LAW OF DIMINISHING RETURNS PART I

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ABSTRACT

In the paper there was presented an issue of the law of diminishing returns in agriculture. It was shown, that despite its general character, it is impossible to satisfactorily explain issues of input´s transformation into output in a farming process in agriculture.

Key words: economics of agriculture, law of diminishing returns, production intensity, production efficiency, hormesis phenomenon.

INTRODUCTION

The aim of the paper is to present the issue of input´s transformation into final products in agriculture in the aspect of the law of diminishing returns (input´s diminishing efficiency). Current knowledge level of this law cannot answer for a key question raised for economics of agriculture: why does not production intensity go hand in hand with production profitability?

Issues presented in this paper are effects of looking for factors responsible for efficiency level in animal production. A key element of searches was finding an answer for a question: why does not increase in intensity level lead to farming efficiency and profitability increase? Analysis of empirical data from animal production showed that farming efficiency level in this branch of production depends on results achieved in plant production. Further researches showed that traditional measures of farming intensity level did not have, or their influence on production efficiency was little. Next phase was finding others factors, describing them and examining their influence on agricultural production.

Issues presented in this paper introduce a concept of hormesis phenomenon in economics of agriculture. This phenomenon means organism´s positive answer for small doses of substances, which in higher concentrations are growth inhibitors. This material is first part of a study, which task is to explain issues connected with farming intensity in agriculture. There was presented a subject concerning signs of law´s of diminishing returns working in agriculture and above all it was pointed at its deficiencies resulted from insufficient knowledge about this law.

The study aims to catch up last 250 years from the moment of the law´s of diminishing returns discovery. It is a proposal to connect this law with hormesis phenomenon well documented and working in the world of living organisms. Issues presented in this paper are first study of this type all over the world. They explain input´s transformation into final output in satisfactory way.

Getting knowledge, possibility of quantity measure and describing strength of effect on living organisms of substances and strengths omitted previously during a process of defining farming efficiency may be important step for agriculture. It will enable to go on higher quality and quantity level of farming. It can also contribute to remove constrains blocking increase of land productivity and as a result - whole agricultural production. It also opens up new, great possibilities for researchers engaged in agriculture. It should be realised, that it will be first step, which will have been done in this direction. It will determine the most important research directions, which should be carried in the closest future to organise issues of agricultural production intensification.

THE LAW OF DIMINISHING RETURNS

The law of diminishing returns is one of milestones of economy. It has universal application in huge number of production branches. All economists and students of economic subjects encounter with this issue being conscious that it comes from agriculture. Observation of regularities in farms was inspiration to formulate this law was. In 1765 French aristocrat and financier A. J. Turgot - recognised as a representative of theory of phisiocrats by contemporary economy - announced, that additional doses of labour and capital per area unit yield smaller and smaller output. Several years later - in 1777 the same phenomenon was discovered by Scottish economist Anderson, but in economic literature Turgot is recognised as a first who discovered the law of diminishing returns.

In 1817 the law of diminishing returns was used by D. Ricardo to create the theory of land rent in the work entitled: *Principles of political economy and taxation* [22]. Ricardo as first used simplified marginal analysis, which depicts the law´s of diminishing returns effect in practice. This law´s development and transfer to economy as "*universum*" in all branches of human activity took place thanks to: N. W. Senoir, J. S. Mill, J. H. von Thünen, M. S. Longfield and in later period A. Marshall, W. S. Jevons, C. Menger and L. Walras [4]. Economists pointed at phisiocrats´ mistake, who connected this law only with land not noticing that it concerns economics as a whole [3,6]. Apart from that, it was accepted that the proper name for phenomenon observed by Turgot should be "the law of variable input´s efficiency" or "the law of diminishing returns". Despite differences in name, the core of the phenomenon is the same.

Except from supporters the law of diminishing returns, there was also a group of oppositionists , whose main representatives were Marks, Engels and Lenin [8,11,12]. They reckoned that this law is only a bourgeoisie´s invention and criticised its main assumptions [14]. A basic argument was a fact that technological progress can remove diminishing productivity in agriculture. This premise is right if its work is analysed in the long run. However, its effects cannot be denied in static conditions [1,17,21].

The law of diminishing returns entered into macro- and microeconomics under the name of the law of variable input´s efficiency. An attempt to explain regularities of economic development with its help occurred to be so tempting, that researchers from all over the world focused only on this aspect of its working. The law of diminishing returns became universal law not only in agricultural but also in a whole production, the foundations of cost, price and wage theories. It became a pillar of the whole capitalist political economy system and lasts in it invariably up today [13].

Fascinated researchers did not bother to explain biological basis of the law´s of diminishing returns work forgetting about its roots. They referred to difficulties in this case in defining connections occurring in transformation each ingredients of input into output and exact data concerning real possibilities of rational use of resources [2,16]. Since the year 1952 1952, when E. O. Heady made an evaluation of theoretical influence of additional input on volume of production, science has not contributed anything new in the aspect of work and description of the law of diminishing returns [7].

A. J. Turgot - like a lot of other researchers after him, observed the effect of the law´s of diminishing returns work not knowing mechanisms, which manage it. The Effect, which lies at the bottom of so universal law, must be immutable otherwise it did not become the milestone in theory and practice of economy. This law must always and under all circumstances work, even if there often occurs an impression that it is very unruly. Its work causes that experiments carried out in agriculture and economy give surprising effects. Results occur where they should not be and they do not occur where they are expected. Signs of working effects causing the law of diminishing returns are treated as anomalies and are often ignored.

Phenomenons taking place in agriculture describe signs of the law´s of diminishing returns work, even if phenomenon´s nature, which lies at its bottom, had been a riddle until recently. There were attempts to explain it with use of biological organisms´ capacity, Liebieg´s minimum or homeostasis - without success. It is not something amazing that the law of diminishing returns was discovered but its source remains unknown. Examples for this statement´s support could be multiplied. For instance light - humankind uses it, can produce it, decompose and apply in a lot of branches of economy and daily life. At prehistoric times human used only its natural source - fire for homes´ lightening and heating. Gradual getting knowledge of light´s nature bore fruit in obtaining embers light, next neon, finally laser. Ostensibly small step in this field - discovery of a way of production blue laser light in 2001, creates new perspectives for science and

technology. It is important to realize, that, the light´s nature has not been discovered fully so a lot of things can be expected in this field of study.

Similar situation is in case of the law of diminishing returns. Its present application in agriculture recalls light´s use by human at prehistoric times. We know that it exists and works. Exact knowledge about its nature may contribute significantly to improve level of our knowledge about processes taking place in agriculture, enable to find an answer for a question how can farming be more intense and efficient? Moreover, it will make possible to find measure, which will allow to farm in accordance with nature and rules of sustainable development.

Signs of the law´s of diminishing returns work are visible in agriculture practically on each step. Each additional unit of input - comparing with previous - gives smaller and smaller returns, and as a result - income. Farmer´s aim is to fix such level of input, which will guarantee the highest level of incomes. Such process is in accordance with a rational farming rule, presented by A. Smith in *"An Inquiry into the Nature and Causes of the Wealth of Nations"* in the year 1776 [21].

Basic formula determined optimal production level for a producer is marginal cost formula. Production input can be increased until additional cost equals additional revenue. If production is examined as a function of definite input, so production equitation should come down to simple operation:

$$2 + 2 = 4$$

In this case the law of conservation mass and energy is working, which says that the sum of used energy or mass on the case of chemical and physical reaction before a reaction equals energy or mass obtained after a reaction. This problem is quite specific in agriculture, because there are factors, which are not taken into consideration in production process and display their work in an absolute way. In case of agricultural production several other factors have an influence on a final production effect, such as light, water, ionizing radiation, content of heavy metal in a soil, temperature, value of UV-A and UV-B radiation. Up to now they were factors, which quantitative influence on plants´ growth and productivity was impossible to measure.

Issues of increasing input have special meaning in agriculture. Producer, who increases single input, can expect larger effects than used input, what is ostensibly in accordance with the law of conservation of mass. If in an equation showing production process environmental factors (ΣC_n) are taken into consideration, additional input in production can be write out as a finite sequence of following equations:

$$2 + 2.0 + \Sigma C_n = 4.4 \quad [1]$$

$$2 + 2.2 + \Sigma C_n = 4.7 \quad [2]$$

$$2 + 2.4 + \Sigma C_n = 4.9 \quad [3]$$

The equation number 3 shows a point, in which further increase of input should be stopped because in this moment additional input equals additional output:

$$Dk = Dp$$

where:

Dk - increase in input

Dp - increase in output

The lat unit of input, described by the equation number 3, is called marginal cost in economy.

In order to explain cases described by equations number 1, 2 and 3 there is a need to recall the law of conservation mass and energy once more, which says that the sum of used energy or mass in the case of chemical and physical reaction before a reaction equals energy or mass obtained after a reaction. Assuming that additional input took a form of increased nitric fertilization (equations 1-3) in growing of cereals, a producer will look for ways for production increase by use of additional phosphorus fertilizers.

Equations of production will take the following form:

$$2 + 2.4 + 0.2 + \Sigma C_n = 5.2 \quad [4]$$

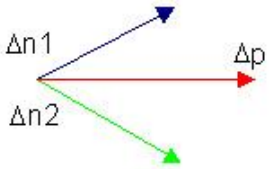
$$2 + 2.4 + 0.4 + \Sigma C_n = 5.5 \quad [5]$$

$$2 + 2.4 + 0.6 + \Sigma C_n = 5.7 \quad [6]$$

Application of additional factor of input, regardless of a level before its use, will also cause marginal cost´s appearance, described by the equation number 6. Next step, which could improve yielding, may be an use of potassium fertilizers, enriching a soil with microelements, liming, irrigation, etc taking the following form:

$$n_1 + n_2 + ... + n_n + Dn_1 + Dn_2 + ...Dn_n + \Sigma C_n = D\,Pn \quad [7]$$

The situation is getting more complicated in this moment. If an increase in single input brings definite effect in form of proportionate increase in production, so this increase in case of huge number of input´s kinds will not be an arithmetical sum of additional input but it will be their resultant according to third Newton´s Law of motion:



where

$$Dn1 + Dn2 \neq Dp$$

It leads to a situation, when additional units of input do not bring expected effect in production increase:

$$2.2 + 2.4 + 0.6 + 0.5 + \Sigma C_n = 5.5 \quad [8]$$

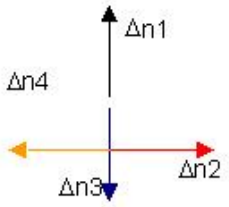
In this case a producer will suffer a loss of 0.2 unit because he expected a result larger than 5.7. There are not also rare cases that the same additional units of input bring smaller increase in production:

$$2.2 + 2.4 + 0.6 + 0.5 + \Sigma C_n = 4 \quad [9]$$

which results in a producer´s loss of 1,7 units. It also occurs, although fortunately not very often, that additional input may lead to block of production:

$$2.2 + 2.4 + 0.6 + 0.5 + \Sigma C_n = 0 \quad [10]$$

This situation can be presented in diagrammatic form as an effects´ reduction according to third law of motion:



In this case, the law of diminishing returns shows its deficiencies because it is impossible to explain these situations, described by equations 8, 9 I 10 with its use. There are also other situations difficult to explain, when economical application of additional input brings surprisingly good effects:

$$2.2 + 2.3 + 0.4 + \Sigma C_n = 10 \quad [11]$$

For today there is no rational concept explaining the law´s of diminishing returns signs in agriculture. It is regarded to be a sign of working strengths connected with biological capacity of living organisms. This capacity does not allow to exceed coded production level, so multiplying of additional input misses a goal and is not in accordance with rules of rational farming. In practice there are some cases that a produce adding more input does not achieve - although he does not exceed biological capacity of farm organisms - expected production level. Getting knowledge of mechanism which rules the law of diminishing returns will allow to consider agricultural production ore rationally in order to avoid situation described by equations 8, 9 and 10, and take measures, which allow to achieve effects according to equation number 11.

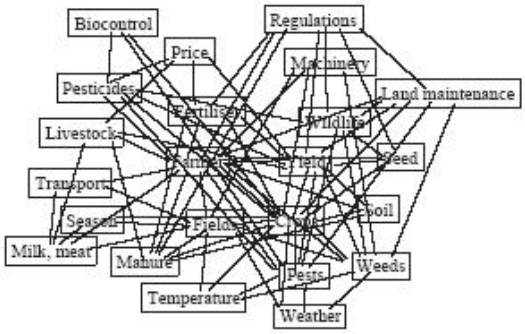
The law of diminishing returns is tightly connected with issues of choosing intensity production level. These issues and their influence on production profitability is nit examined enough. Choosing intensity production level should come down to simple cause and effect relation but in practice there is not like that [2,16,18,19,20]. It occurs that traditional measures of intensity level do not explain a process of forming and amount of achieved revenue in agriculture satisfactorily. Moreover, they sometimes do not have any connections with profitability. These issues are not a subject of thorough economic researches - what is more - is marginalised. After all a question for a farmer: how intensively should he farm? is one of the key issue concerning the fact that ho possesses limited sources, which he wants to transform into as more as it is possible. Furthermore, the number of people is increasing all over the world. Food problem in face of diminishing sources of agricultural land and soil degradation will get more and more significance in the countries of the Third World, which are inhabited by two thirds from the total world amount of people, so it is impossible to ignore it.

Accessible data points out that productivity increase in agriculture should be looked for in plan production and in consequence in a soil. It is actually responsible for failures in increase of production level. It is known that in good conditions corn can yield 19,3 $t.ha^{-1}$ of grain, wheat 14,5 $t.ha^{-1}$ and potatoes even 94,1 $t.ha^{-1}$. However, average yield of these plants are respectively 4,6; 1,9; 28,2 $t.ha^{-1}$, which means an use of production potential at a level of 20-30%. Three factors are responsible for so large difference: diseases, insects and weeds. The rest 83% are physical-chemical properties of a soil [5]. In this situation there is no doubt that efficiency and profitability of agricultural production is conditioned by land fertility, what is indirectly visible in results of some researches [15,19,20].

Results of animal production depend directly on land fertility. It is quite often heard that some activities in animal production - like butcher hog production or poultry keeping - are not connected with land. There is no more false statement. These activities can be conducted without land but animals are bred with feed produced on arable land. In a scale of single farm there is a possibility to use free resources of input from other farms in order to supplement shortage of measures on this farm. In a global scale only land fertility is a limitation for animal production.

Economics of agriculture narrows farming process in agriculture to a factor of land, labour and capital, while a significance of land and natural factors is marginalized. This simplification on the beginning eliminates a law, which manifests its presence wit unrelenting consistency and gives often surprising effects.

Graph 1. A scheme of connections of a farm with an environment and units of agriculture service between themselves



Source: [23]

In practice it is possible to meet a situation, when economical use of input leads to astonishingly good results. In this situation farmers say about a farming person as about a person, whom "on a stone something grows" or so-called "with good hands". It is likely to hear farmers´ opinion that there is a good harvest of wheat and potatoes but bad of barley and corn, while in neighbour´s farm on similar soil these plans grow and yield well. Examples of everyday life prove correct in experiments. On the same soil, with use of the same methods and means of production, production effects are diversified. For instance fluctuation interval of sugar beet´s yield was 185 dt/ha on black soil, 193 dt/ha on alluvial soil and 305 dt/ha on brown soil [9,10]. Such large differences are usually explained by changes in weather conditions and amount of rainfalls. Getting knowledge and understanding a mechanism of hormesis allows to look at these results from more rational perspective. There is no difference in case of animal production. Piglets bought from the same source grow fast and healthy on one farm whereas on the other they do not. On some farms - egg laying is good, cows do not have diseases and chicks does not die, though a farmer does not put an effort in it. On others in spite of use the best methods and means of production a farmer do not obtain expected results. Is it possible to explain these situations rationally? It can be done if there will be used a conception of hormesis phenomenon to explain it, described in detail in

next paper.

CONCLUSIONS

A farm and processes taking place in it are a complicated system of connections between the world of nature and a huge number of branches in economy of every country. Contemporary science about agriculture is not a homogenous field.

It consists of plant and animal production, mechanization, agricultural chemistry, plant protection and other disciplines and additionally each of them divides into detailed disciplines. As a result a basic unit - a farm - disappears in a tangle of various connections vividly presented on the graph 1. As it is pointed out by the author of the paper, this system is a simplification of real connections.

The law of diminishing returns should be a basic instrument of choosing farming intensity level in agricultural production, guarantying obtaining maximal revenue for a producer. Current state of knowledge in this field does not allow explaining reasons of anomalies occurring in agriculture fully and rationally. The law of diminishing returns has been so far a concept, which was difficult to apply in agricultural practice. Connection the law of diminishing returns with biological basis of its functioning - hormesis phenomenon, presented in ext paper, will allow to explain not known fields of agricultural production both from the practical side of farming and economics´ of agriculture side.

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