INNOVATIONS AND ADVANCED TECHNOLOGIES – SOURCES TO INCREASE THE COMPETITIVENESS OF AGRICULTURAL ENTERPRISES FROM THE HORTICULTURAL SECTOR OF THE REPUBLIC OF MOLDOVA

Artur GOLBAN [1], Tatiana GOLBAN[1]

e-mail:golban.artur@yahoo.com

Abstract

Achieving success in business depends indisputably by the notion of competitiveness, which is a very used term in the modern economy, characterizing the level of performance of an enterprise. We can speak about the notion competitiveness at different levels: product competitiveness, enterprise's competitiveness, competitiveness of a branch of economy and competitiveness of a country. Although competitiveness has many definitions al over the World, we can conclude that it doesn't exist an unique opinion regarding this notion and we can afirm that the competitiveness of a country depends on the competitiveness of the enterprises from this country. It is crucially for any long-term organizational development strategy to introduce innovations, advanced technologies in the adopted business models, in the processes of production, which will determine high level of productivity, thus contributing at the increasing of the competitiveness of the enterprises. The purpose of this scientific research is to: analyze the innovations and advanced technologies as a source of increasing the competitiveness of agricultural enterprises from the horticultural sector of the Republic of Moldova, to highlight the major problems faced by the agricultural enterprises in introducing innovations and new technologies in the production of horticultural production, to reveal the role of the state in application of innovations and advanced technologies to develop a high performance agriculture and to propose measures for enhancing the competitiveness of agricultural enterprises through innovations and new technologies.

Key words: innovatios, advanced technologies, competitiveness, agricultural enterprises, total factor productivity

Agricultural sector is the traditional branch of the economy of the Republic of Moldova which, contributed to GDP in 2018 by 10.2% and the gross added value increased by 1.9% compared to 2017.

The increase of the global agricultural production was determined by the increase of the vegetal production – by 3.8%, the animal production being in decrease by 1.1%.

Analyzing the structure of the agricultural production, we can reveal that an important share – more than 25% is represented by the horticultural production, which is high value added production, generating high incomes for the population from the rural areas.

Nowadays the production of the horticultural production is performed manually, without performant technologies, in this sense the enterprises loose from productivity and at the end influencing negatively on competitiveness.

Those enterprises who use the results of the scientifical research, new technologies, innovations and the work of high performant machines are more competitive on the market.

The necessity of innovations is essential for the development of an agricultural enterprise from the horticultural sector, because innovations represent a complex system, an integrated process to the general strategy of the company, which contributes to acheaving the objectives of the company, contributing to increasing the competitiveness of the enterprises.

According to the Oslo Manual 2018, „***an innovation*** is:

- ✓ a new or improved product or process (or combination thereof)
- ✓ that differs significantly from the unit's previous products or processes and
- ✓ that has been made available to potential users (product) or brought into use by the unit (process)".

There are different types of innovations, according to Oslo Manual 2018 (OECD/Eurostat, Oslo Manual, 2018):

- ❖ **Product innovation**: A good or service that is new or significantly improved. This includes significant improvements in technical specifications, components and materials,

[1] The State Agrarian University of Moldova

software in the product, user friendliness or other functional characteristics.

- **Process innovation**: A new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- **Marketing innovation**: A new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- **Organisational innovation:** A new organisational method in business practices, workplace organisation or external relations.

Therefore, innovations are essential for the development of the agricultural enterprises from the horticultural sector of the Republic of Moldova, encouraging technical creativity, through taking risks and their minimization through an adequate change management.

The objectives of the scientific research are: to analyze the situation from the Republic of Moldova regarding the application of innovations, to analyze the role of the state in promoting the innovational activity in enterprises, to evidentiate the role of innovations and advanced technologies in increasing the competitiveness of the agricultural enterprises from the horticultural sector of the Republic of Moldova, using the global indicator of competitiveness: ***Total Factor Productivity***; to propose measures of increasing the innovational activity in the agricultural enterprises from the Republic of Moldova.

MATERIAL AND METHOD

In this scientific research were used data from the:

- ✓ ***National Bureau of Statistics of the Republic of Moldova;***
- ✓ ***National Bank of Moldova;***
- ✓ ***Ministry of Agriculture, Regional Development and Environment of Republic of Moldova; etc.***

In the same time in this scientific study was used the global indicator of competitiveness - ***Total Factor Productivity*** (TFP), being calculated on the basis of the Malmquist productivity index, which consists of two components: the index of technological change and the index of technical efficiency change (Chaudhary S., 2012; Fare R.,et. al, 1994; Knox Lovel C.A., 2003; Cimpoieş D., Racul A., 2006; Squires D., Reid C., 2004; Лисситса А, et al., 2003):

$$M_0(x^{t+1},y^{t+1},x^t,y^t) = \frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^t(x^t,y^t)}[(\frac{D_0^t(x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})})(\frac{D_0^t(x^t,y^t)}{D_0^{t+1}(x^t,y^t)})]^{\frac{1}{2}}$$

Where,

Technical efficiency change:

$$\frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^t(x^t,y^t)}$$

Technological change:

$$(\frac{D_0^t(x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})})(\frac{D_0^t(x^t,y^t)}{D_0^{t+1}(x^t,y^t)})^{\frac{1}{2}}$$

TFP may take the following values:

a) TFP>1, then in the period t (between the moment t and t+1) was registered an increase of productivity;

b) TFP=1, in this case wasn't registered changes at the productivity level;

c) TFP<1, then was registered a decrease of productivity.

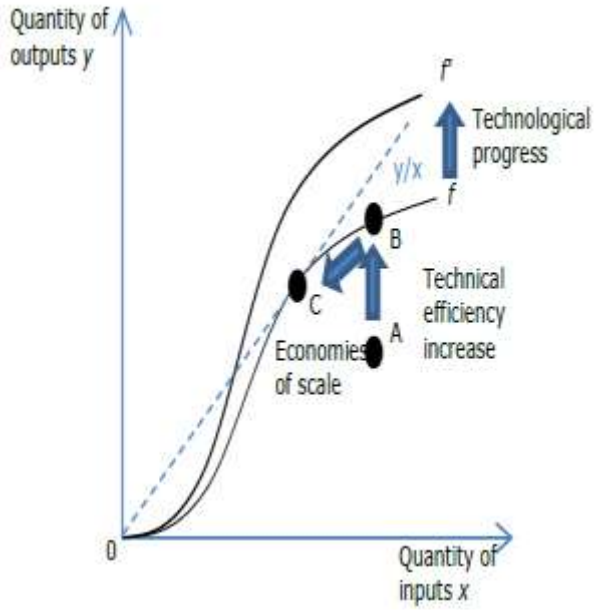

Figure 1. **Ways for increasing productivity of the agricultural enterprises**

Source: Latruffe (2010)

TFP reveals the joint effects of many factors including new technologies, innovations, efficiency gains, economies of scale, managerial skill, and changes in the organization of production (Latruffe L., 2010). Figure 1 shows possible pathways to improve productivity. One way is to shift the production frontier upwards by implementing new technologies (moving from f to f'). Another way is to increase the technical efficiency by better applying existing technologies (catching-up through better management, going from A to B). Economies of scale refer to optimizing the scale of operations to achieve a better output over input ratio (from B to C).

The data processing was performed using the DEAP version 2.1, elaborated by Tim Coelli, Centre for Efficiency and Productivity Analysis, Department of Econometrics, University of New England (Australia).

As research methods were used: analysis, synthesis, comparative method, logical analysis, graphical method.

RESULTS AND DISCUSSIONS

The agricultural production in 2018 constituted 102.5% compared to 2017 year. The increase of the agricultural production was determined by the increase of the vegetal production by 3.8%, the animal production being in decrease by 1.1% (NBS, 2018).

From the total agricultural production the horticultural production constitutes approximately one fourth (NBM, 2018; MARDE, 2018).

The horticultural sector is represented by two sub-sectors:

• Sub-sector of fresh horticultural products

• Sub-sector of processed horticultural products.

From these two sub-sectors, subsector of fresh horticultural products is generating highest incomes, being competitive on the local market.

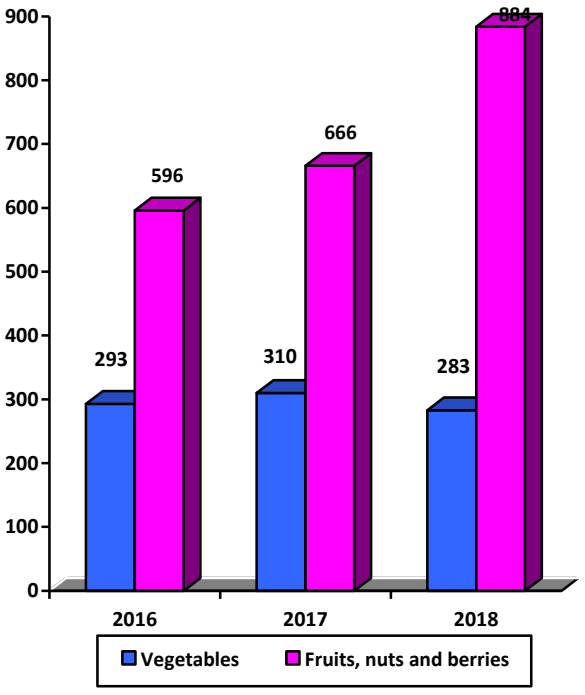

Figure 2 . **The dynamics of production of vegetables and fruits, nuts and berries during 2016-2018 (thousand tonnes)**

Analyzing the dynamics of production of vegetables and fruits, nuts and berries during 2016-2018, we can reveal an increasing trend of fruits from 596 thousand tonnes in 2016 to 884 thousand tonnes in 2018 and a decreasing trend of vegetables from 293 thousand tonnes in 2016 to 283 tonnes in 2018.

Analyzing the structure of the horticultural production in 2018 by categories of households, we can reveal that vegetables were mostly produced in population households – 75.2%, being followed by agricultural enterprises – 14% and peasant farms – 10.8%.

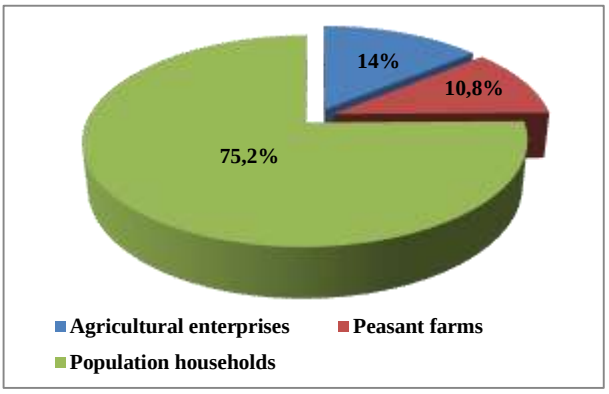

Figure 3. **Distribution of the vegetables production by categories of households, 2018 (%)**

Analyzing the distribution of fruits, nuts and berries production by categories of households we can reveal that the majority of production is produced in peasant farms – 50.1%, being followed by agricultural enterprises – 39.2% and population households – 10.7% (NBS, 2018).

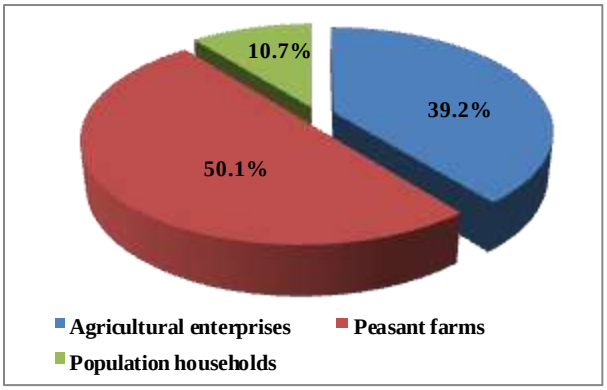

Figure 4. **Distribution of fruits, nuts and berries production by categories of households, 2018 (%)**

The competitiveness of agricultural enterprises from the horticultural sector of the Republic of Moldova was determined using Total Factor Productivity (TFP), which is considered "global index of competitiveness".

In the scientific investigation were used 303 agricultural enterprises, with horticultural frontier of function of production.

The data was processed using the Data Envelopment Analysis Program 2.1.

The function for determining the competitiveness of the agricultural enterprises from the horticultural sector had the following form:

$$\begin{cases} \min\limits_{\theta,\lambda} \theta \\ -y_i + Y\lambda \geq 0 \\ \theta x_i - X\lambda \geq 0 \\ N1' \lambda \leq 1 \\ \lambda \geq 0, \end{cases}$$

Where:

θ- efficiency parameter;

n – number of farmers

Y – output vector, represented by the income from selling the agricultural products

X – input vector, n^x 3 dimensional, given by:

a) Surface of the agricultural lands effectively seeded
b) Costs for labour remuneration, thousands lei
c) Other costs, which include: costs for seeds and planting material, thousands lei + costs for chemical and natural fertilizers, thousands lei + costs for auxiliary activities and indirect consumptions, thousands lei

N1–is vector n- dimensional with 1 component;

λ – variable of linear programming problem which would be solved.

Table 1

The command file hr303.ins of evaluation the competitiveness of the agricultural enterprises from the horticultural sector of the Republic of Moldova

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hr303.dta   DATA FILE NAME
hr303.out   OUTPUT FILE NAME
303         NUMBER OF FIRMS
5           NUMBER OF TIME PERIODS
1           NUMBER OF OUTPUTS
3           NUMBER OF INPUTS
1           0=INPUT AND 1=OUTPUT ORIENTATED
0           0=CRS AND 1=VRS
2           0=DEA(MULTI-STAGE), 1=COST-
               DEA,2=MALMQUIST-DEA,3=DEA(1-
               STAGE), 4=DEA(2-STAGE)
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Source: elaborated by the author using the DEAP 2.1

Analyzing the TFP of the agricultural enterprises from the horticultural sector of the Republic of Moldova during 2014-2017, we can reveal that the average of this indicator is equal to 1.048, which reflects an increase by 4.8%. The increase of the indicator mentioned above, was determined by the increase of the technical efficiency change (ΔTE) by 13.5%, which is the product between the scale efficiency change (ΔSE) and the pure efficiency change (ΔPE).

From the table 1 it is revealed that the average of technological efficiency change (ΔT) during 2014-2017, is equal to 0,923, which is a subunit value, which signifies that the application of the performant technologies, innovations, the results of the technological progress decreased by 7.7%.

The value of this indicator below 1, represents that in the modernization of the park of tractors, machinery, production equipments were not performed significant investments and the enterprises doesn't use the results of the technological progress, innovations in the process of production.

Table 2

The analyze of competitiveness of agricultural enterprises from horticultural sector during 2014-2017 year (extract of 10 registrations from the DEAP results)

Nr. of enterprise	ΔTE	ΔT	ΔPE	ΔSE	TFP
2	1.299	1.013	1.403	0.926	1.315
5	0.731	0.912	0.924	0.792	0.667
41	1.604	0.970	1.423	1.127	1.556
46	1.151	0.928	1.051	1.096	1.068
71	1.153	1.060	1.267	0.910	1.222
80	0.901	0.885	0.865	1.043	0.798
105	1.330	0.897	1.387	0.959	1.193
182	0.959	1.100	1.160	0.826	1.055
217	1.034	0.950	1.238	0.835	0.983
303	0.744	0.774	0.792	0.939	0.576
Average	**1.135**	**0.923**	**1.185**	**0.957**	**1.048**

From the analyze of competitiveness of the agricultural enterprises from the horticultural sector of the Republic of Moldova during 2014-2017, it is revealed that the enterprise number 2 has TFP equal to 1.315 and it is more competitive compared to the average of TFP for 2014-2017, which was equal to 1.048. The increasing of TFP was ensured by the technical efficiency change by 29.99% which also was determined by the increase of the pure efficiency change by 40.3%. The scale efficiency change registered a decrease by 7.4%. The technological change registered an increase by 1.3%, which means that the enterprises is using the results of the technological progress, innovations and new technologies.

Analyzing the enterprise with the number 303, we see that TFP is equal to 0.576, which

means that the enterprise is not competitive, and this indicator decreased by 42.4%. The decrease was determined by the decrease of the technical efficiency change by 25.6% and by the decrease of the technological change by 22.6%. In this company the subunit value of the technological change, reveals low investments in new technologies, new machinery, low degree of innovations, determining low level of competitiveness of the company.

Analyzing the table 2 we can conclude that more competitive are the enterprises with technological efficiency change more than 1, this means that these enterprises apply new technologies, inovations, invest in implementing the results of the technological progress and those enterprises where the technological efficiency change is less than 1, we can see that these enterprises are less competitive with lower value of TFP.

Innovations are the heart of the competitiveness of an enterprise. It is very important that the development strategy within the organization to be based on innovations.

Analyzing the Global Innovation Index for the period 2014-2018, we can reveal that it continuously decreased from 40.7 in 2014 to 37.6 in 2018

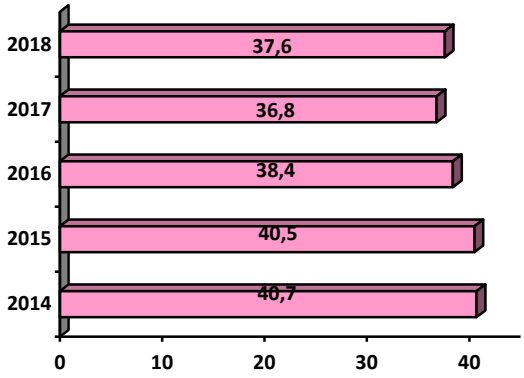

Figure 5 . **The Global Innovation Index of the Republic of Moldova during 2014-2018**

Among the factors determinng the decreasing of the Global Innovation Index is the research and development expenditure, percent of GDP. Analyzing this indicator for the period 2010-2017, we can reveal that it decreased significantly from 0.44 to 0.3 in 2017.

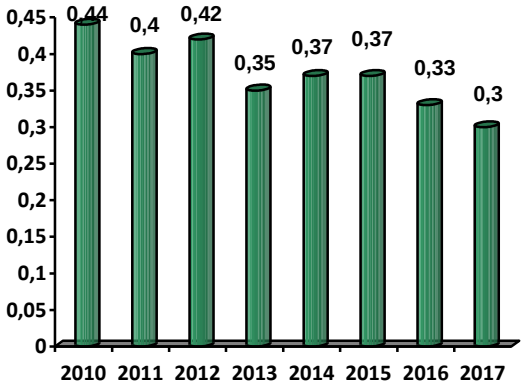

Figure 6 . **The research and development expenditure, percent of GDP of the Republic of Moldova during 2010-2017**

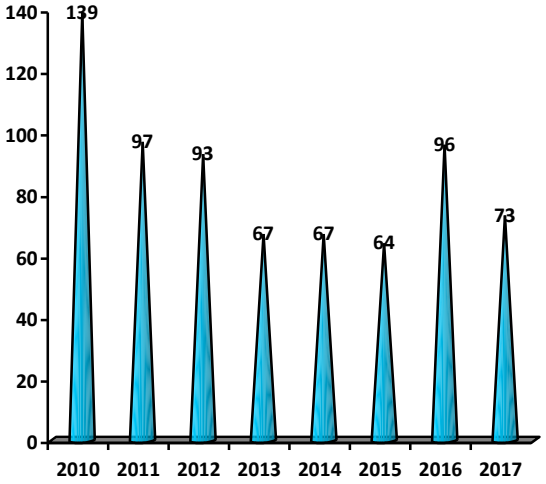

Figure 7 . **The patent application in Republic of Moldova during 2010-2017**

The figure 7 reveals a decreasing trend of the patent application in Moldova during 2010-2017 from 137 registered patents in 2010 to 73 registered patents in 2017.

Thus, we can reveal from the performed analysis that it is very important that the state to increase the research and development expenditures in Moldova, creating innovational parks where will be elaborated performant technologies which will be used in the agricultural production. It is very important, to strengthen the connections between business environment and the activities of research and innovation, which now are weak.

CONCLUSIONS

As a result of the performed scientific investigations we can reveal the following conclusions:

1. The horticultural production constitutes one fourth from the total agricultural production of the Republic of Moldova.

2. Vegetables production is produced mostly (75,2%) in population households, while fruits, nuts and berries are produced mostly in peasant farms (50,1%).

3. The enterprises from the horticultural sector which used innovations, advanced technologies registered values of TFP greater than 1, which was determined by the increase of technological efficiency, which also registered supraunitary values ($\Delta T>1$), being more competitive on the market, compared to those enterprises which did not use innovations, modern technologies in the process of production, registering subunit values of TFP and ΔT.

4. The innovation and research activity from Moldova is directly connected to the investments performed by the state, registering in the period of 2010-2017 a decrease of the research and development expenditure, percent of GDP from 0.44 in 2010 to 0.3 in 2017.

5. It is necessary to strengthen the connections between business environment and the research and innovations activites and to increase at the state level the research and development expenditures, percent of GDP of Moldova, in order to create innovational parks, create new technologies, apply innovations, which will be used in the process of production by the agricultural enterprises from the horticultural sector of the Republic of Moldova, contributing in this sense, at increasing the competitiveness of enterprises.

REFERENCES

NBM, 2018. - *National Bank of Moldova, http://bnm.md*

NBS, 2018. - *National Bureau of Statistics of the Republic of Moldova,*http://statistica.gov.md/newsview.php?l=ro&idc=168&id=6240

Chaudhary S., 2012. - *Trends in total factor productivity in Indian agriculture: state-level evidence using non-parametric sequential Malmquist index.* Working paper 215, Delhi School of economics, Centre for development economics, available on line at: http://www.cdedse.org/pdf/work215.pdf.

Cimpoieş D., Racul A., 2006. - *Aplicarea metodelor neparametrice la determinarea productivităţii şi eficienţi întreprinderilor agricole.* În: Ştiinţa Agricolă, Chişinău, nr.2, p. 83-88.

Coelli T.J., 1996. - *Measurement of Total Factor Productivity Growth and Bases in Technological Change in Western Australian Agriculture.* In: Journal of Applied Econometrics, Vol. 11, p. 77-91, ISSN 0883-7252.

Fare R., Grosskopf M., Norris M., Zhang Z., **1994.** - *Productivity growth, technical progress, and efficiency in industrialized countries.* The American Economic Review, Vol. 84, No 1.

Knox Lovel C.A., 2003. - *The decomposition of Malmquist productivity indexes.* In: Journal of Productivity Analysis 20. Kluwer Academic Publishers, p. 437-458.

Latruffe L., 2010. - *Competitiveness, productivity and efficiency in the agricultural and agri-food sectors.* In: OECD Food, Agriculture and Fisheries Working Papers, No.30, OECD Publishing.

Лисситса А., et al., 2003. - *Теоретические основы анализа продуктивности и эффективности ссельскохозяйственных предприятий.* In: Discussion paper No. 49, Institute of Agricultural Development in Central and Eastern Europe. https://www.econstor.eu/bitstream/10419/28567/1/368211274.pdf

MARDE, 2018. - *Ministry of Agriculture, Regional Development and Environment*.of Republic of Moldova. http://www.madrm.gov.md/en

OECD/Eurostat, 2018. - *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities.* OECD Publishing, Paris/Eurostat, Luxembourg. https://doi.org/10.1787/9789264304604-en

Squires D., Reid C., 2004. - *Using Malmquist indices to measure changes in TFP of Purse-Seine Vessels while Accounting for Changes in Capacity Utilisation, The Resource Stock and the Environment*. In: SCTB17 Forum Fisheries Agency, Working Paper: 1-15.

https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/market briefs/pdf/10_en.pdf

https://www.theglobaleconomy.com/