Scientific quarterly journal ISNN 2083-1587; e-ISNN 2449-5999

Agricultural Engineering

2015: 4(156):35-42

Homepage: http://ir.ptir.org

DOI: http://dx.medra.org/10.14654/ir.2015.156.149

METHODOLOGICAL NOTES CONCERNING DETERMINATION OF THE SCIENTIFIC AND TECHNICAL PROGRESS RATE[1] AND ITS EFFICIENCY

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ARTICLE INFO

Article history:
Received: February 2015
Received in the revised form: September 2015
Accepted: October 2015

Key words:
progress
science
effectiveness
agriculture, method

ABSTRACT

Based on the previous micro and macro-economic scale research studies concerning agri-economic rates, not only positive aspects of the suggested and tested methods of assessment of the mechanization level were taken into consideration, but also repeatable methodological weaknesses which ultimately affect the final research results. Thus, this paper suggests methodological changes concerning determination of indicators which decide on the level of the management intensity and in particular of the scientific and technical progress and its effectiveness for individual farms. Numerical data obtained from Małopolskie and Świętokrzyskie Voivodeship were used in the paper.

Introduction

A scientific and technical progress means new scientific discoveries, inventions and innovations, which lead to such changes in technique, technology and production organization, which bring not only economic benefits but also social and ecological ones. It comes down to application of scientific discoveries, inventions and innovations in production, in order to reduce the inputs necessary to manufacture a particular commodity, or to improve the product itself and even to invent a new product which better satisfies recipients' requirements.

A scientific and technical progress is thus a sequence of non-regulated changes which introduce new improvements to production and more efficient technical equipment, which allows obtaining even bigger production effects from given resources or achieving current (satisfactory) production effects at the use of a lower number of resources (Figurski and Lorencowicz, 2011; Pawlak, 2008).

In agriculture three types of the scientific and technical progress can be distinguished: biological, chemical and technical (Michałek et al., 1998; Grotkiewicz and Michałek, 2009b). Organizational progress accompanies the technical one and includes even one more

[1] This Research was financed by the Ministry of Science and Higher Education of the Republic of Poland

category, namely: change of the work technology, thus there are two categories of technical progress: technological and structural progress (Michałek et al., 1998).

A rational implementation of the scientific and technical progress is a required element of transformation both of economy as well as the entire economy, which aims at reaching standards in the developed countries of Western Europe. It is achieved by (Kowalski et al., 1994a; Neal et al., 2014).

– increase of productivity of farms,
– increase of efficiency of manual work in farms,
– rising farmers' qualifications,
– reduction of losses and damages,
– reduction of discomfort at work

It could be concluded that a high index of scientific and technical progress should be an objective. However, one should keep in mind that ultimately an economic effect of the achieved progress will be important. The final measure of evaluation of the technical progress is a measure of its efficiency (E_{PT}). Only the rate of effectiveness of the scientific and technical progress allows assessment of the effects of replacing human work with objectified work (Michałek and Kuboń, 2009; Tabor, 2006).

The objective and scope

The previous research studies presented and analysed the entire scientific issue (Grotkiewicz, 2013a), which constitutes an accepted and realized research conclusion.

The research, which was carried out in four stages, both on the national and international scale, no connections between the scientific and technical progress and land productivity were proved and simultaneously a methodological error concerning calculation of the above measures, which decide on the intensity of farming in agriculture was found out. Therefore, a fundamental objective of this paper is suggesting a change in the method of calculation of the rates concerning the scientific and technical progress and its efficiency. Methodological notes concerning the analysed rates were presented on the example of 300 individual farms from Małopolskie and Świętokrzyskie Voivodeship. Detailed data can be found in the literature concerning this issue (Grotkiewicz, 2013a).

Course and the research method

All issues in the research, which has been carried so far and all agri-economic rates necessary for comparison on the national and international arena were divided into four stages.

The first stage included research in the macro-economic scale of the selected countries of the European Union.

The second stage was also related to the research in the macro-economic scale and covered the selected regions of Poland.

The obtained results of the second stage allowed determination of the third stage of research. It concerned analysis in the micro-economic scale. In this stage team farms from Opole region were the object of the research.

The fourth and at the same time the last stage of research concerned also the analysis in the micro-economic scale. It constitutes a fundamental core of the entire paper. It included small area farms from 10 communes of the Southern Poland from Małopolskie and Świętokrzyskie Voivodeship (Grotkiewicz, 2013a).

These investigations had a nature of a guided survey and included in total 300 farms from the following communes: Radziemice, Tymbark, Trzyciąż, Olkusz, Łukowica, Drwina, Łososina Dolna, Grybów, Słaboszów (Małoposkie Voivodeship) and Wiślica commune (Świętokrzyskie Voivodeship). In the further part of this stage, four variants were presented, which constituted a division of the investigated farms on account of: area groups, a simplification degree, production trend and work inputs. The research period is related to 1995 (T0) to 2009 (T1) (Grotkiewicz, 2013a; Grotkiewicz et al., 2013).

Analysis in the micro and macro-economic scale concerned the most important agri-economic indicators inter alia, the area of agricultural land in total and per 1 citizen, demographic relations including the total number of people, working people, people from rural areas, farming people who are professionally active in agriculture, the agrarian structure of agriculture, average area of a farm, sowing structure, plant yield, structure of the machinery park and its value, labour inputs on specific production departments, production value in agriculture: a global, clean value, material inputs, technical infrastructure rate, efficiency of the scientific and technical progress, work and land productivity (Grotkiewicz, 2013a).

Two working hypotheses were presented in the previous research:

1. A scientific and technical progress directly and positively influences the work efficiency indicator.
2. Scientific and technical progress does not influence the increase in the land productivity rate, which depends on the scientific, biological and chemical progress (Grotkiewicz, 2013a; Grotkiewicz et al. 2013).

The scientific and technical progress rate, which constitutes a difference between the rates of technical infrastructure within time, even though it is a logical consequence of methodological assumptions, in the last determination it assumes various sizes as an absolute number and thus it is difficult to compare with other authors' research carried out on various facilities. Therefore, it is suggested to take it down to a relative number and express in percentages (Grotkiewicz et al., 2013).

Before methodological notes:

$$P_T = W_{UT(T1)} - W_{UT(T0)} \,(\text{PLN}\cdot\text{man-hour}^{-1}) \tag{1}$$

where:

P_T – scientific and technical progress, (PLN·man-hour^{-1})
W_{T1} – technical infrastructure rate in the year of the final one (target), (PLN·man-hour^{-1})
W_{T1} – technical infrastructure rate in the year of the input one (target), (PLN·man-hour^{-1})

After methodological notes:

$$P_T = \frac{W_{UT(T1)} - W_{UT(T0)}}{W_{UT(T0)}} \cdot 100(\%) \tag{2}$$

where:
$\mathbf{P_T}$ – scientific and technical progress, (%)
$\mathbf{W_{T1}}$ – technical infrastructure rate in the year of the final one (target), (PLN·manhour^{-1})
$\mathbf{W_{T1}}$ – technical infrastructure rate in the year of the input one (target), (PLN·manhour^{-1})

The current research, entirely confirmed in this paper, indicates that there is no connection between the scientific and technical progress and land productivity. In the light of my own research, obtained in the macro and micro-economic scale, I consider a methodological error in determination of this rate. The assumptions of the paper show that the technical progress does not affect the increase in the land productivity, only the work productivity. Thus a change in the method of its calculation was suggested. In the numerator, instead of production increase the work efficiency increase should be assumed (Grotkiewicz et al., 2013).

Before methodological remarks:

$$E_{PT} = \frac{\Delta PC}{P_T}(-) \tag{3}$$

where:
E_{PT} − efficiency of the scientific and technical progress, (-)
ΔPC – clean production increase, (PLN)
P_T – scientific and technical progress, (PLN·man-hour^{-1})

where $\Delta PC=PC_{(T1)} - PC_{(T0)}$ (PLN)

After methodological notes:

$$E_{PT} = \frac{\Delta Wp}{P_T}(-) \tag{4}$$

where:
E_{PT} − efficiency of the scientific and technical progress, (-)
ΔWp – efficiency of work, (PLN·manhour^{-1})
P_T – scientific and technical progress, (%)

where: $\Delta Wp=Wp_{(T1)} - Wp_{(T0)}$ (PLN·manhour^{-1})

Research results

Based on the collected data, the previously discussed research methods concerning agri-economic rates were analysed. The rates were divided into specific groups depending on the research variant with respect to 10 communes from Małopolskie and Świętokrzyskie Voivodeship (tables 2,4,6,8) (Grotkiewicz et al., 2013).

Tables 1, 3, 5, 7 present for comparison a progress rate and its efficiency rate calculated acc. to the research method analysed in the previous papers.

Table 1
A scientific and technical progress and its efficiency with respect to area groups (before methodological remarks)

Area groups	I	II	III	IV
P_T (thousand PLN·manhour^{-1})	0.004	0.015	0.013	0.019
E_{PT} (-)	-9,186.0	-5,809.7	35,097.3	-17,601.7

Table 2
A scientific and technical progress and its efficiency with respect to area groups (after methodological notes)

Area groups	I	II	III	IV
P_T (%)	8.05	19.22	15.76	20.75
E_{PT} (-)	0.00004	0.000005	0.00015	-0.00048

The final analysis proves that along with the increase of AL area, the progress rate rises at average. Only farms with area between 10-20 ha do not confirm the assumed hypothesis that along with the increase of the agricultural land area their progress also rises. Along with the increase of the AL area the efficiency rate also grows except for group IV where its negative value was reported.

The biggest scientific and technical progress is reported in the group with the highest increase of the technical infrastructure rate within the investigated period namely in group II. In case of the two remaining groups this progress in minimal and is within 11.64 and 14.17%. In case of efficiency the situation is reverse (table 4). Within the investigated period, as a result of the work efficiency decrease, the progress efficiency in group II achieved a negative value.

Table 3
A scientific and technical progress and the progress efficiency acc. to the production trend (before methodological notes)

Production trend	I	II	III
P_T (thousand PLN·manhour^{-1})	0.010	0.37	0.01
E_{PT} (-)	86,956.6	-163.4	-4,448.0

Table 4
A scientific and technical progress and the progress efficiency acc. to the production trend (after methodological notes)

Production trend	I	II	III
P_T (%)	11.64	375.15	14.17
E_{PT} (-)	0.0009	-0.00001	0.00004

Table 5
A scientific and technical progress and the progress efficiency acc. to the production trend (before methodological notes)

Degree of simplification	I	II	III	IV
P_T (thousand PLN·manhour^{-1})	0.046	0.004	0.011	0.019
E_{PT} (-)	-22,901.8	-327,926	18,136.5	108,697.6

Table 6
A scientific and technical progress and the progress efficiency acc. to the production trend (after methodological remarks)

Degree of simplification	I	II	III	IV
P_T (%)	59.10	3.90	18.78	29.19
E_{PT} (-)	0.00016	-0.00138	-0.00002	0.00007

In each farm a scientific and technical progress is reported. The biggest changes took place in the group of farms which constitute the highest degree of simplification i.e. which have 1-3 plants (group I). In this group, farmers by the increase of their equipment in technical infrastructure thus affected the progress achieving the rate of almost 60%. In the remaining groups this rate was reduced, but with the decrease of the simplification degree it raised its value achieving almost 30%. Whereas, the progress efficiency rate indicates that farms from group I achieved the highest values and farms from group II and III got closer to the negative level.

Table 7
Scientific and technical progress and the progress efficiency acc. to the work inputs (before methodological notes)

Labour inputs	I	II	III	IV
P_T (thousand PLN·manhour^{-1})	0.018	0.006	0.002	0.020
E_{PT} (-)	23,511.7	193,966.6	94,823.2	-92,305.9

Table 8
Scientific and technical progress and the progress efficiency acc. to the work inputs (after methodological notes)

Labour inputs	I	II	III	IV
P_T (%)	11.87	6.92	3.41	39.75
E_{PT} (-)	0.0009	0.0011	0.0001	-0.0003

In the analysed period of time, in groups I-III a decrease in the scientific and technical progress was reported, reaching almost 3.5% but the facility IV increased the progress level from the lowest of less than 10% and thus obtained the highest value from among the investigated groups.

On the other hand, the progress efficiency rate assumed a quite varied form. The highest efficiency was obtained by farms from the range of 2000-3000 of man-hour. In farms from 3000 man-hour and above the efficiency was rising significantly. The reason for such conditions was the fact that the value of the agriculture mechanization means was rising at the simultaneous decrease of work productivity.

Summary and conclusions

Based on the thorough research of the national and foreign literature and in particular of the Krakow Centre, not only positive aspects of the suggested and tested methods of assessment of the mechanization method were taken into consideration, but also a repeatable methodological weaknesses which ultimately affect the final research results. The research which was carried out previously, both on the national and foreign scene as well as in this paper proves that the scientific and technical progress does not affect the land productivity or does insignificantly but it influences the work productivity rates (Michałek et al., 1993, 1998; Tabor, 2006; Grotkiewicz, 2013a). It results in the proposal concerning the change in calculation of the progress efficiency rate. In the current method, it was calculated as a ratio of the production increase to the the scientific and technical progress; after modification in the numerator we assume the work productivity increase. The research which was carried out is a basis for suggesting methodological corrections concerning calculation of the scientific and technical rate presenting it in percentage values. The suggested methodological remarks may considerably improve and at the same time better depict current rules of procedure.

References

Figurski, J., Lorencowicz, E. (2011). Nakłady pracy w gospodarstwach rolnych o różnej wielkości ekonomicznej. *Inżynieria Rolnicza, 1*(126), 55-61.

Grotkiewicz, K. (2013a). Postęp naukowo-techniczny a wydajność pracy i ziemi w rolnictwie. Maszynopis, UR Kraków, WIPiE.

Grotkiewicz, K., Kuoń, M., Michałek, R., Peszek, A. i in. (2013). Postęp naukowo-techniczny w procesie modernizacji polskiego rolnictwa i obszarów wiejskich. Inżynieria Rolnicza, ISBN 978-83-935020-5-9.

Grotkiewicz, K., Michałek, R. (2009b). Postęp naukowo-techniczny a wydajność ziemi i pracy w rolnictwie. *Inżynieria Rolnicza, 6*(115), 109-116.

Kowalski, J., Cupiał, M., Tabor, S. (1994a). Badania efektywności postępu naukowo-technicznego na przykładzie gospodarstw chłopskich Polski południowej. *ZPPNR, 403*, 81-88.

Michałek, R., Kowalski, J. (1993). Metodyczne aspekty określania postępu naukowo-technicznego w rolnictwie. Cz. II, *Roczniki Nauk Rolniczych, t.79-C-4*.

Michałek, R. i zespół. (1998). Uwarunkowania technicznej rekonstrukcji rolnictwa. PTIR, Kraków, ISBN 83-905219-1-1.

Michałek, R., Kuboń, M. (2009). Postęp naukowo-techniczny i jego skutki społeczno-ekologiczne. *Inżynieria Rolnicza, 1*(110), 207-212.
Neal, K., Van, Alfen (2014). Policy Frameworks for International Agricultural and Rural Development. *Encyclopedia of Agriculture and Food Systems, Volume 5*, 489-50.
Pawlak, J. (2008). Zrównoważony rozwój rolnictwa, rola mechanizacji. *Problemy Inżynierii Rolniczej, 1*, 13-19.
Tabor, S. (2006). Postęp techniczny a efektywność substytucji pracy żywej pracą uprzedmiotowioną w rolnictwie. *Inżynieria Rolnicza, 10*(85), ISSN 1429-7264.

METODYCZNE UWAGI DOTYCZĄCE OKREŚLANIA WSKAŹNIKA POSTĘPU NAUKOWO-TECHNICZNEGO I JEGO EFEKTYWNOŚCI

Streszczenie. Na podstawie wcześniejszych badań w skali mikro i makroekonomicznej dotyczących wskaźników rolno-ekonomicznych, zwrócono uwagę nie tylko na pozytywne aspekty proponowanych i testowanych metod oceny poziomu mechanizacji, ale także na powtarzające się słabości metodyczne, rzutujące ostatecznie na końcowe wyniki badań. Stąd też w niniejszej pracy zaproponowano metodyczne zmiany dotyczące określania wskaźników decydujących o poziomie intensywności gospodarowania, a w szczególności postępu naukowo-technicznego oraz jego efektywności dla gospodarstw indywidualnych. W pracy korzystano z danych liczbowych z województwa małopolskiego i świętokrzyskiego.

Słowa kluczowe: postęp, nauka, efektywność, rolnictwo, metoda