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### **PROBLEMS AND TRENDS IN THE DEVELOPMENT OF TECHNOLOGY TRANSFER SYSTEMS OF AGRICULTURAL INSTITUTIONS OF HIGHER EDUCATION: REGULATORY ASPECT**

**Інна Ковальчук, Анна Пахомова, Вікторія Мельник. ПРОБЛЕМИ ТА ТЕНДЕНЦІЇ РОЗВИТКУ СИСТЕМ ТРАНСФЕРУ ТЕХНОЛОГІЙ АГРАРНИХ ЗВО: НОРМАТИВНИЙ АСПЕКТ.** У статті висвітлено наукові підходи до аналізу нормативно-правової бази та її відповідності тенденціям розвитку систем трансферу технологій аграрних закладів вищої освіти на основі прогнозування показників інноваційного розвитку з урахуванням світового досвіду. Такий аналіз дасть змогу досягти ефективності процесів нормативно-правового регулювання інноваційної діяльності в національній економіці та прискорити темпи її розвитку.

Розглядаються зарубіжні та вітчизняні наукові праці та нормативні документи, які присвячені практиці та досвіду найвідоміших офісів трансферу технологій. На основі аналізу кращих світових практик їх роботи отримано практичні рекомендації щодо функціонування вітчизняних аналогів з урахуванням сучасних реалій. Виявлено, що лише невелика кількість технологій серед великого портфеля об'єктів інтелектуальної власності здатна приносити значний прибуток. У статті подано рекомендації для вітчизняних наукових установ, які базуються на багаторічному досвіді західних офісів трансферу технологій.

У статті зроблено окремий акцент на питання менеджурвання при трансфері технологій. Адже при вирішенні питання спрямування інвестицій у створення офісів трансферу технологій наразі суттєво недооцінюється найважливіший ресурс – кваліфікований управлінський персонал. Адже, по мірі розвитку офісів зростає спеціалізація менеджерів з трансферу технологій. Слід також підкреслити, що становлення професії менеджера технологій у економічно розвинутих країнах зараз відбувається переважно на основі діяльності професійних асоціацій, які сприяють поширенню успішних практик в сфері комерціалізації технологій, формування стійких зв'язків між університетами, дослідницькими організаціями та промисловістю, а також організують професійну підготовку кадрів у сфері трансферу технологій.

**Ключові слова:** інновації, трансфер технологій, комерціалізація наукових розробок, офіси трансферу технологій, аграрні ЗВО.

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**Relevance of the study.** Currently, the development of scientific activity in the agrarian sphere, as well as the development of the entire agrarian sector in the Ukrainian economy, is going through difficult times. Such a situation, in particular, is connected with the insufficiently high efficiency of scientific activity and its low demand on the part of domestic agricultural producers, which is caused by many factors: first of all, the armed conflict, and as a result of modern internal structural changes in the agrarian sphere, certain foreign economic factors, as well as the quality of legal regulation of scientific activity in general.

As domestic and foreign experience shows, the innovation processes in general and cooperation and integration processes, in particular, greatly contribute to attracting investments, and updating and modernizing the entire material and technical base of the agro-industrial complex, increasing labor productivity, reducing the cost of agricultural products, developing rural regions, which as a whole and in the conditions of the Western European orientation and declarations of Ukraine's future accession to the European Union (EU), it contributes to increasing the stability of the agrarian sphere of the economy and stimulates the development of scientific activity in the agrarian sphere of Ukraine.

In confirmation of this position, in 2013, the Concept of the State Target Program for the Development of the Agricultural Sector of the Economy for the Period Until 2022 (Order of the Cabinet of Ministers of Ukraine No. 1437-r, 2015) was adopted the main programming system-forming document in the field of agriculture, which was supposed to be aimed at the formation of an effective social directed sector of the state economy, able to meet the needs of the domestic market and ensure leading positions in the world market of agricultural products and food based on consolidation of its complexity, which at this stage of development requires the formation of various categories of farms (village-forming farms), the owners of which live in rural areas, as a priority, combine the right to land with work on it, as well as their own economic interests with social responsibility to the community. Unfortunately, the analysis of this document proved that it was developed taking into account the provisions of the current legislation, in which cooperative integration and transfer structures are mentioned only indirectly, without indicating any specific organizational and legal forms and features.

**Recent publications review.** The importance and socio-economic significance of the development of innovative processes in general, and the processes of transfer of knowledge-intensive technologies in the agricultural sector, in particular, attract the attention of scientists for the study of the entire population or individual components of the outlined problems. The fundamental ideas of regulating scientific and innovative relations, including in the agricultural sphere, are laid down in the works of foreign scientists: Y. Terry (Terry, 2007), D. Heher (Heher, 2007), L. Nelsen (Nelsen, 2007), N. Page (Page, 2004), S. Khoury, J. Daniele, P. Germeraad (Khoury, 2011) and others.

Certain aspects of the specified problem were studied in the reseaches of P. Tsybuleva and V. Chebotaryova (Tsybulev, 2005); P. Tsibulova, V. Chebotaryova, V. Zinova, Yu. Suini (Tsybuliv, 2016); and also the reseaches of B. Hrynyova and V. Gusev (Grynev, 2010), S. Korsunsky (Korsunskyi, 2015), Yu. Kapitsa (Kapitsa, 2015), V. Bogdanov (Bogdanov, 2016) and others.

At the same time, some innovative aspects of the development of integration and transfer processes have not been fully studied and are promising for research, including in the agricultural sphere, etc.

Despite a sufficiently large number of scientific reseaches, until now certain aspects of the mentioned issues have not been sufficiently researched, in particular, such as: development of theoretical provisions regarding the main categories regarding integration; development of conceptual provisions of the mechanism of legal regulation of cooperation and integration processes; justification of the complex interaction of its individual components, taking into account the accumulated scientific experience and modern requirements of innovative development of agricultural production in the conditions of the declared Western European orientation and the future accession of Ukraine to the EU.

**The research paper's objective** is to analyze the regulatory and legal basis of innovative activity in agricultural universities and to study the possibilities of changing the status of these institutions in the global market of educational services and high-tech products, with the perspective of their involvement in the subjects of the global innovation network.

**Discussion.** As already mentioned above, currently there are many definitions of the concept of technology transfer, as well as classifications of its forms in a broad and narrow sense. In particular, some experts consider the concepts of commercialization and technology

transfer to be synonymous, others understand technology transfer as any form of transfer of knowledge from the scientific sphere to industry, including research & developments, consulting, engineering, etc.

The legal regulation of technology transfer in Ukraine is based on the Law of Ukraine «On State Regulation of Activities in the Field of Technology Transfer» (Law No. 143-V, 2006), which defines the legal, economic, organizational and financial principles of state regulation of activities in the field of technology transfer and is aimed at ensuring the effective use of the scientific, technical and intellectual potential of Ukraine.

At the same time, at the current stage of the formation of the innovation system in Ukraine, from a practical point of view, a narrower understanding of this term, namely, the transfer of «formed» and «packaged» technology to industry, is of greater value. With this approach, the main forms of technology transfer are licensing and creation of startup companies. Moreover, the second form includes the first plus the creation and management of a new business. Further discussion of the problems of technology transfer will be based on such a «narrow» understanding of the concept of transfer.

Studying world experience in this area is important for a complete understanding of the interaction of subjects creating a knowledge-intensive product with the end user of technology.

International practice proves that the main producer of scientific products, including in the agricultural sector, always remains universities, which cannot always bring their developments to the end consumer. Therefore, for universities that do not have their own production base, a very promising way of commercializing intellectual property objects is the creation of small innovative enterprises (startup companies) and licensing.

Despite the fact that the sale of a license is an additional income for both the university and the inventor, it is not the only and probably not the main goal of the development of the technology commercialization system in the universities of the United States of America (USA) and Great Britain.

The revenues of USA and Great Britain universities from the sale of licenses are usually a few percent of the sums spent on research, but despite this, the state and universities make significant efforts to develop technology transfer. It is obvious that the basis of this state policy is the strategy of developing the knowledge economy and the competitiveness of the state in general based on innovative technologies. The governments of the USA and Great Britain and many other countries are making significant efforts to accelerate the innovative development of their countries, including through the creation of legal conditions (economic interest of market subjects), in order to increase the efficiency of the use of research results obtained by universities. Moreover, the active interaction of universities with industry is constantly encouraged and receives real support both from the federal government and (mainly) from the governments of the regions. The indirect macroeconomic effect of technology licensing is manifested, in particular, in a significant increase in jobs due to the introduction of new technologies. As shown by studies conducted by the Massachusetts Institute of Technology, the financial effect of the impact of technology transfer on the US economy is ten times greater than the profit from licensing revenues (Heher, 2007).

Another reason for the active development of intellectual property commercialization systems in the universities of the USA and other economically developed countries is obviously the decrease in budget funding for research and the «aging» of the teaching staff. This situation was investigated in detail within the framework of the «University Project» conducted by the University of Salzburg in 2012 (Universities Project, 2012). As a result, universities faced the task of preserving and developing the intellectual potential of scientific schools created in the 1960s and 1970s.

The commercialization of technologies and the additional income of researchers, albeit small compared to the total amount of funding, is an additional motivation for attracting professors and teaching staff. For example, at the University of Illinois at Chicago, the fee for using patents averages about 15-20% of the total income of an average professor who combines his activities with invention.

The most important aspect of intellectual property management is the definition of ownership rights to the created results of intellectual activity. For example, the Texas State University system's intellectual property policy includes a requirement that an invention resulting from an activity related to professional duties or with university support or with university's equipment must be owned by the university.

Identifying the object of intellectual property and determining the rights to it is only an element of the process of creating the results of intellectual activity. The resolution of the conflict of interests during research is of great importance when deciding the issue of determining property rights. The problem arises when the inventor performs work on behalf of another employer or customer and it is connected with his performance of labor duties at the university.

This problem is also characteristic of national universities, where scientists are forced to look for additional sources of income in third-party organizations. As a rule, these organizations prefer to contract directly with the inventor to avoid additional costs. The basis of the legal conflict here is that, solving a private research task while working part-time, the researcher inevitably uses the work created at the university, which may be a violation of the legislation in the field of patent rights. Therefore, in the documents regulating the policy of US universities, the provisions on the resolution of conflicts of interests related to the performance of part-time work are of primary importance.

Each university solves this problem in its own way. For example, at the University of Oxford (Great Britain), professors and teaching staff are not allowed to perform work for employment in a third-party organization. In other universities, this possibility exists, but it is clearly regulated. It is very important that the organization has a clear policy in this area, which, unfortunately, is still lacking in national universities.

The number of technology transfer offices of universities and research organizations in our country is constantly growing, including with the support of international funds and programs such as the Civil Research and Development Fund (CRDF), EuropeAid and others.

Over the past 5 years, a number of Government's resolutions have been adopted, as well as new editions of laws in the field of intellectual property aimed at increasing the efficiency of commercial use of technologies obtained at the expense of state budget funds.

However, the measures taken by the Government are clearly insufficient for the successful development of technology transfer as the most important part of the national innovation system. The experience of the foreign countries in the development of university technology transfer systems indicates the need to implement the following state policy priorities in the field of technology transfer:

- formation and development of conditions for the most effective use of innovative developments created at the expense of state budget funds;
- formation and development of technology transfer infrastructure;
- motivation and support of innovative entrepreneurship (Terry, 2007).

In 2008, the European Commission issued the Commission's Recommendation of April 10, 2008 On the Management of Intellectual Property in Knowledge Transfer Activities And the Code of Practice for universities and other public research organizations (Commission Recommendation 2008/416/EC), which establishes the principles by which they should guide the development and revision of institutional policies on knowledge transfer. The Recommendations are addressed to all Member States of EU to assist them in developing and adapting policies or recommendations on intellectual property management and knowledge transfer activities.

At the national level, some EU countries, such as France, the Czech Republic, Denmark, Sweden, Luxembourg, the Netherlands, Hungary, Belgium, Denmark, have adopted legislation that makes it mandatory for universities and public research organizations to cooperate with the private sector and society with the aim of improving technology transfer in order to make it a permanent political and operational priority (Avigdor, 2011).

In our opinion, it is very promising to use the experience of the USA (Stevenson-Wydler Technology Innovation Act, 1980), Austria (Universities Act, 2002) and France (Loi sur l'innovation et la Recherche, 1999) in the field development of motivational systems for the participation of universities and their employees in the creation of small innovative enterprises. Such motivational schemes not only allow, but also stimulate and regulate the participation of university employees in private innovative business. This is very relevant under conditions of low technological demand from enterprises in Ukraine. It should also be emphasized the need to develop a system of control over the effectiveness of the use of the results of intellectual activity, obtained at the expense of the state budget, along with the support of innovative entrepreneurship.

Technology transfer managers often cite the weak interest of industry in university developments as the reason for the low efficiency of their activities. Moreover, as a

compensatory measure, as a rule, stimulating measures from the state are offered. Obviously, such measures make sense (of course, within the limits determined by the conditions of a regulated market economy). However, in our opinion, the problem lies not only in the lack of interest in development, but also in insufficient readiness of development for commercialization.

One of the ways to solve the mentioned problem is the development of small innovative entrepreneurship in order to prepare innovative technologies for sale not in the form of technological documentation, but in the form of a ready-made business. A fairly effective way of state support for the transfer of technologies in the form of the creation of startup companies is the financing of the early stages of the creation of innovative enterprises. The decisions in a startup are made much more flexibly and quickly than in large companies. Another important factor is that the startup is focused on a specific technology and directs all resources and efforts to it. In addition, the Bayh-Dole Act (1980) provides some preferences in the sale of licenses to small and medium-sized enterprises, and startups belong to this group.

Another key point in the exchange of a knowledge-intensive product between a university and a producer is the creation of special units on the basis of universities that deal with the commercialization of intellectual property objects and their further promotion into real production. In many foreign universities, such units are TTOs.

An example of such activity in Ukraine is the creation of university offices of the National Technology Transfer Network (NTTN) according to European principles and standards. The NTTN network was created by the Ministry of Education and Culture of Ukraine in 2014 and currently has 61 participants. The experience of certification of NTTN network participants demonstrated the high motivation of the Higher Education Institutions regarding the creation and development of TTO (Order No. 15 of the Presidium of the National Academy of Sciences of Ukraine, 2008).

For the agricultural sector, the cooperation of TTO with the advisory system is relevant, which in turn is also an innovative platform for the exchange of new scientific products between inventors and agricultural producers (Kovalchuk, 2020).

A key problem (at the same time external and internal) in the development of the technology transfer system is the choice of criteria for the effectiveness of the activities of such offices. It would seem that the obvious answer to this question is the amount of TTO funds earned. In fact, it is not quite so. In most cases, foreign universities allocate the following types of TTO activities:

- promotion of commercialization of the results of scientific research;
- remuneration, retention and selection of teaching staff;
- creation of closer ties with industry;
- generating income for the university and promoting economic growth (Melnyk-Melnikov, 2019).

This approach, in our opinion, is quite relevant, because nowadays it is a mistake to use only the financial result of the research of TTOs as the main criterion of transfer efficiency. It is more correct to evaluate the activity of TTOs according to indicators that characterize the contribution of TTOs to the formation of regional and national innovation systems, which ultimately leads to an increase in the gross profitability of the innovation sector of the economy. So, in particular, one of the implicit but most serious threats to the development of the system of technology transfer centers is the demand to reach self-sufficiency as soon as possible.

Therefore, at today's stage of economic development, it would be correct to consider not direct financial, but indirect indicators of the development of regional and national innovation systems with the involvement of the university, such as, for example:

- the number of winning applications in EU programs supported by TTOs;
- the number of applications for inventions submitted on behalf of the university;
- the number of contacts with enterprises – potential licensees;
- the number of technology transfer seminars for professors and teaching staff.

First of all, this is connected with the circumstances that in the modern conditions of the developing innovation system, the exit of TTOs to self-sufficiency within 3-5 years is possible only as an exception. As a rule, it is related to the outstanding personality and capabilities of the head of the technology transfer office, the support of the first person of the university or scientific organization, as well as regional and national authorities. For example, Stanford University's Technology Licensing Office (is considered one of the oldest and most

successful OTTs (Melnyk-Melnykov P.G., 2019)).

However, the maximum income from licenses was in 2018 and amounted to USD 41 million, and during the entire existence of the office (starting from 1970), the total income from the sale of licenses amounted to almost USD 2 billion. During the 50 years of TTO's existence, out of 12,500 university technologies with which TTOs worked, only three were very successful.

At the EU level, a number of measures have been implemented to increase access to venture capital, including pilot initiatives on technology transfer for universities (European Commission, 2010).

Another problem is the demand from TTOs to achieve self-sufficiency as soon as possible – refusal to work with seemingly unpromising developments of their university and concentration on commercial services to third-party organizations. These can be consulting services for technology transfer, as well as development patenting services. They bring real money, which can be used, in particular, to report on the effectiveness of the TTOs, but do not solve the tasks for which the TTOs was created.

In foreign universities, in particular in the USA, this issue is clearly resolved – TTOs promotes only the technologies of its university, but for most other countries, unfortunately, this is not the case.

For the most part, TTOs are engaged in commercial activities to the detriment of the main mission – the development of the technological sector of the economy of the region and the country, through the development of connections between university science and industry. Moreover, this is characteristic even for those TTOs universities that were created with the financial support of the Ministry of Education and Science, other programs of the Civil Research and Development Fund (CRDF). The solution to the problem, in our opinion, is as follows: for the effective development of the innovation system, long-term financial support for the activities of TTO is necessary, which provides the opportunity to engage in the technologies of one's own university (Kovalchuk, 2022). This support in Ukraine is currently provided, but in an insufficient amount and for an insufficient period of time. To date, the primary task of TTO is the formation of positive experience, examples of own success.

Unfortunately, such offices in Ukraine exist only in a small percentage of scientific institutions, therefore the transfer of technologies in universities is currently developing independently of the activities of TTO and, in many respects, spontaneously. This is really a need of time and the ability of TTO to make this process more effective acquires special significance.

It should also be emphasized that when solving the issue of investment allocation in the creation of technology transfer offices, the most important resource of TTOs is currently significantly underestimated – the staff. The key figure of TTOs is the technology transfer manager. As the experience of technology transfer offices in the USA shows, the level of specialization of managers in different TTOs varies from quite narrow to quite broad. As a rule, at the initial stage of TTO development, the manager performs a wide range of functions, sometimes including secretarial functions. Technology transfer is a business, and its first employees are largely entrepreneurs, so they must be able and willing to do any job. As the offices develop, the specialization of technology transfer managers becomes narrower. In some cases, each innovative project successively passes through two managers: an intellectual property manager and a license manager. The Intellectual Property Manager ensures the interaction of the TTO with the inventors, as well as with the law firm that carries out the activity of patenting inventions. The Licensing Manager is responsible for the commercialization of patent-protected technologies. His responsibilities include searching for potential buyers, preparing license agreements, conducting negotiations and concluding an agreement (or assisting the manager in performing this function) (Lysenko, 2015).

Manager of technology transfer is a relatively new profession, which is not yet specifically taught in Ukrainian higher education institutions. It should also be emphasized that there is no such specialty in foreign universities, and the formation of the technology manager profession in the world now takes place mainly on the basis of the activities of professional associations, which contribute to the spread of successful practices in the field of commercialization of technologies, the formation of sustainable ties between universities, research organizations and industry, and also organize professional training in the field of technology transfer.

Such associations already exist in Europe (ASTP), Great Britain (AURIL), USA

(AUTM), Southeast Asian countries and Australia (Hockaday, 2017). The main forms of activity of associations of technology transfer managers are holding conferences, seminars, trainings, publishing magazines, as well as providing information and consulting assistance to specialists in technology transfer.

**Conclusions.** The concentration of innovative activity in agricultural universities fundamentally changes the status of these institutions in the global market of educational services and high-tech products, turning them into key subjects of the global innovation network. Therefore, the development of highly competitive universities, which are able to accumulate and multiply their own intellectual potential and form the intellectual capital of the nation, as well as to promote the systematic integration of education and science and the transfer of technologies into production on this basis, is decisive for the activation of the innovative development of countries, including in the agricultural sphere. provide international competitive advantages for the country as a whole.

Based on the analysis of the best global practices of technology transfer offices, it becomes quite clear that the functioning of domestic TTOs should take into account modern realities and not rely solely on state funding, but rather attract grant funding sources and business funds as much as possible. At the same time, you need to realize that only a small number of technologies among a large portfolio of intellectual property objects can bring significant income, and therefore investments can have long payback periods.

Based on the long-term experience of Western TTOs, it is worth harmonizing Ukrainian legislation with the legislation of the EU, which will make it possible to significantly simplify the mechanisms for attracting funds from different countries and unify reporting for their use.

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#### ABSTRACT

The article highlights scientific approaches to the analysis of the legal framework and its compliance with the development trends of technology transfer systems of agricultural institutions of higher education on the basis of forecasting indicators of innovative development taking into account world experience. Such an analysis will make it possible to achieve efficiency in the processes of normative and legal regulation of innovative activity in the national economy and accelerate the pace of its development.

The article highlights the current problems of the operation of technology transfer offices (TTOs) in Ukraine, it also analyzes the effective practices of the operation of TTOs, but they do not take into account the current problems of the economic development of Ukraine. That is why the purpose of the Article is to analyze the regulatory framework of innovative activity in agricultural universities and to study the possibilities of changing the status of these institutions in the global market of educational services and high-tech products, with the prospect of involving them in the subjects of the global innovation network.

The article reviews foreign and domestic scientific works and regulations, which are devoted to the practice and experience of the most famous TTOs. Based on the analysis of the best global practices of TTOs operation, practical recommendations on the functioning of domestic TTOs were obtained considering modern realities. It was found that only a small number of technologies among a large portfolio of intellectual property objects are capable of generating significant income. The Article provides recommendations for domestic scientific institutions based on many years of experience of western TTOs.

**Keywords:** *innovations, technology transfer, commercialization of scientific developments, technology transfer offices, agricultural institutions of higher education.*