

STUDY ON THE IMPACT OF THE CIRCULAR ECONOMY IN AGRICULTURE AND RURAL DEVELOPMENT THROUGH NON-REFUNDABLE FUNDS

Andreea-Mirabela STEFAN¹, Daniel Valeriu ULIU², Marius VLADU³

¹University of Craiova, Faculty of Economics and Business Administration, Alexandru Ioan Cuza Street, Craiova 200764, Phone:, 0251 411 317, E-mail: stefan.andreea.h3a@student.ucv.ro

²University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 011464, Bucharest, Romania, Phone: +40766287579, E-mails: daniel_uliu@icloud.com

³University of Craiova, Faculty of Agronomy, Department of Agricultural and Forestry Technology, 19 “Libertății” Street, Craiova 200583, Dolj County, Romania, Phone: +40744870085, E-mail: mariusvladu@yahoo.fr

Corresponding author: mariusvladu@yahoo.fr

Abstract

This paper analyzes the distribution of projects financed under the measure DR 30 – Installation of young farmers during the period January-December 2024, with a focus on the implementation of criterion 6.3 (modern technologies, renewable energy, automatic irrigation). The study highlights regional differences in accessing the measure, as well as the main benefits and difficulties encountered by farmers. The sources of information are the database from Agency for Financing Rural Investments (AFIR, selection of reports and the questionnaire applied to farmers, and the methods used are descriptive analysis, the chi-square test as well as statistical interpretation and correlation of results. The results show that most projects were financed in the North-West (1,612 projects) and South-Muntenia (422 projects) regions, while Bucharest-Ilfov (45 projects) and Center (161 projects) had a low representation. Only 40.7% of farmers applied criterion 6.3, the main technologies that started to be implemented by the end of 2024 were sensors for monitoring crops (7 responses) and automatic irrigation systems (5 responses). The benefits reported by farmers included increased productivity (70%) and reduced production costs (30%). Among the major difficulties identified, administrative problems (68.8%), lack of technical support (58.3%) and high implementation costs were highlighted. Farmers highlighted the need for continuous support from authorities (55.8%) and technical training sessions (18.6%) to encourage the adoption of modern technologies. The findings suggest the need for tailored regional policies to reduce administrative barriers, facilitate access to sustainable technologies and improve technical education among farmers.

Key words: modern technologies, modern agriculture, non-reimbursable funding, rural development, sustainable technologies

INTRODUCTION

Modern agriculture is in a period of transition, where emerging technologies such as automation, artificial intelligence [8] and renewable energy play an increasingly important role in increasing farm productivity and sustainability [5]. In this context, DR measure 30 – “Setting up young farmers” – is an essential tool to support farmers in adopting innovative and sustainable farming practices. This measure aims not only to support young farmers through financing, but also to promote the use of modern technologies with low environmental impact, through criteria such as 6.3, which encourages

the implementation of automated irrigation systems, renewable energy and digital solutions [1]. However, the adoption of these technologies varies significantly between the development regions of Romania, being influenced by factors such as access to resources, technical support and administrative barriers [3]. Recent studies by Romanian authors show that regions such as Southwest Oltenia and Northwest have greater access to modern technologies due to local initiatives and financial support [10, 4]. Other research highlights the need for technical training and continuous support for farmers as critical factors in the adoption of modern solutions [7]. Romania accessed European

funds for agriculture and rural development during the period 2014-2020. During this funding period, Romania received over 8.12 billion euro's from the European Union budget, namely from the European Agricultural Fund for Rural Development (EAFRD), through the National Rural Development Program (NRDP) [13] [12]. To use new technologies to achieve real improvement and to increase productivity in a business can only be achieved by analysing the current state of the company [11]. Romanian agriculture began to develop with the entry into the European Union, thus a strong pressure factor was installed to modernize Romanian agriculture and economy.

The main agricultural products, cultivated in Romania are: wheat, potatoes, corn, sunflower, rapeseed, peas, beans, red and yellow melons. The year 2020 represented a deadlock for the economy and agriculture, and besides the pandemic, another problem that affected agriculture was drought, being one of the most serious in the last 50 years. The agricultural sector suffered due to the pandemic, because it only produced negative effects on the activity of farmers and on their opportunity to sell the resulting production. Agriculture is an industry that requires numerous investments, but this can only be achieved with the active help of the state and farmers. An improvement is necessary both in the systems used to care for crops, and in the equipment used. Thus, future directions in machine learning intervene here. For now, Romania is in the early stages of applying artificial intelligence methods, but companies have already emerged that offer consultancy and various programs to achieve quality agriculture.

The circular economy plays an essential role in the sustainable development of agriculture, by reducing resource waste and promoting the reuse of biological and energy materials, Popescu emphasizes that the application of this concept in farms can contribute to reducing production costs and improving energy efficiency, by adopting solutions such as composting organic waste and using bioenergy [9]. In a study on circular economy

models applied in agricultural holdings, Ionescu shows that the integration of smart irrigation systems, precision agriculture and renewable energies can significantly contribute to reducing the consumption of natural resources. These models allow for an optimization of agricultural inputs and an increase in long-term sustainability [6].

On the other hand, Dumitrescu highlights the fact that, in Romania, the degree of implementation of the circular economy in agriculture is still low, and adapted policies and strategies are needed to stimulate the adoption of this model. Among the main challenges mentioned are the lack of access to technology, high costs, and lack of training for farmers in the use of sustainable solutions [2].

In this context, the research goal is to assess the distribution of projects financed under the measure DR 30 – "Installation of young farmers during the period January-December 2024", emphasizing the implementation of criterion 6.3 regarding modern technologies, renewable energy, automatic irrigation. also, regional differences, benefits and difficulties to access this measure have been highlighted.

MATERIALS AND METHODS

The study was conducted between January and December 2024 and had as its main objective the analysis of the impact of the implementation of modern technologies, on the development of agriculture in Romania through the DR 30 measure - "Settlement of young farmers". The analysis targeted all development regions of Romania (North-East, South-East, South-Muntenia, South-West Oltenia, West, North-West, Center and Bucharest-Ilfov).

The primary data set consisted of:

-Data provided by the Agency for Financing Rural Investments (AFIR), extracted from reports published online, which included information on the number of projects financed, the total value of funds granted (70,000 euros/project), and the selection criteria met, including criterion 6.3 ("Promoting modern production technologies and techniques with reduced environmental

impact and streamlining the use of natural resources").

-A **questionnaire** applied to the beneficiaries of the DR 30 measure, to obtain qualitative and quantitative data on the effective implementation of the projects, the difficulties encountered and the impact of the technologies used. The questionnaire was completed by a sample of farmers selected from each development region.

The analysis was carried out in two main directions:

(i) Statistical evaluation of data on the total number of projects financed, their value and distribution by regions.

(ii) Analysis of questionnaire responses to identify the impact of technologies promoted through criterion 6.3.

Statistical methods: descriptive analysis, chi-square test.

To understand the relationship between the development region and the implementation of criterion 6.3, we used the Chi-square test. This test helps us verify whether the differences observed between projects that complied with criterion 6.3 or not are significant or coincidental.

How the analysis was done?

(a) We organized the projects according to development regions and separated the projects that met criterion 6.3 from those that did not.

(b) Chi-square test, with the formula below:

$$\chi^2 = \sum \frac{(O-E)^2}{E} \dots\dots\dots(1)$$

where:

O – observed value (actual number of projects for each category);

E – expected value.

(c) P-value: after calculating the χ^2 value, we determined the probability p, which shows whether the differences are significant. If $p < 0.05$, it means that the differences are real, not random.

Questionnaire: The questionnaire was structured into 8 questions (6 closed and 2 open), being applied online via Google Forms. The questions were designed to obtain clear information about:

Development region (Question 1).

Project implementation status (Questions 2).

Obtaining additional points for criterion 6.3 and the technologies used (Questions 3, 4).

Impact of technology implementation (Question 5).

Difficulties encountered (Questions 6, 7, 8)

RESULTS AND DISCUSSIONS

During January - December 2024, at national level, 3,306 projects (70,000 euros each project) were financed through measure DR 30 Installation of young farmers, with a total eligible value of 231,420,000 euros, of which 48 projects received a score for selection criterion 6.3, and the remaining 3,258 projects did not receive a score for this selection criterion, from which it can be seen that 1.47% of the total number of projects received a score through this selection criterion (Table 1).

Table 1. Situation of projects financed with or without criterion 6.3 - modern technologies, renewable energy, automated irrigation

Publication date	Number of projects in each region															
	R 1 North East		R 2 South East		R 3 S. Muntenia		R 4 SW Oltenia		R 5 West		R 6 North West		R 7 Center		R 8 B. Ilfov	
	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3	Without CS 6.3	With CS 6.3
Feb. 2024	7	0	13	2	1	0	0	0	29	0	257	0	33	0	0	0
Mar. 2024	5	0	27	0	25	8	24	1	94	1	80	0	5	0	6	0
Apr. 2024	9	0	10	0	5	0	6	0	105	2	291	2	63	0	0	0
Jun 2024	17	0	71	0	236	2	189	15	192	2	751	0	19	0	30	1
Jul. 2024	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Aug. 2024	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Nov. 2024	21	0	41	0	143	2	47	9	125	1	231	0	40	0	8	0
Total projects with/without CS 6.3	59	0	162	2	410	12	267	25	545	6	1,610	2	161	0	44	1
Total projects	59		164		422		292		551		1,612		161		45	

Source: Own calculation based on afir.ro [1].

In Development Region 1 (North-East) there were 59 funded projects, this region did not register any projects that met criterion 6.3, indicating a non-existent adoption of modern technologies. Region 2 (South-East) had 164 funded projects, but only 2 of them integrated criterion 6.3, suggesting a limited openness towards sustainable solutions. Region 3 (South-Muntenia) out of the 422 funded projects, 12 obtained additional points by applying criterion 6.3, positioning the region among the most open to modern technologies. Region 4 (South-West Oltenia) registered 292 funded projects, of which 25 met criterion 6.3, demonstrating a significant adoption of innovative solutions. Region 5 (West) with

551 funded projects had only 6 projects compliant with criterion 6.3, which highlights a modest adoption of modern technologies in relation to the total number of projects. Region 6 (North-West), with 1,612 projects funded, is the region with the highest volume of funding, but only 2 projects met criterion 6.3, highlighting an extremely low adoption of sustainable technologies. Region 7 (Center), out of the 161 projects funded, none integrated criterion 6.3, indicating a major lack of access to modern technologies. Region 8 (Bucharest-Ilfov) with only 45 projects funded, had only one project that met criterion 6.3, reflecting a minimal interest in sustainable solutions (Table 1).

Table 2. Contingency table for the number of projects that comply and do not comply with criterion 6.3

Region	Projects without 6.3.	Projects with 6.3	total
1. North East	59	0	59
2. South East	162	2	164
3. South Muntenia	410	12	422
4. South West Oltenia	267	25	292
5. West	545	6	551
6. North West	1,610	2	1,612
7. Center	161	0	161
8. Bucharest - Ilfov	44	1	45
Total	3,258	48	3,306

Source: Own calculation based on afir.ro [1].

Table 3. Chi-square test results and associated probabilities (p-value) for each region

Region	Chi-square (Without 6.3)	Chi-square (Cu 6.3)	Total Chi-square	P-value
1. North East	0.01	0.86	0.87	0.0000000002
2. South East	0.00	0.06	0.06	0.0000000002
3. South Muntenia	0.08	5.63	5.71	0.0000000002
4. South West Oltenia	1.50	101.66	103.16	0.0000000002
5. West	0.01	0.50	0.51	0.0000000002
6. North West	0.29	19.58	19.87	0.0000000002
7. Center	0.03	2.34	2.37	0.0000000002
8. Bucharest - Ilfov	0.00	0.18	0.18	0.0000000002

Source: Own calculation.

In Region 1 North-East, the differences between observed and expected projects are very small (Total Chi-square = 0.87), in this region, criterion 6.3 does not have a significant influence.

In the case of Region 2 Southeast, the differences are insignificant (Total Chi-square = 0.06), most projects did not apply criterion

6.3. In Region 3 South-Muntenia the differences are moderate (Total Chi-square = 5.71), which shows that this region has a greater openness towards criterion 6.3.

In the case of Region 4 South-West Oltenia, the differences are very large (Total Chi-square = 103.16), indicating a high use of criterion 6.3. Farmers in this region were

among the most active in applying this criterion. In Region 5 West, the differences are very small (Total Chi-square = 0.51), this region has a low influence on criterion 6.3. In Region 6 North-West, the differences are large (Total Chi-square = 19.87), indicating a significant influence on the adoption of criterion 6.3. In Region 7 Center, the differences are insignificant (Total Chi-square = 2.37), few farmers applied for the score on criterion 6.3. In Region 8 Bucharest-Ilfov the differences are very small (Total chi-square = 0.18), in this region, criterion 6.3 was rarely applied (Table 3).

The South-West Oltenia and North-West regions stood out with a significant adoption of criterion 6.3, due to the increased interest in

modern technologies, such as renewable energy or automated irrigation. Regions such as North-East, West, and Bucharest-Ilfov had a reduced contribution, which suggests either a lack of access to resources or a low interest in applying the technologies promoted by criterion 6.3 (Table 3).

Figure 1 shows that the highest number of responses came from the South-West Oltenia Region (27.6%) and the South-Muntenia Region (20.7%), which coincide with the regions that had a higher adoption of criterion 6.3 in the overall analysis. Regions with lower participation include the North-West (13.8%), the West (13.8%), and the Center (10.3%), which suggests lower interest or representation in the questionnaire.

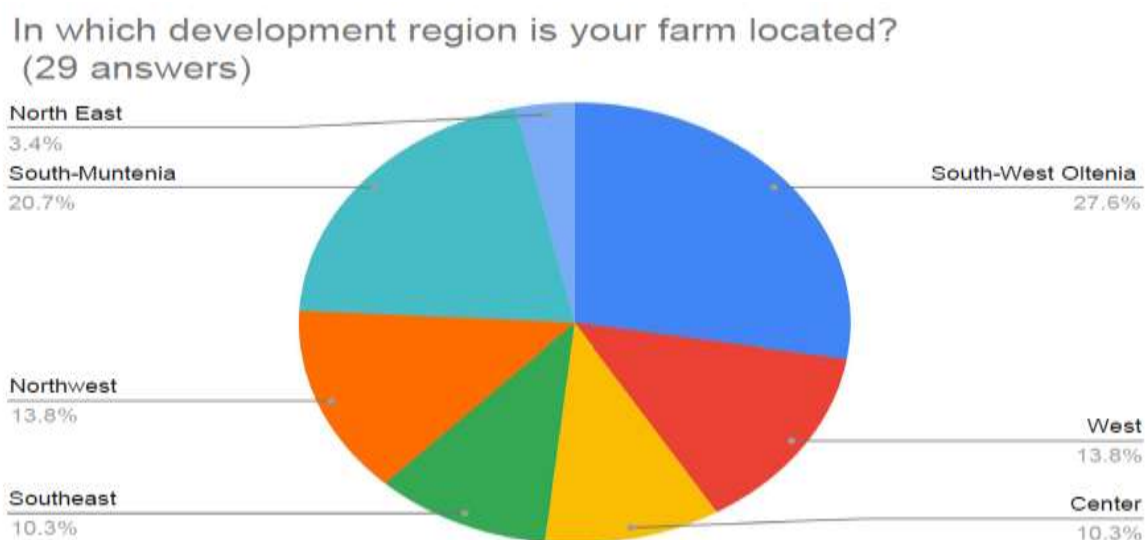


Fig. 1. The location of the farm by development region
Source: Own construction with google forms.

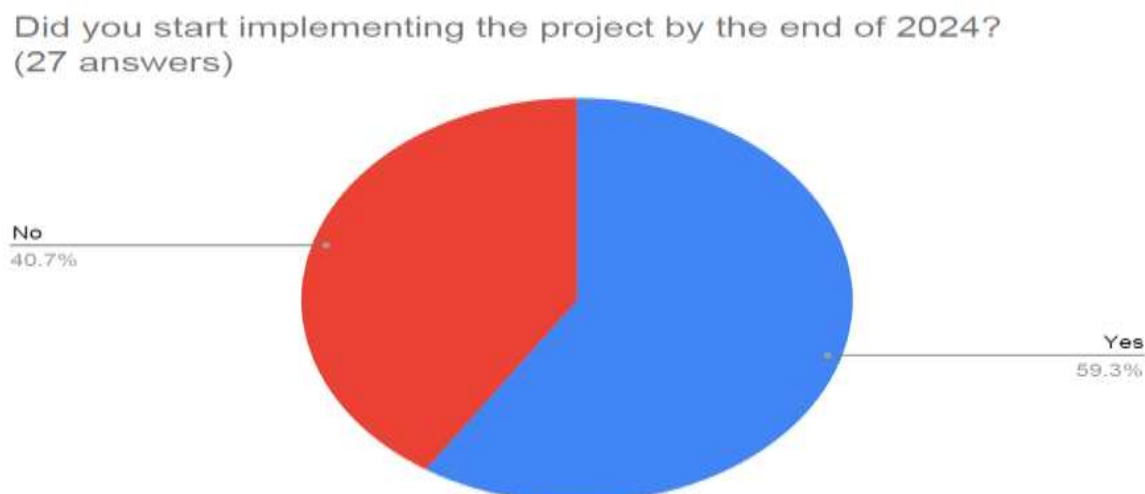


Fig. 2. Farmers who started and not started implementing projects by the end of 2024
Source: Own construction with google forms.

Figure 2 shows that 59.3% of farmers were able to start implementing the projects, suggesting a moderate degree of success. 40.7% were unable to start implementing the projects, and the reasons probably include administrative or financial difficulties, also reflected in subsequent responses. It is observed that 40.7% of farmers scored by applying criterion 6.3, which shows a relatively good interest in modern technologies. However, 59.3% did not apply

this criterion, which indicates barriers in the adoption of promoted technologies (Figure 3). Figure 4 shows that the most commonly used technologies were: Crop monitoring sensors (7 responses), Automatic irrigation systems (5 responses), Renewable energy (3 responses). More advanced technologies, such as farm management software (AI), are less frequently used (1 response), suggesting limited adoption of modern technologies.

Did you score by applying criterion 6.3 (modern technologies, renewable energy, automated irrigation)? (27 answers)

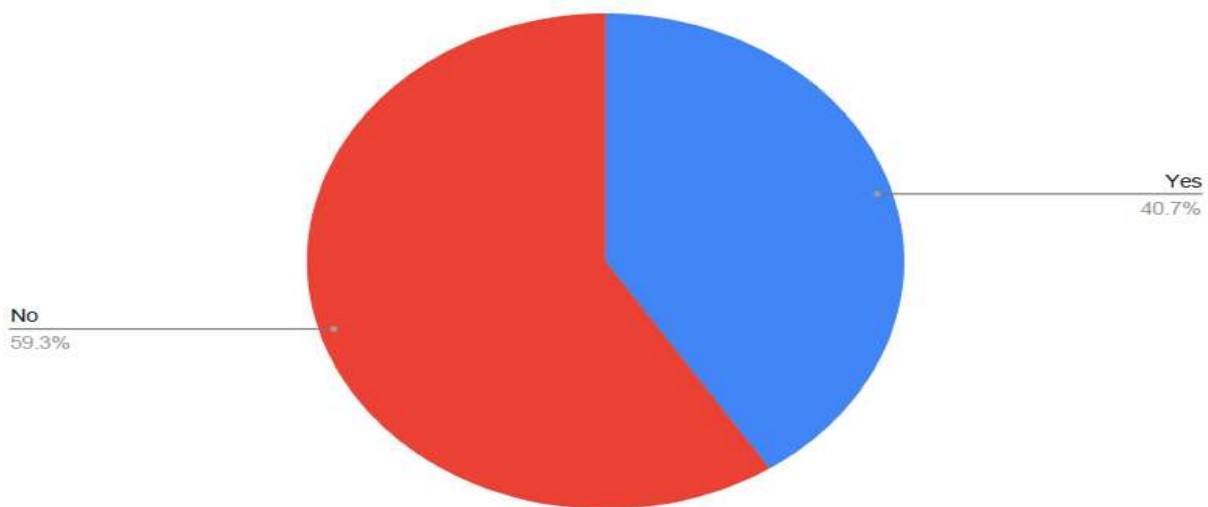


Fig. 3. Application of criterion 6.3
 Source: Own construction with google forms.

4.What technologies do you need to implement in the project to benefit from scoring on criterion 6.3?

8 answers

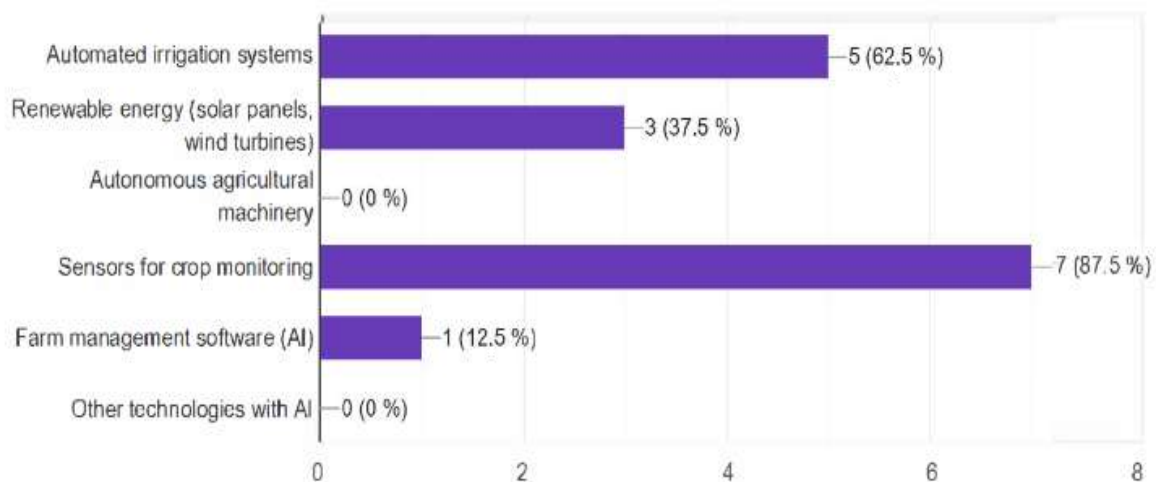


Fig. 4. Technologies to be implemented for criterion 6.3
 Source: Own construction with google forms.

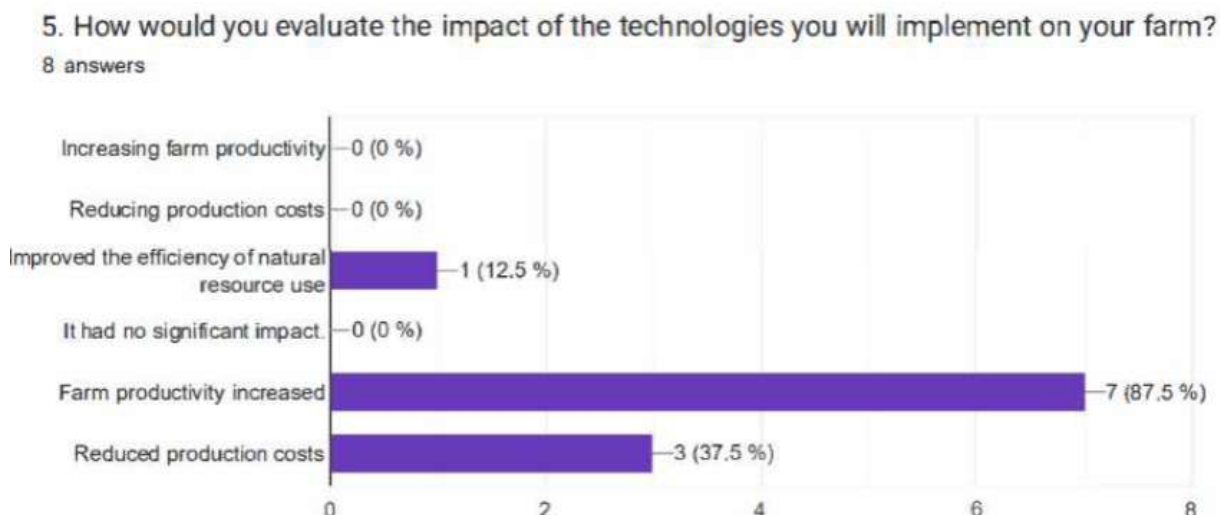


Fig. 5. The impact of the technologies that will be implemented
Source: Own construction with google forms.

Figure 5 shows the impact of the technologies to be implemented, that is, most farmers observed a positive impact, mentioning the following most frequently: Increased farm productivity (7 responses), reduced

production costs (3 responses) and more efficient use of natural resources (1 response) are less common, which shows an untapped level of potential optimization.

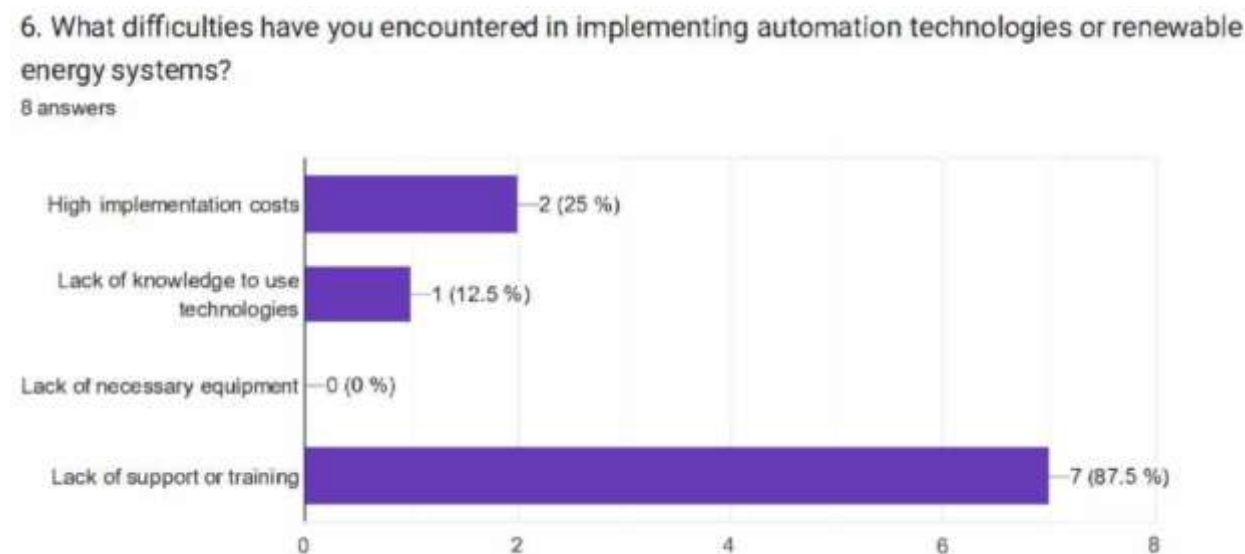


Fig. 6. Answers regarding the difficulties related to the implementation
Source: Own construction with google forms.

The main difficulties encountered in implementing projects are: Lack of support or training (7 responses), high implementation costs (2 responses), lack of knowledge for using technologies (1 response), this indicates a clear need for educational and technical support for farmers (Figure 7).

The most common reason for not implementing the project is administrative or bureaucratic problems (68.8%), which seem

to be the main barrier. Other reasons include lack of additional financial resources (12.5%) and other priorities in farm management (18.8%) (Figure 7).

Farmers identified the following forms of support as the most useful: Continuous support from authorities (24 responses), training sessions and technical instruction (8 responses), other suggestions include specialized consultancy, additional funds and

reduction of implementation costs, but are less common (Figure 8).

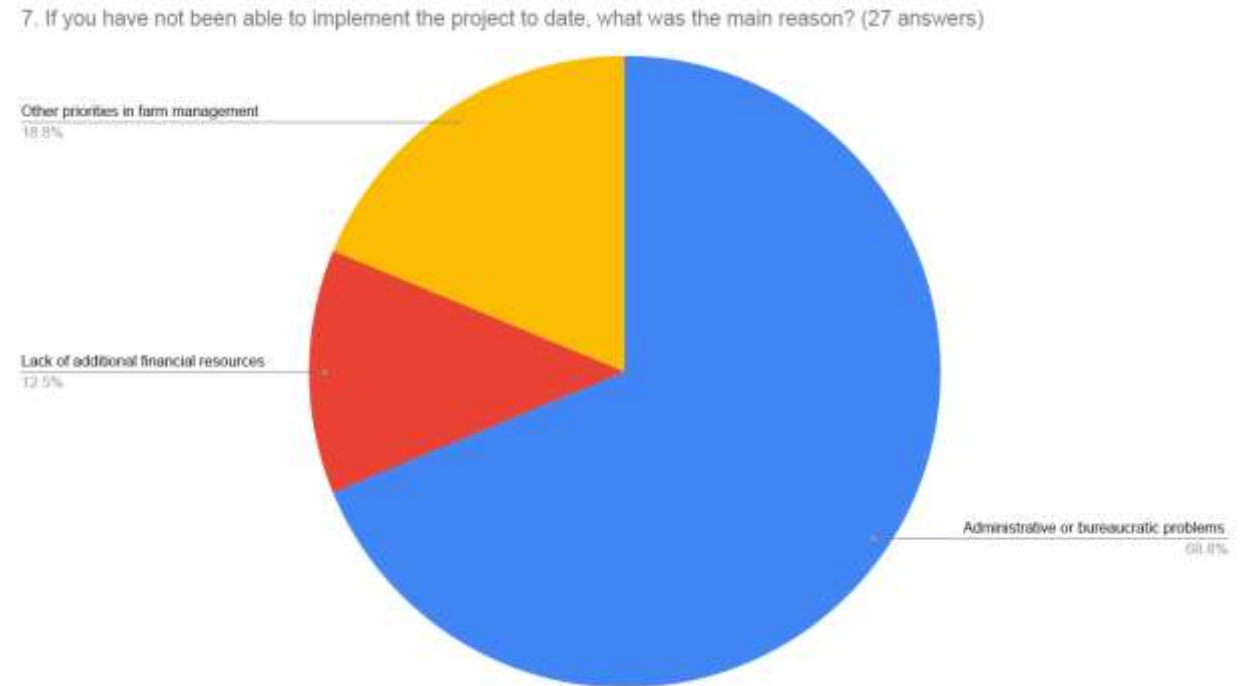


Fig. 7. Reasons why the project was not implemented on time
Source: Own construction with google forms.

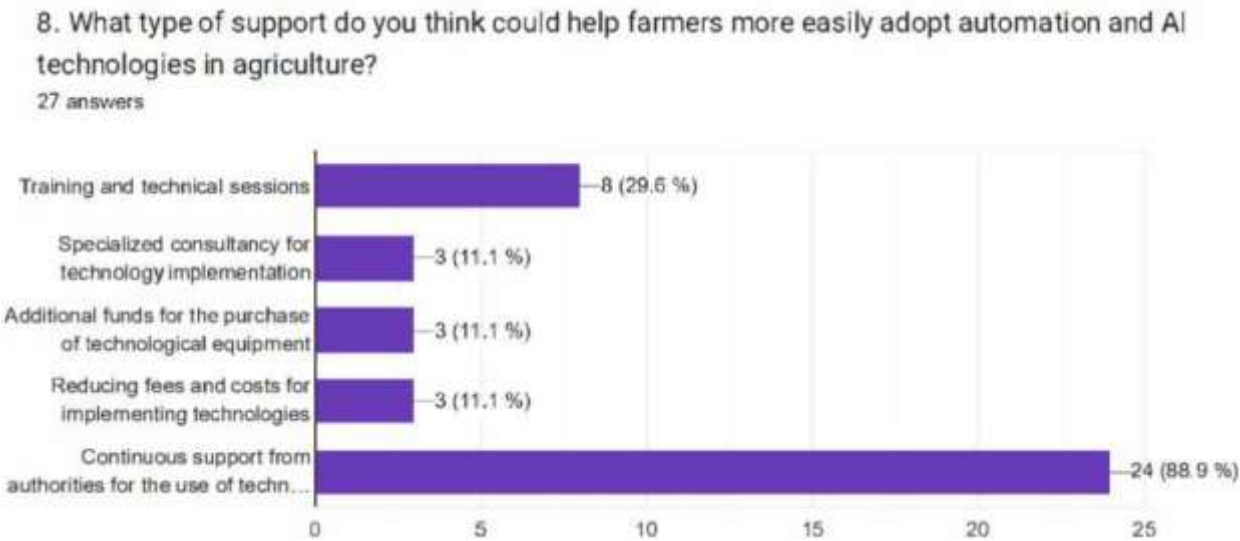


Fig. 8. Types of support needed by farmers to adopt automation and AI technologies?
Source: Own construction with google forms.

CONCLUSIONS

The descriptive analysis of the number of projects financed under the DR 30 measure shows an uneven distribution between development regions. Most projects were accessed in the North-West (1,612 projects) and South-Muntenia (422 projects), while Bucharest-Ilfov (45 projects) and Center (161

projects) had the fewest applications. The adoption of criterion 6.3 was significantly higher in regions with a lower number of projects, such as South-West Oltenia, suggesting that these regions were better informed or had more access to modern technologies. Regional differences highlight the need for personalized support, especially for areas that

have encountered difficulties in implementation, such as the North-East and the West. This support should include simplifying administrative processes and increasing the accessibility of technologies for good implementation, so that farmers can more easily access these projects.

The Chi-square test revealed a significant relationship between the development region and the application of criterion 6.3, with a p-value <0.00001 , indicating that the distribution of projects that comply with this criterion is not random. Regions such as South-West Oltenia and North-West had large contributions to the Chi-square statistic, showing a high adoption of the technologies promoted by criterion 6.3, while the North-East, Center and Bucharest-Ilfov regions recorded low influences.

This regional disparity highlights the need for tailored policies, which specifically support regions with low adoption, through measures such as cost reduction and training programs for farmers. Thus, by introducing directives that help farmers, visible progress can be achieved.

A total of 3,306 projects were financed, of which only 48 opted to receive the additional score on criterion 6.3, representing a very low interest of farmers in this criterion (only 1.43% of farmers). However 40.7% of respondents applied for criterion 6.3, which highlights a limited interest in modern technologies.

The main barriers identified were bureaucratic problems (68.8%), lack of additional funds (12.5%), etc. The implemented technologies, such as monitoring sensors and automatic irrigation, brought clear benefits, including increased productivity. In order to increase the adoption of criterion 6.3, farmers require continuous support from the authorities and technical training sessions. Thus, most farmers observed a positive impact, most frequently mentioning: increased farm productivity (87.5%), reduced production costs (37.5%), and more efficient use of natural resources (12.5%) resulting in the use modern technologies means leading to higher productivity and lower costs.

REFERENCES

- [1]AFIR, 2024, Ghidul solicitantului pentru măsura DR 30 – Instalarea tinerilor fermieri. Agenția pentru Finanțarea Investițiilor Rurale (Applicant's guide for measure DR 30-Installation of young farmers. Agency for the Financing of Rural Investments). <https://stportalafirprod.blob.core.windows.net/media/media/tvmcdzo1/ghidul-solicitantului-dr-30.pdf>, Accessed on December 10, 2024.
- [2]Croitoru, I.M., Grigoras, M.A., Popescu, A., Grigoras, B.A. 2024, Embracing the circular economy: a paradigm shift for sustainable prosperity. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 24(2), 397-406.
- [3]Deboul, J., 2018, Agriculture and economic development in developing countries, <https://www.fondapol.org/decryptage/agriculture-and-economic-development-in-developing-countries/>, Accessed on February 10, 2025.
- [4]European Commission, 2022, Eligibility: who can get funding?, https://commission.europa.eu/funding-tenders/how-apply/eligibility-who-can-get-funding_en, Accessed on February 10, 2025.
- [5]FAO, 2021, The future of food and agriculture – Drivers and triggers for transformation. Food and Agriculture Organization of the United Nations. <https://openknowledge.fao.org/items/66a787f4-af91-4f6e-b436-560010ab72d4>, Accessed on December 5, 2024.
- [6]Frone, D.F., Frone, S., 2017, Circular economy in Romania: An industrial synergy in the agri-food sector. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 17(2), 103-110.
- [7]Gkoutani, V.A., Tsoulfas, G.T., Mouzakis, Y. 2022, Mapping sustainability assessment methods in agri-food supply chains: a circular economy perspective. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 22(2), 361-368.
- [8]Hertzman, A., Fleet, D., 2010, Machine Learning and Data Mining Lecture Notes, CSC 411/D11, Computer Science Department, University of Toronto, Version: February 6, 2012, 2010 Aaron Hertzmann and David Fleet. <https://www.dgp.toronto.edu/~hertzman/411notes.pdf>, Accessed on December 10, 2024.
- [9]Lungu, V., Uliu, D.V., Vladu, M., 2022, studies on the influence of the level of financial support on the trend of area cultivated in organic farming system . Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 22(4), 367-372.
- [10]Popa (Podaru), A.M.P., Turek Rahoveanu, A., 2021, Supporting young farmers and the sustainability of rural regions. Case study - Olt county, Romania. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 21(3), 651-658.

[11]Popescu, A., Tindeche, C., Marcuta, A., Marcuta, L., Hontus, A., Angelescu, C., 2021, Labour force in the European Union agriculture: traits and tendencies. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development 21(1), 475-486.

[12]Uliu, D.V., Olaru, L., VLADU, M., 2020, Studies on the current situation of projects unselected for financing, in the meat processing sector, through the National Rural Development Program in Romania. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 20(4), 563-574.

[13]Uliu, D.V., Vladu, M., 2021, Studies on the economic results of some meat processors who have accessed non-refundable funds in the Oltenia region, Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development 21(1), 771-782.