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Analysis of socioeconomic and environmental problems in farms applying soil health practices in EU

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Abstract

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The main aim of the report is to research socioeconomic and environmental problems in farms applying soil health practices in the EU-TUdi-project[1] – partner countries – Austria, Bulgaria, Czech Republic, Hungary, Italy, and Spain. It was constructed farm typology related to soil heath using two statistical methods. The principal component analysis (PCA) constructed four socioeconomic which evaluate the socioeconomic and environmental problems. On the second step, it was applied cluster analysis (CA) to separate the farmers into homogeneous groups with similar characteristics. There were identified four farm types regarding soil health.

Keywords: farm typology; principal component analysis; cluster analysis; soil health; agricultural systems; socio-economic problems

[1] The name "TUdi" comes from the abbreviation of the project name under which the research is financed: "Transforming Unsustainable management of soils in key agricultural systems in EU and China. Developing an integrated platform of alternatives to reverse soil degradation", Horizon 2020 Research and Innovation action under grant agreement No 101000224.

Introduction

In the European Union's economic landscape, agriculture plays a pivotal role in contributing significantly to both its socioeconomic and environmental sustainability. Several studies have acknowledged the importance of sustainable agriculture and soil health practices in addressing contemporary challenges. For instance, Jones & Johnson (2020) explored the economic implications of transitioning to organic farming methods. However, there remains a gap in literature specifically addressing the nuanced socioeconomic and environmental issues faced by farms in the EU adopting soil health practices. Soil health practices encompass a range of strategies aimed at promoting soil fertility, structure, and overall quality. These practices include but are not limited to cover cropping, crop rotation, conservation tillage, and organic farming techniques. As farmers adopt these practices in pursuit of sustainable agriculture, it becomes imperative to evaluate their impact on both the social and economic aspects of rural communities and the environmental health of farmlands.

The socioeconomic ramifications of soil health practices are of particular interest, given their potential to influence livelihoods, employment patterns, and community dynamics. Additionally, the environmental consequences, such as changes in biodiversity, water quality, nutrient runoff, and greenhouse gas emissions (Kinnebrew et al., 2022), require careful examination of the soil health practices, while farmers are applying these practices. Understanding these ecological challenges is crucial for devising holistic policies that balance the need for agricultural productivity with environmental conservation goals. However, there remains a gap in literature specifically addressing the nuanced socioeconomic and environmental issues faced by farms in the EU adopting soil health practices. *Our paper aims to bridge this gap by synthesizing existing research and conducting a comprehensive analysis of the challenges faced by farms in 6 EU-TUdi-project-partner countries that implement soil health practices.* This research contributes valuable insights to policymakers, researchers, and practitioners working towards a more sustainable and resilient agricultural sector in the European Union.

Materials and Methods

Survey and data description

The 6 EU-TUdi-project-partner countries (Austria, Bulgaria, Czech Republic, Hungary, Italy, and Spain) performed analysis using questionnaire constructed in 2022 using different methods such as face-to-face (Bulgaria), online (Hungary), and mixed (other participants) due to the COVID-19 outbreak. The focus of the analysis is farmers in the following agricultural systems – grass land, tree crops, cereal-based rotation.

It was applied "judgement sampling" approach divided based on economic size and agricultural system according to their country representation. Table 1 gives information about the number of responses to the survey from Europe.

Table 1. Total number of respondents/surveys per country

Country	Number of surveys
Austria	82
Bulgaria	60
Czech Republic	121
Hungary	11
Italy	79
Spain	63
Total	416

Source: Authors' table

To define socioeconomic and environmental characteristics of each group of farms the collected information was analyzed using two statistical methods – PCA and CA.

Principal component analysis

Principle component analysis is a type of factor analysis (Pearson, 1901). It determines the minimum number of variables that are enough to describe a specific problem. PCA groups the variables into different factors which explain some specific features of the farm typology.

The accepted criteria that should be met by the data for performing PCA are the following:

- the KMO coefficient should be above 0.7;
- Bartlett's sphericity test must have a significance level below the accepted level of significance (0.05);
- the correlation between two variables must be between 0.9 and 0.3. The decision for removing variables that do not meet the defined criteria will be based on the conclusions of all data analyses.

The applied rotation is the orthogonal Varimax. The aim of the analysis is to identify independent factors consisting of variables with strong correlation between themselves (Field, 2009).

Cluster analysis

Cluster analysis is a group of statistical procedures which aims to discover a structure within a complex set of data. The different elements (in our study the elements are the different farms/respondents) are combined into clusters. The farms within the cluster have some degree of similarity among themselves (homogeneity) according to the different variables in the study. Different clusters are relatively distinct from each other (heterogeneity). The variables are the economic and social indicators for every farm accumulated by a survey. Depending on the problem that is studied the cluster analysis can help to develop a classification and it may become a basis for classifying new observations (Anderberg, 1973).

The initial set of variables have been delivered by a multistage process of literature study, brainstorming trough the experts in the consortium and stakeholders. The cluster analysis logically follows the PCA and thus uses the same set of data that is prepared and standardized for the purposes of PCA.

As both methods (PCA and CA) are in fact a form of data reduction methods they can be used together. PCA lowers the variables' number. Then, the cluster analysis was performed to determine separable groups.

Results and Discussion

The aim of the study is analysis of the challenges faced by farms in 6 EU-TUdi-project-partner countries that implement soil health practices constructing farm typology for farmers in the following agricultural systems – tree crops, cereal-based rotation, and grass land (Nikolov et al., 2023).

To construct the farm typology is applied two-step approach:

- PCA determines groups of significant variables related to soil health, socioeconomic, and environmental problems.
- Then, CA form homogenous groups of farms with similar, identifiable characteristics.

Principle component analysis

The analysis started using 62 variables based on the answers to questions of the survey. Based on the iterative process, 38 variables were removed because of the following reasons: (i) there is no significant correlation with any of the variables; (ii) low extraction coefficient of communalities (explains the common variance); (iii) make a factor its own.

Finally, 18 variables were determined as appropriate to construct four factors. The KMO coefficient is 0.791 which is high enough to continue the analysis. Also, we can accept the hypothesis that there is no significant correlation between at least two variables, based on the Bartlett's sphericity test.

The eigenvalue analysis (Figure 1) and the number of components show that there are four significant and meaningful factors.

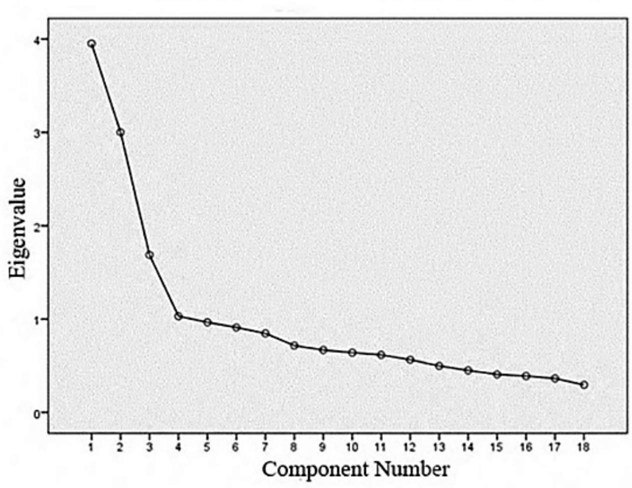


Fig. 1. Analysis of the eigenvalues
Source: Own calculations

The aim of the analysis is to construct an uncorrelated factor related to soil health, socioeconomic, and environmental problems, which will be useful to determine clearly recognizable clusters. In this regard, the applied method of rotation is Varimax. The explained variance is 53.73%, which is an acceptable level in such an analysis. The factor components are determined based on the rotated component matrix (Table 2). The name of the factors is based on the variables that have the higher contribution.

As a result of PCA, 4 factors were constructed as follows:

- The **Social environment** is based on the 5 variables which describe the environment around the farm respondent related to the interests and demand of environmentally friendly products as well as technology development, secure supply chain and political support. The first factor contains the following variables:
  - ➢ the level of societies and consumers' interest and demand for environmentally friendly products;
  - ➢ the level of farmers' awareness and knowledge level of environmental issues;
  - ➢ the level of political will to support delivery of environmental goods and services by farmers;
  - ➢ the level of secure supply chain and certainty of demand for farm products;
  - ➢ and the level of implementation of technology (experience, attitude, access).
- The second factor is called **Soil health problems**. It includes the following identified and related (correlated) soil health problems in the respondents' farms:
  - ➢ soil structure (aggregate stability);
  - ➢ land /soil waterlogging;

Table 2. Rotated Component Matrix

Variable	Description	Factors			
		1 – Social environment	2-Soil health problems	3 – Soil knowledge	4 – Soil restoration
II11_1	Soil structure (aggregate stability)	-.097	.617	-.161	-.053
II11_3	Land /soil waterlogging	.217	.518	.006	-.378
II11_5	Surface compaction	.100	.698	-.044	.063
II11_6	Subsurface compaction	.013	.696	-.045	.002
II11_7	Soil erosion – sheet erosion	-.044	.729	-.076	.082
II11_9	Soil erosion – depositional areas	-.079	.701	-.147	.037
II20_3	From literature	.095	-.056	.733	.020
II20_4	From leaflets	.164	-.111	.790	.038
II20_5	From YouTube and other social networks	.052	-.144	.762	-.006
II20_7	From ministries	-.050	-.115	.664	.201
III30_1	Access to financing for soil restoration practices	.406	.088	.113	.674
III30_2	The level of specific training and equipment for soil restoration practices	.409	.059	.158	.709
III30_3	The level of unified terminology regarding soil quality	.276	-.029	.046	.749
III30_4	The level of society's and consumers' interest and demand for environmentally friendly products	.723	-.081	.082	.055
III30_5	The level of farmers' awareness and knowledge level of environmental issues	.592	.009	-.010	.266
III30_6	The level of political will to support delivery of environmental goods and services by farmers	.656	-.030	.085	.223
III30_8	The level of secure supply chain and certainty of demand for farm products	.717	-.038	.031	.103
III30_9	The level of implementation of technology (experience, attitude, access)	.653	.119	.085	.154

Source: Authors' table

  - surface compaction;
  - subsurface compaction;
  - soil erosion – sheet erosion;
  - soil erosion – depositional areas.
- The third factor is based on the knowledge sources for soil health analysis and its usage in farm management. It is called **Soil knowledge** and includes the following correlated sources:
  - from literature,
  - from leaflets,
  - from YouTube and other social networks;
  - from ministries.
- The fourth factor is **Soil restoration**. It is worth mentioning that the first two variables in this factor also affect the first factor **Social environment**. It is constructed based on the following variables:
  - access to financing for soil restoration practices;
  - the level of specific training and equipment for soil restoration practices;
  - the level of unified terminology regarding soil quality.

Cluster analysis

The four PCA factors were used to perform cluster analysis. Additionally, two more factors are added that are considered important for the study: the economic size of the farm and the farm agriculture system. For the purpose of the study, the farms are divided according to their economic size into 3 groups: small, medium and large. The three farm agricultural systems are: tree crops, grassland, and cereal-based rotation.

The agglomerative hierarchical clustering methods are appropriate to determine the number of clusters. The Euclidean distance and Ward (which analyzes the variance of clusters) method is applied to derive the optimal number of clusters within the iterations in hierarchical clustering.

To define the number of clusters it is performed the following analysis: dendrogram, K-means cluster analysis, and ANOVA test.

Table 3. ANOVA

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	Df		
Soil environment	51.235	3	.634	412	80.786	.000
Soil health problems	57.149	3	.591	412	96.675	.000
Soil knowledge	13.012	3	.913	412	14.259	.000
Soil restoration	10.709	3	.929	412	11.524	.000
Economic size	18.547	3	.872	412	21.264	.000
Code of the system	98.068	3	.293	412	334.485	.000

Source: Authors' calculations

First, the visual determination of the clusters number based on dendrogram shows 4 clusters.

Second, K-means cluster analysis finds the best solution for the number of clusters that is derived from hierarchical clustering. The applied analysis using four clusters makes stable clusters in 16 iterations.

Third, ANOVA test shows that the hypothesis of equality of the clusters is rejected (Table 3). This means that the six factors are different enough in the final cluster solution, so there are separable clusters.

Finally, based on the researchers' experience and expertise, and following the logic of the research, a check was performed so that the number of retained clusters is realistic with respect to the field observation to be accepted as a meaningful classification.

Final clusters give the opportunity to interpret what the typical characteristics for a particular cluster are.

Final cluster centers interpret what is typical for a particular cluster. For the purposes of the analysis, every cluster is identified by four principal components and two additional factors. The four clusters are relatively large with participants spread evenly in them. The number of cases/respondents in every cluster can be seen in Table 4.

Table 4. Number of respondents in each cluster

Number of Cases in each Cluster		
Cluster	1	116.000
	2	98.000
	3	121.000
	4	81.000
Valid		416.000
Missing		.000

Source: Authors' calculations

The final cluster centers presented in Table 5 give the final solution of the cluster analysis.

Interpretation of the results

To describe the identified farm types is used the following scale depending on the value of the final evaluations of

Table 5. Final Cluster Centers

Principal components and additional factors	Cluster			
	1	2	3	4
Soil environment	-.57879	-.40942	.90168	-.02271
Soil health problems	-.52887	1.01896	.12419	-.66094
Soil knowledge	-.22834	-.30943	.12227	.51872
Soil restoration	.30435	-.17364	.14523	-.44272
Economic size	53766	-.45237	-.05094	-.14657
Code of the system	.66213	-.36842	.65593	-1.48235

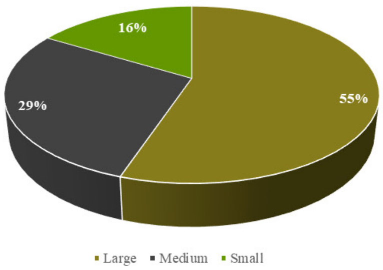
Source: Authors' calculations

the cluster centers: the values from 0 to +/- 0.4 we can define as low/little/slightly (positive /negative); the medium/average/moderate value is from +/-0.4 to +/-0.09; the value above / below +/- 0.9 is high/strongly (positive /negative). The scale is 6 degrees and every degree include relatively the same number of correspondents.

As a result of the analysis there are identified four farm types:

Cluster 1. Intensive Large Farms are on average level composed of large farms growing cereal-based rotations. These Farms account for 27.9% of farms. They use the land intensively, which leads to medium soil health problems. They estimate positively the soil restoration practices but the degree is low. These farmers feel medium negative social environment about their problems. They feel lack of knowledge (low negative). The average age of the farmers is 52 years, and young farmers (<40) are 19.0%. Average size of the farms in Cluster 1 measured is 317.5 ha. Figure 2 represents the structure of farms in cluster 1 by economic size and by cropping system. In terms of economic size, 55% of farms are large, 29% are medium and 16% are small. Taking in consideration the cropping system, 92% of the farms are cereal-based rotation, 8% are grassland and there are no tree crops represented in Cluster 1. This cluster is mainly represented by males with an 80.2% share of farm managers, while the females take the remaining 19.8%.

The analysis of the share of the young farmers according to the farm size shows that the highest share of the young



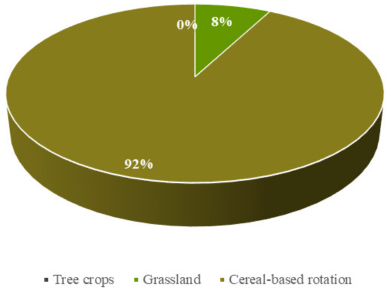


Fig. 2. Economic size of farms (left) and cropping system (right) in Cluster 1
Source: Own calculations

farmers is in the medium farms (24.2%), followed by the large and small farms with 21.9% and 10.5%, respectively (Figure 3).

In terms of agriculture system type, the major share is taken by the conventional agriculture (88%), followed by biological – 8%, and agroecological agriculture – 4% (Figure 4).

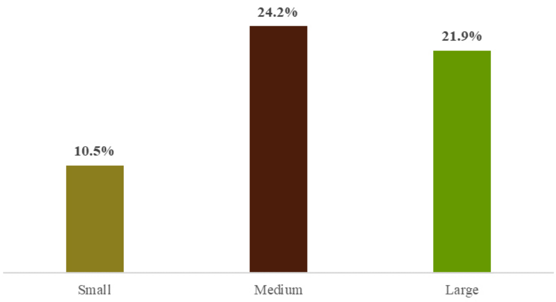


Fig. 3. Share of young farmers according to the farm size in Cluster 1
Source: Own calculations

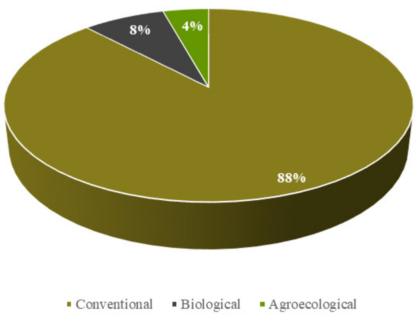


Fig. 4. Type of agriculture in cluster 1
Source: Own calculations

The largest share has farmers with secondary school – 39%, then are the farmers with university education – 33%, higher secondary education with 15% share, primary school have finished 8% and post-graduate are 5% of the farmers (Figure 5).

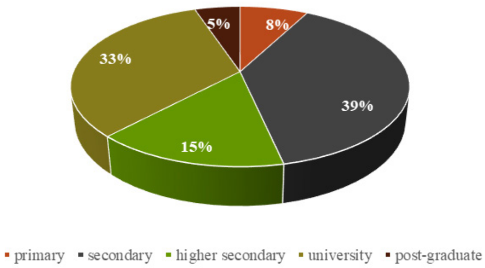


Fig. 5. Education level in Cluster 1
Source: Own calculations

The social environment is assessed primarily as medium negative, which means that the level of societies and consumers' interest about Intensive large farms is negative on average degree. The level of farmers' awareness and knowledge level of environmental issues is also low negative. The political support is estimated as negative on medium level and the implementation of the technology is at the same level. The farmers in cluster 1 estimate soil health problems as moderate negative. That means that farmers find the soil structure, land/soil waterlogging, surface compaction, subsurface compaction, and soil erosion as negative for their farms on an average level. The farmers in Cluster 1 estimate their soil knowledge as slightly (low level) negative. This means that they have small difficulties finding information from literature, leaflets, internet, and social networks. They also have negative relations with the official authorities related with soil health problems. However, the farmers in this cluster find that the soil restoration practices are a little positive because they have access to financing, specific training, and equipment for soil restoration practices.

Intensive Large Farms' characteristics show several opportunities for their socioeconomic and environmental area improvement. The main challenges that they face are the average negative social environment and soil health problems, and small negative knowledge, combined with low positive soil restoration. To improve soil awareness of the society they need to improve the communication policy with different social groups (politics, customers, etc.) and to improve the level of implementation of technology. Probably they need some support to learn how to use new technologies related to soil health practices, get some up-to-date information about the applied technologies in the field. Other supportive tools can be some activities (conferences, exhibitions, etc.) the main purpose of which is to exchange experience with other farmers, companies, and producers. These activities can add to their exchange of information because they feel lack a small degree of it. As these farmers are relatively large, they tend to apply soil restoration practices to a small extent. Lack of information exchange, access to technologies and experience probably prevents them from applying soil-restoring practices to a greater extent, as well as low social support. Increasing the information exchange and involvement of different social groups would contribute to increasing soil restoration. For this cluster, the financial motive is not leading and probably the direct investing of funds would not contribute much to the increase of soil restoration.

Cluster 2 Grassland Small Farms. The small farms dominate in terms of economic size. The level of soil restoration is low negative because they do not need strong soil restoration practices that leads to low negative knowledge about soil restoration problems. Social environment is medium negative for them.

Grassland Small Farms comprised of 23.6% of the farms. The average age of the farmers is 46 years old with a 28.6% share of the young farmers. Average size of the farms in this cluster is much smaller – 72.6 ha. In terms of economic size, 2. 63% of farms are small, 20% are medium and 17% are large (Figure 6). The prevailed cropping system is grassland (48%), followed by cereal-based rotation and tree crop with 30% and 21% share, respectively. In Cluster 2, female farmers are 22.4% which is a higher share compared to cluster 1, while the males represent 77.6% of the farm managers.

The information about young farmers according to the farm size is on Figure 7. The young managers in the small farms in Cluster 2 are 35.5%., in medium farms – 36.8% and 11.8% in large farms.

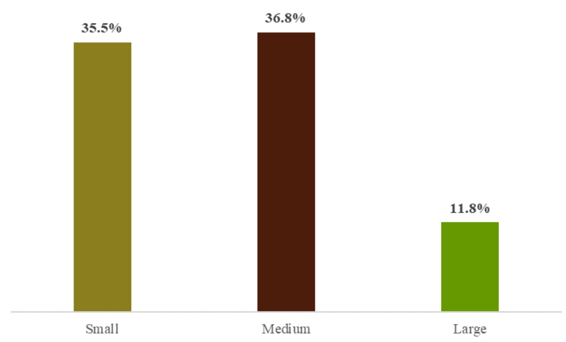


Fig. 7. Share of young farmers according to the farm size in cluster 2
Source: Own calculations

The conventional type of agriculture has a significant share in Cluster 2 – 69% (Figure 8). Biological agriculture has 26% of the respondents, while for 4% of them – it is agroecological.

Figure 9 gives the shares of the farmers in Grassland Small Farms according to their educational level. The largest share has farmers with secondary school – 49%, then are the farmers with higher secondary education – 25%, university education with 18% share. The share of primary school education and post-graduate is relatively insignificant respectively 5% and 3% of the farmers.

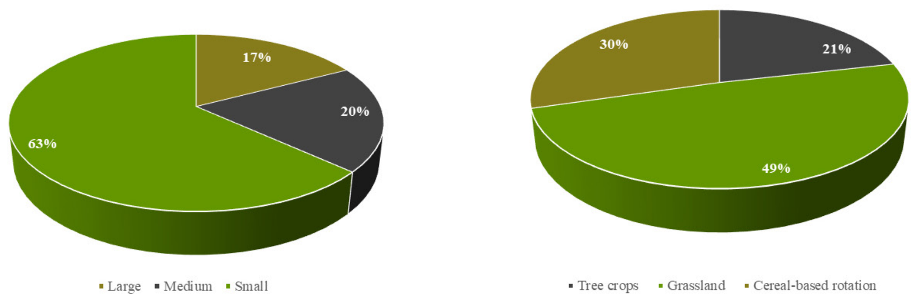


Fig. 6. Economic size of farms and cropping system in cluster 2
Source: Own calculations

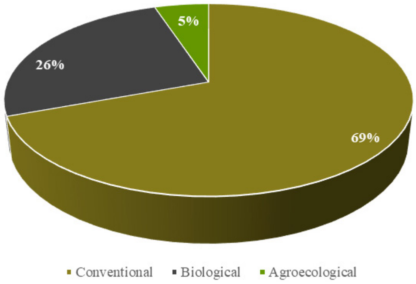


Fig. 8. Type of agriculture in cluster 2
Source: Own calculations

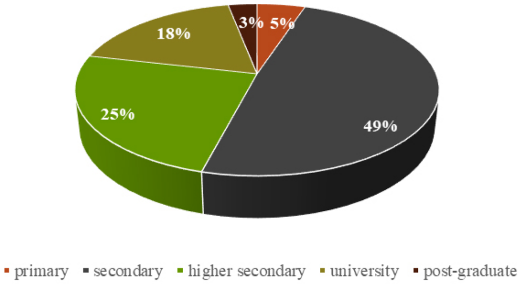


Fig. 9. Education level in cluster 2
Source: Own calculations

They hold mostly grasslands and to a lesser degree tree crops and cereal-based rotation. The managers of small farms in Cluster 2 estimate the soil environment as moderate negative. Again, that means that they find society and consumer commitment to soil health problems negative on an average level. Farmers' awareness and knowledge is not sufficient. Political support and technology implementation is medium negative. The managers of Grassland Small Farms manage to control the soil health problems to a high degree. The grasslands in Cluster 2 do not suffer from bad soil structure, land, and soil waterlogging. Surface and subsurface compaction and soil erosion is strongly controlled. Although soil health is considered as highly positive, the managers estimate their knowledge about soil health as slightly negative. It is hard for them to find information from literature, leaflets, the internet, and social networks. They also suffer negative relations in low degree with the official authorities regarding soil quality. The farmers in Cluster 2 find that the soil restoration is medium level negative because they do not have access to financing, specific training, and equipment for soil restoration practices.

Grassland Small Farms estimate the soil health as highly positive, related to average negative social environment and low-level information sources. They also have low negative restoration practices. *More favorable socioeconomic and environmental conditions could be ensured for this farm type, supporting them in increasing the awareness of different social groups – politicians, customers, suppliers.* Farmers in this cluster can be supported in terms of increasing the awareness of different social groups – politicians, customers, suppliers. They have relatively low access to information, in which case measures can be introduced to increase awareness and exchange of experience, technologies, etc. In this way, the depth of understanding of the problem of soil health can be improved, which will lead to increased demand for soil restoration practices and, accordingly, to further increase the soil health of these farmers. Other support can be toward some easy access to financing, training, equipment, and education.

Cluster 3. Cereal Diversified Farms has an approximately even distribution of farms according to their economic size, with small farms slightly exceeding the number of middle and large sized farms. It consists mainly of cereal-based rotation as agriculture system. They have a highly positive social environment. They estimate soil health problems as low positive. Their knowledge and soil restoration practices are at a low positive level.

Cereal Diversified Farms comprised of 29.1% of the respondents. The average age of the farm managers is 49 years. The share of the young amongst them is 19.8%. Average size of the farms in Cluster 3 is 214.1 ha. The size is well diversified in that cluster – small farms are 40%, medium farms are 32% and large are 28% (Figure 10). Most farms are cereal-

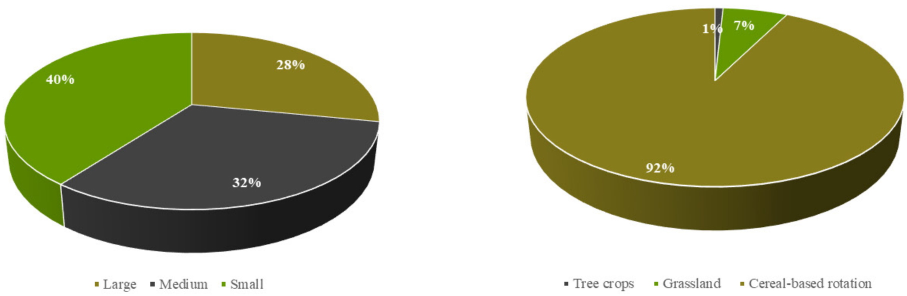


Fig. 10. Economic size of farms and cropping system in cluster 3
Source: Own calculations

based rotation – 92%, 7 % share of the grasslands and 1% are tree crops. Taking into consideration the gender, males represent 88.4% of farm managers and female – 11.6%.

The young managers in the small farms in cluster 3 are 18.8%., in medium farms – 28.2% and 17.6% in large farms (Figure 11).

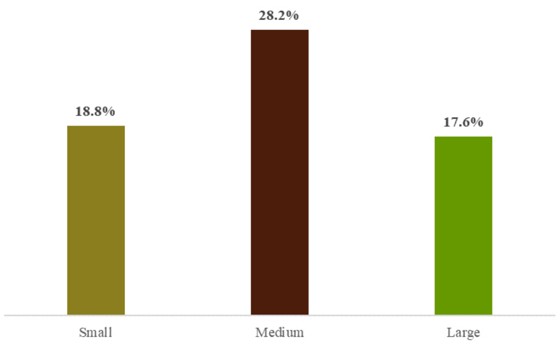


Fig. 11. Share of young farmers according to the farm size in cluster 3
Source: Own calculations

Conventional agriculture represents 74% share, while the biological and agroecological have 18% and 8%, respectively (Figure 12).

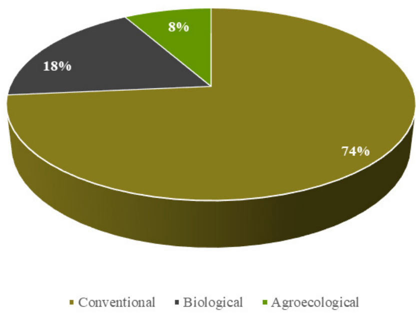


Fig. 12. Type of agriculture in cluster 3
Source: Own calculations

The largest share has farmers with secondary school – 35%, then are the farmers with university education – 28%, higher secondary education with 28% share, primary school have finished 7% and post-graduate are 4% of the farmers (Figure 13).

The farms in Cluster 3 grow mainly cereal-based rotation. The farms in this cluster have strongly positive soil environment, especially in its social aspects – society, consumers, farmers, and politicians have high positive com-

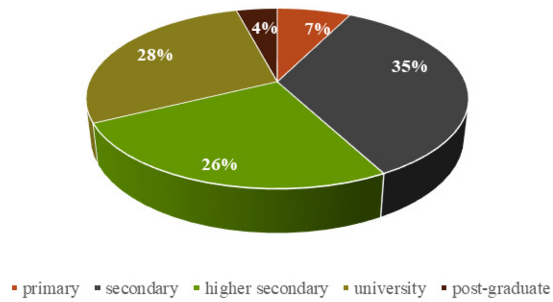


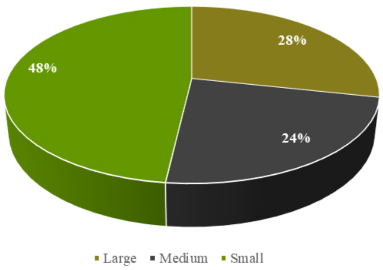
Fig. 13. Education level in cluster 3
Source: Own calculations

mitment and awareness about soil health problems. Technology implementation is also at a high level. The farmers estimate as slightly positive the soil health problems and they are slightly positive about the soil structure. They do not suffer a lot of water logging and surface and subsurface compaction. Soil erosion is controlled at a slightly positive level. The knowledge about soil problems is positive low level. Soil restoration is also slightly positive because they can find financing, get access to specific training and equipment for soil restoration practices.

Cereal Diversified Farms are cereal based rotation farms with different size and have high level of social awareness from different social groups, small positive soil health, and access to information sources and small positive level of soil restoration practices. Although the estimation of soil health is not bad (low positive), the level of soil health can be increased by raising awareness, exchanging information and technology, and promoting soil restoration practices (facilitated access to funding for small farms, training, equipment and raising the level of literature on the question).

Cluster 4. Tree Small Farms is composed of small farms growing mainly tree crops. Their soil health problems are medium. They have average access to knowledge, but do not apply soil restoration practices (medium negative). Their social environment is neither positive nor negative.

Tree Small Farms comprised of 19.5% of the respondents in the sample. The average age of the managers of the farms is 47.6 years. The young farmers amongst them are 27.2%. Average size of the farms in cluster 4 is 101.3 ha. The small farms prevail, representing 48% share, followed by the large with 28%, and medium with 24% (Figure 14). In terms of cropping system, most farms are tree crops – 83%, 17 % share are grasslands, and 0% are cereal-based rotation. The gender structure shows that males represent 87.7% of farm managers while females – 12.3%.



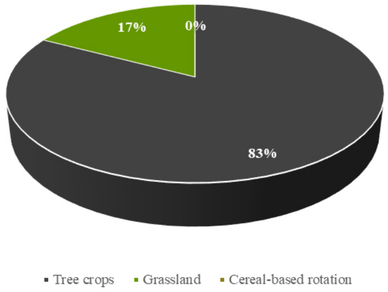


Fig. 14. Economic size of farms and cropping system in cluster 4
Source: Own calculations

In Cluster 4 the young managers in the small farms are 35.9%., in medium farms – 26.3% and 30.4% in large farms (Figure 15).

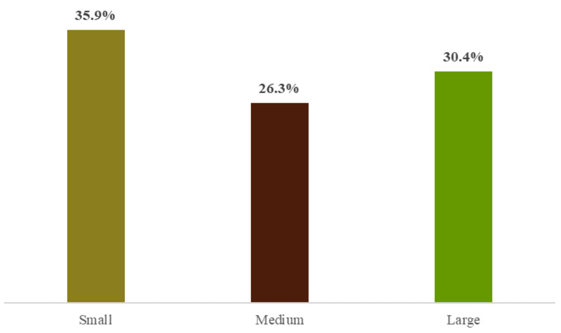


Fig. 15. Share of young farmers according to the farm size in cluster 4
Source: Own calculations

In terms of agriculture structure, Cluster 4 is not significantly different than the other (Figure 16). Farms with conventional agriculture are 70%, with biological – 19%, and with agroecological – 19%.

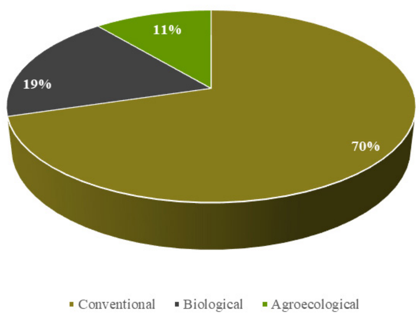


Fig. 16. Type of agriculture in cluster 4
Source: Own calculations

The structure of education in Cluster 4 is different from in the other clusters. The largest share has farmers with university education – 38%, then are the farmers with higher secondary education – 24%, secondary school with 22% share, primary school have finished 10% and post-graduate – 6% of the farmers (Figure 17).

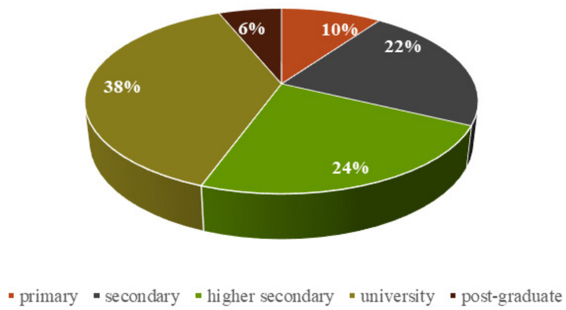


Fig. 17. Education level in cluster 4
Source: Own calculations

Soil environment estimation is neutral. These farmers do not find positive or negative interests in societies and consumers about their problems with the soil health. The level of farmers' awareness and knowledge about environmental issues is neutral too. There are some political supports but not significant. The tree crops in that cluster appears to have soil health problems on an average degree. They have problems with soil structure, waterlogging, soil erosion, etc. Despite soil health problems, the farmers in cluster 4 think that they have average soil knowledge. They can find literature about soil restoration from different sources. They also have medium good relations with local authorities. The farmers in cluster 4 suffer on average degree from the possibility to find financing about soil restoration practices. It is medium hard for them to get access to specific training and equipment for soil restoration practices.

The Tree Small Farms have neutral social environment, average soil health problems (but largest amongst the four clusters). They have average positive access to information sources and average negative soil restoration practices (again the lowest result in the four clusters). Although they have relatively good access to information sources, this does not seem to have a positive effect on soil condition and the implementation of soil restoration strategies. Soil health problems are strengthened by the inability to rotate crops. *Improving the condition of Tree Small Farms can go through improving communication with different social groups to raise awareness of society.* Additionally, because they are small, they need support to find funding for soil restoration practices, training, equipment and raising the level of literature on the issue.

Conclusion

It was applied a two-step methodology to define the farm typology. First, it was conducted a survey among partner project organizations in six countries. Second, it was constructed specific farm typology on socioeconomic characteristics, using statistical methods as PCA and CA. PCA identified the four main factors that are important: **Social environment, Soil health problems, Soil knowledge** and **Soil restoration**. The cluster analysis was fed by these four factors and two characteristics that are important for the study – economic size and cropping system. As a result, four clusters /farm types/ were formed, each of them with different characteristics and problems.

In the first cluster named **Intensive Large Farms** most of the farms are large, cereal-based ration. Because of the intensive land use, they have some soil health problems. They also experience average problems in term of social environment and knowledge. From other point of view, they put efforts in soil restoration, but these efforts can be more significant. Appropriate supporting measures for this cluster could be related with exchange of information, communicating their problems with different part of the society and soil restoring technology training.

The second cluster named **Grassland Small Farms** consists mainly of small grassland farms. They estimate their soil health skills as positive, but they experience problems in other fields like social environment and information sources. They have knowledge gaps in soil restoration practices, which can be targeted by some supporting policies. Farmers in this cluster can be supported in terms of increasing the awareness of different social groups – policy makers, customers, suppliers. Increased access to information, exchange of experience and technologies, can contribute to improvement of the soil health status of their farms. Other support measures can be toward to improve access to financing, training, and equipment.

The third cluster named **Cereal Diversified Farms** contains cereal-based rotation farms with different economic size. The farms in this cluster have high level of social awareness, positive soil health status (the soil health is positive but there is space for significant improvement here), positive access to information sources and positive level of soil restoration practices. Although most of all the factors are assessed positively. The level of soil health can be additionally increased by raising awareness, exchanging information and technology, and promoting soil restoration practices (facilitated access to funding for small farms, training, equipment and raising the level of information exchange on this issue).

The last cluster named **Tree Small Farms** has neutral social environment problem estimation, average soil health problems, average negative soil restoration practices, and relatively good access to information sources. The farmers have soil problems because of the specifics of the production. It is relatively harder for them to apply the soil restoration strategies that are accepted in other areas (like cereal-based rotation for example). Improving the condition of Tree Small Farms can go through improving communication with different social groups, support to find funding for soil restoration practices, training, equipment and raising the level of access to information on the issue.

Developing such farm typology, it was finished an essential step in any realistic evaluation of constraints and opportunities that farmers face with soil health problems. In addition, based on the defined farm typology could be developed appropriate technological solutions, policy interventions, and comprehensive environmental assessment.

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