https://doi.org/10.61308/LSPX6383

Analysis of the socio-economic parameters of farms applying soil restoration strategies in Bulgaria and Austria

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Citation: Nikolov, D., Boevsky, I., Banov, M., Tzvetanova, E., Kostenarov, Kr., Carl Liebhard, G., Strauss, P. (2024). Analysis of the socio-economic parameters of farms applying soil restoration strategies in Bulgaria and Austria. *Bulgarian Journal of Agricultural Economics and Management,* 69(1), 46-57.

Abstract: This article presents the assessment of the degree of influence of socio-economic parameters of farms applying soil restoration strategies over the supply chain cooperation, public-private partnerships, and landscape alliances in Austria and Bulgaria. The aim of the assessment is to highlight new socio-economic opportunities, which can be a target for the public policies. The study is based on the pilot farms analysis of the TUdi[1] project survey results. The analysis of the socio-economic parameters is made with an Analytical Hierarchical Process (AHP). The results are analyzed on both county and soil restoration strategy base.

The analysis shows that Fertilization strategies have impact on supply chain cooperation. The goal aims to involve all suppliers and the most important socio-economic opportunities are certainty of demand, access to finance, and uncertainty of income. In terms of fertilization and remediation strategies, the analysis shows that the most important socio-economic opportunities are related to certainty of demand and access to finance. On the other hand, the implementation of Remediation strategy requires higher consensus in the local society and more activities, which explains the stronger interaction of this criteria with the goals public-private partnership and landscape alliances. In this case, the most important socio-economic opportunities are certainty of demand, access to finance, political support, and training and equipment.

Keywords: Soil restoration strategies; socio-economic parameters; farms; Bulgaria; Austria

[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.*

1. INTRODUCTION

The aspiration to balance agricultural productivity with environmental stewardship has catalyzed a surge of interest in sustainable soil management practices worldwide. Agricultural sustainability and the preservation of soil health are paramount in the face of increasing global demands for food security and environmental conservation.

Soil restoration strategies have emerged as crucial tools in mitigating soil degradation, enhancing agricultural productivity, and fostering long-term environmental sustainability (Lehmann, J., Kleber, M., 2015). In relation to this, the vision of EU Soil Strategy for 2030, developed by

the European Commission (2021a), focuses on the protection, sustainable use and restoration of soil to become the norm. The European Commission (2021b) states that healthy soils are a key enabler to achieve the objectives of the European Green Deal such as climate neutrality, biodiversity restoration, zero pollution, sustainable food systems and a resilient environment. Among these, soil restoration strategies have gained prominence as potent tools to regenerate degraded soils, enhance agricultural resilience, and mitigate environmental impacts (Lal, R., Horn, R., Kosaki, T. (Eds.), 2018).

While previous research has underscored the efficiency, effectiveness and adoption of soil restoration strategies in enhancing soil health and mitigating environmental degradation (Blanco-Canqui, H., Lal, R., 2009), there remains a dearth of comprehensive analyses examining the socio-economic determinants that influence the uptake and success of these practices in specific regional contexts. The efficiency, effectiveness and adoption of these strategies, however, are intricately intertwined with a constellation of socio-economic factors, ranging from access to capital and technological resources to policy support and market dynamics (ECA, 2019; Eurostat, 2020). Understanding the socio-economic dimensions that influence the adoption and effectiveness of these strategies is imperative for designing targeted policies and interventions.

As the United Nations' Sustainable Development Goals underscore the importance of responsible land use and sustainable agriculture, a growing number of farmers across the globe are seeking innovative strategies to enhance soil health and productivity. Therefore, Bulgaria and Austria, situated in the heart of Europe, are good examples that provide intriguing inside information due to their divergent agricultural landscapes, socio-economic conditions, and historical legacies.

Bulgaria, characterized by a predominantly smallholder agricultural system, faces unique challenges in terms of land consolidation and access to resources (Yotova et al., 2023). Conversely, Austria exhibits a more consolidated agricultural sector with a long history of sustainable land management practices.

The aim of our study is to try to fill these gaps assessing and highlighting the new socio-economic opportunities, which can be a target for the public policies. It presents the assessment of the degree of influence of socio-economic parameters of farms applying soil restoration strategies over the supply chain cooperation, public-private partnerships, and landscape alliances in Austria and Bulgaria. The study is conducted on the pilot farms analysis of the TUdi project survey results. By juxtaposing these contrasting contexts, this study endeavors to elucidate the nuanced factors that shape the adoption and success of soil restoration strategies in diverse socio-economic environments. The analysis is made with an Analytical Hierarchical Process. By employing this advanced technique, we aim to disentangle the complex relationships between the socio-economic parameters and the implementation of soil restoration strategies. The results are analyzed on both county and soil restoration strategy base.

After the introduction, we present the methodology and source of data, the analysis of the socio-economic parameters according to the TUdi farm typology, the general results and these of the socio-economic parameters for Austria and Bulgaria as well as the results' discussion. We conclude that there is room for development and increase of soil health awareness using tools such as supply chain cooperation, alliances, or public-private partnerships. It could be invested more in technologies and soil health information sources which could be implemented into day-to-day operational activities. In the long term, these activities' adoption could optimize production costs.

2. METHODOLOGY AND SOURCE OF DATA

For the analysis of the possibilities of the socio-economic parameters (SEP), a two-stage process was used. In the first stage, the SEP were identified using a survey in Austria and Bulgaria.

In the second stage, the new opportunities were defined with AHP.

In the first stage, the SEP included in Q30 (TUdi survey) were used. The SEP are divided in two groups: (i) the first group includes the SEP, which create "Strength", (ii) and the second group contains the SEP, which create "Opportunities". The first group contains relatively well-performing socio-economic parameters (estimated above the average by the farmers). The second group consists of the SEP that need improvement (estimated under the average by the farmers), and they can give the new socio-economic opportunities. Table 1 presents full and short name (for convenience) of the nine SEP.

The estimation of socio-economic parameters in TUdi survey is done by farmers in a five-degree scale (one to five). The accepted threshold to define SEP that need to be improved is the average of the estimations. The SEP, which are below the average value of all parameters (2.48), are the following: Access to financing, Training and equipment, Political support, Uncertainty of income, and Supply chain and demand. These parameters need to be improved, and they could offer a new socio-economic opportunity.

In the second stage, the Analytic Hierarchy Process (AHP) is applied to estimate the importance of the five socio-economic parameters that have been defined as weak.

The creation of new socio-economic opportunities by implementing soil restoration strategies are connected to reach several specific goals as follows:

- ✓ supply chain cooperation;
- ✓ public-private partnerships;
- ✓ landscape alliances.

For the purpose of the analysis, these goals are defined as follows:

Supply chain cooperation – Aligning the activities of two or more organizations/actors in the supply chain to coordinate the supply of goods or services from supplier to end-users, creating an advantage for the members.

Public-private partnerships – Public-private partnerships involve cooperation between a government/public agency and a private-sector company that can be used to finance, build, and operate projects/activities.

Landscape alliances – Agreements between stakeholders to reach objectives of a common landscape interest. The alliance members remain independent and are often in competition.

Three AHP models were constructed based on the defined goals described above. They differ in their goal, but the criteria and the alternatives are the same. The accepted criteria for estimation are the soil fertilization and remediation strategies. The alternatives are the five socio-economic parameters that have been chosen in stage one.

Table 1. Q30 socio-economic parameters and their short name

Parameters Full name	Parameters Short name
1. Access to financing for soil restoration practices	Access to financing
2. The level of specific training and equipment for soil restoration practices	Training and equipment
3. The level of unified terminology regarding soil quality	Terminology development
4. The level of society's and consumers' interest and demand for environmentally friendly products (Society involvement)	Society involvement
5. The level of farmers' awareness and knowledge level of environmental issues	Farmers involvement and knowledge
6. The level of political will to support delivery of environmental goods and services by farmers	Political support
7. The level of farmers' uncertainty of income	Uncertainty of income
8. The level of secure supply chain and certainty of demand for farm products	Supply chain and demand
9. The level of implementation of technology (experience, attitude, access)	Implementation of technology

Source: Own table.

The criteria and alternatives of the models are as follows:

Criteria:

Fertilization strategy;

Remediation strategy.

Alternatives:

✓ Access to financing/loans;

✓ Training and equipment/precise farming;

✓ Political support/subsidies;

✓ Uncertainty of income/cost reduction;

✓ Certainty of demand/farmer-market linkages.

The first AHP model estimates the degree of influence/importance of socio-economic parameters (alternatives) over the "supply chain cooperation" (goal) after application of soil restoration/ remediation strategies (criteria).

The second AHP model evaluates the degree of influence/importance of socio-economic parameters (alternatives) over the "public-private partnerships" (goal) after application of soil restoration/ remediation strategies (criteria).

The third AHP model aims to estimate the degree of influence/importance of socio-economic parameters (alternatives) over the "landscape alliances" (goal) after application soil restoration/ remediation strategies (criteria).

Pilot Farm determination

The analytical process involves an interview conducted with the farmers/managers of the pilot farms. The process was divided into two steps: (i) in the first step, in Austria and Bulgaria the potential Pilot Farms were identified; (ii) in Austria and Bulgaria was made an interview based on the AHP questionnaire.

By identifying the appropriate Pilot Farm, the TUdi farm typology had been taken into consideration. The Farm typology construction is based on six factors:

1. The first factor is the Economic size of the farm. For the purpose of the study, the farms are divided according to their economic size into 3 groups: small (2000 – 25000 EUR), medium (25000 – 100 000 EUR) and large (over 100 000 EUR).

2. The second factor is the Cropping systems – according to the cropping system factor in the study tree crops, grassland, and cereal-based rotation are included.

3. The third factor is Social environment – it describes 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.

4. The fourth factor is Soil health problems – It includes identified soil health problems in the respondents' farms soil structure (aggregate stability) like soil waterlogging, surface compaction, subsurface compaction, soil erosion.

5. The fifth factor is Soil knowledge, and it is related to knowledge sources for soil health analysis and its usage in farm management.

6. The sixth 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.

The Pilot Farms were classified based on four TUdi farm types shown in Table 2. The main characteristics are described below each Farm Type. The estimation of the Pilot Farms characteristics is made on a scale from one to six.

In Austria were fulfilled 3 valid questionnaires and in Bulgaria 4 valid questionnaires from pilot farms.

3. Analysis of the socio-economic parameters according to the TUdi farm typology

For the TUdi project, a specific farm typology on socio-economic characteristics was constructed. Four main factors were identified: Social environment, Soil health problems, Soil knowledge and Soil restoration. These four factors and two important for the TUdi project characteristics (economic size and cropping system) were taken into consideration. As a result, four clusters /farm

Table 2. The four farm types/clusters and their main characteristics

Cluster 1: Intensive Large Farms	Cluster 2: Grassland Small Farms	Cluster 3: Cereal Diversified Farms	Cluster 4: Tree Small Farms
Large farms	Small farms	Medium size farms	Small farms
Cereal-based rotation	Grassland systems	Cereal-based rotation	Tree crops system
Soil problems – average (1, 2, 3)*	No soil problems (4, 5, 6)*	Very little or no soil problems (3, 4 ,5, 6)*	Soil problems – average (1, 2, 3, 4)*
Soil restoration – There are SR (3, 4, 5, 6)*	Soil restoration – low level (1, 2, 3, 4)*	Soil restoration – There are SR (4, 5, 6)*	Soil restoration – insignificant (1, 2, 3, 4)*
Social environment – average negative (1, 2, 3, 4)*	Social environment – average negative (1, 2, 3, 4)*	Social environment – strongly positive (3, 4, 5, 6)*	Social environment – neutral (2, 3, 4)*
Soil knowledge – low negative (1, 2, 3, 4)*	Soil knowledge – low negative (1, 2, 3 or 4)*	Soil knowledge – low positive (3, 4, 5, 6)*	Soil knowledge – large positive (3, 4, 5, 6)*

Source: Own table.

types/ were formed, each of them with different characteristics and problems.

In the first type 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 type 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 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 type 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 estimated 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 type 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 in Cluster 4 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.

4. General Results

From the PCA data, conclusions can be drawn regarding the assessment of the degree of influ-

ence of socio-economic parameters over the *supply chain cooperation, public-private partnerships, and landscape alliances*. The aim of the assessment is to highlight new socio-economic opportunities in each TUdi farm type, which can be a target for tailor-made public policies.

Intensive Large Farms

The data about Intensive Large Farms is presented on Figure 1. Certainty of demand is the most influential parameter for all goals with 31.3%, 32.7% and 34.5% respectively for supply chain cooperation, public-private partnerships, and landscape alliances. Access to financing and training and equipment are on second place in terms of influence with a slight difference between them in all three specific goals (a little over 20%). The third and the group with the lowest influence (11 – 12%) are the parameters political support and uncertainty of income.

Grassland Small Farms

Grassland Small Farms are visualized on Figure 2. For the supply chain cooperation, the most influential parameters with 30.3% and 30.6% are access to financing and certainty of demand. Access to financing is the most influential parameter for the other two goals with 31.1% and 31.4% and

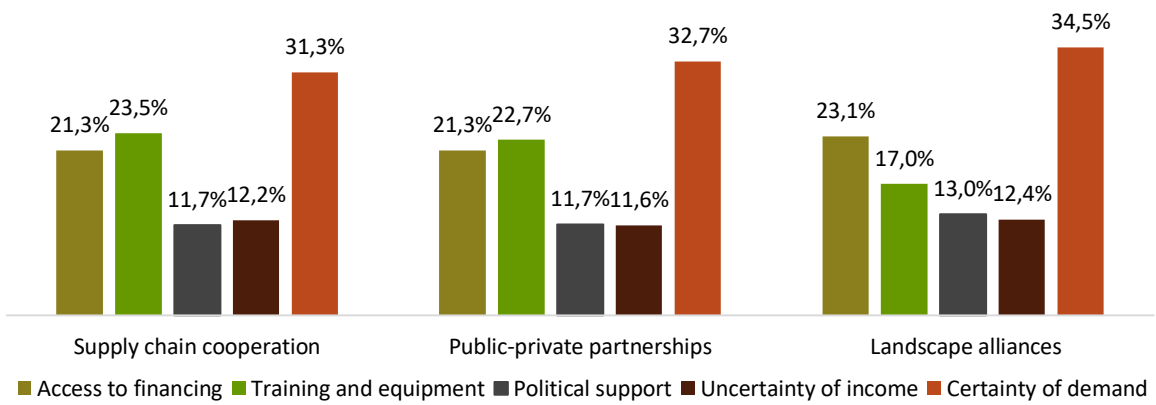

Fig. 1. The socio-economic parameters rating for the three AHP goals for Intensive Large Farms
Source: Own figure.

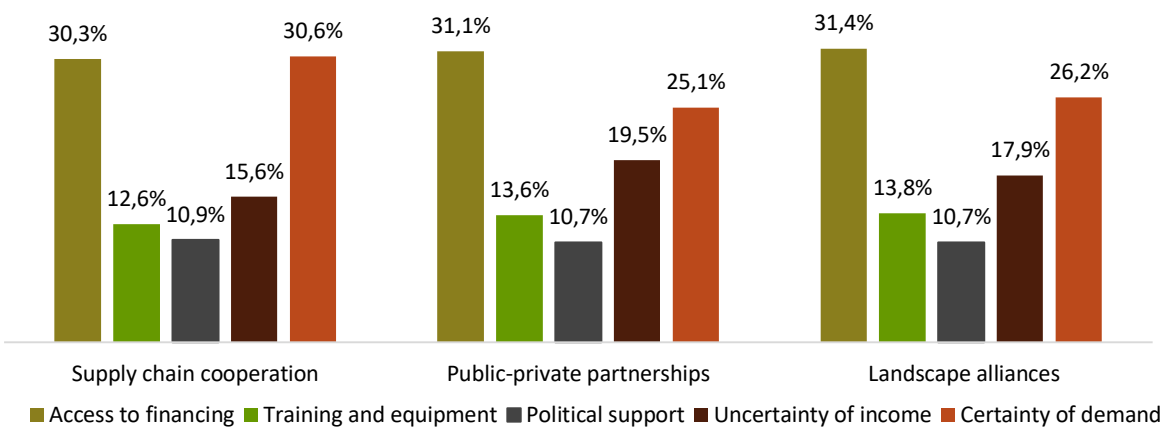

Fig. 2. The socio-economic parameters rating for the three AHP goals for Grassland Small Farms
Source: Own figure.

certainty of demand is also influential although its share is slightly below the parameter access to financing. Uncertainty of income is the third parameter according to the influence with respective 15.6%, 19.5% and 17.9% for supply chain cooperation, public-private partnerships, and landscape alliances. Training, equipment and political support are the group with less influence over the three goals.

Cereal Diversified Farms

Cereal Diversified Farms results are presented in Figure 3. In this farm type, socio-economic parameters have a relatively equal influence. The supply chain cooperation is mostly influenced by certainty of demand with 28.8%, second is uncertainty of income with 23.4%. The last three alternatives access to financing, training and equipment, and political support are grouped together with influence respectively 17.0%, 14.5% and 16.3%. In public-private partnerships, political support and access to financing have the greatest influence. The other parameters have emerged as a group that has an influence from 15.3% to 18.4%. The goal landscape alliances is most influenced by the parameters access to finance, political support, and certainty of demand with 24.2%, 24.4%, and 23.9%, respectively. The

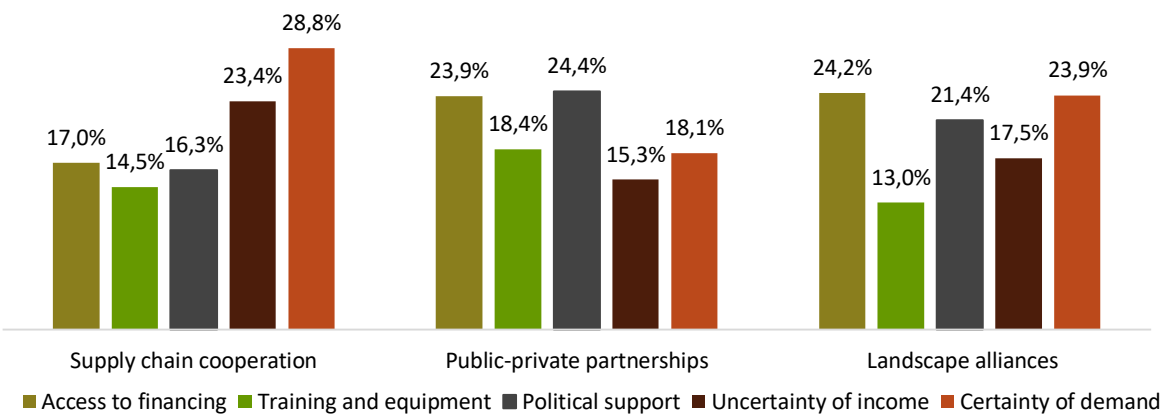

Fig. 3. The socio-economic parameters rating for the three AHP goals for Cereal Diversified Farms

Source: Own figure.

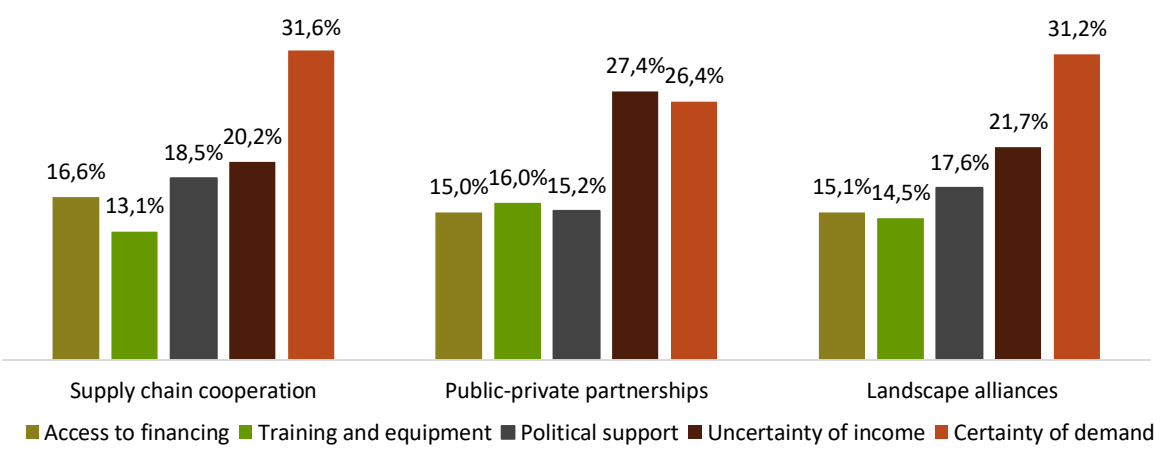

Fig. 4. The socio-economic parameters rating for the three AHP goals for Tree Small Farms

Source: Own figure.

remaining two alternatives training, equipment, and uncertainty of income form the group of parameters with low influence.

Tree Small Farms

Tree Small Farms are introduced in Figure 4. Certainty of demand is the parameter with highest influence on goals supply chain cooperation and landscape alliances with 31.6% and 31.2%. Public-private partnerships is the goal that is influenced by uncertainty of income and certainty of demand with 27.4% and 26.4%, respectively. Access to financing, training and equipment, and political support create the group with a lower level of influence for all three objectives.

4.1. Results of the socio-economic parameters for Austria and Bulgaria

This section presents results from the perspective of both countries, which provide answers of the AHP questionnaire.

• *Austria*

The Pilot Farms in Austria are three in the following farm types: Intensive Large Farms, Grassland Small Farms, and Cereal Diversified Farms.

In terms of supply chain cooperation goal, Austrian Intensive Large Farms are mostly influenced by access to financing and training and equipment (Figure 5). The medium influence has political support with 20.1%. The less impact brings uncertainty of income (14.4%) followed by certainty of demand with 16.8%. The public-private partnership goal is strongly affected by the access of financing with 30.0% followed by the political support and certainty of demand with 19.4% and 18.0%, respectively. The less impact is evaluated for the alternatives training and equipment and uncertainty of income with 17.3% and 15.3%. Landscape alliances goal is significantly affected by the training and equipment with 29.3%. The medium impact on this goal comes from political support and access to financing with about 20.0%. In addition, the lowest impact has uncertainty of income with 13.9% followed by certainty of demand (15.5%).

Austrian Grassland Small Farms are impacted slightly different than the previous farm type (Figure 6). The supply chain cooperation and landscape alliances goals are most affected by access to finance with 33.8% and 27.4%, respectively, followed by training and equipment (21.6% and 24.1%). In public-private partnership, training and equipment alternative is on top with 25.7% and followed by access to finance with 23.1%. Political support has medium impact on all goals, reaching about 20.0%. Both Uncertainty of income and certainty of demand alternatives forms the group of parameters with weakest effect to all goals.

Cereal Diversified Farms in Austria are influenced by the training and equipment (31.7% and 27.8%) for the goals public-private partnership and landscape alliances (Figure 7). About 21% is the impact of the access to financing, followed by certainty of demand with 17.8% and 19.7%, respectively. Medium effect has political support contributing about 17.0%. Lowest contribution

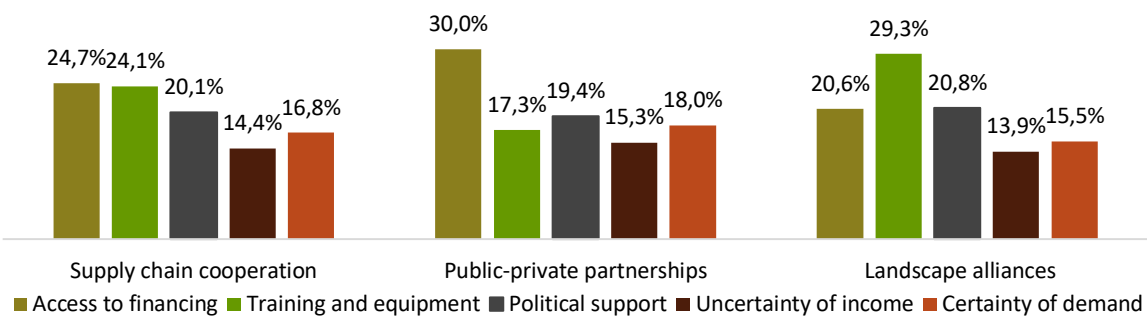

Fig. 5. The socio-economic parameters rating for the three AHP goals for Intensive Large Farms, Austria
Source: Own figure.

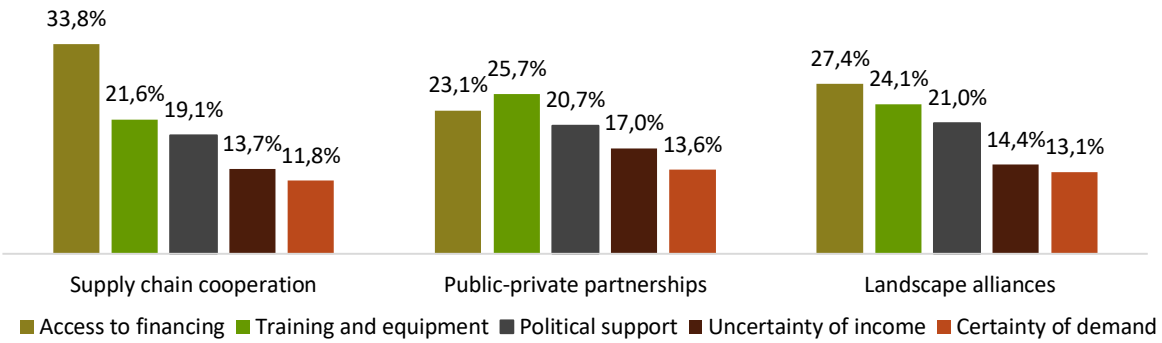

Fig. 6. The socio-economic parameters rating for the three AHP goals for Grassland Small Farms, Austria
Source: Own figure.

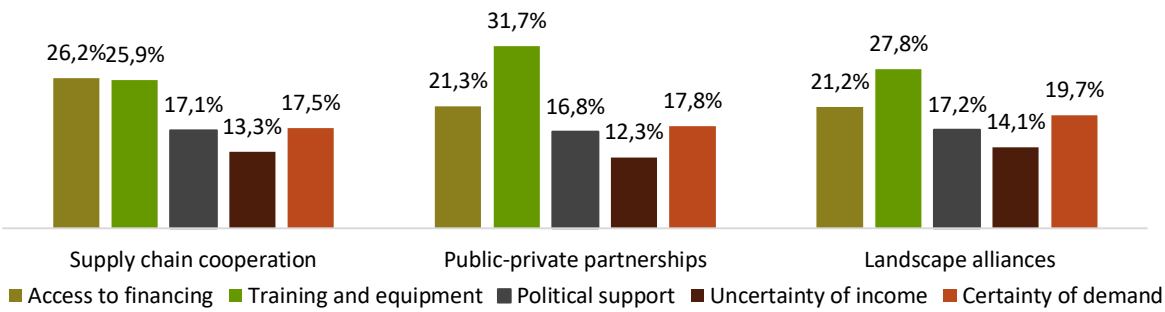

Fig. 7. The socio-economic parameters rating for the three AHP goals for Cereal Diversified Farms, Austria
Source: Own figure.

comes from the alternative uncertainty of income with 12.3% and 14.1%. The goal supply chain cooperation is affected mostly by access to financing and training and equipment with 26.2% and 25.9%, respectively. The group of alternatives with medium impact is formed by certainty of demand and political support with about 17.0%. Like the other goals, uncertainty of income has the lowest impact.

• *Bulgaria*

Bulgaria contributes to the analysis with a Pilot Farms in each Farm Type – Intensive Large Farms, Grassland Small Farms, Cereal Diversified Farms, and Tree Farms. There are significant differences between the farm types.

Analyzing the Intensive Large Farms in terms of both public-private partnership and landscape alliances, the most significant alternative is certainty of demand with 45.7% and 51.6% (Figure 8). It is followed by access to financing and training and equipment with about 20% contribution. Political support and uncertainty of income have the weakest impact on both goals with figures below 10%. In terms of supply chain cooperation goal, training and equipment is the most important alternative with 41.2%, followed by certainty of demand with 28.3%. Access to financing effect is evaluated with 22.2%. Political support and uncertainty of income hasn't got an impact on this goal, reporting effect below 5.0%.

The alternatives' rating for the Grassland Small Farms in Bulgaria is similar for all goals (Figure 9). The most significant impact has the alternative access to financing, followed by certainty of demand. Impact about 10% and below has uncertainty of income, training and equipment, and political support.

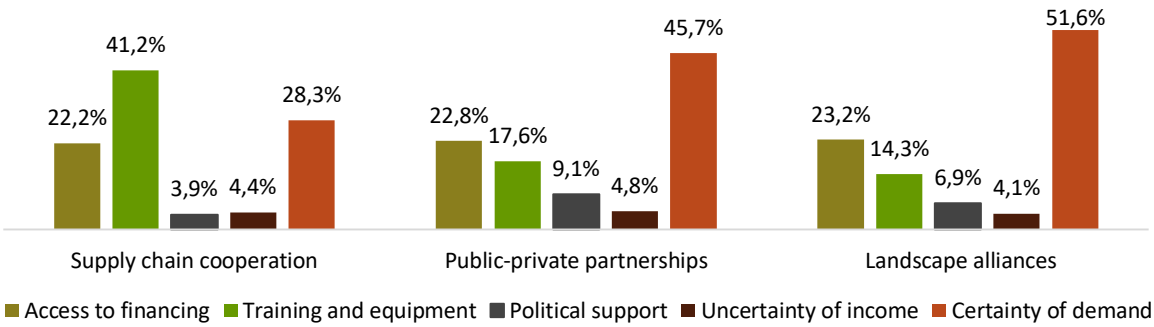

Fig. 8. The socio-economic parameters rating for the three AHP goals for Intensive Large Farms, Bulgaria
Source: Own figure.

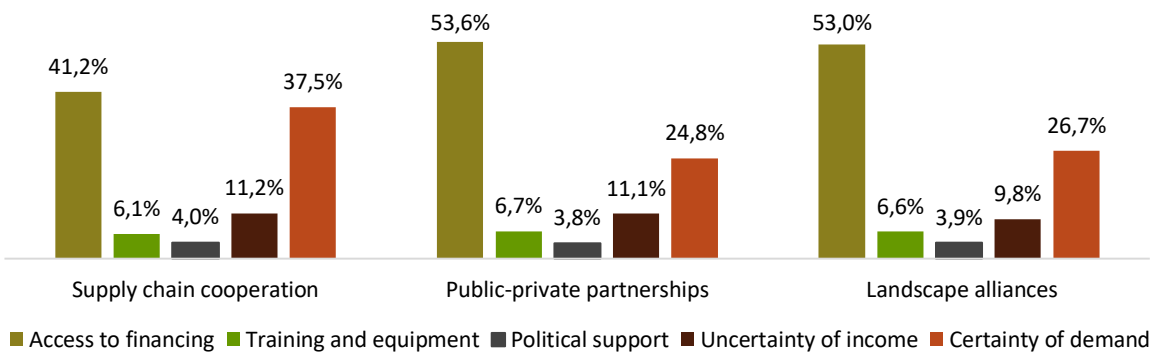

Fig. 9. The socio-economic parameters rating for the three AHP goals for Grassland Small Farms, Bulgaria
Source: Own figure.

Cereal Diversified Farms have different alternatives with high impact, depending on the goal (Figure 10). For supply chain cooperation the most important alternative is certainty of demand with 30.4%, followed by uncertainty of income (22.3%). Medium impact has access to financing and political support with 18.7% and 16.8%, respectively. The less contribution has training and equipment with 11.8%. Analyzing the public-private partnership, the most significant impact has access to financing with 32.2% and training and equipment with 27.8%. Medium impact has political support and uncertainty of income, followed by the lowest influence of the certainty of demand alternative. The alternative influence on landscape alliances goal is close to the supply chain cooperation ones. The difference is that the highest impact comes from access to financing (25.0%), followed by certainty of demand with 24.1% and uncertainty of income – 21.1%. In the medium impact group also falls the political support. The lowest contribution has training and equipment with 9.7%.

Clearly, certainty of demand has the highest impact on all goals for the Tree Small Farms (Figure 11). In supply chain cooperation medium impact have access to financing and political support. On the other hand, less than 10% is the contribution of the training and equipment and uncertainty of income. Public-private partnerships goal depends on the uncertainty of income (25.7%) and access to financing as well (16.4%). For this goal below 6% contribution remain both training and equipment and political support. Landscape alliances goal is affected by the access to financing with 29.2% and uncertainty of income with 13.3%. The lowest contribution has

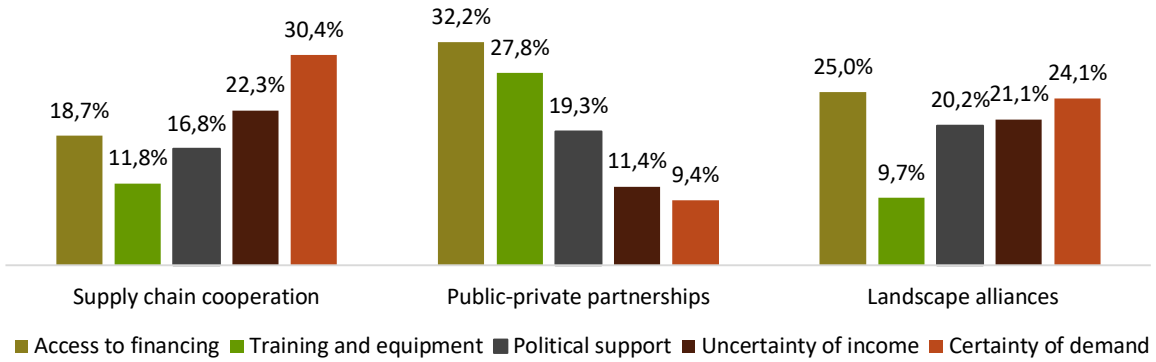

Fig. 10. The socio-economic parameters rating for the three AHP goals for Cereal Diversified Farms, Bulgaria
Source: Own figure.

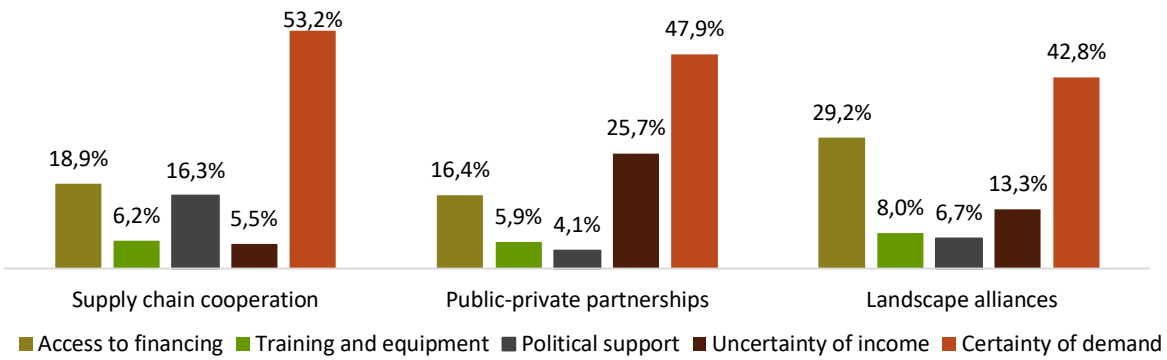

Fig. 11. The socio-economic parameters rating for the three AHP goals for Tree Small Farms, Bulgaria
Source: Own figure.

the alternatives training, equipment, and political support with 8.0% and 6.7%.

5. DISCUSSION AND CONCLUSIONS

Austria's goals are affected mainly by the alternatives access to financing and training and equipment. These SEPs are crucial for the effective and efficient development of the farms. Even if all alternatives are important, affecting with more than 10.0%, the weakest SEPs are *uncertainty of income* and *certainty of demand*.

Bulgaria generally repeats the structure of the influence of the socio-economic parameters made in the typology analysis. *Certainty of demand* and *access to financing* are one of the most important alternatives. Less impact has *technology, equipment,* and *uncertainty of income.*

Intensive Large Farms are experiencing uncertainty about selling their production, which determines the relative importance of socio-economic opportunities in this area. Due to the nature of production (high volumes, machine treatment, need for financing and purchase of heavy machinery) on this type of farm, financing, training, and equipment are grouped together.

Grassland Small Farms have a need for financing and certainty in the marketing of production. While training and equipment, political support and uncertainty of income seem to be secondary to their needs.

Since the farms in **Cereal Diversified Farms** are diversified, the influence of socio-econom-

ic parameters is relatively aligned. In terms of supply chain cooperation, there is a slightly increased influence from certainty of demand. Otherwise, it is difficult to speak of a distinct superiority of one socio-economic parameter over the others. That is, Cereal Diversified Farms would be influenced by a wide variety of new socioeconomic opportunities that may be provided by policymakers.

What is noticeable about **Tree Small Farms** is that access to financing is no longer a leading parameter. For this type of farm, a stable level of demand is key, along with income security. This is to some extent determined by the nature of production, which does not require heavy cultivation of the land, hence does not involve the purchase of expensive machinery. From this point of view, the parameter with the greatest influence is security of demand, which is mainly where the new socio-economic opportunities must be sought.

Acknowledgements

The study was developed with the financial help of the European Union's Horizon 2020 Research and Innovation action under the project "Transforming Unsustainable management of soils in key agricultural systems in EU and China. Developing an integrated platform of alternatives to reverse soil degradation" – TUdi with grant agreement No 101000224.

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Постъпила – **1 ноември 2023 г.**, *Одобрена* – **6 декември 2023 г.**; *Публикувана* - **март 2024 г.**