Bulgarian Journal of Agricultural Science, 30 (No 1) 2024, 170–180

Key agroforestry systems in temperate climate and standardization: evidence from Bulgaria case

Ivan Bozhikin[1] and Elka Vasileva[2*]

[1] *University of National and World Economy (UNWE), Department of Economics, 1700 Sofia, Bulgaria*
[2] *University of National and World Economy (UNWE), Department of Economics of Natural Resources, 1700 Sofia, Bulgaria*
[*]*Corresponding author:* elkav@unwe.bg

Abstract

Bozhikin, I. & Vasileva, E. (2024). Key agroforestry systems in temperate climate and standardization: evidence from Bulgaria case. *Bulg. J. Agric. Sci., 30*(1), 170–180

The standardization of agroforestry systems, processes and products can support and strengthen their transformational potential for implementing sustainable agriculture. However, scientific research in this area is quite limited. Therefore, our study aims to identify the key agroforestry systems in the temperate climate of Bulgaria and to reveal the leading Voluntary Sustainable Standards and Systems (VSSS) in support of their better development. To achieve the set research aim, we use a "case study" approach combined with a review of the Voluntary Sustainable Standards and Systems in Europe. Moreover, the 187 private and public Sustainability Standards and Systems covered by the ITC Standards Map for Europe to assess the degree of association between VSSS and the above types of agroforestry systems have been analyzed. The four identified VSSS groups, although directed at agricultural areas such as Agriculture, Livestock and Forestry, do not prohibit explicitly the use of agroforestry practices. Furthermore, the connection between the discovered VSSS and the studied agroforestry systems in Bulgaria is analyzed. The study has shown scarcity of standards that view agroforestry as an overall sustainable agricultural system.

Keywords: agroforestry; standardization; agroforestry standards; Bulgaria

Introduction

Population growth is exerting increasing pressure on achieving sustainable agriculture that provides the necessary agricultural production, without deforestation, environmental pollution and reduced soil fertility. One of the leading approaches to achieving sustainable agriculture is agroforestry. Burgess & Rosati (2018) consider agroforestry as "the practice of deliberately integrating woody vegetation (trees or shrubs) with crop and/or animal systems to benefit from the resulting ecological and economic interactions". By integrating different production actions, agroforestry systems allow the diversification of economic activities on property, increasing profitability per unit of area, and minimizing the risks of income losses caused by weather events or even adverse market conditions (Costa et al., 2018; FAO, 2017; EIP-AGRI 2017).

On the European map, Bulgaria is among the countries with the largest scope (in absolute values) of agroforestry systems (den Herder et al., 2017). The southern and central regions of the country with a temperate climate are included in the established clusters with the largest abundance of agroforestry systems in Europe, along with central Romania and central and northern Greece. In Bulgaria, agroforestry has its traditions, distinctive features and peculiarities (Kachova et al., 2018; Stancheva et al., 2007). Specific ecological and climatic conditions, characteristics of the local economy and regional traditions influence the types of agroforestry systems (Bhardwaj, 2017). The limited research of the agro-ecological systems, adapted to the temperate climate of Bulgaria, confirms the great potential of the modern

agroforestry for implementing sustainable agriculture in the country (Stancheva et al., 2007).

At the same time, the standardization and certification of agroforestry systems (AFS) and products will facilitate and strengthen their transformational potential to implement sustainable agriculture (Plieninger et al., 2020). The small number of studies on this topic, mainly in North America, gives us reason to say that there are no developed standards with measurable criteria for agroforestry in temperate locations (Craig et al., 2018). On the other hand, Voluntary Sustainable Standards and Systems (VSSS) have a promising potential for supporting sustainable development, its three main pillars (social, environmental, and economic), and agroforestry (UNFSS, 2013). VSSS are widely applied in international trade to make global markets and supply chains more sustainable and relevant to sustainable development strategies (Dias et al., 2015; Millard, 2011). Flinzberger et al. (2020) emphasize that the potential of AFS labeling in support of the UN Sustainable Development Agenda has not yet been explored in depth (Flinzberger et al., 2020).

This study focuses on agroforestry systems in temperate climate and standardization. The latter is an essential factor for expanding the territories with agroforestry systems and improving their eco-efficiency and production performance. However, the research in the field of agroforestry standardization is very limited as mentioned above (Craig et al., 2018; Flinzberger et al., 2020). Hence, our study aims to contribute to these research gaps. The study aims to identify the key agroforestry systems in temperate climate of Bulgaria and to reveal the leading VSSS in support of their better development. Based on this research goal, the following three research questions are formulated:

Q1. What are the most applicable agroforestry systems in Bulgaria as a country with a temperate climate?

Q2. What are the main groups of VSSS suitable for agroforestry systems in Bulgaria?

Q3. Can (and how) standardization and VSSS help for development of agroforestry systems in the context of global markets and supply chains?

To achieve the set research aim, we use a "case study" approach combined with a review of the VSSS in Europe, i.e., we applied a mixed method.

Methodology

Case study approach

The case study method was chosen to study even in its natural environment (Yin, 2014). The study is carried out in Bulgaria as a country with i) a temperate climate (Herder et al., 2017), ii) and the largest scope (in absolute terms) of agroforestry systems among the EU countries (den Herder et al., 2017). The country is situated in Southeast Europe and occupies the eastern quarter of the Balkan Peninsula. In Bulgaria, agroforestry has its own tradi-

Figure 1. The locations of the organizations in the study are marked with a blue star on the map

Source: Ezilon.com. The locations of the organizations in our study are marked with a blue star on the map (✦)

Table 1. Interviewees and organizations from the case study

Interviewee	Position in organization	Organization	Information for organization	A land area with agroforestry
INT 1	Farmer/Owner	ORG 1	The main business of the organization is the cultivation of crops with paulownia.	100 hectares (Paulownia with different crops)
INT 2	Farmer/Owner	ORG 2	This organization gives consultancy and design services in the area of interior and exterior landscaping. The firm owns a garden center situated in Sofia and a nursery in Septemvri.	200 hectares (The assortment of ornamental plants is very rich – more than 150,000 plants of over 200 species)
INT 3	Farmer/Owner	ORG 3	The enterprise is engaged in truffle cultivation.	5 hectares (Agroforestry and truffles cultivation)
INT 4	Farmer/Owner	ORG 4	The main operation of the firm is the distribution of agricultural products, offering saplings and seedlings of fast-growing trees of the species Paulownia elongate and Paulownia tomentosa, auxiliary materials for agriculture, preparations for bio-agriculture.	700 hectares with organic farming and 10 hectares (Paulownia with different crops)
INT 5	Farmer/Owner	ORG 5	The organization is engaged in the cultivation of Bulgarian oil roses with different crops/lavender.	6 hectares (Bulgarian oil roses with different crops)
INT 6.1 INT 6.2 INT 6.3	1. Chief of Department "Resumption of Forests" 2. Chief Expert "Conservation of Forest Areas" 3. Expert in Agroforestry	ORG 6	The organization runs the state forest territories (near 934 968 ha) in seven administrative districts – Sofia District, Pazardzhik, Pernik, Blagoevgrad, Lovech, Sofia City, and Kyustendil. The company unites 36 state forestry holdings, five state hunting farms, and 67 forest nurseries.	4 hectares with trees and strawberries; many additional acres with trees combined with berries, beehives, herbs, and mushrooms
INT 7.1 INT 7.2	1. Expert in agroforestry; 2. Chief of Department "Resumption of Forests"	ORG 7	The firm runs the state forest territories (near 860 572 ha) in four administrative districts – Smolyanska, Plovdivska, Pazardzhik, Kardjaliiska. The planting material is produced in 37 forest nurseries.	many hectares with trees combined with berries, herbs, fruits, forest crops (i.e., walnut), beehives, and mushrooms
INT 8	Expert in Agroforestry	ORG 8	The organization runs the state forest territories (near 287 892 ha) in four administrative districts –Varna, Dobrich, Shumen, and Targovishte. The company has nine forest nurseries.	many hectares with trees combined with forest crops (walnut, melons, etc.), fruits, mushrooms and herbs
INT 9	Expert in Agroforestry	ORG 9	The organization runs the state forest territories in five administrative districts –Veliko Tarnovo, Rousse, Silistra, Gabrovo, and Razgrad. The company unites 13 state forestry holdings and four state hunting farms.	many hectares with trees combined with forest crops (walnut, etc.), herbs and mushrooms
INT 10	Expert in Agroforestry	ORG 10	The organization runs the state forest territories in five administrative districts –Yambol, Burgas, Stara Zagora, Haskovo, Sliven. The firm unites 26 state forestry holdings and five state hunting farms.	many hectares with trees combined with forest crops (walnut, etc.) and herbs
INT 11	Professor/agroforestry expert	ORG 11	This organization aims to train European agricultural stakeholders in agroforestry practices.	–
INT 12	Professor/ agroforestry expert	ORG 12	The Agrarian Faculty of Bulgarian university.	–
INT 13	Professor/Director/agroforestry expert	ORG 13	This organization is the leading research center in Bulgaria in the field of plant and agro-biotechnologies.	–
INT 14	Professor in agroforestry systems	ORG 14	The firm has been the only one in Bulgaria providing education in forestry, forest management, landscape architecture, and wood processing.	–

Source: Drawn by authors

tions, distinctive features and peculiarities (Stancheva et al., 2007).

Seventeen respondents participated in our research (Table 1). One part of our respondents are agroforestry farmers and farm owners. Others are leading agroforestry experts in prominent state enterprises for forest and forest management. A third are researchers and scientists in the field of agroforestry. They were selected based on three key criteria: (1) their extensive experience in agroforestry systems; (2) their comprehensive and in-depth knowledge of agroforestry systems; and (3) the organization in which they work, i.e., we have chosen leading organizations in the field of agroforestry located in different regions of the country (Figure 1).

The total number of organizations in which the respondents work is 14 (Table 1). Semi-structured interviews were conducted with our respondents to provide them an opportunity to freely and unrestrictedly answer the questions asked based on their experience and knowledge in the field (Yin, 2014). The average duration of each interview was about 50 min. Thirteen of the interviews were carried out face-to-face. Two of the interviews were conducted by mobile phone and subsequent additional correspondence by e-mail with these two respondents, and two of them were done only by e-mail. All respondents answered identical twelve questions allocated in the following three groups: i) key agroforestry systems in Bulgaria and their contribution to sustainable development; ii) the essential regulatory mechanisms in agroforestry; iii) agroforestry social actors and partnerships between them. In this study, we used only information received from the first group of questions. Face-to-face and telephone interviews were recorded with the consent of the respondents and transcribed after that. This tactic ensures that the reliability and validity of the study increases. The data collection began in April 2019 and ended at the end of 2019.

A significant number of secondary documents were collected (Table 2), which supplemented the information from the interviews and further increased our study's reliability and validity. Moreover, we conducted a field study in different regions with agroforestry systems (including in the Rhodope Mountains). During our visit to the Rhodope Mountains in July and August 2019 and June-August 2020, we had the opportunity to observe the various agroforestry systems that exist there.

Review of Voluntary Sustainable Standards and Systems, applied in agroforestry

For the purpose of the study related to the review of VSSS in agroforestry, the global ITC Standards Map database (ITC, 2021) was used during February 2021. In this database, the International Trade Center collects, reviews and categorizes requirements and processes information on sustainable development initiatives based on standards, codes of conduct, audit protocols and best practices. This is one of the most comprehensive resources for VSSS, containing information on many aspects of standards, including their geographical scope and organizational processes in connection with the United Nations Forum on Sustainability Standards initiative (UNFSS, 2018).

The ITC Standards Map provides information on sustainability initiatives in more than 1000 thematic data areas. They are divided into two main categories: content criteria and operating systems. The content includes efficiency requirements in areas such as the environment, social standards, quality, economic development and business ethics. Operating system requirements cover support systems for applying the standard. These include assurance, scheme management, standard development process and labeling policy.

The VSSS analysis in agroforestry is limited to a sample of a total of 187 private and public sustainability stand-

Table 2. The information gathered through the case study

Information source	Information quantity
Interviews in Bulgaria	98 A4 pages with Times New Roman Font, 12 point, 1.5 spaced
Internal documents:	
Internal press releases, presentations, reports and speeches	26 documents, about 520 A4 pages
Websites of agroforestry organizations participation in the research	Passim
External documents:	
Reports, newspapers and journal articles	10 documents, 105 A4 pages
Plans and case studies of agroforestry systems	3 documents, 18 A4 pages
Observation notes	9 pages
Visits of Rhodope Mountain in Bulgaria:	
High Western Rhodopes – Batak, Dospat, Smolyan	6 days
Atoluka, Ravnogor, Peshtera	3 days

Source: Drawn by authors

ards covered by the ITC Standards Map for Europe. Search was done in the three sectors "Agriculture" (97 standards), "Livestock" (51 standards) and "Forestry" (39 standards). We focus on these sectors in accordance with the AGFORWARD project concept (Burgess & Rosati, 2018) and the three extreme agroforestry typologies of farm type described (arable production, livestock production and high value trees) plus the fourth type of "agroforestry of high nature and cultural value" defined there. The application of this categorization of agroforestry systems is conditioned by the vision of the project for the development of agroforestry in a European context, including Bulgaria. On this basis, and after excluding repetitive standards from the three sectors, the requirements contained in the identified VSSS are considered for the four types of AFS, according to the above typology. To assess the degree of association between the VSSS and the AFS type, the open requirements contained in the ITC Standards Map are coded according to their relationship with the AFS type suitable for temperate climates. The requirement for VSSS to be considered related to a given type of AFS is taken into account when the specified criteria and actions of the requirement correspond to the description of the type of AFS, according to the AGFORWARD project (Burgess & Rosati, 2018).

This way of coding makes it possible to summarize the collected information with respect to the four types of AFS. The next step is to assess the quality of the relationship between the requirements of the VSSS and the type of AFS by using the criteria of accuracy and compliance, according to the methodology of De Leicht et al. (2020). To be included in the analysis, the relationship must meet the following conditions: the content of the VSSS requirement must be described with a certain level of accuracy (i.e. high or medium accuracy); the content of the VSSS requirement must match the description of the AFS type (i.e. high compliance). The results obtained from the coding and assessment of the links were verified by three independent experts and were deemed as applicable to the temperate climate of the country. The final results are presented in graphical form.

Results

The most disseminated Bulgarian agroforestry systems and their contribution to sustainable agriculture

We found that in Bulgarian forest territories, the following key agroforestry systems can be seen (**Group A**): i) forests with non-timber products (e.g., blueberries, strawberries, raspberries), herbs, mushrooms, and beehives (A1) (e.g. INT 6.1, INT 6.2, INT 6.3, INT 7.1, INT 7.2); ii) forests with herbs, animals (e.g., wild boars and deer), and mushrooms (A2) (e.g., INT 7.1, INT 7.2); iii) forests with herbs, mushrooms, and beehives (A3) (INT 6.2, INT 6.3); iv) forests (e.g., oak, hazelnut, beech or birch trees) with truffles and mushrooms (A4) (e.g. INT 3, INT 9, INT 10); v) forests with beehives (A5) (e.g., INT 7.3, INT 8, INT 9, INT 10); vi) nurseries with saplings, strawberries, and acacia (A6) (e.g., INT 6.1, INT 6.2, INT 6.3); vii) nurseries with saplings and forage crops (e.g., alfalfa, cereals, legumes), where the forage crops are used to feed wild animals in the forest (e.g., deer, wild pigs) (A7) (INT 6.1, INT 6.2, INT 6.3); viii) protective forest belts (A8) (INT 6.1, INT 6.2, INT 11, INT 12); ix) generative gardens of chokeberry and blueberries (A9) (INT 6.1, INT 6.2, INT 6.3); x) wood pastures (A10) (INT 5, INT 10), xi) other combinations between forest and abovementioned non-timber products (A11).

In the plain region of the country, the following famous agroforestry farms and systems can be identified (**Group B**): i) Paulownia with different crops (B1) (e.g., INT 1, INT 4, INT 11, INT 12,); ii) truffle cultivation with trees (e.g., hazelnuts, walnuts, linden) and crops (B2) (INT 3); iii) Bulgarian oil roses with different crops or lavender (B3) (INT 5, INT 11, INT 12); iv) watermelons, melons, and poplars (B4) (INT 6.1, INT 6.2, INT 6.3); v) protective forest belts, built on agricultural land, providing wind protection and higher yields (B5) (INT 8, INT 10, INT 11, INT 12), vi) a combination of different crops and fruit trees in the yards of households and in the fields of small-scale producers (B6) (INT 5); vii) other trees (e.g., linden, oak, ash, poplar) between rows of crops (B7) (INT 7.1, INT 7.2, INT 9), viii) truffle cultivation with trees (e.g., hazelnuts, walnuts, linden) (B8) (INT 3).

The AFS identified by the interviews are presented graphically according to the typology developed under the AGFORWARD project (Burgess & Rosati, 2018). The detected AFS are positioned in Figure 2 as heptagons with different colors, for the forest regions in blue color and for the plain regions of the country – in orange color respectively.

As can be seen Figure 2 (in blue color), the identified AFS for forest regions are mainly classified as "Agroforestry of high nature and cultural value" type. For the Bulgarian state forest enterprises, it is characteristic that along with logging, timber production and hunting of wild animals, forage crops (e.g., alfalfa, cereals, legumes) are grown to feed wild animals in the forest (e.g., deer, wild boars). In other cases, in forest nurseries, strawberries for sale on the market are grown between the trees. Protective forest belts, which are positioned on the border with "Agroforestry for arable systems" can be added to these, as well as "systems that include wood pastures" (Silvopastoral agroforestry), border-

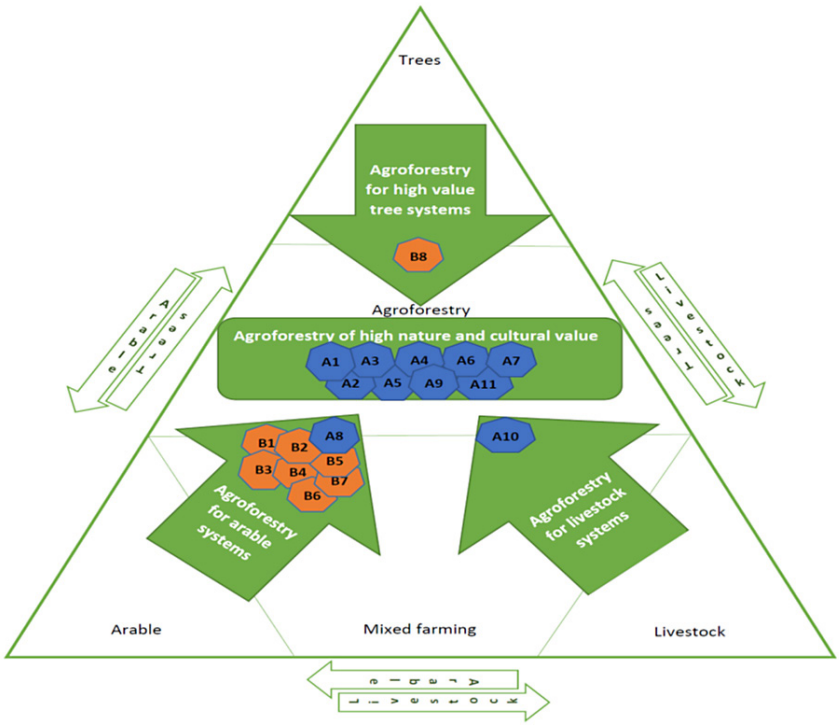

Fig. 2. Distribution of the identified AFS in Bulgaria according to the typology of the AGFORWARD project (Burgess & Rosati, 2018)
Source: Adopted by Burgess & Rosati, 2018.
Legend: for the forest/mountain territories of Bulgaria – blue color; for the plains of Bulgaria – orange color

ing on "Agroforestry for livestock systems". Bulgarian state forest enterprises also provide forest areas for beekeepers to set up their beehives. This is typical agroforestry system that exists in the forests of the country, especially in southwestern Bulgaria.

Most of the AFS found for the plains of the country (Figure 2, in orange color) can be classified as "Agroforestry for arable systems" type, characterized by a wide variety of trees and crops used. There are also protective forest belts built on agricultural land, providing protection and higher yields. Characteristic of the so-called "Terroir" Rose Valley is the cultivation of Bulgarian oil roses with different crops or lavender. The "Agroforestry for high value tree systems" type is illustrated by forest-farming systems such as truffle cultivation with trees (e.g., hazelnuts, walnuts, linden) and paulownia with crops.

Voluntary Sustainable Standards and Systems applicable in agroforestry

The search for VSSS in the ITC Standards Map database covers the following three areas: "Forestry", "Agriculture" and "Livestock", according to the AGFORWARD project concept. The final results of the analysis of the requirements of the identified standards, obtained after their coding and the expert assessment of the relations with AFS, applicable to the temperate climate of the country, can be presented in several groups of standards. The management schemes for these standards cover European countries, including Bulgaria. No VSSS directly related to agroforestry were found in the database.

The *Group of Organic agriculture standards* (**Group C**) covers the following standards: (i) EU Organic Farming, EU, public standard (C1) (Regulation (EU) 2018/848; Regulation (EU) 2020/1693); (ii) Bio Suisse Standards for Imports, Suisse, Private Standard (C2) (Bio Suisse, 2020); iii) Soil Association organic standards – farming and growing, UK, private standard (C3) (Soil Association, 2018); iv) Naturland Standards on Production, Germany, private standard (C4) (Naturland, 2020); v) IFOAM Standard (IFOAM-Organics International) international private standard (C5) (IFOAM-Organics International, 2014).

The Group of *Forest Management Standards* (**Group D**) covers the following two standards: i) Forest Stewardship Council® – FSC® Forest Management, international private standard (D1) (FSC, 2015); ii) PEFC (Program for the Endorsement of Forest Certification Schemes) International – Chain of Custody of Forest Based Products, international private standard (D2) (PEFC, 2018).

The following two standards are included in the group of *Sustainable Biomass Standards* (**Group E**): i) Sustainable Biomass Program (SBP), international private standard (E1) (SBP, 2015); ii) ISCC EU (International Sustainability

and Carbon Certification, EU), international private standard (E2) (ISCC EU, 2016) and *Biodiversity standards.* (**Group F**) is represented by one standard: i) FairWild, UK, private standard (F1) (FairWild, 2010).

The discovered VSSS in the ITC Standards Map are presented in graphical form according to the typology for AFS, developed under the AGFORWARD project (Burgess & Rosati, 2018). They are positioned in Figure 3 as heptagons with different colors (Organic agriculture standards (Group C) – purple color; Forest Management Standards (Group D) – green color; Sustainable Biomass Standards (Group E) – light blue color; Biodiversity standards (Group F) – red color respectively).

The identified Organic agriculture standards (Group C) do not contain explicitly requirements for agroforestry practices, but can be applied to their products, for example organic foods of plant and animal origin. Among the revealed organic standards in the group, only the voluntary standard "European Union (EU) Organic Farming" is defined and regulated at European level with new EU organic regulation 2018/848 in force from January 2021 (Lampkin et al., 2020; Regulation (EU) 2020/1693). Most of them contain requirements related to forest management, but in two of them ("Soil Association organic standards – farming and growing" and "Naturland Standards on Production") additional requirements can be found for exploitation of non-timber forest products or wild grown products (Naturland, 2020). In Figure 3, these standards are generally positioned for 'Agroforestry for arable systems' for products of plant origin and 'Agroforestry for livestock systems' for products of animal origin. Two of them are on the border with "Agroforestry of high nature and cultural value", in accordance with the research of Craig et al. (2018) and Flinzberger et al. (2020).

Both Forest management standards in Group D do not recommend, require or regulate agroforestry practices. At the same time, they contain requirements for the management of non-timber forest products, which can be considered as agroforestry practice (Craig et al., 2018). Unlike organic standards, where non-timber forest products are mainly associated with food, forest management also takes into account the access of local residents to forests for harvesting forest products. These standards work throughout the forest supply chain to promote responsible practices in the forest (FSC, 2015; PEFC, 2018). They can be positioned as Forest management standards on the border with "Agroforestry within high-value tree systems".

The two standards from Group E *"Sustainable Biomass Standards"* can also be set in the same area of Figure 3. Although they do not contain agroforestry requirements, they affect the sustainable production of biomass in the context of climate change mitigation. International Sustainable Biomass Program guarantees that all companies involved in

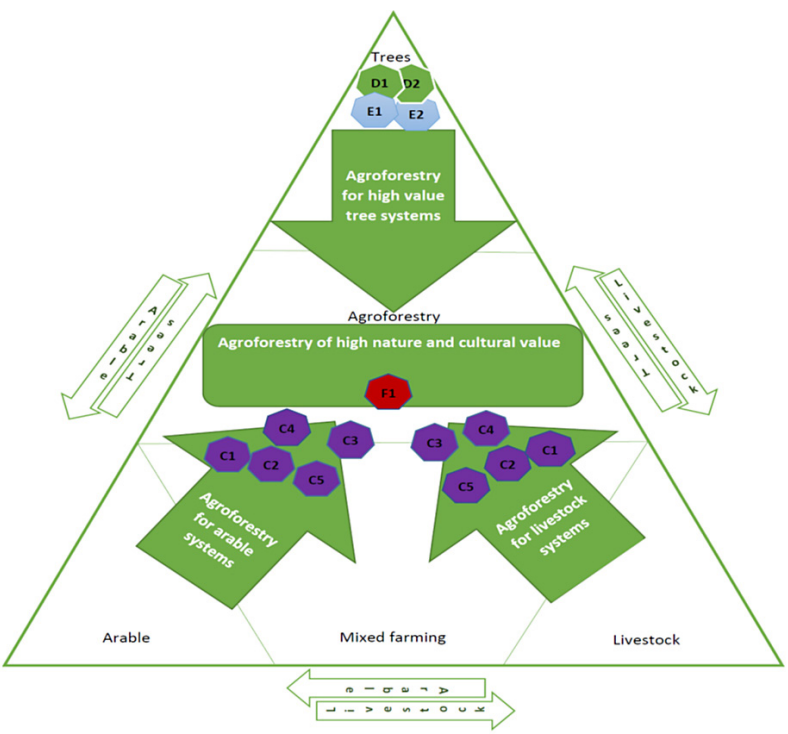

Fig. 3. Distribution of the identified Voluntary Sustainable Standards and Systems in agroforestry from the ITC Standards Map database according to the typology of the AGFORWARD project (Burgess & Rosati, 2018).
Source: Adopted by Burgess & Rosati, 2018.
Legend: "purple" – organic farming; "Green" – forest management; "Light blue" – sustainable biomass; "Red" – biodiversity

the program use and sell woody biomass (pellets and chips) from legal and sustainable sources. (SBP, 2015). In its turn, the standard "International Sustainability and Carbon Certification, EU" focuses on the sustainable production of agricultural and forestry biomass and GHG emission reduction in accordance with European regulations in this sector (ISCC EU, 2016).

The FairWild standard can be added to Figure 3, as a representative of Biodiversity standards (Group F). It is aimed mainly at collecting wild plant materials for commercial purposes. It is dominated by requirements for biodiversity conservation in the management and monitoring of wild collection of plant resources (FairWild, 2010). Although it does not contain explicitly agroforestry practices, the standard requires the establishment of effective procedures to regulate access to bioresources and the use of wild species. It can be linked in Figure 3 to "Agroforestry of high nature and cultural value".

The groups of VSSS described here, although aimed at the three agricultural areas (Forestry, Agriculture and Livestock), do not explicitly prohibit the use of agroforestry practices in the context of the four types of the considered AFS (Figure 3). In their requirements, they contain a wide range of sustainability indicators, including the impact of agricultural production on the environment, respect for fundamental human rights, workers' health and safety, community relations, land use planning, biodiversity conservation, etc. The above results demonstrate that these VSSS play their essential role as widely used tools for assessing and improving sustainability practices in global production networks (UNFSS, 2018). At the same time, none of them considers agroforestry as a comprehensive sustainable agricultural system. All these highlights the need for new standards focused to agroforestry.

Discussion

The presented study revealed a variety of AFS in the mountainous and plain regions of Bulgaria, adapted to the temperate climate of the country, confirming the small number of previous results (den Herder et al., 2017; Kachova et al., 2018; Trichkov & Kachova, 2016). The described types of AFS demonstrate the diversification of the production components of the agro-ecosystem as tree perennials (trees or shrubs) along with the cultivation of crops and/or livestock and at the same time emphasize the agro-ecological links between these components. As a result, agroforestry offers a wide range of traditional forestry and agricultural products and services, but at the same time is a source of the so-called "value-added" products such as forage, construction materials, biomass for energy production, fiber, handicrafts materials, spices, all kinds of animal products (Flinzberger et al., 2020). The identified AFS also offer ecosystem services to the public preserve the landscape and encompass many other sustainable practices.

To demonstrate the added value of the products and services provided by the identified AFS in global markets and supply chains, appropriate tools are needed, considered in the present study as VSSS (Burgess & Rosati, 2018; UNFSS, 2018). The application of these standards can streamline communication on the sustainable nature of agroforestry among consumers and society (De Leicht et al., 2020; Flinzberger et al., 2020).

Agroforestry systems and voluntary sustainable standards and systems relationships

Here, we discuss the relationships between the VSSS discovered in the ITC Standards Map database and the identified agroforestry systems, according to the described results of the study in Bulgaria.

Organic agriculture standards from Group C can further support agroforestry systems and spread their economic, environmental, and social benefits among society. The obtained results show that these standards are applicable to both the described examples for "Agroforestry for livestock systems" and "Agroforestry for arable systems".

The country has developed "Forest pastures" agroforestry systems, the so-called Silvopastoral agroforestry complexes, in which tree and shrub plant species are mixed with herbaceous forage crops (grass mixtures, etc.). In these woods pasture areas, organic livestock farming has been developed and a balance in animal nutrition has been achieved (Kachova et al., 2018). Organic beekeeping can also be mentioned as typical for Bulgaria AFS with high nature and cultural value (Craig et al., 2018; Flinzberger et al., 2020).

Organic standards (Figure 3) can also be applied to disclose the added value of the products from the agroforestry for arable systems identified in the study for the plains of the country. The regulatory role of the "EU Organic Farming" voluntary standard in relation to the European market should be mentioned here (Lampkin et al., 2020).

An emblematic example of successful application of the principles of organic farming in AFS is the cultivation of Bulgarian oil roses with different crops or lavender. Organically certified products – from the "Terroir" of the Rose Valley, rose oil and other essential oils have great potential as ingredients for natural cosmetics on world markets.

The AFS for forest areas of the "Agroforestry of high nature and cultural value" type (Figure 2) described in the study support the findings of other authors on the develop-

ment of forestry in Bulgaria, as an agroforestry system in which trees and shrubs are consistent with economic activities (Trichkov & Kachova, 2016). The inclusion of new activities in forestry and agricultural farms, such as the cultivation of non-timber forest products (herbs, medicinal plants, mushrooms, berries and products from their processing, ornamental plants, etc.); can also be linked to the application of organic standards. (Kachova et al., 2016). Suitable for this are both organic agriculture standards, containing additional requirements for exploitation of non-timber forest products or wild grown products, and Biodiversity standards from Group F, aimed primarily at the collection of wild plant materials for commercial purposes.

Group D *Forest management standards* have been developed worldwide primarily for timber, but can be applied throughout the forest supply chain to promote responsible practices in the forest (Burgess et al., 2018; Craig et al., 2018; Sheppard et al., 2020; Millard, 2011). In accord with other authors (Trichkov & Kachova, 2016), the study has shown that the creation of forest tree plantations with high quality wood through the application of intensive methods of cultivation and management is associated with "Agroforestry within high value tree systems". Such an example are walnut plantations, which form sustainable agroforestry systems and are preferred due to the high value of the wood and the income from the sale of nuts (Glushkova et al., 2008). The creation of plantations of forest fruit species – hazel, almond, wild cherry and chestnut – for obtaining wood and nuts of high value can be noted as an agroforestry prospect for the country (Kachova et al., 2016). The described AFS allow the use of appropriate grass and plant species, biological pest control, intensive use of organic "green" fertilizers, composting and physiological regulators, and this is associated with the application of standards for organic production of high value nuts (walnuts, hazelnuts, almonds, etc.) (Kachova et al., 2016).

Similarly, *Sustainable Biomass Standards* from Group E are applicable in the building of plantations for the production of high quality wood and biomass through the application of intensive production methods in state forest enterprises (Trichkov & Kachova, 2016). The standards in Group E are also related to the AFS of high nature and cultural value described in the study as maintained pastures and semi-open pastures in mountainous areas, where along with the conditions for grazing animals there is a possibility for biomass and foliar and grass forage (Burgess et al., 2018; Kachova et al., 2016; Sheppard et al., 2020).

At the same time, the study has shown a scarcity of standards that view agroforestry as an overall sustainable agricultural system. Creating of such kind of standard could raise the awareness of community about the economic, social and environmental benefits of agroforestry.

Conclusion, Limitations and Future Studies

In conclusion, the study reveals a variety of AFS in the mountainous and plain regions of Bulgaria, adapted to the temperate climate of the country. The described AFS are considered in relation to the typology in the AGFORWARD project, which offers a vision for the development of European agroforestry (Burgess & Rosati, 2018). It has been established that the complex agroforestry systems of the "Agroforestry of high nature and cultural value" type are developed primarily in the mountains and forest areas of the country. In the plains, they are mainly of the "Agroforestry for arable systems" type, with a wide variety of trees and crops used, while demonstrating potential for future integrated development.

The 187 private and public Sustainability Standards and Systems covered by the ITC Standards Map for Europe to assess the degree of association between VSSS and the above types of agroforestry systems has been analyzed. The four VSSS groups identified, although aimed at agricultural areas such as Agriculture, Livestock and Forestry, do not explicitly prohibit the use of agroforestry practices. The relationships between the discovered VSSS and the described agroforestry systems in Bulgaria has been analyzed. At the same time, the study showed a shortage of standards that view agroforestry as an overall sustainable agricultural system. The results demonstrate the role of VSSS as a widely used tool for assessing and improving sustainability practices, in particular agroforestry, in the context of global markets and supply chains. The application of these standards can streamline communication on the sustainable nature of agroforestry among consumers and society. All this outlines the need to create future international consensus standards, taking into account the views of all stakeholders in the development of agroforestry.

The study has several limitations. First, the VSSS in three main agricultural sectors in Europe (Forestry, Agriculture and Livestock), which were not established by standards development organizations at international, regional and national level, such as ISO, CEN, etc., have been studied. Second, standards related to specific products and services as well as applicable commercial practices have been excluded. Third, codes of conduct at company level have not been included in the study. Therefore, future research in this area may cover a wider range of standards applied in other continents and regions, as well as their relevance to agroforestry systems globally.

Acknowledgments

We wish to express our gratitude to all our respondents that agreed to participate in our study and for the information, time, and collaboration provided.

This work was financially supported by the UNWE Research Programme.

References

Bio Suisse (2020). Bio Suisse Standards for the Production, Processing and Trade of "Bud" Products, effective as of 01 January 2020, Bio Suisse: Swiss Association of Organic Agriculture Organizations, Basel. Available at : www.bio-suisse.ch

Bhardwaj, D. R., Navale, M. R. & Sharma, S. (2017). Agroforestry practices in temperate regions of the world. In: *Agroforestry: Anecdotal to Modern Science,* Dagar, J. C., Tewari, V.P., Eds.; *Springer,* Singapore, 163–187.

Burgess, P. J. & Rosati, A. (2018). Advances in European agroforestry: Results from the AGFORWARD project. *Agrofor. Syst., 92,* 801–810.

Burgess, P. J., den Herder, M., Dupraz, C., Garnett, K., Giannitsopoulos, M., Graves, A. R., Hermansen, J. E., Kanzler, M., Liagre, F., Mirck, J., Moreno, G., Mosquera-Losada, M. R., Palma, J. H. N., Pantera, A. & Plieninger, T. (2018). AGFORWARD project final report. 28 Feb 2018. Cranfield University: AGFORWARD (www.agforward.eu – the last accessed on 20 April 2021).

Costa, M. P., Schoeneboom, J. C., Oliveira, S. A., Viñas, R. S. & de Medeiros, G. A. (2018). A socio-eco-efficiency analysis of integrated and non-integrated crop-livestock-forestry systems in the Brazilian Cerrado based on LCA. *J. Clean. Prod., 171*, 1460–1471. https://doi.org/10.1016/j.jclepro.2017.10.063.

Craig, R., Elevitch, D., Mazaroli, N. & Ragone, D. (2018). Agroforestry Standards for Regenerative Agriculture. *Sustainability*, *10*(9), 1-21. https://doi.org/10.3390/su10093337.

De Leicht, S. C., Fiorini, M., Brandi, C., Schleifer, P., Bissinger, K., Elamin, N. E. A. & Fernandez de Cordova, S. (2020). Linking Voluntary Standards to Sustainable Development Goals. International Trade Centre. Geneva, Switzerland. Available at: https://www.intracen.org/publication/SustainableDevelopment/.

Den Herder, M., Moreno, G., Mosquera-Losada, R., Palma, J., Sidiropoulou, A., Freijanes, J., Crous-Duran, J., Paulo, J., Tomé, M., Pantera, A., Papanastasis, V., Mantzanas, K., Pachana, P., Papadopoulos, A., Plieninger, T. & Burgess, P. (2017). Current extent and stratification of agroforestry in the European Union. *Agriculture, Ecosystems & Environment*, *241*, 121-132, https://doi.org/10.1016/j.agee.2017.03.005.

Dias, F. S., Bugalho, M. N., Rodríguez-González, P. M., Albuquerque, A. & Cerdeira, J. O. (2015). Effects of forest certification on the ecological condition of Mediterranean streams. *J. Appl. Ecol., 52*(1), 190–198. https ://doi.org/10.1111/1365-2664.12358.

EIP-AGRI (2017). The European Innovation Partnership "Agricultural Productivity and Sustainability", EIP-AGRI Focus Group Agroforestry: introducing woody vegetation into specialised crop and livestock systems. Final report December 2017, European Commission, Brussels. Available at: https://ec.europa.eu/eip/agriculture/sites/default/files/eip-agri_fg_agroforestry_final_report_2017_en.pdf.

FAO (2017). The future of food and agriculture—Trends and challenges. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/3/a-i6583e.pdf.

FairWild (2010). FairWild Standard: Version 2.0, FairWild Foundation, Weinfelden, Switzerland. Website: www.fairwild.org.

Flinzberger, L., Zinngrebe, Y. & Plieninger, T. (2020). Labelling in Mediterranean agroforestry landscapes: a Delphi study on relevant sustainability indicators. *Sustain Sci.*, *15*, 1369–1382. https://doi.org/10.1007/s11625-020-00800-2.

IFOAM-Organics International (2014). The IFOAM NORMS for Organic Production and Processing; IFOAM-Organics International. Bonn, Germany. Website: http://www.ifoam.bio.

ITC (2021). ITC Standards Map. www.sustainabilitymap.org. – the last accessed on 20 April 2021.

ISCC EU (2016). International Sustainability and Carbon Certification EU, ISCC 202 Sustainability Requirements, Version 3.0, ISCC System, Koeln, Germany. Website: www.iscc-system.org.

Kachova, V., Hinkov, G., Popov, E., Trichkov, L. & Mosquera-Losada, R. (2018). Agroforestry in Bulgaria: history, presence status and prospects. *Agrofor. Syst., 92*, 655–665. https://doi.org/10.1007/s10457-016-0029-6.

Lampkin, N., Stolze, M., Meredith, S., de Porras, M., Haller, L. & Mészáros, D. (2020). Using Eco-schemes in the new CAP: a guide for managing authorities. IFOAM EU, FIBL and IEEP, Brussels. Available at: https://www.organicseurope.bio/content/uploads/2020/06/ifoam-eco-schemes-web_compressed-1.pdf?dd.

Millard, E. (2011). Incorporating Agroforestry Approaches into Commodity Value Chains. Environmental Management, 365–377.

Naturland (2020). Naturland Standards on Production, Association for Organic Agriculture, Grafelfing, Germany. Website: www.naturland.de.

PEFC (2018). Program for the Endorsement of Forest Certification Schemes, Sustainable Forest Management—Requirements (PEFC ST 1003: 2018); PEFC International, Geneva, Switzerland. Website: www.pefc.org.

PEFC (2019). PEFC endorsement process for the Certification of Trees Outside Forests, 3 September 2019. Available at https://www.pefc.org/news/trees-outside-forests-pefc-reaches-beyond-forests.

PEFC BG (2019a). Bulgaria takes a step toward certified forests through PEFC endorsement, 8 November 2019. Available at: https://www.pefc.org/news/bulgaria-takes-a-step-toward-certified-forests-through-pefc-endorsement.

PEFC BG (2019b) Program for the Endorsement of Forest Certification Schemes, Sustainable Forest Management in Bulgaria (PEFC ST 1002: 2017); PEFC Bulgaria, Sofia, Bulgaria. Website: http://www.pefc.bg/ (Bg).

Plieninger, T., Muñoz-Rojas, J., Buck, L.E. & Scherr, S.J. (2020) Agroforestry for sustainable landscape management, *Sustainability Science, 15*, 1255–1266. DOI: 10.1007/s11625-020-00836-4.

Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007. Website: https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming_en.

Regulation (EU) 2020/1693 of the European Parliament and of the Council of 11 November 2020 amending Regulation (EU) 2018/848 on organic production and labelling of organic products as regards its date of application and certain other dates referred to in that Regulation.

SBP (2015). Sustainable Biomass Program, SBP Framework Standard 1: Feedstock Compliance Standard (Version 1.0, 2015), The Sustainable Biomass Partnership, London, UK. Website: https://sbp-cert.org/.

Stancheva, J., Bencheva, S., Petkova, K. & Piralkov, V. (2007). Possibilities for agroforestry development in Bulgaria: Outlooks and limitations. *Ecol. Eng., 29,* 382–387. https://doi.org/10.1016/j.ecoleng.2006.09.013.

Trichkov, L. & Kachova, V. (2016). Necessity, opportunities and priorities for development of agroforestry in Bulgaria. *For. Ideas, 22*, 3–15.

UNFSS (2018). 3rd Flagship Report: Voluntary sustainability standards and trade and sustainable development. United Nations Forum on Sustainability Standards.

Yin, R. K. (2014). Case Study Research Design and Methods (5th ed.) Sage.

Wani, A. A., Basira Mehraj, T. H., Masoodi, A. A. & Gatoo Mugloo, J. A. (2020). Assessment of Trees Outside Forests (TOF) with Emphasis on Agroforestry Systems January 2020 In book: *Agroforestry for Degraded Landscapes*, Springer Nature Singapore Pte Ltd., DOI: 10.1007/978-981-15-6807-7_4.

Received: **October, 17, 2022**; *Approved*: **May, 03, 2023;** *Published:* **February, 2024**