

Multifunctional organic agriculture with particular emphasis on the vine and wine sector – a review

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The multifunctionality of agriculture is a prerequisite for the environmental, economic and social viability of regenerative organic farming. This naturally requires a rethinking of agricultural production, the product structures that can be developed and the services connected to agriculture and the marketing of agricultural products. Modern multifunctional agriculture therefore involves the use of the most advanced precision technologies, which of course does not exclude the revival of certain environmentally friendly traditional methods, the use of renewable energies, zero-waste concept and total recycling, complex finished product structure and the associated service systems, and well-developed agritourism, which can be a key complementary service and a key factor in the local marketing of products. The Azienda Agricola Model, based on good practices of organic farms, integrates the production, food processing and service (including tourism) functions of organic agriculture into a holistic system based on the sustainable use of ecosystem services. Although the model was originally developed for the wine sector, based on the multifunctional product and service potential of the grapevine, it is also highly applicable to all agricultural, fisheries, forestry and wildlife sectors. The model also indicates the new requirements for agricultural management systems and necessary development in higher education and research to meet the sustainability challenges posed by environmental and socio-economic changes. This concept promotes a transdisciplinary approach integrating humanities, social and natural sciences, embracing different forms of knowledge and skills development.

The introduction of multifunctional and ecological (organic) agriculture - the basis for a high-quality food supply, ecological, economic and social sustainability

The development of a sustainable organic economy and multifunctional agricultural enterprises is gaining ground worldwide in order to eliminate the adverse environmental impacts of traditional, often monocultural, agricultural production (Velten et al. 2015; Bazaluk et al. 2020; Adams et al. 2025). There is a growing focus worldwide on food safety, the production of additive-free food, the marketing of local and specialised products with emphasizing the landscape character within a given region, and the development of tourism based on local characteristics (Gonda 2014; Kumawat et al. 2023). The conditions for this can be created through sustainable, multifunctional, precision and organic agricultural production and food processing.

However, in order to achieve sustainable multifunctionality, the original contexts need to be reinterpreted, production systems need to be significantly transformed in many cases, and the concept of traditional agriculture needs to be extended both horizontally and vertically (Figure 1). In multifunctional agriculture, “deepening” activities that can ensure both the economic viability of production and the protection of the natural environment and cultural heritage appear alongside the original production. In this way, agriculture produces new products that meet changing societal needs while remaining competitive in terms of quality and value for money, especially when sold with as few intermediary links as possible, ideally directly from the producer or through local and regional distribution networks. Thus, innovative supply chains can increase the economic viability of small and medium-sized agricultural enterprises (Berti and Mulligan, 2016). The acceptance of multifunctional agriculture is growing, and in many places, it is already reflected even in peri-urban agricultural activities (Zasada, 2011; Song et al. 2023). The change in consumer attitudes (demand for environmentally and health-conscious nutrition or additive-free, organic food, organic products) and the related market and service sector are converging with the demand for natural raw materials. The exploitation of local innovation potential and the development of skills in this area, the promotion of manufacturing, small and medium-sized enterprises, popular crafts, the cultivation and progressive and evolutionary use of folk arts, traditions and cultural heritage, the development of communities and civil society will broaden rural economic activity, create new jobs and increase the rural its capacity to retain population (Sivini and Vitale, 2023). An indispensable condition for this is the development of a “a process of “re-foundation” that takes into consideration the ecological, economic and social carrying capacity of

regions, which of course includes the sustainable use of ecosystem services (Némethy et al. 2016; Zhang et al. 2022).

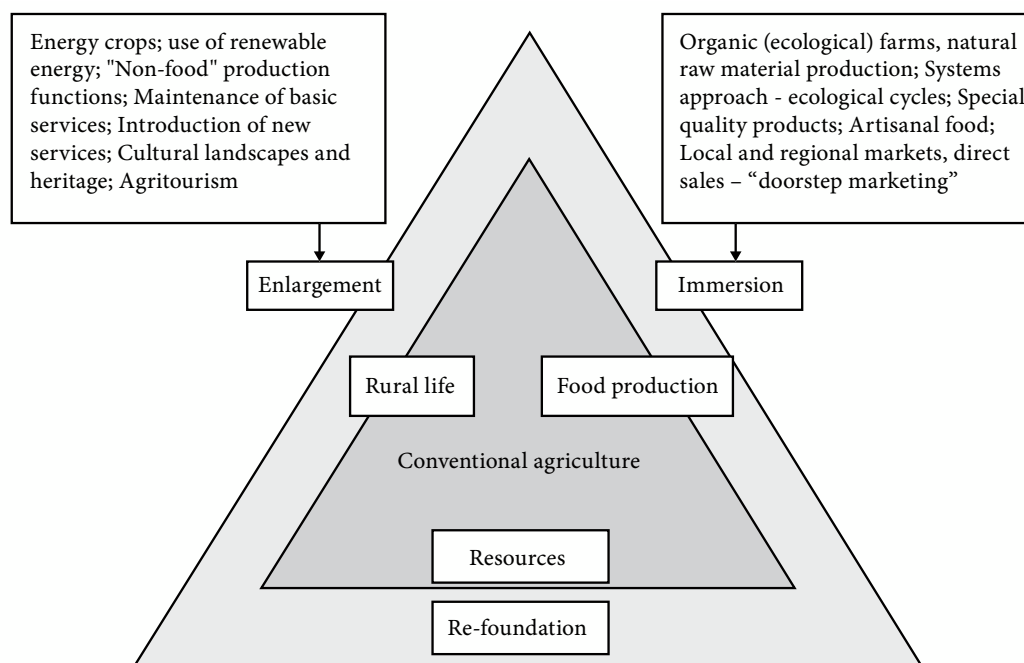


Figure 1. The concept of multifunctional agriculture. Together, “deepening” and “broadening” will transform agriculture into a qualitatively new system through organic and precision farming, livestock and food processing, services and agritourism, reducing production costs and broadening marketing opportunities. Source: modified and further developed after Van der Ploeg and Roep (2003).

In multifunctional agriculture, this resource utilisation, the re-foundation for sustainability, includes the use of alternative raw materials and renewable energies, the production and marketing of so-called “non-food” products (biodiesel, bio-alcohol, energy crops, fibre and dye materials, polymer and oil plants, traditional handicraft products), the development of the aforementioned services and agritourism (Némethy & Molnár 2014). Growing environmental awareness and increasingly stringent environmental laws, as well as the declining use of agricultural chemicals and the growing demand for organic products, have fundamentally changed a once polluting sector. The environmental consolidation of agricultural production can be summarised as follows:

- Restricting the use of chemicals, banning pesticides classified POPs (Persistent Organic Pollutants)¹
- The production and widespread use of biofuels (bioethanol, biodiesel, biogas)
- The rise of low-input, precision agriculture in organic farming
- Increasing the uptake and support for organic farming
- The rise of agroecological considerations in farm planning
- GMO law, preserving the GMO-free status of agriculture
- Rationalising and regulating water management, protecting groundwater and surface water
- Tightening up the infrastructural, ecological and animal protection/welfare requirements for livestock farming, and legislation
- Legislation on food quality, origin, nutritional requirements and permitted levels of contaminants
- The spread of environmental quality assurance systems
- The expanding international market for organic products

Precision Organic Agriculture: the most advanced form of precision agriculture - the entry of geo-spatial information and remote sensing and AI into agriculture

Precision agriculture is based on high precision continuous positioning using satellite navigation tracking, a toolbox of geo-spatial information and remote sensing tools for analysis, and highly automated field work (Ayaz et al. 2019). What can the average farmer expect from the introduction of precision agriculture? First and foremost, increased efficiency and reduced input costs. Efficiency is increased by reducing losses, as farmers have better decision support information systems at their disposal. Environmental pressures can be quality improved and production processes better organised. All in all, it is a new production system and working culture that can be changed and that covers all farming processes and whose introduction will have a major impact on the competitiveness of the near future in a fiercely competitive international agricultural market. Precision farming is therefore the site-specific control of all crop inputs (fertilisers, lime, pesticides, insecticides, seeds, etc.) with the aim

¹ POPs are substances that are toxic, persistent (i.e. persist in the environment for a very long time) and readily accumulate in the tissues of individual organisms (bioaccumulation). Most POPs are cyclic or polycyclic halogenated hydrocarbon derivatives.

of reducing losses, increasing profits and preserving the quality of the environment. However, mainly as a result of the English literature, the system is also referred to by a number of names that better highlight certain sub-functions. Site-specific production emphasises the nature of a farming system that is more responsive to environmental needs and meets sustainable farming requirements, while site-specific technology refers to a technological system that makes good use of site-specific features (Getahun et al. 2024). The name spatial variable technology also emphasises the technological aspects with less emphasis on data collection and complex spatial decision supporting systems. Satellite farming emphasises the importance of the Global Positioning System (GPS) and remote sensing, but less emphasis on the similar importance of ground sensors and on-board computers. We do not have precise data on the use of certain technological elements of precision farming, the number of farmers using precision (site-specific) farming methods in agricultural practice, or the amount of land cultivated using these methods. The definition of precision agriculture from a technical and informatics point of view is essentially based on the collection and management of site-specific, positional information. One should not rely solely on an interpretation of the concept of precision, since a technology can be very precise and yet not fall within this concept if it does not take into account the different conditions within a given production unit (field) and does not change the characteristics of the treatments accordingly. From a technical point of view, precise data collection and management is different in precision agriculture in that it requires 'quick', positional changes without changing the precision (e.g. application). On the other hand, since economic considerations cannot be ignored, the precision needed to achieve production objectives must also be examined. Experience has shown that biological systems can tolerate and correct certain "inaccuracies". From a technical point of view, 'anything' - or almost anything - can be achieved, but increasing the accuracy of the system means a sharp increase in the financial outlay required and in the cost of the equipment and its operation. However, the biggest challenge and opportunity is the development of artificial intelligence directly or indirectly related to agriculture, which has and will continue to bring greater changes in a few years than any other innovative technology introduced in decades. These include revolutionary agrobots (robots for agricultural purposes), such as machines that recognise ripe fruit, pick it with the necessary delicacy and place it in a crate or viticultural robots doing spraying and pruning or monitoring the health conditions of vines or the ripeness of the grapes (Ammoniaci et al. 2021; Sharma and Shivandu, 2024). It is important to highlight the scale of the potential savings that the new high-tech era could bring, and it is certainly food for thought for the near and distant future as a basis for a strategy to solve current problems.

Differences within the field had been perceived before, with each generation carrying on the previous experience, but site-specific cropping opened new perspectives for the cultivation of areas previously managed according to the knowledge of the time. The basic territorial unit of large-scale farming is now the agricultural field, where both crop and technology are uniform. Precision farming, on the other hand, requires the definition of patterns within the field, in particular soil properties, and the implementation of tillage, fertilisation, plant protection, etc. tasks linked to these patterns. The pattern within the field can be linked partly to local geographic and agroecological conditions and partly to dynamically changing physical and chemical conditions. It seems that the characteristic of precision cropping, which has been 'only' site-specific but less precise, is changing. The availability of accurate location tools is therefore an essential prerequisite for precision (site-specific) farming. The most widespread and accurate means of positioning at present is based on satellite technology. The widely used Global Positioning Systems (Navstar GPS, Glonass, Galileo) allow us to predict our position within the field with relative accuracy at any time, regardless of weather, visibility, etc. The accuracy and reliability of positioning based on satellite technology can vary greatly depending on the system used. Satellite signal reception is suitable for general use, as the accuracy of positioning can be close as less than one metre, but agricultural applications require more precise positioning and therefore require signal correction.

Precision farming is not, of course, the same as organic farming per se, but merely reduces the environmental burden by targeting the amount of nutrients and chemicals that are needed to the crops in the mostly large-scale farms to the minimum required by the production method. However, the combination of precision farming and organic farming as described above results in a qualitatively new system, precision and multifunctional organic farming, which is currently considered the most advanced and complex form of sustainable agriculture. It is particularly noteworthy that this system is based on the sustainable use of ecosystem services, taking into account their carrying capacity preventing the often serious damage caused by the overuse of natural resources. Combining this with the multifunctional farming described above, the completion of the product structure of the agricultural sectors with relevant non-food products and a system of ancillary services and agri-tourism, both for other farmers and for consumers, will create a fully sustainable production structure that can form the basis for future rural development.



Increasing efficiency and economy: rethinking precision production systems and the use of renewable energy systems, combined with precision technologies

Thus, the main elements of precision agriculture in the traditional sense are high-precision continuous positioning based on satellite navigation, a toolbox of geo-informatics and remote sensing for analysis, and highly automated field work, but it from conventional agriculture only in terms of the use of chemicals and synthetic additives. Although one of the main objectives of farming remains to ensure the highest possible soil fertility with the least possible intervention in the most economical way, this system has been further developed by replacing the concept of precision agriculture with that of precision organic farming and complementing it with elements of compost, nutrient irrigation, aquaponics and renewable energy production based on and supporting organic farming, all produced in strictly controlled and instrumentally regulated processes. A precision organic farming system uses precision technologies at all levels of the agroecosystem and at all stages of the production process, so that the term 'precision' no longer refers only to the site-specific control of crop inputs but covers all elements of the production process. What can the average farmer expect from the introduction of precision organic farming? First and foremost, increased efficiency, reduced input costs, improved product structure and higher product quality, and a more secure market, given that the cost-reducing effect of precision farming can allow more competitive pricing of otherwise more expensive organic products.

Efficiency is increased by reducing losses as farmers have better decision support information systems in a full ecological cycle and energy self-sufficient system. The key elements of the new system could be (even if it is not always feasible to use all the systems here together):

1. Outdoor forage and food raw material production
2. Geospatial and remote sensing tools for site-specific control of crop inputs; monitoring and developing AI applications
3. Animal husbandry (cattle, sheep, goats, pigs, poultry) - controlled feed intake and manure production, weight gain and milk yield measurement, indoor calorimetric measurements and energy consumption measurement - also a kind of precision technology
4. Biogas reactors: fermentation of manure and compostable organic waste, biogas production
5. Irrigation systems: use of fermenter supernatant and biologically purified

wastewater and water from fish farming with high organic matter and mineral content for nutrient irrigation

6. Worm humus production: from biogas production sediment, possibly also in suspension form. Excess worm castings can be used as poultry and fish feed.
7. Aquaponics: fish farming and the use of the resulting high nutrient water for nutrient irrigation in soil-free crops, with a large proportion of the water being recycled. Possible nutrient supplementation: worm humus solution. Incorporation of biologically purified water from production into aquaculture. Fish (e.g. African catfish) can be sold at a good price (also organic!).
8. Waste management units: waste sorting and recycling, waste-to-energy programmes, development of incinerators or pyrolysis units
9. Finished product-oriented production and economic efficiency through complex product structure and total recycling - sustainability of multifunctionality
10. Ancillary services scheme (e.g. agritourism)

In our holistic system, we can therefore reduce the environmental impact and improve quality by making production processes more organised. Overall, we are talking about a new production system and a new working culture that encompasses all the work processes of farming and that can be changed, the introduction of which will have a fundamental impact on the competitiveness of the near future in a fiercely competitive international agricultural market. The elements of a simple ecosystem are the producer organisms, the consumers, the decomposing organisms (bacteria and fungi) and the inanimate materials (water, carbon dioxide, nitrogen, phosphorus, various salts, etc.). In ecosystems, it is the functioning interrelationship of these that creates food chains, shapes biogeochemical processes and ensures the capture and flow of solar energy in a cyclic sustainable system. The building blocks of the system, with precision technologies indicated, are therefore as follows:

- a) production unit corresponds to the activity of agricultural crop and food production (*constant monitoring of soil quality, precision nutrient application, irrigation systems, precision harvesting, nutrient and energy balance measurement*), but in fact it includes all finished product production based on the complete processing of raw materials and recycling of waste - a key component of multifunctionality.
- b) the analogy of consumers is made up of the animals kept and the products consumed (*measuring crop yields, measuring feed utilisation, measuring manure produced, measuring the amount and energy content of organic waste produced by consumers*) - this category includes the system of services linked to agricultural activities that allow the products produced to be sold

and consumed locally and increase the economic stability of the agricultural enterprise (e.g. agro-tourism). This is also an important component of multifunctionality.

- c) the unit corresponding to the decomposing organisms is formed by biogas plants, the transformation of biomass into high-value worm humus by worms (more often also known as dung worms, *Eisenia foetida*) and biological wastewater treatment systems, usually in four stages (*measurement of material and energy flows, precision control of biogas production, measurement of the nutrient content of the biologically treated effluent, control of the bioavailable nutrient content of the worm humus*). This is also an element of the valuable “non-food” segment of multifunctionality.
- d) the natural inorganic components of the system and external inputs such as machinery, tools, auxiliary materials, etc. correspond to the inputs of inanimate matter to ecosystems (*precision application of natural mineral soil conditioners (e.g. rhyolite tuff, limestone powder, zeolites, alginite), development of driverless, lightweight machinery with no or very low damage to soil structure, development of nutrient delivery and irrigation systems, relevant hardware and software development and application*).

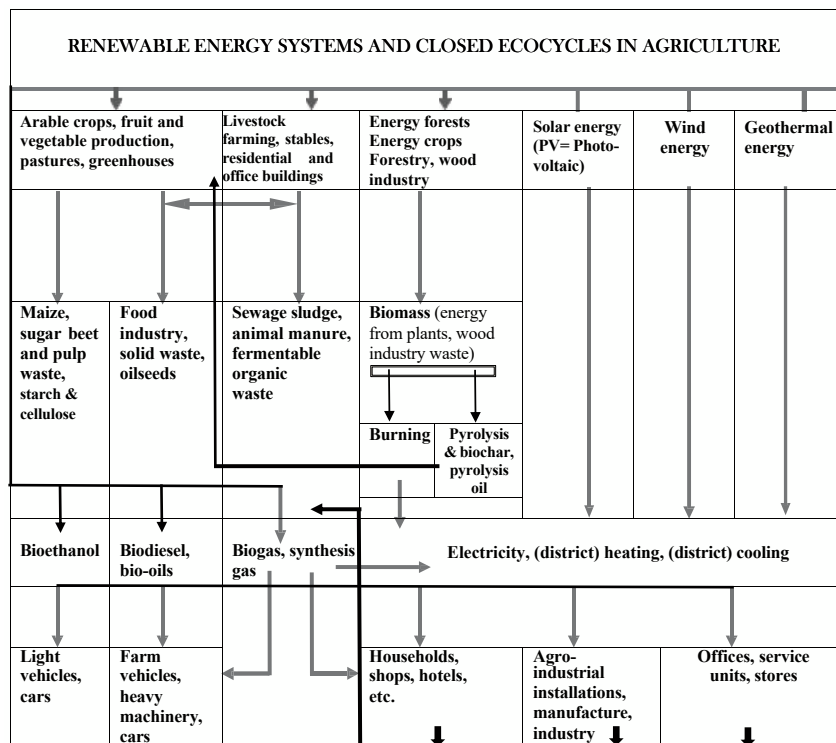


Figure 2. Renewable energies and closed ecological cycles in agriculture: the concept of an economically sustainable bioeconomy based on ecological cycles (modified after Némethy & Dinya, 2012).

In addition to providing healthy, cost-effective local food from organic farming using precision farming techniques, the system is energy efficient, by meeting as much of its energy needs as possible from local, renewable energy sources and by creating “green jobs” for the population in the spirit of social sustainability. Agriculture has a key role in making this possible: by relocating food production, making it more integrated, increasing its spatial efficiency by the most creative use of human labour and skills through good design. This will create the basis for a strong local economy, where goods, services and other values are produced and consumed locally by the population (Gonda, 2012). Of course, for such a system to work, it needs the right political support, given that the ‘energy lobby’ of large multinational companies, often serving short-term profit interests, works against local and regional independent energy cooperatives.

Another problem that renewable energy, ecological architecture, ecological farming, alternative, “green” lifestyles are statistically perceived by people as distant from their everyday lives and therefore not really thought about their beneficial, actual use (Paustian et. al. 1998; Dinya, 2012). There are also several international (mainly Swedish) examples² that show that the use of agricultural land for ‘industrial’ agriculture, is not always a viable option (Smeets et.al. 2007) - it is therefore in the interest of the people working there to convert their land into organic farms, not only to protect their environment, but also to increase their competitiveness and stimulate the country’s economy. The countryside is based on agriculture, which is closely linked to the food production, waste management, water management and renewable energy production (Pelly, 2003; Dias de Oliveira et.al, 2005). The ultimate goal is to establish a sustainable energy - food - minimum waste/zero waste system (Figure 2; Edmonds, 2004; Eidman, 2005; Faaij, 2006; Némethy and Dinya, 2012; Pestisha et al. 2023; Sharma and Das, 2024), always adapted to and based on local conditions, with the creation and maintenance of the associated social and economic structures.

Agritourism, which is particularly important for small and medium-sized agricultural enterprises, makes a significant contribution to the economic and social sustainability of the precision and organic agricultural production structures outlined above. Agri-tourism also takes many forms, but always includes a non-formal training objective, including the promotion and protection of the cultural heritage of the countryside, the characteristics of the cultural landscapes and the values of the living

2 In Sweden, agricultural activities are also covered by the Environmental Protection Act (Miljöbalken), which regulates all economic activities and is based on the national environmental objective (nationella miljömål), which is summarised in sixteen points. The Swedish regulatory system is significantly stricter than EU environmental legislation.

and non-living environment. The integration of organic farming and agritourism in a single system is achieved through the Azienda Agricola model, based on Italian and Alsatian good practices, which was originally developed for one of the most complex sectors of agriculture, viticulture and wine production, but which is perfectly suited to all areas of agriculture where, in addition to the main products there is scope for the production of complementary products directly or indirectly linked to production and the introduction of new services.

The Azienda Agricola Model as a system of precision organic farming based on a complete product structure and complementary services including agrotourism

The Azienda Agricola Model, a multi-stage organic farming model based on the whole product structure and the services and types of agritourism that can be linked to it, was first developed for the wine and viticulture sector, based mainly on experiences from Italy and Alsace, with a special focus on wine tourism and its economic potential. There were several reasons for this choice:

1. Diversity, gastronomic and physiological importance of products obtained from vine plants
2. The advantages of agroecological systems and agroecosystems in viticulture and their applicability to other agroecosystems (e.g. cover-crop systems)
3. The feasibility of multifunctional farming
4. The spread of organic farming
5. Quality product requirements and established systems of origin protection
6. The global crisis of overproduction in the wine industry - the need for more legs
7. The international expansion of wine tourism and wine-related cultural tourism
8. Developing the international market for Hungarian wines
9. The spread of wine culture in non-wine producing countries
10. The results of the international VITOUR project for the protection of World Heritage vineyard sites, including Hungarian sites in Tokaj (Val de Loire - Loire Valley World Heritage (2011).

Wine tourism, as a special type of agritourism, has developed significantly in Europe's wine-producing countries in recent decades. France, Italy and Spain are home to some of the world's most popular tourist attractions, including wine tourism, but

its organisation (including all other EU countries) still lags behind that of the New World, which has a well-developed network of services. The main exception is Italy, which has well developed good practices⁸ and a traditionally well organised network of agritourism, including wine tourism, although there are differences from one area to another. In the EU-28 countries, overproduction caused the ‘wine crisis’ (‘crise viticole’) with serious economic difficulties and marketing problems (Jordan, Zidda, & Lockshin, 2007; Bettini, 2013, 2014, 2015). Producers have had to recognise that, instead of producing large quantities of ordinary wine ‘vin ordinaire’ (i.e. table wine, country wine), they need to concentrate on quality production by relying on the whole product structure of the sector, complemented by wine tourism and other services (e.g. wine-related event organisation). It is curious that, while wine producers in the New World have always considered wine tourism as an integrated part of the economy, in Europe producers’ interest in wine tourism has started to grow as a result of the losses caused by the crisis of overproduction and, presumably, the accompanying decline in rural development (Bonnieux & Rainelli, 2000). Several studies have shown that wine tourism, both as a direct marketing tool and as a marketing method to increase local trade, can have a positive impact on future wine trade (CNCCEF 2009; Bettini, O. 2013). As described above, the wine and wine sector is already complex in terms of its product structure and services. This is also true for wine tourism, whose development depends to a large extent on the quality and diversity of the services provided by producers to tourists, when farm diversification has been recognized as a resilience strategy (Gonda, 2016; Zanetti et al. 2023), on brand loyalty certified by returning visitors and on cooperation with authorities that guarantee infrastructure improvements, allowing visitors to access wineries (Mitchell and Hall, 2004; Mitchell, 2006; Ingrassia et al. 2022). It is interesting to note that in many notable wine regions without sales problems, where producers export most of their wine (e.g. Champagne), wine tourism is often seen by some companies as a waste of time and an unnecessary expense in the light of their international commercial success (Charters and Menival, 2011). From a strategic point of view, it would be interesting to assess whether there is a link between wine tourism and consumer behaviour that could have a positive long-term impact on the export of high-quality wines with a high reputation. The main attractions of wine tourism are therefore:

1. the quality and uniqueness of the wines - famous brands
2. the complex product structure of the wine sector
3. gastronomy linked to wine
4. terroir and vine-growing areas
5. the cultural heritage of the wine region
6. other relevant tourist attractions that can be marketed as a complex package of programmes within the framework of wine tourism (e.g. wellness, recreation, health tourism, etc.)

7. wine routes
8. accessibility, communication
9. infrastructure development
10. the quality of accommodation and other services such as wine courses, practical training: „make your own wine”, personal wine tasting, etc.

Wine tourism is therefore not only beneficial for individual wineries because they can sell their wines directly but also improves the infrastructure and economy of the whole region, given the strengthening of businesses providing other services to tourists. Byrd (2016) classifies the products and services of wine regions into three main categories (Figure 3):

1. The „core product” is wine itself, but we include here directly all food and food-like products derived from the vine plant and related to wine (grape fruit, grape juice, grape brandies, grape must, grape spirit, grape marc, grape-seed oil, grapeseed meal, grape skin extract, grape jam and grape jelly, raisins, dried grape pulp and grape powder), which is more a family of main products, which fits better into the concept of multifunctional agriculture (Némethy et al. 2016).
2. Augmented services include all services and activities directly related to the winery, such as vineyard and wine works, customer service, social events and wine clubs.
3. Ancillary services that are not part of the wineries’ activities but contribute to their success (other regional tourism programmes, local entertainment, accommodation and transport).

Recent research has shown that the benefits directly linked to the main product, i.e. wine, such as wine tasting and shopping, are the most important factors attracting tourists to a particular wine region or winery. Complementary services and attractions such as the winery environment, the aesthetic value of the cultural landscape, and visiting winery-related events and activities were ranked second, while ancillary services such as the historical and cultural attractions of the area and other recreational services were also important, but not as important as the previous two categories, the main product and the complementary services (Byrd, 2016; Chauvin, 2025). A specific segment of wine tourism is eco-wine tourism. Organic farming is spreading in the wine-growing sector and the demand for organic wines is steadily increasing, so that more and more wine tourists are interested in organic (both “traditional” organic and biodynamic) farming, which further increases the economic viability of organic production.

Wine routes are also an essential element in the development and marketing of wine

tourism and the protection of cultural heritage. Wine routes are tourist routes that link several wineries in a region, providing the public with the possibility to taste and buy wine directly from the producer, ideally with hotel/boarding house and restaurant services. Three main types of wine routes are distinguished:

1. Classic wine routes, traditional routes that tourists can follow independently
2. Thematic wine routes linked to a specific theme or attraction (gastronomy, natural environment, terroir, cultural landscape)
3. Open wine routes, formed by a network of different wine production and wine culture sites (Bujdosó & Dávid, 2007).

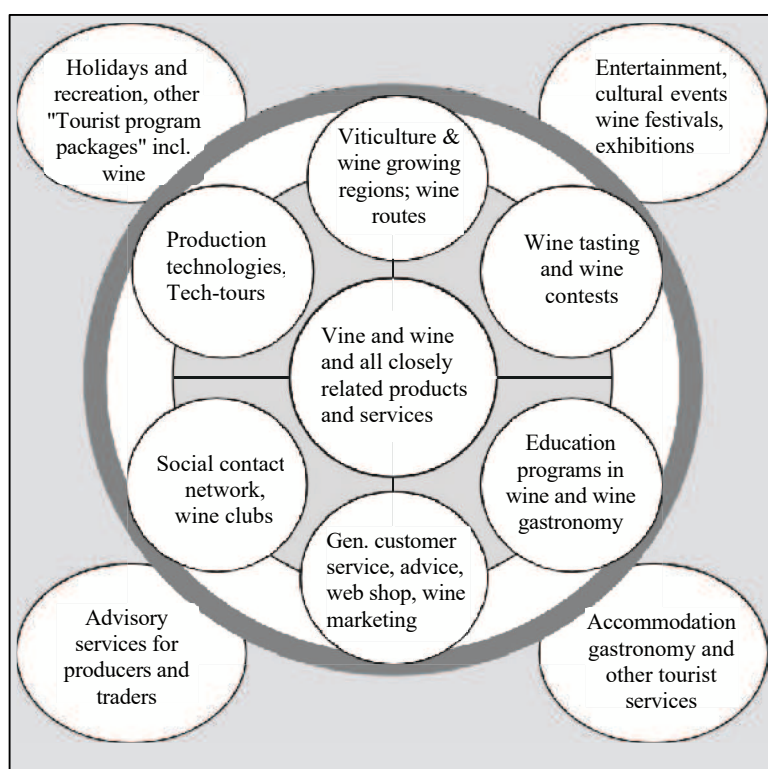
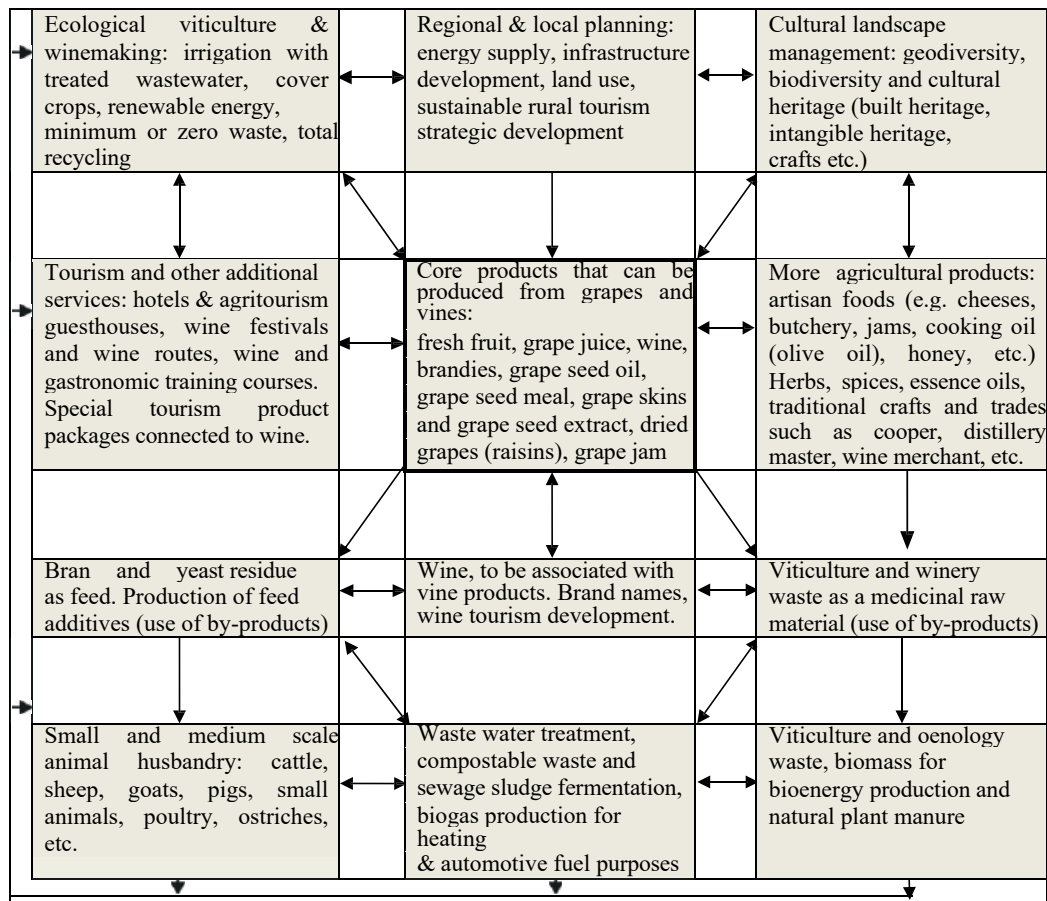


Figure 3. Products and services of wine regions based on Byrd's (2016) system, modified and adapted to the concept of the holistic Azienda Agricola Model. Although wine is considered the main product, all products derived from grapevines (grape juice, brandies and their various aged versions, grapeseed oil, grapeseed meal, grape skin extract) are also included in this category. Complementary services are closely related to the main product family. These include production techniques, knowledge of the countryside and wine trails, organised wine tours, training, wine judging, sales, wine tasting, social contacts, wine clubs. Although not always directly linked to the production process, ancillary services are essential for branding, marketing, broadening professional and commercial relations and increasing economic stability.

The Azienda Agricola Model (Figure 4) is therefore based on the concept of multifunctional ecological agriculture. As mentioned above, the vine is a highly valuable multifunctional special crop, which forms specific vineyard landscapes, provides the opportunity for multiple levels of agroecosystems and the overall product structure described above, and the system of services that can be linked to it, which together with the elements necessary to sustain the operation (e.g. energy supply, waste management, infrastructure development, human resource management, etc.) form the framework of the Azienda Agricola Model. This holistic agricultural production system and management allows farmers to ensure their economic sustainability by developing a complete finished product and service system that serves not only grapes and wine but also wine tourism, encompassing everything that a farm that designs its complementary products and services in a proportionate way can provide (Figure 4).

Figure 4. The Azienda Agricola Model for the vine and wine sector. A model of multifunction-



al agriculture based on ecological cycles, sustainable use of ecosystem services, sustainable cultural landscape management, protection of cultural heritage and total product structure (modified after Némethy et.al. 2016).

The Azienda Agricola Model is therefore not only an organic farming and service business model but also includes links to local and regional development by understanding the sustainable use and protection of ecosystem services and the maintenance of natural and anthropogenic ecological cycles not only within the framework of the own economy, but also within the larger local and regional systems. One of the key features of this is the preservation of the character of vine-growing cultural landscapes through the development of local and regional development strategies that take into account ecological conditions and cultural heritage (Val de Loire - Loire Valley World Heritage, 2011; Lagerqvist & Bornmalm, 2015). The model can in fact be seen as a functional CSR map, taking into account the ever-present requirement for continuous improvement, monitoring mechanisms, a strategic approach, the need for a workplace and a socially responsible approach to the development of the region. Creative and social functions and, not least, a commitment to organic farming is encouraged (Barber et al. 2010; Gonda, 2017; Gamage et al. 2023). The development of the service sector and agritourism reduces the vulnerability of agribusinesses to, for example, weather conditions, providing a significant income even if a major crop loss or quality deterioration has been caused by weather in a given year. This is particularly true for wine production, which is specifically 'seasonal'.

Conclusions

Multifunctional organic farming is the sustainable form of farming of the future, applied in the right system, it guarantees not only the protection of the environment but also the economic viability of the farm enterprise. Multifunctionality implies the pursuit of a complete finished product structure, the production and marketing of local products locally or at least regionally, the development of a system of non-food products and services (renewable energy, energy crops, waste-to-energy systems, traditional crafts, agritourism, advisory services, etc.). The multifunctional Azienda Agricola model can only be understood in this context.

Agritourism (including wine tourism) is a highly complex sector of tourism, with high demands in terms of tourism product development, target group-oriented marketing and management. Well-planned wine tourism, considering the carrying capacity of the region, can make a major contribution to increasing the economic viability of wine-growing enterprises. Of particular interest is the link between wine tourism and gastronomy, the organisation of wine tourism programmes, wine festivals, special events promoting national gastronomic traditions (e.g. goulash cooking competi-

tions, fairs of artisanal foodstuffs), their marketing impact and their importance in preserving the gastronomic cultural heritage.

The cultural landscape perspective is a basic requirement for sustainable rural development and the preservation of cultural heritage. Agricultural landscapes, including wine-growing landscapes, are exposed to a number of natural and anthropogenic threats. Particularly serious are those threats that may fundamentally, adversely and irreversibly alter the image of the landscape, reduce or prevent access to ecosystem services (e.g. encroachment and development of coastal, river and lake areas - a typical conflict between inappropriate land use and nature conservation). A management concept based on a cultural landscape perspective interprets agricultural landscapes and their associated agro-ecosystems, natural ecosystems and ecosystem linkages (ecotones), the use of natural resources, the conservation and progressive use of cultural heritage, and their integration into spatial development strategies, as well as the ecological, social and economic carrying capacity of the area concerned when developing tourism strategies, as a coherent system.

Precision organic agriculture supported with Artificial Intelligence, introduction of robotics in farming and food production will ensure the environmental and economic viability of agricultural enterprises, enhance the remediation of agroecosystems adversely affected by monoculture and increase climate resiliency by reducing GHG emissions and increasing biodiversity and the carbon storage capacity of soils.

Organic wine production and organic, additive-free food in general are gaining popularity and can be further improved in value for money systems based on the principles of the Azienda Agricola Model, given the economics of the energy-product/service-waste cycle and the possibility of selling products locally without any intermediate links, which is created by agritourism. Bio-wine tourism and ecological agritourism can be easily linked to other tourism packages, especially ecotourism, which can be good examples of non-formal training and offer an excellent opportunity to promote the cultural heritage of tourist destinations.

The Azienda Agricola Model is universal, although it was developed for wine production, it can be applied to all sectors of agriculture with the right modifications. Its role in the development of agritourism is significant: its holistic approach offers excellent opportunities for tourism product development. It is strategically sound, with built-in monitoring functions and feedback, it greatly facilitates adaptation to changes in the natural, social and economic environment.

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