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THE USE OF AGRIVOLTAIC SYSTEMS, AN ALTERNATIVE FOR ROMANIAN FARMERS

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Abstract

The climate changes of recent years require more and more the finding of alternative solutions for the provision of electricity at the farm level. More farmers from countries such as Germany, France, Italy or USA use agri/agrovoltaic systems. Such a system used in livestock farms and placed directly on the grassland, allows, in addition to obtaining the necessary electricity for the operation of essential consumers (e.g. watering system, electric fence or electric tractor), providing shaded spaces for species such as sheep, cows or rabbit. Research carried out over the years has demonstrated the effectiveness of such systems, especially in the case of shade-tolerant fodder crops (clover, alfalfa). At the EU level, legislative solutions are being wanted that can be easily implemented in the member states and that can support farmers. This study reviews and analyzes the existing legislative solutions for Romanian farmers and opportunity to use agrivoltaic systems on the lands intended for grazing and the cultivation of fodder plants.

Key words*: agrivoltaic farming, climate change, Farm 5.0, solar grazing.*

INTRODUCTION

The extreme climatic phenomena (prolonged droughts, floods, extreme temperatures for several days, etc.) present more and more frequently in the last decades in countries where they appeared at large intervals of years, have attracted the attention of farmers and researchers from all over the world. The reduction of greenhouse gases is currently an international priority to prevent these extreme phenomena.

The use of renewable energy sources is imperative and also represents an extremely beneficial option for farmers, where local sources can be used (solar energy, thermal energy, wind energy, biomass, biogas, etc.). In this context, one of the first actions in the European Green Deal is the 2030 Climate Target Plan, aiming to reduce 55% of the greenhouse gases by 2030 (European Green Deal, 2020). Among the challenges of the last few years, the most often talked about are land use conflicts for agricultural purposes or for the installation of equipment for the conversion of renewable sources (Brohm & Nguyen, 2018). Food and energy systems have a profound impact on society, economies and the environment, making them central to meeting multiple Sustainable Development Goals (IRENA-FAO 2021).

As is knows, solar photovoltaic energy is one of the cheapest sources of electricity available (Vartiainen et al., 2019). In this context, the German Fraunhofer-Institute for Solar Energy Systems (Fh-ISE) in Freiburg has been a pioneer for solar dual use research in the early 1980’s. Researchers from this institute have tried to find a solution for the dual use of the land, both for obtaining solar energy and for growing plants, using solar panels mounted at height and not at ground level. This type of installation allows the activities specific to agriculture, horticulture or aquaculture to be carried out under these panels (Frauenhofer, 2022).

The simultaneous use of the same area of land for photovoltaic and agricultural production (which includes aquaculture also) is known as agrivoltaic, agrovoltaic or agrophotovoltaic systems (abbreviated AV or APV). Many studies, carried out in specialized research institutes or universities worldwide, have discussed international best practice in solar energy dual use applications in different regions of the world. As previously stated, a frequently discussed problem in countries where the production of electricity at the level of photovoltaic parks is in full development is represented by the conflict of land use, respectively mono-use versus food production. (Trommsdorff et al., 2022). A variant proposed by researchers and accepted by farmers in several countries is represented by the integration of solar energy and grazing in one place. This solution offers benefits to both renewable energy operators and animal breeders. Thus, the productive use of agricultural land can be maximized, especially pastures or more degraded land, but also to reduce the operating costs of the photovoltaic park (Clean Energy Council, 2021).

After Germany, Japan is the second "birthplace" of the solar dual-use concept (being called "solar sharing"). A guideline for dual-use solar applications on agricultural land has been introduced in this country by the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) since 2013 and 2014 (https://www.maff.go.jp/e/pdf). Sheep grazing on solar farms ('solar grazing') has been introduced and employed in the past decade across many countries across Europe, Americas and Oceania (especially Australia and New Zealand) (ASGA, 2019).

The Innovative Solar Practices Integrated with Rural Economies and Ecosystems (InSPIRE) program, managed by the National Renewable Energy Laboratory (NREL), seeks in this context to improve the mutual benefits of solar, agriculture, and native landscapes in USA (U.S. Department of Energy, 2022). In additions to sheep, other species (e.g. cattle, goats, horses, rabbits, chickens or geese) have been proposed and tested for solar grazing. Depending on the chosen mounting system of the AV panels (height from the ground, way of orientation, fixing of the supporting frame, etc.) they were considered in the case of certain species unsuitable for large-scale solar farms, for example due to the size (in the case of cattle) or their behavior (in the case of goats) (Stepanek Shiflett, 2021). In the case of rabbits, researchers from the Michigan Technological University tested a new way to integrate the agrovoltaic system in micro farms with the assessment of the life cycle of these animals. (Pascaris et al., 2021).

It must be stated that the obtained electricity on a 'solar pasture' it can be used to run the farm with electric tractors and precision equipment or to provide electricity for irrigation installations with reduced consumption and losses. Depending on the daily consumption, the surplus energy can be stored in battery banks, for use during the night or in bad weather, or it can be sent to the grid for use by other farmers (Nealon, 2023).

In countries with a tradition of sheep grazing, good practice guides have been developed in recent years to inform farmers of the advantages of agrivoltaic systems. For example, in 2015 the first Australian solar farm that started grazing sheep and implemented agrisolar practice was Royalla Solar Farm (Stepanek Shiflett, 2021). With the growing interest in Solar Grazing in 2016 in the US, the American Association was established to connect solar farm advocates and agricultural businesses (ASGA, 2019). In many cases it has been shown that animals that graze around solar fields offer several benefits. Besides the fact that their manure enriches the soil, a big advantage is the fact that the consumption of the vegetation around the panels keeps plants from growing too tall and by this to shade the panels. Therefore, by grazing in the area of solar panels, lower vegetation maintenance costs are obtained, largely replacing lawnmowers or other landscaping (Freehill–Maye, 2020). Field-scale arrays of ground-mounted PV modules, or "solar farms", were seen in Britain only since 2011. The general design and construction philosophy appears to be to minimize any changes to the ecosystem and to maintain agricultural production. To help promote the dual use of land the British Renewable Energy Trust has in July 2014 produced the Agricultural Good Practices Guide which details various agricultural uses such as sheep, geese, chickens and hay (Fletcher & Lewis, 2014).

For sheep or cattle's farmers, in the context of solar grazing, vertical bifacial solar panels can replace farm fences, thus improving animal welfare, protecting grazing areas and providing protection against predators (Fookes, 2020).

In the year 2020 in Baden-Württemberg (Germany) was put into use the Donaueschingen-Aasen solar park. This is the largest agrivoltaic system in Europe. The 14 ha total area is use for hay and silage (Next2sun

2022). Also, previous experiments carried out on different types of crops have shown that agrovoltaic systems work well with both shade-tolerant and shade-intolerant plants (Sekiyama & Nagashima, 2019).

Fish farming is particularly a sensitive sector in terms of environmental impacts (www.maff.go.jp). In the case of aquaculture in recent years, some applications have appeared for the integration of solar energy in this sector as well. In Asian countries (for example, Thailand or Vietnam), where there is a tradition of eating fish and seafood, photovoltaic power plants have been built over shrimp farms and fish farms on land. They ensure, in addition to the necessary shade for certain periods of the day or for different species, the production of electricity used to operate pumps, aerators or food distributors (Fraunhofer, 2020).

A special attention was paid at a solar pasture, to the mixture of native or sown honey plants, which can provide a habitat for bees and other pollinators (Burns, 2019).

Supporting biodiversity and maintaining or restoring native vegetation in solar farms represented another objective proposed and pursued both in European countries and in the USA or Australia. The aim is thus to provide a protected habitat for wildlife and beekeeping (Horowitz et al., 2020). Thus, the first and most important step when thinking of combining both activities (livestock and energy production) will be analyzing the different crops and livestock options also the legislation in the field of renewable sources for every type land and countries.

MATERIALS AND METHODS

In the next years investments in the solar sector will definitely answer the rising demand for electricity in the all countries. Yet the most likely from an ethical point of view, it must be ensured that the production of food always takes priority, instead of removing the land from agricultural use and installing solar panels on these surfaces. Thus, an agrivoltaic system presents a number of advantages compared to traditional ground-based photovoltaic systems: higher electricity yield (especially in the case of bifacial vertical systems), harvest yield (systems that can self-orient during the day) and savings of water (for washing the panels) compared to usual practices (Campana, 2022). When an agrivoltaic project is proposed, there are usually two or more parties whose interests may be different. On the one hand, the farmer or the land administrator, and on the other, the company developing the solar park. In some cases, the opinion and acceptance of the local community of the development and implementation of such a project is also taken into account (Dreves, 2022).

Agrivoltaic systems

By definition the Agrivoltaic systems refers to the way of farming parallel to generating solar power by installing solar panel arrays on arable land and cultivating crops on the ground, beneath or between the panel (Kim et al., 2021). As is known at the present time there are two types of agrivoltaic systems: a) systems involving agricultural activities on available land in pre-existing PV facilities, and b) systems intentionally designed and installed for the co-production of agricultural crops and PV power (Kumpanalaisatit et al., 2022). There are several possibilities for mounting agrivoltaic systems. They can be installed like a traditional solar plant, with the panels in close rows slightly raised from the ground or spaced and elevated to provide more light to the plants and to allow livestock and farm equipment to move between and under them (Dreves, 2022). In recent years several forms of Agrivoltaic have been developed around the world, the innovative approaches emerging depending on the specifics of the area or countries, the legislation regarding agricultural land, use (for horticultural crops or animal husbandry) etc. (Clean Energy Council, 2021). Typically, agrovoltaic systems are broadly classified according to different criteria (Figure 1). Thus one can take into account: the type of system (closed or open), the type of structure (interspaced PV, overhead PV, integrated PV greenhouses), the inclination of the modules (fixed, one-axis tracking, two-axis tracking) and the type of application (grassland farming, arable farming, horticulture and aquaculture) (Gorjian et al., 2022).

As previously stated, agrivoltaic applications are diverse and include, depending on the country: the production of crops and food (vegetables, cereals, hay or vines), solar greenhouses, animal production and ecosystem services through vegetation management (Figure 2) (Macknick et al., 2022)

Many studies carried out up to now had as their objectives the finding of optimal technical solutions, from the point of view of the materials used in the manufacture of solar cells, (e.g. modules based on c-Si, a-Si, CIGS, and CdTe) the way of mounting the solar panels and their orientation during the day (Victor du John et al., 2020). The degree of opacity of the photovoltaic panels was also studied, establishing its influence on the development of plants in the area shaded by them and the rate of water evaporation (Yano et al., 2014, Pulli et al., 2020). Dupraz et al. proposed since 2011 a combination of PV panels and food crops to maximize land use. An indicator initially introduced to determine the productivity of a certain land and used to evaluate the value of mixed crop systems is the LER (Land Equivalent Ratio) (Dupraz et al., 2011). Because it combines two types of production on the same land area, the concept of LER can be successfully applied to the agrivoltaic system (dual-use solar system)

So according to the definition, the LER of a dual-use agrivoltaic/solar system is defined as follows:

LER = (Yieldcrop in dual use / Yieldmonocrop) + (Yieldelectricity in dual use / YieldelectricityPV)

Marrou et al. (2013) and Adeh et al. (2018) proposed another coefficient, namely the water usage efficiency (WUE) that quantifies the impact of the PV design on agricultural production.

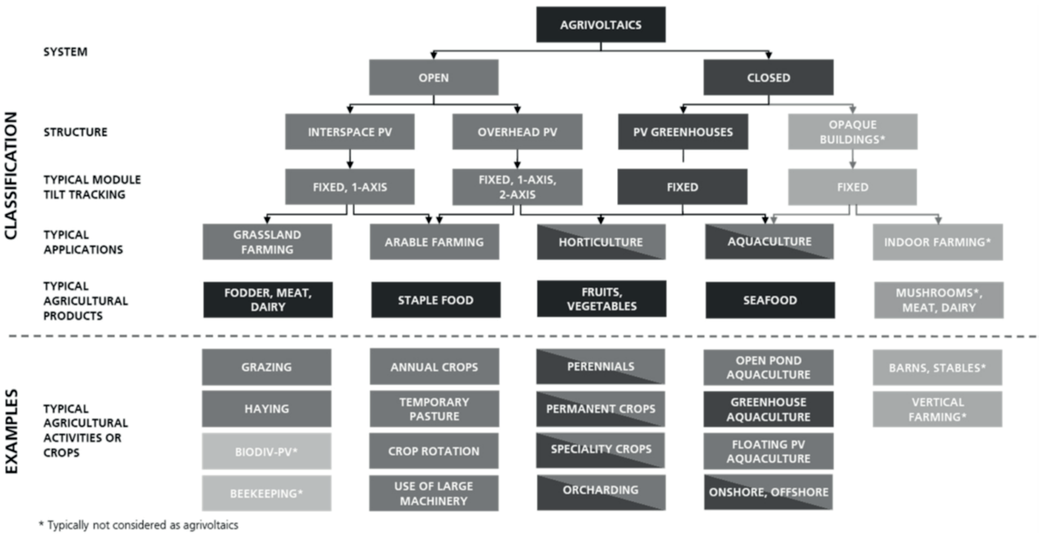

Figure 1. Classification of agrivoltaic systems (Gorijan et al., 2022)

Water use efficiency (WUE) is defined as *the amount of carbon assimilated as biomass or grain produced per unit of water used by the crop* (Hatfield & Dold, 2019).

According to *The Green Grid* (Watkins, 2013), water consumption includes, in the case of MW solar farms, water used for equipment cooling, humidity regulation and on-site electricity generation. The photosynthetic process and the transpiration of the crop represent two elements with major influence on the yield of the crop. It has been demonstrated through numerous studies that the solar radiation of the soil represents an influencing factor of these processes, being a parameter that can change under the conditions of agrivoltaic systems. Also, the important factor for crop growth is the wavelengths between 400 nm and 700 nm of the solar spectrum that is called the photosynthetically active radiation (PAR) (Willockx et al., 2020).

Usually, the design and evaluation of agrivoltaics must open new perspectives, this being possible if the system is approached as a three-dimensional model (Toledo & Scognamiglio, 2021). As shown in the Figure 3, such a model is characterized by a certain degree of randomness, both in the horizontal and vertical arrangement of the modules.

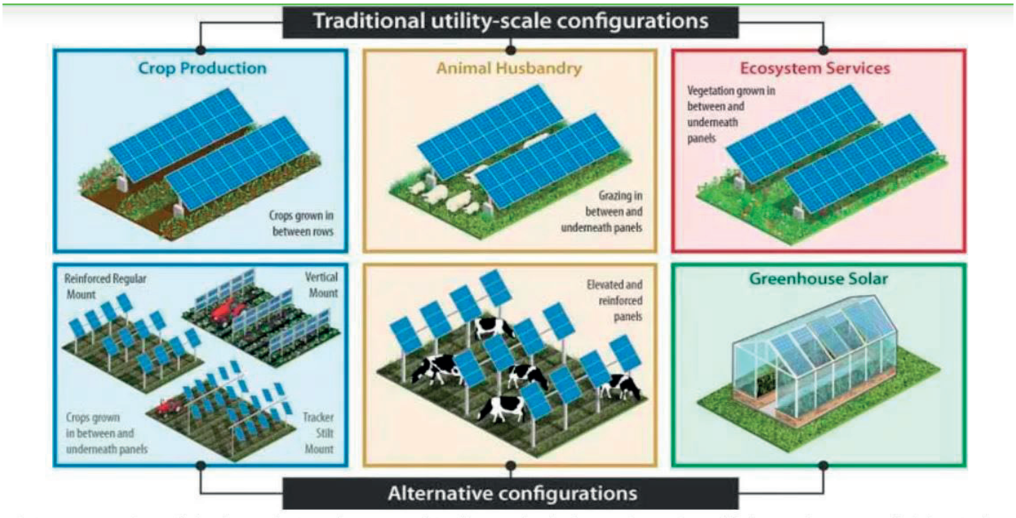

Figure 2. Different types of agrivoltaics systems (Macknick et al., 2022)

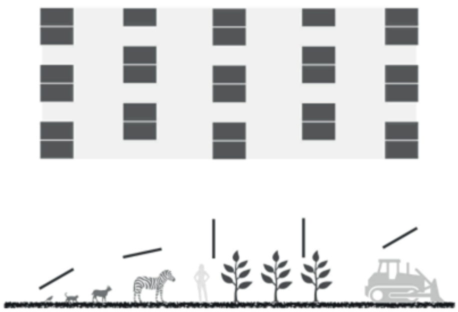

Figure 3. The design of agrivoltaics
(Toledo C. and Scognamiglio A., 2021)

For technical barriers, there are already commercial solutions that combine mobile panels that are automatically controlled by software (Toledo & Scognamiglio, 2021). These can be integrated with a specific agricultural crop, processing data on temperature, soil moisture, weather forecasts, etc., to ensure optimal performance and a better plant protection (Weselek et al., 2019).

The type of farming activity that is possible and its success can be determined by the type of racking system. The construction type and the installation of the panels can affect the availability of the land for vegetation, crops and animal activities (Macknick et al., 2022).

From an agricultural point of view, an agrivoltaic system can reduce water evaporation, protect crops from certain weather conditions and generate new agricultural business models, by being able to incorporate new varieties of shade-tolerant plants, especially for areas intended for grazing (Chalgynbayeva et al., 2023).

In most cases, the photovoltaic panels are positioned approximately 5 m from the ground, free to rotate around 1 or 2 orthogonal axes. At such a height it is possible to use, for example, machines for harvesting fodder or those for meadow maintenance.

Next2Sun Company (Germany) has developed and experimented a series of installations vertical, installations with bifacial photovoltaic modules facing east and west and with a distance about 10 m between the rows, which lends itself very well to activities in agriculture (https://www.next2sun.de).

Bifacial modules are characterized by the fact that both sides have a glass surface, so can both generate electricity. At the moment, bifacial n-type glass-glass modules with an output of approximately 400 watts and efficiency of around 20% are generally used. A vertical fence with a southern orientation produces only around 5% lower electricity yield than an east-west orientation (if neither are shaded (https://next2sun.com/en/solar-fence/solar-fence-the-pv-innovation/).

Already, worldwide, AV systems are used on a GW scale. We can definitely say that an AV system can increase the efficiency of the land, through the massive expansion of photovoltaic energy in the farm area. At the same time, fertile soils are preserved for agriculture or grazing, and in the case of lean soils, biotopes rich in different species can be created (Wirth, 2021).

In recent years, with the decrease in the costs of solar PV technology, it has been demonstrated worldwide that the development of the dual-use application can be successful. Romania can develop its own agrivoltaic good practice projects, taking as an example the countries that have successfully implemented them, this approach being a viable option for Romanian farmers to avoid or reduce agricultural land use conflicts.

RESULTS AND DISCUSSIONS

The concept *Farm 5.0* describes *sustainable agriculture*. The aim of this is firstly to reduce CO_2 emissions, but also for preserve biodiversity and restore natural cycles (Goldbeck Solar GmbH, 2023). PV modules on agricultural land produce electricity used to operate electric agricultural machines (water pumps, tractors, robots) but also for consumers in production buildings (e.g. animal shelters or greenhouses). The farmers' current goal is for the entire farm to become CO_2 neutral (Goldbeck Solar GmbH, 2023). At the same time, an AV system can integrate into the landscape without causing additional damage. Agrivoltaic systems developed for livestock include grazing and livestock management under, around and directly adjacent to solar infrastructure (Macknick et al., 2022). Very important is the way the animals are directed/housed in the area of the AV modules. They can be on site year-round, seasonally or as needed. This is established by the farmer or together with the solar site administrator.

Sheep

From the experience of farmers from countries with an old tradition in raising sheep it has been demonstrated that hair sheep breeds are popular choices into most solar grazing farms (Hartman, 2022). Other breeders prefer the Merino breed that has a reputation for keeping their heads down and not jumping on equipment (Shiflett, 2021).

In any farm, access to water for animals is essential. The Australian experience indicates that having multiple water sources is all the more ideal for housing sheep in a solar farm. In this way, the grazing of the plots can be ensured and at the same time the risk of the animals consuming too much energy at large distances from these sources are eliminated. Another advantage is the reduced risk of dust formation and thus increased contamination of the PV panels (Clean Energy Council, 2021). It is recommended that the grazing plan can be designed such that sheep are rotated from paddock to paddock, preferable every one to four days (Agrivoltaic Solutions, 2020).

In the case of sheep that graze near adjustable panels (with shaft-tracking systems), a problem that must be avoided is the entanglement of the wool in the moving parts of the motors and joints of the adjustment devices (Clean Energy Council, 2021). For the safety of the equipment and the animals, the protective casings of the electric motors and the emergency stop buttons must also be checked periodically. The method of fixing the electrical cables is also very important. They should be fixed tightly behind the modules, reducing the risk of interference with the wiring of the modules and also eliminating the risk of the sheep's horns getting tangled. A very serious accident that can occur in the case of fallen or improperly fixed cables is strangulation (Clean Energy Council, 2021).

Another aspect that any farmer must take into account is the expenses of operating the livestock. They, also known as variable costs generally vary according to: volume of production (e.g cost with sheep expenses, labor expenses), number of grazed sheep or contracted area (Shiflett, 2021).

Sheep grazing around agrivoltaic systems can be a profitable practice offering local, grass-fed lamb, solar grazing in protected areas and free from polluting agents. This technique brings important incomes to local sheep producers and can help to regenerate damaged land by cultivating specific plant species (Kochendoerfer et al., 2018; Shiflett, 2021; Hartman, 2022).

It is very important that in the case of grazing in the areas of the photovoltaic systems there is a contract between the farmer and the operations manager of the site. This implies collaboration and permanent communication between the farmer and the weekly or monthly maintenance staff. Most of the time, according to local legislation, the farmer can be compensated for grazing under these panels, because grazing significantly reduces the costs of removing excessively high vegetation that can block the orientation systems or cover the surface of the panels. American Solar Grazing Association provides farmers with various sample contracts (Hartman, 2022).

Horses and Catlles

In the case of large animals, such as horses and cattle, the problems that arise are due to the risk of dislocation of the standard mounting systems, the animals having enough strength and weight to destroy them (Scurlock, 2014). In the case of dairy cows raised on pastures provided with AV systems, studies conducted in recent years have demonstrated that in most cases, during the summer, the intensity of heats stress can be reduced and the well-being of the cows can be increased. At the same time, the efficiency of land use also increases (Sharpe et al., 2021). The shadow effect produced by AV modules and the influence on milk production (by reducing heats stress) is a current and future concern of researchers and farmers in areas with solar potential and with herds of dairy cows kept on pasture (Sharpe et al., 2021).

In other case, in a New Zealand farm with Angus bull yearlings was built an array that had panels set at 2.4 meters off the ground. It was observed that the 15-month-old bulls particularly love to scratch on it. The high cost of installation (an extra 80% compared to one suitable for sheep) come from the use of more robust materials to withstand the higher winds found at height, the heavier animals rubbing against them, and added construction costs at height (Delwyn, 2022).

Goats

It is known that the most important characteristic of photovoltaic systems is the production of direct current. The studies carried out in the case of goats, shows some problems due to the fact that they sometimes jump on panels and chew wires (Freehill-Maye, 2020). This behaviour can lead to problems in the operation of an AV system, which generates continuous electricity as long as the surface of the panels is illuminated. Therefore, they cannot be stopped so easily. Due to the fact that sometimes the wires are partially destroyed or the connectors between the panels becomes loose, the flow of current is not interrupted immediately, and the appearance of an electric arc can cause either electrocution of animals or the outbreak of a fire, especially when there is dry vegetation (Wirth, 2021).

Rabbits

In the case of rabbits growth, Michigan Technological University researcher have conducted a life-cycle assessment for a new possibility to integrate the AV system in such a farm. The objectives pursued were the reduction of CO_2 emissions and the consumption of fossil fuels, compared to classic maintenance systems. Three experimental variants were analyzed and compared: an agrivoltaic project based on pasture-fed rabbits, solar photovoltaic generation combined with conventional rabbit farming, and a conventional electricity generation business combined with rabbit farming. In the case of the developed new agrivoltaic concept the results showed a 69.3% reduction in CO_2 emissions and an 82.9% reduction in fossil fuel consumption, compared to non-integrated production (Pascaris et al., 2021). In another study by Lytle et al., in 2020, it was found that the integration of some AV systems in rabbit farms may have enough benefits to lean towards their widespread use. For example, economic gains can be recorded (income either from the sale of rabbits or from land rent), cost savings for maintenance (e.g. by using the ground support for the panels, as a support for the installation of protective fences) and a better animals welfare (through protection against of the sun or precipitation and last but not least of the predators from the air) (Lytle et al., 2020).

Honeybee

The problem of natural pollinators, especially bees, is also a fairly current and intensively discussed topic. The dangers, to which bees are exposed, due to the excessive use in agriculture of various chemical substances as well as due to urban pollution, have been a topic of worldwide interest for many years. A solution that can help both the breeder and the local bee population can be the use of areas with potential for the growth of honey plants for a double purpose: the integration of AV systems on these surfaces and the cultivation of some plant species without the risk of being contaminated.

At the same time, the success of a solar beekeeping venture depends on a solid relationship between the beekeeper and the solar project manager. The best practice guidelines established after the studies carried out by in the New York State in the field of solar beekeeping recommend, among other things, the establishment of positive working relationships between a commercial beekeeper and a solar site (MacKenzie, 2021). It must be taken into account that beekeepers prefer unrestricted access to their apiary locations. Another requirement of the beekeepers is related to the confidentiality of the location of the hives, to ensure the security of the bee colonies. But, at the same time, those who maintain the panels must be warned not to destroy the hives by mistake and worse, not to be attacked by bees. Another aspect that should not be omitted is the bees' access to water, for drinking and moderate temperature in the hive, the source being preferably located near the hive (MacKenzie, 2021).

Fish

The integration of solar infrastructure with aquaculture activities constitutes another area of interest, being an application that is starting to be promoted and developed especially in Asian countries (Vo et al. 2021). Even if in some countries the use of these systems in intensive fish farms are not yet recognized as agrivoltaic systems, with climate change they can be successfully integrated to ensure, in addition to the production of energy necessary for the operation of various equipment (pumps, filters, aerators, food distributors, etc.) better conditions for the growth of species less tolerant to light or high water temperature.

Agrivoltaic in Romania

Due to its geographical position, Romania has a fairly extensive solar potential. The country benefits from approximately 210 sunny days per year in the south-east, west, center and east, which are the best places to locate a PV park (Vrînceanu et al., 2019). In 2021, approximately 7% of the energy generated in Romania was from solar PV sources (International Trade Administration, 2022). The government of Romania announced plans to add around 7 GW of new renewable capacity comprising around 3.7 GW of solar energy by 2030 (Mordorintelligence, 2022). In the year 2020 about 38.75 % of the arable area of Romania utilised for agriculture and horticulture (Data Worldbank Romania). The concept of "prosumer" introduced in Romanian legislation starting in 2018, allows people to produce green energy for their own consumption and deliver any surplus to the distribution grid (RWEA 2021).

The biggest problem for the symbiosis of agriculture and energy in is the ban on the use of concrete constructions on agricultural land. Until now, the process of building SRE in agricultural areas in Romania has been quite complicated and confusing. First of all, the land must be prepared, the status changed from "agricultural" to "for construction purposes", so that the construction activities of SRE plants can start on it. The fees for this transformation in Romania are not small at all and are paid before there is any certainty regarding the final success of the project (European Commission, 2020). According to Emergency Ordinance 34/2013 regarding the organization, administration and exploitation of permanent pasture and for the amendment and completion of the Land Fund Law no. 18/1991 ("Pasture Ordinance"), permanent pasture located outside the village can only be used for animal grazing and fodder production (Nyerges, 2022; Bellini, 2022).

By way of exception, the permanent pasture located outside the village can be used for

certain objectives, including the establishment of new renewable energy production capacities.
A practical solution to ensure the coexistence of solar projects and grasslands is to install taller poles to allow livestock grazing and forage production under the panels (Nyerges, 2022). By Law no. 21/2023, the new changes are implemented that favor the acceleration of the development process of photovoltaic parks in Romania and of green energy in Romania with a significant period of time. (Official Monitor - Law no. 21 of January 9, 2023)
The new rules also set lower permit fees for PV projects in case of dual system applications. (Mărgărit et al., 2023).
The new concepts of agrivoltaic use developed on the plan worldwide can be represent land sharing solutions without interfering with different environmental policies.

CONCLUSIONS

Different national legislations forbid the fixing of photovoltaic panels to the ground using concrete, which limits the technical possibilities of installation. An Agrivoltaic system defuses the land use conflict and offers farmers additional sources of income. With this, farmers can supplement or even replace their electricity consumption from conventional sources and at the same time improve the conditions for raising animals and fodder plants. The numerous studies carried out in recent years in countries on all continents, show that an AV power plant is not incompatible with the grazing activity or other agricultural activities carried out on the land where it is locate. And unlike classic PV constructions, it has a minimal impact on the environment. Installing solar panels on farmland, slightly elevated to allow sheep or other animals to graze underneath, is an easy way to combine food production and electricity production on the same land. As long as there is enough sun for grass to grow, sheep provide the advantage of controlling vegetation, thus avoiding overgrowth and fire hazards. Farmers hope that the new amendments to the Land Fund Law will open a new stage in the development of agrivoltaic systems in Romania.

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