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Legal analysis of the management of harvest residues in South-West Europe¹

1. The strategic lines of the CAP and the crop residues

According to the Food and Agriculture Organization of the United Nations (FAO), conservation agriculture comprises a series of techniques whose fundamental objective is to conserve, improve and make more efficient the use of natural resources through integrated management of soil, water, biological agents and external inputs, in order to obtain sustainable production, developed under the strategic lines laid down by the Common Agricultural Policy (CAP).

To this end, we must bear in mind that the fruits derived from all agricultural production are diverse and take into account the type of crop and production system from which the fruits will always be derived (from the olive grove, the olive tree, from the greenhouse of vegetable growers, pepper, tomato, aubergine, among others, etc.) which is where the farmer obtains the main income; together with the by-products (wood from the olive grove; and from the greenhouse for vegetables the vegetable remains) from which the farmer can obtain income derived from the sale, or reduction in the production costs after an adequate treatment that reverts, for example, in fertilizers for the soil

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¹ Work developed by the author as researcher Project of the Research Project with “Integral management of harvest remains in greenhouses for a profitable and sustainable production: technical and legal challenges (GREENSOILS)”, with reference: AGL2017-83551-R financed in the call PPUENTE2019/005; and Project “Retos y oportunidades en los procesos de concentración e integración del sector agroalimentario”, with reference: P12-SEJ-2555.

or as feed for the cattle. In this way, the farmer fulfils one of his obligations as a producer: to carry out agricultural activity without damaging the environment, avoiding as far as possible to affect the resources used for production, such as water, soil and air; from the economic and social sustainability, as established in the new CAP and by the FAO.²

We are going to focus our work on the fruits derived from all agricultural exploitation that are not included in the main production, under any of their categories, vegetable remains or by-products such as firewood, which form part of the circular economy, and we will examine them in terms of the valuation of the remains and improving the environmental sustainability and quality of the subsequent production, through the improvement of the soil and preventing the arrival of remains of phytosanitary products derived from fertilisers in the water, with good practices in the use and management of the by-products and harvest remains.

1.1. South-west Europe: Almeria

The study on the remains of the harvest will focus on Almeria, located in South-west Europe, because it is the place with the highest concentration of greenhouses in Europe; and because here the horticultural sector continues to demonstrate its strength and its value is strategic for the national and Andalusian economy, both for its contribution to final agricultural production and for its clear suitability for being exported, mainly to Europe, which enable the production of fruit and vegetables in a sustainable way under the innovation and development of a sector that needs specific regulation on the use and management of the remains of the harvest.

The data obtained from the Ministry of Agriculture, Fisheries and Rural Development of the Junta de Andalucía confirm that Almería concentrates 87.4% of greenhouse facilities in Eastern Andalusia with a total of 31.614 hectares (representing 58.9% of Europe's wintering area³), thus monopolising the increase in the entire Mediterranean strip by registering 580 hectares more than in 2017, all this, with the regions of Almería's Poniente (21,545 hectares, 260 more) and Campo de Níjar and Bajo Andarax (8,748 hectares, 280 more than in the previous year) as the main bastions. The map of crops produced in foil tunnels in Almería covers the areas of

² M.J. Cazorla González, F. Millán Salas, *Agricultura de conservación y restos de cosecha derivados del invernadero y del olivar*, "Revista de Derecho Agrario y Agroalimentario" September 2020.

³ <https://www.juntadeandalucia.es/organismos/agriculturaganaderiapescaydesarrollosostenible/actualidad/noticias/detalle/197488.html> [accessed on 20.06.2020].

Bajo Almanzora (686 hectares), Campo de Tabernas (326 hectares), Río Nacimiento (243 hectares) and Alto Andarax (66 hectares).⁴

These surface data are translated into tons of production and harvest residues as we will see below, which when they leave the greenhouse are classified as residues with the presence of pesticides.⁵ This source of contamination of the environment by pesticides is very important given the large amount of plant residues generated in greenhouse crops in Almería.

This area yields annual production exceeded 3.5 million tonnes of debris in the 2014/15 seasons in Almería, and in the last 7 years the figure has not been lower than 3 million tonnes of green plant debris a year.

The production systems that we find in foil tunnels in Almería are diverse, and serve two cycles per annual i.e. autumn and spring, which focus on tomato, pepper, courgetti, cucumber, eggplant, lettuce, watermelon, melon and bean.

However, in order to regulate the use and management of plant remains in terms of economic profitability, these data must be centred on the harvest residues generated per cultivated product, as it is not the same vegetable mass that remains in a production of cabbages, than the one obtained from a tomato production at the end of the season, since tomato biomass is lower. But it is not only the amount of organic matter, but also its use for the soil which is important, because while the remains of cabbage allow us to disinfect the soil, those of the tomato will need other external inputs of plant remains, organic fertilizers or even chemical elements, depending on the type of soil disinfection or other desired uses.

This agriculture takes into account the change that has taken place enterprises located in the vicinity of the farmer's land, not only the ones which sell to him goods in order to enable him to carry out his production, but also are the ones which carry out research to bring added value to the work in the greenhouse and contribute to the fact that the horticulturist's own profit and loss account gives positive dividends each season, by ensuring respect for the environment, bringing at the same time food to the consumer.

However, the weaknesses is the high seasonal concentrations of plant remains in two seasons of the year the producers of Almería consider that

⁴ Data from the work presented at the CEDR Congress held in Potsdam. XXX European Congress and Colloquium of Agriculture law. September 2019 by M.J. Cazorla and A. Guarnido.

⁵ Endosulfán was the most frequently detected pesticide (in 33 of the 45 samples), so there is an urgent need to control these post-harvest remains, particularly if they are used as livestock feed. A. Garrido Frenich, *Rapid pesticide analysis, in post-harvest plants used as animal feed, by low-pressure gas chromatography-tandem mass spectrometry*, "Analytical and Bioanalytical Chemistry" 2003, Vol. 377, No. 6; J.L. Martínez Vidal, M.J. González-Rodríguez, A. Belmonte Vega, A. Garrido Frenich, *Estudio de la contaminación por pesticidas en aguas ambientales de la provincia de Almería*, "Revista Científica Ecosistemas" 2004^a, No. 13(3).

in order to achieve a more efficient and productive system, more attention should be given to greater energy efficiency and the use of water, advances, innovation, technology and modernization of structures, and better management of the remains of the harvesting season. Moreover, a further increase in organic production will keep them on the path of sustainable growth, bearing in mind the consumer as a reference center when considering innovations related to environmental sustainability and the quality demanded by the markets where the final buyers purchase the agricultural products.

1.2. Strategic lines of the CAP

The current situation of intensive agriculture in south-west Europe, which is mainly based on greenhouse horticulture production, implies the harvesting and removing the crop on two occasions, at the end of the autumn cycle, between January and February, up to and including March and the end of the spring cycle in May and June, with the consequent economic cost.

Both cultivation cycles lead to the generation of a large volume of plant remains, some of which have been described as a management problem in areas⁶ such as south-east Spain, where there is a high concentration of intensive cultivation in foil tunnels, and which we, as we are going to try to demonstrate, may become an opportunity for the farmer and of environmental advantage, both in line with the new Strategic Plan of the CAP.

In this respect, we must bear in mind that the monitoring and evaluation of the common agricultural policy requires comparable, up-to-date and reliable information on the economic situation of the agricultural sector⁷ and, more specifically, on the evolution of the agricultural income. There are three general objectives for developing the measures in the Strategic Plans of the new CAP (period 2021–2027)⁸:

⁶ J. Rivera, *Conclusiones del encuentro medioambiental almeriense*, Almería 1999. For Riviera it constitutes an environmental and economic problem in the productive zones of Almería. In the same sense, Torres Nieto speaks. See J.M. Torres Nieto, *Uso agronómico de restos de cosecha en los invernaderos enarenados de la cuenca mediterránea*, Almería 2016, https://www.researchgate.net/publication/278302016_USO_AGRONOMICO_DE_RESTOS_DE_COSECHA_EN_LOS_INVERNADEROS_ENARENADOS_DE_LA_CUENCA_MEDITERRANEA [accessed on 20.06.2020].

⁷ Economic accounts for agriculture are drawn up in accordance with the basic concepts and rules of Council Regulation (EC) No. 2223/96 of 25 June 1996 on the European system of national and regional accounts in the Community. Regulation as last amended by Regulation (EC) No. 1267/2003 of the European Parliament and of the Council (OJ L 180, 18.07.2003, p. 1).

⁸ On 1st June 2018 the European Commission presented its legislative proposals on the future of the CAP after 2020 (period 2021–2027). These legislative proposals aim to adapt the new CAP

- a) promoting an intelligent, resilient and diversified agricultural sector to ensure food security;
- b) strengthen environmental care and climate action and contribute to achieving the EU's climate and environmental objectives;
- c) strengthen the socio-economic fabric in rural areas.

Thus, the general objective of this work will be to point out the deficiencies and loopholes and present legal arguments that will be supported by economic data, under the methodology of economic analysis of the law; since in the present times and in the future, the CAP is giving priority to the implementation of a more sustainable management of the food complex, for which it is essential to improve the management of plant remains of protected crops under the prospects of a circular economy, responding to the specific problems currently presented by its management in the absence of regulation. These challenges are well known by the sector and have been contrasted by the CAPDR and all stakeholders, through a set of measures that are financed with the specific support instruments currently available.⁹

1.3. Indexes of vegetable crop residues

The regulation of crop residues must be guided by the new CAP strategies, promoting a diversified agricultural sector that helps to ensure food security and strengthen environmental protection (soil and water). At the same time it is necessary to strengthen the socio-economic fabric in rural areas, which in turn boosts the incomes of farmers who will derive the best benefits from lower production costs.

The most reliable data on harvest indices on the residual phytomass come indirectly from the studies of the harvest index (IH), which is the relationship between the crop yield – whether seeds, leaves, stems or edible roots – and the total phytomass of the crop in the area. This proportion has been of great interest to plant breeders because impressive yield improvements during the 20th century have been the result of a significant increase in the proportion of photosynthesis channeled into harvested tissues.¹⁰

to the future and are condensed into three regulations: on the Strategic Plans of the CAP; on the single Common Market Organization (CMO); and on the financing, management and monitoring of the CAP. We detail each of them to inform you in detail.

⁹ Lines of action in the management of plant remains in horticulture in Andalusia, Regional Ministry of Agriculture, Fisheries and Rural Development Regional Ministry of the Environment and Territorial Planning, September 2016.

¹⁰ C.M. Donald, J. Hamblin, *The biological yield and harvest index of cereals as agronomic and plant breeding criteria*, “Advances in Agronomy” 1976, No. 28, pp. 361–405; R.M. Gifford, L.T. Evans, *Photosynthesis, carbon partitioning, and yield*, “Annual Review of Plant Physiology”

There is no lack of published crop indices for the main crops, but the choice of average values for calculating the national or global production of residues is difficult because the proportions vary, both between the main crops and for the same crop grown in different environments.

On the other hand, the HDI is also determined by agronomic factors that take into account the date of planting or the irrigation regime. In addition, experiments by Roberts et al. (1993) showed that in the case of Californian aquatic seed rice, the HI varied more and decreased more rapidly with the increase in nitrogen applications in tall crops (from a maximum of 0,58 to 0,37) than in semi-deciform varieties (from 0,59 to 0,47).¹¹

From the data previously described by other authors, it can be deduced that the quantity and characteristics of the vegetable remains of the crops vary, and specifically taking into account the area of Almería, we have to take into account the crop in question, the type of greenhouse (a traditional greenhouse is not the same as an industrial greenhouse) and the specific campaign.

Following the aforementioned criteria, the production indices of plant remains of the main greenhouse crops in Almería, according to two consulted sources that differentiate the indices according to the type of greenhouse (traditional or industrial) for some crops.

Until a few decades ago, the plant remains produced in the course of an agricultural activity were used as a source of energy, as organic amendments to the soil, as food for livestock or were simply buried or burned. Nowadays the knowledge of new technologies makes possible the valorization of this organic matter in a more efficient and respectful way to the environment, using the by-products of one activity in the next one, and closing the productive cycles,¹² and the key ideas in the circular economy¹³ applied to the sector.

1981, No. 32, pp. 485–509; R.K.M. Hay, *Harvest index: A review of its use in plant crop physiology*, “Annals of Applied Biology” 1995, No. 126, pp. 197–216.

¹¹ S.R. Roberts et al., *Biological yield and harvest index in rice: “Nitrogen response of tall and semidwarf cultivars”*, “Journal of Production Agriculture” 1993, No. 6. pp. 585–588.

¹² It is the process of the decomposition of organic remains mediated by the combined action of earthworms and microorganisms, from which a stabilized, homogeneous and fine grain final product is obtained, called vermicompost or earthworm humus, and which is very appreciated in the market.

¹³ The circular economy is “an economic concept that is included in the framework of sustainable development and whose objective is the production of goods and services while reducing the consumption and waste of raw materials, water and energy sources.” This is the definition made by the Circular Economy Foundation, which, as it points out, is based on the principle of “closing the life cycle” of any product. At the end of 2015, the European Commission adopted an ambitious package of measures on circular economy to be applied in companies and consumers

2. The regulatory framework for crop residues in foil tunnels

2.1. General reference framework through the Waste Directive

In the European context where the production of waste is constantly increasing and where economic activity linked to waste is becoming increasingly important, both because of its scale and because of its direct impact on the sustainability of the European economic model, the Sixth Community Environment Action Programme was implemented more than a decade ago for a review of waste legislation, a clear distinction between waste and non-waste, and the development of measures relating to waste prevention and management, including the setting of targets. In the same vein, the Commission Communication of 27 May 2003 “Towards a Thematic Strategy on the Prevention and Recycling of Waste” called for progress in its revision.

However, to date, although harvest residues are partially excluded from the Directive while remaining on the farm, have been classified as such under the definition given in art. 3 of the Waste and Contaminated Soil Act¹⁴: “any substance or object which the holder discards or intends or is obliged to discard,” as regulated by Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste, which establishes the European Union’s legal framework for waste management, provides the tools to dissociate the relationship between economic growth and waste production, with particular emphasis on prevention, understood as the set of measures taken before a product becomes waste, to reduce both the quantity and content of hazardous substances and the adverse impacts on human health and the environment. It thus incorporates the principle of hierarchy in waste production and management which should focus on prevention, preparation for reuse, recycling or other forms of recovery, including energy recovery, and aims to transform the European Union into a “recycling society” and contribute to the fight against climate change. All these matters are necessary to be determined in a future regulation of crop residues, where the rights and obligations of the different agents are

with the aim not only of acting on climate change and the environment, but also to boost employment and economic growth.

¹⁴ Spanish Law 22/2011 of 28 July on waste and contaminated soil. Spanish name is Ley 22/2011, de 28 de julio, de residuos y suelos contaminados. Publish in Official State Gazette. In Spain: BOE núm. 181, de 29/07/2011. BOE-A-2011-13046, <https://www.boe.es/buscar/act.php?id=BOE-A-2011-13046&p=20160512&tn=3> [accessed on 20.06.2020].

determined: public administrations, producers and managers of vegetable residues (producers, transporters, processing companies); and, on the other hand, the prevention, production and management of vegetable residues together with the principles that inspire it, based on environmental sustainability and the profitability of rural areas.

This profitability requires regulations that promote the implementation of prevention measures, the reuse and recycling of plant remains, or disposal by incineration through their valorization at the level of energy efficiency; it also aims to increase the transparency and environmental and economic efficiency of different activities.

Finally, it is part of the spirit of any regulation of this nature to facilitate the development of the same by providing lines of support for solutions with greater value for society at all times, which will complement the objective of environmental sustainability, reducing greenhouse gas emissions associated with this sector and contributing to climate conservation.

2.2. Transposition of the Directive: exclusion of crop residues

In accordance with the Waste Directive¹⁵ which does not include agricultural waste used in the agricultural sector or used for energy production, and its transposition into Law 22/2011 of 28 July on waste and contaminated soil (transposition of the Waste Framework Directive) and the Waste Regulation of Andalusia, which applies to all waste, we should remember that it only excludes from its scope “faecal matter [...] straw and other natural, agricultural or forestry material, non-hazardous, used in agricultural and livestock farms, in forestry or in the production of energy from this biomass, by means of procedures or methods that do not harm the environment or endanger human health.”

Thus, for the purposes of Law 22/2011, of 28 July, on waste and contaminated soil, “waste” shall mean any substance or object that the holder discards or intends or is obliged to discard – art. 3 a). As we can see, the legal concept of waste depends on the will or intention of its holder to dispose of the substance or object. As Andres Betancor Rodríguez maintains “It is too

¹⁵ Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). DOUE 22.11.2008. There is currently a draft national law of 2010. Currently there is a Preliminary draft law on waste and contaminated soils, https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/participacion-publica/200602aplrresiduossysc_informacionpublica_tcm30-509526.pdf [accessed on 2.06.2020].

controversial and insecure a criterion. Any object or substance could legally become waste if its producer or holder so wishes.”¹⁶

Law 22/2011 attempts to delimit the concept of waste to which its regulations apply, on the one hand, by excluding from its application: straw and other natural, agricultural or forestry, non-hazardous material used in agricultural and livestock farms, in forestry or in the production of energy from this biomass, through procedures or methods that do not endanger human health or damage the environment – art. 2.1(e); and, on the other hand, by distinguishing waste from by-products. Thus, with regard to the latter, article 4 states that:

1. A substance or object, resulting from a production process, the primary purpose of which is not the production of that substance or object, may be considered as a by-product and not as waste as defined in article 3(a), when the following conditions are met:

- a) it is certain that the substance or object will be used at a later stage;
- b) the substance or article can be used directly without further processing other than normal industrial practice;
- c) the substance or object is produced as an integral part of a production process;
- d) the further use complies with all relevant requirements relating to the products and to the protection of human health and the environment, without leading to overall adverse impacts on human health or the environment.

2. The Waste Coordination Commission shall evaluate the consideration of these substances or objects as by-products, taking into account what has been established in this respect at European Union level, and propose their approval to the Ministry of the Environment and Rural and Marine Affairs, which shall issue the relevant ministerial order.

According to this precept, a substance or object resulting from a production process and which can be used directly because it complies with the rules relating to products and the protection of human health and the environment is not a waste but a by-product.

In view of the regulation of Law 22/2011, harvest residues are not considered waste while they remain on the farm or exploitation, since once they leave the farm or exploitation the use and management will be regulated under the Waste Directive and its transposition.

Therefore, plant remains that are not excluded from the scope of the Law as mentioned above, are considered waste and their management is conditioned on what is contained in the aforementioned regulations, in Law

¹⁶ A. Betancor Rodríguez, *Derecho Ambiental*, Madrid 2014.

7/2007 of Integrated Management of Environmental Quality (Law GICA)¹⁷ and in Decree Law 5/2014 of regulatory measures to reduce administrative burdens for companies.

Currently, the management of crop residues does not have a specific regulation and its generic regulatory framework does not resolve the doubts generated by its use, since although by analogy we could in some cases apply the regulation referring to waste, this does not include organic matter or non-commercial production that has not yet left its production environment, as it is initially inside the greenhouse, although at a later time its end could be for the sector itself, for livestock feed,¹⁸ for bio-waste or for energy production.

All of them are fruits that, under adequate management and use regulations, contribute to improve the farmer's income, to enhance the value of the production understood not only in relation to the fruits derived from the main production, but also including the by-products, which, as we will see, can be withdrawn in order to decide on their use and management by the owner or whoever has the right as owner of the farm (tenant, sharecropper or usufructuary, for example) or under the right of harmless use, provided that it is permitted by the holder who manages the production, although the analysis of the responsibility in the latter case may vary with respect to the holder, because the collection of the harvest remains by an outsider may be constituted under a contractual relationship or it may be asked whether

¹⁷ Spanish Law 7/2007, of 9 July, on Integrated Environmental Quality Management Autonomous Community of Andalusia, "BOJA" n.º. 143, of 20 July 2007 "BOE" no. 190, of 9 August 2007 Reference: BOE-A-2007-15158. Translated to Spanish: Ley 7/2007, de 9 de julio de Gestión Integrada de la Calidad Ambiental. Comunidad Autónoma de Andalucía «BOJA» núm. 143, de 20 de julio de 2007 «BOE» núm. 190, de 9 de agosto de 2007 Referencia: BOE-A-2007-15158.

¹⁸ OM AAA/699/2016 of 9 May (modifies operation R1 of Annex II of L 22/2011 of 28 July, waste and contaminated soil). Art. 24: The environmental authorities will promote, without prejudice to the measures deriving from the actions undertaken at Community level in compliance with the last paragraph of article 22 of Directive 2008/98/EC, measures that may be included in the waste management plans and programmes provided for in art. 14, to promote:

- a) separate collection of bio-waste for composting or anaerobic digestion, in particular of the plant fraction, bio-waste from large generators and bio-waste from households;
- b) household and community composting;
- c) the treatment of separately collected bio-waste in such a way as to achieve a high degree of environmental protection carried out in specific installations without mixing with mixed waste throughout the process. Where appropriate, the authorization of this type of installation shall include technical requirements for the correct treatment of bio-waste and the quality of the materials obtained;
- d) the use of compost produced from bio-waste and environmentally safe in the agricultural sector, gardening or the regeneration of degraded areas, replacing other organic amendments and mineral fertilisers.

it constitutes a manifestation of *ius usus inocui* that takes advantage of the person who is not the holder of the exploitation right without harming it as we shall see later.

3. Use and management of harvest residues derived from greenhouses

The control of harvest remains on the eastern coast of Andalusia, their use and their management are the determining factors for intensive horticultural production in greenhouses, which has been directed for years towards the development of a model that respects the environment in our productive sector, under the sustainable use of phytosanitary products and under the biological control that has been applied in the last two decades. This has led us today to actions that address the management of plant remains from the perspective of the concept of circular economy, bioeconomy and symbiosis between the different agents involved, so that the plant remains can be valued in a more efficient way, closing the production cycles.

It is true that when the harvest is withdrawn at the end of the campaign, next to the remains of the crop that are produced in the greenhouses: stems, leaves, fruits of destruction that do not meet the necessary quality standards or that are not marketed for market reasons and complete plants that are uprooted at the end of cultivation cycles, there are also plastic elements such as threads used for crops or polypropylene raffia, which are usually not biodegradable and which must be separated from the organic matter. This problem is not regulated as the legislator knows that this involves a cost for the farmer who will be willing to pay only if there will be sustainability benefits derived from clean production.

In order to understand better understand what expense we are referring to, let us take the tomato as an example, as it is the one of the most extensive crops in Almería. In this crops the separation of non-biodegradable elements, such as raffia threads and plastics, costs 0.045 euros per square meter, to which we must add the management of raffia threads which represents 0.018 euros per square meter, plus the crushing of plant remains which is where the farmer can get the added value to their production, and which represents a cost of 0.103 euros per square meter.

With these data, we can summarize that for the farmer the separation and management of raffia and plastics, together with the shredding of crop residues in an average greenhouse of one hectare is approximately 1030 euros per harvest, so that a year we would speak of more than 2000 euros of costs to be borne by the farmer.

3.1. Characteristics of crop residues: their use and management

Considering the tons, seasonality and the cost added to the farmer to obtain the biomass, it is easy to understand the need for a regulation on the handling and management of crop residues for subsequent use, being decisive to keep them exclusively, as they are characterized by specific and concrete properties: (1) they have a high moisture content (up to 60% at the time of withdrawal); (2) they have a high salt content; (3) they are easily biodegradable.

These physical-chemical characteristics of the remains of organic matter have a high degree of humidity and a low weight/volume ratio,¹⁹ so they need a minimum time for their degradation to occur. This condition is important in what the fertility of the soil affects, because it is buried and mixed with the soil or sanded, increasing the nutrients of the soil where the next crop will be cultivated; although when the productive system is not done under soil but in perlite, hydroponic or coconut fiber, and consequently, no soil is required for production, these remains must be removed before starting the next crop. Hence the need for an adequate and close harmonization of the time needed to collect the means of prevention and transparency under environmental and economic efficiency.

One of the uses of the harvest remains affects the soil, both by contributing natural fertilizers, which allows us to reduce the use of inputs, and consequently, a greater and better sustainability, and, parallel with the biodisinfection of the soil, by providing large amounts of organic matter to decompose within the soil and produce sterilizing effects,²⁰ and if the above is covered with plastic without leaving a hole, ensuring watering abundantly during the month of July, reaching 70 degrees with the summer heat, which is called biosolarization.²¹

But the remains of harvest have other uses outside the greenhouse. In this sense, we mean for example, a situation when a transformation is required

¹⁹ They have a variable density between 75 and 200 kg/m³ and a variable C/N ratio that can vary between 15 and 30.

²⁰ J.M. Torres Nieto, *Uso agronómico...* The author considers the management of harvest remains from planting to completion of the crop inside the greenhouse by considering biodisinfection valorization with harvest remains (COL) as the most efficient and profitable way to manage local resources A. Bello et al., *The use of biofumigation in Spain*, in: R Labrada (ed.), *Workshop on non-chemical alternatives to replace methyl bromide as a soil fumigant*, FAO, Rome 2008, pp. 79–86; M.M. Guerrero et al., *Effect of biosolarization using pellets of Brassica carinata on soil-borne pathogens in protected pepper crops*, Leuven 2010.

²¹ J.M. Torres Nieto, *Uso agronómico...* The use of fresh crop remains as a resource becomes valuable in soil biodisinfection understood as the set of techniques, which include biofumigation and biosolarization, that allow the restoration of soil health, even when sick crop remains are used.

(composting or other modalities), matter changing into fertilizer, or going to be used as feed for livestock, or eliminated via landfill. For this reason, and taking into account the use to which remains are destined, it must be remembered that the Plant Health Law²² applies to them, and it is the duty of the owner of the holding to prevent the spread of pests and diseases (Ministry of Agriculture, 2012), where the maximum phytosanitary limits are regulated for residues in the plants, their products and their transformations,²³ although and we must note that at the end of the campaign there are few phytosanitary remains that exist in all production.

On the other hand, we must bear in mind that not only the remains of the harvest remain in greenhouses and are used to fertilize the soil, since in most cases, they are removed and taken away from the greenhouse, although in both cases it is necessary to avoid any phytosanitary risk and regulate their use and management accordingly.

In this regard, it should be pointed out that if plant remains are not well managed under the principle of prevention and appropriate measures, they can be vectors of pests and diseases, which is why there are specific health regulations in various areas that regulate their management. In addition, we must remember that they may contain a certain concentration of phytosanitary residues, which is important to bear in mind if they are destined for animal feed, although it must also be mentioned that when they are produced at the end of the cultivation cycle, they will rarely present worrying contents, since weeks will have passed since the last applications, if the product safety deadlines have been properly respected.

Finally, we must point out that this is organic material which easily generates liquid fractions and which may cause contamination of aquifers, and this is a risk which will have to be taken into account under the principle of prevention in the regulations regulating the vegetable remains of harvest.

²² Spanish Law 43/2002, of 20 November, on Plant Health. “BOE” no. 279, of 21 November 2002 Reference: BOE-A-2002-22649. Translator to Spanish: Ley 43/2002, de 20 de noviembre, de Sanidad vegetal. «BOE» núm. 279, de 21 de noviembre de 2002. Referencia: BOE-A-2002-22649.

²³ Article 42. Maximum residue limits.

1. Plants, plant products and their processed products, intended for human or animal consumption, may not contain, from the moment of their first commercialization after harvest, or from the exit of the warehouse in case of post-harvest treatment, residues of phytosanitary products at levels higher than the maximum limits established by regulatory standards, following a report from the Joint Commission on Residues of Phytosanitary Products.

2. The provisions of the previous paragraph shall not apply to plants, plant products and their processed products intended for planting or sowing or for the manufacture of products not intended for human or animal consumption.

3.2. The actors involved in the different forms of management of crop residues

At present, plant debris from greenhouse cultivation may have different destinations involving different forms of management²⁴:

1. Delivery to an authorized manager. When plant remains are managed (in this case under the legal nature of waste) through their delivery to an authorized manager, it is the farmer who bears the cost of the removal service and transport to a treatment plant.²⁵ The price of this service usually depends on the volume to be transported. This destination implies the participation of another agent in the chain, the transporter, who acts as an intermediary between the farmer and the management plant and whose activity requires prior authorization from the regional administration.

2. Use or reuse of plant remains on the farm itself: Self-management of the harvest remains is another possible destination for the biomass from the crop. There are two options to take advantage of it, its use buried in green or self-composting.

Regarding the role to be played by each of the agents involved in the actions:

a) The farmer is the active subject of any initial action because he is the one who produces the crop residue and consequently the person responsible for it. For this reason, he must try to maximize the volume of vegetable waste that he can self-manage or valorize, either individually or through the producer groups in which he is integrated, so that he can introduce them back into his production process, thereby increasing his efficiency in the use of inputs. This can be achieved through self-composting and burial in green, or through other forms of valorization with which yields are obtained in addition to mere management as would be the task of crushing or chopping the remains, as it facilitates the management of the remains, whatever their subsequent destination;

b) Producer groups (cooperatives, SATs, OPFH) are a key element for optimized management, as a service to their farmers and as an example of clean management of the market;

c) In cases where it is necessary to transport the plant remains to the transfer or recovery plants, it is essential for the transporter to authorize a sufficient fleet to manage the transfer of tonnes of plant remains that are

²⁴ A. Tolón Becerra, X. Lastra Bravo, *La agricultura intensiva del poniente almeriense Diagnóstico e instrumentos de gestión ambiental*, "Revista Electrónica@ de Medio Ambiente" 2010, No. 8, pp. 18–40.

²⁵ A process in which aerobic biological decomposition of organic debris occurs under controlled conditions.

generated at two specific times in the year corresponding to the end of the campaigns, together with the development of route optimization systems;

d) The regions have a key integrating role in the improvement process, as they have the possibility of drawing up a public incentive plan that facilitates and promotes actions with good practices, as well as developing a diagnosis of the regulations for their optimization following the harmonizing role of the State in compliance with European regulations. At the same time, local entities can contribute to the search for sites for the network of small treatment plants and collaborate in their implementation, as this improves the per capita income of the farmer, who converts part of the production costs into profit, thus improving both the family economy and that of the region; together with the improvement and environmental sustainability of the area;

e) The research centres must work on new management systems for the remains inside and outside the greenhouse, new forms of plant valuation and diversification of the uses of the resulting products; together with an appropriate and proportional regulatory framework yet to be developed;

f) Finally, waste managers must be able to innovate both in processes and in management models in order to be more effective and obtain yields.

All this intensive production and the management of vegetable waste has great repercussions at an environmental level, as well as other challenges faced by the Almeria countryside for environmental sustainability and the maintenance of economic growth, especially in matters of water resources, solid waste and pollution from the use of fertilizers and pesticides, which makes us move towards an agriculture based on the circular economy, in which we achieve greater use of our resources and give a second life to the remains of the harvest in benefit of producer profitability, food safety and environmental sustainability. As would be the composting, which is a process of biological decomposition of organic materials, which in optimal conditions allow for their high rate of aerobic decomposition, is an appropriate proposal to recycle organic matter and nutrients.

4. Guiding principles and role of the actors involved

The lines of action for the management of plant remains in horticulture on the eastern coast of Andalusia arise from the producing sector itself, which,²⁶ knowing the problems involved in the management of crop remains,

²⁶ W. Baudoin et al., *Good agricultural practices for greenhouse vegetable crops: Principles for Mediterranean climate areas*, Rome 2013, <http://www.fao.org/3/a-i3284e.pdf> [accessed on 20.06.2020].

is determined to provide a solution, moving forward with a production model that respects the environment based on the circular economy, which allows it a benefit by lowering production costs, as it would be less need to buy fertilizers and inputs in the season, or obtaining an income from its transformation or use in addition to that which would be the sale for feeding livestock.

The remains of the harvest, understanding it as biomass, is an area of intersection between different administrations and regional Councils, which is subject to European regulations under the regulation of plant health standards and environmental sustainability, which makes it difficult to regulate. This is why it is necessary to articulate measures that, safeguarding the sense of protection and respect for the environment, promoting a standard that avoids distortions and facilitates the management of plant remains by farmers and other agents involved, is an unequivocal definition of what is meant by harvest remains, determining what criteria are required for their management according to the use to which they are intended, awarding certifications relating to environmental sustainability for the benefit of the circular economy, with a view to protecting, preserving and improving the quality of the environment, as well as protecting human health, ensuring the prudent, efficient and rational use of natural resources, through additional measures on sustainable production and consumption, focusing on the complete life cycle of products, in a way that preserves resources and closes the circle.

Thus, the main challenge in the *lege ferenda* proposal lies in the use and management of the crop that requires policies that maximize the probability of profitability and sustainability, since, as we have pointed out, there is a great gap in our knowledge about the implementation of harvest regulations that affect control methods and that determines how the residual crop is inadequately managed, which weakens the world's food production capacity and contributes to an undesirable biospheric change. Harvest residues should not be seen as residues but as providers of essential environmental services, ensuring the perpetuation of productive agroecosystems.

To this end, measures are required that are regulated and aimed at protecting the environment and human health, i.e., must be determined in the systems of prevention and / or reduction of the generation of crop residues and the negative impacts of their generation coupled with their management, in order to improve the efficiency of such use. This general purpose will be translated into a norm that it determines in a specific way:

- a) dangerous vegetable harvest residues (may cause risk) of those that are not;
- b) determination of phytosanitary limits in plant remains, taking into account their subsequent use;

- c) percentage limits that are not allowed as crop residues per hectare without a destination according to the strategies determined by the EU;
- d) the distribution of responsibilities for waste management between public and private agents, from the producer;
- e) measures to encourage the proper use of crop residues;
- f) the procedure for selecting operators for the management of plant debris;
- g) measures for the prevention of crop residues in accordance with sustainable consumption;
- h) valorization: regulating the measures that guarantee that the harvest remains are prepared for reuse, recycling, biowaste or biodisinfection;
- i) alert systems and data communication.

All of these measures are necessary for the management and reduction of greenhouse plant remains, from administrative governance based on an appropriate regulation to bioeconomy, to move towards a more sustainable management of the agri-food complex, including new processes that allow diversification of results and optimum use of resources, thus favouring the aforementioned commitment to encourage the transition to a circular economy.

These measures shall seek to provide a response to the farmer, with his own involvement in solving the problems, either individually, through the promotion of green manure and self-composting, or collectively, through producer organizations. To this end, measures are proposed for investments in farms, as well as in plants for the transfer and recovery of plant remains, in order to deploy on the ground a network for the management of plant remains that covers all phases (collection, pre-treatment, recovery, etc.), and that in turn bets on small and medium-sized facilities in order to obtain an articulated, flexible and environmentally efficient economic and economic model.

5. Conclusions

The accumulation of tons of crop residues, if well managed, can represent an added value to the producer, and therefore, to the region and the environment, as well as to the consumer who day by day demands a more sustainable production with the environment, although the infrastructures and previous measures necessary for an adequate environmental management should not be considered as an exclusive responsibility of the farmer.

Unfortunately, in Spain there is no legislation regulating the use and management of crop residues, not even a preliminary draft that makes prog-

ress on a complicated issue as far as competition is concerned, as Spain has delegated powers in agriculture to the Autonomous Regions, and although the EU includes the issue in its CAP strategic lines for the coming years, so far no first steps have been taken.

Once the fruits crops have been lifted or separated by those who are entitled to them, the other fruits that may have been left without being lifted or separated, or lifted or separated, but fallen on the ground, are those that constitute the remains or surplus of the harvest.

As we have seen, there are regulations such as the Directive and the Law on Waste that refer, for example, to the remains that are used for energy such as those derived from pruning the olive grove, regulating them as under the category of waste or when the vegetable remains leave the greenhouse to be treated and reused as fertilizer in the following campaign.

However, there are no regulations governing the use and management of crop residues while they are inside the farm, so we understand the need to propose a regulation in this regard. Because Europe does determine among the lines of the CAP the agricultural sustainability of the productions that are carried out in European territory and, consequently, the lack of regulation on vegetal remains while they remain in the farm is a matter to be developed, both in the area of the circular economy as valorization of the remains or as subproducts, and with respect to the environment, which will be benefited by the use of less industrial inputs and more organic fertilizers derived from the vegetal remains of the harvest once treated.

Consequently, it is a matter that, considering the region, acquires more or less importance, and in this sense, Andalusia should take the legislative initiative, since there are many types of crops with intensive and extensive production systems, which with innovation and techniques for their development could make us different from other regions and references in the agricultural sector with respect to other competing countries.

When it comes to establishing an adequate legal framework, and with regard to compliance with the obligations of environmental sustainability, we must bear in mind that this is not an exclusive and excluding obligation of the producer, since as we have seen, there are several agents that intervene and are responsible for the obligations that are specific to them and that affect both public institutions responsible for developing appropriate policies for agriculture, and natural or legal persons that are producers or that intervene in the management of crop residues. In other words, the system of responsibility must be distributed in accordance with the agent involved and the obligations that are specific to their activity and function.

On the other hand, control and guarantee systems are necessary in the regulation of all economic activity, and in particular, as in our case, of the primary sector, for competitive and sustainable development, and that they adjust to the principles of prevention and precaution in the development of all economic activity such as agriculture, as the TJEU has reiterated, although we understand that although both principles are an effective instrument in the face of ecological or environmental risk as a prior and precautionary mechanism, they will be really useful for us when drawing up regulations on harvest residues.

Finally, we must not forget that the collection of harvest residues by a person outside the farm does not constitute a manifestation of *ius usus inocui*, since to enter the farm and collect harvest residues, a written authorization from the owner of the farm is required.

LEGAL ANALYSIS OF THE MANAGEMENT OF HARVEST RESIDUES IN SOUTH-WEST EUROPE

Summary

The Waste Directive establishes the basic principles of waste management, but it does not regulate issues relating to crop residues that remain on the farm, which creates a legal vacuum at the level of European Union law. In this situation, Member States are obliged to respond to problems arising from certain types of production. The article presents the current situation in this area in south-west Europe, where, due to the seasonal nature of production, crop residues arise at certain times of year. As we know, the common agricultural policy promotes the sustainable development of agriculture in relation to production carried out on European territory, which is why, according to the author, it is necessary to introduce appropriate legal regulations. The proper use and management of these residues by farmers may contribute to the improvement of their income which is consistent with the principles of circular management as part of the valorisation of these harvest residues.

LA GESTIONE DEI RESIDUI CULTURALI NELL'EUROPA SUDOCCIDENTALE: UN'ANALISI GIURIDICA

Riassunto

La direttiva sui rifiuti stabilisce i principi di base per la gestione degli stessi, ma non disciplina le questioni riguardanti i residui del raccolto rimasti nell'azienda agricola, il che crea un vuoto giuridico a livello di diritto dell'Unione europea. Per cui, gli Stati membri sono obbligati a reagire ai problemi derivanti da alcuni tipi di produzione. Al riguardo, l'articolo presenta la

situazione attuale nell'Europa sudoccidentale, in cui – a causa della stagionalità della produzione – si formano residui di raccolto in determinati periodi dell'anno. Come noto, la politica agricola comune promuove lo sviluppo sostenibile dell'agricoltura in relazione alle produzioni realizzate sul territorio europeo. Pertanto, secondo l'Autrice, è necessario introdurre regolazioni giuridiche adeguate. Un corretto utilizzo e gestione dei residui in oggetto da parte degli agricoltori potrebbe contribuire ad accrescere il loro reddito, in coerenza con i principi dell'economia circolare portando alla valorizzazione dei residui stessi.