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Identifying Functionality of Peri-Urban Agricultural Systems: A Case Study

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Abstract

Some agricultural systems, especially peri-urban agricultural systems, are characterized as agricultural ecosystems that provide goods and services related to leisure and recreation, the process development beneficial to the environment, such as fixing CO₂, the production of healthy and safe food, and the preservation of natural and cultural heritage. Public intervention in agriculture has traditionally been known as a basic economic task performed by the government whose main objective is food security. But now, agricultural policies have been increasingly challenged by civil society demand, such as a new agricultural model with stronger consideration for non-commodity goods and services. The main obstacles for public intervention are, knowing production of goods and services and externality by peri-urban agriculture system, and identifying what specific demands agriculture needs to satisfy social preferences for goods and services.

We created a descriptive approach for the functionality of peri-urban agricultural systems based on a scientific literature review, which focused on multifunctionality and the goods and services of agricultural systems. This review shows a wide variety of functions that can be grouped according to their economic dimension, social dimension and environmental dimension. We propose a methodology to quantify the functionality of peri-urban agricultural systems by means of indicators.

The proposed methodology was applied to a peri-urban area in Valencia. This is identified as Huerta de Valencia, an agricultural system around Valencia City with a wide variety of resources. The “Comunidad Autónoma de Valencia” government and local government in Valencia City are interested to define a protection scheme and there is open political-institutional debate. The results are very interesting and useful to enrich this debate.

Keywords: Urban fringe, Multifunctionality, Public goods, Joint production, Externality, Market failure, Diversification

1. Introduction

To the conventional role of farming activity as a production sector of raw materials, mainly food products, whose objective was to obtain economic benefits from globalized markets, since the post-productivist paradigm, other capacities have been added: social, economic and ecological implication on the surrounding territory where it has been implemented. To a greater or lesser extent, it is acknowledged that, simultaneous to the production of food and raw material, agriculture contributes to the provision of public goods and services that are related with entertainment and recreation, and to developing beneficial processes, such as CO₂ fixation, healthy safe food production, preserving natural and cultural heritage, and respecting and maintaining the natural environment. The consideration of these aspects results in an agricultural model known as multifunctional [1–7].

It has recently begun to attract considerable attention, with discussion on urban agriculture in industrialized countries. Some agricultural systems on the urban fringe are characterized by being highly valuable spaces that maintain a fragile equilibrium between considering agricultural spaces and/or peri-urban areas that are subject to pressure by alternative land uses (industrial, infrastructure, commercial and leisure centers, etc.). However, society demands of them opportunities to undertake recreational activities, produce quality organic products locally, conserve and maintain spaces relatively near cities and towns under suitable environmental conditions for living, conserving cultural ethnological heritage, etc. [2, 3, 6, 8, 9]. These functions performed by agricultural systems, and the goods and services they can provide, result from the agriculture practice itself, and are generated simultaneously with the production of foodstuffs and raw materials [8, 10–12]. They possess the character of Positive Externality¹ and Public Goods^{2,3}, without markets where farmers can interchange them for income, and the existence of market failure that provides theoretical arguments for justifying possible forms of public intervention for correcting these is acknowledged.

Many public goods associated in some form or another with agricultural activities are local [2, 9, 13]. Developing intervention policies requires studying the functional analyses of peri-urban agricultural systems which, beyond the sectorial perspective of agriculture as an economic sector, incorporate detailed analyses of enviro-friendly-related functions, healthy food production, provision of entertainment spaces, etc., as well as the Non Marketable Goods and Services (NMGSs) that they can provide. This work adopts a descriptive approach that takes the multifunctionality of agriculture as a basis to later carry out empirical analyses of peri-urban agricultural systems, the functions they can perform, and the goods and services they can provide.

¹ Refers to situations in which the producer of a particular output is not remunerated for it (positive externalities) or does not pay for its detrimental effects (negative externalities).

² Refers to goods for which use cannot be easily excluded to other beneficiaries (low excludability) and which can be used various times by different beneficiaries without being destroyed (low rivalry).

³ Environmental and social functions are known as non-productive, or also as non-marketable, and goods and services are often identified as non-marketable (NMGS). The economic literature about multifunctionality talks indistinctly about (positive or negative) externalities, and about public goods (or “bads”), as most externalities are non-exhaustible, of joint consumption and are impossible to exclude, which render them as public goods.

When applying this theoretical framework to analyze the functionality of any peri-urban agricultural system, it is fundamental to improve the exactness of the spatial scales applied to these analyses by limiting the system under study and suitably detailing the beneficial processes that can be developed.

The Huerta de Valencia is a wealthy agricultural system with a wide variety of resources, but one that is also subject to pressures that can condition its development and survival. Its peri-urban nature (since it is located in the metropolitan area of the city of Valencia), has been greatly conditioned by this fact, and also by the great pressure from competition given the possibilities of alternative activities in this space. You can see the area in Figure 1.

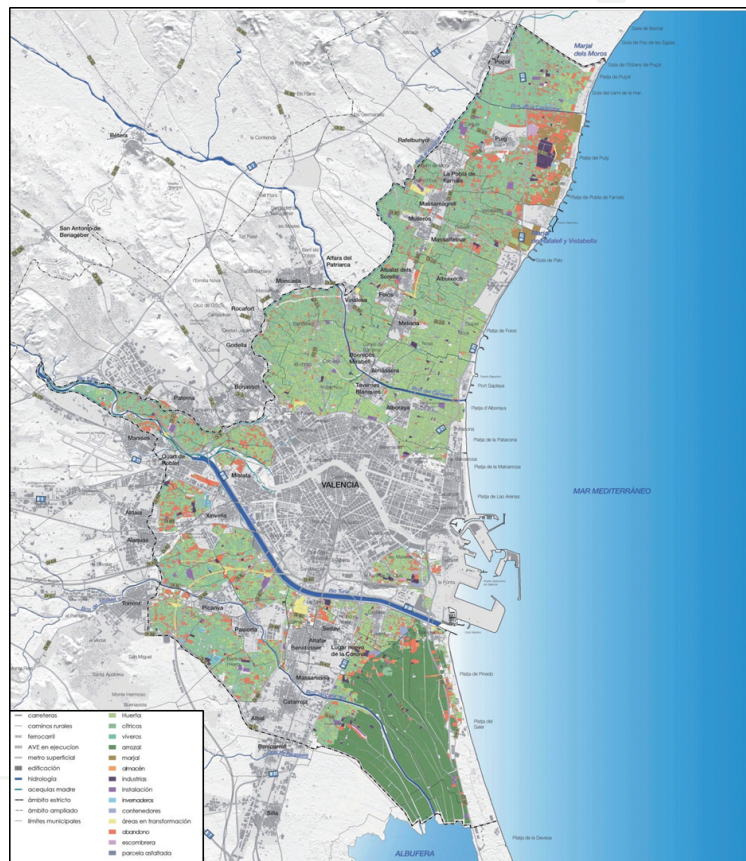


Figure 1. Huerta de Valencia.

From all the above information, we put forward some working hypotheses to respond to our research:

- First: “The multifunctionality framework is a suitable approach to study the functionality of agricultural systems, especially when these systems are characterized by constituting highly valuable spaces, and are acknowledged as performing functions that result in the provision of public goods and services”.
- Second: “Peri-urban agricultural systems are characterized as agricultural ecosystems that provide goods and services related to leisure and recreation, the process development

beneficial to the environment, such as fixing CO₂, the production of healthy and safe food, and the preservation of natural and cultural heritage”.

- Third: “Developing intervention policies requires a study of the functional analyses done of peri-urban agricultural systems which, beyond the agricultural sectorial perspective as an economic sector, incorporates detailed analyses of the functions that are related to respecting the natural environment, production of healthy foods, provision of recreational scenarios, etc., and NMGS”.
- Fourth: “There is concern and social interest about the Huerta de Valencia, and its conservation and preservation”.

The first part of this study centres on the multifunctionality concept, and its connection with new sustainable agriculture and multifunctionality approaches of lands, as well as peri-urban agriculture, and provides the most interesting corollaries to define the functions and goods and services that peri-urban agricultural systems can supply, which legitimize public intervention for their conservation. Accordingly, the intention is to specify the supply of public goods and services acknowledged to agricultural systems by defining indicators that allow an empirical analysis. Finally, we include the analysis that we are interested in, the peri-urban system of the Huerta de Valencia.

2. Descriptive approach of peri-urban agrosystems functionality

2.1. Multifunctional, sustainable, and peri-urban agricultural system

Agricultural multifunctionality (AMF) is a conceptual framework within which agricultural activity, which goes beyond the merely productive and commercial domain, forms part of a broader conception by attributing to agriculture functions that care for the natural environment and landscape, conservation of cultural heritage, and functions that improve aspects of the social equilibrium [2]. To these we can add the possibility of providing recreational services, which would perform a recreational function. The fact, that these other (non-productive) agricultural functions exist, which generate NMGS, and for which social demand exists in developed countries, is the basis on which the argument about protecting agriculture and its justification lie.

There has been considerable debate about AMF in different domains. In the political domain, the debate for more than one decade on agricultural policy has been about the multifunctionality of agriculture. The assumed case of this multifunctionality being an intrinsic quality of agriculture as a result of joint production has been underlined in positive AMF approaches. OCDE [4, 5] was probably the first statement who, for legitimacy of policy support to agriculture, adopts the neo-classical economic approach with joint of production of commodities and positive externalities, and market failure for public goods (biodiversity, landscape etc.) as key notions. The legal approach, however, considered it to be the result of the plurality of objectives that the agricultural policy considers and is, therefore, a desirable model [2].

Wilson [7] criticizes that, depending on the research field, the term multifunctionality has been widely and confusedly conceptualized, and goes from agricultural economy to geography, and even moves on to rural sociology. It distinguishes between the MFA concept [11], with its more economic-type discourse, and multifunctionality from a broader landscape and ecology perspective [14, 15], with discourses based on broader and more holistic interpretations. For the first concepts, we could state that multifunctionality is observed from a sectorial perspective, while the second concept seeks the agricultural-rural areas interrelation, and multifunctionality not only of agricultural activity, but also of lands. They point at important implications for analytical research tools such as models for agronomic and agro-ecological relations at farm and regional levels.

Jongeneel et al. [8] defend that multifunctionality in agriculture is directly, although not exclusively, linked to the different functions agricultural land can fulfil. The functions that agricultural land can fulfil include traditional production functions (food, feed), an ecological function (habitat for wildlife), a cultural function (typical landscapes), and a recreation function (enjoying landscape, on-farm attractions and accommodation). Multifunctional agriculture can simultaneously fulfil different combinations of these functions. The goods produced by these functions may be marketable (food, raw materials, ornamental plants, etc.) or non-marketable (wildlife and landscape) [8].

After indicating that the most important non-agricultural functions that it contributes are to help maintain rural areas and the natural environment (in practice this contribution is not easy to measure and is ever-changing). Compés and García Alvarez-Coque [16] defend an agricultural policy that necessarily contemplates reducing negative impacts and agriculture's contribution to mitigating greenhouse effect gases. In parallel, conditions are increasingly imposed and society places more value on positive environmental functions of agriculture, which include CO₂ fixation or maintaining biodiversity, two important cases, and recommend instruments that award surfaces, extensification, quality, sustainable development, biodiversity and rural landscapes.

Renting [2] promotes AMF as a concept and agricultural development course trajectory from an integrated perspective within the sustainable development framework of sustainable development. Reig [12] explores possible connections between multifunctionality and sustainability by understanding that the multifunctional orientation of agriculture leads to measures being taken to correct market failures and to provide coverage of specific environmental functions (protecting biodiversity, landscaping, etc.), which can help enhance social well-being and reinforce environmental sustainability. All this contributes to develop more sustainable agricultural activity.

Chiara [17] indicates that the most significant components of the non-built-up peri-urban areas in some Italian urban areas, are agricultural lands, which usually fulfil environmental, productive, recreational, water balance, and cultural functions, just as multifunctional agriculture does [2, 18]. These multifunctional activities of peri-urban agriculture enrich both the rural and the urban context [19, 20].

Pascucci [21] defends that the multifunctionality of peri-urban agriculture is performed or materializes in the same way as the rural one, insofar as it is the joint production of activity that is firstly oriented to the direct production of market goods and services (food and raw material), but secondly produces goods and services that help land sustainability, preserve biodiversity, and maintain the economic and social vitality of the urban areas in which it is practiced.

Finally, Zasada [22] finds that MFA has been commonly recognized in peri-urban areas. The multifunctional development paradigm provides an approach that strengthens and modernizes peri-urban agriculture. There is a reasonable demand among the urban public for multiple functions and values from farming.

2.2. Provision of goods and services by peri-urban agriculture

Ecosystem services have often been narrowly defined and restricted to natural ecosystems. In recent years, the scope of the ecosystem services concept has been extended, and more studies refer to ecosystem services in agricultural systems. Serious discussion about AMF has resulted from political discussion.

The extensive academic literature available shows recurring concern for the conceptualization of multifunctionality, discussion about the concept, and the supply and demand of the non-commercial functions attributed to it. However, they do not represent an alternative set of compact well-defined contributions, with new contributions on multifunctionality [23]. Nor has a clear definition of the objectives and functions of agriculture beyond the generic (economic, social, and environmental) ones initially established by the Commission been completed.

We reviewed papers that address goods and services of agricultural systems, and that study the peri-urban fringe, its particular characteristics, and especially goods and services related to agriculture. Based on our scientific literature review, we adopted a descriptive approach of the functionality of peri-urban agro systems.

The makeup of peri-urban areas may differ depending on each urban area, the characteristics of the city's growth and systematic land occupancy for town planning, and also on interrelations between town planning and the surrounding rural environment.⁴ There are three ways of considering agriculture: land, the living environment and production. Agricultural activity plays a key role in the conception of agricultural peri-urban spaces. In developing countries,⁵ agriculture plays an important role in enhancing urban food security and nutrition, local economic development, poverty alleviation, and the social inclusion of disadvantaged groups and sustainable environmental management in cities. In industrialized countries, beyond the

⁴ Consult the document, Agricultural management in peri-urban areas [45], which describes the debate on different future models or scenarios for peri-urban areas in France and Italy, according to the interrelation and urban growth over the peri-urban/rural areas near cities.

⁵ In November 2001, the following document was presented: Annotated Bibliography on Urban Agriculture, prepared for the Swedish International Development Agency (Sida) by ETC-Urban Agriculture Programme, in cooperation with TUAN and other organizations.

urban sprawl and unplanned situations, agriculture is taken into account to: care for space (fertile land is a non-renewable resource); provide a view of agriculture in land tenure terms (agriculture is an economy activity and land is an economic resource); contribute to urban employment and to reduce inequalities; favour the conservation of memory and the roots of agriculture (it forms part of the territory's identity); and contribute, through its environmental functions, to management of water and natural risks, to fight against greenhouse effects, to value waste, and to increase the value of landscapes and tourism. This peri-urban scenario is enhanced by AMF.

It is not unreasonable to indistinctly talk about the agricultural areas located in urban areas where agricultural activity is a multifunctional economic activity, and about peri-urban areas of disperse urban growth where agricultural activity is actually marginal; that is, in a small space in local interstitial areas, or in an almost continuous urban matrix, but one that is broken by small closed agricultural spaces. Isolated agricultural areas influence the main agricultural functions, and hence agri-urban development. This isolation is a disadvantage for small fields given conflicts with local inhabitants, high land prices and low income. Non-agricultural work opportunities are scarce, and the share of part-time agriculture and hobby farming is large. These areas can be termed infra-urban.

The interest of the present work lies in peri-urban systems, where the productive structure and agricultural areas are almost continuous, although there is a separation between the urban and the agricultural/rural matrix. In these agricultural areas, agricultural land is more available, and the productive, environmental and landscape functions of agriculture are more important.

In relation to agriculture, and its multifunctional activity consideration, Reig [24], considers that it produces a wide range of goods, and includes a diagram to summarize and classify them as public and private. Private ones include the production of food and raw material of an agricultural origin, rural tourism, and other possible private goods. Public goods are classified as: 1) environmental: protecting landscape values, protecting biodiversity and protecting land, plus controlling erosion; 2) social: contributing to the feasibility of unfavoured rural areas, protecting cultural values in rural areas, and protecting rural areas from population loss.

Specifically for peri-urban agriculture, Zasada [22] reviews societal demands and the provision of goods and services by farming. Beyond traditional agricultural functions, peri-urban agriculture is increasingly acknowledged for its deliverance of local food, as well as recreational, educational and other social services: Environmental and landscape amenities, Leisure and recreation, Regional food supply which directly, Lifestyle farming, Recreation-oriented diversification, Social farming, Short supply chains and Direct marketing.

If we consider one of the broadest and more specific definitions for sustainable agriculture, that by Gómez-Villarino et al. [25] is in accordance with the basic functions that the natural environment performs as a source of resources, a receiver of effluents and a support of activities, sustainable agriculture will be orientated to the rational exploitation of renewable resources, depending on their renovation rates, will not emit effluents to nature that exceed its assimilation capacity, and will respect ecosystems' hosting capacity when inducing

transformations in them: it will promote savings and efficiency in water resources, use of alternative irrigation sources (wastewater), energy savings and efficiency, use of renewable energies, land management that avoids erosion phenomena, integrated and ecological production methods; it will avoid practices that pollute water, will respect the natural vocation of ecosystems, and will limit accessibility to the whole land; it will conserve traditional buildings and constructions, the makeup of plots and farms, and separation elements: walls, edgings, hedges, dispersed trees. It will also defend these functions: territorial equilibrium: fixing a dispersed population in the land to counteract the concentration tendency; creating a social system for activity by developing population settlements and constructed elements to also confer a material value, and historical and cultural interest; it will be a support for infrastructures and more productive economic activities, whose sustainability lies in respecting the natural vocation of various types of ecosystems.

The more an agricultural system approaches the pattern defined by Gómez-Villarino, the further it will move from productivity patterns.

The research by Ivesa and Kendalb [26] lists the following as components of the value of peri-urban agricultural areas: Culture (agricultural land near cities is an important part of cultural heritage), Education (farms near cities are important places for people to learn about the natural world, Agricultural land near cities provides good opportunities to teach people about where their food comes from), Environment (farmland near cities is important because it protects natural landscapes. The agricultural land closest to where people live is valuable because it contains natural areas not found in the city. Land near cities used for farming is not a place with worries about protecting native species of plants and wildlife. I like to know that native plants and animals are able to survive on the edge of cities), Aesthetics (people enjoy the scenery of agricultural landscapes on the edge of cities. It is important that people can see farm animals near where they live), Food security (farms near cities should produce food to make sure that people who live there have a secure food supply), Food availability (it is important that people have access to food produced near where they live. We can still have a fresh supply of food without preserving agricultural land near cities. People prefer to buy locally produced food).

As a result of studying and analyzing these works, we proposed a descriptive approach of the multifunctionality of peri-urban agricultural systems, and the goods and services they can provide, by differentiating private ones from public ones, and among these, positive and negative externalities. We classified the various functions depending on whether they are economic, social or environmental.

We considered the following functions and/or goods and services:

- **Configuring natural heritage:** Agricultural systems are local in nature, and the surrounding conditions they develop in (climate, soil type and characteristics, edaphic properties, availability of water resources, the land's orography, etc.), condition the configuration of true natural heritage in accordance with crops, the production practices and techniques applied, and the agricultural structures that are implemented.

- **Creating new landscape forms:** as a result of the previous point, the generated landscape is unique and irreplaceable, and is, more often than not, high quality. The impact of agricultural activity is attractive landscapes, which is why citizens are very sensitive about their conservation and maintenance.
- **Conserving biodiversity:** the diversity of ecosystems and the ecological processes developed by agricultural practice has led to much heritage being accumulated as biological diversity and ways of life.
- **Protecting water resources:** in quality terms, distribution in time and quantity for urban, rural, industrial and hydroelectric use by protecting and sustainably using aquifers, springs, and water sources in general, protecting and recovering basins and microbasins, etc., and introducing practices that help minimize and correct negative externalities that generate diffuse pollution.
- **Producing energy:** agriculture is a source of biological material and products to generate biomass.
- **Mitigating greenhouse effect gases** by fixing, reducing and storing carbon (CO₂) and other greenhouse effect gases.
- **Scenic beauty:** it results from the presence of forests, natural landscapes and biodiversity elements that are appealing and act as a basis to develop various forms of tourism: ecotourism, sun-and-beach tourism, scientific, observation and adventure tourism.
- **Maintaining areas** such as forests, wetlands, reefs and mangrove swamps to mitigate impacts of disasters caused by flooding, landslides, drought, etc., which are associated with natural phenomena.
- **Protecting soil:** agricultural activity plays a key role in soil formation and soil conservation processes as it favours organic matter accumulation and soil fertilization by nutrient fixation.

However, agricultural activity can also have negative effects, or negative externalities, such as:

- **Consuming water resources:** Irrigation agriculture consumes vast amounts of water resources, which restricts their availability to other sectors and ecosystems. In some cases, aquifer overexploitation can have very negative effects on nearby ecosystems, which can even disappear. As for quality of water resources, irrigation agriculture, but also intensive farming, has caused major problems by contaminating aquifers because growing concentrations of leached nitrates accumulate. Thus, practices need to be introduced that help minimize these effects, implement more efficient irrigation technologies, and help minimize and correct the negative externalities that diffuse pollution generates.
- **Healthy safe food:** Irrigation agriculture, especially horticulture, intensively uses phytosanitary products: fungicides, herbicides, insecticides and phytochemicals. Its use of others types is more restricted, such as nematicides, acaricides, etc. They can spell enormous problems from the presence of waste in food, persistence and accumulation problems in soil

which, through leaching, can affect bodies of water. As regulations progressively tighten the use of these substances, they are used less. The inclusion of good agricultural and livestock practices, and an agriculture that respects ecological and integrated production systems, are not only necessary to comply with laws, but to also meet new consumer food trends; and to attend consumers who are concerned about the health of food, traditional production with traditional varieties and cultivars that offer excellent taste quality, production by applying traditional more enviro-friendly working techniques, and production obtained from family-run farms related with traditional ways of life in a nearby agricultural space that offers good quality of life.

Regarding the use and enjoyment of peri-urban agricultural spaces as recreational and entertainment spaces, outsourcing activities is feasible in such a way that some surfaces would no longer remain agricultural, but would be occupied for other uses, termed land activities which, by adding value, sum complementary income to the primary value. Such activities include rural tourism as various ecotourism forms, sun-and-beach tourism, scientific, observation and adventure tourism: e.g., birdwatching and wildlife, hiking, cycling, fishing, hunting, and even swimming. Accordingly, the positive effects set out in the previous section that agricultural activity has on land also apply to such spaces. In these cases, other production activities should also maintain an environmental function that respects nature and biodiversity, as well as other factors, such as the landscape and cultural heritage, on which the agricultural system's multifunctional nature is sustained.

		GENERIC SERVICES	Functions	Goods and services	E	S	M	
PRIVATE		0. Land	Heritage	Land as heritage	x			
		1. Food production	Primary production of foodstuffs	Provides vegetable foods, seeds, plants, and edible fruits, and biological material.	x			
		2. Recreation	Generator of tourism	Provides space for eco-tourism, fishing, hunting, and relaxing.	x			
		3. Energy production	Biomass	Provides biomass (plant remains and energy crops).	x			
PUBLIC E: NEGAT IVAS	E: POSITIVES	4. Configuration of natural heritage and creation of new landscapes	Configuration of a farming system that contributes to an agrarian system by creating an agricultural landscape of great value	Natural heritage and beautiful landscape			x	
		5. Production and conservation of biodiversity	Environment for animals and plants	Enables development of biological flows. Enables preservation of plant resources: populations of important species such as pollinators, native species, rare or threatened species			x	
		6. Protection of water resources	Water storage				x	
			Frees resources by improving irrigation efficiency	Improves water supply			x	
			Frees irrigation resources with alternative sources				x	
		7. Mitigation of greenhouse effect	Sink for greenhouse gases	Regulates climate by regulating greenhouse gases			x	
			Reduction of emissions	Reduces greenhouse gas emissions using alternative energy sources			x	
			Regulation on atmosphere chemical composition	Contributes to improving air quality			x	
		8. Mitigation of disasters caused by floods, landslides, and droughts.	Regulation of water flows	Improves ability to respond and adapt to natural disasters: storms, floods, droughts			x	
			Retention of sediments and erosion control				x	
		9. Territorial and cultural scientific	Territorial equilibrium	Articulates nuclei and avoids congestion		x		
				Creates jobs		x		
				Makes business more dynamic		x		
Cultural use	Provides a unique cultural heritage			x				
	Provides space for education			x				
Scientific use	Provides important scientific elements: practice, vocabulary, tools, infrastructure		x					
10. Land protection	Soil forming process	Favours soil formation.			x			
	Soil conservation	Favours accumulation of organic matter and soil fertility by fixing nutrients			x			
11. Water resource protection	Diffuse pollution	Causes loss of quality of groundwater through pollution of aquifers			x			
	Degradation of wetlands	Damages surrounding wetlands			x			
12. Production of safe healthy food	Risks to human health from pesticide residues	Interferes with supply of healthy and safe food		x				

Table 1. Peri-urban agricultural system: functions, goods and services.

The attached **Table 1** includes a list of the goods and services that an agricultural system can provide, distinguishes between those considered private from public, and those with a positive or a negative externality nature. All goods and services are classified according to whether they are economic, social or environmental. Up to 12 generic services are defined, which are subdivided into 22 functions and 22 goods and services. This is contemplated as a descriptive approach to AMF as a basis to later carry out empirical analyses on peri-urban agricultural systems.

The public goods that agriculture generates differ from some agricultural systems to others depending on different aspects of the environment, agricultural practices, etc. Consequently, the supply and demand of public goods is extremely heterogeneous.

Regarding the joint production characteristic, interdependence exists between agricultural production and production of other goods (NMGS), regardless of their technical or biological nature. Moreover, some production factors exist from which several different outputs are obtained, which cannot be separately assigned to each one. Reig [9] considers that joint production is related with the production techniques applied, environmental conditions, technology and the subsequent allocation of resources, etc., therefore knowledge of it demands multidisciplinary research efforts, and must be oriented to specific geographic locations.

Supply will be more heterogeneous as a result of differences between the physical basis (climate, soil type, quality of irrigation water, etc.) on which the activity in different regions lies, and also due to the agricultural activity management at the exploitation level with intensification or extensification of production systems. The fact that externalities exist and that market failure is acknowledged will trigger intervention. However, knowledge about the joint production process is essential to select and design intervention instruments that can promote the production processes or systems that generate the positive externalities or public goods that are in demand [27].

3. Analysis of the functionality of agricultural systems

Conducting studies about multifunctionality entails defining the significant indicators which suitably explain the underlying processes and relations that link the agricultural activity and functions, and the goods and services that it provides. These indicators should be defined and proposed in different case studies and in accordance with not only the most relevant aspects of the agricultural system to be studied, but also with the purpose of the study in question, but mainly according to existing sources of information, etc. **Table 2** includes the defined indicators.

For a multidimensional assessment, the next task is to identify appropriate indicators of economic, social and environmental dimensions of multifunctionality in peri-urban areas.

Specially, we want select a limited number of attributes which can be quantified, in order to evaluate the performance of agriculture, and determine its multifunctional character, in different settings and situations.

This selection was made by review of literature about some indicators, proposed by some authors related to economic dimension [20, 28–31] to social dimension [32, 33], and to environmental dimension [22, 34, 35]. There are some works which integrate all dimensions together [2, 36, 37].

Were used too, some reference papers, from statements, public institutions, government institutions, etc. which include information about some indicators in different dimensions:

- OCDE 2001: Environmental Indicators for Agriculture Volume 3: Methods and Results [38].
- OCDE 2002: Effects of agricultural policies and practices on the environment: review of empirical work in OCDE countries. COM/AGR/CA/ENV/EPOC(2001)60/FINAL [39].
- Proyecto WADI: The Sustainability of European Irrigated Agriculture under Water Framework Directive and Agenda 2000 [40].
- COM (2006) 508 final, COMUNICACIÓN DE LA COMISIÓN AL CONSEJO Y AL PARLAMENTO EUROPEO. Establecimiento de indicadores agroambientales para el seguimiento de la integración de las consideraciones medioambientales en la política agrícola común.
- OCD 2008: Environmental Performance of Agriculture since 1990: Main Report, Paris, France (2008).

As a result, a set of indicators were selected (**Table 2**), designed to verify and control the multifunctionality of agriculture farming system level. **Table 2** includes indicators used to evaluate the peri-urban agricultural system of Huerta de Valencia.

	GENERIC SERVICES	Functions	Goods and services	INDICATORS	
PRIVATE	0. Land	Heritage	Land as heritage	Land prices	Estimated by capitalization of farm income
	1. Food production	Primary production of foodstuffs	Provides vegetable foods, seeds, plants, and edible fruits, and biological material	Value of gross agricultural output	Farm income / production orientation
	2. Recreation	Generator of tourism	Provides space for eco-tourism, fishing, hunting, and relaxing.	Value of turistic output	Tourism production according to supply of rural accommodation
	3. Energy production	Biomass	Provides biomass (plant remains and energy crops).	Value of energy output (renewable energies)	Biomass value
PUBLIC	4. Configuration of natural heritage and creation of new landscapes	Configuration of a farming system that contributes to an agrarian system by creating a highly valuable agricultural landscape	Natural heritage and beautiful landscape	Soil cover	% Soil cover
				Forming plots and management (shape and orientation)	Distribution of plot size, management (shape and orientation)
	5. Production and conservation of bio-diversity	Environment for animals and plants	Enables development of biological flows. Enables preservation of plant resources: populations of important species such as pollinators, native species, rare or threatened species	Presence of boundaries, walls, hedges and irrigation canals	ml of boundaries, walls, hedges and irrigation canals
				Crop variety (mosaic of colors and textures)	Crops ratio
				Natural area protected around agricultural area	Natural surface area protected around agricultural area / total surface agricultural area
				Trends in population distributions and numbers of bird species related to agriculture	Trends in population distributions and numbers of bird species related to agriculture: number of bird species
	6. Protection of water resources	Water storage Free resources by improving irrigation efficiency Free irrigation resources with alternative sources	Improves water supply	Key "non-native" species threatening agricultural production and agro-ecosystems	Numbers of key "non-native" species threatening agricultural production and agro-ecosystems
				Crop varieties/livestock breeds that have been registered and certified for marketing	Total number of crop varieties that have been registered and certified for marketing
				supplying adjacent wetlands	Feedback water resources that supply adjacent wetlands of all the resources used
	7. Mitigation of greenhouse effect	Sink for greenhouse gases	Regulates climate by regulating greenhouse gases	Irrigated system/ Absolute volume of water used per cultivated hectare	Irrigation efficiency: m ³ /Ha Irrigated system: hectare/system
		Reduction of emissions	Reduces greenhouse gas emissions by using alternative energy sources	Alternative resources used	% of alternative resources of all water resources
	8. Mitigation of disasters caused by floods, landslides, and droughts.	Regulation of atmosphere chemical composition	Contributes to improving air quality	Absorption of greenhouse effect gases	Absorption Tm CO ₂ /Ha
Regulation of water flows		Improves ability to respond and adapt to natural disasters: storms, floods, droughts	Intensity of renewable energies use	Distribution of energy sources	
9. Territorial and culturally scientific	Retention of sediments and erosion control	Articulates nuclei and avoids congestion	Air quality	Air quality indices	
			Risks of flooding	Thematic cartography: risk of flooding	
	Territorial equilibrium	Creates jobs	Potential erosion	Tm of land loss/Ha	
			Population in a metropolitan area	The <i>Huerta de Valencia</i> population/ The city of Valencia population	
			Importance of agricultural employment	Agricultural employment of all employment	
			Importance of the level of contracting	Agricultural contracts of all contracts	
Cultural use	Provides a unique cultural heritage	Agricultural employment	UTA's/Ha		
		No. companies	Farms or surface area, according to farm owner		
10. Land protection	Soil forming process	Favours soil formation	Architectural heritage: catalogued goods	Catalogued goods	
			Soil conservation	Favours accumulation of organic matter and soil fertility by fixing nutrients	
	Diffuse pollution	Causes loss of quality of groundwater through pollution of aquifers	Water heritage: catalogued goods	Catalogued goods	
			Road network	Km covered by historic road network	
11. Water resource protection	Degradation of wetlands	Damages surrounding wetlands	Provides space for education	Infrastructure for educational	
			Scientific use	Provides important scientific elements: practice, vocabulary, tools, infrastructure	
12. Production of safe healthy food	Risks to human health from pesticide residues	Interferes with supply of healthy safe food	Infrastructure for Science		
			Current erosion	Tm of land loss/Ha	
NEGATIVE	10. Land protection	Soil forming process	Favours soil formation	Current erosion	
			Soil conservation	Favours accumulation of organic matter and soil fertility by fixing nutrients	
POSITIVE	11. Water resource protection	Diffuse pollution	Favours accumulation of organic matter and soil fertility by fixing nutrients	Agrological classification	
			Degradation of wetlands	Damages surrounding wetlands	
NEGATIVE	12. Production of safe healthy food	Risks to human health from pesticide residues	Causes loss of quality of groundwater through pollution of aquifers	Water quality	
			Degradation of wetlands	Damages surrounding wetlands	
POSITIVE	10. Land protection	Soil forming process	Causes loss of quality of groundwater through pollution of aquifers	Water quality	
			Soil conservation	Favours accumulation of organic matter and soil fertility by fixing nutrients	
NEGATIVE	11. Water resource protection	Diffuse pollution	Damages surrounding wetlands	Nitrate content in groundwater	
			Degradation of wetlands	Damages surrounding wetlands	
POSITIVE	12. Production of safe healthy food	Risks to human health from pesticide residues	Use of fertilizers and phytosanitary products	Use of fertilizers and phytosanitary products	
			Adoption of IPM by vegetable growers	Surface used for IPM	

Table 2. Peri-urban agricultural system: indicators for functions, goods and services.

Indicators need the requirements [38] that they are:

- Policy-relevant: indicators should be related to the government decisions and other stakeholders, and results, in the agriculture sector;
- Scientific and analytically basis: indicators based on science, with possibility to be developed and improved in progress;
- Measurable: indicators from available data, with reasonable collection cost;
- Simple interpretation: indicators should be easy to interpret by policy makers, stakeholders or the wider public.

3.1. Indicators for economic function

Indicators that explain the economic function are related to indicators on economic viability of farming. They are taken into consideration: 1) Farm real estate values. It is the principal source of collateral for farm loans, enabling farmers to finance the agricultural activity. 2) Farm income as indicator of economic performance. Also, rents resulting from possible alternative activities that can develop in the field of agriculture, more related to the possibility of outsourcing activity and development related to the possibilities of using agricultural areas for leisure and recreation activities. Considering potential income, as complementary income from farming tourism. Calculation of income as defined by the OECD [38] as the difference between the value of gross output and all expenses, including depreciation at the farm level from agricultural activities.

The use of agricultural areas for leisure and recreation is related to rural amenities from landscape, biodiversity, and wildlife habitat, the existence of a cultural heritage related to traditional agricultural practice: architecture, civil engineering, agricultural engineering, hydraulic engineering, etc. In many cases, specific local environmental and external factors drive urban farms to develop unique innovations for space-intensive production systems, often creating a dominant paradigm for urban farming for a given location [28].

3.2. Indicators for environmental function

The environmental function is related to the configuration of farming systems that contribute to the creation of characteristic agricultural landscapes of great value, to the conservation of biodiversity, to the conservation of the soil, to the protection of water resources, etc.

3.2.1. Configuration of Natural Heritage and Creation of new landscape shapes

Agriculture is, in many cases, responsible for shaping landscapes and ecosystem with specific characteristics. Managing human intervention over nature, the crops, cultural practices, plot size, shape of the plots, alignment of the plots, and infrastructures creation, can contribute to the creation of agricultural heritage, natural with great value. These agricultural landscapes deliver cultural and recreational, services, which do not sustain agricultural production, but deliver benefits derived from the aesthetic function of landscapes, including tourism, sense of

place, spiritual experiences and recreation, offering possibilities for additional income through, e.g., the recreation and tourism sector [41].

Agricultural landscapes are characterized by their spatial structure and composition. Landscape structure includes the diversity and complexity of the spatial (and temporal) structure of the landscape: orography, slope of the land, spatial organization of fields, plot size, shape of the plots, alignment of the plots, and infrastructures creation. Landscape composition refers to the relative prevalence of land use/land cover types, crops types, and landscape elements: water, trees, etc.).

Indicators proposed are:

- Soil cover as number of days in a year that the soil (agricultural land) is covered with vegetation [38]. See you Table 3
- Mosaic or tessellation is interpreted by agricultural matrix more or less plotted, more or less broken in small agricultural spaces, with a great variety of crops. Mosaic can be interpreted by number of agricultural plots, and variety of crops.

Farmland		Arable land	
Farms	Ha	Farms	Ha
10.030	21.975	9.079	20.123
	100%	91%	92%

Table 3. Arable land in Huerta de Valencia.

	Total farmland surface (Ha)		Arable land (Ha)	
	Number of farms	Total surface(Ha)	Number of farms	Total surface (Ha)
From 0.1 to 0.2 Ha	5	0.38	3	0.35
From 0.2 to 0.5 Ha	1,161	389.34	1,043	353.37
From 0.5 to 1 Ha	1,283	885.50	1,261	893.84
From 1 to 2 Ha	1,766	2,448.25	1,760	2,424.21
From 2 to 3 Ha	921	2,196.66	892	2,113.11
From 3 to 4 Ha	493	1,668.58	474	1,597.20
From 4 to 5 Ha	298	1,307.19	271	1,188.70
From 5 to 10 Ha	632	4,254.70	604	4,056.80
From 10 to 20 Ha	256	3,415.14	246	3,264.29
From 20 to 30 Ha	67	1,602.28	56	1,348.93
From 30 to 50 Ha	36	1,359.24	28	1,039.07
From 50 to 70 Ha	13	727.76	11.00	621.82

	Total farmland surface (Ha)		Arable land (Ha)	
	Number of farms	Total surface(Ha)	Number of farms	Total surface (Ha)
From 70 to 100 Ha	6	495.34	4.00	322.67
From 100 to 150 Ha	4	510.74	2.00	262.70
From 150 to 200 Ha	1	150.00		
From 200 to 300 Ha	1	200.00	1.00	200.00
From 300 to 500 Ha	1	399.71	1.00	399.71
Total	6,837	21,974.87	6,837.00	20,122.77

Table 4. Farm size in Huerta de Valencia.

There are a lot of very small size plots. **Table 4**, indicates that there are around 22.000 farms. From these, 60% are short farms, smaller than 10 ha. 25% between 4 and 10 Ha.



Figure 2. Spatial structure and composition.

There are a wide variety of crops (**Table 5**): traditional orchard crops, grain represented by rice, and a lot of citrus.

Vegetables		Other arable crops
ARTICHOKES	CANTALOUPE	Alfalfa
EGGPLANT	CUCUMBER	FLOWERS
ONION	WATERMELON	ORNAMENTALS
LETTUCE	TOMATO	CITRUS
CABBAGE AND CABBAGE	GREEN BEAN	SWEET ORANGE
CAULIFLOWER	GREEN BEAN	MANDARINO
ESCAROLE	SPINACH	LIMONERO

Vegetables		Other arable crops
GRAIN CEREALS	TUBERS HUMAN CONSUMPTION	FRUIT
	Potato TOTAL	GRANADO
RICE (PADDY)	CHUFA	ALGARROBO

Table 5. Variety of crops.

3.2.2. Biodiversity protection

Variety of natural conditions and farming traditions can create unique landscapes that are not only pleasing to the eye but provide the living conditions for many plants and animals. Differing farming practices have led to a variety of agricultural habitats that host a large number of plant and animal species. Maintaining adequate farming practices is therefore key to biodiversity conservation. Biodiversity generally decreases when the intensity of farming increases. On the other hand, land use change affect negatively, and abandonment is considered detrimental to biodiversity. So, extensive farming systems are most vulnerable to abandonment, and so to decrease biodiversity. Small farm size usually entails the consolidation of fields boundary, such as hedges and small trees, structures for feeding, nesting and shelter against predators. These are important for the crop protection [2]. Farmland birds are too, indicative of overall biodiversity.

In the area of Huerta, we find sites hosting natural diversity of habitats subject to different forms of protection. South of the Huerta de Valencia is the Albufera Natural Park. Paddy field area is located within the Albufera Park.



Figure 3. Paddy fiels area in Albufera Park.

North of the Huerta de Valencia, is the wetland “Rafalell I Vistabella”, and “Marjal del Moro”. Both are protected wetlands included in the Ramsar Convention. Albufera is also a wetlands. Tree areas are included in Nature 2000. Ecosystems located into or in the immediate vicinity and bordering on agricultural land.

The structural composition and dynamics of these ecosystems can't be understood but as a result of interdependencies with the surrounding agricultural areas and certain agricultural activities. In all cases, irrigation returns is very important for wetland. Moreover, the agricultural environment intervenes in biological flows, allowing the species movement through connection elements present, such as trails, enclaves and hedges that include either through called frames biophysical, hydrological flow to the surface. The canals and drainage system,

and irrigation canals connected, in all cases, with these spaces, forming a waterways system in some cases with abundant marsh vegetation that act as ecological corridors, linking together different spaces. A lot of species use marsh vegetation in canals for feeding, nesting and shelter.

Indicators proposed:

- Relationship between the surface of protected areas and the area under crops. 14,33%, according to **Table 7**.
- Trends in population distributions and numbers of bird species related to agriculture. We can see the annual inventory of species in protected areas. Regional administration make every year an annual inventory. In these inventories we have found many bird groups (rallidos, ducks, waders, terns, etc.) but also fish fauna among which include eel (*Anguilla anguilla*), mullet (*Mugil cephalus*) and especially the fartet (*Aphanius iberus*), amphibians as samaruc, and vertebrates.

On the other hand, biodiversity that is dependent on agricultural activities and/or affected by it, is related with the diversity of crop varieties/livestock used in agricultural production. These indicators help to reveal the resilience of agricultural production to environmental changes and risks which occur through diversifying the number of varieties/breeds in production.

- “non-native” species threatening agricultural production and agro-ecosystems.
- Crop varieties/livestock breeds that have been registered and certified for marketing.

Natural area protected	Type
Albufera	Parque Natural, LIC, ZEPA, Zona Húmeda
Marjal dels Morors	LIC, ZEPA, Zona Húmeda, incluye microrreserves
Marjal de Rafalell i Vistabella	Zona Húmeda
Parque Natural del Turia	Parque Natural

Table 6. Natural area protected.

Total farmland surface (Ha)		Arable land (Ha)		Natural area protected (Ha)
Number of farms	Total surface (Ha)	Number of farms	Total surface (Ha)	
10,030	21,975	9,079	20,123	3,150
	100%		92%	14.33%

Table 7. Natural protected area for arable land.

3.2.3. Water use

Agriculture has capacity to interfere on the supply and quality of water to improve it. Agriculture performs storage functions and water retention. Agriculture regulates the water regime in the crop area and in bordering wetlands, already named above.

The share of agriculture in total water utilisation is normally high. Irrigation technology help to achieve economic efficiency by management and distribution.

We are developing three indicators related to agriculture's use of water:

- Irrigated system/ Absolute volume of water used per arable area:
 - 1) Irrigation efficiency: m³/Ha
 - 2) Share of irrigation water applied by different forms of irrigation technology (**Table 8**).

Total Surface (Ha)	Irrigation method (Ha)			
	Sprinkler	Drip	Flood	Other method
19,044	253	4,886	13,782	122

Table 8. Surface by irrigation method (Ha).

The least efficient method, flooding, is the most used irrigation method in Huerta de Valencia. This suggests that water be used more efficiently. Water is considered a scarce resource and consequently issues related to irrigation efficiency are of importance. But, the irrigation method, is important for another function:

- The reservoirs and canals provide habitat for waterfowl and fish.
- Wetlands around agricultural areas receive seepage and drainage from canals.
- Irrigation canals provide habitats.
 - 3) Supplying adjacent wetlands: relationship between feedback water resources that supply adjacent wetlands of all the resources used in arable area.

3.2.4. Climate change and global warming contribution

It is now widely believed that the increased atmospheric concentration of greenhouse gases (GHGs) is contributing to the process of climate change and global warming.

Huerta de Valencia as agrarian system has capacity to act as a GHG sink, regulation of local and global climate change, and contributes to atmosphere composition regulation, and the improve of quality air. But the cover cropping, tillage systems and crops management in Huerta de Valencia make these capacities difficult, because the most important crops are vegetable and there are few trees.

3.2.5. Soil protected, land conservation

Appropriate land use, combined with environmentally sound soil and water management practices can help to reduce the peak flow of surface water and loss of soil sediment.

3.2.6. *Negative externalities*

Environmental value includes negative impacts of farm management practices. These negative impacts refer to pollution derived from intensification in irrigation crops, and from pesticides applied.

Huerta de Valencia is an agricultural system which practices farm management that can induce environmental damage. Nitrogen (N) and phosphorus (P) surplus in excess can run-off into surface waters and percolate. So it is important to consider the risk of groundwater pollution. Regional administration has rated the area with high risk of groundwater vulnerability.

- Water quality risk indicator: Potential concentration of nitrate (or phosphorus) in the water flowing from a given agricultural area, both percolating water and surface run-off.
- Water quality state indicator: Nitrate concentration in water in agricultural areas when these areas are included as vulnerable areas.

It is important to have analysis from soil and water, to adjust surplus N and P to the crop needs.

Pollution by pesticide, include soil, water and air pollution. The most important result is the potential risk to human health and the environment. It required pest management, to reduce the environmental and health impacts of pesticide use. Recommended farm management practices can reduce pesticide residues left in soil, by lowering the quantity of pesticides applied and using less toxic and less persistent pesticides. Indicator:

- Adoption of IPM by vegetable growers. Land management practices: Share of the total crop area under environmental land management practices.
- Provision of agricultural employment opportunities

3.3. Indicators for social function

Social goods and services of Huerta de Valencia derive from territorial and cultural-scientific elements.

3.3.1. *Equilibrium territorial*

Urban expansion has been the most important driver of very high consumption of land and agricultural resources. The urban fringe is often characterized by uncontrolled urban development that results in discontinuous patterns and consequent fragmentation of farmlands. As a result, it becomes a particular contemporary peri-urban landscape, where residential low-density settlements are intertwined with farmlands that have been partially modified and reduced by urbanization. This is the main landmark of metropolitan areas [42].

In Mediterranean cities, for decades, small residential urban settlements around the big city, absorb some of the population growth (Barcelona, Valencia, Milan, etc.), creating major metropolitan areas very densely populated. Agriculture involves this urban development process with opportunity of working, building communities, connect people to each other and the land, family cohesion, producing food and other products for consumption and for sale.

Actually, in these developed cities, agriculture, rather than food production per se, takes on an important role in providing recreational opportunities for citizens (recreational routes, food buying and meals on the farm, visiting facilities) or having educational functions (bringing youth in contact with animals, teaching about ecology, etc.).

Huerta de Valencia has been shaped historically by the farmers, from small settlements, the network of canals and historic trails, and scattered farmhouses and “barracas”⁶. As a result of agricultural activity, it has developed important agronomic heritage (agricultural practices, varieties, tools, vocabulary, etc.), hydraulic heritage necessary to water resources management, and civil architecture (mills, farmhouse, etc.). All together, these make Huerta de Valencia an agricultural system with great cultural and scientific value.

In Valencia, from 1950, economic growth resulted in very important changes in the city and pre-metropolitan settlements. Population in this area has exhibited a considerable growth. In small settlements, this is faster than Valencia City. You can see Table 9.

Year	Now VMA	Valencia	(VMA/Valencia)x100
1877*	88,000	165,000	53.33
1900*	110,000	209,000	52.63
1950*	214,000	450,000	47.56
1975*	470,000	718,000	65.46
2008**	758,232	771,466	98.28
2011	746,696	798,033	93.57

Table 9. Population evolution in Valencia Metropolitan Area (VMA).

On the other hand, agriculture provides agricultural employment opportunities. De Zeeuw (2003) noted that in addition to the economic benefits to the urban agricultural producers, urban agriculture stimulates the development of related enterprises: the production of necessary agricultural inputs and, the processing, packaging and marketing of outputs. The activities or services rendered by these enterprises may owe their existence wholly or in part to urban agriculture [43].

Indicators:

- Employment: agricultural employment in total civilian employment.

Agricultural sector has a declining role in overall economic activity. This is reflected in the decrease of farm employment.

⁶ Typical farmhouse in Huerta de Valencia.

	C. Valenciana			Spain		
	Total	Men	Women	Total	Men	Women
farming	4.2	5.5	2.5	3.3	4.9	1.3
industry	14.7	19.7	8.3	16.7	22.5	9.3
construction	10.0	16.4	1.8	10.8	17.9	1.5
services	71.1	58.5	87.5	69.2	54.7	87.9

Table 10. Employment by economic sector, 2009.

If we consider employments for the last years, by activity sector, we find in Huerta de Valencia that agriculture maintains low employment proportion, less 2%, with progressive decrease.

- Employment per hectare of cultivation: agricultural employment in total surface of farmland.

Farms with land	Farms	AWU's	TS (Ha)	UFS (Ha)	UTA's/ST(Ha)	UTA's/SAU(Ha)
Huerta de Valencia	10,030	4,542.88	21,975	20,122.77	0.21	0.23
Provincia Valencia	67,774	37,740.99	431,429	309,171.22	0.09	0.12
Comunidad Valenciana	120,180	71,020.10	890,426	657,469.61	0.08	0.11

Table 11. AWU's/surface.

However, it must be pointed out, in **Table 11**, that agricultural employment per hectare of cultivation is most important in this area.

- Number of companies. In **Table 12** it is described the types of businesses and their legal form.

	Farmland	%	TS (Ha)	%	SAU (Ha)	%
All farms	13,321	100.00	22,761	100.00	20,410	100.00
Individual entity	12,977	97.42	19,769	86.85	18,096	88.66
Individual entity and manager	11,550	86.71	17,486	76.82	15,986	78.32
Company	97	0.73	723	3.18	662	3.24
Public entity	20	0.15	548	2.41	62	0.30
Cooperative entity	8	0.06	83	0.36	83	0.41
Agrarian Transformation Company	62	0.47	601	2.64	582	2.85
Other legal company condition	157	1.18	1,038	4.56	925	4.53

Table 12. Farmland and surface, by farmland type.

3.3.2. Cultural-scientific function

Agricultural land near cities is important for food availability. We can still have a fresh supply of food preserving agricultural land near cities.

The cultural and scientific value is recognized by agricultural activity development and local knowledge related to farmland multifunctionality and sustainable land usage:

- Scientific: related to agronomic engineering. In many cases, specific local environmental and external factors drive urban farms to develop unique innovations for space-intensive production systems, often creating a dominant paradigm for urban farming for a given location [28].
- Culture: Agricultural land near cities is an important part of cultural heritage.
- Education: Farms near cities are important places for people to learn about the natural world, and provides important opportunities to teach people about where their food comes from.

The scientific value in Huerta de Valencia is recognized by agricultural activity development throughout the centuries, from Roman times, with the development of environmental practices adopted by farmers:

- Development of crop farming that has changed over the centuries, providing plant foods, raw materials and biological material. Actually, supplying a variety of quality fresh produce,
- For each soil, farmers choose the most appropriate crop, and the best agricultural practices, creating a peculiar vegetation cover, resulting in a landscape-type non-common in Europe,
- Special working tools design adapted to the structures' type, plot size, shape of the plots, alignment of the plots, crops and agricultural practices,
- Specific vocabulary,
- Adaptation of plots for soil conservation: embankments, low walls,
- Small hydrological corrections, variety of techniques to collect and provide water to crops,
- Species conservation and preservation of plant genetic resources,

Cultural value derive from adaptation of activity, to the ecosystem:

- creating a unique space, organized according to the farming system,
- own customs, such as those derived from water resources management models through a historic hydraulic infrastructures with mills, towers, canals,
- development of agricultural practices that have contributed to soil conservation and improvement of their agrologic characteristics,
- creation of an important architectural heritage and civil engineering, with an important set of built elements (buildings, farms, barracks houses), and other elements associated with

the activity, and irrigation management, such as mills, canals, dams, etc. Glick [44], an American historian and scholar of historical irrigation systems, has studied the irrigation system in the Huerta de Valencia, and places its origins in medieval times.

Indicators:

- unique innovations
- listed as protected architectural heritage: farms, “barracas”, mills, etc.
- existence of a network of historic trails
- listed as protected hydraulic heritage
 - length preserved historic canals
 - floodgate, sluice

4. Conclusion

On our objective in this paper was created a descriptive approach for the functionality of peri-urban agricultural systems, and proposed a methodology to quantify the functionality of peri-urban agricultural systems by means of indicators. Here, we reviewed the literature on peri-urban agricultural system, the literature on indicators, to define an analytical framework to determine and assess ecosystem services at peri-urban agricultural systems. The review shows a wide variety of functions that can be grouped according to their economic dimension, social dimension and environmental dimension. The descriptive approach for the functionality includes a list of the goods and services that an agricultural system can provide, distinguishes between those considered private from public, and those with a positive or a negative externality nature. All goods and services are classified according to whether they are economic, social or environmental. Up to 12 generic services are defined, which are subdivided into 22 functions and 22 goods and services.

To quantify the functionality of peri-urban agricultural systems we propose 36 indicators that cover the three components of the concept (economic, social and environmental). Some of these indicators are defined from previous studies around sustainable agriculture. There are some papers which propose indicators to economic and environmental analysis but do not completely cover the selected aspects of multifunctionality. In order to yield a broader coverage, we include new indicators defined specifically for the analysis of the peri-urban agriculture particularities. Specifically, indicators related to territorial aspects of the special location of these agricultural systems, and pressures to which they are subject. Other indicators related to the education and cultural function that these agricultural systems can provide to the hipsters.

From descriptive approach for the functionality of peri-urban agricultural systems derive that these can't be considered as an economic activity *sensu stricto*. On the other hand, society demands of these opportunities to undertake recreational activities, produce quality organic products locally, conserve and maintain spaces relatively near cities and towns under suitable environmental conditions for living, conserving cultural ethnological heritage, etc.

The planners and political decision makers should consider society demands and the contribution from peri-urban system to the economic, socio-ecological, psychological, cultural, and spiritual welfare of the urban community.

So, to planners, it is important to determine functions and services actually, in the peri-urban system. Then, it can determine social preferences for them though determining social welfare function. Finally, planners and political decision makers can define desirable future scenarios to the peri-urban agriculture system, quantifying the weight, as a starting point, and define policies to achieve those desirable scenarios.

The analytical framework presented can apply for every peri-urban system. The proposed methodology was applied to the Huerta de Valencia, a peri-urban agricultural system around Valencia City. This is a rich agricultural area with a variety of resources. There is an open political-institutional debate to define a protection scheme. The results from this study help to enrich this debate.

Indicators proposed are relevant to quantify every empirical value of function and services that explain. But the indicators proposed are highly questionable as there is no clear connection between the indicator value pure amount and the value of multifunctionality. Some authors [37] recommend transforming base indicators into adimensional variables (normalization) and then aggregate. Another question is determine the minimum/maximum values of the indicator values, a range of values that determine the multifunctional character for each aspect, or for the aggregate value.

For next research it is necessary to work in the normalization of indicators, as previous step to aggregation. To evaluate the multifunctional character it is necessary to have a range of values.

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References

- [1] Fielke SJ & Bardsley DK. 2015. *Regional agricultural governance in peri-urban and rural South Australia: strategies to improve multifunctionality*. Sustainability Science, Vol. 10, pp. 231–243.
- [2] Renting H, Rossing WAH, Groot JCJ, Van der Ploeg JD, Laurent C, Perraud D, Stobelaar DJ & Van Ittersum MK. 2009. *Exploring multifunctional agriculture. A review of conceptual approaches and prospects for an integrative transitional framework*. Journal of Environmental Management, pp. S112–S123.
- [3] Mather A, Hill G & Nijink M. 2006. *Post-productivism and rural land use: cul de sac or challenge for theorization?* Journal of Rural Studies, pp. 441–455.
- [4] Organisation for Economic Co-operation and Development (OECD). 2001. *Multifunctionality: Towards an Analytical Framework*. Paris: OECD Publications, p. 27.
- [5] Organisation for Economic Co-operation and Development . 2003. *Multifunctionality: The Policy Implications*. Paris: OECD Publications.
- [6] Wilson GA. 2001. *From productivism to post-productivism... and back again? Exploring the (un) changed natural and mental landscapes of European agriculture*. Transactions of the Institute of British Geographers, Vol. 26, pp. 77–102.
- [7] Wilson GA. 2007. *Multifunctional Agriculture. A Transition Theory Perspective*. Wallingford: CAB International, p. 374.
- [8] Jongeneel RA, Polman NBP & Slangen LHG. 2008. *Why are Dutch farmers going multifunctional?* Land Use Policy, Vol. 25, pp. 81–94.
- [9] Reig E. 2002. *La multifuncionalidad del Mundo Rural*. Revista de Economía, Información Comercial Española, Vol. 803, pp. 33–44.
- [10] Amekawa Y, Sseguya H, Onzere S & Carranza I. 2010. *Delineating the multifunctional role of agroecological practices: toward sustainable livelihoods for smallholder farmers in developing countries*. Journal of Sustainable Agriculture, Vol. 34, pp. 202–228.
- [11] Huylenbroeck Van, Vandermeulen V, Mettepenningen E & Verspecht A. 2007. *Multifunctionality of agriculture: a review of definitions, evidence and instruments*. Living Reviews in Landscape Research.
- [12] Reig E. 2007. *Fundamentos Económicos de la Multifuncionalidad [aut. libro]. Pesta y Alimentación Ministerio de Agricultura. La Multifuncionalidad de la Agricultura Española*. Madrid: Eumedia, pp. 19–39.
- [13] Wilson GA. 2008. *From 'weak' to 'strong' multifunctionality: conceptualising farm-level multifunctional transitional pathways*. Journal of rural studies, Vol. 24, pp. 367–383.

- [14] Brandt J & Vejre H. 2004. Multifunctional landscapes – motives, concepts and perspectives. *Multifunctional Landscapes, Volume I—Theory, Values and History*, Vol. 1, pp. 3–31.
- [15] Zander P, Knierim A, Groot JCJ & Rossing WAH. *Multifunctionality of agriculture: tools and methods for impact assessment and valuation*. *Agriculture, Ecosystems & Environment*, Vol. 120, pp. 1–4.
- [16] Compés RG & Álvarez-Coque JM. 2009. *La reforma de la PAC y la Opex*. Observatorio de política exterior. Fundación Alternativas.
- [17] Chiara M, Stefano C & Guido S. 2015. *Agricultural land consumption in periurban areas: a methodological approach for risk assessment using artificial neural networks and spatial correlation in Northern Italy*. *Applied Spatial Analysis and Policy*, pp. 1–18.
- [18] Rogge E & Desein J. *Perceptions of a small farming community on land use change and a changing countryside: a case-study from Flanders*. *European Urban and Regional Studies*, pp. 1–16. DOI: 10.1177/0969776412474664
- [19] Filippini R, Marraccini E, Lardon S & Bonari E. 2014. *Assessing Food Production Capacity of Farms in Periurban Areas*. *Italian Journal of Agronomy*, Vol. 9.
- [20] S Corsi, Mazzocchi C, Sali G, Monaco F & Wascher D. 2015. *L'analyse des systèmes alimentaires locaux des grandes métropoles. Proposition méthodologique à partir des cas de Milan et de Paris*. *Cah Agric*, Vol. 24, pp. 28–36.
- [21] Pascucci S. 2007. *Agricoltura periurbana e strategie di sviluppo rurale*. Nápoles: Dipartimento Di Economia e Politica Agraria, Università degli Studi di Napoli Federico II.
- [22] Zasada I. 2011. *Multifunctional peri-urban agriculture—A review of social demands and the provision of goods services by farming*. *Land Use Policy*, Vol. 28, pp. 639–648.
- [23] Moreno O. 2009. *Estrategias y Dinámicas de las Explotaciones Agrarias de Base Familiar: El caso de una Agricultura-Intensiva* (thesis).
- [24] Reig E. 2008. *Agricultura, desarrollo rural y sostenibilidad medioambiental*. CIRIEC, Vol. 61, pp. 103–126.
- [25] Gómez-Villarino T & Gómez-Orea D. 2012. *Agricultura y Medio Ambiente: en pos del desarrollo sostenible*. Universidad de Flores, UFLO Calidad de Vida, Vol. 7, pp. 3–22.
- [26] Ivesa CD & Kendal D. 2013. *Values and attitudes of the urban public towards peri-urban agricultural land*. *Land Use Policy*, Vol. 34, pp. 80–90.
- [27] Atance I. 2007. *Política Agraria Para una Agricultura Multifuncional. Un Análisis de la PAC Reformada Frente a la Multifuncionalidad* [aut. libro]. Pesca y Alimentación Ministerio de Agricultura. *La Multifuncionalidad de la Agricultura Española*. Madrid: Eumedia, pp. 91–102.

- [28] Pfeiffer A, Silva E & Colquhoun J. 2015. *Innovation in urban agricultural practices: responding to diverse production environments*. Renewable Agriculture and Food Systems, pp. 79–91.
- [29] Pelzer E, Pelzer E, Fortino G, Bockstaller C, Angevin F, Lamine C, Moonen C, Vasiladiadis V, Guérin D, Guichard L, Reau R & Messéan A. 2012. *Assessing innovative cropping systems with DEXiPM, a qualitative multi-criteria*. Ecological Indicators, pp. 171–182.
- [30] Thapa RB & Murayama YM. 2008. *Land evaluation for peri-urban agriculture using analytical hierarchical process and geographic information system techniques: a case study of Hanoi*. Land Use Policy, Vol. 25, pp. 225–239.
- [31] Mittenzwei K, Fjellstad W, Dramstad W, Flaten O, Loureiro M & Prestegard SS. 2007. *Opportunities and limitations in assessing the multifunctionality of agriculture within the CAPRI model*. Ecological Indicators, Vol. 7, pp. 827–838.
- [32] Wiltshire K, Delate K, Flora JL & Wiedenhoef M. 2011. *Socio-cultural aspects of cow-calf operation persistence in a peri-urban county in Iowa*. Renewable Agriculture and Food Systems, Vol. 26, pp. 60–71.
- [33] Silva R. 2010. *Multifuncionalidad agraria y territorio. Algunas reflexiones y propuestas de análisis*. EURE, Vol. 109, pp. 5–33.
- [34] Laterra P, Orúea ME & GC Boo. 2012. *Spatial complexity and ecosystem services in rural landscapes*. Agriculture, Ecosystems and Environment, pp. 56–67.
- [35] Howe RW, Regal RR, Niemi GJ, Danz NP & Hanowski JM. 2007. *A probability-based indicator of ecological condition*. Ecological Indicators, pp. 793–806.
- [36] Brinkley C. 2012. *Evaluating the benefits of peri-urban agriculture*. pp. 259–269.
- [37] Gómez-Limón JA & Sanchez-Fernandez G. 2010. *Empirical evaluation of agricultural sustainability using composite indicators*. Ecological Economics, pp. 1062–1075.
- [38] OECD. 2001. *Environmental Indicators for Agriculture Volume 3: Methods and Results*. París: OECD Publications.
- [39] Brouwer F. 2002. *Effects of agricultural policies and practices on the environment: review of empirical work in OECD countries*. Directorate for Food, Agriculture and Fisheries, Organisation for Economic Co-operation and Development. COM/AGR/CA/ENV/EPOC(2001)60/FINAL.
- [40] Berbel Vecino J. & Gutiérrez Martín C. 2004. *Sustainability of European Irrigated Agriculture under Water Framework Directive and Agenda 2000 – WADI*.
- [41] Van Zanten BT, et al. 2014. *European agricultural landscapes, common agricultural policy and ecosystem services: a review*. Official Journal of the Institut National de la Recherche Agronomique (INRA), Vol. 34, pp. 309–3025.

- [42] Muñoz F. 2003. *Lock living: urban sprawl in Mediterranean cities*. *Cities*, Vol. 20, pp. 381–385.
- [43] de Zeeuw H. 2003. *Annotated Bibliography on Urban Agriculture*. Leusden, The Netherlands: ETC – Urban Agriculture Programme in cooperation with TUAN and other organisations, Swedish International Development Agency (Sida).
- [44] Glick TF. 2003. *Regadíos y Sociedad en la Valencia Medieval*. Biblioteca Valenciana.
- [45] Galli M, et al. 2010. *Agricultural Management in Peri-Urban Areas. The Experience of an International Workshop*. Ghezzano: Felici Editore Srl.
- [46] Hoogeveen Y, et al. 2004. *High nature value farmland. Characteristics, trends and policy challenges*. Environmental Production, European Environment Agency. Copenhagen: Scanprint a/s. ISBN 92-9167-664-0.
- [47] Wilson GA. 2007. *Multifunctional Agriculture: A Transition Theory Perspective*. CABI.