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Fostering complementarities between traditional and scientific knowledge: Agricultural researchers´ perceptions

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Abstract

Scientific and traditional knowledge have followed their own paths and there is a need to combine both knowledge resources. It implies strong dialogue between researchers and farmers, which requires good insights about perceptions and activities performed by both groups. In this research, the focus is on agricultural researchers' perceptions about their own and farmers' activities in order to find strategies to strength communication between both groups. A survey carried out among 156 agricultural researchers has provided insights about their perceptions with respect to farmers' knowledge and information sources, their motivations toward dissemination activities and perceptions about dissemination activities. Results show great distance between researchers and farmers but also willingness to bridge the gap. Strategies indicate that indirect approaches could be more useful than direct communication. Researchers should be evaluated in accordance with social needs, because their actual activities are far away from farmers' interests, and farmers need to improve their training to have easier access to knowledge resources, as professional experiences are yet their main knowledge

source. Innovation requires joint activities that could be performed in many different ways. This research provides new references about researchers' perceptions related to the Spanish agricultural sector.

Keywords: Traditional & scientific knowledge, information, dissemination, innovation.

Introduction

Background…

The Innovation Union is one of the initiatives of the Europe 2020 strategy for smart, sustainable and inclusive growth. European Innovation Partnership (EIP) is a key point in this initiative. EIPs support the cooperation between research and innovation partners so that they are able to achieve better and faster results compared to existing approaches. This new approach requires better understanding of different partners.

The European Commission launched EIP-AGRI in 2012, for more productive and sustainable agriculture and forestry. It brings together innovation actors (farmers, advisors, researchers, business, NGOs, etc.) and helps to build bridges between research and practice, through a dynamic approach.

This approach is coherent with Agricultural Knowledge and Innovation Systems (AKIS) proposals: social innovation for agricultural innovation. In this way, AKIS emphasizes two ideas: on one side the integration of traditional and scientific knowledge and, on the other side, a horizontal approach.

Both ideas are based on knowledge communication among stakeholders. AKIS tries to reduce the distance between actors in order to work on a common and specific problem. Traditional agricultural knowledge systems were vertical structures. Firstly, knowledge was

generated by scientists, and then, it was transferred to the agricultural sector. Farmers´ background and experience were not considered. Nowadays, this approach hinders the innovation from being more effective. It is necessary a change in the agricultural scientists' way of work. In order to do it is important to know their perceptions.

The innovation is not a lineal process from scientists to farmers. Current approaches raise models where innovation works in a systemic context. Regulations, policies, infrastructure or funding are key drivers in the innovation process (Klerkx, 2008). Thus, innovation involves a creative and networking process between different subsystems. In this approach, collaboration among stakeholders is essential.

The current dominant agrarian model in developed countries stems from the necessity of feeding a population, that after having suffered two great wars during the first half of 20th century, it has been growing and demanding new quality products. It is an agricultural model marked by the objective of knowledge dominance, first off giving raise to the industrial revolution and then to the green revolution. The expert knowledge superseded the local knowledge (Morgan and Murdoch, 2000). This model fulfilled the goals it pursued, however, it has had economic, social and environmental impacts, and thus, it is necessary to rethink the whole model to ensure sustainability and survival.

A sustainable agricultural model cannot be achieved without a change in the agricultural paradigm knowledge. This sustainable agriculture implies highly adapted practices to local and traditional context. In addition, these practices have to be suitable regarding the ecosystem where they are carried out (Curry & Kirwan, 2014; Ingram, 2008; Ingram & Morris, 2007). This implies the necessity of taking into account different epistemologies and ways of knowledge, hence, the involvement of various social actors in an

interactive and creative discussion. It is a model that not only highlights a combination of different sources of knowledge, but also the way this knowledge is produced, combined, distributed and shared.

Lundval y Johnson (1994) mentioned four ways of knowledge:

- know-what, refers to the knowledge about facts.

- know-why, refers to scientific laws in relation to nature and society.

- know-how, refers to how to use tools and concepts.

- know-who, refers to know who knows what and who knows to do what.

Morgan and Murdoch (2000) reduce these to two categories; the first one clusters know & what and, the second one merges know & why. The former would be the knowledge codified, explicit and standardized. The latter refers to the knowledge tacit, implicit, local, dependant of the context and the experience. Sutherland et al. (2017) also mentions the two types of knowledge as tacit and codified. This paper mentions that some authors focus on remarking the differences (Morgan and Murdoch, 2000), others emphasize the complementary nature of both knowledge (Molnar et al., 1992; Nonaka and Takeuchi, 1995; Pretty, 1995; Black, 2000).

The tacit knowledge is linked to direct experiences and practices. It includes intangible elements, such as, beliefs, insights, value system, etc. (Isoe, 2011). Farmers' knowledge is intuitive, derived from their daily work. This kind of knowledge enables them to give meaning to their spatial and temporal context. Ingram (2010) applies these concepts to the case of soil management practices, drawing contrasts between farmers' knowledge and researchers' knowledge.

In accordance with the green revolution´s mantras, the relationship between both knowledge was based on a one-way linear model, mainly relying on technology supply, poor feedback, the public sector as the main stakeholder, focusing on the most purely agronomic issues, etc.

Nevertheless, the change of framework, the free trade agreements and the globalization have increased the competition. The knowledge, the information and the technology are not anymore constrained to the scope of universities and public research centres. The communication technologies shape the knowledge dissemination processes, the civil society participates in the decision-making and the decentralization raises the responsibilities and resources at local level. To all of this, we have to add the adjustments on the public accounts, which have direct impacts on the research budgets and agricultural extension services.

The increase of social dynamism, along with the multiple knowledge sources, have speeded up the knowledge and innovation generation processes, to an extent where in many cases knowledge and innovation are almost simultaneously produced. The main drivers of this change have been the shift in food consumption, the emerging technologies, the climate change and the redefinition of public-private relationships.

Agricultural knowledge communication

The step from knowledge to innovation requires communication. Communication refers to sharing information, making somebody aware of something. Knowledge communication is a bridge that links individual experience with their group experience and,

when necessary, with individuals from other groups. In fact, it is the way cultures build in and transform.

Traditionally, knowledge communication has been defined as "the exchange of feelings, opinions or any other type of information through speech, writing or another kind of signals". According to Leagans (1961), knowledge communication is the process by which, two or more people exchange ideas, facts, feelings or insights, in a manner that a shared understanding of meaning, intentions and use of messages is generated.

It is a conscious attempt to share information, ideas, preferences or attitudes with other people. The setting of a shared meaning is a common element in all definitions and the way to verify the proper knowledge communication implies a feedback or reaction of message receptor. It is important to distinguish knowledge communication from simple information, because to achieve knowledge communication it is necessary a response from the interlocutor. On the other hand, the information only provides some data, new or fact.

Everett Rogers developed the foundation of the diffusion theory. He received a Bachelor of Science (1952) and a Master's degree in Agriculture. However, his approach came from the social sciences point of view. He was interested on the resistance of farmers to use innovative techniques in agriculture. Therefore, in 1962 Everett Rogers published one of the most influence work about innovation "Diffusion of Innovations". In fact, innovation and agriculture are in the origin of current theories about innovation.

Purpose of the study

This research aims at providing insights about agricultural researchers' perceptions and motivations towards their own activities as well as farmers' activities, in order to generate

knowledge for sound strategies to foster dialogue between both groups and enhance innovation.

There are three sub-objectives, such as:

1) To analyse agricultural researchers' perceptions about farmers' knowledge and information sources
2) To explore researchers' motivations toward the dissemination activities
3) To analyse researchers´ perception about farmers and innovation.

Methodology

A link to an online survey was sent (June - September 2018) by email to researchers included in the database of the Spanish National Institute for Agricultural and Food Research and Technology (INIA). This institution is responsible for the management and coordination of Agrifood R&D Spanish programs. It was complemented by other regional sources.

The survey includes three blocks of questions. The first one is about researchers' perception with regard farmers' knowledge and information sources. The second one is about researchers' attitudes with respect dissemination activities. And finally some questions about researchers' profile were included in the third block.

Survey includes ninety-five questions, most of them with values included in a scale between 0 and 9, to quantify the opinion of researchers about the considered statements.

Finally, 156 researchers answered the survey; 86.5% is focused on commodities, and 8,3% on processing industry. The 19% works in the University and 81% in agricultural research centres, most of them in public centres (92%).

Analysis, with IBM SPSS Statistics, includes tree steps. First step is a descriptive analysis in order to offer a general researchers' perception about farmers' knowledge and

information sources. Second step is a classification of researchers' motivations toward the dissemination activities. Finally, last step is an analysis focusing on researchers´ perception about farmers and innovation. This last analysis identifies different strategies of researchers according to different types of farmers. Principal Component Analysis (PCA) has been used in the second and third steps.

PCA is a multivariate technique used to simplify the numerous and complex relations that can be found in a set of quantitative observed variables. This technique seeks to find common dimensions or factors that group highly correlated variables and explain a great part of the common variability. As opposed to what occurs with other techniques, such as regression variance analysis, in factor analysis all the variables are independent, given that there is no a priori conceptual dependence of some variables on others.

Factor analysis consisted of four representative steps: 1) the calculation of a matrix capable of expressing the joint variability of all the variables; 2) the extraction of initial factors; 3) the rotation of the solution to facilitate its interpretation; and 4) the denomination of the initial factors.

In the extraction method by principal components, the factors found are the autovectors of the matrix of rescaled correlations. The criterion used to extract these factors was when autovalues were greater than unity, i.e. factors that explain more variance than any original variable. The Varimax method with Kaiser executes an orthogonal rotation that minimizes the number of variables that have high saturation in each factor, simplifying the interpretation of the results. Once the final factorial solution is reached, the factors are named, and this is subjective, requiring a combination of intuition and knowledge of the variables.

The statistical contrasts used to evaluate the goodness of the fit of the factorial models formulated are: the mean of the KMO (Kaiser-Meyer-Olkin) measure and Bartlett's test of sphericity. In this study, a factorial principal components factor analyses was carried out by a Varimax rotation with Kaiser normalization.

Findings

Agricultural researchers' perceptions about farmers' knowledge and information sources

One of the suggestions provided by the AKIS approach in order to rebuild the agricultural innovation systems is to create a more horizontal model. A model where scientists and farmers are able to establish a dialogue. A previous step is that researchers should recognise farmers' knowledge and, at the same time, farmers should be confident about scientific knowledge improving their farms. In order to establish such a dialogue it is important to know researchers' perceptions about farmers as well as the opposite. Thus, based on data survey, the "know how" gets low recognition (5.9/9) by agricultural researchers as a knowledge source to solve problems, although, they value it correctly because is well adapted to specific local areas (78%). From the researchers´ point of view, farmers do not demand general knowledge but solutions for specific problems and advice (7.0/9). On the other hand, farmers consider poorly research centres as information and advice references (6.2/9). It seems that each collective believes on their own knowledge resources.

Researchers consider that farmers´ knowledge is mainly based on experience (7.9/9), above of formal training, tradition, non-formal training and intuition (Table 1). According to national farm records, just 5% of farmers (head of the holdings) have formal training and,

experience is the knowledge source for 85% of farmers, which is in accordance with findings in this research.

Table 1. Farmers' knowledge sources

	Mean
Experience	7.9
Formal training	6.5
Tradition	6.3
Non-formal training	6.1
Intuition	5.6

Furthermore, researchers also consider that technicians of cooperatives are the main farmers' source of information (7.3/9) for farmers, which provides an idea of the coverage that cooperatives have in the Spanish agricultural system, followed by peer learning, research centres and agricultural commercials (Table 2). Internet and university rank very low. Scientific journals become irrelevant. It is a clear recognition by researchers that they have little direct impact on farmers.

Table 2. Farmers' information sources

	Mean
Technicians of the cooperatives	7.3
Peer learning	6.8
Research Centres	6.5
Agricultural commercials	6.4
Technicians of the Government	6.4
Sectorial journal	6.2

Extension office	6.1
Internet	5.6
University	5.5
Scientific journals	3.9

The PCA, in this case, associates knowledge and information sources and it explains the 49% of variance. Kaiser-Meyer-Olkin (KMO) test is 0.8 and significance level of Barlett's test of sphericity is .000, so data are suited for this analysis. It identifies two principal components (Tables 3, 4, 5 and 6). The first one explains 33% of variance and the second 16%. The first one includes University, research centres and sectorial journals as the main drivers, all of them with correlation values >0.8. Intuition and traditional knowledge get information from peer learning and agricultural commercials. They have very limited relationship with any other kind of information source. On the other side, farmers with formal training focus their attention on university, research centres, sectorial journals and scientific journals.

Table 3. Principal component analysis. Extraction method. Communalities

	Initial	Extraction
Experience	1,000	,035
Formal training	1,000	,473
Non-formal training	1,000	,301
Intuition	1,000	,499
Tradition	1,000	,505
Agricultural commercials	1,000	,444
Peer learning	1,000	,540

Internet	1,000	,324
Extension offices	1,000	,494
Technicians of the Government	1,000	,603
Technicians of the cooperatives	1,000	,458
University	1,000	,711
Research centres	1,000	,712
Sectorial journals	1,000	,672
Scientific journals	1,000	,629

Table 4. Total variance explained

Component	Eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5,078	33,852	33,852	5,013	33,423	33,423
2	2,324	15,495	49,347	2,389	15,923	49,347
3	1,462	9,746	59,093			
4	1,119	7,461	66,554			
5	,927	6,178	72,732			
6	,712	4,747	77,479			
7	,670	4,470	81,948			
8	,501	3,342	85,290			
9	,465	3,102	88,392			
10	,395	2,630	91,023			
11	,354	2,361	93,384			

12	,313	2,088	95,472			
13	,285	1,898	97,370			
14	,241	1,609	98,979			
15	,153	1,021	100,000			
Extraction method. Principal component analysis						

Table 5. Component matrix[a].

	Component	
	1	2
Experience		
Formal training	,683	
Non formal training		
Intuition		,700
Tradition		,659
Agricultural commercials		,612
Peer learning		,719
Internet		
Extension offices	,647	
Technicians of the Government	,772	
Technicians of the cooperatives	,586	
University	,843	
Research centres	,836	
Sectorial journals	,820	
Scientific journals	,789	

Extraction method. Principal component analysis
a. 2 extracted components.

Table 6. Rotated component matrix[a]

	Component	
	1	2
Experience		
Formal training	,662	
Non formal training	,511	
Intuition		,707
Tradition		,692
Agricultural commercials		,645
Peer learning		,734
Internet		
Extension offices	,682	
Technicians of the Government	,776	
Technicians of the cooperatives	,631	
University	,831	
Research centres	,808	
Sectorial journal	,812	
Scientific journal	,767	

Extraction method. Principal component analysis. Rotation method: Varimax with Kaiser normalization.
a. Rotation have converged in 3 iterations

Researchers' perceptions and drivers for carrying out dissemination activities

Researchers devote 23% of their time on dissemination activities. They consider that informative workshops (7.6 mean/9) and designing multiactor research and innovation projects (7.5/9) are the best interaction and communication channels, which are valued with similar levels (Table 7). It is important to emphasize that communication through mobiles is not considered better than personal communications.

Table 7. Best communication channels between researchers and farmers

	Mean
Informative workshops	7.6
Designing multiactor research and innovation projects	7.5
Agricultural journals	7.1
Direct communication with farmers	6.6
Mobile application	6.6

The two most important researchers' drivers to participate in dissemination activities are to offer solutions for agricultural problems (8.3/9) and to do something useful (7.7/9), both of them based on practical matters (Table 8).

Table 8. Researchers' drivers to carry out dissemination activities

	Mean
To offer solutions to concrete problems	8.3
To do something useful	7.7
To improve the image of the research centre	6.8
To consolidate the research group	6.4
To rethink research topics	6.4
To access to knowledge networks	6.2
To get to research data	6.2
To get complementary funding	6.0
Professional recognition	5.6
Scientific specialization	5.3
Prestige	4.5
Economic profit	3.0

Principal component analysis let identify two type of researchers according to their motivation to disseminate their findings (Tables 9, 10, 11 and 12). Two components explain the 57,2% of variance. Kaiser-Meyer-Olkin (KMO) test is 0.856 and significance level of Barlett's test of sphericity is .000so data are suited for this analysis.

The first component (41%) is highly correlated (>0.7) with variables defining scientific career focused researchers, such as, focus on getting complementary funding, professional recognition, prestige, getting research data or scientific specialization. On the other side, the second component (15.7%) defines functional or sector focused researchers

including variables such us offering solutions to concrete problems or doing something useful (correlation >0.7).

Table 9. Principal component analysis. Extraction method. Communalities

	Initial	Extraction
Prestige	1,000	,628
Scientific specialization	1,000	,613
To do something useful	1,000	,544
To offer solutions to concrete problems	1,000	,639
To get complementary funding	1,000	,637
To consolidate the research group	1,000	,624
To access to knowledge networks	1,000	,613
To rethink research topics	1,000	,536
Professional recognition	1,000	,639
To get to research data	1,000	,597
To improve the image of the research centre	1,000	,345
Economic profit	1,000	,448

Table 10. Total variance explained

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5,337	44,477	44,477	4,975	41,455	41,455
2	1,525	12,712	57,188	1,888	15,734	57,188

3	1,144	9,534	66,723			
4	,709	5,910	72,633			
5	,666	5,551	78,184			
6	,591	4,929	83,113			
7	,541	4,505	87,619			
8	,433	3,612	91,230			
9	,350	2,913	94,143			
10	,267	2,225	96,368			
11	,231	1,927	98,295			
12	,205	1,705	100,000			
Extraction method. Principal component analysis.						

Table 11. Principal component analysis. Extraction method

	Component	
	1	2
Prestige	,723	
Scientific specialization	,782	
To do something useful		,700
To offer solutions to concrete problems		,765
To get complementary funding	,778	
To consolidate the research group	,776	
To access to knowledge networks	,779	
To rethink research topics	,716	
Professional recognition	,786	
To get to research data	,765	

To improve the image of the research centre.	,463	
Economic profit	,592	
a. 2 extracted components.		
Table 1. Component matrix[a]		

Table 12. Matrix of rotated components[a].

	Component	
	1	2
Prestige	,788	
Scientific specialization	,759	
To do something useful		,737
To offer solutions to concrete problems		,799
To get complementary funding	,795	
To consolidate the research group	,692	
To access to knowledge networks	,719	
To rethink research topics	,633	
Professional recognition	,793	
To get to research data	,760	
To improve the image of the research centre		,486
Economic profit	,659	
Extraction method. Principal component analysis. Rotation method: Varimax with Kaiser normalization.		

a. Rotation have converged in 3 iterations.

It should be underlined that in line with our findings the Standing Committee on Agricultural Research (SCAR) also draws up two profiles in this way. It advocates a "distinction between science-driven research" and "innovation-driven research in the motivation of research" (Table 13) (SCAR, 2012).

Table 13. Resume of researchers' profile. Adapted from SCAR, 2012

Aspect	Science drive research	Innovation-driven research
Incentive to program a topic	Emerging science that can contribute to solving a societal issue (or a scientific question)	An issue/ problem in society that can be solved by new research, or a new idea to solve an existing issue
Participation of users	In demonstration phase/ via research dissemination	In agenda setting, defining the problem and during the research process
Quality criteria	Scientific quality	Relevance (for the sector or a region)
Focus	Research organizations	Networks of producers and users of knowledge
Diffusion model	Linear model	System (network) approach
Type of government policy	Science/ research policy	Innovation policy
Economic line of thinking	Macro- economics	Systems of innovation
Finance	To a large extent public money: more speculative and large spills over effects	Public private partnerships very possible / advantageous
Type of research	Interdisciplinary with	Transdisciplinary and translational

	absorption capacity in AKIS	with close interactions

Researchers´ perception about farmers and innovation

Almost 34% of the researchers recognise that results are not transferred to the sector. In order to foster innovation, researches demand opportunities and spaces to meet with the agricultural sector and, from a global point of view, to improve communication between researchers and farmers. In addition, they recommend defining common research objectives. All of them get the same value (8.0/9) and a more applied research to resolve real and specific farmers' problems (7.5/9) (Table 14).

Table 14. Key points in order to foster innovation

	Mean
Spaces to meet with agricultural sector	8.0
Improve communication between researchers and farmers	8.0
Common definition of research objectives	8.0
More applied research	7.5

Practical/Theoretical/Political Implications

These findings offer interesting thoughts about the complementarity between, traditional and scientific knowledge. Currently, researchers' direct dialogue is difficult with traditional farmers because their information sources are peer learning and agricultural commercials. If researchers want to share knowledge with these profiles, they must focus on leader farmers and agricultural inputs companies. If researchers focus on formal trained farmers, the dialogue will be easier. Unfortunately, those farmers are not the main profile in

the Spanish agricultural sector. Therefore, one of the challenges is to propose methods where scientific and experiential knowledge can be a complement.

According to those findings, another important challenge is to support researchers' motivations. Researchers focused on scientific careers and researchers focused mainly on sectorial problems must be both professionally recognised. Scientific publications and extension activities or spreading information and knowledge should be considered when evaluating researchers' professional activities.

Agricultural researchers state that they spend a considerable time, almost one quarter of their time, on dissemination activities. It is striking that they spend so much time because it has very little recognition on their professional scientific careers that most agricultural researchers are concerned. Spite those difficulties they value highly multiactor involvement on research and innovation projects. It means that they belief that the best dissemination is when the different agrofood chain agents get to work together since the beginning and not only at dissemination stages. This approach is hardly put in practice nowadays in Spain. In any case, they believe that their dissemination activities should be useful and prepared to solve problems.

In real terms, there is a contrast between those beliefs and the significance of the majority of agricultural researchers preoccupied for the usual standards to promote their professional careers, like funding, prestige and recognition. It means that researchers move in between their beliefs and the official evaluation parameters. In order to promote innovations they propose to work more closely with farmers and other agents along the agrofood chain.

Communication is a key element for further developments but strategies could be different depending on the farmers' level of training because they acquire knowledge and get

information from different sources. Accordingly, if the strategy is not adequate could be useless. Unfortunately, a great majority do not have formal training but many of them belong to cooperatives where technicians could play an important role on transmitting information and knowledge. Researchers should carefully pursue their communication strategies.

These data offer an interesting picture about the agricultural researchers´ position in the new AKIS proposals. We can appreciate a large distance between scientific and traditional knowledge, but also there is a very good opportunity and willingness in order to change the researchers´ way of work.

Originality/Value

This communication offers an interesting approach to the innovation systems from the researchers' point of view. It opens several interesting action lines in order to get a more dynamic and innovative relationship between farmers and researchers, between traditional and scientific knowledge. Furthermore, it targets how to foster these processes, supporting to researchers to change towards a new model of agricultural knowledge and innovation systems.

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References

- Curry, N. & Kirwan, J. (2014). The role of tacit knowledge in developing networks for sustainable agriculture. Sociologia Ruralis, 54, 3.
- Ingram, J. & Morris, C. (2007). The knowledge challenge within the transition towards sustainable soil management: An analysis of agricultural advisors in England. Land Use Policy 24, 100–117.
- Ingram, J. (2008). Are farmers in England equipped to meet the knowledge challenge of sustainable soil management? An analysis of farmer and advisor views. Journal of Environmental Management 86, 214–228.
- Ingram, J., Fry, P., Mathieu, A. (2010). Revealing different understandings of soil held by scientists and farmers in the context of soil protection and management. Land Use Policy, 27, 51–60.
- Isoe, Y. & Nakatani, Y. (2011). Agricultural knowledge transfer based on experience from failures. IADIS International Conference ICT, Society and Human Beings.
- Klerkx, L. & Leewis, C. (2008). Balancing multiple interests: Embedding innovation intermediation in the agricultural knowledge infrastructure. Technovation 28. 364–378.
- Leagans, P. (1961). Extension Education in Community Development Handbook.
- Lundvall, B. & Johnson, B. (1994). The learning economy. Journal of Industry Studies, 1, 2, 23-42.
- Morgan, K. & Murdoch, K. (2000). Organic versus conventional agriculture: knowledge, power and innovation in the food chain. Geoforum 31, 159-17.

- Sutherland, L., Madureira, L, Dirimanova; V., Bogusz, M; Kania, J; Vinohradnik, K; Creaney, R; Ducketta, D; Koehnen, T., Knierim, A. (2017). New knowledge networks of small-scale farmers in Europe'speriphery. Land Use Policy 63, 428–439.