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Knowledge Transfer on Digital Transformation: An Analysis of the Olive Landscape in Andalusia, Spain

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Abstract: The global economy, and agriculture, in particular, faces significant challenges and transformation pressures. A major challenge, and opportunity, is the transformation towards digital agriculture or agriculture 4.0, where knowledge transfer (KT) has an important role to play not only in ensuring that digital innovations reach end-users, but also that these innovations contribute to development in rural landscapes. This paper analyses the role of KT in the framework of digital transformation (DT) in the Andalusian olive landscape. Thus, from the perspective of knowledge-generating agents, the main knowledge emitting and receiving actors in the DT are identified by using Social Network Analysis techniques (SNA). Subsequently, the performance of the Technological Innovation System (TIS) in KT is evaluated by using the multi-criteria Analytic Hierarchy Process (AHP) method. The results suggest that the knowledge-generating agents, the knowledge transfer actors, and the scientific and dissemination media actors are the main knowledge emitters and highlight their role as cohesive actors of the social network. The main knowledge receivers are olive growers, cooperatives and non-cooperative groups. The results also indicate that the global performance of the TIS in the KT function is medium/low. Furthermore, in the KT sub-functions where the TIS in DT performs best is the quality of the transfer processes of DT, and where it performs worst is the sufficiency of spaces for KT.

Keywords: technological innovation system; digitisation; innovation agents; olive groves; explicit knowledge

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1. Introduction

Today, digital agriculture or agriculture 4.0 presents itself as one of the main challenges, and opportunities, for transforming the rural landscape [1–3] Digital transformation (DT), i.e., the implementation of digital technologies, in rural environments would not only contribute to the Sustainable Development Goal of eradicating hunger but also to combating climate change (e.g., through the efficient use of water, fertilisers and plant protection products, use of cleaner energy, traceability of food chains, among others) [4–6]. The next period of growth in mobile connections is expected to come mainly from rural communities [7]. However, rural landscapes, due to deficient technological infrastructures, high technology costs, low levels of e-literacy and digital skills and limited access to services risk being left behind in the digital transformation process [8]. The potential benefits of digital agriculture are compelling, but major transformations of farming landscapes, rural economies, communities and natural resource management will be needed [9,10]. This implies major changes in public policies, as they should focus on boosting knowledge diffusion [11–13], as new knowledge disseminated from public and private research and development could encourage information-based entrepreneurship and often manifests in new high-tech or ICT companies [14].

Knowledge diffusion is a key factor that leads to innovation and has far-reaching effects not only on economic growth but also on the pace of humankind's evolution [15–17]. However, the academic literature shows that the growth of an industry or economic sector depends on the rates and mechanisms of knowledge diffusion [11,15,18]. Thus, understanding how knowledge is transferred between individuals and organisations, and how it diffuses over time, is of exceptional importance for the economic performance of a society [15]. The process of knowledge diffusion can be characterised as the adoption of freely available knowledge that can be exploited by recipients [19]. This knowledge can be (i) tacit, i.e., not easily verbalised or (ii) codified or explicit, e.g., written in books [15]. Due to the fact that tacit knowledge is abstract, it is usually embedded in the cognitive processes of individuals and can only be communicated through active interaction between knowledge generators and knowledge receivers [20]. Typical tacit knowledge includes innovation experience, know-how integration knowledge, management techniques, innovation culture or know-how communication [21]. Explicit knowledge can be conveyed in formal and systematic language, such as procedural or technical manuals, available books and documents, lectures and demonstrative experiences [22].

Knowledge transfer (KT) is therefore the part of the knowledge diffusion process that comprises the intentional activities of transferring explicit knowledge from place, person, or ownership to another [23,24]. Knowledge diffusion, and hence KT, is a social phenomenon in which people participate as potential generators, transmitters and adopters [15,23], which leads to defining KT as a network activity [23,25]. The process of knowledge diffusion is driven, firstly, by the social links between knowledge sender and receiver agents and, secondly, by the individual attributes of these agents themselves [15,26]. Networks provide individuals with access to knowledge, resources or technologies [27,28] and through network membership and the resulting long-term and repeated knowledge-sharing relationships, network members create the potential for knowledge acquisition [9,29].

When it comes to technological knowledge or innovations, KT can be framed within technological innovation systems (TIS). A TIS is defined as the network of agents interacting in the economic/industrial sphere under a given institutional framework and involved in the generation, diffusion and use of technology [25,30,31]. The analysis of a TIS is concerned with distinguishing between organisations and functions, as organisations increasingly have multiple roles [32]. The functions of a TIS are the types of activities (with associated events) expected for its proper performance [33–35]. In the framework of functional-structural analysis, functions of a TIS are analysed as structural elements [34,36]. All aspects of the economic and institutional contexts that may affect the searching, exploring, transmitting and learning of new knowledge are defined as structural elements of a TIS [37]. Seven key functions are described in the scientific literature for a TIS: (1) entrepreneurial activities, (2) knowledge development, (3) knowledge transfer, (4) research orientation, (5) market formation, (6) resource mobilisation and (7) legitimacy creation. The level of performance of the seven functions in each TIS is influenced by the presence and quality of the structural elements. KT function is the connecting bridge between different actors in a TIS and its importance is such that if it is not carried out properly, the knowledge developed would not be useful to society. For this reason, this research focuses on the analysis of this function.

One of the rural landscapes where DT processes are being driven is the world's most important olive-growing region, i.e., Andalusia (Spain). This region accounted for 15.35% of the world's olive area and 40.81% of the world's olive oil production in 2018 [38]. In Andalusia, DT is widely supported at the institutional level, from the EU to the regional administration of Andalusia and several policy initiatives are starting to be implemented [39]. A diagnosis of the conditioning factors for DT in this olive landscape highlights environmental issues as an opportunity for its promotion, as well as the growing interest in developing an interoperability strategy, which represents an opportunity to overcome the scarce technological integration of the value chain and to allow for a more transparent value chain and better traceability [40]. Aspects that undoubtedly require strengthening the innovation system and KT processes. However, there is a lack of empirical and methodological studies on the performance of KT on DT in rural landscapes. In particular in Andalusia, despite the potential of DT, with an important base of agri-food economic agents and an extensive R&D&I support network and the strong support from public administrations to our knowledge there is no scientific work that analyses the transfer of knowledge in DT in the olive sector, in terms of the functioning of the network (TIS), nor the role of the different actors involved.

In this context, this paper aims to contribute to filling this knowledge gap, both empirically and methodologically, by analysing the role of KT in the framework of the TIS of DT in the Andalusian olive landscape. Thus, from the perspective of knowledge-generating agents, the main knowledge emitting and receiving actors in the TIS will be identified. For this purpose, Social Network Analysis (SNA) techniques will be applied. Additionally, the performance of the KT function in this TIS will be evaluated. In this case, the Analytic Hierarchy Process (AHP) multi-criteria methodology will be used. The final aim of the work carried out is to contribute to the boosting of the DT in the olive landscape in Andalusia.

2. Materials and Methods

2.1. Case Study: The Olive Landscape in Andalusia

The region of Andalusia accounted for 62.50% of the olive-growing area and 76.83% of olive production in Spain in 2017 [41], being this country the world's leading olive grower. The olive sector plays an important socio-economic role in the region, as olive oil and olives accounted for 18.1% of the total production of the Andalusian agricultural sector in 2020 [42]. However, they are currently facing a critical situation, especially upstream in the agri-food chain, due to (1) the atomisation of the sector; (2) the low productivity of a significant number of olive growers; (3) the fall in olive oil prices and CAP subsidies; among others [43–45]. Previous studies in the olive sector in Andalusia have analysed its innovation capacity linked to the technological packages of organic farming [46,47], integrated production [48] and different certified quality systems such as PDO [49,50] and ISO 9001 [51]. These studies point to the generally low innovative attitude of olive growers in Andalusia, which operates as a fixed system with little openness to external sources of information. Specifically, several factors make farmers reluctant to adopt digital technologies and practices [40].

2.2. Social Network Analysis (SNA)

SNA is a methodology, also called Structural Analysis, which proposes a set of techniques for analysing the relationships between actors in a network and the social structures that emerge from these relationships. A network is composed of two basic elements: the actors (nodes/points in the network) and the relationships established between them (edges/lines in the network). SNA is based on the mathematical language of graph theory, matrices and relational algebra [52,53]. SNA makes it possible to calculate a series of indicators that allow characterising the structure of the relationships of a network and the relevance of the nodes (actors). The structure indicators are measures of the entire network, as opposed to the node indicators, which are individual measures (Table 1). Thus, one can identify closed networks, in which all nodes are connected [27,54], or bridged networks, in which relationships are not as strong, but there are connecting nodes [27].

Primary information was obtained through interviews with 14 experts and/or people linked to the DT of the Andalusian olive sector, belonging to universities and research centres (knowledge generation agents), between August and October 2020. A structured questionnaire was used to identify the interactions of 21 types of actors previously defined in the TIS of DT of the Andalusian olive landscape (Table 2). For each identified interaction between the actors of the TIS, interviewees rated its intensity on a scale between 0 and 9 (0 = no relationship, 9 = very high relationship intensity). For data analysis, the free and open-source software Gephi 0.9.2 (https://gephi.org/, accessed on 10 December 2021) was used. The ForceAtlas distribution with repulsion force 200,000 and a gravity of 30.0 was implemented. This configuration allows minimising crossings between edges, i.e., nodes do not overlap links that do not affect them and maintain a uniform edge length [55].

Table 1. Main statistics and indicators in the SNA.

Network Structure		Position of the Nodes	
Medium degree	Arithmetic mean of the relations for each node	Degree	No. of connections of a node. Can be incoming or outgoing
Centralisation	Extent to which the network is or is not organised around more central nodes	Degree centrality	No. of nodes to which a specific node is connected. A node with a high degree of centrality can be considered "well connected"
Network density	No. of connections established in the network out of the total number of possible connections. It measures how close a network is to be complete. A complete network has all possible edges (relationships) and a density equal to 1.	Authority	Importance of a node based on the quality and connectivity of the nodes that connect it. A node has a high authority when it is connected by many other nodes that in turn are connecting many other nodes

Own elaboration based on Scott (2017).

Table 2. Types of actors in the TIS of DT in the Andalusian olive landscape.

1	Olive Grower
2	Cooperative/Cooperative Group
3	Non-Cooperative Group (e.g., Interoleo, etc.)
4	Protected Designation of Origin (PDO)
5	Agricultural Association (SAT, ATRIA, API)
6	Agricultural Organisation (e.g., UPA, COAG, ASAJA)
7	Refinery
8	Packaging Company
9	Distribution Agent
10	Rural Development Group (RDG)
11	Communal Olive Heritage
12	Interprofessional Olive Oil
13	Private Consultant
14	Company Supplying Agricultural Inputs
15	Digital Technologies Company
16	Knowledge Generating Agent (University, Public Research Organisation, etc.)
17	Knowledge Transfer Agent (Technology Centre, etc.)
18	Knowledge Management Agent (e.g., IDEA, RETA, etc.)
19	Public Administration (Agricultural Delegation, OCA, County Council, etc.)
20	Financial Institution (Bank, Savings Bank)
21	Scientific and Dissemination Media (Journal, Internet, etc.)

2.3. *Analytic Hierarchy Process (AHP)*

The multi-criteria decision-making methodology AHP [56,57] proposes the modelling of a decision-making problem and the achievement of an overall objective (or goal) by defining a hierarchical structure of decision elements (sub-objectives, alternatives). This makes it possible to determine the priorities (weight or performance) of the alternatives with respect to the sub-objectives, the priorities of the sub-objectives with respect to the overall objective and, finally, the priorities of the alternatives with respect to the overall objective.

Thus, an AHP model has been developed to evaluate the performance of the KT function of the TIS of DT of the olive landscape in Andalusia. The model consists of three levels (Figure 1):

- Level I: It corresponds to the overall objective of the model. In this case, to evaluate the performance of the KT function of the SIT of the DT in the Andalusian olive landscape.
- Level II: It consists of the five key sub-functions of KT according to [33,35,58–61].
- Level III: It includes the alternatives to be evaluated. In this case, there is one alternative: The TIS of DT in the Andalusian olive landscape.

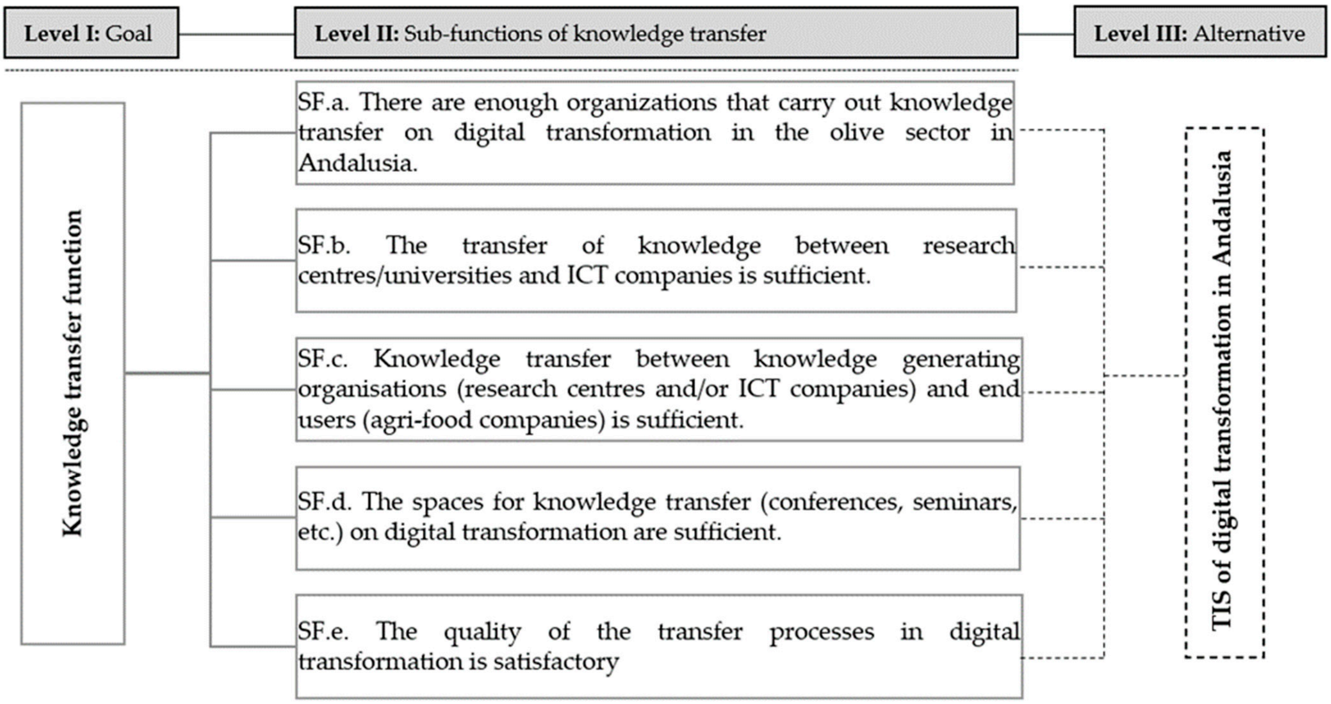

Figure 1. AHP model for the KT function performance of the TIS of DT in the Andalusian olive landscape.

Once the model has been defined, the local priority (weight or performance) of each of the sub-functions of KT and alternatives must be evaluated with respect to the element on which they depend. AHP allows a quantitative evaluation of the decision elements, prioritising them on a ratio scale and making them commensurable and comparable [62–64]. In this case, expert knowledge was used to evaluate the model due to the low availability of objective data for Andalusia and the complex nature of the issues investigated. In particular, 14 experts and/or people linked to the DT of the Andalusian olive sector, the same as for the SNA, were interviewed. A direct rating method [62,65] was used to prioritise sub-functions and alternatives, on a scale ranging from 1 (very low priority) to 9 (high priority) [66]. Subsequently, the individual local priorities assigned by the experts to the sub-functions were normalised to sum to 1 [67]. The local priority of the alternative in each sub-function for each expert is converted proportionally from scale 9 to scale 1. Therefore, local priorities for the subfunctions and the alternative can vary between 0 and 1. Subsequently, the individual local priorities for each expert must be aggregated as the arithmetic mean for the group of experts [1,2]. The priorities of each sub-function and the alternative for the group can also vary between 0 and 1.

Subsequently, the priority of the alternative must be synthesised in terms of its satisfaction with the overall objective. It can be calculated by the weighted sum of the local priorities of the sub-functions with respect to the overall objective and the local priorities of the alternative in the sub-functions [3], already aggregated for the group. The global priority of the alternative can vary between 0 and 1.

3. Results and Discussion

3.1. Knowledge Transfer Network

3.1.1. Network Features

The KT network of the DT in the olive landscape in Andalusia is composed of the 21 actors previously identified and 439 connections established between them. A first analysis focuses on the 'global' network which is based on the accumulated links, regardless of their quality (i.e., type and intensity of connections) (Figures 2 and 3). The density of the network is 1, indicating that all actors are connected to each other. Moreover, it is a complete network as no actor is disconnected. In terms of centralisation, it should be noted that there is no single central actor, but rather a set of actors at the centre of the network, forming a decentralised network, indicating that decision-making is substantially distributed throughout the KT network. This finding is in line with the literature in that networks are centralised in their initial phase, and later in the knowledge diffusion phase, they become decentralised as part of their functioning [60].

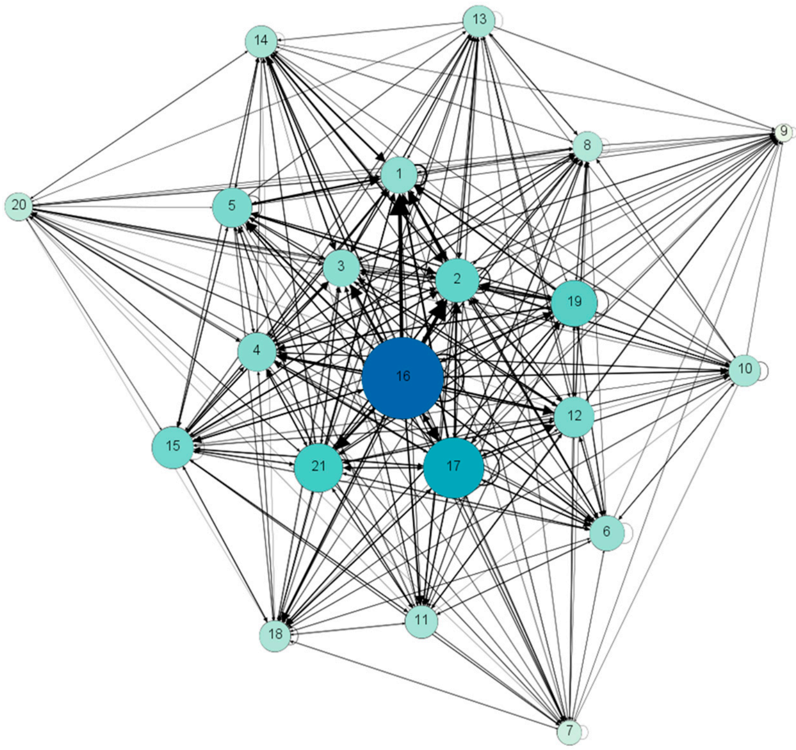

Figure 2. Social network of DT in the olive landscape in Andalusia—Actors emitting knowledge. The size and colour of the nodes indicate the degree of output, the larger and darker the node, the greater the degree of information emission.

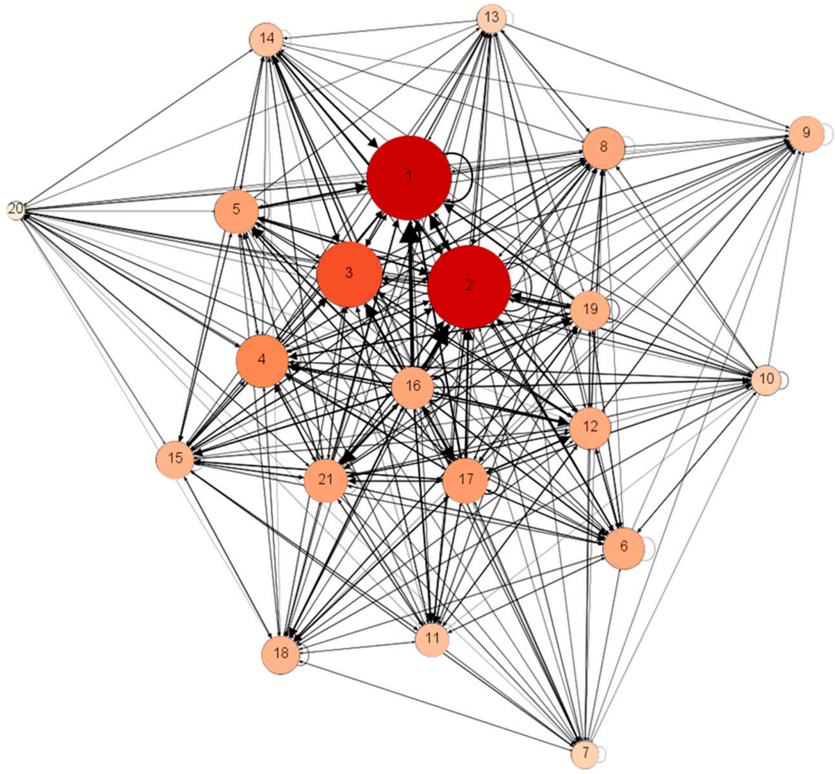

Figure 3. Social network of DT in the olive landscape in Andalusia—Actors receiving knowledge. The size and colour of the nodes indicate the degree of input, the larger and darker the node, the greater the degree of information reception.

3.1.2. Actors in the Network of Knowledge Transfer

Figure 2 shows that the main actors that send knowledge to other actors are, from highest to lowest degree: 16. Knowledge generating agent, 17. Knowledge transfer agent, 21. Scientific and dissemination media, 19. Public administration and 2. Cooperative/cooperative group. In many countries, universities (one of the knowledge-generating agents) also play a connecting role between research and the transfer of this knowledge to end-users, although they may be constrained by a lack of financial resources. Furthermore, some research highlights the role of donors or funders in KT networks as a factor that may condition the transparent and reliable flow of information [68,69]. In the case of the Andalusian olive region, the universities have not pointed out the lack of financial resources, however, in terms of the influence or direction of external actors, it would be worthwhile to explore more into the role of public administration and the media in the direction of knowledge generation and the flow of KT, given their importance in this network as funders (public administration) and transmitters (media).

Figure 3 shows that the main knowledge receiving actors are, from highest to lowest degree: 1. Olive grower, 2. Cooperative/cooperative group, 3. Non-cooperative group, 4. Protected Designation of Origin (PDO). These results highlight the role of end-users in the network and are in line with some studies that have shown that farmers with a central position are engaged in acquiring, developing and transferring knowledge to other individuals in their networks [70] and thus contribute to improving the governance of the whole network [71]. On another note, it is important to highlight the dual role of the actors 2. Cooperative/cooperative group, both as emitter and receiver of knowledge in DT. According to other research, cooperatives play a key role in bringing knowledge closer to farmers located in isolated territories and who usually cannot satisfy the need for access to new knowledge and new market opportunities [72]. Therefore, these actors play a key role in the transfer of knowledge and the best approach to transfer new information is through the dominant group or actors in the network so that this group will capture the information and transmit the knowledge acquired through knowledge sharing [23].

3.2. Knowledge Transfer Function

3.2.1. Local Priorities of the KT Sub-Functions

Figure 4 shows that, in the KT function of the DT in the Andalusian olive landscape, knowledge-generating agents attribute the greatest importance to SF.c 'KT between knowledge-generating organisations (research centres and/or ICT companies) and end-users (agri-food companies) is sufficient', followed by SF.a 'There are enough organisations that carry out KT on DT in the olive sector in Andalusia'. The least prioritised sub-function was SF.d 'The spaces for KT (conferences, seminars, etc.) on DT are sufficient'. The prioritisation of SF.c may be justified by the evidence in the literature that early involvement of key actors (in this case knowledge generators and olive agents as end-users) could reduce innovation uncertainty, thus improving the performance of TIS [33,60]. Along the lines, Ref. [68,73] state that in a well-functioning extension (or KT) system, a knowledge network uses feedback mechanisms to innovate a technology or set of practices. It implies that end-user experience (olive agents) is transmitted to researchers and knowledge from researchers to end-users through extension, which generates legitimacy and demand for the technology.

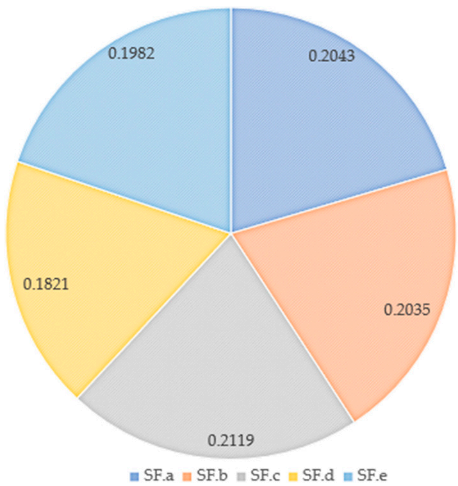

Figure 4. Local priorities of the KT sub-functions.

3.2.2. Performance of the TIS in the KT Function and Sub-Functions

Figure 5 shows the performance of the TIS of DT in the Andalusian olive landscape according to the opinion of the knowledge-generating agents. Thus, it can be seen that in the sub-functions where it performs best are (from highest to lowest): SF.e 'The quality of the transfer processes in DT is satisfactory', and SF.a 'There are enough organisations that carry out KT on DT in the olive sector in Andalusia'. In the sub-function where it performs worst is SF.c 'KT between knowledge-generating organisations (research centres and/or ICT companies) and end-users (agri-food companies) is sufficient'.

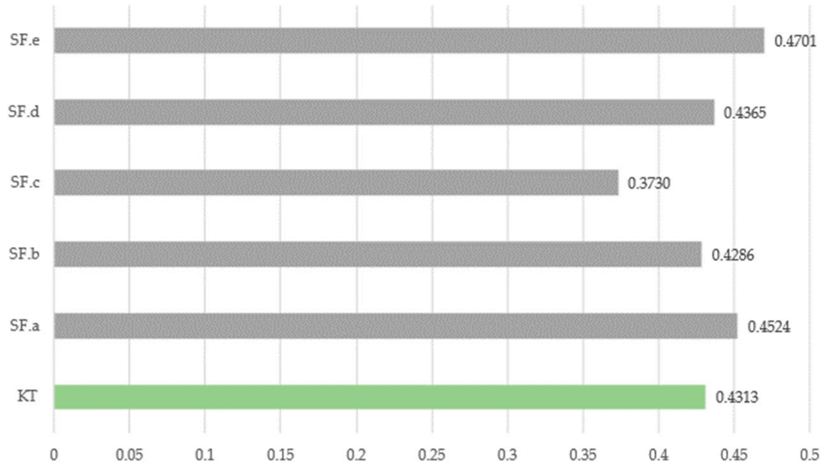

Figure 5. Performance of the SIT in the KT function and sub-functions.

Finally, the global performance of the TIS of DT in the olive landscape in Andalusia in the KT function (0.4313) can be classified as medium/low (0.5 or less) (Figure 5). This result is consistent with [74], who evidenced the existence of a generalised deficit of innovation and KT actions by the national R&D&I system to companies and farmers in the olive oil sector in Spain. In this scenario, some studies have pointed out that strengthening the research and extension system requires the provision of funds for the training of extension agents, increasing the linkages between research and extension, and increasing the number of demonstration projects for knowledge dissemination [68]. In the case of the olive landscape in Andalusia, this issue is of extreme importance considering the low demand propensity and low adoption of innovations that Spanish olive companies have on average today [74].

4. Conclusions

This study analysed knowledge transfer (KT) on digital transformation (DT) in the Andalusian landscape from the perspective of knowledge-generating agents. Although different authors have suggested diverse methodologies to study KT, an approach that integrates social networks analysis (SNA) and the technological innovation system (TIS), using an AHP multi-criteria decision model had not been addressed so far in the scientific literature. This represents a novelty for this research.

Hence, the present research aimed to lay the foundations for the first empirical description of the network of KT agents in the DT of the Andalusian olive landscape. Although the map of the network is not exhaustive, as not all the actors of the innovation system have been interviewed, this research offers a first approach to the panorama of KT in this area. In the approach from the social network of KT, the results indicate that among the actors that stand out for their role as knowledge emitting are the knowledge-generating agents, the knowledge transfer actors and the scientific and dissemination media. On the other hand, the main knowledge receivers are olive growers, cooperatives or cooperative groups and non-cooperative groups. It is important to highlight the dual role of cooperatives or cooperative groups, both as emitters and receivers of knowledge. The density of relationships, measured by the number of relationships established in the KT network of the DT is quite high, so it has a high potential for the creation of social capital. Moreover, it is a complete network, with no disconnected actors, and it is decentralised, indicating that decision-making is distributed throughout the network.

In addition, the results of the AHP model for assessing the performance of KT indicate that the sub-function with the highest importance or priority for assessing adequate functioning is KT between knowledge-generating organisations (research centres and/or ICT companies) and end-users (agri-food companies) is sufficient; the one with the lowest importance is the spaces for KT (conferences, seminars, etc.) on DT are sufficient. In terms of functioning, the highest performance of the TIS is found in the quality of the transfer processes in DT is satisfactory, while it has the lowest performance in KT between knowledge-generating organisations (research centres and/or ICT companies) and end-users (agri-food companies) is sufficient. The global performance of KT in the olive sector DT in Andalusia is low/medium. It is important to point out that the results achieved should not be understood as a definitive and permanent prioritisation in Andalusia, but rather as a dynamic and changing attribute over time, and dependent on the interaction of the different actors involved in the transfer of knowledge. Thus, although the results obtained may not be generalisable beyond the olive sector in Andalusia, the proposed methodology might be extrapolated to the analysis of other economic sectors and landscapes.

These findings may be of high importance for policymakers and other authorities, national and regional, who need to understand these qualities of knowledge sharing mechanisms in the Andalusian olive landscape and use the networks, the qualities of social capital and the sub-functions of KT to share new information or knowledge effectively and sustainably. Furthermore, it is of vital importance that the drivers of DT consider the socio-economic conditions in rural areas, to avoid that the implementation of digital technologies does reinforce current systems that are considered economically, socially and ecologically unsustainable (e.g., intensive production leading to depletion of natural resources, exploitation of labour, the concentration of power, etc.). Thus, we propose that research on DT should be developed within the academic framework of responsible research and innovation (RRI).

Finally, to improve the transfer between knowledge-generating actors and end-users of digital technologies in the olive landscape in Andalusia, future research in this area could further explore the implications of the KT network on the social capital of the territories, as well as assess the overall functioning of the SIT in all the functions of an SIT. In addition, actions should be promoted that focus on three areas:

1. Capacity building of stakeholders: actions that involve the development of specific capacities of knowledge-generating and transferring agents should be promoted, such as the networking (between knowledge generators and with end-users), shared governance, transdisciplinary approaches and the inclusion of the social responsibility of innovations.
2. KT mechanisms: designing KT actions that are not only based on a top-down flow of information but also seek a dialogue of knowledge between the stakeholders. Thus, for example, forums, symposia, congresses and so on should include a section for end-user feedback. Furthermore, such actions can be reinforced by participatory action research approaches. In this way, KT will move from being a mere space at the end of research projects to a real iterative process of technological and social innovation that creates real solutions for sustainable rural development.
3. Incentives for KT: future public policies should acknowledge that knowledge generation and knowledge transfer go hand in hand and should be implemented together. In this context, the "transfer six-year period" promoted in Spanish universities is a valuable tool to encourage new knowledge to materialise into tangible solutions in society. However, it is not enough, as it is not part of a comprehensive transfer programme that (a) grants the corresponding funding to carry out KT, (b) fosters research on the effectiveness and efficiency of KT mechanisms and (c) establishes transversal quality mechanisms for evaluated KT processes.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Kernecker, M.; Knierim, A.; Wurbs, A.; Kraus, T.; Borges, F. Experience versus Expectation: Farmers' Perceptions of Smart Farming Technologies for Cropping Systems across Europe. *Precis. Agric.* **2020**, *21*, 34–50. [CrossRef]
2. Klerkx, L.; Jakku, E.; Labarthe, P. A Review of Social Science on Digital Agriculture, Smart Farming and Agriculture 4.0: New Contributions and a Future Research Agenda. *NJAS-Wagening. J. Life Sci.* **2019**, *90–91*, 100315. [CrossRef]
3. Lamprinopoulou, C.; Renwick, A.; Klerkx, L.; Hermans, F.; Roep, D. Application of an Integrated Systemic Framework for Analysing Agricultural Innovation Systems and Informing Innovation Policies: Comparing the Dutch and Scottish Agrifood Sectors. *Agric. Syst.* **2014**, *129*, 40–54. [CrossRef]
4. Krishnan, R.; Agarwal, R.; Bajada, C.; Arshinder, K. Redesigning a Food Supply Chain for Environmental Sustainability—An Analysis of Resource Use and Recovery. *J. Clean. Prod.* **2020**, *242*, 118374. [CrossRef]
5. Makate, C.; Makate, M.; Mango, N.; Siziba, S. Increasing Resilience of Smallholder Farmers to Climate Change through Multiple Adoption of Proven Climate-Smart Agriculture Innovations. Lessons from Southern Africa. *J. Environ. Manag.* **2019**, *231*, 858–868. [CrossRef]
6. Shepherd, M.; Turner, J.A.; Small, B.; Wheeler, D. Priorities for Science to Overcome Hurdles Thwarting the Full Promise of the 'Digital Agriculture' Revolution. *J. Sci. Food Agric.* **2018**, *100*, 5083–5092. [CrossRef]
7. World Bank. *World Development Report 2016: Digital Dividends*; World Bank: Washington, DC, USA, 2016.
8. Trendov, N.; Varas, S.; Zeng, M. *Tecnologías Digitales En La Agricultura y Las Zonas Rurales*; FAO: Rome, Italy, 2019.
9. Mwila, N.K. The Role of Social Networks in Knowledge Transfer: A Study of the Small and Medium Scale Agriculture Sector in Zambia. Ph.D. Thesis, Monash University, Clayton, Australia, 2016.
10. Fundación de Estudios Rurales Agricultura Familiar en España. *Anuario 2019*; UPA-MAPA: Madrid, Spain, 2019.
11. Perez-Trujillo, M.; Lacalle-Calderon, M. The Impact of Knowledge Diffusion on Economic Growth across Countries. *World Dev.* **2020**, *132*, 104995. [CrossRef]
12. CELAC. *Sistemas de Innovación Para El Desarrollo Rural Sostenible*; Comunidad de Estudios Latinoamericanos Caribeños: Santiago, Chile, 2017.
13. FAO. *Transformar La Alimentación y La Agricultura Para Alcanzar Los ODS*; FAO: Rome, Italy, 2018; ISBN 9789251306741.
14. Audretsch, D.B.; Bönte, W.; Keilbach, M. Entrepreneurship Capital and Its Impact on Knowledge Diffusion and Economic Performance. *J. Bus. Ventur.* **2008**, *23*, 687–698. [CrossRef]
15. Klarl, T. Knowledge Diffusion and Knowledge Transfer Revisited: Two Sides of the Medal. *J. Evol. Econ.* **2014**, *24*, 737–760. [CrossRef]
16. Skare, M.; Soriano, D.R. Technological and Knowledge Diffusion Link: An International Perspective 1870–2019. *Technol. Soc.* **2021**, *66*, 101652. [CrossRef]
17. Dost, M.; Badir, Y.F.; Sambasivan, M.; Umrani, W.A. Open-and-Closed Process Innovation Generation and Adoption: Analyzing the Effects of Sources of Knowledge. *Technol. Soc.* **2020**, *62*, 101309. [CrossRef]
18. Stanko, M.A.; Olleros, X. Industry Growth and the Knowledge Spillover Regime: Does Outsourcing Harm Innovativeness but Help Profit? *J. Bus. Res.* **2013**, *66*, 2007–2016. [CrossRef]
19. Morone, P.; Taylor, R. Knowledge Architecture and Knowledge Flows. In *Encyclopedia of Information Science and Technology*; IGI Global: New York, NY, USA, 2009; pp. 2319–2324.
20. Deng, C.-P.; Wang, T.; Teo, T.S.; Song, Q. Organizational Agility through Outsourcing: Roles of IT Alignment, Cloud Computing and Knowledge Transfer. *Int. J. Inf. Manag.* **2021**, *60*, 102385. [CrossRef]
21. Ryan, S.; O'Connor, R.V. Development of a Team Measure for Tacit Knowledge in Software Development Teams. *J. Syst. Softw.* **2009**, *82*, 229–240. [CrossRef]
22. Dhanaraj, C.; A Lyles, M.; Steensma, H.K.; Tihanyi, L. Managing Tacit and Explicit Knowledge Transfer in IJVs: The Role of Relational Embeddedness and the Impact on Performance. *J. Int. Bus. Stud.* **2004**, *35*, 428–442. [CrossRef]
23. Dasanayaka, U.; Matsuda, Y. Role of Social Capital in Local Knowledge Evolution and Transfer in a Network of Rural Communities Coping with Landslide Disasters in Sri Lanka. *Int. J. Lightweight Mater. Manuf.* **2021**, *67*. [CrossRef]

24. Carlile, P.R.; Rebentisch, E.S. Into the Black Box: The Knowledge Transformation Cycle. *IEEE Eng. Manag. Rev.* **2003**, *31*, 67–80. [CrossRef]
25. Hekkert, M.P.; Suurs, R.A.A.; Negro, S.O.; Kuhlmann, S.; Smits, R.E.H.M. Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technol. Forecast. Soc. Change* **2007**, *74*, 413–432. [CrossRef]
26. Inkpen, A.; Tsang, E. Social Capital, Networks, and Knowledge Transfer. *Acad. Manag. Rev.* **2005**, *30*, 146–165. [CrossRef]
27. Arévalo, A.B.; Pérez, J.E. Desarrollo, Territorio y Capital Social. Un Análisis a Partir de Dinámicas Relacionales En El Desarrollo Rural. *Redes Revista Hispana Para el Análisis de Redes Sociales* **2013**, *24*, 81–113. [CrossRef]
28. Granovetter, M. Granovetter-Economic Action and the Problem of Embeddedness. *Am. J. Sociol.* **1985**, *91*, 481–510. [CrossRef]
29. Azhar, A.; Malik, M.N.; Muzaffar, A. Social Network Analysis of Army Public School Shootings: Need for a Unified Man-Made Disaster Management in Pakistan. *International J. Disaster Risk Reduct.* **2019**, *34*, 255–264. [CrossRef]
30. Carlsson, B.; Stankiewicz, R. On the Nature, Function and Composition of Technological Systems. In *Technological Systems and Economic Performance: The Case of Factory Automation*; Carlsson, B., Ed.; Kluwer Academic Publishers: Dordrecht, The Netherlands, 1995; pp. 21–56.
31. Musiolik, J.; Markard, J.; Hekkert, M. Networks and Network Resources in Technological Innovation Systems: Towards a Conceptual Framework for System Building. *Technol. Forecast. Soc. Change* **2012**, *79*, 1032–1048. [CrossRef]
32. Galli, R.; Teubal, M. Paradigmatic Shifts in National Innovation Systems. In *Systems of Innovation*; Edquist, C., Ed.; Pinter: London, UK, 1997.
33. Bergek, A.; Jacobson, S.; Carlsson, B.; Lindmark, S.; Rickne, A. Analyzing the Dynamics and Functionality of Technological Systems: A Manual. *Technology* **2008**, *37*, 407–429.
34. Bergek, A.; Hekkert, M.; Jacobsson, S.; Markard, J.; Sandén, B.; Truffer, B. Technological Innovation Systems in Contexts: Conceptualizing Contextual Structures and Interaction Dynamics. *Environ. Innov. Soc. Transit.* **2015**, *16*, 51–64. [CrossRef]
35. Markard, J.; Hekkert, M.; Jacobsson, S. The Technological Innovation Systems Framework: Response to Six Criticisms. *Environ. Innov. Soc. Transit.* **2015**, *16*, 76–86. [CrossRef]
36. Bergek, A.; Jacobsson, S.; Carlsson, B.; Lindmark, S.; Rickne, A. Analyzing the Functional Dynamics of Technological Innovation Systems: A Scheme of Analysis. *Res. Policy* **2008**, *37*, 407–429. [CrossRef]
37. Wieczorek, A.J.; Hekkert, M.P. Systemic Instruments for Systemic Innovation Problems: A Framework for Policy Makers and Innovation Scholars. *Sci. Public Policy* **2012**, *39*, 74–87. [CrossRef]
38. FAOSTAT. Statistical Database of the FAO; Rome. Available online: http://faostat.fao.org (accessed on 21 October 2021).
39. *Junta de Andalucía Implementación de La Guía Metodológica Para La Identificación de Necesidades y Barreras Para La Digitalización Del Sector Agroalimentario, Para La Elaboración de Mapas de Capital Relacional y Para La Identificación de Buenas Prácticas y Proyectos*; Regions 4Food Proyect-Interreg Europe; Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible: Sevilla, Spain, 2019.
40. Parra-López, C.; Reina-Usuga, L.; Carmona-Torres, C.; Sayadi, S.; Klerkx, L. Digital Transformation of the Agrifood System: Quantifying the Conditioning Factors to Inform p Olicy Planning in the Olive Sector. *Land Use Policy* **2021**, *108*, 105537. [CrossRef]
41. MAPA. *Avance Del Anuario de Estadística 2018 (Datos 2017 y 2018)*; MAPA: Madrid, Spain, 2019.
42. CAGPDS. Macromagnitudes Agrarias de Andalucía. Renta Agraria de Andalucía. Año 2020. Avance.; Sevilla, Spain, 2020. Available online: https://www.juntadeandalucia.es/export/drupaljda/2_estimacion_renta_agraria2020_Nov_2020_Rev-2.pdf (accessed on 21 October 2021).
43. CAPDER. *Plan Director Del Olivar Andaluz*; Junta de Andalucía: Sevilla, Spain, 2015.
44. Gómez-Limón, J.A.; Arriaza Balmón, M. *Evaluación de La Sostenibilidad de Las Explotaciones de Olivar En Andalucía*; Fundación Unicaja: Malaga, Spain, 2011; ISBN 9788492443161.
45. Gallardo-Cobos, R.; Sánchez-Zamora, P. Olivar y Desarrollo Rural: Las Oportunidades Derivadas de La Diversificación Concéntrica. In *J. Gómez-Limón, y M. Parras (Cords.), Economía y Comercialización de Los Aceites de Oliva. Factores y Perspectivas Para el Liderazgo Español del Mercado Global*; Caja Mar Rural: Jaén, Spain, 2017; pp. 161–177, ISBN 9788495531858.
46. Parra-Lopez, C.; Calatrava-Requena, J. Comparison of Farming Techniques Actually Implemented and Their Rationality in Organic and Conventional Olive Groves in Andalusia, Spain. *Biol. Agric. Hortic.* **2006**, *24*, 35–59. [CrossRef]
47. Parra-Lopez, C.; De-Haro-Giménez, T.; Calatrava-Requena, J. Diffusion and Adoption of Organic Farming in the Southern Spanish Olive Groves. *J. Sustain. Agric.* **2007**, *30*, 105–151. [CrossRef]
48. Hinojosa-Rodríguez, A.; Parra-López, C.; Carmona-Torres, C.; Sayadi, S.; Gallardo-Cobos, R. Certified Quality Systems and Farming Practices in Olive Growing: The Case of Integrated Production in Andalusia. *Renew. Agric. Food Syst.* **2014**, *29*, 291–309. [CrossRef]
49. Hinojosa-Rodríguez, A.; Parra López, C.; Carmona Torres, C.; Sayadi Gmada, S. Protected Designation of Origin in the Olive Growing Sector: Adoption Factors and Goodness of Practices in Andalusia, Spain. *New Medit* **2014**, *13*, 2–12.
50. Parra-López, C.; Hinojosa-Rodríguez, A.; Sayadi, S.; Carmona-Torres, C. Protected Designation of Origin as a Certified Quality System in the Andalusian Olive Oil Industry: Adoption Factors and Management Practices. *Food Control.* **2015**, *51*, 321–332. [CrossRef]
51. Parra-López, C.; Hinojosa-Rodríguez, A.; Carmona-Torres, C.; Sayadi, S. ISO 9001 Implementation and Associated Manufacturing and Marketing Practices in the Olive Oil Industry in Southern Spain. *Food Control.* **2016**, *16*, 23–31. [CrossRef]
52. Sanz Menéndez, L. Análisis de Redes Sociales: O Cómo Representar Las Estructuras Sociales Subyacentes. *Apuntes de Ciencia y Tecnología* **2003**, *7*, 21–29.

53. García, M.S.; Méndez, P.N. Los Sistemas Productivos Regionales Desde La Perspectiva Del Análisis de Redes. *REDES-Revista Hispana Para el Análisis de Redes Sociales* **2004**, *6*, 1–26.
54. Coleman, J. Social Capital in the Creation of Human Capital. In *Networks in the Knowledge Economy*; Cross, R., Parker, A., Lisa, S., Eds.; Oxford University Press: New York, NY, USA, 2003; pp. 57–81, ISBN 00029602.
55. Camacho, D.; Panizo-LLedot, Á.; Bello-Orgaz, G.; Gonzalez-Pardo, A.; Cambria, E. The Four Dimensions of Social Network Analysis: An Overview of Research Methods, Applications, and Software Tools. *Inf. Fusion* **2020**, *63*, 88–120. [CrossRef]
56. Saaty, T.L. How to Make a Decision: The Analytic Hierarchy Process. *Eur. J. Oper. Res.* **1990**, *48*, 9–26. [CrossRef]
57. Saaty, T.L. Decision Making with the Analytic Hierarchy Process. *Scientia Iranica* **2002**. [CrossRef]
58. Bach, H.; Bergek, A.; Bjørgum, Ø.; Hansen, T.; Kenzhegaliyeva, A.; Steen, M. Implementing Maritime Battery-Electric and Hydrogen Solutions: A Technological Innovation Systems Analysis. *Transp. Res. Part D Transp. Environ.* **2020**, *87*, 102492. [CrossRef]
59. Edsand, H.-E. Technological Innovation System and the Wider Context: A Framework for Developing Countries. *Technol. Soc.* **2019**, *58*, 101150. [CrossRef]
60. Liu, G.; Gao, P.; Chen, F.; Yu, J.; Zhang, Y. Technological Innovation Systems and IT Industry Sustainability in China: A Case Study of Mobile System Innovation. *Telemat. Inform.* **2018**, *35*, 1144–1165. [CrossRef]
61. Planko, J.; Cramer, J.; Hekkert, M.P.; Chappin, M.M.H. Combining the Technological Innovation Systems Framework with the Entrepreneurs' Perspective on Innovation. *Technol. Anal. Strateg. Manag.* **2017**, *29*, 614–625. [CrossRef]
62. Forman, E.H.; Selly, M.A. *Decision by Objectives: How to Convince Others That You Are Right*; World Scientific Publishing: Singapore, 2001.
63. Kurttila, M.; Pesonen, M.; Kangas, J.; Kajanus, M. Utilizing the Analytic Hierarchy Process (AHP) in SWOT Analysis—A Hybrid Method and Its Application to a Forest-Certification Case. *For. Policy Econ.* **2000**, *1*, 41–52. [CrossRef]
64. Parra-López, C.; Groot, J.C.J.; Carmona-Torres, C.; Rossing, W.A.H. An Integrated Approach for Ex-Ante Evaluation of Public Policies for Sustainable Agriculture at Landscape Level. *Land Use Policy* **2009**, *26*, 1020–1030. [CrossRef]
65. Calabrese, A.; Costa, R.; Levialdi, N.; Menichini, T. Integrating Sustainability into Strategic Decision-Making: A Fuzzy AHP Method for the Selection of Relevant Sustainability Issues. *Technol. Forecast. Soc. Change* **2019**, *139*, 155–168. [CrossRef]
66. Carmona-Torres, C.; Parra-López, C.; Hinojosa-Rodríguez, A.; Sayadi, S. Farm-Level Multifunctionality Associated with Farming Techniques in Olive Growing: An Integrated Modeling Approach. *Agric. Syst.* **2014**, *127*, 97–114. [CrossRef]
67. Ramanathan, R.; Ganesh, L.S. Group Preference Aggregation Methods Employed in AHP: An Evaluation and an Intrinsic Process for Deriving Members' Weightages. *Eur. J. Oper. Res.* **1994**, *79*, 249–265. [CrossRef]
68. Sixt, G.N.; Klerkx, L.; Griffin, T.S. Transitions in Water Harvesting Practices in Jordan's Rainfed Agricultural Systems: Systemic Problems and Blocking Mechanisms in an Emerging Technological Innovation System. *Environ. Sci. Policy* **2018**, *84*, 235–249. [CrossRef]
69. Schiller, K.J.F.; Klerkx, L.; Poortvliet, P.M.; Godek, W. Exploring Barriers to the Agroecological Transition in Nicaragua: A Technological Innovation Systems Approach. *Agroecol. Sustain. Food Syst.* **2020**, *44*, 88–132. [CrossRef]
70. Ngwese, N.M.; Saito, O.; Sato, A.; Boafo, Y.A.; Jasaw, G. Traditional and Local Knowledge Practices for Disaster Risk Reduction in Northern Ghana. *Sustain. Times* **2018**, *10*, 825. [CrossRef]
71. Bodin, Ö.; Crona, B.I. The Role of Social Networks in Natural Resource Governance: What Relational Patterns Make a Difference? Global Environ. *Change* **2009**, *19*, 366–374. [CrossRef]
72. Audouin, S.; Gazull, L.; Gautier, D. Territory Matters: Exploring the Functioning of an Innovation System through the Filter of Local Territorial Practices—The Example of the Adoption of Cashew Trees in Burkina Faso. *J. Rural Stud.* **2018**, *63*, 130–140. [CrossRef]
73. Rivera, M.; Guarín, A.; Pinto-Correia, T.; Almaas, H.; Mur, L.A.; Burns, V.; Czekaj, M.; Ellis, R.; Galli, F.; Grivins, M.; et al. Assessing the Role of Small Farms in Regional Food Systems in Europe: Evidence from a Comparative Study. *Glob. Food Secur.* **2020**, *26*, 100417. [CrossRef]
74. Sanz Cañada, J.; Sánchez Escobar, F.; Hervás Fernández, I.; Coq Huelva, D. Investigación, Innovación y Transferencia En El Sector Del Aceite de Oliva En España. Un Análisis Mediante Paneles Presenciales de Expertos. *OLIVAE* **2014**, *120*, 31–48.