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Research Article

Integration of Local Farmers' Knowledge for Sustainable Agriculture (Case Study of Horticultural Farmers in Waihatu Village)

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ABSTRACT

This research aims to explore farmer knowledge and learning practices with a focus on the role of informal knowledge and learning in strengthening agricultural sustainability and resilience. This research was conducted from May-June 2023 in the village of Waihatu, Kairatu District, West Seram Regency, Maluku Province, which is a center for horticultural crop production. This research uses a qualitative research design using case studies and in-depth interviews, observation, and document research. The results showed that the diversity of knowledge sources and forms of learning used by farmers and the special role of local farmer knowledge. That the knowledge potential of farmers is not utilized optimally and there are several ways in which various types of knowledge can be integrated by individual farmers by synthesizing knowledge from various sources, through farmer networks, both facilitated by formal agriculture and knowledge institutions, through collaboration between farmers and researchers as knowledge generators, and through multi-actor knowledge networks that bring together various fields. That dynamic context, complexity and local specificity of today's challenges facing agriculture and the many roles it is asked to fulfill requires more inclusive, flexible modes of knowledge generation, integration and sharing. All stakeholders and all types of knowledge need to be brought together on the same basis in the innovation process. To this end, policy frameworks and initiatives that promote interactive multi-actor approaches to development agriculture, can play a sizeable role.

Keywords: *Integration, Local Knowledge, Knowledge Sources, Sustainable Agriculture*

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Introduction

With the modernization and industrialization of agriculture, the role of farmer knowledge has largely deteriorated; much of this knowledge has even been lost along with the spread of productive logic and standard solutions, and the decline of farming communities (Jin et al., 2022; Shao, Chen, Wang, Hou, & Chen, 2021). However, in the face of many contemporary challenges, such as climate change, food security, resource depletion, more and more development specialists recognize that smallholders and local knowledge are valuable resources for reorienting modern agriculture towards sustainable and resilient development.

In this paper, we explore farmer knowledge and learning practices with a particular focus on the role of informal knowledge and learning in building sustainable and resilient agriculture. We use the distinction between formal and informal knowledge to better clarify the various forms of knowledge that exist outside of formal agricultural knowledge systems generated by practitioners, without externally imposed criteria and agendas (Ma et al., 2023).

It is recognized that sustainable agriculture, due to its holistic, diverse and distinctive nature, explicitly interrelated environmental, social and economic dimensions also requires content and new forms of knowledge and learning (Iim Mucharam et al, 2020). As formal agricultural knowledge and innovation systems are still heavily focused on agricultural production-oriented models, farmers who choose more sustainable paths often rely on alternative learning networks and knowledge sources. Therefore a better recognition of local farmers' knowledge, and the combination of local and scientific knowledge is needed to meet the goals of sustainability in agriculture (Shalaby et al., 2022). In recent years, agricultural sustainability has been linked to the concept of resilience, which awakens the capacity of agricultural systems to adapt and change to survive in the long term. Learning to live with change and uncertainty, and combining different types of knowledge, including that of farmers, appears to be important for building resilience (Kiruba N & Saeid, 2022).

The research literature gives rise to several overlapping concepts that describe informal

knowledge (local, practice-based, traditional, smallholders, adat and others) as well as informal learning models (self-education, learning by doing, experimenting, observing, from one's own or others' experience). others, in social interaction and others) in agriculture. We focus on two types of interrelated core informal knowledge namely local and farmer. Local knowledge involves something dynamic and complex from knowledge, practices and skills, developed and maintained over time based on the experiences of local communities in environmental and socio-economic realities (Lasaiba, 2023). Farmer knowledge is a subset of local knowledge that makes it possible to farm under certain local conditions. Because agriculture is so dependent on the local environment, local farmer knowledge is essential which includes a deep understanding of specific local cultural sets and natural resources.

The holistic and adaptive character of local knowledge, considers the local system as a whole, integrating their social, environmental and economic aspects, empirical and spiritual dimensions (Khikmah & Gamaliel, 2018). This is illustrated by the development of agriculture in its social environment and setting through the accumulation and application of local knowledge in many areas of the world, from generation to generation (N. Gruda, 2019). For example, traditional farmers integrate their farming methods with natural processes of ecology and reproduction of biodiversity (Disha, Harun, Akter, Billah, & Noman, 2020); Local farming practices address local community needs, food security, social activities related to food, local economic conditions and sustainable land management (Rahmi et al., 2021). This points to the relationship of local farmers' knowledge to certain ethical, environmental, and social values. This issue is particularly relevant when discussing sustainable agriculture driven by conventional agricultural values and new ways of thinking (Hariyadi, Nizak, Nurmalasari, & Kogoya, 2019).

Informal knowledge is often seen as having something to do with formal knowledge and as a push to subordinate positions (see Table 1). Science drives conventional agriculture with its technology and organizational changes that have provoked that farmers are increasingly

dependent on external inputs, and knowledge is lax due to alienation from the production process, and reduction and standardization of skills (Zachariah & Leela, 2018).

Table 1. Differences and similarities between informal and formal knowledge

	Informal Knowledge	Formal Knowledge	
		Academic	Industry
Source	Own experiments and practical experience	Research center	Research center
Ownership	Practitioners, farmers, local communities	Scientist	Specialist, scientist
Approach	Thorough	Complexity	Fragmentation, specialization
Transition	Local specific solutions	Standard and local specific solutions	Standard decontextualization solution
Access	Exchanged with friends, passed down from generation to generation	Peer-reviewed articles, conferences	Education in schools, courses, training groups

Informal and formal knowledge is very helpful to clarify the characteristics of farmers. However, it does not reflect well the reality of agriculture where farmers integrate and use all types of relevant knowledge they access (see Table 1). Moreover, the dominance of formal knowledge indirectly, farmers do not take it for granted. Instead they negotiate local experts and information against their own experience-based knowledge (Yamuangmorn et al., 2022). They even tend to value practice-based knowledge and are able to mobilize their local knowledge to counter scientific ones. However, beyond the agricultural gates, scientific knowledge predominated. Along with increasing standardization and certification of knowledge. Farmers' knowledge and skills are devalued and application is limited by legal means, laws and regulations. In other cases farmers' knowledge is adapted and codified by scientists and industry, excluding producers and local communities from the benefits of product valorization (Wen et al., 2022). The poor links and exchanges between the world of life and scientific and practitioner knowledge, their asymmetrical strengths and interests make it difficult to apply and implement scientific knowledge in practice and the integration of farmers' perspectives in scientific research.

However, there is an increasing number of studies showing the complementarity between informal and formal knowledge and the expan-

sion of multi-stakeholder and participatory approaches where co-production of transdisciplinary knowledge is possible (Bhunias, Bhowmik, Pramanik, Mallick, & Mukherjee, 2023). This research confirms that contemporary sustainable agriculture is advanced by multi-actor knowledge networks where different types of knowledge are exchanged, and new meanings and agricultural practices are negotiated and institutionalized by Gema Wibawa Mukti.

The creation and dissemination of knowledge for agricultural sustainability often occurs through informal mechanisms (such as daily networks, personal and local relational structures, shared learning, mutual support) rather than formal ones (Liu, Muzolf-Panek, & Kleiber, 2022). When multi-actor knowledge networks bring together different stakeholders, the negotiation of the meaning and practice of sustainable agriculture is part of their interaction and contestation. Such "social" brings more sustainable results than purely rational top-down planning, especially in situations when decisions have to be taken on complex issues (Jia, Zhang, Cui, & Feng, 2019). To achieve mutual understanding of different stakeholders and enhance the transition towards sustainable agriculture, mediators or knowledge intermediaries play a key role through interaction facilitation, collaborative reflection, integration of various knowledge cultures.

This paper aims to analyze the potential of informal knowledge and local farmers' knowledge in strengthening agricultural sustainability.

Methods

Research Design

This study uses a mixed approach (quantitative and qualitative). According to Hardani (2020), qualitative and quantitative data can be combined into one database which is used side by side to strengthen one another. The research design used was a case study design in the form of a single case. The single case study in this research is the integration case study of local farmers' knowledge. Specifically, this research looks at the integration process of farmers' knowledge. This approach was chosen because the researcher intends to explain or describe a phenomenon experienced by research subjects, such as where the source of farmer's knowledge in farming is cultivated. Holistically by means of descriptions in the form of words and language in special contexts that are experienced by utilizing various natural methods. Qualitative research is scientific research that aims to understand a phenomenon in a natural social context by prioritizing a process of in-depth communication interaction between the researcher and the phenomenon being studied (N. S. Gruda, 2022).

Research Instruments and Procedures

Research instruments are tools or facilities used by researchers in collecting research data so that their work becomes easier and better, in the sense that it is more accurate, complete and systematic so that it is easier to process. The instruments used in this research are observation, questionnaires and documentation. While the research procedure in this study refers to the stages put forward by Merriam, S., B., & Grenier, R., S. (in Gruda, Bisbis, & Tanny, 2019), namely: (1). Making a research design. Starting from determining the problem to be studied, preliminary studies, formulating the problem, objectives, determining the research methodology, and looking for sources that can support the course of the research; (2). Research Implementation. Includes data collection, analysis of data obtained through observation, interviews

and questionnaires, so that conclusions can be drawn.

Population and Sample

The research was conducted in Waihatu Village, Kairatu District, West Seram District, Maluku Province in May-June 2023. There are 16 farmer groups in Waihatu village and each farmer group consists of 20 members. So that the total population is 320 people. From this population, 10% was taken as a sample using the slovin formula.

$$n = \frac{N}{1+Ne^2}$$

The sampling procedure is carried out by means of probability sampling. Probably sampling is sampling using the opportunity method which is done randomly and can be done by lottery. One of the sampling procedures by means of this probability is systematic random sampling. This sampling procedure is done by numbering the population. The first sampling is carried out randomly, then it is carried out systematically according to a certain interval. By using the slovin formula, the number of samples in this study were 76 people with the following calculations:

$$n = \frac{320}{1 + 320 (0,10)^2}$$

$$n = \frac{320}{4,2}$$

$$n = 76$$

Furthermore, the selection of informants was carried out purposively using the snowball sampling method. According to Jordan Nunan, et al (2020), collecting informants with this method is an approach to placing rich information from key informants. The informants taken in this study were farmers, village officials, agricultural extension workers, agricultural practitioners, traders and district officials.

Data collection technique

The data collected in this study are primary and secondary data. Primary data collection techniques are carried out as follows: (a) Observational techniques include various matters relating to observing farmer activities (b) Purposive sampling technique, namely selecting a

sample of farmers who know for sure about the source of farming knowledge. This data was obtained by conducting in-depth interviews with the community and key informants. In-depth interviews use questionnaires in the form of written questions in a structured manner which are given to respondents according to the research problem. (c) Participatory observation, namely the author is directly involved in the daily life of the community by hearing and distinguishing what farmers as research subjects have said and done. While secondary data in the form of data from residents of Waihatu village and results of research on sources of knowledge of farmers in different locations were obtained through library research techniques (Basir, Neswati, Baja, & Lopulisa, 2018).

Data analysis technique

Researchers used descriptive qualitative methods in analyzing the data. The data obtained through interviews in this study were analyzed using qualitative descriptive analysis by means of which the data obtained from interviews with informants was thoroughly described. Interview data in research is the main data source which is used as material for data analysis to answer research problems (Gusta & Same, 2022). Data analysis begins by conducting in-depth interviews with respondents and informants. Then the researcher made a simple tabulation using MS Excel. Processed data is displayed in a table to facilitate the presentation of the conditions of the research location. Furthermore, the researcher made data reduction by means of abstraction, namely taking data that is appropriate to the research context and ignoring data that is not needed (Chrysargyris, Antoniou, Xylia, Petropoulos, & Tzortzakis, 2021). Data from in-depth interviews, field notes and other documents were analyzed qualitatively, namely the source of farmers' knowledge in farming

Result and Discussion

Overview of Agriculture in Waihatu Village

The people of Waihatu Village have been placed since 1974 as transmigrants from the island of Java. Since being placed (1974-1978) most of them have been working as paddy rice farmers, with various facilities already

available such as ready-to-work rice fields and no irrigation yet. To obtain water, wells without concrete rings were used to irrigate the paddy fields. Then in 1979-1981 it used semi-technical irrigation from dams prepared by the government. After modernization in 1982-2007 using technical irrigation, semi-technical and technical irrigation required cooperation in controlling water flows and cleaning waterways (Olenchenko & Osipova, 2022).

From 1974-1993, for seed-seeding activities, they used human labor individually. After modernization in 1994-1996 using the TABLEA (Direct Sowing of Seeds) pattern, this pattern did not last long because it did not get optimal results so that the seedlings returned to using human power in 1997 until now. In planting activities (1974-1997) specifically for rice plants, it was carried out in groups with a labor exchange system without wages. After modernization in 1978 until now the planting of special seeds for rice plants is carried out by paying labor. Maintenance activities are divided into three parts, namely: (a) fertilization: from 1974 until now fertilization was done using human power individually, (b) spraying: from 1974-1977 was done manually. After modernization in 1978-2009 using handsprayer was carried out by individuals, then from 2010 until now using an electric sprayer was carried out by individuals, and (3) weeding: 1974-1994 using human power was carried out in groups with a power exchange system without wages, and wages Work. After modernization in 1994-2009 using herbicides, then in 2010 until now using plastic mulch.

Harvesting activities (1974-2007) using human labor were carried out individually for horticultural crops and in groups with a labor exchange system without wages, and wage labor using the bawon system for rice plants. After modernization in 2008 until now harvesting using cutting machines is done individually, for farmers who do not have machines they can rent a bawon system. In 2008 until now, there was a damage to the dam which resulted in local farmers using concrete ring wells. As a result of this damage, most of the farmers abandoned paddy rice farming. Local farmers prefer to cultivate horticultural crops rather than

paddy rice due to limited water availability. The types of horticultural crops cultivated since 2009 until now are tomatoes, chili beans, cucumbers, corn, eggplants and long beans.

Sources of Farmer Knowledge

The results of research on the source of knowledge of horticultural farmers in Waihatu village can be seen in Figure 1.

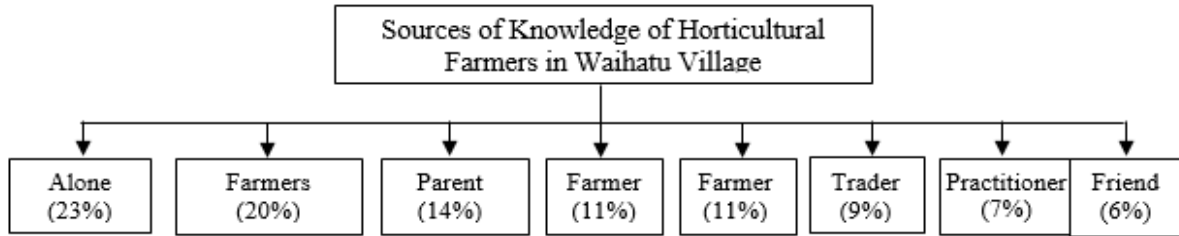


Figure 1. Sources of Knowledge of Horticultural Farmers in Waihatu Village

The data above shows that the source of farmers' knowledge comes mostly from themselves. This is related to the experience of local farmers in farming which is carried out continuously, that one of the factors that influences the level of motivation of farmers in farming is farming experience. The second biggest source of knowledge comes from farmer groups. The results of Rifki Arbian Hidayat's research. et al (2022), said that farmer groups play a role in improving the economic status of farmers. Furthermore, the second source of knowledge is that which comes from parents. This is according to the opinion of Myxa Cezar Ranzez. et al. (2020), that the role of parents in supporting the regeneration of farmers can be done by increasing lifestyles that are more inclined to agriculture.

Lessons for Sustainable Agriculture

Farmers Need Knowledge and Learning Motivation

We found the personal and social drivers behind farmer learning decisions. The developing character of agriculture and the demands of the new society on it require knowledge and skills from farmers. Also the motivations and values of farmers guide them in choosing subjects, sources and forms of learning. This motivational grouping is divided into two axes, namely business and ethics and social (Almadani, Ibrahim, Al-Amri, Fnais, & Abdelrahman, 2019).

Business, becomes very important when farmers learn to improve their market performance, increase income, gain stability and

economic growth. In all cases, one of the key knowledge needs is marketing, particularly for small-scale farmers and those establishing new marketing channels (eg, direct selling, processing, or market chains). Others are technical know-how most prominent in cases that depend on advanced technology, such as bioenergy production or farming under harsh conditions in the desert. Competition, demands for quality and opportunities created by scientific progress lead to the constant technical renewal of knowledge. To run a business successfully, farmers also need bureaucracy, administrative and legal knowledge. The motivation to do better in business also involves building certain social and personal skills, such as networking, conflict management, creativity and managing time (Islami, Taib, Yusoff, & Ghani, 2018).

While a strict division cannot be made between business and non-business, we examine "ethical" and social and appropriate knowledge needs separately. "I like what I do" is a common phrase farmers use to describe their work. This passion also urges them to discover, learn and experiment in their area of interest. Pride and responsibility for working a family-owned farm for generations is another common learning framework, prioritizing some solutions over others. This can form a certain path dependency, an unwillingness to break away from family traditions. But long-term engagement fosters creativity as farmers learn and develop solutions to stay on their farms even in high stress situations (Sendrós, Himi, Lovera, Rivero, Garcia-Artigas, et al., 2020). Responsibility for

agriculture involves caring for its natural environment; soil, landscape, wildlife, and more.

Farmers tend to conserve this resource and learn how to do it, sometimes even at the cost of production efficiency. Another "ethical and social" motivation is consideration for community interests and resources: neighboring farmers, cooperatives, local villages or the wider region. Finally, striving for a certain autonomy guides knowledge acquisition as farmers seek to maintain independence from market, financial, public forces and wish to remain in control of their farm decisions and operations.

Source of Knowledge

Figure 1 data shows that farmers use and integrate knowledge from various sources sequentially to meet their diverse knowledge needs. In many cases, farmer knowledge is the most prominent and reliable knowledge base because of its relevance and significance locally. In their daily operations the farmers mainly rely on their own knowledge accumulated over long periods of time from practical experience by conducting, experimenting and observing.

Traditionally, the family farm has been the core platform for learning and knowledge decisions are still very common. Another basic source of knowledge presented in this case is other farmers. Farmers regard their successful colleagues as reputable experts and can be highly trusted because of their practical experience in such matters. Traditional farmer knowledge serves as a solid source of production and a source of inspiration. In all cases farmers also used knowledge from formal agricultural institutions (provided in the form of training courses).

Sometimes farmers choose formal courses over informal learning due to high profile, clear production-oriented knowledge content, higher public awards, approved certificates (Sendrós, Himi, Lovera, Rivero, Garcia-Artigas, et al., 2020). Public administration and control institutions are an important source of knowledge for farmers to receive public support (Qaisar et al., 2020). Because production and distribution are tightly regulated and agricultural regulatory frameworks and support measures change regularly, farmers need to

frequently update their knowledge. Farmers often perceive this as a burden that demands financial investment, practical adaptation in agriculture and considerable bureaucratic work.

Market players, especially traders, are a source of knowledge and innovation for farmers. In the case of Austria and Switzerland, direct contact with consumers stimulates farmers to rethink their working habits, and to design new products and services. For part time farmers, their off-farm work and exposure to other sectors provides additional soft skills, new ideas and experiences to integrate on their farm. The diversity of knowledge sources brings us back to the problem of integration, which occurs (or fails) in interactions within networks.

The Relationship Between Formal and Informal Knowledge Bases Mediation and Knowledge Transmission In Networks

This research shows that farmers operate within a multi-actor knowledge network consisting of overlapping formal and informal sub-networks. The formal knowledge network contains a variety of formal institutions: research institutes, service advisors, farmer organizations, and others. They have strong historical and institutional 'back-ups', have more structured agendas, operate on a larger scale and receive some public funding.

Formal knowledge is often written down in print and digital artifacts that circulate in networks and link actors. In contrast, informal knowledge and learning operate in more obscure networks, relying on farmer knowledge, self-interest, community ties, family and personal relationships, neighborhood associations, peer groups, territorial communication structures and traditions. They are often part of the farmer's daily routine and the first channel for exchanging and disseminating ideas and practices. These networks are more local, but not exclusive, thanks to mobility and modern farming tools, connections are possible to more distant partners.

In some cases the central node in the farmer learning network is the farmer farmer group. As organic farmers point out, farmer groups are particularly important in the piloting phase of

new agricultural approaches when formal knowledge, consultation or manuals are limited and farmers seek knowledge and moral support. Organizational farmers maintain an important role also in established sectors and businesses as a site for sharing information, knowledge and experience, as well as assisting farmers in managing agricultural and non-agricultural related issues. Farmers' organizations also link farmers with other knowledge sources under the assumption of broader mediation.

Complementary and Creative Synergy

Informal and formal knowledge often complement each other. research results indicate several ways to integrate different types of knowledge. At the individual level, farmers use and integrate the many sources of knowledge available to them, from scientific knowledge to their own experiential knowledge. Local farmers demonstrate how a scientifically based tool supports farmer decision-making about nutrition management. Its application increases farmers' awareness of the organic nutritional value of manure, improves resource use and planning efficiency, results in savings in chemical fertilizers and convinces farmers of their own estimates.

Another level of integration and knowledge sharing occurs through farmer networks in both formal organizations and informal structures. It is easier for farmers to adopt external ideas and practices that have been accepted and successfully implemented by other farmers. Another example of the key role of informal knowledge networks in supporting scientific knowledge is: the eradication of fruit flies in the Arava region, where informal social networks and parallel interactions at the agricultural and social levels contributed to successful eradication across the region, not elsewhere.

Formal institutions, especially advisory services can provide another way to facilitate the transfer and exchange of knowledge between farmers. They organize knowledge exchange among farmers through field visits, comparative studies, farmer discussions and training groups, formal forums and the like. A variation from the previous is the creation of shared knowledge between farmers and researchers as equal partners, with mutual benefits. Finally,

mixed actor groups, involving both agricultural and non-agricultural participants, can lead to completely new and unexpected insights and developments. For example in the Oddebæk river basin (Denmark), collaboration between farmers, local government and academia has raised awareness of the diversity of local environmental and cultural resources and resulted in a shared vision and strategy for landscape management in the Oddebæk watershed. The initiative integrates agriculture within the broader context of rural development and has launched a more complex approach to local development.

Each site and level of integration of different knowledge sources has its role in agricultural development and modernization. Better results in terms of agricultural sustainability and resilience are achieved when different types of formal and informal, local and external knowledge are incorporated into the value network, and all actors are reflexive and sensitive to potential synergies.

Conflicts and Contests

Different sources of knowledge can also provide conflicting knowledge. Such knowledge clashes between the practical knowledge of farmers rooted in their experience and the knowledge of agricultural practices presented in the regulations on food production and distribution. Increasing standardization of agricultural knowledge and practices can limit the knowledge and skills of diverse farmers, lack credibility, and demand cognitive, financial and practical effort to adopt. For example, Latvian small-scale farmers testify that often agricultural knowledge is locked into certified expertise, and they cannot carry out some of the exercises on their own due to regulations. In these cases farmers are not valued as experts, and their experience-based knowledge and skills are ignored, undermining the sustainability of their agricultural practices.

Thus, formal and informal knowledge and their respective networks may be in competition with one another. Where informal knowledge networks are strong, formal consulting services have a weaker role as informal networks (Lamine et al., 2015). In addition, there is a tendency for the formalization of

knowledge structures and an increase in the need for formal knowledge, reducing informal networks and learning (Oyeyemi et al., 2021).

The existence of conflicting knowledge can close or open space for innovation and new things; it demands flexibility from growers to assume and work it for their use. But these restrictions push them to seek new market and organizational solutions, such as expanding processing, cooperation among farmers, creating joint commercial enterprises. However, this energy and creative efforts of farmers will be more effective if other formal agricultural institutions are willing to acknowledge farmers not only as recipients of information, but also generators of knowledge. In the context of modernization their expertise is often overlooked, even though it holds the resources to increase resilience and sustainability.

Contribution of Informal Knowledge and Learning for Sustainable and Resilient Agriculture

The research results confirm that the informal knowledge generated in the local context tends to be holistic by considering the complexity of the reality in which agriculture operates integrating many or at least several environmental, economic, social, financial, technical, and other dimensions into one unit. As an example the diverse and dynamic strategy of Latvian smallholder agriculture describes how farmers develop and adapt their farms on the basis of their personal interests, family situation, knowledge of agricultural agro-environmental conditions, regional traditions, market opportunities, available technical and financial resources, workforce, public support, and others (Alarifi, Abdelrahman, & Hazaea, 2022).

Practical knowledge and experience add to the farmer's confidence, professional satisfaction and autonomy. Farmers admit to having difficulties in their profession, but in general they express a sense of pride and pleasure in applying their creativity and knowledge and seeing them bring good results to their families and communities. Their knowledge accumulated over a long time through personal experiences in local settings forms a reliable basis for farming and increases their adaptive capacity

to choose the solution that best suits their unique conditions.

Likewise, farmers' confidence and capacity to act are increased through informal knowledge networking with other farmers. Informal learning networks facilitate the diffusion of innovations as farmers adopt practices that are more easily accepted by their peers. What is important is that knowledge obtained from family or neighboring farmers often becomes a motivator and guide for the beginning of agriculture for young and new farmers. Local farmer knowledge continues to be a valuable support and source of inspiration and innovation for experienced farmers as well (Permanasari, Ipmanawan, & Khairuman, 2020).

Informal sources of knowledge diversify farmers' knowledge and in this way also strengthen resilience (Hasan, Shang, Akhter, & Jin, 2019). They compensate for knowledge gaps in the formal knowledge system, particularly with regard to alternative farming practices as well as non-technical knowledge and pay less attention to the skills of formal knowledge institutions. Informal knowledge is even more important given the weakness or weakness of the state and the public accessibility of formal agricultural knowledge systems in some areas.

Direct knowledge exchange not only helps develop and disseminate sustainable practices, but also strengthens social structures through shared practices: bonds of friendship or solidarity, community and identity building. This is even more relevant when collective benefits result from shared learning: better local governance, pest eradication, improved local economy, empowered farming communities. In addition, we also identify environmental benefits associated with informal local knowledge. For example, many of the small-scale farmers studied practice less intensive farming techniques linked to specific local knowledge, rooted in natural processes and creating less environmental stress.

In the case of the study sites, local knowledge experience has been the key to developing shared agricultural management experiences. The farmers' unique local knowledge about farming in extreme climatic

conditions is relevant when considering climate. In this way informal knowledge and the social mechanisms through which it is acquired and disseminated, can compensate for deficiencies of formal knowledge systems, demonstrating multiple contributions to resilient and sustainable agriculture, including to farmer identity, community and environment.

Conclusion

The diversity of knowledge sources and learning structures in agriculture, the integrative relationship between informal knowledge and formal knowledge demonstrates the important role of informal knowledge of farmers for sustainable and resilient agriculture. Integration of various sources of knowledge and forms of learning emerge as a key aspect of survival, adaptation in modern agriculture, in particular, if one is to innovate and wish to depart from the well-trodden path. Personal curiosity and willingness to learn, together with social networks and formal knowledge and supportive governance structures emerge as central elements for successful learning, knowledge integration and innovation. Both formal and informal knowledge sources have their strengths, but it is networks and exchange of knowledge that make knowledge flexible and increase sustainability. The special role of informal knowledge lies in the fact that the adaptation and transfer of knowledge is mediated by the farmers themselves and local knowledge. The recognition and use of smallholder knowledge will support the goals of an inclusive knowledge-based society, built on respect for the diversity of knowledge, broad access to knowledge and participation by everyone with their knowledge. More recent engagement in multi-actor knowledge networks and closer collaboration with smallholders indicates a development towards knowledge and learning in a more participatory, inclusive and comprehensive process.

This research suggests several areas of engagement for formal knowledge institutions and agricultural policy makers:

1. Facilitating connection and knowledge exchange among various stakeholders for mutual learning: such as, joint events with experts from all related fields, collaboration

between farmers and formal research institutions in field trials or new product development, consultation of farmers to integrate their knowledge.

2. Support local level initiatives: networking, partnerships, mentoring, exchange of experiences, young farmer projects, etc. Advisors can engage in such knowledge exchanges acting as professional knowledge mediators and facilitators.
3. Training in social networking, collaboration, and co-learning skills can help to strengthen both networks by avoiding over-reliance on a few skilled leaders and learning outcomes.
4. The changing nature of agriculture, its linkages with other rural sectors, the current challenges facing agriculture and the many roles it demands, require the development of a mix of knowledge and learning networks with greater inclusion of agricultural and non-agricultural stakeholders

The data above shows that the source of farmers' knowledge comes mostly from themselves. This is related to the experience of local farmers in farming which is carried out continuously, that one of the factors that influences the level of motivation of farmers in farming is farming experience. The second biggest source of knowledge comes from farmer groups. The results of Rifki Arbian Hidayat's research. et al (2022), said that farmer groups play a role in improving the economic status of farmers. Furthermore, the second source of knowledge is that which comes from parents. This is according to the opinion of Myxa Cezar Ranzez. et al. (2020), that the role of parents in supporting the regeneration of farmers can be done by increasing lifestyles that are more inclined to agriculture.

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While a strict division cannot be made between business and non-business, we examine "ethical" and social and appropriate knowledge needs separately. "I like what I do" is a common phrase farmers use to describe their work. This passion also urges them to discover, learn and experiment in their area of interest. Pride and responsibility for working a family-owned farm for generations is another common learning framework, prioritizing some solutions over others. This can form a certain path dependency, an unwillingness to break away from family traditions. But long-term engagement fosters creativity as farmers learn and develop solutions to stay on their farms even in high stress situations (Sendrós, Himi, Lovera, Rivero, Garcia-Artigas, et al., 2020). Responsibility for agriculture involves caring for its natural environment; soil, landscape, wildlife, and more.

Farmers tend to conserve this resource and learn how to do it, sometimes even at the cost of production efficiency. Another "ethical and social" motivation is consideration for community interests and resources: neighboring farm-

ers, cooperatives, local villages or the wider region. Finally, striving for a certain autonomy guides knowledge acquisition as farmers seek to maintain independence from market, financial, public forces and wish to remain in control of their farm decisions and operations.

Source of Knowledge

Figure 1 data shows that farmers use and integrate knowledge from various sources sequentially to meet their diverse knowledge needs. In many cases, farmer knowledge is the most prominent and reliable knowledge base because of its relevance and significance locally. In their daily operations the farmers mainly rely on their own knowledge accumulated over long periods of time from practical experience by conducting, experimenting and observing.

Traditionally, the family farm has been the core platform for learning and knowledge decisions are still very common. Another basic source of knowledge presented in this case is other farmers. Farmers regard their successful colleagues as reputable experts and can be highly trusted because of their practical experience in such matters. Traditional farmer knowledge serves as a solid source of production and a source of inspiration. In all cases farmers also used knowledge from formal agricultural institutions (provided in the form of training courses).

Sometimes farmers choose formal courses over informal learning due to high profile, clear production-oriented knowledge content, higher public awards, approved certificates (Sendrós, Himi, Lovera, Rivero, Garcia-Artigas, et al., 2020). Public administration and control institutions are an important source of knowledge for farmers to receive public support (Qaisar et al., 2020). Because production and distribution are tightly regulated and agricultural regulatory frameworks and support measures change regularly, farmers need to frequently update their knowledge. Farmers often perceive this as a burden that demands financial investment, practical adaptation in agriculture and considerable bureaucratic work.

Market players, especially traders, are a source of knowledge and innovation for farm-

ers. In the case of Austria and Switzerland, direct contact with consumers stimulates farmers to rethink their working habits, and to design new products and services. For part time farmers, their off-farm work and exposure to other sectors provides additional soft skills, new ideas and experiences to integrate on their farm. The diversity of knowledge sources brings us back to the problem of integration, which occurs (or fails) in interactions within networks.

The Relationship Between Formal and Informal Knowledge Bases Mediation and Knowledge Transmission in Networks

This research shows that farmers operate within a multi-actor knowledge network consisting of overlapping formal and informal sub-networks. The formal knowledge network contains a variety of formal institutions: research institutes, service advisors, farmer organizations, and others. They have strong historical and institutional 'back-ups', have more structured agendas, operate on a larger scale and receive some public funding.

Formal knowledge is often written down in print and digital artifacts that circulate in networks and link actors. In contrast, informal knowledge and learning operate in more obscure networks, relying on farmer knowledge, self-interest, community ties, family and personal relationships, neighborhood associations, peer groups, territorial communication structures and traditions. They are often part of the farmer's daily routine and the first channel for exchanging and disseminating ideas and practices. These networks are more local, but not exclusive, thanks to mobility and modern farming tools, connections are possible to more distant partners.

In some cases the central node in the farmer learning network is the farmer farmer group. As organic farmers point out, farmer groups are particularly important in the piloting phase of new agricultural approaches when formal knowledge, consultation or manuals are limited and farmers seek knowledge and moral support. Organizational farmers maintain an important role also in established sectors and businesses as a site for sharing information,

knowledge and experience, as well as assisting farmers in managing agricultural and non-agricultural related issues. Farmers' organizations also link farmers with other knowledge sources under the assumption of broader mediation.

Complementary and Creative Synergy

Informal and formal knowledge often complement each other. research results indicate several ways to integrate different types of knowledge. At the individual level, farmers use and integrate the many sources of knowledge available to them, from scientific knowledge to their own experiential knowledge. Local farmers demonstrate how a scientifically based tool supports farmer decision-making about nutrition management. Its application increases farmers' awareness of the organic nutritional value of manure, improves resource use and planning efficiency, results in savings in chemical fertilizers and convinces farmers of their own estimates.

Another level of integration and knowledge sharing occurs through farmer networks in both formal organizations and informal structures. It is easier for farmers to adopt external ideas and practices that have been accepted and successfully implemented by other farmers. Another example of the key role of informal knowledge networks in supporting scientific knowledge is: the eradication of fruit flies in the Arava region, where informal social networks and parallel interactions at the agricultural and social levels contributed to successful eradication across the region, not elsewhere.

Formal institutions, especially advisory services can provide another way to facilitate the transfer and exchange of knowledge between farmers. They organize knowledge exchange among farmers through field visits, comparative studies, farmer discussions and training groups, formal forums and the like. A variation from the previous is the creation of shared knowledge between farmers and researchers as equal partners, with mutual benefits. Finally, mixed actor groups, involving both agricultural and non-agricultural participants, can lead to completely new and unexpected insights and developments. For example in the Oddebæk river basin (Denmark), collaboration between farmers, local government and academia has

raised awareness of the diversity of local environmental and cultural resources and resulted in a shared vision and strategy for landscape management in the Oddebæk watershed. The initiative integrates agriculture within the broader context of rural development and has launched a more complex approach to local development.

Each site and level of integration of different knowledge sources has its role in agricultural development and modernization. Better results in terms of agricultural sustainability and resilience are achieved when different types of formal and informal, local and external knowledge are incorporated into the value network, and all actors are reflexive and sensitive to potential synergies.

Conflicts and Contests

Different sources of knowledge can also provide conflicting knowledge. Such knowledge clashes between the practical knowledge of farmers rooted in their experience and the knowledge of agricultural practices presented in the regulations on food production and distribution. Increasing standardization of agricultural knowledge and practices can limit the knowledge and skills of diverse farmers, lack credibility, and demand cognitive, financial and practical effort to adopt. For example, Latvian small-scale farmers testify that often agricultural knowledge is locked into certified expertise, and they cannot carry out some of the exercises on their own due to regulations. In these cases farmers are not valued as experts, and their experience-based knowledge and skills are ignored, undermining the sustainability of their agricultural practices.

Thus, formal and informal knowledge and their respective networks may be in competition with one another. Where informal knowledge networks are strong, formal consulting services have a weaker role as informal networks (Lamine et al., 2015). In addition, there is a tendency for the formalization of knowledge structures and an increase in the need for formal knowledge, reducing informal networks and learning (Oyeyemi et al., 2021).

The existence of conflicting knowledge can close or open space for innovation and new things; it demands flexibility from growers to

assume and work it for their use. But these restrictions push them to seek new market and organizational solutions, such as expanding processing, cooperation among farmers, creating joint commercial enterprises. However, this energy and creative efforts of farmers will be more effective if other formal agricultural institutions are willing to acknowledge farmers not only as recipients of information, but also generators of knowledge. In the context of modernization their expertise is often overlooked, even though it holds the resources to increase resilience and sustainability.

Contribution of Informal Knowledge and Learning for Sustainable and Resilient Agriculture

The research results confirm that the informal knowledge generated in the local context tends to be holistic by considering the complexity of the reality in which agriculture operates integrating many or at least several environmental, economic, social, financial, technical, and other dimensions into one unit. As an example the diverse and dynamic strategy of Latvian smallholder agriculture describes how farmers develop and adapt their farms on the basis of their personal interests, family situation, knowledge of agricultural agro-environmental conditions, regional traditions, market opportunities, available technical and financial resources, workforce, public support, and others (Alarifi, Abdelrahman, & Hazaea, 2022).

Practical knowledge and experience add to the farmer's confidence, professional satisfaction and autonomy. Farmers admit to having difficulties in their profession, but in general they express a sense of pride and pleasure in applying their creativity and knowledge and seeing them bring good results to their families and communities. Their knowledge accumulated over a long time through personal experiences in local settings forms a reliable basis for farming and increases their adaptive capacity to choose the solution that best suits their unique conditions.

Likewise, farmers' confidence and capacity to act are increased through informal knowledge networking with other farmers. Informal learning networks facilitate the diffusion of innovations as farmers adopt practices

that are more easily accepted by their peers. What is important is that knowledge obtained from family or neighboring farmers often becomes a motivator and guide for the beginning of agriculture for young and new farmers. Local farmer knowledge continues to be a valuable support and source of inspiration and innovation for experienced farmers as well (Permanasari, Ipmawan, & Khairuman, 2020).

Informal sources of knowledge diversify farmers' knowledge and in this way also strengthen resilience (Hasan, Shang, Akhter, & Jin, 2019). They compensate for knowledge gaps in the formal knowledge system, particularly with regard to alternative farming practices as well as non-technical knowledge and pay less attention to the skills of formal knowledge institutions. Informal knowledge is even more important given the weakness or weakness of the state and the public accessibility of formal agricultural knowledge systems in some areas.

Direct knowledge exchange not only helps develop and disseminate sustainable practices, but also strengthens social structures through shared practices: bonds of friendship or solidarity, community and identity building. This is even more relevant when collective benefits result from shared learning: better local governance, pest eradication, improved local economy, empowered farming communities. In addition, we also identify environmental benefits associated with informal local knowledge. For example, many of the small-scale farmers studied practice less intensive farming techniques linked to specific local knowledge, rooted in natural processes and creating less environmental stress.

In the case of the study sites, local knowledge experience has been the key to developing shared agricultural management experiences. The farmers' unique local knowledge about farming in extreme climatic conditions is relevant when considering climate. In this way informal knowledge and the social mechanisms through which it is acquired and disseminated, can compensate for deficiencies of formal knowledge systems, demonstrating multiple contributions to resilient and sustainable agriculture, including to farmer identity, community and environment.

Conclusion

The diversity of knowledge sources and learning structures in agriculture, the integrative relationship between informal knowledge and formal knowledge demonstrates the important role of informal knowledge of farmers for sustainable and resilient agriculture. Integration of various sources of knowledge and forms of learning emerge as a key aspect of survival, adaptation in modern agriculture, in particular, if one is to innovate and wish to depart from the well-trodden path. Personal curiosity and willingness to learn, together with social networks and formal knowledge and supportive governance structures emerge as central elements for successful learning, knowledge integration and innovation. Both formal and informal knowledge sources have their strengths, but it is networks and exchange of knowledge that make knowledge flexible and increase sustainability. The special role of informal knowledge lies in the fact that the adaptation and transfer of knowledge is mediated by the farmers themselves and local knowledge. The recognition and use of smallholder knowledge will support the goals of an inclusive knowledge-based society, built on respect for the diversity of knowledge, broad access to knowledge and participation by everyone with their knowledge. More recent engagement in multi-actor knowledge networks and closer collaboration with smallholders indicates a development towards knowledge and learning in a more participatory, inclusive and comprehensive process.

This research suggests several areas of engagement for formal knowledge institutions and agricultural policy makers:

1. Facilitating connection and knowledge exchange among various stakeholders for mutual learning: such as, joint events with experts from all related fields, collaboration between farmers and formal research institutions in field trials or new product development, consultation of farmers to integrate their knowledge.
2. Support local level initiatives: networking, partnerships, mentoring, exchange of experiences, young farmer projects, etc. Advisors can engage in such knowledge

exchanges acting as professional knowledge mediators and facilitators.

3. Training in social networking, collaboration, and co-learning skills can help to strengthen both networks by avoiding over-reliance on a few skilled leaders and learning outcomes.
4. The changing nature of agriculture, its linkages with other rural sectors, the current challenges facing agriculture and the many roles it demands, require the development of a mix of knowledge and learning networks with greater inclusion of agricultural and non-agricultural stakeholders

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