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Community Readiness for Agro Living Lab (ALL) Projects: Factors Influencing Engagement of Young Urban Residents

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Abstract: The aim of this research is to analyze the drivers of young urban residents' readiness to actively participate in agro living lab (ALL) projects, contributing to sustainable and resilient urban systems. This study is based on a literature review and a survey conducted among students from selected universities in Kraków. Using factor analysis and regression trees, the profiles of the individuals most inclined to participate in ALL projects were identified. The analysis included a wide range of variables, such as education, proximity to agriculture, perception of urban agriculture, and various sociodemographic characteristics. These findings indicate that readiness to engage in ALL projects is strongly associated with respondents' field of study, interests, and individual experiences. Moreover, participants with positive attitudes toward urban agriculture and personal relationships with farmers were more likely to express a readiness to participate in ALLs. These results provide new insights into the social conditions influencing ALL participation and offer valuable guidance for developing strategies to promote the active engagement of urban populations in sustainable food initiatives.

Keywords: agro living lab; urban agriculture; public engagement; students; factors

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Academic Editor: Youhua Chen

Received: 28 November 2024
Revised: 23 December 2024
Accepted: 31 December 2024
Published: 3 January 2025

Citation: Sroka, W.; Król, K.; Kulesza, J.; Stanuch, M.; Lisek, S. Community Readiness for Agro Living Lab (ALL) Projects: Factors Influencing Engagement of Young Urban Residents. *Agriculture* **2025**, *15*, 94. https://doi.org/10.3390/agriculture15010094

1. Introduction

The concept of sustainable urban development has been gaining increasing attention, particularly when considering climate change and the dynamic pressures of urban expansion [1,2]. The lessons from the COVID-19 pandemic and political tensions, including the conflict in Ukraine, have contributed to highlighting the problem of food security and resilience of urban areas in general [3,4]. Crises have spurred the revitalization—or at least the popularization—of urban agriculture (UA) [5–8]. This has led to more urban projects and research attempts discussing UA. This concept has become relevant to the future of sustainable and resilient cities [9,10].

Urban agriculture is increasingly being recognized as a key contributor to urban cohesion and resilience. However, scholars have suggested that its full potential can only be realized through public acceptance and active engagement of local communities [11–13]. Urban agriculture, with its innovative implementations—such as vertical farms, building-integrated agriculture, and hydroponic systems—is based on pioneering technological and organizational approaches that strengthen urban food security [14,15]. Initiatives such as community and school gardens, recreational farms, and social farming enhance quality of life by fostering interactions with nature and involving local communities in shaping their environment. Urban agriculture initiatives contribute to the growth of diversity in ecosystem services, leading to improved air quality, rainwater management, and increased biodiversity. Additionally, some of them foster social bonds and promote environmental education [15–19].

Recently, scholars have emphasized that innovative concepts like living labs may serve as pivotal catalysts for urban agriculture (UA) initiatives [20,21]. Living labs (LLs) are defined as 'user-centered, open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real-life communities and settings' [14]. Living labs are spaces promoted and supported by public funding, including European Union funds, where locals, researchers, entrepreneurs, and decision-makers cooperate in experiment, design, and test solutions in an actual urban context [22]. The LL approach facilitates effective urban strategies that extend beyond theoretical frameworks and that adapt to the specific needs of local communities.

Poland, like other European Union countries, has seen an increased interest in initiatives that engage local communities in co-creating future cities [20,23]. This has led to the growing relevance of LLs as platforms for co-innovation and collaboration [22]. Still, the concept of agro living labs (ALL) as innovative spaces engaging various groups of stakeholders in co-creating and testing innovations in agriculture and sustainable food systems, particularly in the urban context, is just gaining a foothold [24–26]. While ALL has been characterized in the literature, few studies have explored its recognizability, understanding of its background, factors influencing engagement, and perception within local communities [23]. Although boosting civic engagement and fostering the acceptance of efforts in ALL projects remains a significant challenge [26,27], these objectives are critical to their success [28–30].

A few studies have demonstrated that not all ALL projects achieve their goals due to low civic engagement [14]. In their analysis of food policies in 33 global cities, Sonnino et al. [18] noted that fewer than half of these cities formally engaged 'regular' residents in management processes. This highlights the necessity of raising awareness about the importance of public involvement in the development of urban food systems among city decision-makers and residents [11,31]. This article, therefore, aims to characterize the concept of agro living labs, assess the awareness of young urban residents (students) about them, and analyze the factors influencing their engagement in ALL projects. The authors pose three research questions:

1. How familiar are young urban residents (students) with the ALL concept?
2. How interested are students in participating in ALL projects?
3. What are the characteristics of students most inclined to engage in ALL projects?

The article introduces the concept of ALLs and explores their potential impact on developing sustainable and resilient solutions for urban food systems. Next, the authors discuss the conceptual framework and research methodology. The primary focus of the article is the results of a survey conducted among a purposefully selected group of Kraków residents, namely, students. Students are future leaders and decision-makers who will soon influence urban policies. They represent a substantial diversity of beliefs and high environmental awareness combined with broad interests [14]. Considering they are young, active, and ready to experiment with new approaches, they may turn out to be key users of ALLs. Understanding their opinions on ALLs and their potential engagement in co-creating urban initiatives can significantly shape future urban policies [32].

The results yielded a profile of young urban residents who were inclined to engage in ALL projects. This profile was derived from an analysis of sociodemographic characteristics, young residents' relationships with agriculture, their perceptions of agriculture, and other relevant factors. The findings were then juxtaposed with other analyses, leading to key conclusions and recommendations for future research.

These insights may prove valuable in developing strategies to promote social inclusion and increase the activity levels of young urban populations. They can also help address concerns and debunk myths regarding the acceptance of agricultural activities in urban areas [24]. This is particularly significant in countries where the acceptance of urban agriculture among residents remains relatively low [11].

2. Living Lab Support Toward Resilient and Sustainable Food Systems: Theoretical Background

2.1. Living Labs: A Variety of Formats and Objectives

The general concept of a living lab can be traced back to the Chicago School of Urban Sociology, which engages in highly qualitative research characterized by methodological eclecticism, combining ethnography with various other qualitative and participatory methods [14]. The term 'living lab' was introduced by Prof. William Mitchell of the Massachusetts Institute of Technology in the early 2000s. He used it to describe a user-centric research methodology for developing solutions in dynamic real-life contexts [33]. In recent years, this approach has been applied mainly in disciplines related to computer science and new information and communication technologies [34]. Living labs are recognized as a progressive form of promoting innovation and enhancing collaborative planning [35].

The main goal of living labs is to deliver innovation [36]. Living labs are the most common participatory design approaches that facilitate user engagement in the innovation development process and research in real-world settings [21,24,37]. This can be accomplished by inviting stakeholders to participate in an open innovation process and assigning them the roles of direct and indirect users [24,38]. The aspect of openness is built upon the full integration of internal and external ideas into the process of innovation development [39].

Living labs were initially perceived as research infrastructure, such as a building replicating a home with facilities to support the living of temporary residents [33].Over time, they were slowly acknowledged as a dynamic multi-stakeholder network that aims at accelerating and managing user-driven innovation in real-world settings [33]. Currently, LLs are perceived as both networks and as parts of networks. Regardless of their orientation within the network, they are always a temporal and spatial delimitation of reality [34]. These innovative spaces were created for the co-production of knowledge and experimental environments. These environments, whether physical or virtual, create social spaces for designing and experiencing the future of all their inhabitants [38]. Living labs are, therefore, geographically or institutionally bounded spaces where stakeholders conduct experimentation for socio-technical innovation [34]. Table 1 presents selected examples and their areas of application to illustrate the diversity of formats and objectives of Living Labs.

Table 1. Diversity of living lab formats and objectives: selected elements and areas of application.

Format ALL	Objective	Scope	Stakeholders Involved
Digital Platform [34]	Facilitate collaboration and knowledge exchange in a virtual environment	Digital Living Labs for e-services	Developers, end users, policymakers
Research Infrastructure [33]	Simulate real living conditions	Facility simulating residential buildings	Scientists, end users

Table 1. *Cont.*

Format ALL	Objective	Scope	Stakeholders Involved
Multi-Stakeholder Network [33]	Support collaboration and innovation; gain new knowledge and develop experimental environments	Urban Living Labs	Scientists, policymakers, citizens, private sector
Educational Model [40,41]	Build social awareness and introduce innovations in education	Educational Living Labs in schools	Teachers, lecturers, students, parents
Social Initiatives [42]	Strengthen local community engagement and support social development	Living Labs supporting inclusivity	NGOs, citizens, policymakers
Cultural Innovation Labs [43]	Develop innovations in the field of culture and art	Artistic Living Labs	Artists, citizens, creative sector
Healthcare Labs [44]	Develop technologies supporting health and well-being	Living Labs in hospitals and healthcare	Doctors, patients, scientists
Agroecological Experimental Labs [45]	Engage citizens; develop local, sustainable solutions	Agroecological Living Labs (ALL)	Farmers, citizens, local communities

Source: original work.

Living lab practices involve various types of users and stakeholders, including scientists, public decision-makers, private sector representatives, and citizens [24]. This configuration of stakeholders is described by the Quadruple Helix model. It highlights the growing importance of citizen involvement in innovation processes [33]. All stakeholders collaborate at a local level and accelerate the development and adoption of solutions at the operational level [45]. In this context, the living lab approach serves as a mechanism for institutional transformative change by integrating top-down and bottom-up strategies to promote sustainability [45].

The primary function of a Living Lab is to collaborate in creating, prototyping, validating, and testing innovations in a real-world setting— whether they involve technologies, services, products, or systems [46]. All resultant initiatives should adopt a vision aimed at addressing problematic situations through a co-creation process [34]. Co-creation assumes that new knowledge and insights are generated through collaborative methods by people from various disciplines working together to develop new ideas or concepts [38]. This process helps acquire new knowledge that cannot be codified yet, but paves the way for defining relevant projects [47]. It also reveals the exploratory aspect of LLs, where user-centered space integrates research with innovation processes [48], transforming users from merely observed subjects into active participants and co-creators of value [33]. In this way, LLs act as a bridge between open innovation and user innovation within the Quadruple Helix model, providing opportunities to implement 'socially acceptable' and effective 'stakeholder-driven' projects [47]. This approach helps reduce innovation costs [33] and shifts innovation processes away from cloistered laboratories and closer to society [49].

The user-centered approach found in the LL methodology places users in the role of carriers in the innovation process [24]. The goal of user engagement is not only to have users test innovations in the more advanced stages, but to involve them throughout the entire innovation development process [37]. In LLs, users are co-creators of emerging ideas and innovative concepts [38]. By applying facilitating methods, users can co-create and interact with an operational system, assess the potential and usefulness of the proposed solution, and transfer the experience to other areas [45]. The LL approach allows citizens to (re)build their relationships with the environment and identify what is important to all by introducing the concept of commons [34]. Living labs can support the local community's capacity to invent and experiment with more sustainable lifestyles by bringing attention to the shared commons of all stakeholders [33].

Cities need to provide food, shelter, water, and air to sustain life [50]. The global food security discussion remains focused on the idea that increasing rural production should ensure food security for the global population, even though just having food available does not guarantee security [50]. The resilience of the local food system is underlined as one of the most important strategic goals for a sustainable future [51]. Urban agriculture has great potential for addressing sustainability issues, reducing the negative effects of industrialized agriculture, and providing food for urban populations [50]. Agroecosystem LLs can accelerate the adoption of innovations focused on enhancing the sustainability and resilience of agriculture and agri-food systems [21].

2.2. Impacts of Agro Living Labs on Urban Systems

Agro living labs can be viewed as a specialized form of urban living labs, especially when considering their emphasis on sustainability, complexity, and a place-based context [52]. As McPhee et al. [21] note, the goals of ALLs place a distinct emphasis on innovation for the resilience of the agri-food system in addition to sustainability. This highlights the aim of creating a sustainable system in terms of ecology and economy that withstands disturbances while maintaining a systemic balance. Agro living lab activities emphasize co-creation, co-development, co-production, and iteration. However, they also underline the need for qualitative and quantitative measurements, evaluations, and scientific effort. The impacts of ALLs are relevant to the broader and local agroecosystems in which they function [21].

Urban ALLs can play a crucial role in building resilient urban food systems by providing dedicated space to test solutions tailored to the needs of urban communities. Agro living labs support the development of UA by integrating local stakeholders and fostering active community involvement. This, in turn, increases the availability of fresh food, reduces dependence on external supply chains, and strengthens food security. Furthermore, this approach promotes sustainable development and the regeneration of urban spaces. It also addresses the growing demand for local healthy food in cities, aligning with the goals of the European Farm-to-Fork strategy [51].

Resilience planning should be guided by the experiences of the vulnerable populations. It should include input from civil society organizations and incorporate practices that have proven effective in strengthening household and community resilience [53].

More than simply growing food in the city, UA is intertwined with the economic, social, ecological, and physical infrastructure components of the urban environment (Table 2) [54]. UA is also considered an effective approach to combat climate change by reducing greenhouse gas emissions through shorter food supply chains and minimizing losses in food quantity and quality due to long-distance transportation [5]. The most effective way to enhance food self-sufficiency in urban and peri-urban areas while supporting social and environmental goals involves simultaneously addressing multiple aspects, such as promoting plant-based, healthier diets, reducing food waste, and encouraging organic farming [55].

Urban and peri-urban agriculture offer numerous benefits, primarily improving the city's ecological environment by increasing organic matter content, creating jobs, promoting sustainability and socialization, and reducing production costs [56]. For example, urban gardens are part of a trend that addresses the social need to build sustainable resilience to environmental challenges in cities. They contribute to counteracting individual biopsychosocial issues, which are largely caused by disconnection from nature [23]. Urban horticulture significantly enriches the cultural fabric of cities worldwide by encouraging social interactions, educating communities about the environment, preserving cultural heritage, creating green spaces, improving well-being, and fostering environmental awareness [57].

Table 2. Key benefits of agro living labs (ALL) for urban areas.

Environmental and Health	Economic	Social
- biodiversity and climate protection; - regenerating urban areas and increasing green spaces; - recycling of urban biodegradable waste; - improving individual and public well-being.	- local fresh food trade and food processing; - reducing production costs through localization and shorter supply chains; - ensuring food security; - employment and income generation (innovative projects); - promoting local economies through the sale of local products.	- strengthening local community engagement through stakeholder, - supporting vulnerable groups through active involvement and resilience planning; - building social ties and promoting social integration; - creating spaces for ecological and social education; - cultivation of local tradition.

Source: original work.

Finally, UA contributes to the regeneration and restoration of urban spaces [58]. The agroecological approach questions many assumptions tied to the innovation-driven mindset, such as the dominance of agribusiness, reliance on abstract indicators, prioritization of technology as the main form of innovation, and the portrayal of food producers as mere consumers or end users [59]. It advocates a radical shift by placing the collective role, voice, agency, and autonomy of food producers and their communities at the heart of decision-making in food system governance, a perspective often overlooked by the innovation imperative [59].

2.3. Factors of Community Activity and Engagement in Agro Living Lab Projects

According to McPhee et al. [21], agroecosystem living labs are characterized by three general components: (1) transdisciplinary approaches, (2) co-design and co-development with participants, and (3) monitoring, evaluation, and research on working landscapes.

Agro living labs provide frameworks that enable researchers and practitioners to explore and address specific challenges and opportunities, enhancing their effectiveness in developing sustainable and resilient agricultural and agri-food systems [21]. Today, the discourse on transforming food systems into healthier and more sustainable ones often portrays citizens as engaged individuals who act thoughtfully based on shared beliefs and an understanding of food consumption and culture [14]. As noted by Gamache et al. [34], living labs can empower local communities to innovate and experiment with more sustainable lifestyles.

Living labs introduce various roles, including activators (triggering innovation), browsers (searching for innovative solutions), creators (coming up with ideas), developers (implementing ideas), and facilitators (enabling stakeholder collaboration) [33]. User engagement in the living lab context during the early stages of innovation is a complex process influenced by various factors, including the innovation itself, the context of engagement, and the voluntary nature of participation [37].

Living labs use a mix of methods to understand what people do in their daily lives regarding food, health, and sustainability, acknowledging various practices and viewpoints of real-life situations [14]. Therefore, understanding residents' needs, effective communication channels, and methods to reach them are essential for planning sustainable urban development measures [23]. According to the Living Labs (LL) approach rooted in the Quadruple Helix model, urban society plays a key role as a central element in innovation processes. This model involves the collaboration of four sectors: academia, business, public administration, and society, with an emphasis on the needs and engagement of residents. The approach is based on the assumption that actions undertaken by academia, business, and public administration should be directed toward societal needs while also being inspired by its input [60].

The factors of community engagement in ALL projects vary and concern multiple domains (Figure 1). External factors, such as public policies and subsidies, combined with access to technology and public infrastructure, may increase the likelihood of initiating and growing ALL projects [36,61]. In addition, the regional development level (economic stability) and the social and ethical framework that shape attitudes among inhabitants significantly influence their participation in ALL projects [62]. These factors are critical for cross-border comparisons where external conditions may meaningfully drive community engagement in ALL projects. Acceptance and willingness to participate in UA projects vary significantly between countries with different levels of socioeconomic development, such as those in the Global North and South, where urban agriculture serves different functions [63].

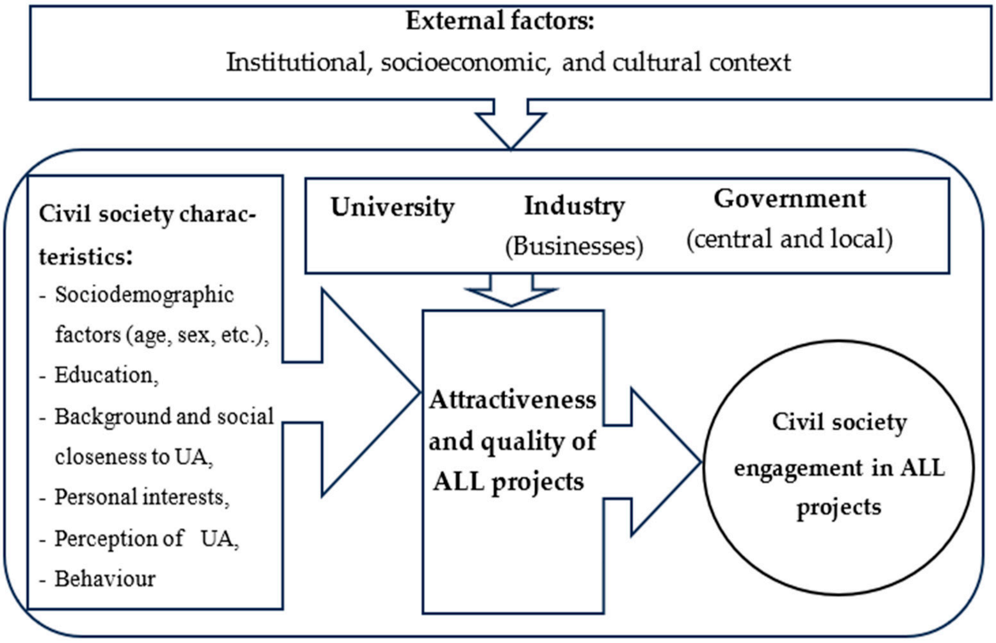

Figure 1. Key factors influencing civil society engagement in ALL projects; Source: original work.

Research to date shows that projects considered interesting and responsive to the community's actual needs attract more participants [64]. The transparency of goals and a clear understanding of the benefits of participation significantly enhance residents' motivation for active involvement [20].

Previous experience indicates that the conceptualization and implementation of ALL projects is quite challenging, partly due to the fact that the key fourth helix, i.e., civil society, is a highly heterogeneous group of actors [65]. The success of many projects depends on the appropriate selection of the participants. Therefore, many studies on citizen engagement in civic projects have concluded that the individual characteristics of users are pivotal for participation. These include specific sociodemographic characteristics, such as age, sex, income [57,66,67], type, and level of education [62,68]. Societal and physical closeness, translating into the strength of connections with potential ALL users, is another critical factor [69,70]. Perceptions and perspectives, including acceptance of civic projects, are also crucial [11,67,70,71]. In relation to UA projects, several scholars have also analyzed the impact of potentially adverse external effects or even risks (e.g., potential health risks related to food contamination with heavy metals and other harmful substances) on the acceptance of such projects [72].

Recent research shows that projects that are interesting and address the actual needs of the community attract a large number of participants [64]. In the presented (original) model, the attractiveness and quality of the projects play an intermediary role in fostering engagement. Individual actors, such as universities, businesses, and governments, should effectively promote residents' participation by providing clear project goals and explicitly highlighting the benefits of involvement. Such communication significantly enhances a community's motivation for active participation [20].

As a final insight, it is worth noting that the literature does not provide unambiguous evidence regarding the key factors shaping community engagement in ALL projects. While studies on various civic projects rarely focus specifically on ALL, many scholars addressing the acceptance of UA emphasize the significance of individual characteristics. Factors such as sociodemographic traits, degree of social closeness, educational background, personal interests, and perception, including the acceptance of urban agri-food systems, can play a crucial role in fostering community engagement in ALL projects.

Some researchers have delved more deeply into the personal and psychological characteristics of individuals that influence their engagement with ALL projects. Among these approaches, negative bias theory stands out, highlighting that negative experiences often have a stronger influence on decision-making than positive ones [73]. Another relevant concept is the NIMBY (Not In My Back Yard) attitude, which describes opposition to initiatives implemented in one's immediate surroundings. These theories suggest that new and unfamiliar projects, even when offering public goods, may face social resistance due to perceived risks and barriers [72]. Considering these psychological aspects can provide deeper insights into the mechanisms driving community engagement in ALL projects.

3. Materials and Methods

3.1. Data Collection

The study period was May to November 2024. During this time, the authors analyzed the literature and conducted a survey. Secondary data were collected from publications, reports, and articles on UA and the concept of LLs, while primary data were obtained through the survey. The respondents were students of public universities in Kraków (Poland). As young, well-educated, and active individuals, students are potentially interested in the future of urban systems and participation in ALLs [14].

The survey questionnaire consisted of four parts: (a) food security, (b) urban and peri-urban agri-food systems, (c) agro living labs, and (d) socioeconomic profiles of the respondents. Most of the 43 questions were semi-closed. Opinions, attitudes, and beliefs were primarily measured using a five-point Likert scale. Two control questions were included to verify whether respondents were paying attention during the survey.

The survey was conducted through computer-assisted web interviews (CAWIs). The questionnaire was developed using Google Forms (Mountain View, CA, USA) and distributed via e-mail and social media platforms (Facebook and WhatsApp). The main survey followed a pilot CAWI survey with 37 respondents. The questionnaire was verified and approved by the Rector's Research Ethics Committee for Human Research of the University of Agriculture in Kraków. The introductory section of the questionnaire explained the general idea and purpose of the survey and assured the participants that all data would be used solely for research purposes. Prospective participants were granted access to the questionnaire only after providing their consent to participate. They were informed of their right to withdraw from the study at any time. The survey did not collect any personal data, such as e-mail addresses or other identifying information.

The respondents were invited through stratified snowball sampling. The first selection criterion was that the respondent had to be a student in Kraków. The sampling process was guided to reflect the student population in Kraków in various scientific fields. A team of four researchers sent e-mails containing links to the questionnaire, inviting groups of at least 20 students from five academic fields: social sciences, medical and health sciences, humanities, engineering and technical sciences, and natural and agricultural sciences. The respondents were asked to share the survey (via e-mail, Facebook, or WhatsApp) with five additional students in Kraków, following the snowball approach. According to Baltar and Brunet [74], snowball sampling is a simple and cost-effective method that reduces sampling error and provides a representative sample.

The minimum sample size was determined using the following formula:

$$\mathrm{n} = 1 + \left(\frac{Z^2 \times p(1-p)}{e^2\, N} \right)$$

where $Z = 1.96$ is a standard constant determined by the convention based on the accepted level of error, e represents the margin of error, N is the total population of students, and n refers to the sample size. The selected sample was adequate to achieve a 95% confidence level and a 5% margin of error, assuming $p = 0.05$. The resultant minimum sample size is 383.

The first stage of the survey yielded 518 responses. The procedure was then repeated, targeting only selected groups of students (medical sciences and humanities) to represent the student population structure in Kraków better. This resulted in a response count of 668. After reviewing the responses, 89 questionnaires were excluded due to suspected inaccuracies, as indicated by the control questions designed to identify inattentive respondents. The final sample was representative of the general student population in Kraków in terms of the fields of study.

Although the study sample is sufficiently large and demonstrates similar proportions in certain characteristics, such as gender, education level, and social background, chi-square tests revealed no statistically significant similarity between the sample structure and the general population structure of students in Kraków. Therefore, it should be emphasized that while the study provides valuable insights into students' readiness to engage in ALL projects, its interpretation should be limited to the specific characteristics of the studied group.

3.2. Study Area

Kraków is located in southern Poland. According to Statistics Poland, the city's population is 806.2 thousand, making it the second most populous city in Poland after Warsaw, with a population density of 2467 people per square kilometer. The 2020 agricultural census revealed that approximately 42% of Kraków's area comprises agricultural land. There are 1528 agricultural holdings in the city, 84% of which are smaller than five hectares. Agriculture in the city is increasingly being displaced by other functions, such as housing, despite the high agricultural suitability of the land, including very good soil quality. Neither agricultural landowners nor the city administration consider local agriculture an important part of the urban agri-food system [75]. Sroka et al. [76] identified approximately 50% of agricultural land as abandoned and not used for agricultural purposes. Furthermore, city authorities have not incorporated agricultural land protection mechanisms into the new or amended local zoning plans. Kraków's development strategy also lacks objectives for promoting or even preserving urban agriculture [76].

Apparently, the attitudes of agricultural producers and the efforts of city decision-makers fail to align with the needs of residents who declare their readiness to support UA. Sroka et al. [76] demonstrated in their study on UA acceptance, conducted on a relatively small sample, that over three-fourths of the residents were interested in purchasing agricultural products sourced from within the city limits and believed agriculture should be a permanent part of the urbanscape. Grassroot initiatives to establish allotment gardens and similar projects aimed at enhancing food security are on the rise, with partial support from the city [77,78].

Considering the above data, Kraków is a very interesting research area and may be well suited as a hub for ALL initiatives. It is also a thriving student city with 18 universities, including Jagiellonian University, which is one of the oldest in Europe. According to POL-on [79], the student population in Kraków exceeded 128 thousand in 2022. Therefore, students represent a substantial part of a city's population and form a significant group of stakeholders, both as clients and co-creators of the urban agri-food system.

3.3. Research Methods and Conceptual Framework

A variety of statistical methods were applied to analyze the residents' readiness to engage in agro living labs (Figure 2). First, the authors described the basic respondent profile and conceptualized the distribution of the variables using descriptive statistics like the arithmetic mean and standard deviation. The next analytical step was to assess the reliability and dimensionality of the responses using Cronbach's alpha [80]. Sampling adequacy was tested using the Kaiser-Meyer-Olkin test (KMO = 0.834), and its high value suggested a high potential for exploratory factor analysis (EFA). EFA was used to identify latent structures within the investigated variables and reduce the number of variables. The number of factors was determined using the Cattell scree test [81]. The authors determined the items in the intercorrelated cluster of factors through varimax rotation of the raw factor loadings.

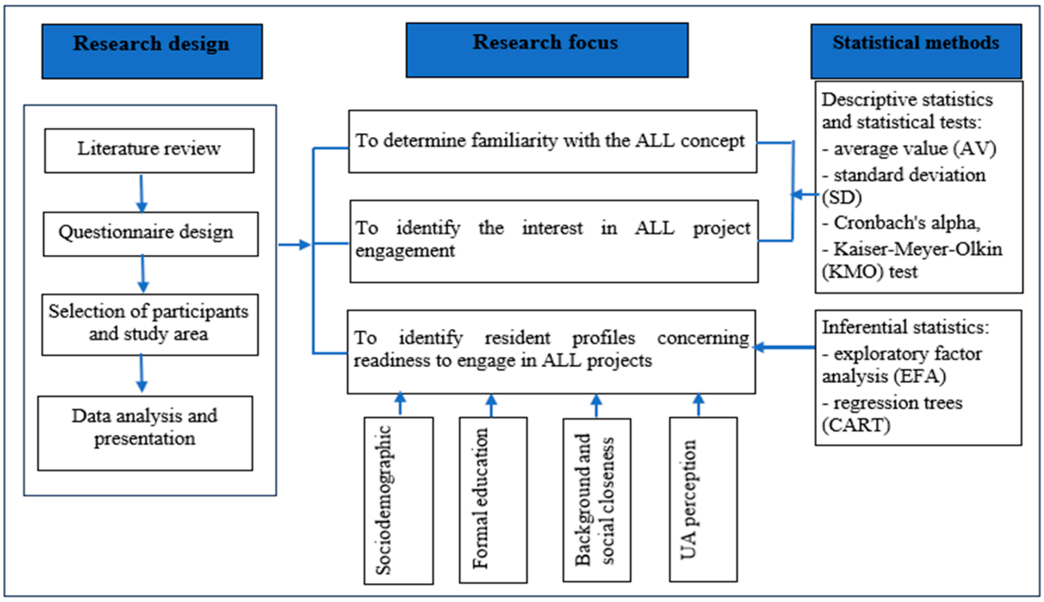

Figure 2. Conceptual framework. Source: original work.

The critical characteristics of the residents (sociodemographics, formal education, social closeness, etc.) related to their inclination to participate in ALL projects were identified using classification and regression trees, an exploratory and non-parametric data analysis method [82]. Such models are particularly useful in the analysis of new research areas in which established theories and models are lacking. They enable the identification of key variables and the formulation of preliminary hypotheses, which help outline directions for further research. This approach is especially important for analyzing phenomena that are just beginning to be explored and do not yet have clearly defined theoretical frameworks [83]. As opposed to traditional regression models, regression tree models are better suited for handling categorical and qualitative data, eliminating the need for conversion. They also impose fewer requirements on the distribution of predictor and target variables [83]. Moreover, this method can clearly and unambiguously present complex relationships between variables [84], including the combined effects of multiple factors.

The idea behind regression trees is to split the data using a series of 'if-then' conditions. These models employ an algorithm to minimize variance and iteratively split data into increasingly homogeneous subsets based on the predictor variable splitting criteria [85]. The present analysis identified two groups of respondents at each step of the tree to maximize the differences in their declared readiness to participate in ALL projects.

The CART model provides an important output: the predictor importance score. This score determines the extent to which each variable contributes to explaining the variability of the target variable. It is calculated based on the measure of improvement from each variable, either as a primary or surrogate splitter in the decision tree [86]. This approach helps to identify the variables that have the greatest impact on the model and how they contribute to data splitting.

The tool was described in detail by Loh and Zheng [87], Ives and Kendal [88], and Dębska and Guzowska-Świder [89]. Calculations were performed using STATISTICA 13 software (StatSoft, Tulsa, OK, USA).

4. Readiness of Students to Engage in Agro Living Labs: A Survey in Kraków

4.1. Respondent Profile

This section presents the key characteristics of the sample, which are partially compared to the general population where relevant data are available. The respondents' characteristics and opinions form a set of potential factors (predictors) influencing the readiness to engage in ALL projects, as identified in the literature review (Section 2.3) and are presented in Appendix A. The sample of young residents of Kraków adequately represents the basic characteristics of the general population. As assumed, the groups varied in terms of the field of study (Figure 3).

Approximately 42% of the sample were enrolled in social science courses, closely mirroring the general population (41.4%). Engineering and technical sciences, as well as natural and agricultural sciences, were also well represented in the sample (11.7% and 9.5%, respectively). Most students were pursuing a bachelor's degree at the time of the survey (67.7%). The sample accurately reflected the sex distribution and background of the student population, with 43.7% coming from rural areas.

The majority of respondents were aged 19–20 years (35.4%), while only 6.2% reported being older than 24 years (Figure 4).

These characteristics adequately reflect the age structure of the student population in Kraków and in Poland, where approximately 93% of students are aged 19–29 [79]. Most of the students in the sample did not work full-time, particularly those pursuing first-cycle studies. Over 40% reported having a part-time job, and about 4.5% were business owners. Their financial standing was relatively good (nearly 50% of the answers) and 23.5% declared a very good situation.

The respondents were asked about their participation in training and courses related to agricultural or horticultural sciences to assess the impact of formal education on their engagement in ALL projects. Nearly three-quarters had never received formal education in this area (school or university). About 10% of the students reported attending many such courses, which is consistent with the distribution of students among disciplines (9.5% study natural or agricultural sciences). Nearly 17% of the respondents had participated in several training courses.

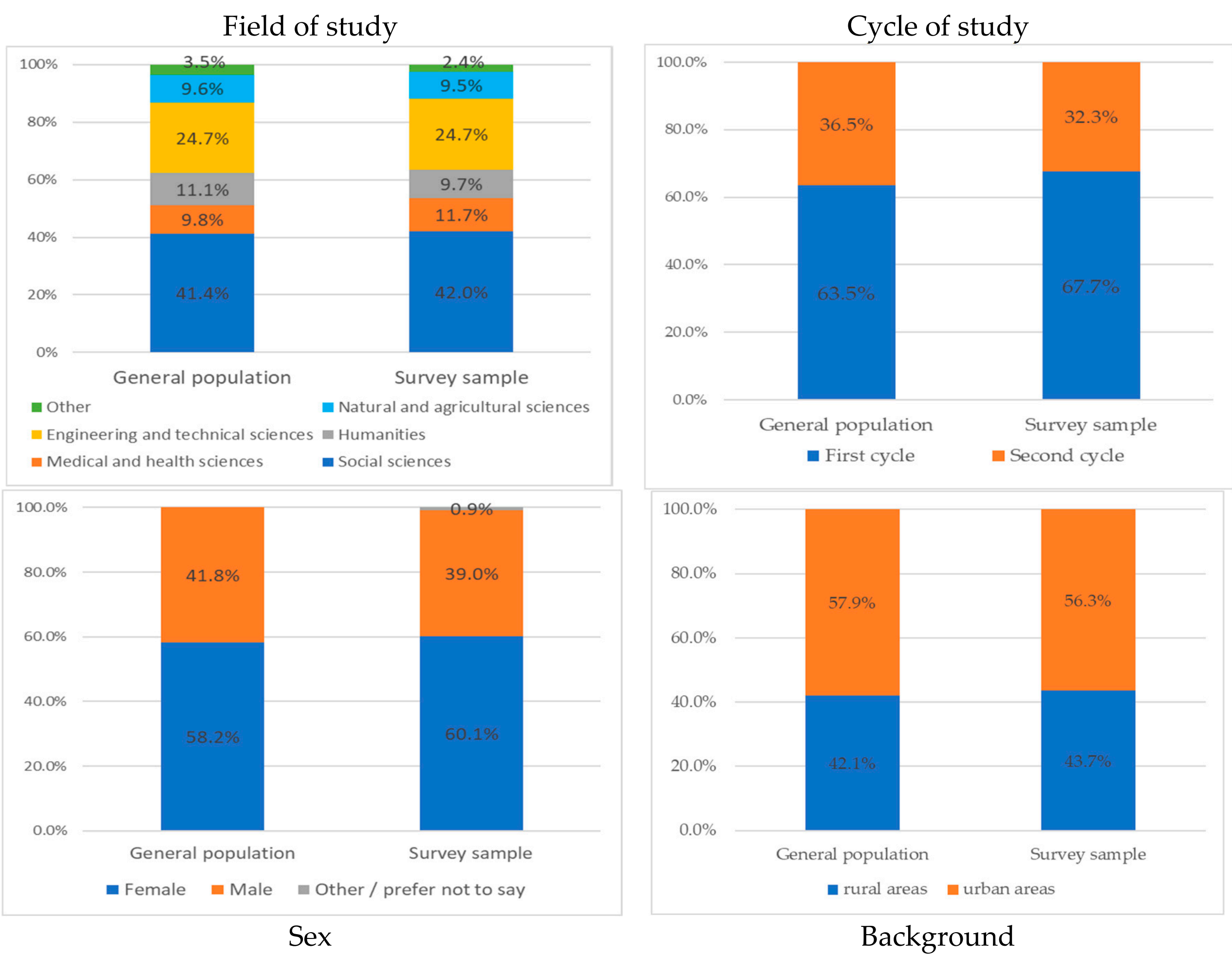

Figure 3. Selected characteristics of the respondents compared to the general population (n = 579). Original work based on the survey and POL-on data [79].

The students came mainly from cities, including 14.3% from Kraków and 25.9% from other cities (Figure 5). About 43.7% declared that they had grown up in rural areas. However, over 90% of the respondents stated that they lived in Kraków during their study period, while the remainder commuted. The respondents' background structure is evidently associated with their familiarity with agricultural production and reflects their relationships with agricultural producers. More than half of the respondents knew farmers, with 10.2% indicating that they knew more than one. Furthermore, the sample demonstrated relatively strong bonds and relationships with agriculture and horticulture.

About 20% of the respondents grew up on a farm, and families of another 9.8% had a kitchen garden or allotment garden. In total, nearly 64% of the respondents reported personal engagement in agricultural or horticultural production. Some of them worked on their own or their families' holdings (10.5%) or used kitchens or allotment gardens. Some respondents had no real ties with agriculture. About 37% reported being unfamiliar with agriculture. Additionally, over 26% of the respondents indicated that they did not know any farmers and were not involved in farm-gate marketing or food production.

Some questions focused on the respondents' knowledge and perceptions of UA. Only 2.4% reported being able to define UA, and 19% believed that they were familiar with the concept in general (Figure 6). Nearly 44.4% had never encountered the term before. Furthermore, the survey revealed that a large group of respondents had no specific associations or opinions on agricultural production in cities.

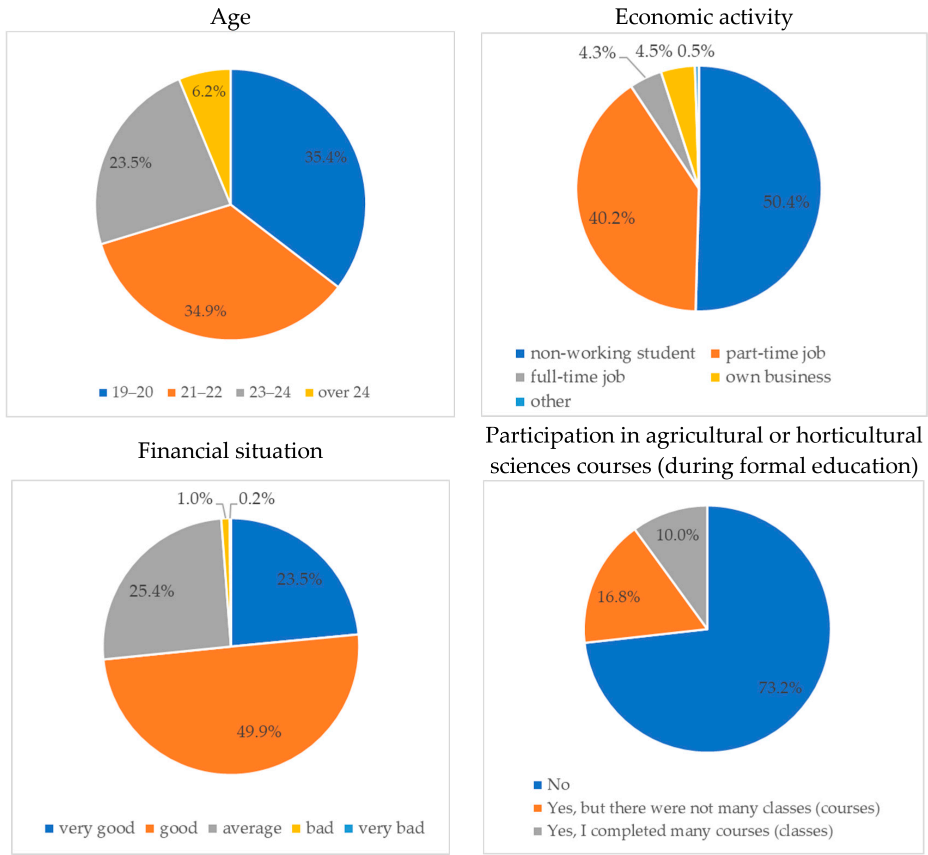

Figure 4. Sociodemographic characteristics and formal education of the respondents (n = 579). Source: original work.

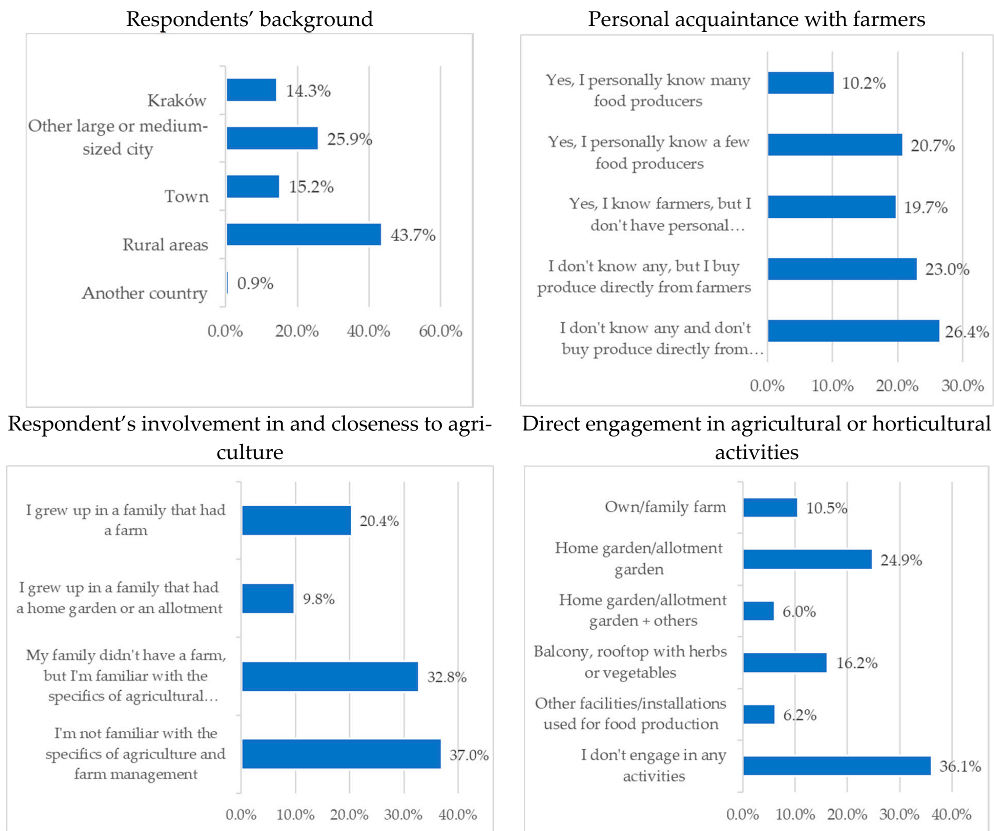

Figure 5. Background and social closeness (n = 579). Source: original work.

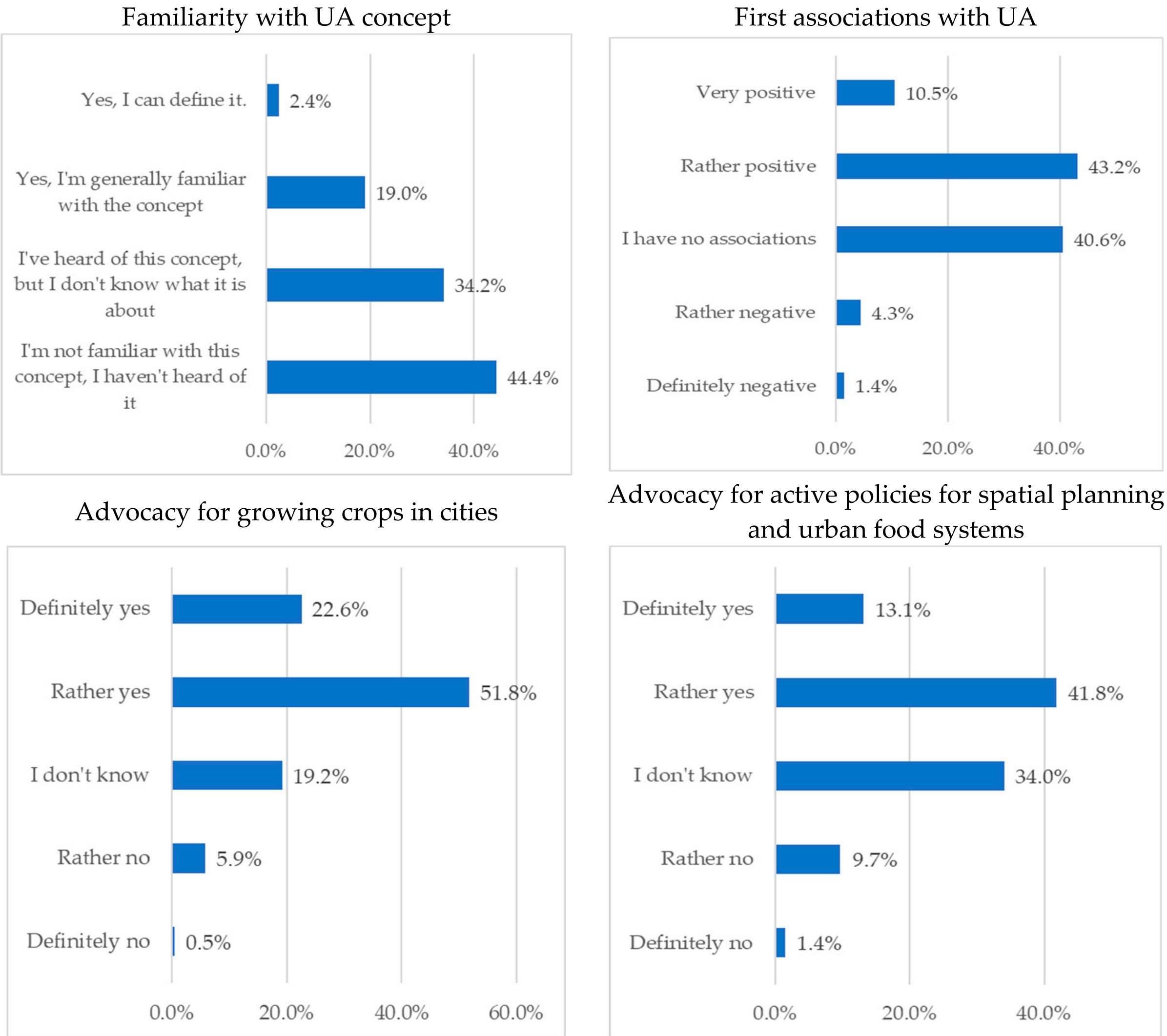

Figure 6. Perceptions of urban agriculture (n = 579). Source: original work.

Despite the relatively low level of familiarity with the concept of urban agriculture, over 70% of the respondents expressed support for farming in cities and nearly 55% supported active policies for spatial planning and fostering urban food systems. Only a small group of students opposed the initiatives for UA.

4.2. Familiarity with and Readiness to Engage in ALL Projects

Although increasingly popular in many European countries, particularly in Scandinavia and Western Europe, ALL remains largely unrecognized and underappreciated in Poland [23]. The present study supports this conclusion, as 77% of the respondents were completely unfamiliar with the notion of ALL (Figure 7). Half of them encountered the term for the first time during the survey. Only three respondents were able to characterize ALL, and each had participated in such projects. A small percentage of the sample (7.4%) reported a general knowledge of ALL. Furthermore, only 5.7% of respondents could name an ALL project. One respondent mentioned that their university had organized a scientific conference on ALL, which motivated them to engage. Overall, general awareness of the LL concept remains very low despite the projects being carried out in Poland.

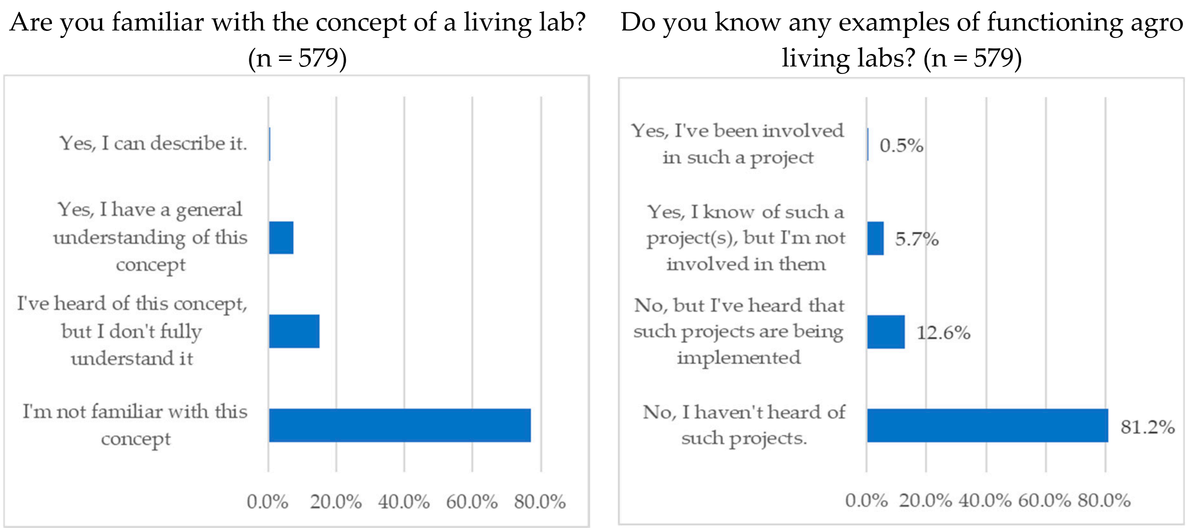

Figure 7. Familiarity with the LL concept. Source: original work.

After answering questions about their knowledge of the LL concept, the respondents were provided with a definition and a brief description of ALL (a control question was included to verify their level of attention). Next, the respondents were asked whether they would like to engage in an ALL project as a 'tester,' consumer, or innovator in eleven different ALL projects (Figure 8).

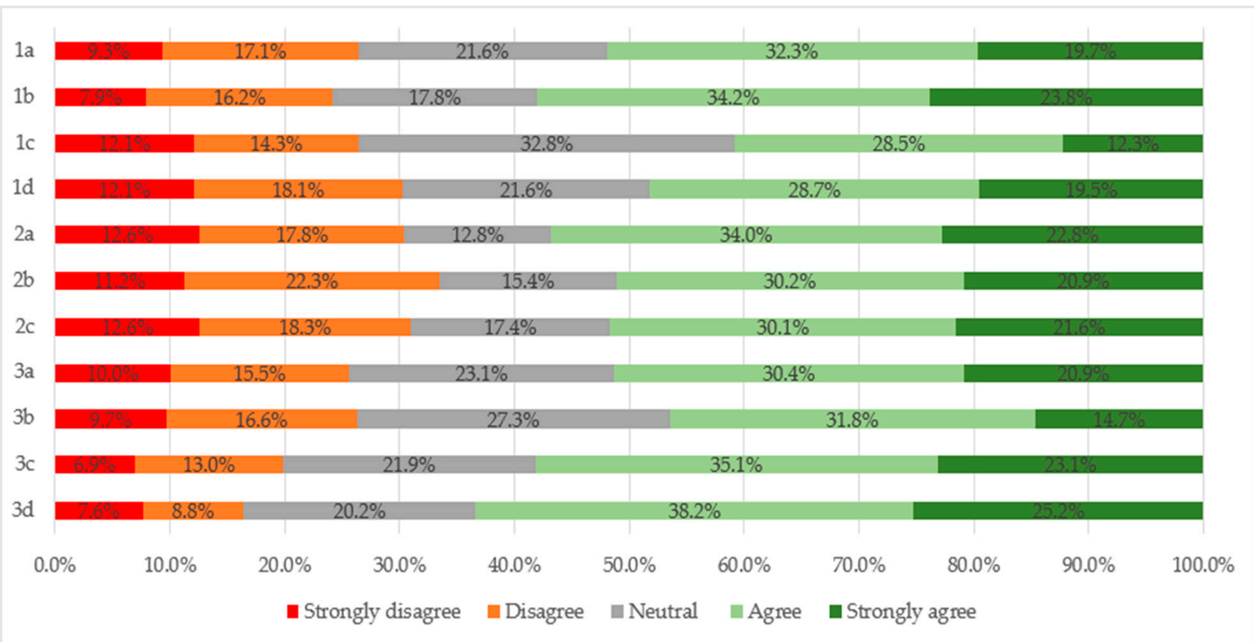

Figure 8. Declared readiness to engage in various ALL projects (%). Source: original work. Labels 1a–3d are explained in Table 3 and presented in Appendix A.

Table 3. Descriptive statistics, EFA factor loadings, and Cronbach's alpha for the items of readiness to engage in ALL projects (n = 579).

Types of ALL Projects:	Basic Statistical Metrics		Cronbach's Alpha If the Item Is Excluded (Cronbach's Alpha: 0.864310)	EFA Factor Loadings *		
	Average Value (AV)	Standard Deviation (SD)		F1	F2	F3
1a. Restoration of regional traditions and (agrarian) culture (i.e., education and creation of digital heritage)	3.36	1.24	0.850108	0.859		
1b. Development of recreational/tourist services as part of UA (play areas, recreation for children and families, etc.)	3.50	1.24	0.851110	0.871		
1c. Promotion of active life among socially excluded people with UA (workshops, social urban farming)	3.15	1.18	0.850046	0.865		
1d. Services for people with disabilities (social farming, horticultural therapy, hippotherapy, etc.)	3.25	1.29	0.846555	0.805		
2a. Creation of new food products (experiments with new flavors, e.g., jams with original additions, liquors, wines, etc.)	3.37	1.34	0.864305		0.878	
2b. Creation of new non-food products (such as creams, balms, oils, and other natural products)	3.27	1.32	0.862052		0.912	
2c. Creation of healthy products (rich in fiber, vitamins, minimally processed foods, etc.)	3.30	1.33	0.857519		0.855	
3a. Innovative urban agriculture projects (farming in/on buildings, etc.)	3.37	1.25	0.852155			0.790
3b. Smart farming projects with new technologies in UA (digital agriculture, hi-tech agriculture, etc.)	3.26	1.18	0.851847			0.847
3c. Smart city projects: climate protection (improving urban green cover, curbing the urban heat island effect, etc.)	3.55	1.18	0.847500			0.888
3d. Smart city projects: environmental protection (protection of water, promotion of biodiversity, etc.)	3.65	1.17	0.845886			0.851
Eigenvalues				3.105	2.423	3.059
% of variance (78.0%)				28.2	22.0	27.8

Note: The average values for the questions on the five-point scale were calculated after assigning numerical values to the answers, ranging from 5 ('strongly agree') to 4 ('agree') and 3 ('neutral') to 2 ('disagree') and 1 ('strongly disagree'). * EFA = Explanatory Factor Analysis. Varimax rotation was applied. Source: original work.

On average, slightly over 10% of the respondents declined the offer, but over 20% were very interested in actively participating in the projects. However, their interests varied across projects. The respondents declared the greatest readiness to engage in smart city projects. These urban initiatives employ new technologies to improve the efficiency of urban governance, quality of life, and sustainable development. In this particular case, the projects concerned climate protection, mitigating the urban heat island effect (3a), protecting water resources, and promoting biodiversity (3c). Both projects won 60% of the 'strongly agree' or 'agree' answers. Another relatively popular group included projects concerning the development of new food products and experimenting with new flavors (nearly 57% of affirmative answers overall). Projects involving promoting active lifestyles among socially excluded individuals (1c) and providing services to people with disabilities, such as horticultural therapy or hippotherapy, were chosen much less frequently (1d). Note that a relatively small group declared neutral attitudes, which may indicate significant awareness and serious consideration of the answers on their part.

The mean values of the quantified Likert scale for all variables were over 3.0, indicating that most respondents declared a readiness to engage in ALL projects (Table 3). The reliability and validity of the responses were evaluated as required by the research methodology and conceptual framework. Both EFA and Cronbach's alpha confirmed the reliability and validity of the answers. The KMO value was 0.834, confirming the feasibility of EFA. Cronbach's α was 0.864 and did not increase after individual items were excluded, demonstrating high reliability [80]. EFA was employed to identify covert structures in the data and to reduce the number of variables. Using an EFA with varimax rotation, the analysis revealed a three-factor solution that accounted for 78% of the variance in the data.

The first factor can be labeled Social Inclusion and Cultural Heritage (SI and CH) because high loadings reflect respondents' readiness to engage in projects concerning the restoration of regional traditions and agrarian culture (1a), promoting an active life among excluded people (1c) and people with disabilities (1d), and developing recreational services as part of UA (1b). The second factor, Innovative Agri-Product Solutions (IAPS), can be perceived as a common plane for innovative activity focused on the creation and development of new food products (2a), non-food products (2b), and health products (2c). High factor loadings for these variables indicate a strong correlation with the factor, suggesting that they all concern a shared dimension of innovation in agriculture.

Factor No. 3, Smart Solutions for Urban Agriculture and Environmental Protection (SSUA and EP), encompasses a range of innovative, technology-driven initiatives that integrate smart solutions in both urban and agricultural contexts. The variable innovative urban farming projects (3a) highlight new methods of growing crops in urban environments, such as rooftop and vertical farming, which address the challenges related to space limitations and sustainability in cities. Smart farming projects (3b) refer to the use of digital and high-tech solutions in agriculture, including precision farming and automation, aimed at enhancing efficiency and reducing resource consumption. Additionally, smart city projects focused on climate protection (3c) tackle urban environmental issues, such as heat islands, while smart city projects for environmental protection (3d) concentrate on conserving water resources and biodiversity. Overall, this factor underscores the integration of smart technologies in fostering sustainable practices, and illustrates how advancements in farming and urban planning can collaboratively promote environmental stewardship and efficiency in modern ecosystems.

The factor analysis identified three key factors that together explain 78% of the variance in the data. These factors adequately reflect the potential engagement of the respondents in various ALL project groups. The reduced number of variables simplified further analyses. This enabled the authors to investigate in more detail the respondent characteristics that affected their potential engagement in various groups of ALL projects.

4.3. Factors Determining Readiness to Engage in ALL Projects

The impact of various factors on readiness to engage in ALL projects is presented using three classification and regression trees. The target variables in the models are composite variables identified through factor analysis: (1) Social Inclusion and Cultural Heritage (SI and CH), (2) Innovative Agri-Product Solutions (IAPS), and (3) Smart Solutions for Urban Agriculture and Environmental Protection (SSUA and EP). The literature review identified four groups of variables that may affect readiness to engage in ALL projects: sociodemographic characteristics, formal education, background, and social closeness to, and perception of UA (Figures 2–7). The analyses revealed respondent characteristics that differentiated them in terms of readiness to engage in ALL projects.

4.3.1. Factors Influencing Engagement in ALL Projects: Social Inclusion and Cultural Heritage (SI and CH)

Figure 9 shows a regression tree with the SI and CH factors. As the average value of the factor scores was zero and the standard deviation was close to one, the mean value of SI and CH was 0 (Node ID = 1). Values of the variable higher than 0 represent an above-average readiness to engage in Social Inclusion and Cultural Heritage (SI and CH) projects. The variable that differentiated SI and CH the most was the field of study. Students of the natural, agricultural, and medical sciences and humanities (Node ID = 3) declared readiness to engage in ALL projects ($p < 0.05$) more often (AV = 0.43) than the other respondents (Node ID = 2). Further splits on the right-hand side of the tree demonstrated that humanities students were particularly eager to engage (Node ID = 13; AV = 0.65).

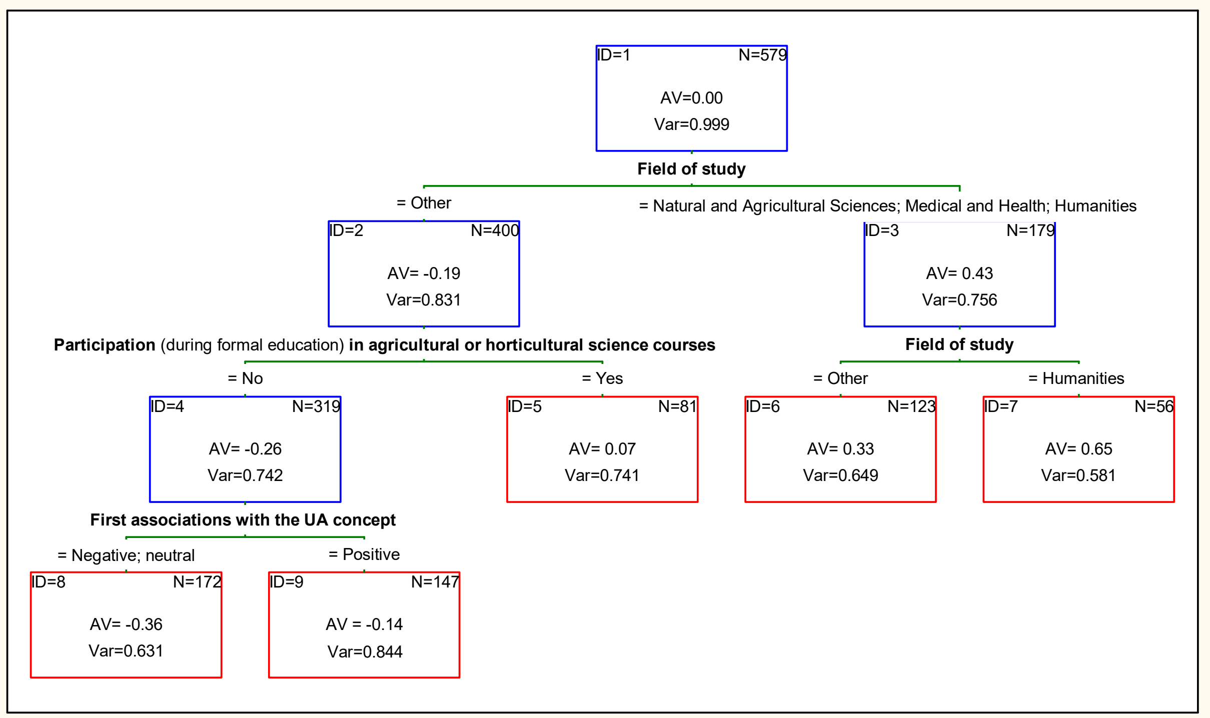

Figure 9. Regression tree diagram (CART) illustrating factors influencing engagement in social inclusion and cultural heritage (SI and CH) ALL projects. Source: original work.

Students in fields other than natural, medical, and humanities (Node ID = 2) declared lower levels of readiness to participate in ALL projects in Social Inclusion and Cultural Heritage. However, those who attended agricultural or horticultural courses as part of their formal education exhibited significantly higher readiness to engage (Node ID = 5; AV = 0.07). The formal education variable also demonstrated a significant impact on readiness to engage in ALL projects. In addition, the regression tree model revealed that students who had positive associations with UA (Node ID = 9) were statistically significantly ($p < 0.05$) more inclined to engage in ALL projects.

The regression model can also build a profile of people who are not interested in ALL projects. These include students of social and technical sciences who have never attended agricultural or horticultural courses and lack positive associations with UA (Node ID = 8, AV = –0.36). Tree splits represent only one of the variants (optimal from the perspective of model quality and complexity); however, many other divisions are possible. Other configurations of variables could yield similar conclusions. Figure 10 shows a list of alternative variables. The software employed in the analysis can generate a standardized (1–100 points) ranking list of predictor importance. High values indicate a significant impact on the target variables.

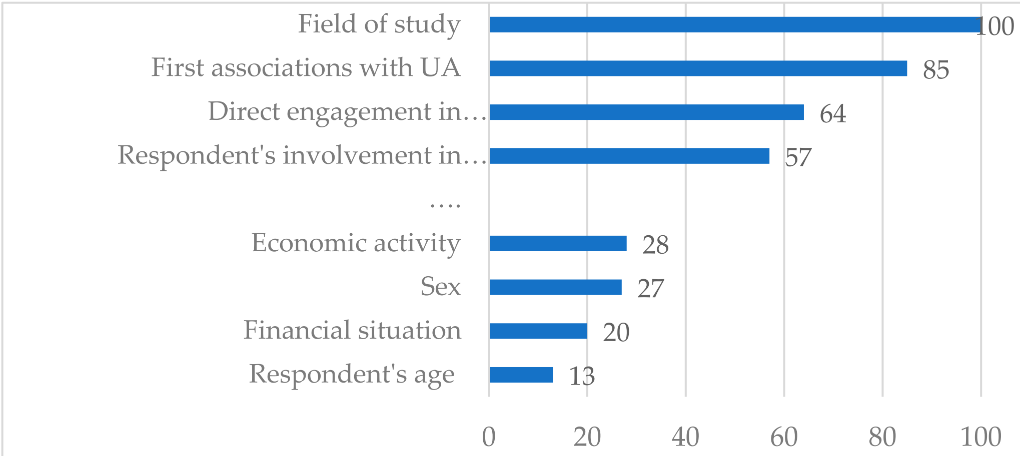

Figure 10. Importance of predictors in determining engagement in social inclusion and cultural heritage ALL projects. Source: original work.

Tree 1 clearly shows that the field of study, perception of UA, and variables linked to the respondent's associations with agriculture most significantly influence readiness to engage in ALL projects. Different configurations of the variables yield similar results. Age, financial standing, and sex have only a slight impact on differentiating readiness to engage in ALL projects.

4.3.2. Factors Influencing Engagement in ALL Projects: Innovative Agri-Product Solutions (IAPS)

The next regression tree model (Figure 11) shows the factors influencing respondent engagement in projects focusing on innovative food products, including health (functional) foods and natural non-food products from the UA (creams, oils, etc.). The tree splits indicate that people who personally know farmers (Node ID = 3) significantly more often declare readiness to engage in such projects. This is true for more than half of the respondents. The significant differences between the mean values of the IAPS composite variable at Node ID = 2 and Node ID = 3 demonstrate a significant predictive power of the variable.

Further splits demonstrate that respondents who personally know farmers and study natural, agricultural, or medical sciences (Node ID = 7; AV = 0.81) are particularly interested in IAPS projects. Thirty percent of this group declared a strong readiness to engage in all IAPS projects. Another driver of ALL project engagement is participation in agricultural and horticultural classes and courses. Students of non-agricultural disciplines who have participated in agricultural or horticultural courses (Node ID = 9) demonstrate a significant interest (AV = 0.65) in engaging in ALL projects.

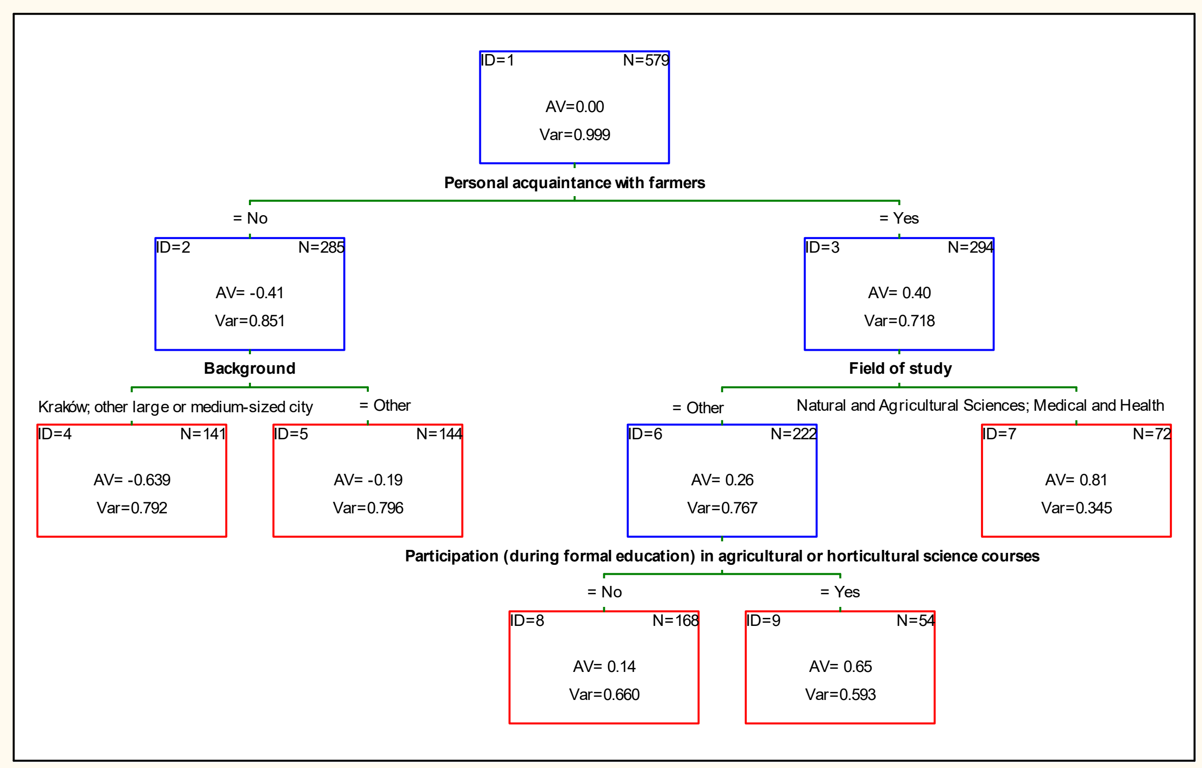

Figure 11. Regression tree diagram (CART) illustrating factors influencing engagement in Innovative Agri-Product Solutions ALL projects. Source: original work.

The left-hand side of the regression tree shows the profile of people skeptical about engaging in IAPS projects (a negative value of the target variable). These individuals usually do not personally know any farmers and come from Kraków or other cities. Respondents from rural areas who do not know farmers and have no relationship with them are somewhat less unconvinced about their engagement in ALL projects.

The predictor importance ranking list (Figure 12) shows that readiness to engage in projects where innovative food and non-food products are developed depends mostly on characteristics defined as background and social closeness. The field of study and participation in agricultural and horticultural classes are also relatively important.

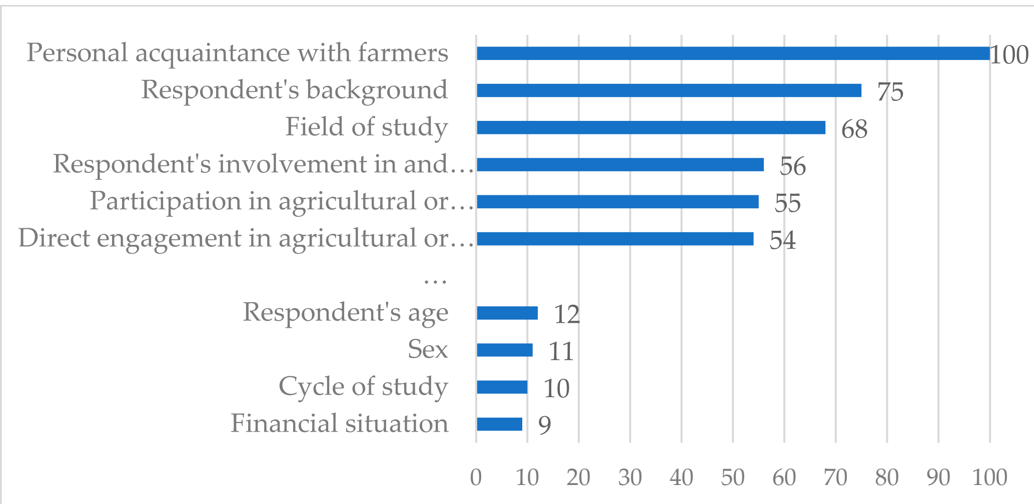

Figure 12. Importance of predictors for determining engagement in ALL projects focused on Innovative Agri-Product Solutions. Source: original work.

The study shows that sociodemographic characteristics, such as age, sex, and financial situation, do not significantly differentiate the declared engagement in IAPS ALL projects.

4.3.3. Factors Influencing Engagement in ALL Projects: Smart Solutions for Urban Agriculture and Environmental Protection (SSUA and EP)

Smart Solutions for Urban Agriculture and Environmental Protection (SSUA and EP) ALL projects were popular among the respondents (Figure 13). Students of the natural, agricultural, and technical sciences (Node ID = 3) exhibited an above-average readiness to engage in such projects (AV = 0.27). Nevertheless, the relatively high variance at the node suggests diversity of answers.

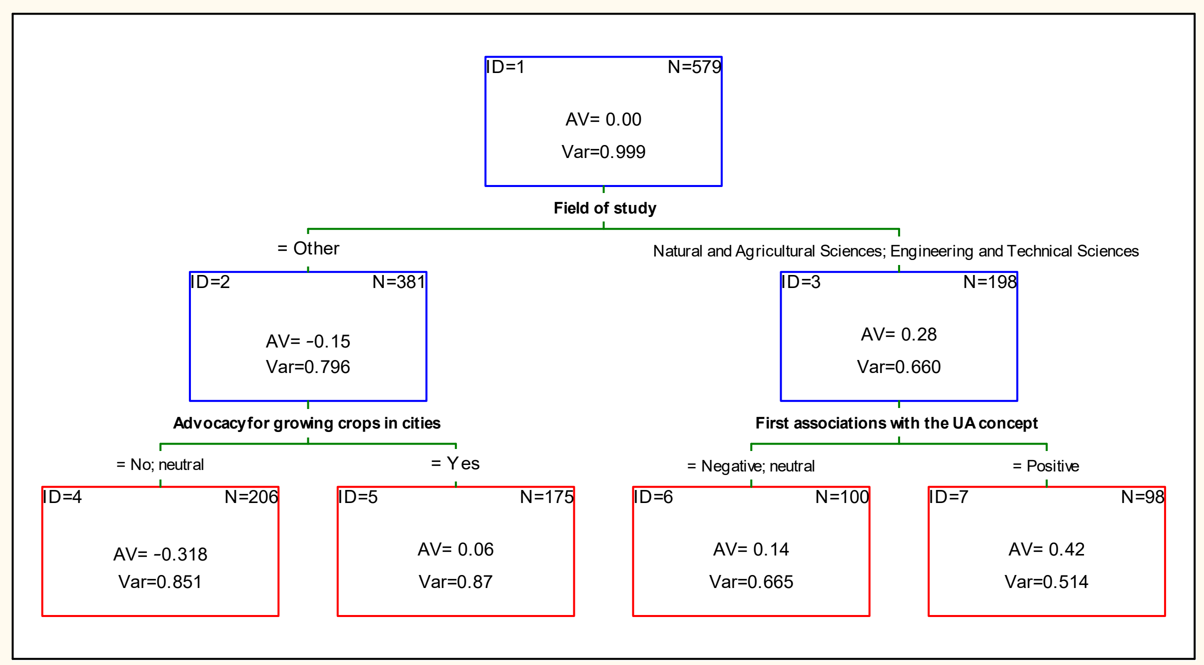

Figure 13. Regression tree diagram (CART) illustrating factors influencing engagement in Smart Solutions for Urban Agriculture and Environmental Protection ALL projects. Source: original work.

Consecutive splits demonstrate that the probability of engaging in SSUA and EP projects increases with positive attitudes toward UA. The average value of the predictive variable of 0.42 (range: –2.8 to 2.8) indicates a relatively significant readiness to participate in ALL projects, although some respondents remained neutral or even skeptical. Participants who pursued fields of study other than technical and natural sciences and did not approve of UA (Node ID = 4) were much less interested in SSUA and EP projects. However, those who did not study agricultural and technical sciences but were open to UA (Node ID = 29) declared much greater readiness to engage in ALL projects. The average value of the composite mean (AV = 0.06) indicates an above-average readiness to engage in ALL.

The model is rather simple and only modestly explains the diversification in respondents' answers (the overall variation is reduced by 30%). The investigated variables, i.e., respondent characteristics, do not allow for an unambiguous determination of the factors driving respondents' engagement. Admittedly, further splits could create more detailed division conditions, but they would also 'over-train' the tree, reducing its predictive performance in relation to student engagement in ALL projects.

The predictor importance ranks indicate that the field of study was the most important variable in determining readiness to engage in SSUA and EP projects. This finding suggests that the academic background of the respondents plays a pivotal role in their openness to such initiatives (Figure 14).

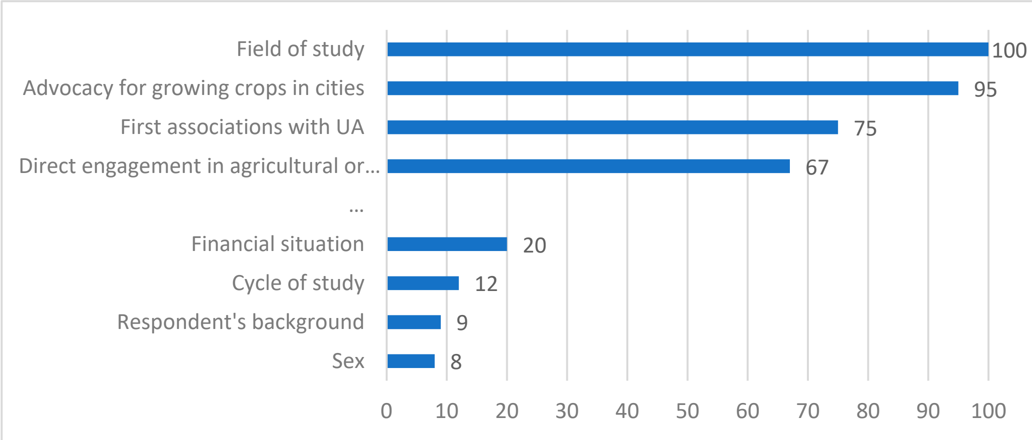

Figure 14. Importance of predictors for determining engagement in smart solutions for urban agriculture and environmental protection ALL projects. Source: original work.

Another important factor was the respondents' perceptions and approval of agricultural activities in cities (such as crop cultivation). While the general perception of UA and direct involvement in agricultural activities were less important, they remained meaningful contributors. No links were found between demographics (such as sex or age), background, cycle of study, and readiness to engage in ALL projects.

5. Discussion

5.1. Awareness of the ALL Concept

Research to date indicates that ALL is primarily recognizable among academics and experts, while the general public remains largely unaware of it. Living lab innovations are often tested at universities and research institutions [90,91]. The present study confirms that the ALL concept is yet to gain broader recognition among the Polish population. Only three respondents out of 579 reported familiarity with the concept and participation in such an initiative. Another 7.4% reported a general familiarity with the idea. This relatively poor awareness of ALL may stem from insufficient efforts of Polish universities to promote such projects. The same applies to other Central and Eastern European countries [92]. Moreover, limited awareness of the living lab concept in Poland may result from a shortage of infrastructure and a lack of traditions in collaboration between the public, private, and civic sectors, which is critical for the effective implementation of LLs [92,93]. By contrast, countries where LLs have been more successful, such as Sweden, Finland, and Germany, provide ecosystems that foster collaboration among research institutions, local governments, and communities. These ecosystems drive the dynamic growth of this concept [91,93–95].

Although only a few Polish students were familiar with ALL, most of them declared readiness to engage and expand their knowledge and skills after learning about it. The present survey results corroborate past analyses indicating that ALL projects focused on environmental protection and climate receive more attention as they are perceived as 'more interesting' and in the public spotlight [20,64].

This type of project draws on widely accepted public values and instills a sense of responsibility for the future of the natural environment [96], which boosts its popularity. High levels of motivation to engage may also stem from the potential improvement in the quality of life, such as curbing the urban heat island effect or improving urban ventilation, as addressed by 'smart city' projects [24,62,97–99]. Urban agriculture projects are often considered tools for promoting social inclusion, particularly for people with disabilities, at-risk youth, and other excluded social groups. Furthermore, such projects tend to enjoy substantial public acceptance [11,72]. Still, the present study demonstrates that the respondents relatively infrequently expressed readiness to engage in projects aimed at promoting an active life among socially excluded people and supporting people with disabilities. As noted by Kim et al. [100], healthcare and social inclusion ALL projects primarily attract experts in the fields. Cyr et al. [101] reported similar findings, demonstrating that user engagement in LL projects remained low, and that readiness to engage was often limited to healthcare and social workers. This may explain the significantly greater interest in these projects among medical students.

Although the levels of readiness to engage in various types of ALL projects varied significantly, three primary patterns of engagement were identified through a factor analysis: Social Inclusion and Cultural Heritage (SI and CH), Innovative Agri-Product Solutions (IAPS), and Smart Solutions for Urban Agriculture and Environmental Protection (SSUA and EP). This approach allowed for a more effective grouping of projects and facilitated further analyses of respondents' preferences and motivations.

5.2. Factors of Engagement in ALL Projects

The regression trees identified several general patterns of potential respondent engagement in ALL projects. First, students from different fields of study provided distinctly different responses. Second, declarations concerning engagement in ALL projects were associated with personal relationships with farmers and direct involvement in agricultural activities (e.g., growing vegetables in gardens or on balconies). Third, the perception of UA has emerged as a relevant factor.

5.2.1. The Impact of Formal Education, Knowledge, and Experience of the Respondents

The analyses demonstrate that students of natural and agricultural sciences, medical and health sciences, and engineering and technical sciences statistically significantly more often declared readiness to engage in ALL projects. They tended to choose projects that aligned with their fields of study. For example, students in the technical and engineering sciences primarily preferred smart city projects where smart technologies were implemented, students in the humanities were attracted to educational projects, and students in the natural and agricultural sciences chose projects focused on agricultural production [102]. These results are consistent with those reported in the literature. In their review of citizen engagement in sustainability transition research, Huttunen et al. [31] noted that the level of engagement in various civic projects is clearly correlated with personal interests, knowledge, and skills. Park and Fujii [68] and Sattayapanich et al. [70] also emphasized that the level and type of education determined ALL project engagement. Likewise, Chen and Liu [62] found that citizens' specialized knowledge significantly enhances their participation in ecological and environmental governance. This pattern applied, for example, to projects promoting support for people with disabilities, which were selected mainly by medical students. Their knowledge and skills prepare them for such activities [101].

Furthermore, the analyses demonstrate that even limited participation in agricultural or horticultural courses can significantly increase interest in ALL projects. These results are supported by the findings of Campbell and Rampold [96].

5.2.2. Social Closeness to Farming and Hands-On Involvement in Agricultural Activities

This study shows that close relationships with farmers and personal involvement in agriculture, such as home gardening, significantly influence engagement in UA initiatives. This is particularly evident for Innovative Agri-Product Solutions and Social Inclusion and Cultural Heritage ALL projects. People with personal experience with farmers are more open to participating in innovative solutions [69,96,103]. They also better understand agriculture and its environmental and health benefits, which encourages them to become involved in projects founded on these values.

In addition, personal relationships—such as friendships, blood ties, and work experience with farmers—foster trust and engagement in ALL projects [71]. Furthermore, people with no experience in agriculture or involvement in agricultural activities, such as many urban residents, exhibit a lower propensity to engage in ALL projects [104–107].

5.2.3. Relevance of Urban Agriculture Perceptions

Regression tree analyses demonstrate that familiarity with the idea of urban agriculture and its functions can increase readiness to engage in ALL projects. Positive associations with farming significantly enhance trust and appreciation of the initiatives [72,108,109]. Other studies, such as those on civic engagement in CSR projects [70] or renewable energy source projects [66], have revealed that a positive attitude toward the initiatives translates into greater readiness to engage. However, Sroka et al. [11] noted that negative attitudes toward UA may have an even stronger influence on readiness to engage. They emphasized that, in most situations, negative events and experiences are more salient and impactful, with negative contributions being overall more influential than positive impacts. This aligns with negative bias theory [73]. This suggests that people who dismiss the benefits of UA or believe it has a negative influence on the city are likely to exhibit a negative attitude toward such projects [72]. Therefore, education and the shaping of attitudes toward agriculture are critical for LL projects aimed at integrating agriculture into the urban setting [110].

5.2.4. Demographics: A Limited Predictor of ALL Engagement

The analyses and literature indicate an interesting conclusion regarding the relatively low impact of demographic variables, such as age, sex, or financial situation, on ALL engagement. According to Schneider et al. [67], engagement in environmental protection and agricultural innovation projects is primarily driven by values and attitudes, rather than demographics. The present study supports these findings. Factors such as the level of education, perception of ALL projects, and past experience with similar initiatives have a much greater influence than standard demographic variables [57,66,67].

The limited impact of demographics on ALL engagement may result from the multifaceted nature of UA, which extends beyond typical demographic divisions and appeals to more universal values of sustainable development [11,67].

5.3. Multidimensional Factors of Engagement in ALL Projects

The analyses confirm that the factors affecting ALL engagement are complex and require a multifaceted approach. The results show that the decision to engage in ALL projects depends on a combination of various characteristics and conditions, as proposed by Deng et al. [111]. From the characteristics of the respondents, different profiles emerge, displaying diverse levels of readiness to engage. For example, the model for Engagement in Innovative Agri-Product Solutions demonstrated that ALL projects are particularly attractive to people who know farmers and are students of natural sciences, including agriculture. Another model (SI and CH) showed that students of technical and social sciences who have never taken agricultural or horticultural courses and have negative connotations with UA are not interested in projects aimed at restoring regional traditions and agrarian culture.

The regression tree method can also be used to build a hierarchy of the importance of individual variables in ranking their impacts on decisions to engage in ALL projects. The results and identified patterns of regression trees offer practical guidance for engagement in ALL. By identifying the critical factors that differentiate readiness to engage, participant profiles can be built, allowing more homogeneous groups to be brought together. Therefore, this method can be used to develop targeted strategies for engaging various segments of the population, facilitating a better alignment of ALL efforts with the needs and expectations of specific target groups.

These conclusions offer an in-depth insight into the motives and barriers related to engagement in ALL projects. They represent a crucial first step toward a better understanding of the social mechanisms driving these initiatives.

6. Research Limitations

This study has certain limitations. First and foremost, it focuses on a single social group—students from Kraków—which restricts the possibility of generalization. Furthermore, the measurements are based mainly on self-reported declarations concerning readiness to engage, which may not necessarily translate into specific actions; the actual level of engagement might be lower. In addition, as the study sample was not monitored over a long period, it is impossible to determine the long-term persistence of engagement, which represents a valuable consideration for future research.

7. Summary and Conclusions

Agro living lab projects have a great potential for building sustainable and resilient urban systems. However, their performance depends heavily on the active engagement of the community. For these initiatives to be durable and effective, they need to win widespread public acceptance and support from residents, who can become both co-creators and beneficiaries of the outcomes. Therefore, this article examines the factors that may influence the urban population's readiness to actively engage in ALL projects, with a focus on the young generation as future public leaders.

The survey involved students of universities in Kraków. Students represent a special part of the population and can play a central role in the future of initiatives like ALL. Being young, environmentally aware, open to innovation, and publicly spirited, students are important beneficiaries and potential participants of ALL projects. Their attitudes toward sustainable development and UA may significantly shape urban environmental policies in the years to come. Gaining insight into the factors driving students to engage in ALL projects can help identify the key motives and barriers that may also apply to the broader context of city inhabitants.

These insights indicate that despite limited knowledge of UA ALL projects, respondents demonstrated significant readiness to engage. The most popular projects were smart city, climate, and environmental protection initiatives. Such undertakings, aimed at curbing the urban heat island effect, improving urban ventilation, enhancing biodiversity protection, aligning with current environmental challenges and attracting young people interested in new technologies. The readiness to engage in ALL projects was clearly associated with the respondents' field of study, interests, and individual experiences. The students selected projects that aligned with their academic focus and personal interests. Students of the natural, technical, and agricultural sciences were more likely to declare readiness to engage in projects involving UA and smart city solutions. In addition, respondents displaying positive attitudes toward UA and personal relationships with farmers more frequently expressed readiness to engage. The results demonstrate that a positive perception of UA and close ties to agriculture are significant drivers of participation in ALL projects.

This study offers fact-based recommendations that may help improve the effectiveness and social impact of ALL projects, as a new method for integrating various groups to co-create sustainable urban systems.

1. Universities should play a central role in advancing ALL projects by incorporating this approach in their curricula. The broader adoption of ALL in higher education addresses the needs of students who express readiness to engage in innovative and sustainable initiatives. Integrating this approach into the educational process equips future experts with the practical skills and knowledge to support the implementation of these projects in urban environments.
2. Universities, local authorities, and the private sector should collaborate to harness the potential of students who show a particular interest in Agro Living Labs (ALL) projects. Understanding the personal characteristics and preferences of students will enable better tailoring of educational and promotional programs, ultimately facilitating the optimal selection of individuals for implementing ALL projects. This approach may also support the long-term sustainability of these initiatives. Engaging highly motivated participants increases the likelihood of durability and effectiveness in the implemented projects.
3. City authorities should recognize the potential of ALL projects as a crucial preparatory step for testing innovative UA solutions under real local conditions. This approach can empower urban decision-makers to gradually implement proven initiatives that address the actual needs of local communities while fostering sustainable urban development.

Despite the outlined limitations, the conclusions and recommendations may be applicable to countries with similar socioeconomic and political conditions, such as those in Central and Eastern Europe. Similarities in social structures, levels of economic development, and policies supporting urban agriculture suggest the potential for partial implementation of the findings in this region. However, it is important to note that these conclusions require further verification and adaptation to specific local conditions.

Implications for Future Research

The findings of this study highlight significant links between education, personal experience, and attitudes toward urban agriculture in the context of readiness to participate in Agro Living Labs projects. Future research should focus on exploring these relationships in a cause-and-effect framework, particularly the role of education as a potential mediator between personal experience and attitudes toward urban agriculture. Comparative studies in diverse urban settings, taking into account cultural and political diversity, would also be valuable. Such analyses could provide a better understanding of contextual differences in acceptance and engagement levels. This exploration may offer valuable insights for transferring and generalizing the findings as well as for designing strategies tailored to specific local conditions.

Author Contributions: Conceptualization, W.S.; methodology, W.S.; software, W.S.; validation, W.S. and K.K.; formal analysis, W.S. and S.L.; investigation, W.S., J.K., M.S. and S.L.; resources, W.S., K.K., J.K., M.S. and S.L.; data curation, W.S.; writing—original draft preparation, W.S. and J.K.; writing—review and editing, W.S. and J.K.; visualization, W.S. and K.K.; supervision, W.S.; project administration, W.S.; funding acquisition, W.S. and K.K. All authors have read and agreed to the published version of the manuscript.

Funding: This was work was co-financed by the Minister of Science under the 'Regional Initiative of Excellence' program. Agreement No. RID/SP/0039/2024/01. Subsidized amount of PLN 6,187,000.00. Project period: 2024–2027.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Rector's Research Ethics Committee for Human Research of the University of Agriculture in Kraków (protocol code 185/2024; 7 May 2024) for studies involving humans.

Data Availability Statement: The data presented in this study are stored in the authors' archives and are available upon request from the corresponding author.

Acknowledgments: We would like to express our sincere gratitude to our colleagues from the Department of Economics and Food Economy at the University of Agriculture for their valuable support and contributions to this research. We also extend our thanks to the anonymous participants of the survey for their time and insights, which were crucial for the completion of this work.

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

Appendix A

Table A1. Independent Variables Used in the Regression Tree Model.

Factors	Name of Variable	Definition of Variable	Size
Socio-demographics	Sex	- Male - Female - Other / prefer not to say	348 226 5
	Age	- Years	18-27
	Economic activity	- Non-working student - Part-time job - Full-time job - Own business - Other	292 233 25 26 3
	Financial situation	- Very good - Good - Average - Bad - Very bad	136 289 147 6 1
Formal Education	Field of study	- Social sciences - Medical and health sciences - Humanities - Engineering and technical sciences - Natural and agricultural sciences - Other	243 68 56 143 55 14
	Cycle of study	- First cycle - Second cycle	392 187
	Participation in agricultural or horticultural sciences courses (during formal education)	- No - Yes, but there were not many classes (courses) - Yes, I completed many courses (classes)	424 97 58
Background and social closeness	Background	- Krakow - Other large or medium-sized city - Town - Rural areas - Another country	83 150 88 253 5
	Personal acquaintance with farmers	- I don't know any and don't buy produce directly from farmers - I don't know any, but I buy produce directly from farmers - Yes, I know farmers, but I don't have personal relationships with them - Yes, I personally know a few food producers - Yes, I personally know many food producers	153 133 114 120 59
	Respondent's involvement in and closeness to agriculture	- I'm not familiar with the specifics of agriculture and farm management - My family didn't have a farm, but I'm familiar with the specifics of agricultural production - I grew up in a family that had a home garden or an allotment - I grew up in a family that had a farm	214 190 57 118
	Direct engagement in agricultural or horticultural activities	- I don't engage in any activities - Other facilities/installations used for food production - Balcony, rooftop with herbs or vegetables - Home garden/allotment garden + others - Home garden/allotment garden - Own/family farm	209 36 94 35 144 61

Table A1. *Cont.*

Factors	Name of Variable	Definition of Variable	Size
Urban agriculture perception	Familiarity with UA concept	- I'm not familiar with this concept, I haven't heard of it - I've heard of this concept, but I don't know what it is about - Yes, I'm generally familiar with the concept - Yes, I can define it.	257 198 110 14
	First associations with UA	- Definitely negative - Rather negative - I have no associations - Rather positive - Very positive	8 25 235 250 61
	Advocacy for growing crops in cities	- Definitely no - Rather no - I don't know - Rather yes - Definitely yes	3 34 111 300 131
	Advocacy for active policies for spatial planning and urban food systems	- Definitely no - Rather no - I don't know - Rather yes - Definitely yes	8 56 197 242 76

Source: original work.

Table A2. Variables Used in Exploratory Factor Analys.

Types of ALL Projects:	Number of Respondents' Answers				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1a. Restoration of regional traditions and (agrarian) culture (i.e., education and creation of digital heritage)	54	99	125	187	114
1b. Development of recreational/tourist services as part of UA (play areas, recreation for children and families, etc.)	46	94	103	198	138
1c. Promotion of active life among socially excluded people with UA (workshops, social urban farming)	70	83	190	165	71
1d. Services for people with disabilities (social farming, horticultural therapy, hippotherapy, etc.)	70	105	125	166	113
2a. Creation of new food products (experiments with new flavours, e.g., jams with original additions, liquors, wines, etc.)	73	103	74	197	132
2b. Creation of new non-food products (such as creams, balms, oils, and other natural products)	65	129	89	175	121
2c. Creation of healthy products (rich in fibre, vitamins, minimally processed foods, etc.)	73	106	101	174	125
3a. Innovative urban agriculture projects (farming in/on buildings, etc.)	58	90	134	176	121
3b. Smart farming projects with new technologies in UA (digital agriculture, hi-tech agriculture, etc.)	56	96	158	184	85
3c. Smart city projects: climate protection (improving urban green cover, curbing the urban heat island effect, etc.)	40	75	127	203	134
3d. Smart city projects: environmental protection (protection of water, promotion of biodiversity, etc.)	44	51	117	221	146

Source: original work.

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