Enabling Factors for the Adoption of Sustainable Agriculture **in Lebanon**

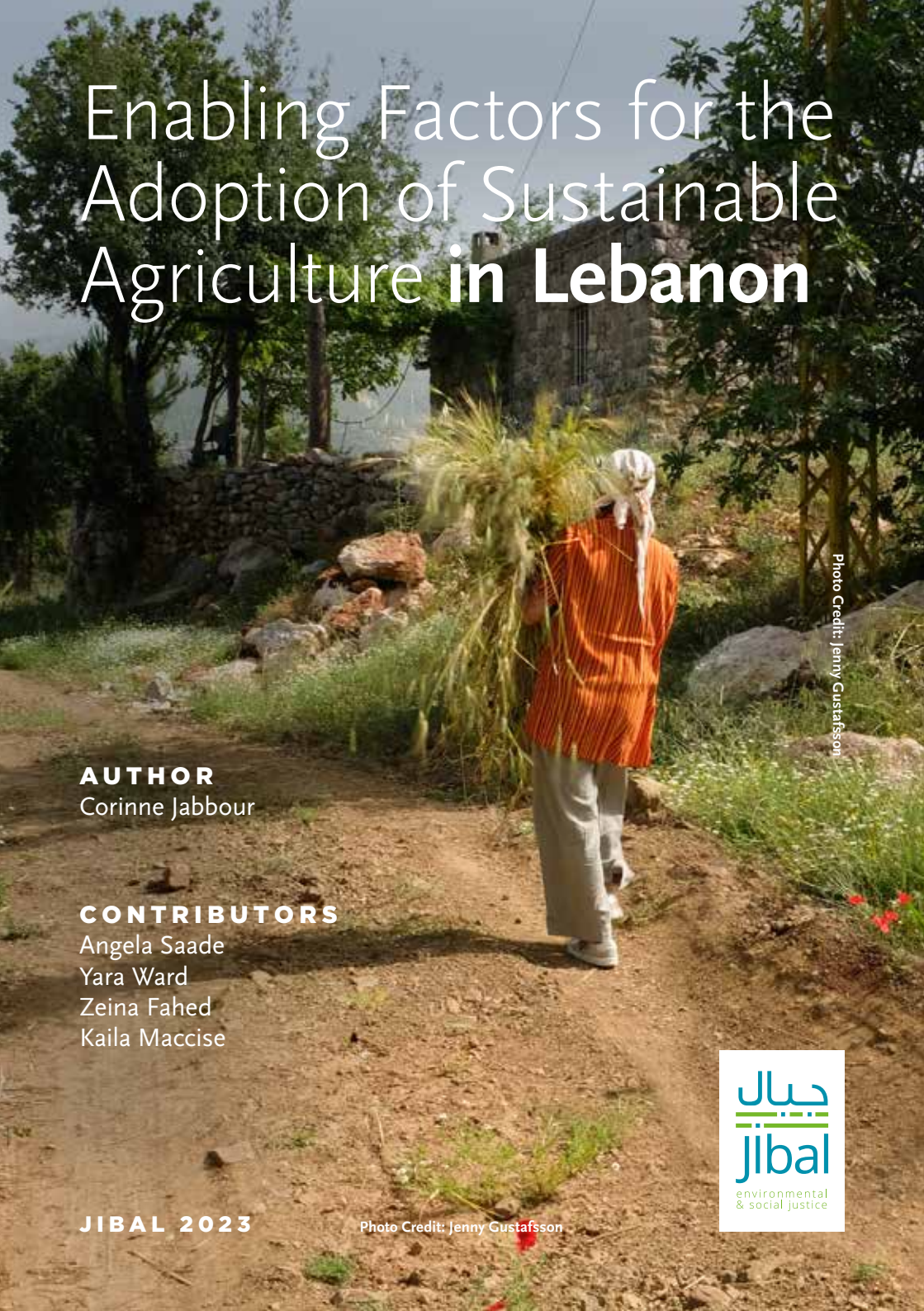

Photo Credit: Jenny Gustafsson

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JIBAL 2023

Photo Credit: Jenny Gustafsson

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جبال
Jibal
environmental
& social justice

About Jibal

JIBAL is a not-for-profit association founded in Beirut in 2017, with final governmental approval in January 2019. It promotes and advances social and environmental justice – or the fair and equitable distribution of environmental and social benefits and burdens – in Lebanon through collective organisation, accessible and open knowledge, and regenerative principles.

JIBAL's work intertwines socio-cultural and ecological perspectives to promote a holistic approach to societal development. It promotes sustainability in all its aspects – in the built and natural environments, in human societies, and in economic and social policies – by developing and implementing programs on environmental justice, food sovereignty, and social justice.

Abstract

In response to the pressing challenges posed by the global agri-food system, there has been a notable global shift towards sustainable agriculture. Against the backdrop of Lebanon's agricultural landscape, this study investigates the multifaceted dynamics influencing the shift towards sustainable farming practices among local farmers. Through an exploration involving in-depth interviews, field observations, and focus group discussions, the study seeks to uncover the fundamental factors shaping farmers' choices regarding the adoption of sustainable methods. Cognitive, social, and behavioral dimensions are thoroughly examined, spanning from access to knowledge and economic considerations such as market accessibility and financial constraints to the influence of descriptive and injunctive social norms, network affiliations, cultural heritage preservation, and environmental and health concerns. Building upon these findings, the study proposes a comprehensive framework of recommendations to facilitate the widespread adoption of sustainable agriculture. These recommendations are intended to inform interventions and policies and ultimately enhance resilience and environmental sustainability within Lebanon's agricultural sector.

Source: Lifestyle of ecofriendly person, freepik.com

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Introduction

The dire state of the global agri-food system has led to a widely recognized need for major change. The conventional farming industry, which dominates production in the global agri-food system, is primarily characterized by the usage of intensive tillage, monocultures, genetically modified seeds, synthetic fertilizers, and synthetic biocides (pesticides, herbicides, and fungicides), in addition to the use of growth hormones and antibiotics for animal rearing. These practices not only affect soil fertility but also pose serious health and environmental hazards.[1] They cause pollution and loss of biodiversity as well as being a major contributor to global warming. As of 2015, the global food system represented one-third of global greenhouse gas emissions, amounting to 18 gigatons of CO_2 (34% of total global GHG emissions). These numbers result primarily from conventional agriculture's contribution to devastating land-use change (71%), but also from unsustainably organized activities like retail, transport, consumption, fuel production, waste management, industrial processes, and packaging.[2] Additionally, the capital-intensive nature of conventional agriculture rewards those with the ability to make large upfront investments while often precluding small to medium scale farmers whose livelihoods have increasingly become threatened.[3]

In Jibal's interactions with farmers, the underlying question is consistently "why?" What drives two farmers to choose differing methods? What shapes their choices? What spurs a transition to new farming techniques? This report examines the agri-food system through Lebanon's lens, emphasizing factors that encourage, inspire, and empower farmers to embrace sustainable agricultural practices. The aim is to better comprehend the priorities and apprehensions guiding farmers' decisions. With this insight, we can refine interventions and potentially policies to cultivate an environment conducive for the uptake of sustainable practices. This approach benefits farmers, consumers, and the environment, and represents a pivotal move towards the ultimate goal of food sovereignty.

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1. Neha Chausali, and Jyoti Saxena. 2021. "Conventional Versus Organic Farming: Nutrient Status, Neha Chausali, Jyoti Saxena." Advances in Organic Farming. https://doi.org/10.1016/B978-0-12-822358-1.00003-1

2. M. Crippa et al. 2021. "Food Systems are Responsible for a Third of Global Anthropogenic GHG Emissions." Nat Food 2, 198–209. https://doi.org/10.1038/s43016-021-00225-9

3. J. Pretty. 2008. "Agricultural Sustainability: Concepts, Principles and Evidence." Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1491): 447-465. https://doi.org/10.1098/rstb.2007.2163

2

Context:
The State of the Agri-Food System in Lebanon

2.1 Challenges In Lebanon's Agriculture Sector
- Unfair Local Markets
- Mismanagement Of Resources And Rising Costs For Farmers
- Misuse Of Agricultural Inputs

2.2 A Shift Towards Sustainable Agriculture

Source: chandlervid85, freepik.com

2.1 Challenges in Lebanon's Agriculture Sector

Lebanon's agriculture sector makes up only about 3% of the country's gross domestic product (GDP), which is relatively low compared to other dominant sectors like banking, tourism, and services.[4] However, agriculture plays a crucial role in the country's peripheral areas, particularly the Bekaa Valley and Akkar, which are largely agricultural regions. The post-war period in Lebanon has seen little to no effective strategies or investments in the development of agriculture, leading the sector to rely on the intervention of international donors and the influence of local non-state actors. The war in Syria further aggravated the situation as Lebanese farmers previously imported subsidized agricultural inputs from Syria. The closure of borders resulted in a sharp increase in the cost of inputs specifically, and agricultural production overall. Concurrently, the reduction in import of Lebanese agricultural products by the Gulf led to the major decline of a previously vital export market.[5]

Unfair Local Markets

Domestically, farmers rely on intermediaries (i.e.wholesale markets, middlemen traders) to access the market. Yet the lack of regulation and transparency in price-setting mechanisms exploited by the intermediaries leaves farmers in a weak bargaining position. They are often coerced to accept unfair prices.[6] In short, middlemen are in a position that enables them to exploit farmers to increase their own profit margin. For example, traders often own cold storage units which farmers rely on to rent in the off-season. While traders largely profit from their sales in this period, they often fail to compensate farmers. Because the agricultural wholesale market works on a consignment system, middlemen have also been known to underreport to farmers the profit made on their produce at the end of the season.[7] Tony Khalil, a farmer interviewed, described the bullying he and other farmers experience at the wholesale market. His crates of produce were purchased for 80,000LBP each while he saw that they were being sold at five times the price. He describes how he simply went to the trader to inquire about the huge discrepancy between the low prices he was being paid for his produce and the prices they were sold at: "he [the trader] told me bluntly that since I don't like it [the price], I should come take my produce, then he actually left all my produce out in the sun to spoil."

4. World Bank. 2020. "The World Bank Annual Report 2020 : Supporting Countries in Unprecedented Times." World Bank Annual Reports & Financial Statements. https://openknowledge.worldbank.org/handle/10986/34406

5. A. Aden. et al. 2018. "Value Chain Analysis in the Bekaa Plain, Lebanon: Potatoes, Tomatoes, and Dairy products." ICARDA - CACH. https://hdl.handle.net/20.500.11766/10360

6. Ruijs M. 2017. "Value Chain Analysis of (Greenhouse) Vegetables in Lebanon, Wageningen Economic Research." Wageningen.

7. Nathalie Allam. 2011. "Farming is Like Gambling: An Examination of the Decline of Produce Farming in Lebanon's Central Bekaa Valley, PhD diss." The George Washington University. https://scholarspace.library.gwu.edu/etd/9019s269z

Mismanagement of Resources & Rising Costs for Farmers

The agriculture sector in Lebanon relies mostly on conventional practices which require large amounts of natural resources (i.e. land, water, energy) as well as imported inputs including fertilizers, biocides, seeds, and machinery (e.g. tractors, tilling machines). This results in high production costs for farmers which was unsustainable for many in the face of the recent economic crisis. The Lebanese Lira has experienced significant depreciation, plummeting from its official exchange rate of 1,500 LBP to the US dollar in 2019 to 100,000 LBP to the US dollar in 2023. The rampant inflation caused these imported inputs to skyrocket. The economic situation also increased the cost of labor. Local animal manure, which became a highly sought after input alternative, also exponentially increased in price due to market demand. Additionally, energy and transportation expenses rose, particularly at the height of the fuel crisis in 2021 caused by the government's lack of foreign currency. Irrespective of the economic crisis, farmers are routinely burdened with high operating costs due to neglectful policies and planning, including machinery maintenance or rental fees of land and machinery. All these factors aggregate to threaten the livelihoods of farmers who were already struggling.[8]

Misuse of Agricultural Inputs

The agricultural sector in Lebanon suffers from gross mismanagement of resources and agricultural inputs. Poor soil management practices, such as overuse of pesticides and fertilizers, has detrimentally affected the livelihoods of many farmers. Lebanon has some of the highest per hectare use of fertilizers and pesticides in the world.[9] A study conducted in 2021 revealed that more than half the samples of tomatoes and cucumbers obtained from around the country contained residue of pesticides that had been banned years ago in the country. The study also noted that one fifth of samples collected contained levels of pesticide that greatly exceed the maximum residue limit set by the Lebanese Standards Institution (LIBNOR), with one sample reported to exceed the limit by 18 times.[10] The absence of adequate testing procedures related to levels of synthetic chemicals in water, soil, and agricultural products undermines food and health safety on the one hand, and on the other, greatly restricts export opportunities which farmers are often dependent on.[11]

It is important to note that the agricultural input industry is dominated by an oligopolistic structure, benefits only

8. Beirut Today. 2020. الحاج حسن، ع.، القطاع الزراعي ينهار ومزارعون يروون مآسيهم مع الدولار https://beirut-today.com/ar/2020/07/07/%D8%A7%D9%84%D9%82%D8%B7%D8%A7%D8%B9-%D8%A7%D9%84%D8%B2%D8%B1%D8%A7%D8%B9%D9%8A-%D9%8A%D9%86%D9%87%D8%A7%D8%B1-%D9%88%D9%85%D8%B2%D8%A7%D8%B1%D8%B9%D9%88%D9%86-%D9%8A%D8%B1%D9%88%D9%88%D9%86-%D9%85/

9. FAO, "FAOSTAT." FAO. http://www.fao.org/faostat/en/#data

10. Zainab Muhsin. 2022. "Lebanon: Banned Pesticides at the Dinner Tables." Arij. https://arij.net/investigations/agricultural-pesticides-en1/

11.ibid

a select few sellers, and lacks regulatory policies and monitoring systems.[12] Because of this, input suppliers have greatly exploited their position, often selling ineffective or expired products to farmers. Unpublished interview data collected by Jibal revealed that one-third of 500 farmers interviewed across several regions of Lebanon complained about a decrease in quality and efficiency of the pesticides and fertilizers they are using. Most assigned blame to their input suppliers, for lack of transparency, and to the authorities, for poor supervision and control over the market. As a result the farmers either increased the amounts of inputs applied–– and in doing so increasing their costs–– or changed to a different product often based on the profit-driven advice from the input suppliers themselves. In both cases, farmers' ad hoc coping strategies lacked scientific support, led to increases in costs, and increased soil degradation, water pollution, and a decline in crop quality due to the high levels of synthetic chemicals introduced.[13] The inadequacy and unsustainability of these input use methods has contributed to the undermining of food safety, decline in the quality of farm products, the reduction in profit margins for growers, and the devitalization of this sector as a whole.[14]

12. FAO, EU, and CIRAD. 2022. "Food Systems Profile – Lebanon." Statistical Yearbook World Food and Agriculture. https://doi.org/10.4060/cb9543en

13. Angela Saadeh and Corinne Jabbour. 2022. "The Agriculture Sector in Lebanon: Assessment of Farmer Needs." Jibal internal publication.

14. ibid

2.2 A Shift Towards Sustainable Agriculture

There is now global mobilization on part of global institutions and donors calling for shifts to sustainable agriculture. It has become clear that the way our global food system is organized is no longer viable. The Food and Agriculture Organization (FAO) published a seminal article in 2022 mentioning some of the main challenges across food systems. These include but are not limited to: "[the] heavily [reliance] on imported inputs, seeds, materials, and equipment, resulting in high production costs for agriculture and the agrifood industry, which significantly affects the food system,...the high use of pesticides, ...inadequate, inefficient, and unsustainable land use and management practices."[15] While these challenges are faced globally, they are particularly heightened in the Lebanese context. As mentioned previously, farmers already struggle to make ends meet due to high import costs of inputs and the unsustainable land management practices that directly threaten their livelihoods.

The organization of a more sustainable and collaborative food system in Lebanon– one which adopts sustainable agriculture and prioritizes local consumption– could potentially reduce the heavy expenses that burden farmers. There has been an increased promotion of sustainable farming practices in Lebanon in the past

15. FAO. 2022. "The Future of Food and Agriculture Trends and Challenges." FAO. https://www.fao.org/3/i6583e/i6583e.pdf

Source: prostooleh, freepik.com

decade, particularly at the national level. In 2010, a Memorandum of Understanding (MOU) was signed between the Ministry of Agriculture in Lebanon (MOA) and the Mediterranean Agronomic Institute of Bari (CIHEAM [International Centre for Advanced Mediterranean Agronomic Studies]-IAMB) to establish common activities on enhancing sustainable agriculture.[16]

The MOU was signed after the MOA's willingness to support sustainable farming practices in Lebanon through collaborations with Mediterranean organizations focused on agriculture in the region. The MOU included areas of training, research, and collaboration: resource management, integrated pest management (IPM), organic agriculture, rural development, fisheries, improving quality based on EU standards, improving local production, gender empowerment, and protection of natural resources.

In addition, the Lebanese National Agriculture Strategy 2020-2025 set by the MOA included 5 pillars, one of which - Pillar 4 - was about improving climate change adaptation and sustainable management of agrifood systems and natural resources.[17] More specifically, this pillar aimed to support the promotion of sustainable farming, food processing and logistics practices, as well as more effective awareness and communication campaigns on responsible food consumption. However, this is far from sufficient. In evaluating the strategy, it becomes evident that the approach, while extensive, might not have a long-term plan tackling the main concerns of food sovereignty. It underscores the importance of imported inputs and aligns with global market standards, often prioritizing quantity-focused growth. Essential elements of food sovereignty, such as the conservation of local seed varieties, community-driven land ownership decisions, and a holistic, systemic approach centered on local needs and cultural relevance, appear less accentuated. Though the strategy acknowledges stakeholder engagement, it doesn't provide clarity on the depth of community participation in shaping these policies.

Civil society has also been active in supporting the shift to sustainable agriculture. Multiple NGOs and initiatives such as Jibal, Buzuruna Juzuruna, SOILS Permaculture Association, Dikken El Mazraa, SIAC, Nohye El Ared, Mada, Habaq Movement, among others, have been working on promoting and upscaling sustainable farming practices (agroecology, permaculture, agroforestry...) in the country. This work primarily focuses on providing extension services. This has included training sessions by experts, coaching, and supplying sustainable agricultural inputs. These groups have also been involved in establishing community farms or learning gardens, supporting the development of farming collectives and cooperatives, and promoting seed-saving and the proliferation of heirloom seeds. While localized, this work has been vital in the face of the economic collapse which left many farmers unable to farm conventionally due to high costs.

16. CIHEAM. 2016. "Country Activity Report: Lebanon Edition 2015, CIHEAM." CIHEAM. https://www.ciheam.org/uploads/attachments/155/CAR_Liban_-_2015.pdf

17. MOA Lebanon. 2020. "National Agriculture Strategy 2020-2025." Ministry of Agriculture. http://www.agriculture.gov.lb/getattachment/Ministry/Ministry-Strategy/strategy-2020-2025/NAS-web-Eng-7Sep2020.pdf?lang=ar-LB

3

3. Research Objective

The objective of this study is to gain a better understanding of the motivations that led to adoption of sustainable farming behaviors of farmers in Lebanon. It focuses on their individual drives to adopt sustainable agriculture practices, and works to identify the enabling factors that prime farmers to make said decisions. Behavioral changes, especially ones that can directly impact one's livelihood, are difficult for most people, and farmers are no exception to that. In the course of Jibal's work, it has become clear that getting farmers to radically change their way of farming is a real challenge. As noted in one study, transformative changes often only occur when they coincide with an extreme opportunity or problem.[18]

In the Lebanese context, the 'extreme problem' is the economic crisis which adds weight to the already long list of issues farmers face globally. The rupture caused by the crisis has led many farmers to question the viability of conventional farming practices, particularly because they have become inaccessible and expensive to many. This point coupled with the incoming funding and projects around sustainable agriculture provide an 'extreme opportunity' to be leveraged. This makes it a critical time to better understand the factors that are encouraging farmers to shift and leverage them.

By shedding light on the factors affecting individual farmers' transitions, the hope is to contribute to the design and development of more effective policies, programs and initiatives that promote the adoption of sustainable agriculture in Lebanon and other similar contexts.

18. D.J. Pannell. 1999. "Social and Economic Challenges in the Development of Complex farming systems." Agroforestry Systems, 45 (1/3): 395–411. https://doi.org/10.1023/A:1006282614791

Source: wirestock, freepik.com

4

Desk Review:
Enabling Factors

4.1 Sustainable Agriculture
4.2 Adoption of Sustainable Agriculture
4.3 Theories on Behaviour
4.4 Studies on Farmer Behaviour Worldwide

4.1 Sustainable Agriculture

Sustainable agriculture practices have existed for thousands of years among traditional communities, and in recent years, they have been deliberately promoted by grassroots and international organizations, policies, and scientific research.[19] These practices gained prominence after it was recognized that agriculture is alarmingly both vulnerable and a contributor to climate change.[20] These emerging agricultural models fall along a spectrum, with technology-intensive, productivist models on one end and on the other, models that valorize more traditional ways of farming and require little external input.[21] The latter alternative farming models tend to be more labor and knowledge-intensive and place higher attention on the socio-political aspects of farming. One such alternative farming model is agroecology, also referred to as sustainable agriculture or low-input farming, which is of interest to this paper. This type of farming is more ecologically sound and can be more economically sovereign for farmers. Despite being labor-intensive which can incur costs, it does not require the recurring and expensive purchase of inputs such as patented seeds, synthetic fertilizers, and synthetic biocides, in addition to costly heavy machinery to prepare the land.[22]

FAO defines sustainable agriculture as "the efficient production of safe, high-quality agricultural products, in a way that protects and improves the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species." Sustainable agriculture is a core part of achieving a sustainable food system. Sustainable food systems involve balancing the economic, environmental, and social dimensions of sustainability to meet the needs of society while also protecting natural resources and ensuring the well-being of farmers and their communities.[23]

This report employs the term sustainable agriculture to encompass the principles and practices of agroecology, agroforestry, permaculture, and other alternative farming frameworks that focus on environmental, social, and economic dimensions of the food system.

4.2 Adoption of Sustainable Agriculture

Despite the benefits listed above, the adoption of sustainable farming practices can be a challenge. Farmers

19. Colin Ray Anderson, Janneke Bruil, Michael Jahi Chappell, Csilla Kiss, and Michel Patrick Pimbert. 2019. "From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems Through Agroecology." Sustainability 11, no. 19. https://doi.org/10.3390/su11195272

20. T. Garnett, and H. C. J. Godfray. 2019. "Sustainable Intensification in Agriculture. Navigating a Course Through Competing Food System Priorities." Food Security, 11(2): 209-214. https://doi.org/10.1093/aob/mcu205

21. Jules Pretty, and Zareen Pervez Bharucha. 2014. "Sustainable Intensification in Agricultural Systems." Annals of Botany, Volume 114, Issue 8, December 2014, Pages 1571–1596. https://doi.org/10.1093/aob/mcu205

22. M. A. Altieri, and V. M. Toledo. 2011. "The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants." Journal of Peasant Studies, 38(3): 587-612. https://doi.org/10.1080/03066150.2011.582947

23. FAO. 2008. "Sustainable Food Systems – Concept and Framework." FAO. http://www.fao.org/3/ca2079en/CA2079EN.pdf

often perceive it as a high-risk endeavor. It also requires more on-farm labor for inspection, prevention, field design, and crop rotation planning.[24] Yields are also relatively low in the first few years of the transition from conventional to agroecology though they do increase exponentially over the years as the soil microbiome and biodiversity regenerate and increase the land's resiliency.[25]

The agroecologist Gliessman, conceptualized the transition to agroecology in five levels, noting that farmers often start transitioning into an agroecological system in stages, through small actions over time (see Figure 1):[26]

↦ **Level 1 and 2:** the reduction of synthetic agricultural inputs (e.g. via integrated pest management) and the substitution of inputs (e.g. biofertilizers), in these levels, the chemical/conventional methods are being replaced by agroecological practices.[27]

24. C. Béné, et al. 2019. "Exploring the Contribution of Social Innovations to the Resilience of Rural Communities and Ecosystems." Ecology and Society, 24(2): 1-13. https://doi.org/10.5751/ES-10804-240202

25. M. A. Altieri, and V. M. Toledo. 2011. "The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants." Journal of Peasant Studies, 38(3): 587-612. https://doi.org/10.1080/03066150.2011.582947

26. Stephen R. Gliessman. 2015. "Agroecology: The Ecology of Sustainable Food Systems Third Edition." https://www.amazon.com/Agroecology-Ecology-Sustainable-Systems-Third-ebook/dp/B00UVAW5OI?asin=B00UVAW5OI&revisionId=&format=4&depth=1

27. Mateo Mier y Terán Giménez Cacho, et al. 2018. "Bringing Agroecology to Scale: Key Drivers and Emblematic Cases." Agroecology and Sustainable Food Systems, 42(13):1-29. https://doi.org/10.1080/21683565.2018.1443313

28. Source: Biovision 2020. https://www.agroecology-pool.org/

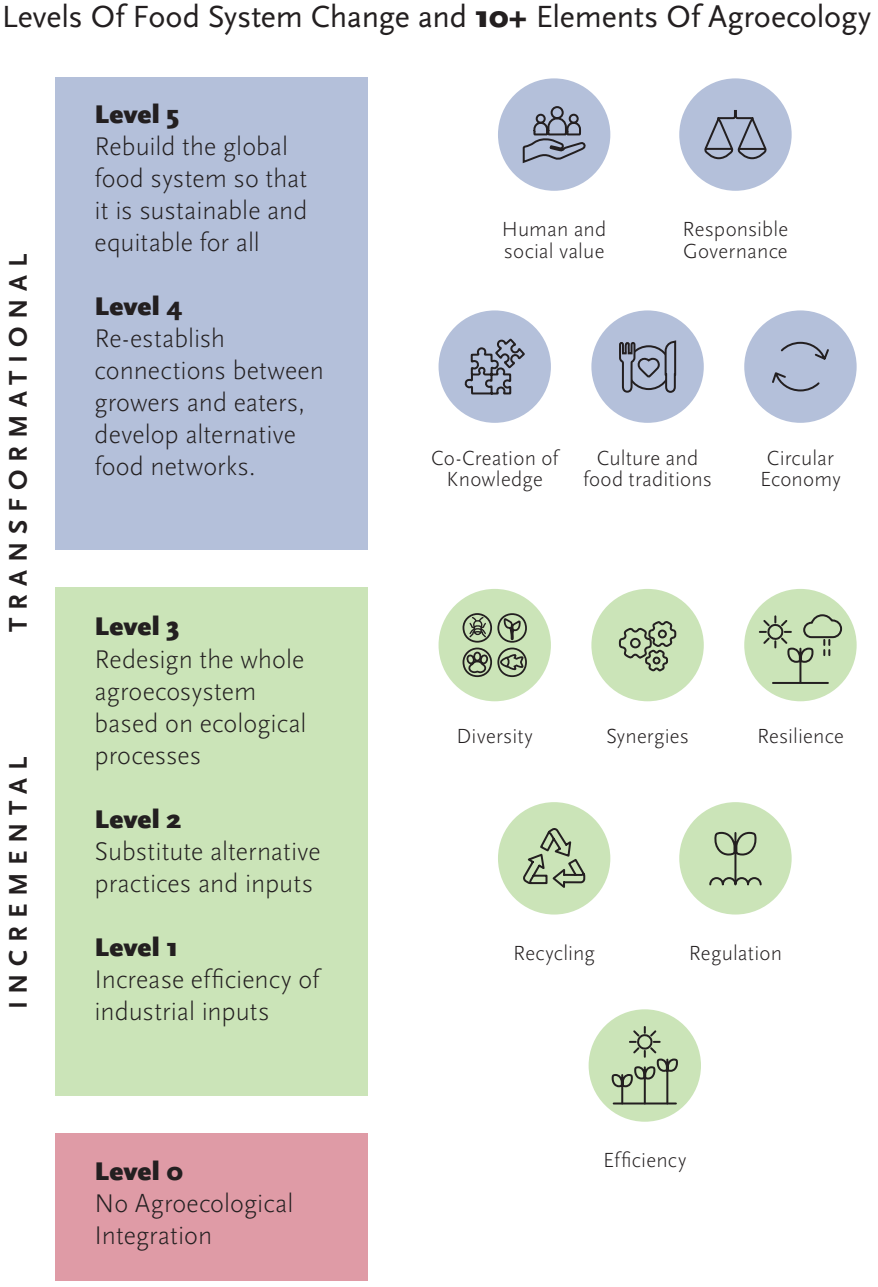


Figure 1: Conceptual framework of the 10 elements of agroecology from FAO and the 5 levels of transition towards SFSs (Gliessman, 2007)[28]

- **Level 3:** The development of autonomous mechanisms to keep the soil healthy and control pests and weeds, as well as using resources like space, nutrients, water, and sunlight in a coordinated synergistic way.

- **Level 4 and 5:** These levels have more to do with structural changes at the level of the food system such as the development of alternative food networks, re-linking consumers and producers, and eventually, transforming the global food system.

Other literature mentions different scales of sustainable agriculture adoption: the individual, subnational, and national scales, with the latter taking on the form of a movement.[29] There is still open debate on the impact of adoption at individual scales, though some conceptualize individual farmers' adoption of sustainable agriculture to serve as a sort of 'lighthouse' for surrounding farmers to do the same.[30]

29. Colin Ray Anderson, et al. 2019. "From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems Through Agroecology." Sustainability 11, no. 19. https://doi.org/10.3390/su11195272

30. Clara I. Nicholls and Miguel A. Altieri 2018. "Pathways for the amplification of agroecology." Agroecology and Sustainable Food Systems, 42, no. 10.

31. Ajzen Icek. 1991. "The Theory of Planned Behavior." Organizational Behavior and Human Decision Processes, Volume 50, Issue 2, 1991, Pages 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

4.3 Theories on Behaviour

To explore the adoption of agroecological practices among farmers in Lebanon, it was useful to examine literature on the theories of behavioral change. This provides insights into the factors that influence farmers' decision-making processes and their willingness to embrace new agricultural approaches. The Theory of Planned Behavior (TPB), a social psychology theory formulated by Icek Ajzen, provides a comprehensive framework for understanding the factors that influence behavioral change. This study applies the TBP to the context of farming to specifically examine the behavior of farmers and the various factors influencing their adoption of agroecology. Although TPB was not created specifically to understand the behavioral changes of farmers, several studies have adapted it as a lens to comprehend farmer behavior. Because none have used it specifically to understand farmer adoption of agroecology, we also explored other studies whose main focus is adoption of sustainable farming in the following section. This allowed us to develop a more robust theoretical framework to understand farmer potential for adoption of agroecology from a behavioral lens. The TBP proposes that an individual's behavior is determined by three main factors (see figure 2): the attitude towards a behavior (dispositional), the subjective norm (social), and the perceived behavioral control (cognitive) which is clarified below.[31] These factors interact with each other and ultimately influence the individual's intention to perform a behavior, which can help predict actual behavior.

Theory of planned behavior

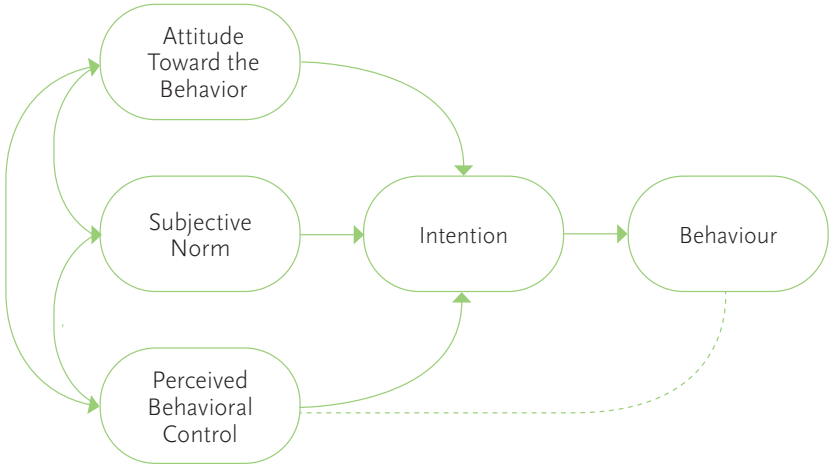


Figure 2: Adapted from Theory of Planned Behavior, Ajzen 1991

- **a. Dispositional Factors** (Attitude Toward the Behavior) refer to an individual's personality traits and values. These factors include beliefs, attitudes, and values related to the behavior in question. For example, if an individual values health and fitness, they may be more likely to engage in regular exercise. Similarly, if an individual believes that a certain behavior is important for their overall well-being, they are more likely to adopt it. Dispositional factors can also include personality traits such as conscientiousness, which may influence an individual's ability to stick to a behavior over time.

- **b. Social Factors** (Subjective Norm) refer to the influence of others on an individual's behavior. These factors include subjective norms (what people expect the person to be doing) as well as descriptive norms (what other people are doing) and values related to the behavior.

- **c. Cognitive Factors** (Perceived Behavioural Control) refer to an individual's beliefs and perceptions about the behavior. Perceived behavioral control is the perceived ability to perform the behavior in question, such as the knowledge and skills required for the task at hand, these cognitive factors also include beliefs about the outcomes of the behavior, such as perceived benefits or costs.[32]

Overall, the TBP provides a comprehensive framework for understanding the factors that influence behavioral change. By taking into account an individual's personality, social context, and cognitive beliefs, interventions can be tailored to effectively promote the adoption of new behaviors.[33] To gain insights into how TPB can be applied in relation to changes in farmer behavior in agricultural practices, it was important to explore studies that have been conducted with this specific objective. The following section presents these studies.

32. ibid

33. J. O. Prochaska, and W. F. Velicer, 1997. "The Transtheoretical Model of Health Behavior Change." American Journal of Health Promotion, 12(1), 38-48. https://doi.org/10.4278/0890-1171-12.1.38

4.4 Studies on Farmer Behaviour Worldwide

The nine studies mentioned below have all been conducted to explore the factors that influence farmer behavior in several regions worldwide, from the global south, the global north, the mediterranean climate, and Lebanon specifically.

#1 **The first study** we included examined the behavior of farmers through the lens of the TPB which is the main framework used in this study to understand factors influencing behavioral change. It grouped the different factors that led farmers to adopt a certain technology or practice into Cognitive, Social and Dispositional.[34] The authors suggest that the following factors may influence farmers' intentions to adopt a particular technology or practice:

- **Dispositional:** Farmers' attitudes, their perceptions of the benefits and costs of the new practice, including its potential impact on crop yields, profits, and environmental sustainability.
- **Social:** Subjective norms, the influence of peers, neighbors, and other members of the farming community on farmers' decisions to adopt new practices.
- **Cognitive:** Perceived behavioral control, the degree to which farmers perceive that they have the necessary knowledge, skills, and resources to successfully adopt the new practice.[35]

The figure below (see figure 3) was taken from this study and reveals where these factors are positioned in relation to decision making on a proximal-distal spectrum–– distal being relatively stable and having influence over several aspects of a farmer's decisions, and proximal pertaining more specifically to a specific behavior (in this case the adoption of an agricultural practice or technology).

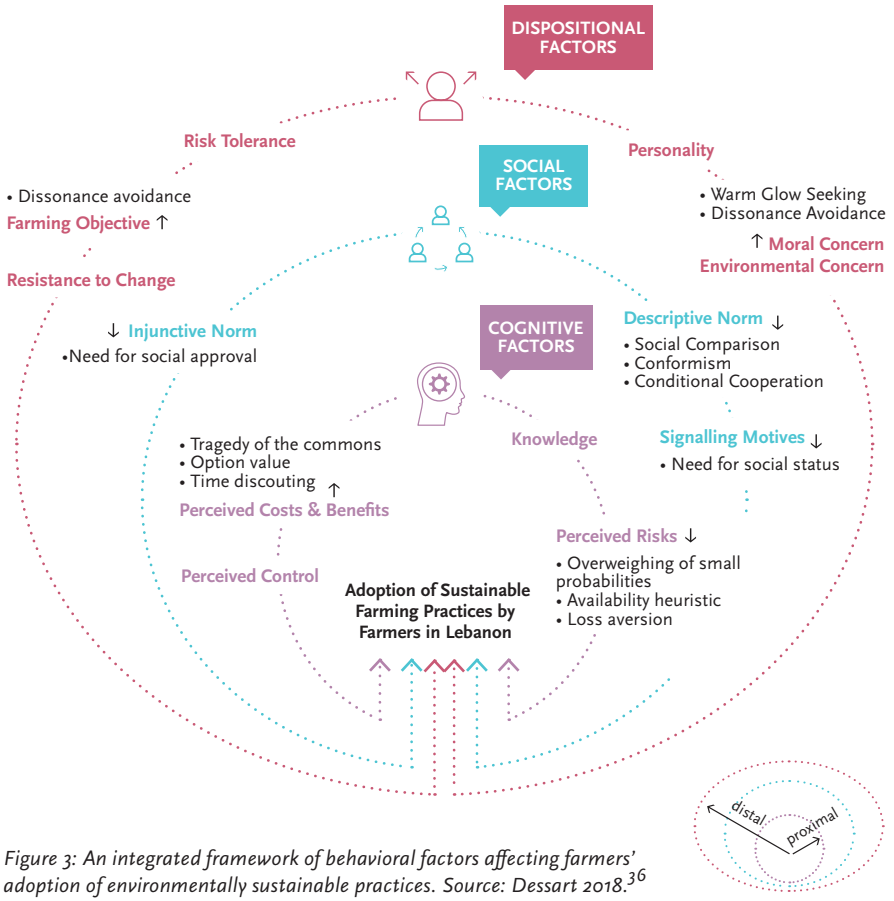


Figure 3: An integrated framework of behavioral factors affecting farmers' adoption of environmentally sustainable practices. Source: Dessart 2018.[36]

34. François J. Dessart et al. 2018. "Behavioral Factors Affecting the Adoption of Sustainable Farming Practices: a Policy-Oriented Review." European Review of Agricultural Economics, Volume 46, Issue 3, July 2019, Pages 417–471. https://doi.org/10.1093/erae/jbz019

35. ibid

36. ibid

#2 **The second study** selected was conducted in Andalucía, Spain. It developed a framework that integrates many different types of factors that explain the adoption of agroecological practices and demonstrates their interrelations.[37] This framework divides the enabling factors into three 'scales': the farmer, the direct context, and the distal context. The farmer scale can be understood as the individual farmers' motivations, abilities, the perceived demand for sustainable produce, and the legitimation of the sustainable practice by the surrounding environment. The main conditions for farmer adoption were motivation, ability, demand, and legitimacy. Each of these 4 conditions had multiple influencing factors, some of which included: Cost-benefit ratio, an understanding of the ecosystem, subsidies, norms and values, financial abilities, community of practitioners, among others.

#3 **The third study** was included because it conducted a systematic review of the literature addressing European farmers' shifts to sustainable farming, even though it focused more so on technological systems. Still, one of its main findings suggests that government subsidies in EU countries were a major factor leading to farmer adoption of sustainable agriculture.[38] This study identified several key factors that influenced the adoption of bundled sustainable agricultural practices, the two main ones being:

- **Economic sustainability -** the most deterministic factor, adoptive decision making can be encouraged through supporting better economic paradigms and proving to farmers the long term profitability of sustainable farming.

- **Learning and management capacities -** these can be developed through extension services (NGOs and public), training, and engagement with farmer associations. In their paper they noted that "NGOs are well respected and trusted by farmers" and that training offered by the representatives of these organizations resulted in application of more sustainable practices by the farmers.

#4 **The fourth study** selected for inclusion was conducted in Ghana, where 500 smallholder rice farmers were interviewed, to identify and rank the most-important factors promoting the adoption of agricultural green production technologies (AGPTs).[39] The authors established the following order of magnitude of influence that each factor had on farmer adoption of AGPT (in descending order): Knowledge, perceived cost and

37. Schoonhoven Yanniek, and Runhaar Hens. 2018. "Conditions for the adoption of agro-ecological farming practices: a holistic framework illustrated with the case of almond farming in Andalusia." International Journal of Agricultural Sustainability, 16:6, 442-454. https://www.tandfonline.com/doi/full/10.1080/14735903.2018.1537664

38. Dmytro Serebrennikov, Fiona Thorne, Zein Kallas, and Sinéad N. McCarthy. 2020. "Factors Influencing Adoption of Sustainable Farming Practices in Europe: A Systemic Review of Empirical Literature." Sustainability 12, no. 22. https://doi.org/10.3390/su12229719

39. Asiedu-Ayeh, Love Offeibea, Xungang Zheng, Kobina Agbodah, Bright Senyo Dogbe, and Adjei Peter Darko. 2022. "Promoting the Adoption of Agricultural Green Production Technologies for Sustainable Farming: A Multi-Attribute Decision Analysis." Sustainability 14, no. 16: 9977. https://doi.org/10.3390/su14169977

benefit, descriptive norm (what other farmers do), moral and environmental concern, injunctive norm (what the farmer is expected to do), perceived control (believing one has ability and time to actualize the practices quickly), personality traits, perceived risks, and farming objectives.

#5 **The fifth study** identified 'pathways' for the amplification of agroecology practices through case studies from Central and South America. They mention that in addition to enabling factors (extension services and research, equitable markets, enabling policies, and alliances between farmers and researchers) the agroecological approach itself, that is used to share farming knowledge can have an amplifying effect. Specifically reviving traditional systems, transferring knowledge through farmer-to-farmer horizontal learning methodologies, and 'farmer lighthouses' (e.g. nearby demonstration farms and agricultural institutes), reconfiguring agroecological territories (territorial food systems), as well as alternative food networks are all conducive to the spread of agroecology.[40]

#6 **The sixth study** included was conducted in Thailand. Researchers held group discussions and surveys with 172 farmers investigating the factors affecting organic vegetable farming (OVF), while also exploring those affecting the extent of adoption (area). The factors identified in this study were: Motivation by governmental organizations (GOs) & NGOs, women having a leading role, attendance of training on OVF, motivation by fellow farmers, satisfaction with the price of organic vegetables, and access to information.[41] These findings are echoed in several studies which emphasized the influence of extension services (by GOs and NGOs), knowledge (training and access to information), social descriptive and injunctive norms (perception and encouragement from fellow farmers), and perceived cost and benefit (price). As one would expect, the study found that pest infestation could have a negative impact on the adoption of these practices. The extent of adoption was influenced by the amount of organic fertilizers produced by the farmer (more fertilizer produced = larger area of the land dedicated to OVF), the farmer's perception of the bad effects of inorganic pesticides (farmer considering them harmful = larger area of land dedicated to OVF), and the length of experience of the farmer (more experience = larger area).[42]

#7 **The seventh study** selected was an analysis of data gathered from 120 cocoa farmers in Nigeria. It identified factors motivating them to participate in an agroforestry program which included: Income and availability of

40. Clara I. Nicholls, and Miguel A. Altieri 2018. "Pathways for the amplification of agroecology." Agroecology and Sustainable Food Systems, 42, no. 10. https://doi.org/10.1080/21683565.2018.1499578

41. Gopal B. Thapa, and Kanokporn Rattanasuteerakul. 2011. "Adoption and Extent of Organic Vegetable Farming in Mahasarakham Province, Thailand." Applied Geography, Volume 31, Issue 1, 2011, Pages 201-209, ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2010.04.004

42. ibid

funds, provision of extension services and knowledge of benefits, availability of irrigation, and provision of early warning information. On the other hand, negative farmer attitudes hindered willingness to adopt agroforestry.[43]

#8-9

The last two studies mentioned here were conducted in Lebanon. In 2017 farmer adoption behavior was investigated for Conservation Agriculture among 121 households cultivating wheat. The study revealed that several factors played a significant role in adoption, including participation in specific training and farmers' perception of the long-term impact of conservation agriculture, as well as years of farming, farm size, farming experience, information sources, irrigation frequency, and weed infestation severity in the past.[44]

In 2018, a study conducted in Lebanon, where 120 smallholder farmers from the Bekaa region were interviewed on climate change adaptation practices, showed that when it comes to factors favoring the adoption of these techniques, extension services (training and in kind support), closeness to market, and off farm income had a very significant impact.[45]

The commonalities echoed throughout the all the studies and reviews mentioned above could be distilled into the following key points:

↦ **Cognitive:**
- Economic: Perceived cost and benefit, income stability, availability of funds, and a profitable economic model...
- Knowledge: extension services, training especially with NGOs, access to knowledge, and perceived control...

↦ **Social:**
Descriptive norms and subjective norms, being part of farmers associations...

↦ **Dispositional:**
Disposition of the farmer, farming objectives, environmental concerns, and other underlying conditions (age, education, farm size...)

43. K. Arimi, K., and A. Omoare, 2021. "Motivating Cocoa Farmers to Adopt Agroforestry Practices for Mitigating Climate Change." Renewable Agriculture and Food Systems, 36(6), 599-604. https://doi.org/10.1017/S1742170521000223

44. A. Chalak, A. Irani, et al. 2017. "Farmers' Willingness to Adopt Conservation Agriculture: New Evidence from Lebanon." Environ Manage. 2017 Oct;60(4):693-704. https://doi.org/10.1007/s00267-017-0904-6

45. A. Al Dirani, G.K. Abebe, R.A. Bahn, et al. 2021. "Exploring climate change adaptation practices and household food security in the Middle Eastern context: a case of small family farms in Central Bekaa, Lebanon." Food Sec. 13, 1029–1047. https://doi.org/10.1007/s12571-021-01188-2

5

Methodology

In order to address its objective of better understanding the behaviors that motivate farmers to shift to sustainable agriculture, this study uses four methodological approaches.

#1 **First,** a desk review of existing literature related to sustainable agriculture transitions, theories on behavior, and farmer behavioral studies, to formulate a theoretical framework. It does so to better understand the underlying factors and motivations that lead farmers to adopt sustainable practices and the barriers they may face in doing so.

#2 **Second,** a semi-structured interview approach to investigate individual stories of 33 farmers around their transition, and an analysis of this data.

#3 **Third,** observational data collected from the ongoing fieldwork of the organization, Jibal.

#4 **Fourth,** a focus group discussion of practitioners and experts where the findings of the study were circulated and the results were discussed, additional insights gathered, conclusions drawn from the study refined, and future interventions and policy recommendations proposed.

This study examined the practices and feedback of 33 farmers from different regions across Lebanon including the Bekaa, Chouf, Tyre, Batroun, and Zgharta. In the first phase of the study, a preliminary interview was conducted with 14 farmers which supported the design of a more comprehensive interview questionnaire that would take place in the second phase of the study. From the initial pool of 14 interviewees, nine were included in the study due to their practices being more in line with agroecology. The remaining five, practicing either conventional agriculture or having completely abandoned farming, were not included. In the second phase, an additional 24 farmers were added to the pool of interviewees and 24 in-depth interviews were conducted individually with these farmers. Table 1 outlines the location of farmers interviewed, the type of interviews conducted, as well as other qualities.

All participating farmers were invited via snowball sampling methods, leveraging contacts from Jibal's fieldwork and networks, with their inclusion being strictly voluntary. The recruitment process was designed to ensure a diverse mix of farmers (see Table 1), factoring in variables such as gender, region, land size, land ownership, years of sustainable farming experience, and the extent to which they've incorporated agroecological practices (explained further in section 2.2). The bulk of the interviews were conducted on-site at the farms, enabling walk-throughs for gathering auxiliary observational data. While most interviews were carried out in-person, two were done virtually due to logistical constraints or based on the interviewees' preferences.

Nb	Name	Gender	Town	Governorate	Type of Interview	Land Ownership	Land size	Years utilizing sustainable methods
1	Qassem Al Zoaabi	Male	Saadnayel	Bekaa	Brief	-		
2	Samir Ashii	Male	Taanayel	Bekaa	Brief	-		
3	Jamal Hasan	Male	Batloun	Chouf	Brief	-		
4	Mazen Halawani	Male	Chouf	Chouf	Brief	-		
5	Fr. Ibrahim Bou Rjeili	Male	Zgharta	North	Brief	-		
6	Fawwaz Bassim	Male	Zgharta	North	Brief	-		
7	Maroun Jabbour	Male	Zgharta	North	Brief	-		
8	Youssef Finianos	Male	Zgharta	North	Brief	-		
9	Tarek Rabah	Male	South	South	Brief	-		
10	Alya Hazim	Female	El Jered	Akkar	In Depth	Yes		2 years
11	Hussein Mohammad	Male	Fnaidek	Akkar	In Depth	Yes		4 years
12	Faysal Khodor	Male	Mishmish	Akkar	In Depth	Yes	8,000 sqm	3 years
13	Bahaa Mahfouz	Male	Rahbeh	Akkar	Akkar	No	24,000sqm	1.5 years
14	Richard Hanna	Male	Rahbeh	Akkar	Akkar	Yes		10 years
15	Badawi Harfoush	Male	Saadnayel	Bekaa	Bekaa	No	500sqm	4 years
16	Intisar Al Jarrah	Female	Saadnayel	Bekaa	Bekaa	No	500sqm	3 years
17	Jawaher Al Ali	Female	Saadnayel	Bekaa	Bekaa	No	500sqm	4 years
18	Mohammad El Ali	Male	Saadnayel	Bekaa	Bekaa	No	500sqm	4 years
19	Safaa Al Jumaa	Female	Saadnayel	Bekaa	Bekaa	No	500 sqm	3 years
20	Ramzi and Wajdi Abou Saabr	Male	Ain Zhalta	Chouf	Chouf	Yes	15,000sqm	5 years
21	Kamal Temraz	Male	Barouk	Chouf	Chouf	Yes	6,000sqm	10 years
22	Tarek Kerbaj	Male	Barouk	Chouf	Chouf	Yes	28,000sqm	3 years
23	Nada Bou Wadi	Female	Batloun	Chouf	Chouf	Yes	2000sqm	Decades
24	Elias Rizk	Male	Damour	Chouf	Chouf	Yes	60,000sqm	3 years
25	Walid and Maysoon Nasreddine	Male (main)	Kfar Katra	Chouf	Chouf	Yes	3,000sqm	5 years
26	Georges Tekli	Male	Majdel Meouch	Chouf	Chouf	No	300,000sqm	2 years
27	Rabih Saber	Male	Majdel Meouch	Chouf	Chouf	No	9,000sqm	3 years
28	Tony Khalil	Male	Majdel Meouch	Chouf	Chouf	No	15,000sqm	9 years
29	Jihad Bou Rjeile	Male	Serjbel	Chouf	Chouf	Yes	4,000sqm	3 years
30	Rjeili Bou Rjeili	Male	Serjbel	Chouf	Chouf	Yes	20,000sqm	Months
31	Karim Arsanios	Male	Batroun	North	North	Yes	30,000sqm	30 years
32	Karim El Hassan	Male	Kadmous	South	South	Yes	1,200sqm	3 years
33	Akil Ezzedine	Male	Tyre	South	South	Yes	6,000sqm	Decades

Table 1: List of farmers interviewed in this study.

The semi-structured interview questionnaire asked farmers questions that sought to uncover the main factors that led farmers to shift their farming practices. After analyzing the interview data qualitatively, main themes related to enabling factors for adoption of sustainable agriculture emerged. Jibal also utilized observational data from prior experiences supporting farmers in the transition from sustainable to conventional to tag on the additional 4 factors (farming objective, type of cultivation, land ownership, and access to inputs). This observational data was a result of analysis of training and coaching reports, field observations, and interactions with various stakeholders. It was collected over the span of two years while Jibal was involved in supporting 120 farmers to shift to sustainable practices. These 120 farmers were situated in multiple villages within the Bekaa and Mount Lebanon governorates.

Following analysis and identification of the enabling factors, findings were shared and discussed during a one-hour focus group session. This discussion included representatives from Jibal: Corinne Jabbour and Zeina Fahed, alongside seasoned farmer trainers: Khaled Sleem, Ghassan Al Salman, and Serge Harfouche as well as manager of the solidarity grocery "Dikken El Mazraa," Karim Hakim. The purpose of the focus group was to validate the results, gather additional insights, refine the conclusions, and guide future interventions. Conclusions drawn from this focus group discussion are presented in the same section as the list of enabling factors.

This study does present some limitations, such as the relatively small sample size of farmers interviewed (33 in total), and the ranking of enabling factors based on the number of mentions rather than their perceived impact. To further refine our understanding, a larger sample size, accompanied by a questionnaire designed to specifically measure the importance of each factor in the farmers' decision-making process, could be beneficial. Another aspect that could be beneficial to study would be the impact on the scale (level) and extent (area of land) of agroecology adoption.

6

Results:
Shifting to Sustainable Practices in Lebanon

6.1 The Practices Adopted by the Farmers
6.2 The Enabling Factors
6.3 Focus Group Discussion

> “Among the farmers interviewed, the application of **compost** and **manure emerged** as the most **prevalent practices.**”

Source: Compost still life concept, freepik.com

This section presents the results of interviews conducted with farmers, as well as the field observations by the coaches, and the expert opinions from the focus group discussion. First, we present the farming practices of farmers interviewed to contextualize the agroecological level of their farm (re: Gliessman's agroecological levels). Information around their sustainable farming practices indirectly revealed insights regarding why farmers may have shifted. Second, we present the enabling factors directly mentioned or identified by the farmers, those mentioned by trainers working directly with farmers, and the relevant points mentioned in the focus group discussion.

6.1 The Practices Adopted by the Farmers

Regarding soil management, among the farmers interviewed, the application of compost and manure emerged as the most prevalent practices. Recollection of traditional knowledge played a significant role, as many farmers had inherited the practice of using manure and composting was considered an extension of this practice. Georges, one farmer interviewed, described their transition to new soil management methods: "Before, we used to use manure but since we got trained on sustainable agriculture, we now mix it with pruning leftovers and let it ferment before we spread it". Only 10 farmers out of the 24 interviewed utilized nitrogen-fixing crops, while 15 out of 24 employed conservation tilling to mitigate the adverse effects of conventional traditional tilling on soil health. As for green cover, a mere 9 out of 24 of the sustainable farmers confirmed its use. Their approach mostly involved preserving wild weeds during the winter season and subsequently removing them as part of their spring planting preparations. Furthermore, the utilization of mulch among these farmers was found to be limited, with only one-third of the interviewees applying it to their land. Even windbreaks, once prevalent in Lebanese agriculture, were present on only 3 of the surveyed farmers' lands. Most of these windbreaks were pre-existing and not deliberately planted by the farmers themselves. Remarkably, even among farmers practicing sustainable agriculture, there persists a misconception that tilling is beneficial for soil health, with 8 out of 24 inaccurately considering it a method of soil improvement or a necessary evil for weed management.

For pest management, a significant majority of the farmers (21 out of 24) heavily rely on the utilization of homemade do-it-yourself (DIY) natural pesticides. These homemade mixtures consist of various ingredients such as garlic, pepper, onion, soap, nettle, chinaberry (Melia Azedarach), and oils. In addition to this, around half of the farmers mentioned incorporating companion plants, including flowers and aromatics, into their pest management strategies. These companion plants serve multiple functions, such as repelling or trapping pests, attracting beneficial insects, and enhancing soil fertility. Furthermore, less than half of the farmers surveyed make use of store bought organic pesticides (ex: Bacillus thuringiensis Bt), as part of their pest management practices. However, it is worth noting that despite usage of homemade or store bought organic pesticides, a quarter of the surveyed farmers still resort to the application of chemical pesticides in the event of severe infestations. Nonetheless, the quantities of chemical pesticides used have significantly decreased, as highlighted by Hussein Mohammad, who stated, "we used to spray 10 times, now we spray once."

Tomato plants pose a real challenge for farmers striving to eliminate pesticide usage completely. Farmers have encountered difficulties due to the recent surge in the frequency and scale of the Tuta Absoluta (also called tomato leaf miner) infestations, which often cause substantial or total destruction of tomato plants during tomato growing season.[46]

46. Dalida Darazy, Elias Zgheib, Johnny Nehme, Marwan Dagher, and Dani Fadel. 2021. "Comparative Study Between ATOMES Novels, NOVOSECT SC21®, ATO BED BUG® and NEO-BOOST® as a Bio-organic Solution in Managing Tomato Open Field Plantation in Hrajel Area in Lebanon." Journal of Agricultural Science, Vol. 13, No. 8 (2021). https://doi.org/10.5539/jas.v13n8p1

Nb	Name	Soil management	Pest management	Weed management	Type of crops	Foraging wild herbs	Crop Rotation	Animal farming	Trained by an NGO
1	Alya Hazim	Soil cover, compost and manure, conservation tilling, legumes for N-fixation	Companion plants, organic and DIY pesticides, chemical pesticides rarely (for potatoes)	Manual, animal grazing, cover crops, tilling		Yes	Yes	No	No
2	Hussein Mohammad	Soil cover, compost, manure, conservation tilling, legumes for N-fixation	Companion plants, organic and DIY pesticides	Mulch, occultation (temporary dark plastic cover)	Vegetables, trees, aromatics	No		No	Yes
3	Faysal Khodor	Soil cover, compost, manure, mulch, conservation tilling	Organic and DIY pesticides	Manual, mulch	Vegetables, cereals, aromatics	No		No	Yes
4	Bahaa Mahfouz	Compost, manure	DIY pesticides	Manual, tilling	Vegetables, cereals	No		Yes	Yes
5	Richard Hanna	Soil cover, manure, conservation tilling	Companion plants, organic and DIY pesticides	Manual, cover crops	Vegetables, trees, aromatics	No		No	No
6	Badawi Harfoush	Compost and manure, mulch, conservation tilling, legumes for N-fixation	Companion plants, DIY pesticides	Manual, mulch, tilling	Vegetables, aromatics	Yes	Yes	No	Yes
7	Intisar Al Jarrah	Compost and manure, mulch, conservation tilling	Companion plants, DIY pesticides	Manual	Vegetables, aromatics	Yes	Yes	Yes	Yes
8	Jawaher Al Ali	Compost and manure, mulch, conservation tilling, legumes for N-fixation	Companion plants, DIY pesticides	Manual, mulch	Vegetables, aromatics	Yes	Yes	Yes	Yes
9	Mohammad El Ali	Conservation tilling, legumes for N-fixation	DIY pesticides	Manual	Vegetables, aromatics	Yes	Yes	Yes	Yes
10	Safaa Al Jumaa	Compost, manure, legumes for N-fixation	DIY pesticides	Manual	Vegetables	No	Yes	No	Yes
11	Ramzi and Wajdi Abou Saab	Soil cover, compost, manure, mulch, conservation tilling, legumes for N-fixation	Companion plants, organic and DIY pesticides	Manual, animal grazing, cover crops, sallow tilling, burning	Vegetables, cereals, trees, aromatics	Yes	Yes	Yes	Yes
12	Kamal Temraz	Manure	Companion plants, DIY pesticides, chemical pesticides rarely (for mice by wall)	Manual, animal grazing, tilling	Vegetables, trees, aromatics	Yes	Yes	Yes	Yes

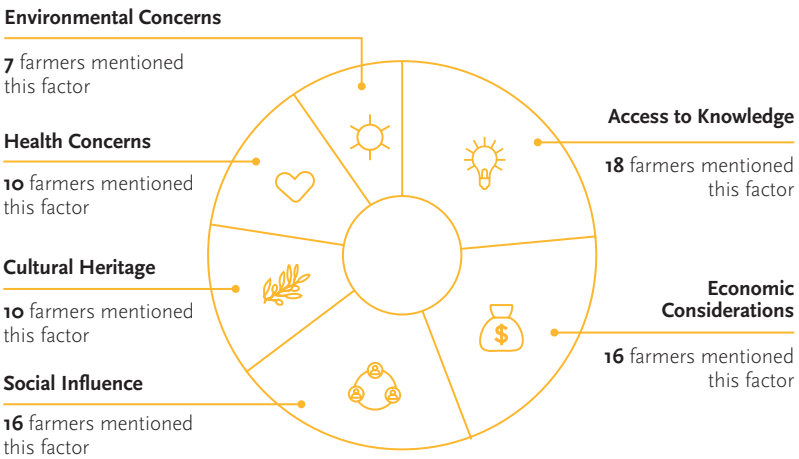
Table 2: Farmer Agricultural Practices.

Nb	Name	Soil management	Pest management	Weed management	Type of crops	Foraging wild herbs	Crop Rotation	Animal farming	Trained by an NGO
13	Tarek Kerbaj	Compost	DIY pesticides	Manual, tilling	Vegetables, trees	No	Yes	Yes	Yes
14	Nada Bou Wadi	Soil cover, compost and manure, conservation tilling, legumes for N-fixation	DIY pesticides	Manual, cover crops	Vegetables, trees, aromatics	Yes	Yes	Yes	Yes
15	Elias Rizk			Manual	Vegetables, trees, aromatics	Yes	No	No	No
16	Maysoon and Walid Nasreddine		Companion plants, organic and DIY pesticides	Manual	Vegetables, aromatics	Yes		No	Yes
17	Georges Tekli	Soil cover, compost, manure, conservation tilling	Companion plants, organic and DIY pesticides, chemical pesticides for infestations	Manual, animal grazing, cover crops, tilling	Vegetables, trees, aromatics	Yes	Yes	Yes	Yes
18	Rabih Saber	Legumes for N-fixation, compost, manure, conservation tilling	Companion plants, organic pesticides, chemical pesticides for infestations	Manual, animal grazing	Vegetables, cereals, trees, aromatics	No	Yes	Yes	Yes
19	Tony Khalil	Compost, manure	Companion plants, organic and DIY pesticides, chemical pesticides for infestations	Manual, animal grazing, cover crops, tilling, herbicide rarely	Vegetables, aromatics	No	Yes	Yes	Yes
20	Jihad Bou Rjeile	Compost, conservation tilling	DIY pesticides	Manual, animal grazing	Vegetables, trees, aromatics	Yes	Yes	Yes	Yes
21	Rjeili Bou Rjeili	Compost and Manure		Cutting	Vegetables, trees	Yes	Yes	No	Yes
22	Karim Arsanios	Compost and conservation tilling		Manual, animal grazing, tilling	Trees, aromatics	No	No	Yes	No
23	Karim El Hassan	Soil cover, compost, manure, legumes for N-fixation, mulch, windbreaks	DIY pesticides	Manual, mulch, tilling	Vegetables, trees, aromatics	Yes	Yes	No	No
24	Akil Ezzedine	Soil cover, compost, manure, conservation tilling, legumes for N-fixation, windbreaks	Companion plants, DIY pesticides, nets	Manual, mulch, cover crops	Vegetables, trees, aromatics	Yes	Yes	Yes	Yes

Table 2: Farmer Agricultural Practices.

6.2 The Enabling Factors

The main six enabling factors identified through this study are mentioned in the table below. These were extrapolated from the in-depth interviews conducted with the 33 farmers. The other four enabling factors mentioned in the section that follows were the result of the observations and deductions of coaches and trainers who worked with a group of 120 farmers over two years. Relevant points from the discussions of the expert focus group are also included in this section and a summary follows in the next section.Ranked in descending order from most to least mentioned, the following are the main enabling factors that appear to be most influential in fostering the adoption of sustainable agricultural practices among our pool of interviewees:



47. A. Chalak, A. Irani, J. Chaaban, I. Bashour, K. Seyfert, K. Smoot, G.K. Abebe. 2017. "Farmers' Willingness to Adopt Conservation Agriculture: New Evidence from Lebanon." Environ Manage. 2017 Oct;60(4):693-704. https://doi.org/10.1007/s00267-017-0904-6

1. Access to knowledge:

Farmers need access to accurate and up-to-date information on sustainable agricultural practices to empower them to make informed decisions and implement sustainable practices effectively. Access to knowledge can be facilitated through training programs, workshops, demonstration farms (model or lighthouse farms), and extension services such as those offered by NGOs.

Among the interviewed farmers, a substantial majority (18 out of 33) had participated in training sessions and received coaching from various non-governmental organizations (NGOs) such as Chouf Biosphere, Buzuruna Juzuruna, Jibal, SOILS, and Mada. The influence of specific experts during these sessions, who provided ongoing support and problem-solving assistance, was frequently acknowledged by the farmers. It is worth noting that the data may exhibit a bias towards this factor as the most important due to the nature of the sampling method. The majority of the farmers interviewed were a part of Jibal's network, either through participation in the organization's projects or through the network of colleagues who are actively involved in NGOs also working on projects centered around agroecology and food sovereignty.

These findings support the previous studies conducted in Lebanon stating that knowledge, whether gained through experience, information sources, training sessions, or understanding the long-term effects of conservation agriculture, is the primary factor influencing farmer adoption behavior.[47]

During the Focus Group Discussion, trainers acknowledged the crucial role of access to knowledge in promoting the adoption of sustainable agriculture practices. "Training farmers in problem-solving is of the utmost importance, particularly with problems like pest infestations, which can present significant potential losses and can prompt farmers to revert to conventional methods" said expert Khaled Sleem. The group agreed on the importance of extended interventions and the presence of consistent support over multiple years. A deep-rooted partnership is crucial to prevent a shift back to chemically-intensive methods. Notably, agroecology expert Ghassan Al Salman commented, "the highest risk of reverting to conventional farming arises when the transition lacks a comprehensive design." He continues, "a farmer switching from chemical to sustainable agriculture but continuing with monocultures is essentially practicing chemical agriculture without the chemicals. This isn't sustainable, and the farmer will likely revert in times of crisis." The focus group participants strongly agreed with this sentiment.

2. Economic considerations:

Economic considerations were the second most frequently mentioned enabling factor (16 out of 33). Mention of this factor manifested in multiple different ways as explained below.

a. Access to Market: A significant contributor to the financial strain on farmers is limited access to markets. Hussein Mhammad and Faysal Khodor, both based in Akkar, explicitly highlighted the crucial role of the NGO Mada in supporting them by purchasing their produce. They emphasized that without this support, they would struggle to sell their products at fair prices, particularly considering their distance from Beirut, a main market hub. This struggle is a common challenge faced by numerous farmers, particularly due to increased transportation costs.

16 of the 24 farmers interviewed mentioned that they believe that the market for sustainably grown crops in Lebanon is not big enough. They note that it needs more marketing and awareness campaigns: "The primary assistance we need revolves around selling our produce. We require a market that values naturally grown products," says Tarek Kerbaj. "Unfortunately, customers often prioritize aesthetic appeal over quality and flavor," adds Toni Khalil, indicating that consumer preference does not sufficiently value the quality of the produce or the farming methods employed. He elaborates further on this problem, particularly regarding locally made preserves known as 'mouneh':

"We used to produce a diverse range of 'mouneh', but we've had to stop due to the lack of a fair market. For example, it costs between 6 to 8 dollars to produce a single, high-quality bottle of mulberry syrup. Yet, no one is willing to pay that price, so we discontinued its production. Just this season, we had to leave our mulberries to fall and waste on the ground."

To boost consumption, several interviewees proposed focusing on marketing and raising awareness about eco-friendly products. They envisioned positioning these products as a desirable "trend" among consumers, thus driving demand. Furthermore, the farmers expressed

a strong interest in exploring alternative avenues and markets to engage directly with consumers. During regular meetings conducted with farmers by Jibal, the problem of a "market shortage" consistently and repeatedly emerges as one of the most significant challenges faced. Many also noted that bettering the pricing of the crops to be more fair would improve their financial stability. Regarding pricing of their farm products, they acknowledge the delicate balance needed to ensure that they are still affordable to consumers. This perspective on the importance of access to market was further underscored in the focus group discussion held.

Agroecology specialist Khaled Sleem, along with Karim Hakim, highlighted the challenges posed by the constrained market access for sustainable products. They remarked how the limited market access imposes an economic burden, and can obstruct the upscaling of agroecology or sustainable agricultural practices in Lebanon. They emphasized that this market gap and the financial problems it creates makes in-kind support all the more crucial as a transitional aid. "We require a superior alternative to the conventional wholesale market; we require a better way of increasing farmers' income by training them to foster land equivalent profitability by multi-cropping... a transformative strategy is needed to foster trust between consumers and producers. Without addressing the market dilemma, we'll find ourselves in a perpetual loop" remarked agroecology expert Khaled Sleem. This view resonated among the group members.

- **b. Expenses:** Reduction of expenses such as input cost, or transportation cost play an important role in encouraging a transition into different farming practices since expenses pose one of the main challenges for farmers. When directly asked about the primary challenges encountered on their farms, many pointed to escalating expenses as a significant burden. Specifically, they mention rises in fuel and transportation costs as well as mounting expenses associated with labor, land rental, and the recurring costs of essential inputs such as manure and mulch. Sustainable methods adopted by many farmers were often chosen to reduce expenses. For example, Rabih Saber, who farms land in Majd El Meouch, mentions one sustainable farming technique that helps him save on costs. He says, "I am trying no-till farming this year, it will save me cost in machine rental and labor, so far it's going well, let's see!"

Safaa Aljumaa mentioned that during her time working on her employer's land, chemical fertilizer was exchanged for the use of compost and manure because the chemicals became too expensive. The desire to reduce expenditures associated with the purchase of synthetic fertilizers and pesticides was echoed often by the farmers interviewed. However, it's important to note that sustainable inputs like manure and compost are increasingly regarded as valuable commodities and often further strain farmers' budgets. Due to their previous unpopularity, they were either provided at no cost or made available at more affordable rates.

Access to affordable rental prices or ownership of land reduces expenses on farmers and appears to be an enabling factor for sustainable farming. Among those interviewed, 15 out of 24 either owned their land or had partial ownership and supplemented their farming activities by renting or borrowing additional plots. The

remaining 9 farmers who did not own any land had access to rented or borrowed land at reduced prices or for free. This was thanks to support from NGOs or the church. This reduced or waived cost plays a critical role in enabling them to sustain their farming operations.

Several farmers mentioned solutions that they envision would alleviate their challenges and further support sustainable farming. These include securing funding for transportation, essential repairs, and vital inputs such as compost, mulch, seeds, and natural pesticides.

c. Economic crises: Economic crises caused by political, security, or other factors, such as the 2006 war, the COVID-19 pandemic, or the recent inflation in Lebanon, were frequently mentioned by the farmers interviewed. These crises had various impacts, including rekindling people's connection to their land, motivating farmers to expand their farming areas, prompting individuals to return to their family farming legacy after working in unrelated fields, and encouraging a transition to less chemically intensive farming practices due to the rise in pesticide and fertilizer costs.

Economic factors seem to be one of the main disabling and enabling factors. All the farmers mentioned in this study alluded to the financial struggles they were experiencing, "I don't think I will do this much longer, it is becoming a waste of time and effort," said Kamal Termaz. This sentiment to quit if the situation in Lebanon does not improve was explicitly echoed by 3 other farmers interviewed. Whereas relief from economic burdens, such as the availability of funding as in-kind contributions facilitating the acquisition of materials including compost, mulch, manure, plants, seeds, and do-it-yourself (DIY) natural pesticides, enabled the transition into sustainable practices for farmers.

This echoes with the data found in this study since extension services include access to knowledge and in kind support (goods, services, material, tools... instead of cash) providing relieving economic burden (the top 2 ranking factors mentioned in this research), closeness to market increases access to market and reduces cost of transportation, and off farm income increases economic security, all of which impact economic concerns (the 2nd ranking factor in this research). "In-kind support serves as an initial catalyst, yet it does not constitute a sustainable framework. It is essential that farmers undergo training in input production, otherwise, there exists a substantial risk of returning to conventional practices as soon as the necessity to procure inputs emerges," remarked agroecology expert Serge Harfoush during the focus group discussion. The discussion further illuminated that in-kind support can sometimes lure farmers to attend training sessions solely for the immediate financial relief, even if they lack genuine interest in or intention to adopt sustainable practices.

3. Social influence:

This section focuses on the social aspects that enable farmers to shift to sustainable practices. These social aspects can include what other farmers do (descriptive norms), expectations placed on the farmer (injunctive norms), or being part of a network (e.g. market, collective, or cooperative). Around half of farmers (16 out of 33) reported the positive influence of trainers,

organizations, or fellow farmers they were trained with on sustainable farming. Half of the farmers also focused on the influence of being members of networks which provided support, exchanged knowledge, and provided motivation for sustainable agricultural practices. Two farmers interviewed also noted that they were introduced to sustainable farming through their social network. For example, Karim El Hasan says: "I first heard about permaculture from a friend who was working on a permaculture project in Ethiopia."

In the focus group discussion, Ghassan Al Salman underscored the potential negative repercussions of social influence, emphasizing that the absence of community support had hindered the sustainability of various potentially successful farm models over the years. He stressed the paramount importance of social support for the viability of any farm.

4. Cultural heritage:

A third of the farmers (10 out of 33) emphasized the influence of previous generations in their families who practiced sustainable farming. This heritage of sustainable farming techniques provided a sense of familiarity and ease in adopting sustainable methods. Alya Hazim, who farms in Akkar, expressed a mission "to revive ancestral grains and knowledge of wheat and grain cultivation, advocating for the incorporation of ancestral grains into everyday food by making it trendy." Alya perceives ancestral agricultural practices as not merely about farming methods, but also as a means of "Decolonization of our own minds and our bodies...this happens with food!". Karim Arsanios produces olive oil from his farm of organic olive trees in the Batroun area. He explains that his father did not put any chemicals on the trees which influenced him to do the same. Safaa' Assaf, a Syrian woman who lives in the Bekaa, plants mainly vegetables for personal use while also working as an agricultural worker on other people's lands. She says that previously, in Syria, "we didn't have chemical fertilizers, we used to use manure. When we came to Lebanon, we saw how much they use chemicals here." This was also true for pesticides: "I can't remember my father spraying anything on meqte (armenian cucumbers), for example." She recollects how the crops planted in the summer would barely be irrigated. In other words, varieties chosen for planting were better adapted to the local climate. Most of the farmers interviewed came from a family of farmers, or from families who owned farm land and even families that owned the land that they farmed. During the interviews, some farmers mentioned farming traditions that existed in their villages. Georges Tekli, an experienced farmer from Majdel Meouch recalls fondly how his parents" used to sprinkle grains on the surface of the snow to feed the partridge birds (alhajal) and help them survive the harsh winter days, or how when we went to the olive harvest we kept some olives in the higher branches of the trees because my father said the birds need to eat. There was generosity there, the people were generous and the land was generous!". He still practices the traditional methods he learned. One traditional technique has to do with utilizing a specific combination of different animal manure (sheep, horse, or chicken manure) at different stages of the plant's life to optimize growth and production. Another farmer, Akil Ezzedine, recalls how "the birds used to eat so much of our grapes, and yet my father would never let

us kill them!" Though these were mostly lost traditions, they're recollections portrayed the sustainable approach of traditional farming and the appreciation for biodiversity that existed in traditional wisdom.

5. Health concerns:

Health considerations served as a motivating factor for around one third of the farmers interviewed (10 out of 33). "I used to have migraines a long time ago, I cured myself with food," said Maysoun Nasreddine who was interviewed at her restaurant in Kfar Katra El Chouf. By transitioning to a vegan lifestyle, she discovered a community focused on healthy food, including Kamal Mouzawak who later started Souk El Tayyeb, a farmer's market in Beirut. Richard Hanna also recounts a health crisis that acted as a wake-up call to the dangers of chemically-intensive agriculture: "When my parents fell ill, I began researching the factors that contribute to bodily toxicity. One of the main culprits I discovered was food. While there are other factors involved, I realized that food is something we can control."

6. Environmental concerns:

A moral obligation to protect the environment emerged as a significant motivator for several interviewees (7 out of 33). For example, one farmer, Akil Ezzedine began planting crops that were traditionally grown in his village and did not require pesticides which included wheat, barley, and corn. Akil says that "the environment exists in a complete manner, where all the elements balance each other, even insects like the ladybug are needed to make it healthy. When people spray synthetic chemicals, they kill everything, harming the environment including themselves. My goal is to protect both our health and the environment." While most farmers mentioned the environment during the interviews, these 7 farmers expressed a deep-seated concern for environmental sustainability.The fact that they were driven to adopt sustainable agriculture practices as a means to contribute to the preservation of natural resources and ecosystems is notable here.

7. Other factors:

Some additional enabling factors are included here. These were deduced as a result of a project evaluation that included training sessions for 120 farmers facilitated over a two-year period (2021-2022) in several villages in Mount Lebanon and Bekaa governorates.

a. Farming objective: Whether the farmer is planting for personal subsistence or for selling greatly influences willingness to transition to sustainable or not. Farmers who plant mainly for subsistence usually operate on a small farm (less than 10,000 m2) and are more likely to diversify their crops, reduce chemical interventions to none and introduce more sustainable farming methods since they will be feeding themselves and their families. Also, they do not need to produce a specific amount of farm products to ensure their livelihoods unlike farmers who are selling their produce. Farms operating for selling are usually medium to large plots (above 10,000 m2), and have more reluctance in diversifying their produce

and reducing chemical interventions since it will threaten their production in the short term, and by extension, their profits and livelihood.

- **b. Type of cultivation:** Established tree plantations, for example, are harder to transition, since they usually consist of fruit or nut tree monocultures. These cannot be managed in a sustainable way without diversification, which may require replacing some existing trees. This requires a long term plan and commitment, as trees take several years for production to provide fruits. "Orchard farmers will only start diversifying when one crop is not profitable anymore" says trainer Charbel Tawk, "one of the farmers I coached started diversifying because apples were no longer profitable for him". On the other hand, farms with vegetables crops are more prone to change their practice since they plant new crops once or twice a year, making any changes easier to apply and reverse.

- **c. Rented or owned lands:** Farmers who rent their lands have less agency over what they choose to do on their lands, so they are less likely to introduce trees, for example, since it might be a big investment for a land that is not theirs. Farmers who rent are also less likely to focus on building their soil health since they don't have long-term insurance of the land. An agroecological trainer of farmers from Buzuruna Juzuruna, Walid Al Youssef, says, "I was insisting on introducing trees into the system, but most of them rented their lands so they couldn't plant trees because the trees need around 5 years to start producing... it is simply inconvenient for them."

- **d. Access to inputs (compost, DIY pesticides, seeds, mulch...):** Most farmers do not have the time or the knowledge and ability to produce their own compost, DIY pesticides, or fertilizers. These inputs should be made locally available and affordance to replace conventional inputs. Planting cover crops and mulching, which are important sustainable practices, require the purchase of big quantities of seeds and mulch, which is not always feasible for many farmers. While farmers could purchase wood chippers to make their own mulch and compost, these machines are expensive and are not needed frequently by farmers. Ideally, this machinery could be purchased and shared by a group of farmers in a certain area or by members of a cooperative. Farmers who produce large amounts of these inputs on site find adoption of sustainable practices more practical and feasible.

6.3 Focus Group Discussion

In line with the findings of this study, the consensus from the focus group discussion emphasized the need to enhance sustainable practices by:

- **Boosting the productivity of sustainable systems:** This can be achieved through knowledge enhancement, accompanied by in-kind support to assist farmers during the experimental and transitional phases, and availability of more developed sustainable model farms.

- **Market Expansion:** Concurrently, market expansion efforts should be undertaken through diverse approaches, including Community Supported Agriculture (CSA) which can help address challenges from several perspectives.

7

7. Summary

This study identifies several crucial factors that have an impact on Lebanese farmers' adoption of agroecology, most of which are in line with existing literature. These factors include:

- **Cognitive factors:**

  a. Access to Knowledge: Extension services, training especially with NGOs, access to data and research, perceived control, and presence of model farms...

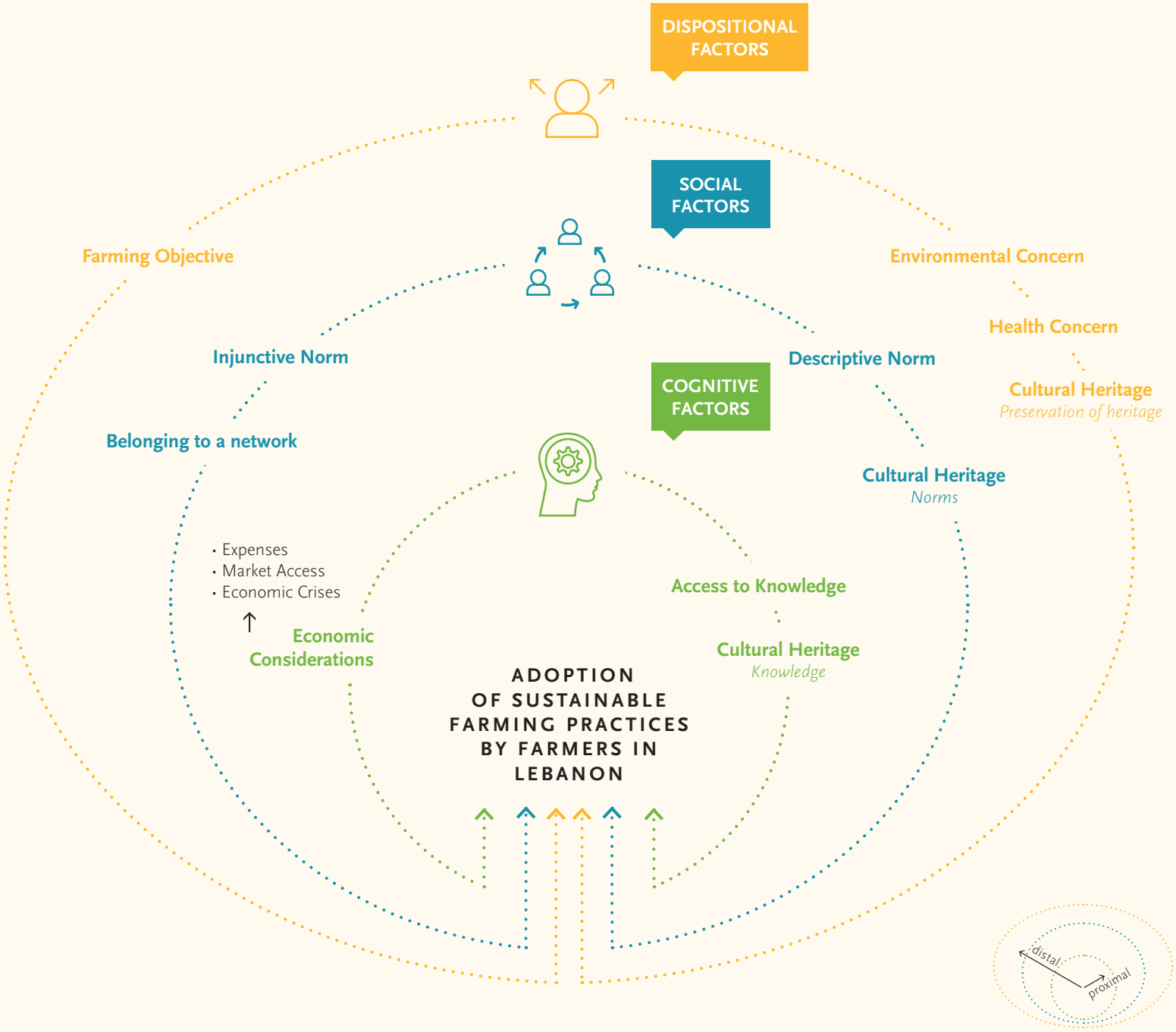
  b. Economic considerations: Expenses, access to market, economic crises, access to inputs, availability of funds, and a profitable economic model...

- **Social factors:** Descriptive norms and injunctive norms, being part of farmers associations or networks, cultural heritage...

- **Behavioral factors:** Disposition of the farmer, farming objectives, health and environmental concerns, and other underlying conditions (e.g. age, education, farm size).

It is evident that farmers are influenced by a multitude of complex and interconnected factors, highlighting the need of a holistic approach in addressing these issues. It is also clear that different types of farmers require varying levels and types of support to transition effectively to sustainable practices.

An integrated framework of behavioral factors affecting farmers in Lebanon in their adoption of environmentally sustainable practices, Adapted from Dessart 2018 with data gathered by Jibal.[48]



48. François J. Dessart et al. 2018. "Behavioral Factors Affecting the Adoption of Sustainable Farming Practices: a Policy-Oriented Review." European Review of Agricultural Economics, Volume 46, Issue 3, July 2019, Pages 417–471. https://doi.org/10.1093/erae/jbz019

8

Recommendations

In response to the findings, a set of diverse recommendations to synergistically enhance and facilitate the adoption of sustainable agriculture by farmers is proposed.

Enhance Access to Knowledge: Both governmental and non-governmental organizations should commit to offering continuous technical training, coaching, and farmer to farmer mentorship programs that focus on sustainable agricultural practices. This effort should be complemented by providing in-kind support (further elaborated in the next point). The training should extend beyond just farming techniques and encompass a diverse array of topics, spanning from financial record-keeping to cooperative organizing. The latter aspect equips farmers with abilities that foster organization among themselves and with other stakeholders within the food system.

Establish Local Model Farms: Creating local model farms, sometimes referred to as Lighthouse Farms, involves implementing sustainable practices systematically while showcasing a viable economic model. These farms act as a demonstration of the feasibility and financial sustainability of this system, and can play the role of regional sustainable agriculture innovation hubs.

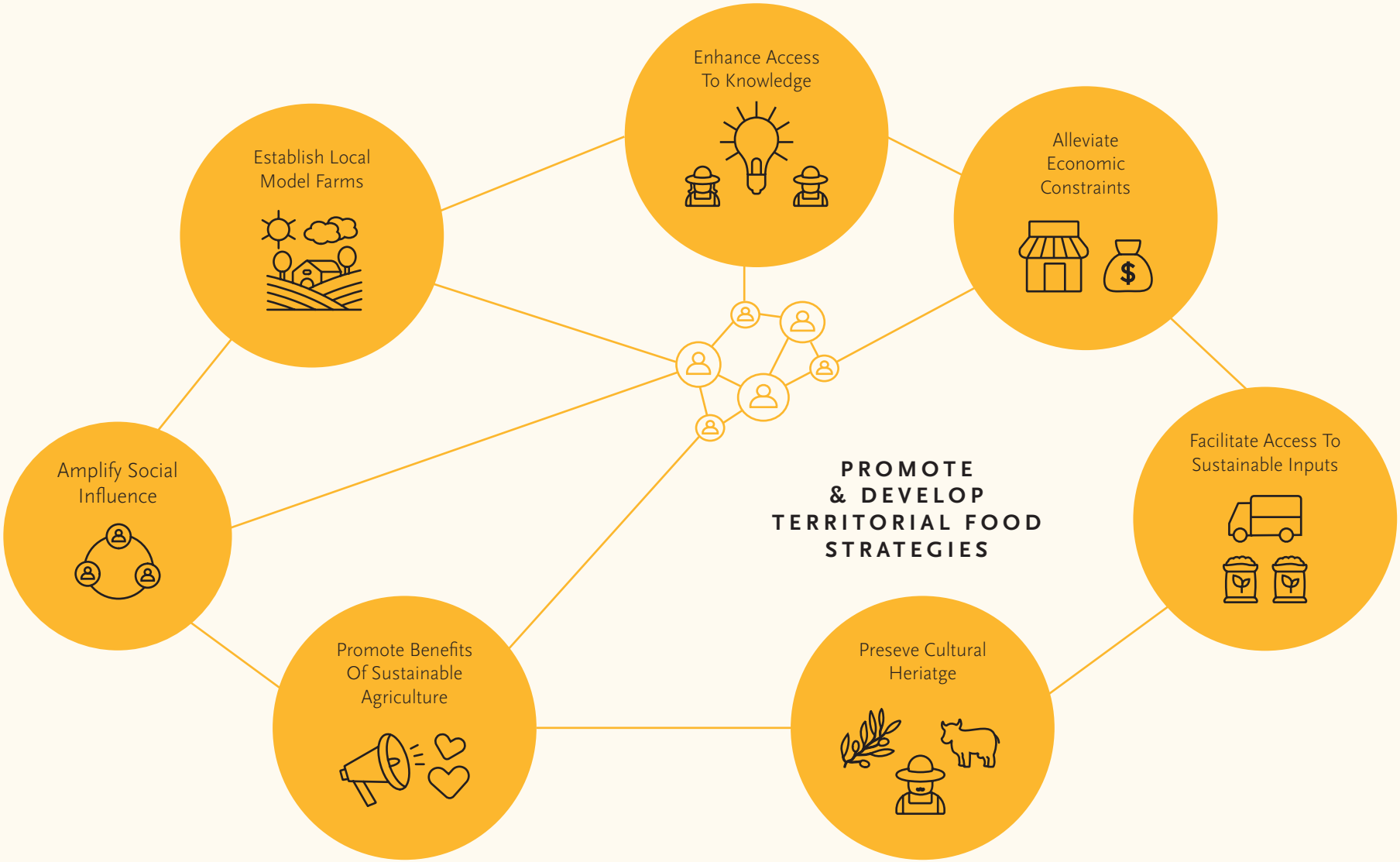
Alleviate Economic Constraints: To mitigate the economic challenges encountered by farmers, both policy and market reforms are necessary. These could involve the endorsement of fair pricing mechanisms, provision of subsidies and affordable loans for those transitioning to sustainable practices, and ensuring greater accessibility to funds for essential farming inputs and transportation. In the scope of a project, providing in-kind support can ease these barriers, creating a buffer for farmers taking the leap towards sustainability. This acts as a safeguard, encouraging and simplifying the transition to sustainable agriculture.

Amplify Social Influence: Bolstering farmer networks, cooperatives, syndicates, and associations can substantially contribute to promoting agroecology and facilitating its widespread adoption. These networks can serve as platforms for peer-to-peer support, shared learning, and collective bargaining power in the marketplace.

Promote the Benefits of Sustainable Agriculture: Awareness campaigns highlighting the health, environmental, economic, and social benefits of agroecology can influence both farmers and consumers. Educating consumers about the quality and health benefits of sustainably grown crops can create more demand and support fair pricing for such produce. Educating young people about the benefits of sustainable agriculture through partnerships with schools, universities, or youth leadership programs could also foster enduring positive impacts.

Facilitate Access to Sustainable Inputs: Measures to enhance local availability of essential sustainable inputs

Recommendations for enhancing and facilitating the adoption of sustainable agriculture by farmers, by Jibal, based on analysis of the findings of the study "Enabling Factors for the Adoption of Sustainable Agriculture in Lebanon" 2023.



like compost, natural pesticides, and seeds can facilitate the transition to sustainable practices. Strategies might encompass creating directories to link farmers with input suppliers, or training initiatives to empower farmers to generate these inputs on their own farms or through collaborative efforts within collectives or cooperatives.

Preserve Cultural Heritage: Initiatives that recognize and promote traditional and ancestral agricultural practices can motivate farmers towards sustainable adoption. A significant portion of agricultural heritage, particularly localized knowledge unique to different regions, is eroding.. Such efforts also contribute to the conservation of Lebanon's rich cultural legacy of farming.

Promote and Develop Territorial Food Strategies: These strategies, when applied with the aim of furthering food sovereignty, encompass creating region-specific comprehensive plans that among other things, optimize the management of local resources, minimize expenses, and localize the food web. They actively promote the consumption of locally and sustainably cultivated and transformed products, thereby broadening market access for farmers engaged in sustainable farming practices. By prioritizing local production and consumption, these strategies aim to build resilient local economies, reduce environmental impact associated with extensive product transportation, and contribute to the overall food sovereignty of the region.

In conclusion, promoting sustainable agriculture practices in Lebanon requires a holistic approach that addresses the interconnected challenges faced by farmers. The recommendations provided in this study could significantly contribute to the advancement and upscaling of sustainable farming practices in the country.

Bibliography

A. Aden. et al. 2018. “Value Chain Analysis in the Bekaa Plain, Lebanon: Potatoes, Tomatoes, and Dairy products.” ICARDA - CACH. https://hdl.handle.net/20.500.11766/10360

A. Al Dirani, G.K. Abebe, R.A. Bahn, et al. 2021. “Exploring climate change adaptation practices and household food security in the Middle Eastern context: a case of small family farms in Central Bekaa, Lebanon.” Food Sec. 13, 1029–1047. https://doi.org/10.1007/s12571-021-01188-2

A. Chalak, A. Irani, et al. 2017. “Farmers› Willingness to Adopt Conservation Agriculture: New Evidence from Lebanon.” Environ Manage. 2017 Oct;60(4):693-704. https://doi.org/10.1007/s00267-017-0904-6

Ajzen Icek. 1991. “The Theory of Planned Behavior.” Organizational Behavior and Human Decision Processes, Volume 50, Issue 2, 1991, Pages 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Angela Saadeh and Corinne Jabbour. 2022. “The Agriculture Sector in Lebanon: Assessment of Farmer Needs.” Jibal internal publication.

Asiedu-Ayeh, Love Offeibea, Xungang Zheng, Kobina Agbodah, Bright Senyo Dogbe, and Adjei Peter Darko. 2022. «Promoting the Adoption of Agricultural Green Production Technologies for Sustainable Farming: A Multi-Attribute Decision Analysis.» Sustainability 14, no. 16: 9977. https://doi.org/10.3390/su14169977

Beirut Today. 2020 .الحاج حسن, ع., القطاع الزراعي ينهار ومزارعون يروون مآسيهم مع الدولار
https://beirut-today.com/ar/2020/07/07/%D8%A7%D9%84%D9%82%D8%B7%D8%A7%D8%B9-%D8%A7%D9%84%D8%B2%D8%B1%D8%A7%D8%B9%D9%8A-%D9%8A%D9%86%D9%87%D8%A7%D8%B1-%D9%88%D9%85%D8%B2%D8%A7%D8%B1%D8%B9%D9%88%D9%86-%D9%8A%D8%B1%D9%88%D9%88%D9%86-%D9%85/

Biovision 2020. https://www.agroecology-pool.org/

C. Béné, et al. 2019. “Exploring the Contribution of Social Innovations to the Resilience of Rural Communities and Ecosystems.” Ecology and Society, 24(2): 1-13. https://doi.org/10.5751/ES-10804-240202

CIHEAM. 2016. “Country Activity Report: Lebanon Edition 2015, CIHEAM.” CIHEAM. https://www.ciheam.org/uploads/attachments/155/CAR_Liban_-_2015.pdf

Clara I. Nicholls and Miguel A. Altieri 2018. “Pathways for the amplification of agroecology.” Agroecology and Sustainable Food Systems, 42, no. 10. https://doi.org/10.1080/21683565.2018.1499578

Clara I. Nicholls, and Miguel A. Altieri 2018. “Pathways for the amplification of agroecology.” Agroecology and Sustainable Food Systems, 42, no. 10. https://doi.org/10.1080/21683565.2018.1499578

Colin Ray Anderson, et al. 2019. «From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems Through Agroecology.» Sustainability 11, no. 19. https://doi.org/10.3390/su11195272

Colin Ray Anderson, Janneke Bruil, Michael Jahi Chappell, Csilla Kiss, and Michel Patrick Pimbert. 2019. «From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems Through Agroecology.» Sustainability 11, no. 19. https://doi.org/10.3390/su11195272

D.J. Pannell. 1999. “Social and Economic Challenges in the Development of Complex farming systems.” Agroforestry Systems, 45 (1/3): 395–411. https://doi.org/10.1023/A:1006282614791

Dalida Darazy, Elias Zgheib, Johnny Nehme, Marwan Dagher, and Dani Fadel. 2021. “Comparative Study Between ATOMES Novels, NOVOSECT SC21®, ATO BED BUG® and NEO-BOOST® as a Bio-organic Solution in Managing Tomato Open Field Plantation in Hrajel Area in Lebanon.›› Journal of Agricultural Science, Vol. 13, No. 8 (2021). https://doi.org/10.5539/jas.v13n8p1

Dmytro Serebrennikov, Fiona Thorne, Zein Kallas, and Sinéad N. McCarthy. 2020. «Factors Influencing Adoption of Sustainable Farming Practices in Europe: A Systemic Review of Empirical Literature.» Sustainability 12, no. 22. https://doi.org/10.3390/su12229719

FAO, “FAOSTAT.” FAO. http://www.fao.org/faostat/en/#data

FAO, EU, and CIRAD. 2022. «Food Systems Profile – Lebanon.» Statistical Yearbook World Food and Agriculture. https://doi.org/10.4060/cb9543en

FAO. 2008. “Sustainable Food Systems – Concept and Framework.” FAO. http://www.fao.org/3/ca2079en/CA2079EN.pdf

FAO. 2022. “The Future of Food and Agriculture Trends and Challenges.” FAO. https://www.fao.org/3/i6583e/i6583e.pdf

François J. Dessart et al. 2018. “Behavioral Factors Affecting the Adoption of Sustainable Farming Practices: a Policy-Oriented Review.” European Review of Agricultural Economics, Volume 46, Issue 3, July 2019, Pages 417–471. https://doi.org/10.1093/erae/jbz019

Gopal B. Thapa, and Kanokporn Rattanasuteerakul. 2011. “Adoption and Extent of Organic Vegetable Farming in Mahasarakham Province, Thailand.” Applied Geography, Volume 31, Issue 1, 2011, Pages 201-209, ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2010.04.004

J. O. Prochaska, and W. F. Velicer, 1997. “The Transtheoretical Model of Health Behavior Change.” American Journal of Health Promotion, 12(1), 38-48. https://doi.org/10.4278/0890-1171-12.1.38

J. Pretty. 2008. “Agricultural Sustainability: Concepts, Principles and Evidence.” Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1491): 447-465. https://doi.org/10.1098/rstb.2007.2163

Jules Pretty, and Zareen Pervez Bharucha. 2014. “Sustainable Intensification in Agricultural Systems.” Annals of Botany, Volume 114, Issue 8, December 2014, Pages 1571–1596. https://doi.org/10.1093/aob/mcu205

K. Arimi, K., and A. Omoare, 2021. “Motivating Cocoa Farmers to Adopt Agroforestry Practices for Mitigating Climate Change.” Renewable Agriculture and Food Systems, 36(6), 599-604. https://doi.org/10.1017/S1742170521000223

M. A. Altieri, and V. M. Toledo. 2011. “The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants.” Journal of Peasant Studies, 38(3): 587-612. https://doi.org/10.1080/03066150.2011.582947

M. A. Altieri, and V. M. Toledo. 2011. “The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants.” Journal of Peasant Studies, 38(3): 587-612. https://doi.org/10.1080/03066150.2011.582947

M. Crippa et al. 2021. “Food Systems are Responsible for a Third of Global Anthropogenic GHG Emissions.” Nat Food 2, 198–209. https://doi.org/10.1038/s43016-021-00225-9

Mateo Mier y Terán Giménez Cacho, et al. 2018. «Bringing Agroecology to Scale: Key Drivers and Emblematic Cases.» Agroecology and Sustainable Food Systems, 42(13):1-29. https://doi.org/10.1080/21683565.2018.1443313

MOA Lebanon. 2020. “National Agriculture Strategy 2020-2025.” Ministry of Agriculture. http://www.agriculture.gov.lb/getattachment/Ministry/Ministry-Strategy/strategy-2020-2025/NAS-web-Eng-7Sep2020.pdf?lang=ar-LB

Nathalie Allam. 2011. “Farming is Like Gambling: An Examination of the Decline of Produce Farming in Lebanon’s Central Bekaa Valley, PhD diss.” The George Washington University. https://scholarspace.library.gwu.edu/etd/9019s269z

Neha Chausali, and Jyoti Saxena. 2021. “Conventional Versus Organic Farming: Nutrient Status, Neha Chausali, Jyoti Saxena.” Advances in Organic Farming. https://doi.org/10.1016/B978-0-12-822358-1.00003-1

Ruijs M. 2017. “Value Chain Analysis of (Greenhouse) Vegetables in Lebanon, Wageningen Economic Research.” Wageningen. https://repo.mel.cgiar.org/handle/20.500.11766/10360

Schoonhoven Yanniek, and Runhaar Hens. 2018. “Conditions for the adoption of agro-ecological farming practices: a holistic framework illustrated with the case of almond farming in Andalusia.” International Journal of Agricultural Sustainability, 16:6, 442-454. https://www.tandfonline.com/doi/full/10.1080/14735903.2018.1537664

Stephen R. Gliessman. 2015. «Agroecology: The Ecology of Sustainable Food Systems Third Edition.” https://www.amazon.com/Agroecology-Ecology-Sustainable-Systems-Third-ebook/dp/B00UVAW5OI?asin=B00UVAW5OI&revisionId=&format=4&depth=1

T. Garnett, and H. C. J. Godfray. 2019. “Sustainable Intensification in Agriculture. Navigating a Course Through Competing Food System Priorities.” Food Security, 11(2): 209-214. https://doi.org/10.1093/aob/mcu205

World Bank. 2020. “The World Bank Annual Report 2020 : Supporting Countries in Unprecedented Times.” World Bank Annual Reports & Financial Statements. https://openknowledge.worldbank.org/handle/10986/34406

Zainab Muhsin. 2022. “Lebanon: Banned Pesticides at the Dinner Tables.” Arij. https://arij.net/investigations/agricultural-pesticides-en1/