

## IS IRRIGATION A BARRIER OR A LEVER FOR AGROECOLOGICAL TRANSITION? INSIGHTS FROM SOUTHWESTERN FRANCE

EST-CE QUE L'IRRIGATION EST UN OBSTACLE OU UN LEVIER DE LA  
TRANSITION AGROECOLOGIQUE? PERSPECTIVES TIREES DU SUD-OUEST DE  
LA France

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### ABSTRACT

How irrigation shapes the agroecological transition of farming systems remains poorly understood, despite mounting pressure on water and increasing market constraints. Drawing on an agrarian diagnosis and 107 in-depth interviews in an irrigated region of southwestern France (Barguelonne, Adour-Garonne basin), this communication analyzes how water access and value-chain organization shape farms' transition pathways. Results show that water access is a key factor in both farming system differentiation and transition pathways. Three main trajectories emerge: (i) farms with limited water access tend to engage in redesign strategies based on diversification and system restructuring at the cost of taking an economic risk and investing a considerable amount of effort; (ii) farms with secure and abundant water supplies mainly follow efficiency-oriented pathways, often constrained by capital-intensive production systems; and (iii) intermediate situations are associated with substitution strategies, particularly organic conversion. Value-chain organization further shapes these trajectories through two conceptions of agroecology, a "lever-based" approach focused on targeted technical fixes, and a "systemic" one oriented toward whole-system redesign. Value chains thus prove ambivalent, acting as both a resource and a constraint that can either foster or lock in the transition. These findings show that agroecological transitions arise from the interplay of water access, farm characteristics and value-chain dynamics, not from water availability alone. For policymakers, fostering them in irrigated agriculture means looking beyond water infrastructure and allocation, and coordinating water management, agricultural support and value-chain governance across diverse territorial contexts.

**Keywords:** agroecological transition; limited water access; water supplies; Value-chain organization; irrigated agriculture.

### RESUME

La manière dont l'irrigation façonne la transition agroécologique des systèmes agricoles reste mal comprise, en dépit d'une pression croissante sur les ressources en eau et des contraintes de marché de plus en plus fortes. Sur la base d'un diagnostic agricole et 107 entretiens approfondis menés dans une région irriguée du sud-ouest de la France (Barguelonne, bassin de l'Adour-Garonne), cette communication analyse l'influence de l'accès à l'eau et de l'organisation de la chaîne de valeur sur les trajectoires de transition des exploitations agricoles. Les résultats montrent que l'accès à l'eau joue un rôle important à la fois dans la différenciation des systèmes agricoles et les trajectoires de transition. Trois trajectoires principales apparaissent : (i) les exploitations disposant d'un accès limité à l'eau ont tendance à s'engager dans des stratégies de refonte basées sur la diversification et la restructuration du système, au prix d'une prise de risque économique et d'un investissement considérable en efforts; (ii) les exploitations bénéficiant d'un approvisionnement en eau sûr et abondant suivent principalement des trajectoires axées sur l'efficacité, souvent limitées par des systèmes de production à forte intensité capitaliste; et (iii) les situations intermédiaires sont associées à des stratégies de substitution,

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notamment la conversion à l'agriculture biologique. L'organisation de la chaîne de valeur façonne davantage ces trajectoires à travers deux conceptions de l'agroécologie : une approche «axée sur les leviers» centrée sur des solutions techniques ciblées, et une approche «systémique», orientée vers une refonte globale du système. Les chaînes de valeur se révèlent ainsi ambivalentes, agissant à la fois comme une ressource et une contrainte pouvant soit favoriser, soit entraver la transition. Ces résultats constatent que les transitions agroécologiques résultent de l'interaction entre l'accès à l'eau, les caractéristiques des exploitations agricoles et la dynamique des chaînes de valeur, et non de la disponibilité de l'eau seulement. Pour les décideurs politiques, favoriser ces transitions dans l'agriculture irriguée implique de ne pas se limiter aux infrastructures et à la répartition de l'eau, mais de coordonner la gestion de l'eau, le soutien à l'agriculture et la gouvernance des chaînes de valeur dans des contextes territoriaux variés.

**Mots-clés :** Transition agroécologique; Accès limité à l'eau; Approvisionnement en eau; Organisation de la chaîne de valeur; Agriculture irriguée.

## INTRODUCTION

Agroecology has progressively emerged as a central orientation of French and European agricultural policies, both as a response to environmental challenges and as a pathway to enhancing the resilience of farming systems (Wezel et al., 2009; Duru et al., 2015). It encompasses a set of practices, principles, and values aimed at reconciling agronomic performance, ecosystem stewardship, and farm autonomy (Wezel et al., 2009). Although its main conceptual frameworks are now well established (Altieri, 1995; FAO, 2018), their practical implementation at the farm level remains highly heterogeneous, both in terms of transition pathways and levels of adoption of agroecological practices. Research on agroecological transitions has shown that these dynamics are shaped not only by farmers' motivations and strategic choices, but also by the economic, technical, and organizational constraints that structure their professional environment (Lamine, 2017; Meynard et al., 2015).

Among the contexts in which agroecological transitions appear particularly complex to analyse, irrigated farming systems occupy a distinctive position. Historically associated with trajectories of agricultural intensification and productive specialization, these systems are now facing increasing pressures arising from water scarcity, stricter environmental regulations, and growing climatic uncertainty. In this context, irrigation is increasingly viewed as an adaptation strategy to climate change, as it can contribute to maintaining agricultural production under increasing climatic variability while enabling the diversification of cropping systems (Levidow et al., 2014; Touili et al., 2025). However, its role in agroecological transition processes remains insufficiently explored, particularly when considering the organizational and territorial dimensions within which irrigated farms operate.

Indeed, agroecological transition does not occur solely at the level of farming practices. It also depends on support mechanisms, professional frameworks, and value chain structures that shape access to markets, technical resources, and forms of economic and symbolic recognition of agricultural practices (Vanloqueren and Baret, 2009; Lamine, 2017). Producer organizations, cooperatives, advisory services, certification schemes, and other value chain actors therefore play a key role in shaping agricultural trajectories by defining technical standards, quality requirements, and mechanisms for product valorization. Depending on the context, these structures may foster the emergence of agroecological practices through dedicated support programs or differentiated market opportunities, but they may also reinforce productivist logics or technical standards that are poorly aligned with agroecological transformations.

In this context, this communication analyses the dynamics of agroecological transition in irrigated farming systems located in a territory of southwestern France within the Adour-Garonne Basin. It examines how access to water resources and the organization of value chains influence farms' transition pathways. More specifically, it seeks to understand how these technical, economic, and organizational environments shape farmers' motivations, their scope for action, and their decisions regarding agroecological change.

To address these questions, this research draws on an analysis of the trajectories of farming systems, examined through the concepts and analytical tools of Comparative Agriculture (Mazoyer and Roudart, 1997; Dufumier, 1996; Cochet and Devienne, 2006). This analytical framework is combined, on the one hand, with an examination of access to irrigation, a key resource structuring farming systems in many agricultural regions (Devienne et al., 2022), and, on the other hand, with an analysis of value chain organization and the interactions among actors that shape the socio-economic environments in which farms operate (Vanloqueren and Baret, 2009; Lamine, 2017).

By combining an analysis of farm trajectories with an examination of value chain dynamics in an irrigated territory, this study contributes to a better understanding of the practical conditions under which agroecology is implemented in agricultural systems facing both water-related and organizational constraints.

## **METHODS**

### **Study Area**

The study was conducted in the Barguelonne watershed, a tributary of the Garonne River located in southwestern France, across the Lot and Tarn-et-Garonne departments. This small agricultural region is characterized by a diversity of farming systems, including fruit production, arable crops, mixed crop–livestock systems, and vegetable farming. Access to irrigation is highly heterogeneous: while some farms benefit from collective irrigation networks managed by Water Users' Associations, others rely on on-farm reservoirs or individual river withdrawals, and more than half of the farms have no access to irrigation. These disparities occur in a context of increasing pressure on water resources, where agricultural withdrawals from the Barguelonne are frequently restricted during summer low-flow periods, whereas farms connected to collective networks supplied by the Tarn and Garonne rivers face fewer constraints.

The territory also presents a long history of specialized fruit and cereal value chains, notably linked to the production of Chasselas de Moissac grapes, alongside the recent development of shorter marketing channels. The coexistence of diverse farming systems, unequal access to water resources, and contrasting value chain organizations makes the Barguelonne watershed a particularly relevant case study for analysing the combined influence of irrigation and value chain structures on agroecological transition pathways.

### **Understanding the Role of Irrigation in Agricultural Development**

Understanding the role of irrigation in agricultural development requires a historical and territorial perspective that captures the interactions between farming systems, resource access, and socio-economic dynamics. Previous studies have highlighted the relevance of territorially grounded and interdisciplinary approaches for analysing irrigation-related transformations in agriculture (Perrier, 2005; Devienne et al., 2022; Degroote et al., 2025). In this regard, the scale of the small agricultural region provides a particularly suitable framework for examining long-term changes in farming systems under relatively homogeneous agroecological and socio-economic conditions (Cochet and Devienne, 2006; Degroote et al., 2025).

To investigate these dynamics, the study relied on a farming systems diagnosis conducted between 2021 and 2023 using a diachronic approach. The analysis combined landscape observations, cartographic analysis, and 30 in-depth interviews with local stakeholders, mainly farmers, to reconstruct the historical evolution of agriculture and the role of irrigation in shaping production systems since the 1970s. Based on this diagnosis, the main farming system types were identified and a purposive sample of 45 farmers was selected for semi-structured interviews. These interviews were used to characterize the technical and economic functioning of each system and to analyse the factors underlying their differentiation and evolution, with particular attention to irrigation and access to water resources.

## Identifying Agroecological Transition Pathways at the Farm Level

The second stage of the study focused on farms implementing practices consistent with agroecological principles and contributing to the emergence of alternative farming systems. A total of 47 farms were identified through the farming systems diagnosis and with the support of six local advisory and development organizations. Among these, 19 farms participated in in-depth interviews conducted in spring 2024. The interviews aimed to document the practices implemented, the conditions that facilitated their development, and their effects on farm technical and economic performance.

Given the diversity of transition pathways observed across farms, a more detailed assessment of the degree of agroecological transformation was undertaken. To this end, a complementary analytical framework was mobilized: the Efficiency–Substitution–Redesign (ESR) framework (Hill and MacRae, 1996) which extends the analysis by incorporating socio-economic dimensions of transition, particularly farmers' forms of market integration.

## Analyzing the Role of Value Chain Actors in Transition Pathways

The third stage examined how value chain actors and organizational arrangements influence agroecological transition pathways. Based on the 19 farm surveys, 27 upstream and downstream organizations mentioned by farmers were identified. Among them, 13 semi-structured interviews were conducted in autumn 2024, including interviews with three Geographical Indication management bodies, three cooperatives or cooperative groups, two agricultural traders, one processor, one retailer, and three advisory organizations or farmer-extension groups.

The interviews focused on three main themes: (i) the organization's role within the value chain and its interactions with other actors; (ii) its understanding and definition of agroecological transition; and (iii) the mechanisms implemented to support such transitions, including technical advisory services, contractual arrangements, economic incentives, and production standards. The analysis made it possible to identify both enabling and constraining factors for agroecological transitions, arising from organizational arrangements as well as from interactions among value chain actors.

## RESULTS

### Access to water as a key driver of agrarian differentiation in the Barguelonne basin

The Barguelonne basin can be divided into three main landscape units: (i) an upstream area characterized by narrow terraces and limestone hillsides with shallow soils; (ii) an intermediate zone of steeper slopes dissected by valleys suitable for farm reservoirs; and (iii) a downstream area composed of broad terraces and gentler slopes. Superimposed on this geomorphological gradient is a gradient of access to water, which has played a decisive role in the differentiation of farming systems.

Until the 1960s, relatively small farms (15–45 ha) relied on diversified production systems combining cereals, livestock, melon, tobacco, and table grapes. Specialization began in the 1970s with the modernization of agriculture. In the downstream area, this process was driven by the development of fruit and table grape value chains, supported by the settlement of repatriates from Algeria, the recognition of the Chasselas de Moissac Protected Designation of Origin (PDO) in 1971, and the first irrigation infrastructures, initially based on river withdrawals from the Barguelonne and later complemented by on-farm reservoirs. The introduction of milk quotas in the 1980s further reinforced differentiation according to farms' investment capacity. Farms able to invest in irrigation shifted towards higher-value crops, including melon, seed maize, fruit production, and table grapes, whereas others maintained rainfed livestock and arable farming systems. The extension of the Valence d'Agén collective irrigation network in the early 1990s secured water access for a large share of farms in the downstream area and accelerated orchard specialization, while farms in the intermediate and upstream zones benefited only marginally from these developments.

Recent changes have confirmed the structuring role of water access. In the upstream area, declining milk prices and increasing market volatility in melon production have encouraged the expansion of rainfed arable crops as well as diversification and value-adding strategies, including organic farming, on-farm processing, and short supply chains. In the downstream area, increasing climatic hazards, such as droughts, hailstorms, and spring frosts, have transformed irrigation from a yield-stabilization tool into a key mechanism for climate adaptation and crop protection. Overall, access to water, both in terms of quantity and reliability, emerges as the primary factor underlying the differentiation of the nine farming system groups identified in the watershed (Table 1) and provides the basis for understanding the transition pathways analysed in the following sections.

### Access to water plays an ambivalent role in agroecological transitions

The analysis identified nine dominant farming system groups, whose differentiation is strongly influenced by access to water resources. The 19 farms surveyed in the second phase of the study are representative of this diversity (Table 1).

**Table 1.** Diversity of production systems and characterization of the surveyed farms with respect to their agroecological practices (Hantraye, 2024)

|              | Type of system                                                          | UAA (ha) | % irrigated UAA | Number of interviews on agroecology |
|--------------|-------------------------------------------------------------------------|----------|-----------------|-------------------------------------|
| UPSTREAM     | Arable crops and other irrigated production (seed crops)                | 50–140   | ≈ 20–33%        | 4                                   |
|              | Rainfed arable crops and high-value lowland production (melon, soybean) | 40–200   | ≈ 0–17%         | 2                                   |
|              | Diversified market gardening on a small area                            | 0.5–2    | 100%            | 1                                   |
| INTERMEDIATE | Irrigated fruit growing (incl. table grapes)                            | 10–20    | 50–80%          | 3                                   |
|              | Rainfed arable crops and irrigated fruit growing                        | 80–200   | 10–50%          | 2                                   |
|              | Livestock and rainfed arable crops                                      | 40–70    | 0–2%            | 2                                   |
|              | Rainfed arable crops – dual activity (part-time)                        | 10–50    | 0%              | 2                                   |
| DOWNSTREAM   | Irrigated arable crops and fruit growing                                | 15–120   | 20–30%          | 3                                   |
|              | Irrigated arable and seed crops                                         | 150–320  | 40–55%          | 0                                   |

Three distinct transition pathways emerged among the surveyed farms and deserve particular attention.

#### Pathway A: Partial but relatively secure access to water (intermediate plains and hillsides).

These mixed farming systems combine rainfed crops with high-value irrigated productions, such as seed crops, horticulture, and fruit production. Although irrigated areas remain limited in size, they generate a substantial share of farm value added (up to 75%) and provide an important source of economic stability. This stability creates a dual opportunity for agroecological transition. On irrigated plots, farmers can adopt substitution-based strategies, particularly conversion to organic farming, with relatively limited production risks, often combined with diversification of marketing channels. At the same time, the economic buffer provided by irrigated activities allows experimentation with more profound changes in rainfed enterprises, including conservation agriculture, input reduction, and the introduction of temporary grasslands. These farms therefore occupy an intermediate position between **substitution** and

**redesign**, with some remaining within efficiency-oriented strategies and others moving towards more systemic transformations through diversification, agroforestry, or even reduced dependence on irrigation.

#### **Pathway B: Secure and abundant access to water (specialized downstream systems).**

Often connected to collective irrigation schemes, these farms have developed around reliable water supplies that support highly specialized and capital-intensive production systems, including orchards and contract-based arable crops. In this context, irrigation acts primarily as a source of economic stability rather than a driver of transformation. High levels of fixed capital investment, including irrigation infrastructure, perennial plantations, and frost- and heat-protection equipment, reinforce the need to maintain high levels of productivity and profitability. Consequently, changes are largely limited to **efficiency-oriented** adjustments or compliance with regulatory requirements, such as the establishment of cover crops, reflecting a degree of technological and organizational **lock-in**. Nevertheless, a few farms have pursued more innovative trajectories involving diversification, intercropping, input reduction, on-farm processing, or direct marketing, highlighting the existence of differentiated opportunities for change.

#### **Pathway C: Limited, insecure, or no access to water (hillsides and plateaus, particularly in the upstream area).**

In these systems, water scarcity constitutes a major driver of change, encouraging either farm enlargement or the search for alternative sources of value creation. Based primarily on rainfed cropping systems, sometimes combined with drought-adapted productions (lavandin, prunes) or livestock farming with on-farm processing, many of these farms have adopted agroecological practices. Faced with climate change and volatile market conditions, some have engaged in deep **redesign** processes involving the restructuring of crop and livestock systems (herd reduction, longer rotations, crop associations, conversion to organic farming), increased diversification (new enterprises, agroforestry), and the development of new marketing channels. While such transformations are often associated with lower yields, they reduce vulnerability through greater complementarities among farm activities. These changes often come at the cost of investing a considerable amount of effort. In more moderate transition pathways, substitution strategies rely on the introduction of hardy and less water-dependent species, such as persimmon, pomegranate, or fig trees.

Taking together, these three pathways reveal a structured relationship between water access and agroecological transition. **Redesign** processes are most prevalent where water is scarce (Pathway C), **efficiency-oriented** and locked-in systems dominate where water access is most secure (Pathway B), and **substitution**-based transitions are more common in intermediate situations characterized by partial but reliable access to water (Pathway A). This interpretation should nevertheless be treated with caution. Water access does not operate in isolation but interacts closely with factors such as capital endowment, geographical location, and value chain integration. Based on 19 farms selected through purposive sampling, the objective is not to establish statistical representativeness but rather to identify recurrent mechanisms and configurations shaping agroecological transition pathways.

#### **Value chain structures shape and condition transition pathways: an ambivalent lever**

Value chain structures do not merely influence farmers' engagement in agroecological transition; they also strongly shape the forms that these transitions take by defining technical frameworks, action priorities, and temporal horizons. The interviews revealed two contrasting conceptions of agroecology; each associated with distinct transition pathways.

The first conception can be described as an **"agroecology through technical levers"** approach. It relies on targeted technical solutions, such as soil management practices, varietal selection, input reduction, or specialized equipment, without fundamentally challenging the overall organization of the farming system. This perspective is predominant among marketing organizations and technical advisory services, where market security and economic performance remain the primary objectives. A

representative of BlueWhale (fruit distribution company), for instance, emphasized that “genetics remains the priority [...], which means that other dimensions receive less attention,” while actors such as Qualisol (cooperative) mainly promote innovations with rapidly observable effects, including mechanical leaf removal or optimized nitrogen fertilization. Within this framework, agroecology is understood as a set of adjustments aimed at improving the efficiency of existing production systems.

The second conception adopts a **systemic perspective**, viewing the farm as a complex system and transition as a long-term process involving the combination of multiple and interconnected levers. This approach is promoted by several advisory and collective support organizations, such as Agribio82, which argues that “change must be considered globally, addressing all dimensions simultaneously.” It is supported through a wide range of initiatives, including DEPHY farmer groups, cover-crop programs, climate change training courses, and farmer-led construction of soil moisture monitoring devices.

This orienting role reflects a broader structural ambivalence: value chains act simultaneously as both resources and constraints. As drivers of change, they operate through three main mechanisms. First, they facilitate access to technical and material resources. The president of the Quercynoise machinery-sharing cooperative (CUMA) noted that “we have a large amount of equipment specifically designed for organic farming, and subsidies helped us finance this equipment,” thereby lowering the costs of entry into transition processes. Second, they provide structured technical support and foster experimentation through multi-actor projects. The Bureau Interprofessionnel du Pruneau (BIP, the interbranch organisation for the Agen prune sector) for example, is involved in numerous initiatives related to irrigation reduction, innovation, and agroecological transition. Third, value chain organizations contribute to the political and economic legitimization of agroecological practices. As the managing body of the PGI Pruneau d’Agen, the BIP actively promotes producers’ efforts to public authorities in support of maintaining coupled agricultural subsidies.

However, the same mechanisms can also constrain or lock in transition processes. Dependence on market outlets emerged as the most frequently cited constraint. Interviewees repeatedly highlighted the difficulty of obtaining prices that adequately reward agroecological practices, while the low profitability of certain crops and the limited commitment of large retail chains were also identified as major obstacles. More broadly, the influence of downstream actors may significantly shape production choices and crop rotations. In addition, market saturation in some sectors, particularly organic agriculture, can leave farmers bearing the costs of transition without corresponding economic returns.

Overall, value chains emerge as a fundamentally ambivalent institutional framework: neither inherently supportive nor systematically restrictive, but rather a space in which the forms, pace, and conditions of agroecological transition are continuously negotiated among actors.

## CONCLUSION

This study highlights the dual influence of water access and value chain organization on agroecological transition pathways. While secure access to water can provide opportunities for innovation, it may also reinforce specialized and capital-intensive production systems that limit deeper transformations. Conversely, given the significant technical and economic constraints, more constrained water situations often stimulate redesign-oriented strategies based on diversification and greater system resilience at the cost of taking an economic risk and investing a considerable amount of effort. Beyond irrigation itself, value chains play an ambivalent role by simultaneously enabling and constraining change. Agroecological transitions therefore result from the interaction of biophysical, economic, and organizational factors, calling for integrated approaches that address both water governance and value chain dynamics.

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