

SUPPORTING AGROECOLOGICAL TRANSITIONS IN IRRIGATED FARMING SYSTEMS: PRELIMINARY INSIGHTS FROM A WATER-SCARCE TERRITORY IN SOUTHWESTERN FRANCE

SOUTENIR LES TRANSITIONS AGROÉCOLOGIQUES DANS LES SYSTÈMES AGRICOLES IRRIGUÉS : PREMIÈRES PERSPECTIVES D'UN TERRITOIRE DÉFICITAIRE EN EAU AU SUD-OUEST DE LA FRANCE

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ABSTRACT

Climate change increasingly threatens irrigated agriculture through growing water scarcity, calling for systemic transitions. Agroecology may offer promising pathways to increase the sustainability of irrigated agriculture while reducing pressure on water resources. However, agroecological transitions involve substantial uncertainties and risks for farmers, making support a key enabling factor. Yet, little is known about how agroecology is implemented in irrigated farms and how irrigators are supported in this process. This study investigates in irrigated farms how agroecology is implemented, how farmers perceive links between irrigation and agroecology, and how support contributes to agroecological transitions. It is based on semi-structured interviews with irrigators (n=21) and support service staff (n=20) in southwestern France. Preliminary findings rely on an in-depth analysis of a subset of farmers' interviews, triangulated with insights from the broader interview corpus, while interviews with support service staff are still under analysis. They suggest that agroecology is progressing in irrigated farms, although implementation levels vary considerably among farms. Farmers perceive multiple and sometimes contradictory links between irrigation and agroecology. However, the articulation between irrigation and agroecology remains limited in practice and mostly exploratory. Agroecology-contributing practices are mainly perceived as improving soil water dynamics and reducing irrigation needs, while irrigation is viewed both as a lever facilitating agroecological transitions and as a lock-in factor reinforcing economic dependence and system simplification. Irrigation changes appear relatively stabilised and constraints-reactive, whereas agroecological changes tend to follow longer and iterative trajectories. Support plays a key role in enabling agroecological transitions, particularly by supporting experimentation, learning and decision-making. However, preliminary findings suggest that support mostly address irrigation and agroecology separately, leaving farmers with limited guidance to jointly rethink irrigation and agroecological redesign. These findings highlight the need for more integrated and systemic support approaches to better articulate water management and agroecological transitions in irrigated farms.

Keywords: Climate change; agroecological transition; irrigated farms; irrigation and agroecology; water management.

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RESUME

Le changement climatique menace de plus en plus l'agriculture irriguée en raison de la rareté croissante de l'eau exigeant ainsi des transitions systémiques. L'agroécologie peut offrir des voies prometteuses pour rehausser la durabilité de l'agriculture irriguée tout en réduisant la pression sur les ressources en eau. Cependant, les transitions agroécologiques impliquent des incertitudes et des risques importants destinés aux agriculteurs, ce qui fait du soutien un élément favorable. Cependant, on sait peu de choses sur la façon dont l'agroécologie est mise en œuvre dans les exploitations irriguées et sur la façon dont les irrigateurs sont soutenus dans ce processus. Cette étude examine la mise en œuvre de l'agroécologie dans les exploitations irriguées, la perception que les agriculteurs possèdent concernant des liens entre irrigation et agroécologie, ainsi que la contribution du soutien aux transitions agroécologiques. Elle se base sur des entretiens semi-structurés menés auprès des irrigants (n=21) et du personnel de services généraux (n=20) au sud-ouest de la France. Les résultats préliminaires s'appuient sur une analyse approfondie d'un sous-ensemble d'entretiens menés auprès d'agriculteurs combinés aux perspectives tirées de l'ensemble d'entretiens plus large, tandis que les entretiens avec le personnel des services généraux sont encore en cours d'analyse. Ils proposent que l'agroécologie progresse au sein des exploitations irriguées, bien que les niveaux de mise en œuvre varient considérablement d'une exploitation à l'autre. Les agriculteurs perçoivent des liens multiples et parfois contradictoires entre l'irrigation et l'agroécologie. Cependant, l'articulation entre irrigation et agroécologie reste limitée en pratique et principalement préliminaire. Les pratiques contribuant à l'agroécologie sont principalement perçues comme améliorant la dynamique hydrique des sols et réduisant les besoins en irrigation, tandis que l'irrigation est considérée à la fois comme un levier facilitant les transitions agroécologiques et comme un facteur de blocage renforçant la dépendance économique et la simplification du système. Les évolutions liées à l'irrigation apparaissent relativement stabilisées et dictées par les contraintes, alors que les changements agroécologiques suivent généralement des trajectoires plus longues et itératives. Le soutien joue un rôle important en permettant des transitions agroécologiques, notamment en soutenant l'expérimentation, l'apprentissage et la prise de décision. Cependant, les résultats préliminaires indiquent que le soutien traite principalement l'irrigation et l'agroécologie séparément, laissant aux agriculteurs une orientation limitée pour repenser conjointement l'irrigation et la refonte agroécologique. Ces résultats soulignent la nécessité d'avoir des approches de soutien plus intégrées et systémiques pour mieux articuler la gestion de l'eau et les transitions agroécologiques dans les exploitations irriguées.

Mots-clés : Changement climatique; Transition agroécologique; Exploitations irriguées; Irrigation et agroécologie; Gestion de l'eau.

INTRODUCTION

Irrigation accounts for nearly 70% of global freshwater withdrawals and remains a cornerstone of agricultural productivity worldwide (FAO, 2021). Historically, irrigation has supported the intensification of agricultural systems by improving productivity, profitability and yield stability (Gulhati and Smith, 1967; Perret and Payen, 2020). However, climate change threatens water availability by increasing the frequency and intensity of extreme events such as drought, disrupting rainfall patterns and groundwater recharge, decreasing annual streamflow and increasing ice melt (IPCC, 2022). Climate change is also expected to increase water and irrigation requirements by crops (Reta et al. 2024). As a result, irrigated systems face growing vulnerability despite their historical role in buffering climatic risks. At the same time, conventional irrigated systems often exert considerable pressure on water quantity and quality through input-intensive production systems (Tilman et al., 2002; Perret and Payen, 2020). This context calls for transitions toward more resilient and sustainable irrigated farming systems.

Agroecology (AE), understood here as the implementation of coherent combinations of practices contributing to ecological processes in farming systems (Wezel et al., 2014), may provide relevant pathways for such transitions (Gliessman, 2015; Leauthaud et al., 2025). Evidence increasingly suggests that alternative irrigated systems and practices can improve resilience to climate change while reducing environmental externalities (Leauthaud et al., 2025). Irrigation itself may also support

adaptation through crop diversification and risk reduction (Levidow et al., 2014). Yet, despite growing interest in agroecology, irrigated systems remain relatively underexplored in agroecological research, particularly regarding how agroecological transitions are implemented in practice at farm level (Leauthaud et al., 2025).

Transitions toward AE require farmers to acquire new knowledge and skills and involve major risk-taking, thereby requiring appropriated support (Prost et al., 2023). Several studies have documented the diversity of methods and tools that can be used to support agroecological transitions (Duru et al., 2015; Prost et al., 2023), while the literature on Agricultural Knowledge and Innovation Systems has described how farmers' support services work (Ingram, 2008; Klerkx et al., 2017). However, Rossing et al. (2023) emphasised the still limited understanding on the "how-to" of implementing change on farms toward AE. This limited understanding of agroecological transitions support is accentuated in irrigated systems, which have long been under-explored in agroecological research (Leauthaud et al., 2025).

This work aims to address these gaps by examining (i) how AE is implemented on irrigated farms, and (ii) how irrigating farmers perceive links between irrigation and agroecology, and (iii) how support contributes to agroecological transitions in irrigated contexts.

MATERIAL & METHODS

Study area

Our study area is located in southwestern France, characterised by chronic water scarcity, and situated in a basin that is artificially replenished by the water resource manager. Agricultural water requirements peak in summer, with irrigation covering approximately 16% of cultivated land, primarily for maize (53% of irrigated areas) and soybeans (24%). Twelve main organisations providing support to irrigating farmers were identified in the territory, which are mostly private (or partly private) (n=8). These organisations include public, private and hybrid actors and provide different forms of support related to irrigation management, agronomic practices and, to varying extents, agroecological transitions.

Data collection

Semi-structured interviews were first conducted with irrigating farmers growing arable crops (n=21). Farmers were selected to capture diversity in farming systems, irrigation contexts, agroecology-contributing practices (AEP) and support configurations. Interviews focused on: (i) current farming practices, including irrigation and key AEP (e.g., crop diversification, cover crops, tillage, crop rotations, input use); (ii) trajectories of change in these practices; and (iii) interactions with support services regarding these changes.

Support service staff identified by farmers were subsequently contacted for semi-structured interviews (target n = 20, at least one representative per identified support organisation). Interviews with support staff are currently ongoing and explore support objectives, methods, tools, supported practices and perceived contributions to agroecological transitions in irrigated farming systems.

Data analysis

Data from farmers' interviews were analysed qualitatively through four complementary steps. First, we characterised the agroecological level of irrigating farms using indicators related to crop diversification, cover crop implementation, soil tillage intensity and input use. Second, we characterised farmers' perceptions of positive and negative links between irrigation and AE. Third, we traced changes of farmers' practices, either stabilised, on-going, or under current reflections, as well as the reasons behind these changes (e.g. agronomic, economic, social, support). We therefore considered that support was one of several factors contributing to changes. Finally, we analysed the role of support by identifying support sources related to irrigation, agroecology, or both jointly, and by examining farmers' perceptions, needs and barriers regarding support.

At this stage, analyses of support service staff interviews are still ongoing. Preliminary analyses focus on supported practices, the degree of farming system redesign targeted by support (Hill and MacRae, 1996), and support staff perceptions of relationships between irrigation and AE. A cross-analysis of farmers' and support service staff interviews will be conducted to better understand how interactions between actors shape agroecological transitions in irrigated farming systems.

RESULTS

Preliminary findings from farmers' interviews

Preliminary results are grounded in the in-depth analysis of a subset of interviews (n=4), triangulated with our overall understanding from the full set of interviews conducted. The remaining interviews will be analysed in-depth by 12 October, and will enrich our initial findings.

The interviewed farms are specialised in either mixed cropping (n = 10) or mixed crop–livestock systems (n=11). Two farms are fully organic, and one combines organic and conventional areas. Farm size ranges from 90 to 270 hectares, with irrigable areas varying between 35 and 235 hectares, of which 35 to 180 hectares are effectively irrigated. Water availability differs substantially among farms, reflecting contrasting access conditions and water constraints. Irrigation is predominantly carried out using travelling gun sprinklers, while central pivots remain marginal.

Agroecology is progressing heterogeneously in irrigated farming systems

Preliminary findings suggest that agroecology is progressively developing within irrigated farming systems across the study area, although implementation levels vary considerably among farms. **Agroecology-contributing practices (AEP)** are unevenly implemented and combined, resulting in contrasted agroecological profiles that are currently being characterised more systematically.

Winter cover crops appear to be the most widely implemented AEP. All interviewed farmers reported using them, although implementation remains variable in terms of frequency, area covered and species diversity. Farmers often emphasised agronomic benefits, particularly regarding soil protection and fertility. Current regulations are also playing a major role in the implementation of this practice. However, economic considerations strongly shape implementation choices, with some farmers concentrating cover crops on irrigated plots where perceived returns are higher. Cover crop mixtures generally remain poorly diversified, although some farmers progressively experiment with more complex mixtures to enhance ecosystem services and address agronomic challenges.

Reduced tillage also appears to be an important transition pathway, although trajectories remain heterogeneous and often unstable. Several farmers reported progressive reductions in tillage intensity, while only a few had moved towards no-tillage systems. Farmers engaged in such trajectories highlighted long timeframes needed to improve soil properties, including soil structure and organic matter content. Yet, technical and agronomic difficulties combined with economic hardship sometimes led to partial and occasional reversals, including occasional reintroduction of tillage operations.

Cash crop diversification remains comparatively limited despite farmers recognising its agronomic and economic interest. Irrigation is often perceived as enabling diversification by securing yields and reducing climatic risks. However, irrigated plots frequently remain concentrated on a narrow range of crops due to market constraints, contractual requirements and the economic costs associated with irrigation.

Conversely, **summer cover crops** remain rarely implemented because of financial, organisational and water-related constraints, combined with uncertainties regarding their agronomic and economic performance. On irrigated plots, the prevalence and the high frequency of spring crops succession also limits summer cover crops use. Similarly, **organic fertilisation practices** remain limited by territorial resource availability, although several farmers expressed interest in developing them. When implemented, farmers often reduced mineral nitrogen inputs, underlining their relevance.

Regarding **irrigation management** itself, practices remain largely based on experiential knowledge, field observations (soil, crops and weather) and farmers' familiarity with their plots. Although some farmers use irrigation **decision-support tools** such as tensiometers, irrigation scheduling remains mostly empirical and adaptive. Farmers continuously adjust irrigation according to seasonal conditions and water availability, but their room for manoeuvre is strongly constrained by irrigation equipment, labour organisation, institutional rules and uncertainties regarding yield impacts.

Farmers perceive multiple and sometimes contradictory links between irrigation and agroecology

If all farmers perceived links between irrigation and AE, perceptions are complex, diverse and sometimes contradictory (Figure 1). On the one hand, farmers mostly reported that AEP have positive effects on soil water storage and thus on irrigation water saving. However, translating these perceived benefits into actual modifications of irrigation practices remains uncertain. Farmers often expressed doubts regarding the magnitude and reliability of AEP effects on water dynamics. Many emphasised that improvements in soil water functioning require long-term soil changes, making irrigation adjustments difficult to anticipate or confidently implement. On the other hand, the role of irrigation in the transition to AE is ambivalent. Irrigation oscillates between encouraging or enabling the implementation of AEP, and acting as a barrier to the integration of such practices and a factor of the economic dependency of agricultural systems on a resource that is becoming increasingly scarce and expensive.

These findings suggest that irrigation cannot be considered solely as a technical input or isolated management component. Rather, farmers perceive irrigation as embedded within broader agronomic, economic and ecological dynamics shaping agroecological transitions.

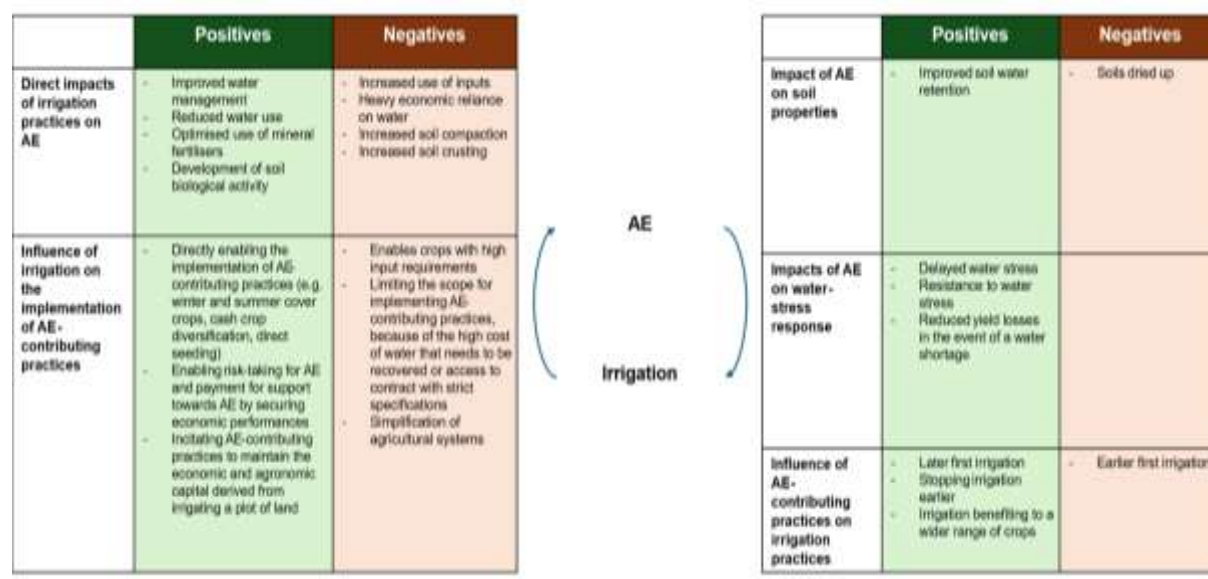


Figure 1. Links between irrigation and AE perceived by farmers. AE = agroecology.

Irrigation and agroecological changes follow contrasting trajectories

We identified between 6 and 12 changes of practices per farms, either stabilised, ongoing or under reflection. **Changes related to irrigation** mainly concerned irrigation infrastructure, water access arrangements and irrigation scheduling. They are often driven by economic and institutional constraints rather than by agronomic reflections. Several farmers implemented structural transformations of irrigation systems, such as shifts from individual pumping to collective systems, adjustments in water contracts, or diversification of water sources. Irrigation practices are evolving through reduced water use (linked to quotas, technical constraints, or cost-saving strategies), delayed first irrigation, or

expansion of irrigation to new crops (e.g. wheat, sunflower). Irrigation practices changes are mostly reactive, responding to climate change, water scarcity, pricing policies, or workload constraints, rather than embedded in a proactive redesign of cropping systems. By contrast, **changes related to AE** are more diverse, including introduction and ongoing adjustment of cover crops, reduction or cessation of tillage, cash crop diversification, and changes in input management. These changes often follow progressive trajectories, with experimentation phases (e.g. testing species mixtures), stabilisation (e.g. recognising benefits of cover crops), and, in some cases, reversals due to technical impasses or constraints (e.g. reintroducing soil tillage). Changes toward AE are primarily driven by agronomic objectives (soil fertility, erosion control, weed management), but also by economic and social considerations. They are supported by learning processes and are frequently described as risky. Importantly, the **articulation between irrigation and AE** remains limited and often exploratory. For example, some farmers indicate that the shift toward earlier maturity cultivars and/or the introduction of winter cover crops has slightly modified their irrigation practices. These adjustments in irrigation practices vary from year to year. Moreover, farmers stress that these adjustments are not always consciously planned and are accompanied by uncertainty regarding their relevance. We have not reported any irrigation changes that have led to the implementation of AEP. Thus, the articulation between irrigation and AE is restricted to a single direction: AEP influencing irrigation practices marginally, but not reciprocally. Support played a central role in these changes, particularly for changes toward AE. It contributed to triggering changes, supporting experiments, and shaping farmers' learning processes. Peer-to-peer interactions and trusted interlocutors appeared decisive in reducing uncertainty and legitimising changes. Support is also present on irrigation, though in a more technical and administrative way (e.g., installation of sensors, irrigation system design, institutional support).

Agricultural support plays a key but fragmented role

Support emerged as a central element in farmers' trajectories of change, particularly regarding agroecological transitions. Farmers reported interacting with between five and ten interlocutors discussing farming practices. On average, farmers reported three interlocutors dealing with irrigation, three dealing with AEP, one at the intersection of both irrigation and AE, and 0.5 not addressing either topic. **Regarding irrigation**, interactions mostly focus on the irrigation system (e.g., equipment, water contracts) and on irrigation management, with or without decision-support tools. Farmers report limited need for additional support on irrigation for two reasons. First, as mentioned before, they rely primarily on their experiential knowledge and on observations, which they generally consider to be satisfactory. Second, adaptation of irrigation practices is limited by organisational constraints also previously mentioned. Nevertheless, a few farmers express a need for more decision-support tools to improve irrigation scheduling in order to make better use of an increasingly scarce and costly resource and, in some cases, to reduce irrigation volumes. In contrast, **support related to AE** is broader in scope and responds to an explicitly expressed demand of farmers. Farmers actively seek guidance to redesign their systems, experiment with new practices and reduce uncertainties associated with change. Support contributes to experimentation processes, knowledge acquisition and confidence-building, particularly through trusted interlocutors and peer-to-peer exchanges. Preliminary findings further suggest that higher levels of agroecological implementation may be associated with both a greater diversity of support sources and support approaches promoting deeper farming system redesign. Their interlocutors' work mostly revolves around the introduction, composition and management of winter cover crops, followed by reduced tillage practices, and includes to a lesser extent cultivar choices of cash crops, cash crop choice and rotations, and reduction of mineral fertilisers and pesticides. Despite farmers expressed a need for support toward AE, they face two significant constraints: the financial cost of support services and their own limiting time. Free support resources do not meet their needs, and commercial ones often represent a financial cost they cannot afford. Farmers' availability for support is limited by substantial workload associated with irrigation, by climate change reducing operational time windows, and by the additional time required by some of their AEP. Most importantly, **interlocutors addressing both irrigation and AE** remain scarce. Existing integrated support mainly focuses on assessing whether AEP can improve water management, yet farmers frequently emphasised the lack of locally grounded evidence to support decision-making. Conversely, irrigation is rarely framed by support services as a lever for agroecological redesign or embedded within systemic approaches to farm transformation.

Analysis of support services staff' interviews

At this stage, interviews with support service staff are still under analysis. Preliminary results from support services staff' interviews suggested that support services in this territory rarely address irrigation explicitly, address a limited range of AEP and rarely make the connection between irrigation and agroecology. In particular, interlocutors for irrigation are sometimes based in different support services of a same structure than interlocutors for AE. Importantly, all interviewees mentioned that they were unaware of these links, which prevents them from discussing these issues with the irrigating farmers. These results will be supplemented by findings from ongoing interviews with support service staff by the time of the Conference.

DISCUSSION AND SIGNIFICANCE

This study is original in its joint focus on irrigation, agroecology and support. It illustrates, in a given local territory where irrigation is prevalent and threatened by climate change, how agroecological transitions operate within irrigated farms and the role of support in these changes. At this stage, this ongoing study points out three major findings.

First, agroecological transitions appear to be underway in irrigated farming systems, yet they follow highly heterogeneous trajectories. Irrigation-related changes tend to be stabilised, reactive and strongly constrained by technical, economic and institutional conditions. By contrast, AE-related changes emerge through longer, iterative and often fragile learning processes characterised by experimentation and uncertainty. These contrasted dynamics suggest that irrigation remains primarily managed as a constrained production factor to optimise, whereas agroecology involves deeper and longer-term transformations of farming systems.

Second, the integration of irrigation and agroecology remains limited and weakly operationalised, although farmers perceive links between irrigation and agroecology. These perceived links highlight the relevance of moving beyond considering irrigation as an isolated component of farms and disjoint from agroecology. They invite to consider irrigation from a system perspective, and to integrate it carefully and strategically as a key component of agricultural systems. However, the lack of local technical and agronomic references contributes to uncertainties and limits farmers' capacity to actively integrate irrigation water management within agroecological redesign. As a result, irrigation remains largely disconnected from systemic approaches.

Third, although support plays a central role in transitions towards agroecology, it simultaneously reinforces this disconnection between irrigation and agroecology. Support is critical in enabling agroecological transitions, particularly through peer-to-peer exchanges, and trusted interlocutors, which foster experimentation, learning, and confidence-building. However, support related to irrigation tends to remain more technical and administrative, focusing on system optimisation rather than systemic redesign. Moreover, very few interlocutors address irrigation and agroecology jointly, reflecting both a lack of knowledge and the persistence of sectoral approaches within support services.

Taken together, these findings highlight a major challenge for irrigated agroecological transitions: strengthening integrated and systemic support approaches capable of articulating water management and agroecological redesign. Developing locally grounded references through experimentation and farmer-support interactions may represent a promising pathway to better support irrigating farmers facing increasing climatic and water-related uncertainties.

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