

Agricultural irrigation in the Austrian Common Agricultural Policy 2023-2027

Incentivizing sustainable water management in the agricultural sector

1 Abstract

Climate impacts such as drought increasingly pressure groundwater renewal, unique ecosystems, and the agricultural sector in the Seewinkel region in Austria. This often leads farmers to increase agricultural irrigation. The WaterStressAT project identified three management areas to reduce agricultural irrigation and lower the pressure on local groundwater levels: a) efficient irrigation, b) crop selection, and c) water holding capacity of the soil. However, uptake of these measures is time and resource intensive. They hence need to be incentivized through policies and financial budgets and promoted among farmers. At the moment, the European Union's Common Agricultural Policy (CAP) and the respective Austrian Strategic Plan are the most influential policy tools in agriculture – at least in terms of budget.

The aim of this study was to visualize the potential impacts of CAP interventions that are relevant for the three WaterStressAT management areas in a Qualitative Systems Map (QSM). Therefore, we analyzed the CAP Strategic Plan for Austria to identify the key interventions influencing the management areas and assessed their impact within the QSM. We found that twelve interventions address the management areas identified in WaterStressAT, although they may not lead to a reduction in irrigation in absolute terms. Employing a qualitative systems perspective shows where exactly CAP policy interventions enter the agricultural production system, and how its effects play out, if at all.

Contents	
1 Abstract.....	1
Contents.....	2
2 Introduction and Rationale.....	2
3 Analytical Process	3
4 The Austrian Common Agricultural Policy (CAP)	6
5 Analysis of the CAP’s (potential) contribution to sustainable agricultural water management	7
5.1 Crop selection	8
5.2 Efficient irrigation	8
5.3 Improving the Water holding capacity of the soil.....	9
6 Discussion and conclusion	10
6.1 Potential observed and impact of the CAP.....	11
6.1.1 Irrigation Technology	11
6.1.2 Crop selection	12
6.1.3 Soil management	12
6.1.4 Overall.....	12
References	13

2 Introduction and Rationale

The Seewinkel region in Eastern Austria offers favorable conditions for agricultural crop cultivation due to the presence of nutrient-rich and fertile soil with high humus content. Vegetable cultivation (as well as viticulture) and biologically farmed land is high in this region, whereas livestock farming, compared to other regions in Austria, is relatively low. The influence of the continental (Pannonian) climate leads to a relatively dry climate with hot summers and cold winters. However, changing climatic conditions are leading to challenging conditions for the agricultural sector (Land Burgenland, 2017; Valencia Cotera et al., 2023). As a result, the highly specialized ecosystems and agricultural sector in the region suffer from increasingly frequent periods of water stress and drought. Around 16% of the agricultural land are used for crops that depend on irrigation which are, for example, maize, potatoes, vineyards, vegetables and wheat (Guillaumot et al., 2022).

The (adaptive) response of farmers is often to increase water use for agricultural irrigation, which is the main driver of water demand in the region and is challenging the groundwater levels (Hanger-Kopp & Palka, 2022; Guillaumot et al., 2022). Irrigation requirements are high due to the interplay of changing climatic conditions and crop selections. Crops choices are, for example, influenced by their contribution margin and predominantly encompass vegetables, hybrid corn, potatoes, and wine grapes. Consequently, there is a potential adverse effect on groundwater levels and the associated ecosystems’ quality. Hence, it becomes important to implement measures to adapt to climate change impacts, especially the challenges posed by drought. Such measures are essential to safeguard food security and sufficient water security (Valencia Cotera et al., 2023). In this regard, reducing agricultural irrigation and hence water use becomes a pivotal approach to preserve groundwater levels (Karner et al., 2019; Kropf et al., 2021).

Within the scope of the WaterStressAT project, we identified three agricultural management areas through a qualitative systems map (QSM). These areas are crucial to reduce the pressure on water management and lower the need for agricultural irrigation for improved climate adaptation of the agricultural sector in Seewinkel: a) efficient irrigation, b) crop selection, and c) strengthening the water holding capacity of the soil. Also Karner et al. (2019) highlight the importance of such measures for adapting to climate change and hence managing its impacts on crop yield and environmental indicators. These management areas, however, are intricately intertwined with other agricultural practices, and their positive and negative side effects are not always clear cut. It is important to note that the successful implementation of the management areas depends on a variety of actors beyond the farmers themselves like retail, policymakers, or consumers, the way they are promoted, as well as the availability of financial incentives for farmers.

The Common Agricultural Policy (CAP) is the master framework of all agricultural policy in the EU and largely determines national agricultural policy measures. The Austrian CAP Strategic Plan entered into force on 01.01.2023 for the 2023/2027 period. It supports a wide range of interventions (99), which were previously referred to as measures, with a funding volume of around 1.86 billion euros per year. The CAP is based on a SWOT analysis that every member state conducted, through which also its' specific needs were identified on a national level. Ultimately, the CAP interventions are based on the member states' needs and aim to achieve EU-level CAP objectivesⁱ and contribute to the European Green Deal.

The CAP may thus have considerable impact on how agricultural management practices affect water availability and resources, and in turn on the uptake of the management areas identified in the WaterStressAT project. Sectoral policies, such as the CAP, have been criticized for not contributing sufficiently to the success of climate and biodiversity objectives, and challenging farmers' livelihoods. Indeed, given the size of this policy instrument and the diverse objectives it caters to, it is not clear what the actual outcomes may be in specific contexts. It is thus useful to explore specific case studies to generate insights into the types of changes – incremental vs. transformational – it may generate for alternative objectives.

The aim of this review was therefore to:

- **identify** whether and how the CAP addresses the three management areas and thereby affects agricultural water management in the Seewinkel region (through identifying links, positive and negative, between CAP and agricultural water management),
- **locate** relevant funding lines in our existing qualitative systems map of the region, and thus better represent policy impacts on agricultural management practices, and
- **evaluate** the systems perspective of the Austrian CAP and the usefulness of Integrative Qualitative Systems Maps to illustrate said systems perspective as well as integrate relevant policy information.

3 Analytical Process

We analyzed all funding aspects of the Austrian CAP, i.e. Pillar 1 (direct and market support) and Pillar 2 (rural development), and the policy measures they entail. The starting point for the thematic analysis were the three management areas to reduce agricultural irrigation demand, which were identified through a qualitative system map (QSM) drawing on available research, policy, and interviews with stakeholders and a workshop with farmers from the region as part of the WaterStressAT project. Based on these measures as well as the related systems elements in the QSM, we derived thirteen keywords which were used to code the text (Table 1), i.e., identify

relevant interventions in the CAP strategic plan for Austria (1,200 pages). This first effort yielded 15 interventions, which were categorized into one or more of the aforementioned management areas (soil, crop types, efficient irrigation), depending on which they addressed.

Table 1: Keywords used for searching the CAP Strategic Plan of Austria according to the Seewinkel management areas.

Management Area	Key Words for the CAP analysis (German)
<i>Efficient Irrigation</i>	Bewässerung
	Technologie
	Bewässerungstechnologie
	Bewässerungsstrategie
	Bewässerungsmethode
<i>Crop Selection</i>	Sorten
	Sortenwahl
	Kultur
	Resilienz
	trockenresistent
<i>Water holding capacity of the soil</i>	Boden
	Humus
	Mulchen
	Bodenbearbeitung
	Grundwasser
	Erosion
	Wasserspeicherkapazität
Wasserhaltekapazität	

We then qualitatively assessed the coded interventions in more detail, including the extent to which they influence the management areas in the Seewinkel region. This was done to establish the intended cause and effect on the management measures, and to build a final list of interventions and revisit their categorizations. On the one hand, the QSM was the baseline for determining relevant interventions; on the other hand, we validated our results comparing whether interventions were assigned to at least one of three cross-cutting needs guiding the CAP, and directly relating to Seewinkel management measures: a) improvement of soil quality, b) improvement of groundwater levels and quality, and c) climate change adaptation. Then, we reviewed each coded intervention in greater detail and the respective needs they address to assess their relevance. Ultimately, all but two interventions that made it into the final selection explicitly referenced at least one of the identified needs. The exceptions are, “Investments in agricultural production” and “Umstellungsförderung”, because even though they do not reference any of the needs we prioritized, they may offer funding aspects for the three management areas in the Seewinkel region that will be outlined in the following sections. Based on our analysis, we ultimately excluded three interventions from our initial selection. First, “the protection of groundwater levels” (German: Schutz des Grundwasserspiegels), which has a misleading title, but ultimately incentivizes improved water quality rather than quantity. Second, “ecological/organic production” (German: ökologische/biologische Erzeugung) was excluded after an expert interview and further analysis due to the lack of clarity about what specifically is funded through this intervention. Finally, the third intervention that was excluded, “improving resilience to pests and plant diseases” (German:

Verbesserung der Resilienz gegenüber Schädlingen und Pflanzenkrankheiten), was first included due to the assumption that crops that are resistant against pests and plant diseases are also more drought resistant. However, after more thorough research, we decided to exclude the intervention as this link is too indirect to be considered in our research context.

Thus, the final selection included twelve interventions (Table 2). The in-depth analysis has also shown that the initial categorization does not hold for all coded interventions, which is why they were reorganized where needed. One example is the intervention on environmentally friendly and biodiversity-promoting agricultural management. At first, we categorized it only under crop selection, but then expanded it to soil due to its focus on greening.

Table 2: An overview of the connections made between the CAP interventions and the existing elements of the Seewinkel agricultural water demand systems map. The blue interventions are from Pillar 1 and the green interventions from Pillar 2 of the CAP.

Interventions	Crop Selection	Irrigation Efficiency	Water Holding Capacity of the soil		
			Humus	Greening	Tillage
Greening of arable land – intercropping				x	x
Erosion protection for vines, fruit and hops				x	x
Greening of arable land - Immergrün system				x	x
Soil conservation					x
Improving the use and management of water		x			
Conversion support		x			
Investments in agricultural production	x	x			
Investments in inter-farm irrigation and slope		x			
Environmentally friendly and biodiversity-promoting management	x			x	
Organic farming	x			x	x
Humus conservation and soil protection on ploughable grassland			x		
Erosion control fields				x	x

Since the interventions were already categorized during the coding and analysis, they could be integrated into the existing qualitative system map for the Seewinkel region, in a sub-map focusing on agriculture. The CAP interventions were not necessarily linked to the management measure elements in the map, but to those systems elements they aim to influence and through which they affect the WaterStressAT management areas. For example, the water holding capacity of the soil can be strengthened through various measures such as mulching, humus, green cover, reduced tillage. Hence, interventions such as protection from erosion and soil conservation were connected to these elements, which in turn have a positive effect on the water holding capacity (Figure 1).

Figure 1: Screenshot of the Seewinkel system map on kumu.io, analyzing the impact chains between Seewinkel management options and agricultural irrigation.



By integrating CAP interventions in a systems map, we can visualize and analyze their potential to foster sustainable water management practices and a reduction in irrigation, as well as to which extent they contribute to an incremental or transformative change of water management strategies.

4 The Austrian Common Agricultural Policy (CAP)

In September 2022, the European Commission approved the CAP Strategic Plan of Austria. The CAP has two pillars through which a diverse set of interventions is funded.

Pillar 1 is 100% financed from the EU budget and is summarized as direct payments and covers direct aids (Barral & Detang-Dessendre, 2023), although it includes several interventions that distinguish specific target groups. For the new funding period, the budget of this pillar has been reduced to 677.6 million euros per year. At the same time, it has been given more direction through earmarking for several objectives, including, and potentially important for the topic at hand, the eco-scheme. Under this scheme, 25% of the Pillar 1 budget are earmarked for agri-environmental and climate-related interventions, which are voluntary, go beyond conditionality, and consist of four interventions of the agri-environment program in Pillar 2 (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft (BML), n.d.; Europäische Kommission, 2022b, 2022a)

The minimum requirements to receive subsidies from Pillar 1 is a farm size of minimum 1.5 hectares and to be considered an “active farmer”. Examples of the interventions are the following: basic income support (e.g., 208 EUR per hectare for homestead land), complementary redistributive income support, which is a new measure (additional payment that is provided for the first 40 hectares of homestead land and is granted in two stages), or complementary income support for young farmers. These are all area-based payments, meaning the subsidies are granted per hectare, or in some cases per RLU (roughage eating livestock unit) (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft (BML), n.d.; Weber, 2022).

Pillar 2, focusing on rural development, is 50% financed by EU funds and 50% financed by national funds (co-financing), with a total of 42 interventions, which farmers can adopt and receive financial support for. The agri-environmental measures of Pillar 2, together with the four eco-scheme interventions from Pillar 1, form the ÖPUL (Österreichisches Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft). Several changes were adopted in the new period. In total, 40% of the Pillar 2 budget is assigned to ÖPUL interventions. Apart from ÖPUL interventions, there are a number of other interventions like agricultural investments (Weber, 2022). In Pillar 2, at least 35% of the budget is specifically reserved for climate, biodiversity, environment and animal welfare interventions (Europäische Kommission, 2022a). Unlike interventions from Pillar 1, the amount that is subsidized in Pillar 2 does not generally depend on the farm size but is specified for each intervention.

The previously existing cross-compliance and greening were merged into "conditionality" which are the mandatory rules that must be met to receive direct payments (Pillar 1) and all agri-environmental and climate interventions (Pillar 2). The conditionality is shaped by the rules for Good Agricultural and Environmental Condition (GAEC) and the Statutory Management Requirements (SMR). The ten GAEC requirements relate to soil protection, water, and biodiversity. The eleven SMRs are based on EU regulations and the need to comply with these to receive CAP funding, such as the Water Framework Directive (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft (BML), n.d.; Weber, 2022)

Moreover, the needs for the agricultural sector are different for each member state. The Austrian CAP identified 45 needs of which three are of particular importance in the context of the WaterStressAT study in the Seewinkel region as outlined before.

5 Analysis of the CAP's (potential) contribution to sustainable agricultural water management

Out of the twelve relevant CAP interventions we elicited, six belong to Pillar 1 and include three eco-scheme and three sectoral interventions, and six belong to Pillar 2 and include two project-related and four ÖPUL interventions. In terms of the CAP needs, ten interventions relate to the groundwater need, nine to soil, and five to climate adaptation and resilience.

All these interventions were systematically assessed based on their impact on the three WaterStressAT management areas: crop selection (focus on drought-resistant crops),

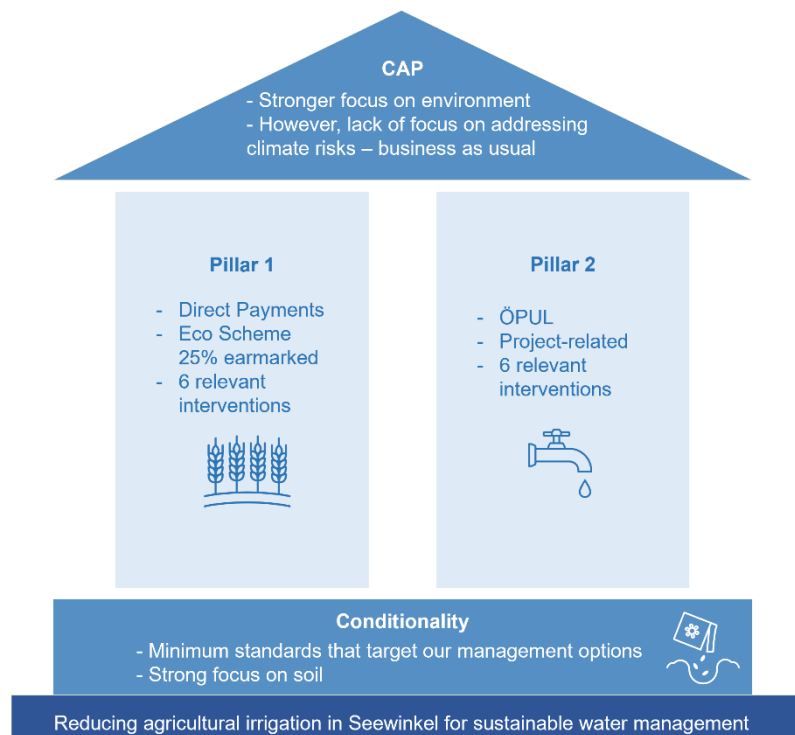


Figure 2: Main components of the CAP Strategic Plan for Austria

efficient irrigation (focus on efficient technology), and improving the water holding capacity of the soil (through adequate greening, tillage practices, and/or mulching). In the following paragraphs, we provide a description of each management area and explain how the CAP interventions are connected to them.

5.1 Crop selection

Crop selection refers to the choice of crops that are cultivated. Currently, crop types are predominantly selected based on projected contribution margins (Hanger-Kopp and Palka, 2019), an approach that often favors crops demanding substantial irrigation. The water requirements of (alternative) crops vary depending on stages of growth, or further uses and processing. Potatoes, for example, need irrigation throughout, but particularly in spring, whereas corn requires irrigation punctually in the early summer. Hence, designing system maps tailored to individual crops would yield different outcomes. To keep this QSM manageable, we conflated the crop selection element, which therefore has ambiguous connections to other system elements. Nevertheless, it can be unequivocally said that increased irrigation requirements of any given crop correspond proportionally to increased water demands for agricultural irrigation.

Three interventions within the CAP, all falling under Pillar 2, encompass aspects that influence crop selection:

- a) Organic farming (German: Biologische Wirtschaftsweise)
- b) Environmentally friendly and biodiversity-promoting management (German: Umweltgerechte und biodiversitätsfördernde Bewirtschaftung)
- c) Investments in agricultural production (German: Investitionen in die landwirtschaftliche Erzeugung)

Within interventions a) and b) support is provided for costs and income losses that arise, among other things, from compliance with requirements related to crop diversification and the associated effects on crop rotation, hence the direct impact on this management measure. The CAP Strategic Plan also provides a list for eligible crop types, which include lavender, Mediterranean herbs, oregano, buckwheat, or poppy seeds. Moreover, financial assistance for the cultivation of commercially viable permanent and specialty crops is provided through intervention c). As farmers would usually opt for crops with high contribution margins which may not be climate resilient, these interventions provide financial incentives for using less profitable but more resilient crops.

On closer examination of its systems implications, crop selection has an undefined impact on the need for irrigation of a crop. This means that the irrigation needs depend on the specific crop type. There is a connection between both elements, however, it cannot be described through a systems map logic with pluses and minuses. The need for irrigation of a crop has ultimately a positive relationship with agricultural irrigation – the higher the irrigation needs of a crop, the higher the agricultural irrigation. This shows that cultivating crops with low irrigation requirements is important for decreasing agricultural irrigation in Seewinkel and improving groundwater levels. However, none of the relevant interventions explicitly target such crops.

5.2 Efficient irrigation

The choice of irrigation technology, among other things like irrigation strategy, directly influences how efficiently irrigation is carried out. As we discovered multiple links between the CAP-interventions and this management area through the element “irrigation technology”, the interventions were linked to this element, which indirectly impacts the irrigation efficiency. The two main technologies currently used in the region are drip irrigation and overhead or rain irrigation. The

former is commonly employed in viticulture, while the latter is used for other crops. At present, it appears not feasible to implement drip irrigation for larger fields, as the effort required to set it up annually outweighs the advantages it offers according to participants of a WaterStressAT workshop.

In total, four interventions, two from Pillar 1 and two from Pillar 2, encompass aspects that are related to efficient irrigation, and efficient irrigation technology specifically:

- a) Investments in inter-farm irrigation and slope stabilization (German: Investitionen in überbetriebliche Bewässerung und Hangstabilisierung)
- b) Investments in agricultural production (German: Investitionen in die landwirtschaftliche Erzeugung)
- c) Improving the use and management of water (German: Verbesserung der Nutzung von und der Bewirtschaftung mit Wasser)
- d) Conversion support (German: Umstellungsförderung)

Intervention a) targets inter-farm irrigation through the promotion of investments in the construction or renewal of water conveyance and distribution systems, as well as the establishment of reservoirs for irrigation purposes. Furthermore, investments in structural and technical facilities for irrigation and watering are promoted through intervention b). Intervention c) directly promotes the construction of, or investment in, water-efficient irrigation systems and the adoption of water-saving irrigation techniques. Finally, intervention d) focuses on viticulture, and among other supported items, it promotes the establishment of drip irrigation systems. Hence, these interventions, particularly intervention c), have the potential to encourage the adoption of drip irrigation or other efficient methods and technologies.

The choice of irrigation technology significantly impacts the efficiency of irrigation. Due to the aggregation level of the elements in our map, no positive or negative relationship can be determined for this link. It can only generally be said that while enhancing irrigation efficiency may decrease agricultural water demand, this reduction may be offset if wider availability of irrigation technologies prompts non-irrigating farmers to adopt irrigation technologies, which may lead to an increase in overall irrigation. Although the interventions described above hold promise for improving irrigation efficiency, there thus remains a possibility of a rebound effect, resulting in increased irrigation overall.

5.3 Improving the water holding capacity of the soil

In our map, three elements directly impact the water holding capacity of the soil: humus, tillage, and green cover. Green cover generally refers to the extensive vegetation cover of agricultural cultivation areas throughout a significant portion of the year. Especially in the face of climate change, humus plays a crucial role in maintaining soil fertility. To enhance soil resilience against extreme weather conditions, it is recommended to augment both its capacity to retain and absorb water (water-holding capacity and infiltration capacity of soils). Measures focused on building up humus content have a positive impact on soil water balance and infiltration capacity. Minimal tillage is about avoiding the use of conventional tillage equipment such as plows, and instead utilizing tools such as harrows or disc harrows. In addition to no-till practices, there are also mulch tillage and direct seeding methods that eliminate soil disturbance.

For this management area, eight CAP interventions were identified – four from Pillar 1 and five from Pillar 2:

- a) Erosion control fields (German: Erosionsschutz Acker)

- b) Humus conservation and soil protection on ploughable grassland (German: Humuserhalt und Bodenschutz auf umbruchsfähigem Grünland)
- c) Organic farming (German: Biologische Wirtschaftsweise)
- d) Environmentally friendly and biodiversity-promoting management (German: Umweltgerechte und biodiversitätsfördernde Bewirtschaftung)
- e) Soil conservation (German: Bodenerhaltung)
- f) Greening of arable land - Immergrün system (German: Begrünung von Ackerflächen – System Immergrün)
- g) Erosion protection for vines, fruit and hops (German: Erosionsschutz Wein, Obst und Hopfen)
- h) Greening of arable land – intercropping (German: Begrünung von Ackerflächen – Zwischenfruchtanbau)

Through the systems elements the interventions are connected so they have a positive or negative relationship with water holding capacity of the soil. Consequently, these interventions have an indirect impact on the water holding capacity, as their systemic connections are directly observed in elements such as mulching, greening, tillage, and humus. Specifically, greening has six links to CAP interventions, tillage features four, while both humus and mulching each have one link.

Mulching practices are supported through intervention a), which promotes erosion-reducing cultivation techniques such as mulch- and direct sowing. Ultimately, an increase in mulching practices also increases humus and decreases erosion. Through its benefits for humus, mulching then also indirectly leads to improvements in water holding capacity of the soil.

Tillage is impacted by e), f), g), and h), which foster tillage reduction and the use of milder procedures. Reducing tillage also leads to an increase in humus and an increase in water holding capacity.

Greening is impacted by a), c), d), f), g), and h). All these interventions foster soil improvements and an increase in ground cover in many ways through increasing greening, intercropping, or biodiversity zones on arable land. An increase in greening leads to an increase in humus and an increase in water holding capacity of the soil.

Humus is directly impacted by b). This intervention is aimed at conserving grassland as the conversion of grassland into arable or permanent crop areas leads to substantial loss of humus. Increases in humus hence lead to an increase in water holding capacity of the soil, among other benefits.

These elements, whether directly (humus, tillage, greening) or indirectly (mulching), influence the water holding capacity of the soil in the Seewinkel region. Augmenting the soil's water holding capacity consequently leads to reduced irrigation requirements for crops, thus implying a negative relationship. This reduction in irrigation requirements further correlates with a decrease in agricultural irrigation, thereby establishing a positive relationship.

6 Discussion and conclusion

This analysis systematically supports the systematic integration of the CAP into a QSM, illustrating water supply and demand in the Seewinkel region in Austria. It qualitatively illustrates to what extent the Austrian CAP Strategic Plan may support reduced water demand for agricultural irrigation in Seewinkel, and what type of measures it would support.

6.1 Potential observed and impact of the CAP

Overall, we found that both pillars of the Austrian CAP encompass several interventions that may support the three management areas in the Seewinkel region and hence lower agricultural irrigation. However, the qualitative systems mapping approach also reveals the difficulty in assessing the impacts of implementing the CAP interventions on the amount of agricultural irrigation in the region as many effects remain implied. Some interventions, especially those related to soil management, have several positive spillover effects. Most importantly for our case study, strengthening the water holding capacity of the soil, but also other effects such as improved soil fertility. Others, in relation to irrigation technology, we have found to align closely with the “business as usual” approach by making technology more efficient instead of lowering irrigation in absolute terms. Interventions related to crop selection do not explicitly demand more heat or drought resistant crops, but may enable them, thus their actual effect is difficult to assess.

While the implementation of the CAP interventions cannot be guaranteed, the GLÖZ standards of the CAP at least require certain minimum standards. For example, certain soil-related measures such as avoiding erosion (GLÖZ 5), minimum ground cover over the winter (GLÖZ 6), or crop-related requirements such as crop rotation and crop diversification (GLÖZ 7), which also relate to the Seewinkel management area of improving the water holding capacity of the soil. For the other management areas, no minimum requirements have been established through the GLÖZ standards.

In the following sections, the impacts, and gaps that we have identified will be discussed in more detail. Overall greening has the most connections (6/18), followed by tillage and irrigation efficiency which both have 4/18 connections, followed by crop selection (3/18), and lastly, humus (1/18).

6.1.1 Irrigation Technology

The CAP interventions with the (potentially) most direct impact on agricultural irrigation promote investments in more efficient irrigation technologies and methods. However, it remains open whether this may lead to an increase or decrease in irrigation in absolute terms. Moreover, Hanger-Kopp and Palka (2019) point to the farmers perceived barriers regarding the investment in and installment of such technologies despite the financial support available. As shown in our mapping exercise and also argued by Kropf et al. (2021), the irrigation technology used depends on the crop that is cultivated. The interventions may incentivize farmers who have not previously irrigated their fields to invest in machines, or to expand on irrigated crops, which may lead to a rebound effect and ultimately more water use for agricultural irrigation. Kropf et al. (2021) similarly raised concerns regarding the effectiveness of incentivizing efficient irrigation technology as it can avert a timely shift in crop types.

We have found that other crucial aspects, such as irrigation strategy, which impacts the efficiency of irrigation, have not been addressed through the CAP interventions. Irrigation strategy refers to when and how often farmers irrigate. For example, there are farmers who believe it is sufficient to irrigate occasionally/sporadically, waiting for the next rainfall (e.g., your plants hold out without rain for longer until they need it so they do not die), while other farmers, because they have enough equipment and other resources, irrigate every day as a precaution.

A gap or potential negative side effect of the CAP that emerged from the QSM exercise regards the implications of promoting more efficient irrigation technologies. In a system already reliant on (less efficient) irrigation, the adoption of more efficient technologies certainly yields positive effects. Nevertheless, the CAP has not yet addressed the implications of increased absolute numbers of irrigation machines. In the Seewinkel region, more irrigation will lead to even more pressures on the

groundwater levels and hence the ecosystems. Especially, when more transformative actions such as soil management efforts are not implemented, and new technology remains the primary action to address irrigation issues.

6.1.2 Crop selection

There is no explicit focus on the promotion of drought resistant crops in the CAP, despite crop types and diversification playing an important role across several interventions. Hence, there are no direct positive impacts that can be observed from the information provided through the CAP. However, we identified certain crops in the list of crop types eligible for subsidies in the CAP document that are likely to be more drought resistant than others such as lavender, Mediterranean herbs, buckwheat, or poppy seeds. Yet the selection of drought resistant crop types is still up to the farmers themselves and is not specifically emphasized under the current policy. We have identified this as one of the gaps within the CAP Strategic Plan as there is no promotion or market incentive for prioritizing such crop types at the moment. Diversifying crops yields a variety of positive effects and feedback loops. However, incentivizing the cultivation of more drought resistant crops is important, especially given the increasing weather extremes under climate change. It is important to note that markets for such crop types are not yet established in Austria, which poses a significant barrier for farmers to adopt such transformative measures. This issue has also been raised by Kropf et al. (2021), who additionally argue that any crop type has some water requirements. Meanwhile, a study by Valencia Cotera et al. (2023) has also shown that switching to drought tolerant crops does not increase irrigation, even if cultivated across larger lands.

6.1.3 Soil management

The management area “strengthening the water holding capacity of the soil” and thus related systems elements have the most connections to CAP interventions, while they are more indirectly impacting agricultural irrigation. However, there are several spillover effects that (positively) impact the system (e.g., soil fertility, erosion) (GAP-Strategieplan Bericht 2021, 2021), which are not further explored in our analysis. The water holding capacity of the soil and crop type together define the water needs of a crop and ultimately agricultural irrigation. The CAP interventions first and foremost impact and target systems elements such as tillage, humus, and greening, which in return positively affects the water holding capacity. Also Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft (BML) (2022) states that it is important to strengthen the water holding capacity of the soil against drought events – humus plays a crucial role for this. As we have identified many interventions related to these aspects, we conclude that the CAP Strategic Plan can make a positive contribution to strengthening the water holding capacity of the soil. Moreover, we did not identify any negative implications or gaps through the CAP analysis for this management area. Hence, these may be considered as the most comprehensive interventions contributing to lowering agricultural irrigation in the Seewinkel region.

6.1.4 Overall

Overall, we conclude that the uptake of the CAP interventions reviewed in our analysis may lead to a reduction in agricultural irrigation under certain/ideal circumstances. However, it remains open whether the interventions will suffice to bring about the far-reaching changes required to reduce the farmers dependency on agricultural irrigation and regulate groundwater levels, and whether the reliance on interventions that promote more efficient irrigation technology is favorable at all. Indeed, to the best of our knowledge, there is no intervention that directly aims to significantly reduce agricultural irrigation through the three management scenarios. Despite that, the soil-related interventions have important spillover effects and relate to the CAP need on improving surface and

groundwater protection. Through our qualitative assessment, the exact magnitude such interventions have could not be fully evaluated (for further analysis, see Valencia Cotera et al. (2023)). The effect of these CAP interventions ultimately depends on the uptake among farmers as well as the funding volume available, among other things. Under the twelve interventions we assessed, “Biologische Wirtschaftsweise” receives the highest funding volume and targets multiple measures. This may imply a higher potential of enabling change for the actions funded under this intervention.

The qualitative systems map for which this analysis was developed draws on available literature and stakeholder and expert knowledge. However, it remains a simplification of a complex system of different nexus issues such as food, water, and biodiversity. This simplification was a conscious decision as the map served as a communication and documentation tool but was not intended to represent a working systems dynamics model. Our analysis of the CAP focused on regionally specific management options emphasized by local farmers and agricultural interest groups throughout the WaterStressAT project. As we have only considered one of these management areas as transformative - crop selection - and the other two were evaluated to be incremental, this could also explain why our analysis of the Austrian CAP did not yield more effective or transformative interventions. To answer these questions, more in-depth (qualitative or quantitative) research needs to be conducted on the systems dynamics at the food-water-biodiversity nexus in the Seewinkel region and the effects of the implementation of CAP interventions. Moreover, the negative implications of the interventions have not been fully explored in our study beyond the discussion on whether incremental change is even favorable. However, these have also not been outlined in the CAP Strategic Plan.

Finally, we have not explored comprehensively whether the measures explored interfere with other climate adaptation and mitigation strategies. Kropf et al. (2021) point out that such measures can prohibit mitigation efforts as they can lead, for example, to an increase in energy consumption. This once again shows the interconnectedness of systems elements and hence also climate measures. Therefore, applying a systemic lens, such as through (qualitative) systems mapping, in developing and implementing solutions becomes imperative.

Our approach offers preliminary reflections and contextualization of the implications of the analyzed interventions on the reduction of agricultural irrigation and sustainable water management. The success of the interventions not only depends on the demand and uptake among farmers in the region and the funding volume available, but also the changes made by actors outside the agricultural sector such as retailers, policymakers, and consumers affecting demand patterns, and market design.

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ⁱ The CAP objectives are: to ensure a fair income for farmers; to increase competitiveness; to improve the position of farmers in the food chain; climate change action; environmental care; to preserve landscapes and biodiversity; to support generational renewal; vibrant rural areas; to protect food and health quality; fostering knowledge and innovation. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27_en (Last accessed: 31 May 2023)