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NbS & regenerative agriculture to transform food systems and address water challenges in Spain

Identifying Danone's role to accelerate the ecological transformation

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SUMMARY

The severe water crisis that Spain is experiencing is amplified by climate change and requires farmers, governments and all stakeholders across the agricultural value chain to adopt and promote resilient practices so that the sector, local communities and nature can thrive.

This study is the result of a partnership between TNC and Danone and has two main goals. First, to identify, for peaches, almonds, forage crops and pastures, regenerative agriculture (RA) practices that can contribute to tackle water security challenges in Spain. Second, to make recommendations on how actors such as Danone can support their adoption at scale.

Through a mix of literature review and interviews of experts and practitioners, the study identified a set of promising RA practices in terms of impacts on water security, biodiversity and other indicators, including crop production, climate change mitigation and adaptation, and soil health. For almonds and peaches, these practices are soil cover, buffer strips and organic soil amendments. For pasture and forage crops, rotational grazing, pasture diversification and a mix of crop rotation with direct seeding/no tillage and mulching with crop residues appeared to be the most promising.

Main trade-offs to be considered are yield losses and high upfront investment cost for machinery. With regards to the former, we found out that under the right conditions, yields can be maintained with proper implementation, which entails strong technical expertise and local knowledge. RA practices can require at least a 1-to-3-year transition period. Upfront investments could be financed by subsidies (Plan RENOVE) and the financial burden shared amongst several farmers.

Despite opportunities to optimise benefits and reduce trade-offs, the adoption of RA practices in Spain is low for the studied crops, with the notable exception of soil cover with natural vegetation for woody crops. On top of the aforementioned high investment costs, the main barriers for adoption are: a lack of knowledge and evidence on the potential benefits of RA practices, uncertainties regarding impacts on yields and revenues, design limitations and, to some extent, limited availability of inputs (manure for soil amendment). All these barriers need to be overcome to incentivise typically risk adverse farmers to adopt new practices.

Agribusiness players can play a role at several levels to overcome these barriers. They could engage either directly with farmers or farmers organisations, or through wholesalers, to work on knowledge dissemination and levers to strengthen the RA business case through financial support for investments or financial incentives, especially during the transition period. The establishment of partnerships amongst buyers to harmonise RA standards and suppliers' selection criteria could also induce a systemic change driven by demand.

CONTEXT OF THE STUDY

Water crisis and agriculture in Spain

Spain faces an acute water crisis, due to recurring droughts caused by the changing climate, namely a reduction in rainfalls and the increasing temperatures. Spain is one of the 33 countries predicted to face extremely high water stress by 2040 (World Resources Institute, 2015).

This scarcity is compounded by significant demand from intensive agriculture. Abstraction for irrigation has skyrocketed as the country has become Europe's fruit basket. Spain is the European country with the largest area of irrigated land[1], which consumes 80% of available water resources, and demand is increasing. Yet, in 2019, the cereal agribusiness sector reported drought-related losses of EUR 1.5 billion.[2]

At the same time, the 2021 report on water quality from the Health Ministry revealed that water has not been safe for drinking at some point during the year in close to 2,300 water supply areas (Ministerio de Sanidad, 2021). Diffuse pollution, in particular from pesticides, has forced villages located in rural areas to rely on water trucks for their daily supply during the dry season, when flows are lower and concentration of pollutants increases.

Nature-based solutions and regenerative agriculture for water security

This water crisis has serious social, economic and environmental consequences. Enabling water security going forward will require a holistic and systemic approach that addresses intertwined issues of water quantity and quality.

Nature-based solutions (NbS) are gaining prominence as a cost-effective way to complement traditional grey infrastructure[3] and technological approaches. They are "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, while providing human well-being and biodiversity benefits" (IUCN, 2016). When applied to water security, they focus on the "provision of an acceptable quantity and quality of water, for health, livelihoods, ecosystems and production, with an acceptable level of water-related risks to people, environment and economies" (Grey and Sadoff, 2007).

Amongst NbS for water security, there is a growing interest in adopting more efficient and sustainable agricultural management practices, such as regenerative agriculture (RA) to reduce water consumption, retain water on farms, and minimise impacts on water quality.

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[1] 13.8% of the country's area. Source: Indexmundi.com.

[2] https://www.cope.es/actualidad/sociedad/noticias/sequia-supone-1500-millones-euros-perdidas-cereales-espana-segun-union-uniones-20190620_441201.

[3] Human-engineered infrastructure for water resources such as water and wastewater treatment plants, pipelines, and reservoirs.

In this study, RA is defined as a set of farming practices that protects and restores the soil and water, preserves and strengthens biodiversity and, when applicable, respects animal welfare and strengthens the well-being of farmers, local communities and consumers. RA practices create more resilient agricultural social-ecological systems in a context of climate change and increasing competition over the use of natural resources.

In Spain, the two most common regenerative agriculture practices are direct seeding (also known as no tillage and reduced tillage) for annual crops and use of vegetation cover in woody crops (figure 1). According to official data (ESYRCE), direct seeding extended over more than 845,000 hectares in 2021 in Spain, representing 12% of the cultivated area for cereals, sunflower, maize and forage crops. According to the same data source, vegetation cover practices in woody crops extended over more than 1,350,000 hectares (or 25% of the total at national level) in 2021.

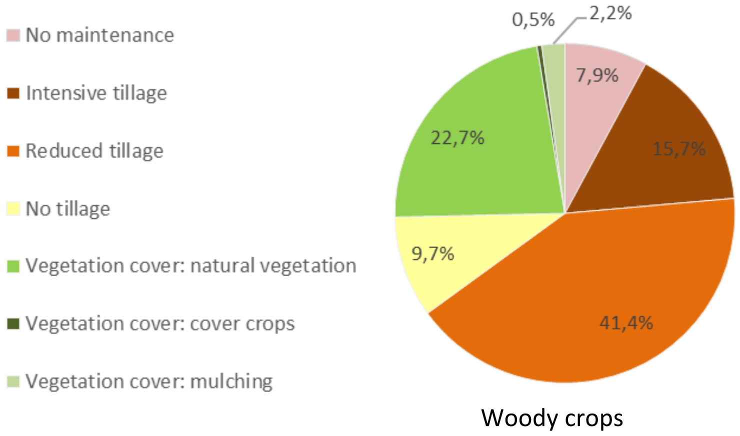


Figure 1. Distribution of soil maintenance techniques for woody crops in Spain. (ESYRCE, 2021)

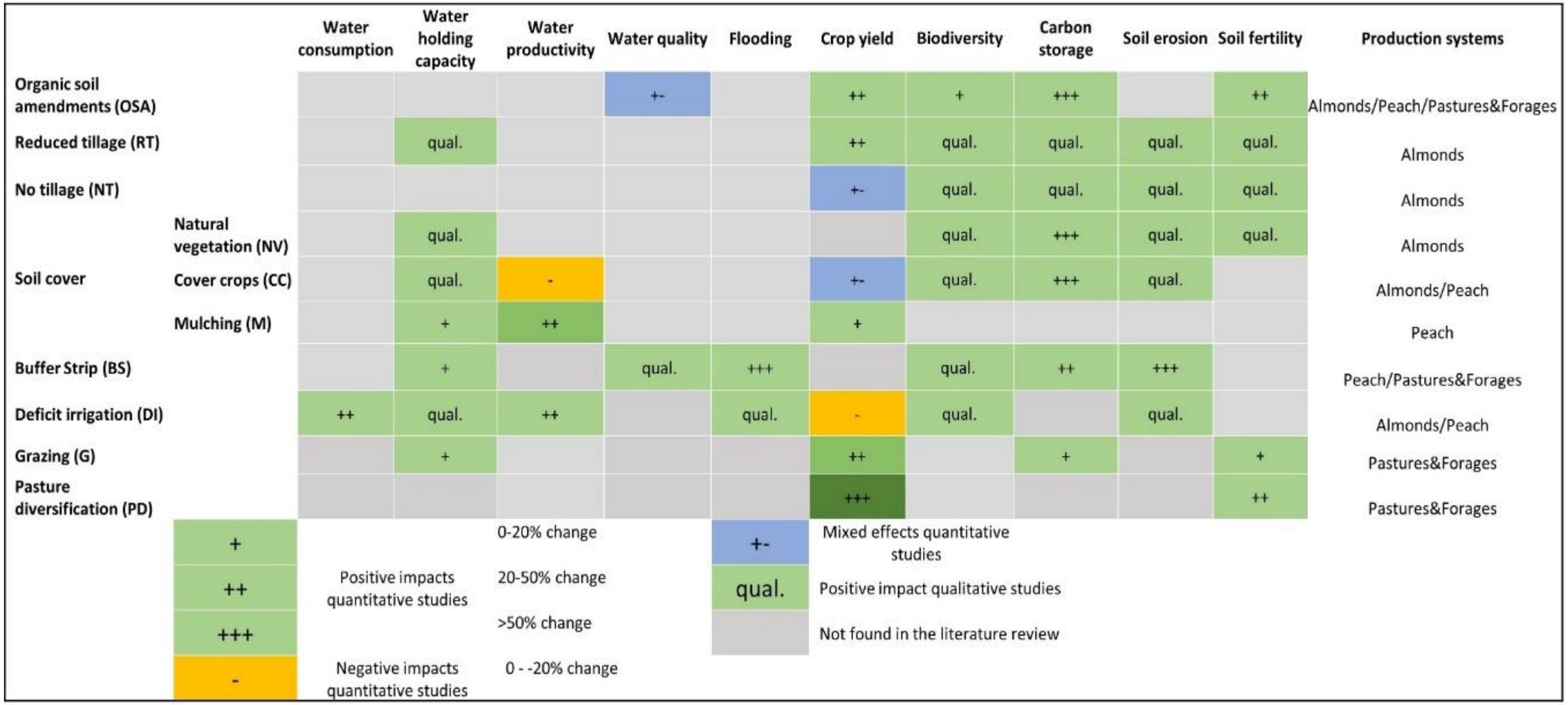
While only around 15% of the land is only managed through conventional intensive tillage practices, the aridity and most generally, climatic context, Spain faces, makes it essential to find the optimal combinations of practices that allows to optimize production while reducing impact on soil and water quantity and quality.

OBJECTIVES AND SCOPE OF THE STUDY

The adoption of NbS and RA practices at the necessary scale requires the involvement of all stakeholders of the agribusiness value chain. Danone, as a key player in Spain, where it manages both production facilities and supply chains for key ingredients, can play a substantive role in fostering the transformation of food systems to improve overall water resilience, in collaboration with others. Thus, Danone partnered with The Nature Conservancy (TNC) to identify priority landscapes and promising RA practices in Spain that it could support to improve water security for people and the environment.

This study focuses on three Danone priority ingredients: almonds, peaches as well as pastures and forage crops for dairy cows. Three landscapes, all located in the Catalonia region, have been prioritized based on a multicriteria analysis that considered importance for Danone, freshwater biodiversity, and potential for implementation of NbS to enhance water security. These landscapes are Parets del Vallés, near Barcelona, a watershed where Danone has a production plant and milk suppliers, Muga basin (presence of milk suppliers for Parets), and the Segriá region where Danone wholesalers for almonds and peaches, as well as farmers for those ingredients are found. After obtaining additional information on the location of milk farm locations in Parets and Muga, and acquiring a better understanding of their current mode of operations that involves little to no on-site grazing, it was deemed however that the potential for switching to NbS and RA practices in those two landscapes would be limited. Therefore, it was agreed that the rest of the study, particularly in terms of project identification, would focus on the Segriá landscape, and thus, specifically in peaches and almonds. Nevertheless, the analysis of the impacts of RA practices was carried out for all three priority ingredients value chains, including dairy.

Table 1. Summary of impacts of identified RA practices



		Water consumption	Water holding capacity	Water productivity	Water quality	Flooding	Crop yield	Biodiversity	Carbon storage	Soil erosion	Soil fertility	Production systems
Organic soil amendments (OSA)					+-		++	+	+++		++	Almonds/Peach/Pastures&Forages
Reduced tillage (RT)			qual.				++	qual.	qual.	qual.	qual.	Almonds
No tillage (NT)							+-	qual.	qual.	qual.	qual.	Almonds
Soil cover	**Natural vegetation (NV)**		qual.					qual.	+++	qual.	qual.	Almonds
	Cover crops (CC)		qual.	-			+-	qual.	+++	qual.		Almonds/Peach
	Mulching (M)		+	++			+					Peach
Buffer Strip (BS)			+		qual.	+++		qual.	++	+++		Peach/Pastures&Forages
Deficit irrigation (DI)		++	qual.	++		qual.	-	qual.		qual.		Almonds/Peach
Grazing (G)			+				++		+		+	Pastures&Forages
Pasture diversification (PD)							+++				++	Pastures&Forages

+	Positive impacts quantitative studies	0-20% change
++		20-50% change
+++		>50% change
-	Negative impacts quantitative studies	0 - -20% change
+-	Mixed effects quantitative studies	
qual.	Positive impact qualitative studies	
▨	Not found in the literature review	

For quantitative studies, the percentage of change (i.e., treatment results -control results)/control results) is indicated with a notation of + and or – based on the average values from the studies included. Quantitative studies are indicated by color (green = positive impact; blue = mixed impacts, orange = negative impacts), whereas positive impacts from qualitative studies are indicated green and with the label "qual". Negative impacts are not shown in qualitative studies as they were not found for the practices under study, or if available, results from quantitative studies are calculated. For the results per cell, between one and three studies reported the results shown. Practices that were not reported to be used as standalone, such as fertirrigation, have not been included in this table.

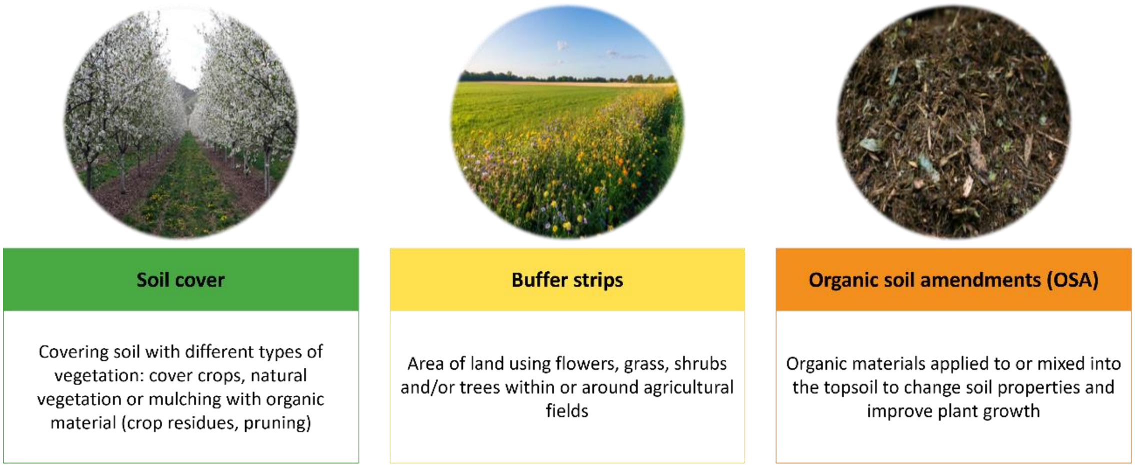
RESULTS

Recommended RA practices

To understand scientific knowledge on RA in the Mediterranean context, a literature review was performed consisting in the analysis of the results of 37 publications to summarize the main practices implemented in peaches, almonds and pastures farms under the current ecologic and economic context. **Impacts cited from the literature review, positives or negatives, should be interpreted as an indication of *potential* for benefits rather than an absolute figure.**

Both positive and negative impacts have been found on crop yields and water quality when implementing different practices. The remaining of the impacts are positive, including a reduction on water consumption (particularly for deficit irrigation) and soil erosion, and with improvements in soil water holding capacity, soil fertility, carbon storage, and biodiversity (Table 1). Although water-related benefits are not the largest ones in magnitude, they are of particular relevance in the Spanish water crisis context to contribute to tackling scarcity and quality degradation issues. Also, improvements of soil structure and fertility, by increased microbial activity, nutrient content, organic matter and carbon storage, are essential for crops and vegetation to be more water efficient, to mitigate crop yield impacts under water-limiting conditions and to support biodiversity.

Literature review results were cross-checked against interviews with experts and practitioners, and a set of promising RA practices was selected based on impacts on water security, biodiversity and soil health.



Soil cover	Buffer strips	Organic soil amendments (OSA)
Covering soil with different types of vegetation: cover crops, natural vegetation or mulching with organic material (crop residues, pruning)	Area of land using flowers, grass, shrubs and/or trees within or around agricultural fields	Organic materials applied to or mixed into the topsoil to change soil properties and improve plant growth

Figure 2. Recommended RA practices for woody crops

Main findings for soil cover, buffer strips and OSA with respect to key indicators (Figure 2) are listed below:

- Soil cover, and in particular mulching, can lead to an 18% increase in **soil water retention capacity**. Coupled with organic soil amendment, this benefit could increase to 40% (peaches)

- When applied appropriately, all three practices have benefits for **water quality**. In particular, soil cover (mulching applied to peaches) and buffer strips (in almonds) were found to significantly **reduce erosion** by more than 90% in both cases.
- Similarly, vegetation cover and cover crops also preserve or even increase **biodiversity** (+15%, organic soil amendment), including the abundance of **pollinators** and **pest regulators** (buffer strips, organic soil amendments, +257%).
- These practices also provide co-benefits such as soil **carbon storage** (+100% for cover crops – almonds) and decreased use of synthetic fertilizers. We also found out that, under the right conditions, yields can be maintained when adopting cover crops, no tillage and reasonable nutrient reductions. Key variables for this are the quality of farmers training and a strong local expertise to guarantee proper implementation (see Box 1). The adoption of RA practices can require at least a 1-to-3-year transition period.

Regenerative rotational grazing	Pasture diversification	Crop rotation + Direct seeding + Mulching
The shifting of livestock to different land units of a pasture during a short time window followed by a resting period of the land to allow the recovery and growth of the pasture plants after grazing	Allowing multiple species in pastures through seeding or natural vegetation succession	Crop rotation (growing different crops in succession on the same land) with No tilling (growing crop forages without disturbing the soil through tillage) and Mulching with crop residues

Figure 3. Recommended RA practices for pastures and forage crops

Regarding pastures and forage crops, the identified practices were found to have significant impacts on soil water and the environment as follows:

- Rotational grazing contributes to increased **water holding capacity** (+14%), whereas the combination of direct seeding and mulching (without including crop rotation) improves **water holding capacity** (e.g., up to 28% using wheat straw residues on untilled soil). Improvements in yields have also been reported, with up to +30% in rotational grazing.
- Rotational grazing can lead in the medium term to pasture diversification providing a greater **pollinators abundance** and resilience to climate change under drought or flooding events. The combination of direct seeding and mulching also contributes to increased **soil biodiversity** (e.g., +20% number and +8% Shannon Index of soil arthropods, respectively).
- Crop rotations can be combined with additional practices of **pest and disease management** and **weeds control**, which also avoids pesticides and herbicides resistance.

Moreover, these practices present co-benefits in terms of **carbon storage**, improved yields and soil structure, and decreased use of industrial fertilizers, herbicides and pesticides.

Box 1: Yield trade-offs: the importance of proper technical support and implementation

We have identified soil cover, buffer strips, organic soil amendments, rotational grazing, pasture diversification, and a combination of crop rotation, direct seeding and mulching with crop residues as practices that can provide water, biodiversity, and other co-benefits in Spain.

Each recommended practice has a range of associated benefits and trade-offs suggesting there are opportunities to finetune each practice to maximize the associated benefits and reduce trade-offs.

Recognizing that yield loss is a key outcome that farmers want to minimise, the following discussion focuses on how implementation expertise can help mitigate yield trade-offs. We focus on the use of cover crops in row cropping systems because 1) there are high-quality data to draw from, 2) cover cropping is commonly framed as an ‘easy’ regenerative management practice, and 3) the conclusions drawn from this practice are transferable to other scenarios. Several authors (see a compilation in Giacalone et al., 2021) have questioned whether competition for water and nutrients by cover crops may affect the quality and sustainability of fruit production compared to tilling or weeding. However, there are other authors (e.g., Repullo-Ruibérriz et al., 2021) who did not find any relevant yield reduction in almond cultivars (South Spain). Therefore, it can be concluded that several factors influence outcome, and this has to be taken into account when planning for implementation.

With cover cropping, farmers must make a series of management decisions including: i) which cover crop species to plant; ii) how to plant; iii) when to plant; and iv) how and when to remove the cover crop. The implications of these choices affect the final outcome. For example, planting time directly affects how long the cover crop grows, which affects how big the cover crops are at termination, which thereby affects the amount of carbon added to the soil. Thus, the longer the cover crop growing period, the more carbon-rich materials go into the soil, increasing the impact of the cover crop on soil carbon content (McClelland et al., 2021). Although in a Mediterranean climate, vegetation cover is not possible for the whole year because of the water-limiting conditions, and the cover crops may only be relevant only during winter months.

How much carbon goes into and is retained in the soil can improve soil health and reduce crop yield variability from year to year, especially in drought years. There is direct evidence that as soil organic matter increases soil health improves, specifically the amount of water the soil can hold (water holding capacity), soil compaction, and nutrient availability (pH becomes more neutral; Oldfield, Wood, and Bradford 2020). Sixteen years of field data spanning 754 counties in the US Midwest also show that as drought conditions become more severe, the protective benefits of soil organic matter on crop yields becomes more pronounced (Kane et al. 2021). In other words, the benefits of soil organic matter are greatest when water is most scarce, something that is becoming increasingly important with global warming.

Building soil organic carbon is a medium- and long-term practice and requires **experience and expertise**. There can be a lot of variability in outcomes with RA practices (see TNC’s AgEvidence webtool (Atwood and Wood 2021)). However, experience implementing RA can increase the benefits associated with the approach. For example, using a large on-farm dataset generated by the Soil Health Partnership, Wood and Bowman (2021) found that after longer periods of use cover crops have a stronger effect on soil carbon, with years 1-3 being associated with the ‘learning years’. Thus, easing the learning curve in some way either through technical assistance, training, or local trials could help facilitate a more rapid and effective uptake of practices and hasten the rate we reach our desired environmental and agronomic outcomes. Our final assumption is that **if implemented properly, yields can be maintained when adopting cover crops, no tillage and reasonable nutrient reductions. A key variable is the quality of the training.**

Business case and monetisation opportunities

Once the set of key practices was defined, the study focused on evaluating the business case. CAPEX and OPEX were reviewed in the literature (tables 2 and 3). This work concluded that the main consideration project developers have to make relates to high upfront investment costs. Costly specific machinery may be needed (e.g., 7K EUR for cover crops – although natural covers are considerably cheaper, 13K EUR for organic soil amendments). These costs could potentially be financed by subsidies (Common Agricultural Policy, Plan RENOVE from Spanish government) and the financial burden can be shared amongst several farmers. On the other hand, OPEX are typically on par or lower than conventional practices.

In terms of ecosystem services monetisation, carbon could represent a good opportunity given the sequestration potential of various practices (in particular soil cover, buffer strips and organic soil amendments) and the existence of an established market mechanism (voluntary market) in Europe. However, carbon projects can be challenging given the scale required to absorb certification and verification costs and will require cooperation amongst landowners.

Additionally, should RA practices generate measurable benefits for other water users in the catchment (e.g., water utilities), Payment for Ecosystem Services schemes could also present an opportunity for generating revenues.

Table 2. Main costs and revenues for the recommended practices for woody crops. Numbers in brackets refer to the qualitative ratings from Box 3 representing the relative magnitude.

Recommended RA practices for woody crops	CAPEX	OPEX	Additional costs	Revenues
Natural vegetation cover	**[+1]** No CAPEX required	**[0]** No OPEX required	**[0]** N/A	**[+1]** CAP subsidies (71.63 - 175.86 €/ha)***
Cover crops	**[-1]** Seeds: 100-200 €/ha (every 3-4 years) + Mower and harvester: 7,000 € (every 10 years)**	**[-1]** 30 €/ha (every 3 to 4 years) + 200 €/year**	**[-1]** Technical advice 20€/ha**	**[+2]** Additional production CAP subsidies (71.63 - 175.86 €/ha)*** Subsidies under PLAN RENOVE
Mulching with crop residues	**[-1]** Low	**[-1]** Low	**[-1]** Technical advice 20€/ha**	**[+2]** CAP subsidies (61.07 – 165.17 €/ha -depending on the slope)***

Recommended RA practices for woody crops	CAPEX	OPEX	Additional costs	Revenues
Organic soil amendments	**[-2]** Materials: 600 €/ha (solid organic fertilizer for buried application)** Machinery: 12,000 € (every 10 years)**	**[-1]** 50 €/ha average Compost: -3.8%* Green Manure: +15.6%*	**[0]** N/A	**[+1]** 600 €/ha – 1,400 €/ha/year* Compost: + 17.2% NPV* Carbon stock valuation: +1.06% annual revenue Subsidies under PLAN RENOVE
Buffer strips	**[-1]** 0.10 – 0.20 €/sq m 0.5 € to 2 €/m 320 - 840 €/ha**	**[-1]** Variable 1 €/m/2yr**	**[0]** N/A	**[+1]** Revenues from flowers if floral species are used CAP subsidies (56.05 – 156.78 €/ha)***

Table 3. Main costs and revenues for recommended practices for pastures and forage crops. Numbers in brackets refer to the qualitative ratings representing the relative magnitude.

Recommended RA practices for pastures and forage crops	CAPEX	OPEX	Additional costs	Revenues
Crop rotation + direct seeding + mulching (with crop residues)	**[-2]** High 60,000 € (direct seeding machinery every 15 years)**	**[-1]** Low	**[-1]** Technical advice 20€/ha**	**[+1]** Subsidies under CAP (90.22 €/ha in humid dryland crops; 52.35 €/ha in rainfed crops; 156.78 €/ha in irrigation; 71.63 - 175.86 €/ha depending on the slope).*** Subsidies under PLAN RENOVE***
Pasture diversification	**[-1]** Low – Medium**	**[0]** Medium Cost savings from lower fertilization**	**[0]** N/A	**[+2]** Lower than arable crops Subsidies under CAP (85.72 €/ha in humid dryland crops; 47.67 €/ha in rainfed crops; 151.99 €/ha in irrigation)***
Rotational grazing	**[-2]** 5,358 - 19,000 €/ha (annual) or above if pastures are non-contiguous*	**[+2]** 350 - 715 €/ha (annual) as compared to 710 € - 1790 €/ha under conventional treatment*	**[0]** N/A	**[+1]** Subsidies under CAP (62,16 €/ha in humid pastures; 41,09 €/ha in Mediterranean pastures)***

Key findings, barriers for adoption and potential roles for Danone and other buyers of agricultural products to support the uptake of RA practices in Spain

Adoption of RA practices in Spain has potential of generating benefits for farmers across Spain, has shown by the generalized used of natural vegetation soil cover in woody crops. Nonetheless, important barriers for adoption still prevent the general implementation of ambitious combinations of practices. On top of the aforementioned high investment costs, the main barriers for adoption are a lack of knowledge (both theoretical and technical) and of evidence on the potential benefits of RA practices, uncertainties regarding impacts on yields and revenues, as well as design limitations and, to some extent, a limited availability of necessary inputs (manure for soil amendment). All these barriers need to be overcome to incentivise typically risk adverse farmers to adopt different practices.

Danone and other buyers of agricultural products could play a role at several levels to overcome the barriers. It could engage either directly with farmers or farmers organisations (unions, cooperatives), or through wholesalers (Figure 4).

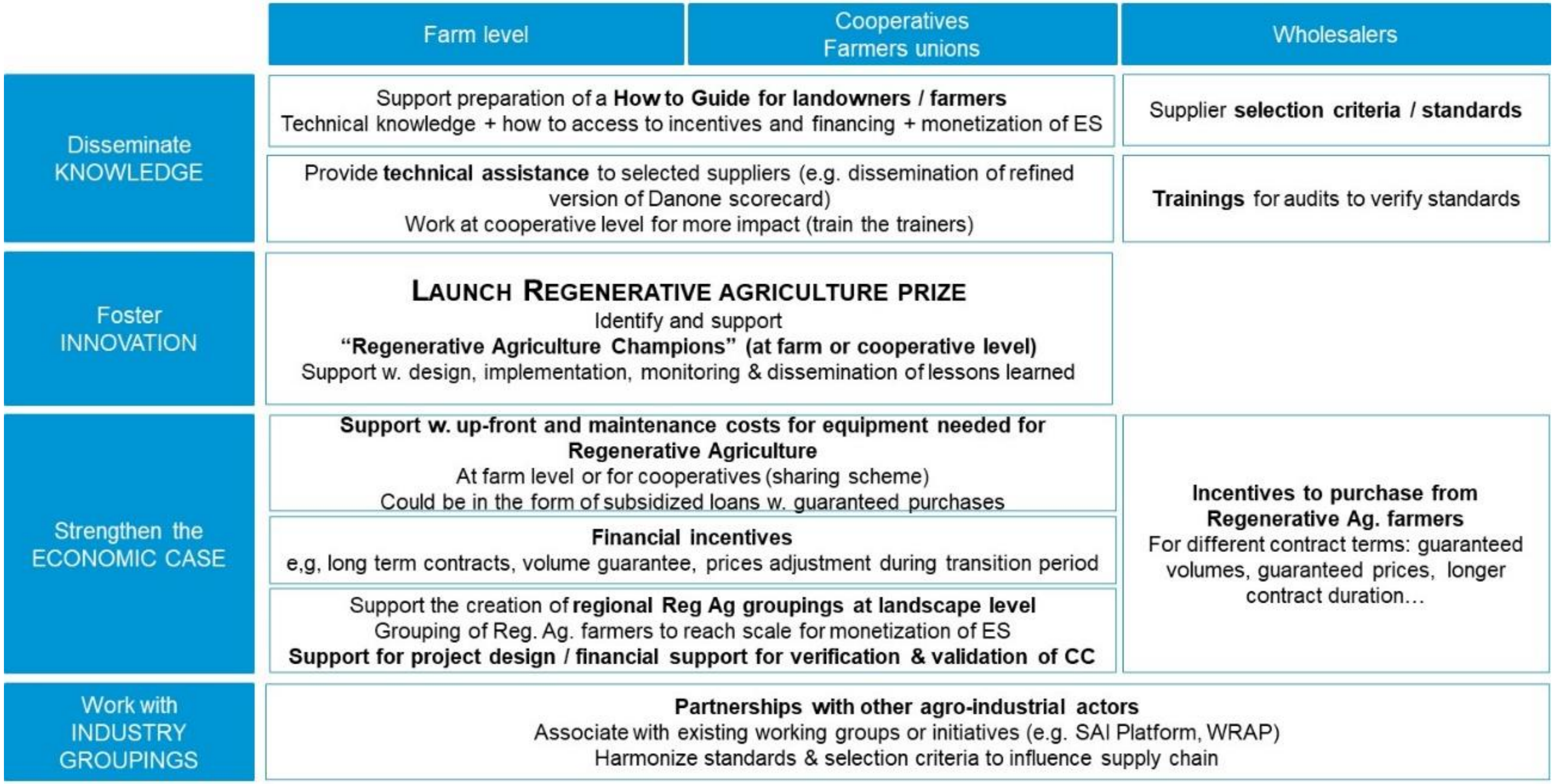
The first lever for Danone relates to knowledge dissemination, which could be catalysed by the creation of a pragmatic how to guide for landowners, targeted on the ground technical assistance to selected suppliers, or work with wholesalers to develop standards for RA and suppliers' selection criteria, as well as on audit procedures.

In addition, to foster innovation and the actual implementation of RA practices in the landscapes, we suggest that Danone supports "RA champions" at farm or cooperative levels through the launch of a RA Prize.

Another important role for Danone is to strengthen the RA business case, for example through financial support to selected suppliers with up-front and maintenance costs associated with specific RA machinery and equipment, design of financial incentives including guaranteed long-term contracts, purchase price premiums, or even warranty-backed sustainable crop plans. Incentives schemes for wholesalers to purchase from RA farms could also be considered.

Last, we strongly recommend that Danone establishes partnerships with other agro-industrial actors that source from the same area to harmonise RA standards and suppliers' selection criteria and generate a systemic change from the demand side.

Figure 4. Potential roles for Danone and buyers of agricultural products to support the adoption of RA practices



	Farm level	Cooperatives Farmers unions	Wholesalers
Disseminate KNOWLEDGE	Support preparation of a **How to Guide for landowners / farmers** Technical knowledge + how to access to incentives and financing + monetization of ES		Supplier **selection criteria / standards**
	Provide **technical assistance** to selected suppliers (e.g. dissemination of refined version of Danone scorecard) Work at cooperative level for more impact (train the trainers)		**Trainings** for audits to verify standards
Foster INNOVATION	**LAUNCH REGENERATIVE AGRICULTURE PRIZE** Identify and support **"Regenerative Agriculture Champions" (at farm or cooperative level)** Support w. design, implementation, monitoring & dissemination of lessons learned		
Strengthen the ECONOMIC CASE	**Support w. up-front and maintenance costs for equipment needed for Regenerative Agriculture** At farm level or for cooperatives (sharing scheme) Could be in the form of subsidized loans w. guaranteed purchases		**Incentives to purchase from Regenerative Ag. farmers** For different contract terms: guaranteed volumes, guaranteed prices, longer contract duration…
	Financial incentives e,g, long term contracts, volume guarantee, prices adjustment during transition period		
	Support the creation of **regional Reg Ag groupings at landscape level** Grouping of Reg. Ag. farmers to reach scale for monetization of ES **Support for project design / financial support for verification & validation of CC**		
Work with INDUSTRY GROUPINGS	**Partnerships with other agro-industrial actors** Associate with existing working groups or initiatives (e.g. SAI Platform, WRAP) Harmonize standards & selection criteria to influence supply chain		

NEXT STEPS – PUTTING RECOMMENDATIONS INTO PRACTICE

As a next step to this study and to put these recommendations into practice on the ground, TNC will work with Danone on a project concept focusing on almond, peaches and a new priority ingredient, oat for water in part of the Segriá landscape.

The project will be articulated around three closely related components that will maximise benefits for water users and the environment: (i) incentivising the adoption of regenerative agriculture practices for priority ingredients, (ii) Identifying other nature-based solutions for water security to complement RA practices and enhance local grey infrastructure investment plans, and (iii) fostering collective action mechanisms to engage local stakeholders in a comprehensive and common long-term vision for water management and investment planning that include RA practices and other nature-based solutions.

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