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Assessing Rural Development Programs in 4 EU regions and their potential to address climate concerns

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Paper prepared for presentation at the 5th AIEAA Conference
“The changing role of regulation in the bio-based economy”

16-17 June, 2016
Bologna, Italy

Summary

Rural Development Programmes (RDPs) are a step to mainstream climate concerns in the Common Agricultural Policy (CAP). National and Regional RDPs for 2014 – 2020 include instruments that promote mitigation and adaptation strategies for agriculture to enhance biodiversity, environmental value of rural landscapes, efficient water management and the transition to a low carbon bio-based economy with reduced rates of GHG and ammonia emissions. This contribution presents a comparative assessment of actions undertaken by two EU Member states, the Netherlands (NL) and Hungary (HU) (national programmes), and two regions, Emilia Romagna (ER) and Valencia (VLC), which represent distinct agricultural and forest systems. It shows that EU regions selected for the case studies move towards mainstreaming climate concerns in Pillar II policies. In the sample, actions on ecosystems under Priority 4 (‘Restoring, preserving and enhancing ecosystems’) represent between 30 and 50% of the foreseen RDP expenditure for the whole period 2014- 2020. Actions under Priority 5 (‘Resource efficiency and shift to a low carbon and resilient economy’) account for less than 20% of the RDP expenditure. Implementation and monitoring become key factors of success to guarantee that measures are not cosmetic and they actually influence the transition to a sustainable bio-economy. Further efforts should contribute to progressively integrate innovative solutions in future adjustments of RDPs. Finally, further analysis of the regulatory framework, red tape, cultural change, and social innovations will be required to improve RDP effectiveness to face climate change challenges.

Keywords: rural development programmes, climate change, pillar II.

JEL Classification codes: Q18, Q54, Q58.

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1. 1. INTRODUCTION

Rural Development Programmes (RDPs) are a step to mainstream climate concerns in the Common Agricultural Policy (CAP). National and Regional RDPs were approved during 2015 and include financial instruments that promote mitigation and adaptation strategies for agriculture to enhance biodiversity, environmental value of rural landscapes, efficient water management and the transition to a low carbon bio-based economy with reduced rates of GHG and ammonia emissions. Although RDP follow a common regulatory framework (EU, 2014), their focus on climate targets varies from one region to another. There is substantial evidence of climate pressures on European agricultural systems. They have been reviewed in recent works (Iglesias et al., 2012a) that stress that climate smart agriculture (CSA) solutions need to be adapted to territorial needs. This contribution wants to present a comparative assessment of actions undertaken by two EU Member states, the Netherlands (NL) and Hungary (HU) (national programmes), and two regions, Emilia Romagna (ER) in Italy and Region of Valencia (VLC) in Spain, which represent distinct agricultural and forest systems.

While CAP Pillar I policies have been criticised by their lack of ambition for providing environmental public goods (Mathews, 2013; Van Zanten et al., 2014), we aim at exploring how CAP Pillar II policies are targeted to climate objectives, through different measures, including compensation for extra-cost of environmental and climate services, investments in physical assets and innovation strategies.

The four case studies analysed in this contribution offer a mapping of the measures, sub-measures and operations supplied by the corresponding RDP. The mapping exercise also assesses how policies match adaptation and mitigation targets. This procedure represents a preliminary study that, in next steps, will be extended to a significant numbers of EU regions.

The paper is structured as follows. First, we highlight the different climate challenges faced by the countries and regions analysed. Second, we tackle the way climate change has been addressed in the general frame of Rural Development Programmes and how we have structured their analysis in the selected case studies. Five, main results are shown and discussed. Finally, some concluding remarks are extracted from the analysis.

2. CLIMATE CHALLENGES AND SELECTED REGIONS

As any other part of the world, Europe will be affected by climate change. Moreover, impacts and challenges will be unequally distributed between the region (highest impact in Southern regions and gradually decline to the North), as the simultaneous presence of 5 different Climate Regions (“multidimensional characteristics”) show.

The warming trend throughout Europe expect an increase in summer temperatures in the south-western parts of Europe, accompanied by a decrease of mean annual precipitation, that is instead expected to increase in northern Europe. Agro-ecosystems respond not only to changes in mean climate, but also to changes in frequency of extreme events (Porter and Semenov, 2005), like hot days, tropical nights, and heat waves. A severe heat wave over large parts of Europe in 2003 extended from June to mid-August, raising summer temperatures by 3 to 5 °C. As far as water is concerned, the impact of climate change is most strongly felt through changes in the water distribution, with increase the risk of floods and droughts in northern, central and eastern Europe, while the risk of drought increases mainly in southern Europe. The increase in water shortage and extreme weather events may cause lower harvestable yields, higher yield variability and a reduction in suitable areas for traditional crops.

Between the most important observed climate related changes in European agroecosystems during the latter part of the 20th century, Olesen (2008) reported advance of potato planting in Finland (Hilden and Lehtonen, 2005), increase in growing season of grapevine and changes in wine quality for France (Duchene and Scheider, 2005; Jones and Davis, 2000), advance of maize sowing dates by 20 days (Benoit and Torre, 2004) or advance in flowering of fruit trees in Germany (Menzel, 2003).

This diversity of situations is also represented in our case study selection. Schmidt-Thomé and Greiving (2013) attach the selected regions to different climate change groupings, with the entire VLC falling into the denominated ‘Mediterranean region’ and ER containing a mix of ‘Mediterranean’ and ‘Southern-Central Europe’ patterns. This last pattern is shared by the entire HU, while NL shows a ‘Northern-Western Europe’ pattern. The quoted authors identified different climate change patterns in the regional groupings, with an increase in mean temperature observed in ‘Southern central Europe’ and the ‘Mediterranean region’. Some indicators suggest vulnerability of the selected regions to climate change. Pressures on resources are evident from the CORINE database (EEA, 2012), which shows that significant land use changes took place between 2000 and 2006 in VLC, NL and HU. Demands on land use are complex, with environmental pressures on biodiversity in VLC and HU, and on air, soil and natural resource in ER and the NL. VLC and ER also face the challenge of reducing water stress and show significant soil erosion by water. A recent vulnerability assessment (Tzilivakis et al. 2015) also reported significant water quality problems in the four regions. The same study reflects that VLC and ER are also vulnerable to forest fires. In fact, the ESPON climate project (ESPON, 2010) placed almost entirely VLC and the NL in the group of regions with highest negative potential impact of climate change, while ER and HU include some areas with low negative potential impact and some areas of medium negative potential impact.

Finally, agricultural systems are not only sensitive to climate change; they are also among the main contributors to global warming through emissions of several greenhouse gases (primarily CO₂, methane (CH₄) and nitrous oxide (N₂O)).

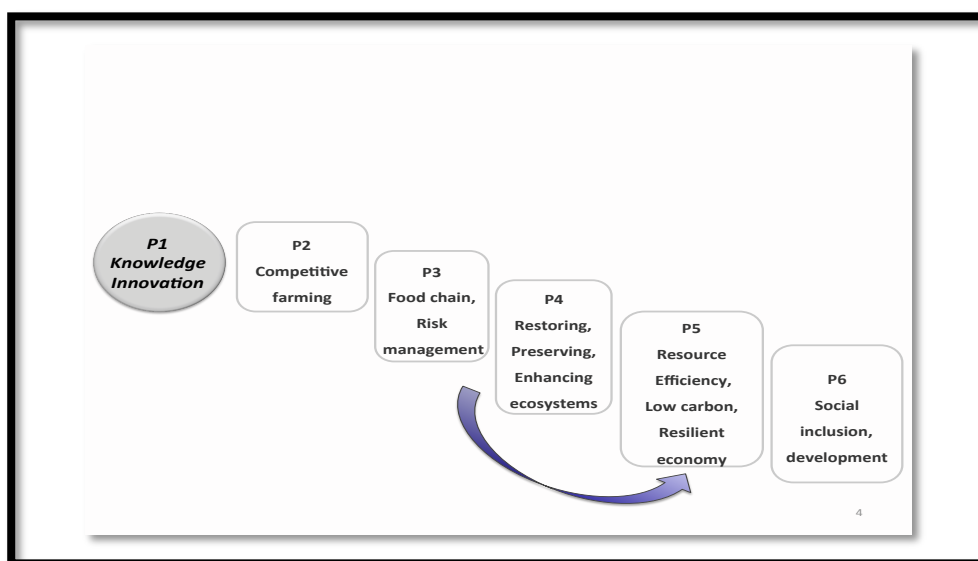
3. RDP AND CLIMATE CONCERNS

The study was carried out within the Climate KIC flagship project CSA Booster. This project is building a “policy hub” that wants to identify supporting policies for the implementation of a climate resilient and low emitting agriculture.

The European Commission has underlined the links between climate change and territorial development in Europe. In the programming period 2014 -2020, the European Agricultural Fund for Rural Development (EAFRD), Regulation (No. 1305/2013) built on the concept of strategic programming including six strategic priorities (Figure 1). Out of these, two priorities contain elements connected to climatic issue and bio-economy, mainly identified in the priorities P4 (‘Restoring, preserving and enhancing ecosystems’) and P5 (‘Resource efficiency and shift to a low carbon and resilient economy’). The connection between measures, sub-measures and operations under both priorities was achieved, in the programming procedure, through the allocation of RDP actions to different focus areas within each priority (Table 1). RDP actions include a monitoring system with the help of a series of indicators. However, the experience of past programming periods reveals that implementation strategies may differ from region to region and that evaluating RDPs is a difficult task, even when sophisticated instruments are used (Piorr and Viaggi, 2015).

In this paper, preliminary steps of evaluation were made, consisting of (i) identifying policies addressing climate concerns in the rural development programs, (ii) comparing their budget allocation among different measures to characterise how different regions approach climate targets; and (iii) assessing their correspondence with a series of climate targets previously defined. For the case studies in this exercise (see in Table 2 the approval date by the EU Commission), the selection of case studies covered two adopted regional programmes (Emilia Romagna and Valencia) and two national programmes (some MS approved a unique RDP for the whole country).

Figure 1: Pillar II. Priorities



Source: Rural Development Regulation (1305/2013) and authors' elaboration

Table 1. RDP Focus Areas

<p>P4 Restoring, preserving, enhancing ecosystems</p> <ul style="list-style-type: none"> • a. Biodiversity • b. Water management • c. Soil management
<p>P5 Resource efficiency, low carbon and climate resilient economy</p> <ul style="list-style-type: none"> • a. Efficiency in water use by agriculture • b. Efficiency in energy use in agriculture and food processing. • c. Facilitating the supply and use of renewable sources of energy. • d. Reducing nitrous oxide and methane emissions. • e. Fostering carbon sequestration

Source: Rural Development Regulation (1305/2013) and authors' elaboration

Table 2. Case Studies.

<p>Two National Programmes</p> <ul style="list-style-type: none"> • Hungary (10-08-15) • The Netherlands (13-02-15)
<p>Two Regional Programmes</p> <ul style="list-style-type: none"> • Emilia-Romagna (26-05-15) • Valencian Community (28-07-15)

Source: Rural Development Programmes (2014 – 2020) and authors' elaboration

In the first stage, the project built comparative tables with budget allocations of specific measures, sub-measures and actions directly linked to the focus areas corresponding to climate priorities. The comparison provided a picture of the pattern of specialization of Pillar II policies related to climate targets. Each climate target, including both mitigation and adaptation target, were linked with the related focus area in the RDP. In these way RDP measures, sub-measures and actions that addressed climate challenges were identified. Thus, mapped measures and actions offer a description of the “supply” of climate policies by RDPs, and represents a pilot exercise for a future database that in the near future can potentially cover the 118 RDPs adopted.

Budget data were directly extracted from adopted RDPs for 2014-2020. The involved teams evaluated the links between the covered instruments in the studied cases and specific climate mitigation and adaptation targets. Following Iglesias et al. (2012b), studied policies cover mitigation targets (reduction of CH₄, NH₃ and CO₂ emissions, efficiency in soil, energy and water management, carbon sequestration and soil

enrichment) and adaptation targets (decreased crop productivity, pests, diseases, weeds, risk of floods, water scarcity, soil erosion, salinity, desertification and pressures on livestock conditions).

RDPs cover a wide range of measures to tackle climate change. For our analysis, we have grouped these public incentives in three types: (i) knowledge, social capital and cooperation; (ii) investment in physical assets; and (iii) compensation payments; Table 3 shows this typology of climate-related measures. So by classifying incentives into the three groups, a picture on the regional strategies to orient RDPs towards climate objectives can be obtained.

Table 3. RDP measures oriented to Priorities 4 & 5

	Measures
Type (i): knowledge, social capital and cooperation	<ul style="list-style-type: none"> • M1. Knowledge transfer and information • M2. Advisory services.... • M16- Cooperation
Type (ii) investment in physical	<ul style="list-style-type: none"> • M4. Investment in physical assets • M6. Business development • M8. Forest Investments
Type (iii) compensation payments	<ul style="list-style-type: none"> • M10. Agri-environment-climate • M11. Organic farming • M12. Natura 2000 and WFD • M15. Forest-environmental-climate

Source: Rural Development Programmes (2014 – 2020) and authors' elaboration

Note that by defining the regional strategies as the present paper does, policies are characterised but their effectiveness is not yet evaluated. This operation can be the result of a comprehensive analysis of the whole group of regions benefiting of RDP and a possible statistical analysis on how RDP correlate with climate indicators of vulnerability. Ex-post evaluations of RDP have been also scarce and the identification of cause-effect relationships has faced the lack of data, although there is some indication that the spatial scale of the analyses matters (Desjeux et al., 2015).

4. FINDINGS AND DISCUSSION

Climate targets were linked with the focus area of both priorities (P4 and P5). It appears that all the identified targets find specific support in RDP. An analysis of the 4 RDP makes it possible to establish a first link between RDP priorities and climate targets. Priority 4 is more oriented on adaptation targets (Table 4), with several focus areas devoted to solve agricultural issues caused by climatic factors, such as decreased crop productivity, increased in irrigation demand, and decline of livestock conditions. Focus areas of Priority 5 (Table 5) are mainly aimed at reducing impact of agricultural production, especially focusing on the reduction of GHG emissions by the agricultural sector. It is important to note that there is not an exact correspondence between focus area and climate targets, and measures under each focus area may pursue a combination of adaptation and mitigation targets. Focus areas 4a (“Biodiversity and landscape”) and 5a (“Efficiency in Water use”) are easily attached to adaptation targets. Focus areas 5b (“Energy efficiency”), 5c (“renewable sources of energy”), 5d (“reducing GHG emissions”) and 5e (carbon sequestration) mainly correspond to mitigation targets. Focus areas 4b (“water management”) and 4c (“soil management”)

correspond to both adaptation and mitigation targets. A more exact matching between policy instruments and targets can be made at the level of submeasure and operation, but very often this is not sufficiently clear from the descriptions made in the RDPs.

Table 4. Adaptation Targets and RDP Focus Areas

Focus areas:	Priority 4			Priority 5
	4a Biodiversity and landscape	4b Water management	4c Soil	5a Water use
Decreased crop productivity	✓	✓	✓	
Pests, diseases, weeds	✓			
Crop quality decreases	✓			
Increased risk of floods		✓	✓	
Coping with water scarcity		✓		✓
Increased irrigation demand		✓		✓
Water quality deterioration		✓		
Soil erosion, salinity, desertification	✓	✓	✓	
Livestock conditions decline	✓			

Source: authors' elaboration

Table 5. Mitigation Targets and RDP Focus Areas

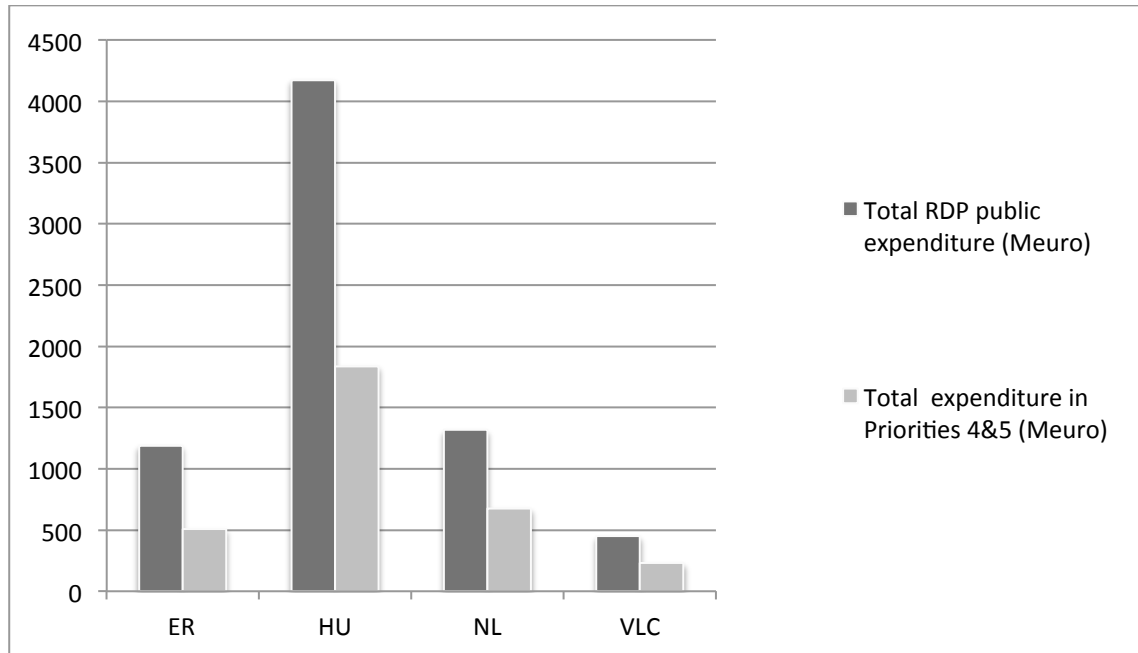
Focus areas	Priority 4		Priority 5			
	4b Water	4c Soil	5b Energy	5c Renew	5d GHG	5e C.Seq.
CH ₄ fermentation of ruminants					✓	
NH ₃ emission form manure storage					✓	
NH ₃ emission form manure distribution					✓	
N ₂ O Manure		✓			✓	
CH ₄ Rice cultivation					✓	
Soil N ₂ O: Applied N	✓	✓			✓	
Solid N ₂ O: grazing		✓			✓	
Energy CO ₂ : fieldwork			✓			
Energy CO ₂ : Other			✓	✓		
CO ₂ Sequestration						✓
Enriched carbon soil						✓

Source: authors' elaboration

Figure 2 shows the RDP expenditure that is allocated to climate objectives. In relative terms, RDP allocate a significant share of the RDPs' budget to priorities P4 and P5 (Figure 3). Percentages of foreseen overall public expenditure in both priorities are well above 40% and exceed 50% in NL and VLC. Consequently, RDPs represent a real opportunity to encourage rural policies to address the provision of public goods related to climate issues. Regarding the RDP budget distribution over the two priorities, the P4

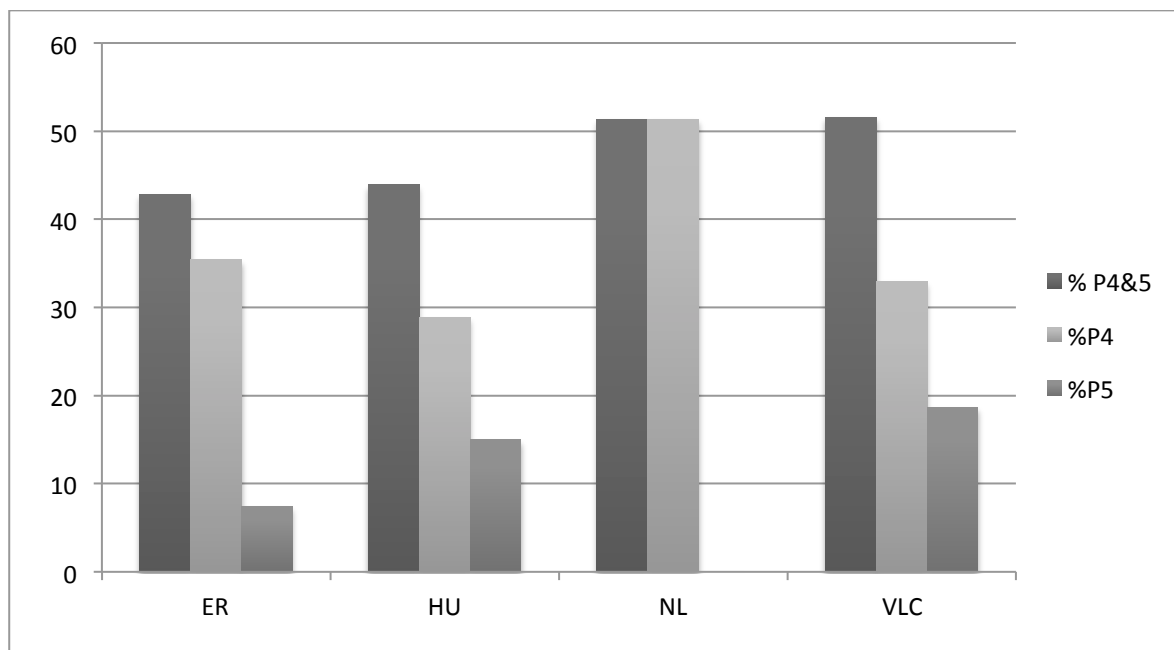
receives a higher share of RDP funds with respect to the P5 in all regions examined. For HU and VLC the budget in P4 is twice respect to P5, while for ER is almost three times higher.

Figure 2: RDP and Climate Budget



Source: Rural Development Programmes (2014 – 2020) and authors' elaboration

Figure 3: Percentage of Priorities 4 & 5 in RDP Public Budget



Source: Rural Development Programmes (2014 – 2020)

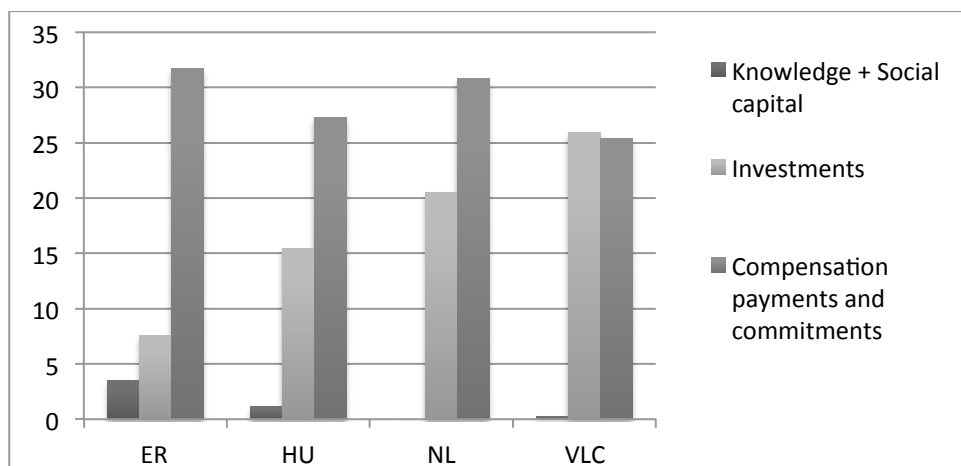
It is also interesting to put in context the size of this expenditure. For instance, considering the whole RDP expenditure for climate mitigation or adaptation, the average public expenditure per farm is around 9000 euro/farm per NL, 7000 euro/farm for ER, 4000 euro/farm for HU and 2000 euro/farm for VLC. Differences reflect farm structures in the corresponding regions, which are more fragmented in VLC, which can increase the management and monitoring burden in this region.

As regards to the average climate public expenditure per UAA hectare, the disparities between countries are lower as the average public expenditure are similar for NL, VLC and HU, between 300 and 400 euro/hectare, and higher for ER with almost 500 euro/hectare. In Annex II, average public expenditure per UAA hectare is presented for Spanish and Italian NUTS2 regions. Expenditure per hectare ranges between 150 and 1600 euro/ha in Spain, and between 370 and 3300 euro/ha in Italy. ER and VLC occupy a central position in the total of NUTS2 in their respective countries. Given that the programming period covers seven years, efforts don't seem to be spectacular, although they should be evaluated with respect to expected outcomes.

Each region has devoted instruments to reach the objectives of the priorities in the RDP. Regional specialization in the policy supply exists, which is consistent with specific targets and will be shown in the next section. Each region has devoted measures to reach the objectives of the P4 and P5 priorities in the RDP (Annex 1). Regarding these priorities, ER and HU exploit opportunities offered by 10 different measures of RDP (all measures presented in Table 3 except for M6 and M15 in ER, and M6 and M7 in HU). VLC concentrates the public expenditures to improve their climate specialization on 6 different measures (M2, M3, M8, M10, M11 and M13). NL concentrates on two measures (M4 and M10) mainly directed to P4, which represent over 50% of the budgeted RDP public expenditure in NL. In the case of ER, HU and VLC, the consideration of forestry, organic farming and the aids in mountain areas contribute to widen the scope of supplied measures. ER and HU allocate budget to knowledge and cooperation, which are not present in VLC, at least in connection to climate objectives. As for NL, a concentration of policies takes places on capital investments (M4) and compensation contracts to improve landscapes, biodiversity and water management (M10). In this country, other measures such as M1 (Knowledge) or M16 (Cooperation) are considered under Priority 2. However, interestingly, Priority 5 is considered in NL as an indirect priority of most measures in the RDP, so it represents a horizontal objective for the whole programme.

Differences in environmental and climate-targeted aids are summarised in Figure 4, which presents the three types of measures defined above. There is a substantial participation of type (iii) measures in all the studied regions. Type (i) measures are only present in ER and HU, but even in this cases represent a small share of the total budget. This suggests that 'soft' policies related to innovation, social capital and cooperation are still not a preferred strategy, which does not favour the promotion of innovative CSA solutions.

Type (iii) policies are the preferred option, in ER, HU and NL, accounting for a share in overall programmes' expenditure that ranges between 25.4% in VLC to 30.8% in NL. Type (ii) measures are less relevant in ER and HU and more present in NL, with focus on non-productive investments in water, biodiversity and landscape, nature, and nitrates; and in VLC, with significant investments for irrigation infrastructure and conservation of wetlands.

Figure 4. Percentage of public budget addressing climate priorities by type of measure

Source: Rural Development Programmes (2014 – 2020) and authors' calculations

As indicated in Tables 4 and 5, the adaptation measures for priority P4 mainly refer actions aimed to preserve agricultural and forest ecosystems, in many respects favouring adequate management practices and investments to protect farm holdings from the risks associated to climatic pressures. The mitigation actions mainly under P5 are implemented by actions that foresee investments for GHG reducing and increasing the energy resources diversification, especially for the implementation of biomass. ER and HU mainly valorise the carbon stock potential of agriculture sector and forestry through actions that support permanent afforestation and a better forest management, fostering carbon sequestration.

A selection of the top actions, classified by allocated budget is presented in Annex III, which gives a more detailed of the selected policies in the studied regions. Thus, the number of actions with shares over 1.5% of the overall RDP budget is 5 in ER, and 6 s in HU and VLC.

While the RDPs allow for flexibility in the types of measures to adapt to climate needs of EU regions, management costs can significantly increase where measures are fragmented into a significant number of actions. Although the NL doesn't allocate budget to P5, contrary to the rest of the studied regions, other economic and social priorities of its RDP are explicitly targeted to P5 focus areas as secondary or indirect objectives, so climate concerns spread over the whole programme.

5. CONCLUDING REMARKS

RDPs foresee investments to mitigate GHG and to ease adaptation in agriculture. It is clear that the EU countries and regions selected for the case studies move towards mainstreaming climate concerns in Pillar II policies. Actions on ecosystems under Priority 4 in the selected regions represent between 30 and 50% of the foreseen RDP expenditure for the whole period 2014- 2020. Resource efficiency and climate transition under Priority 5, account for less than 20% of the RDP expenditure. It makes sense that adaptation keeps a priority as other instruments can be devised in the whole economy to enforce environment standards and a circular economy approach.

It is not clear to what extent foreseen measures adapt to specific adaptation and mitigation targets. The actual monitoring system of RDP provides some indicators but they give little information about specific medium-term impacts.

The differences in the RDPs among the selected case studies reflect the differences in the local agricultural sectors. Nevertheless, climate public expenditures per hectare are quite similar among the countries.

Implementation and monitoring become key factors of success to guarantee that measures are not cosmetic and they actually influence the transition to a sustainable bio-economy. Consequently, the actual management of the approved measures can make the difference in orientating Pillar II policies to promote climate-related objectives. Further efforts should contribute to make the existing measures effective; and progressively integrate CSA solutions in future adjustments of RDPs. The exercise presented in this contribution will be further developed in the next year to evaluate how rural instruments (policy supply) match the adaptation and mitigation targets (policy needs). Climate evaluation of RDPs is relevant for future CAP reforms, where the EU can move towards a greener Pillar I or to integrating Pillar I with Pillar II into a common climate framework. Finally, transition to a low carbon bio-economy requires removing transaction costs of implementing CSA solutions, with further analysis of the regulatory framework, red tape, cultural change, and social innovations, beyond the CAP.

Three limitations of the presented analysis that illustrate the difficulties to evaluate RDP from a climate perspective are the following. Firstly, as indicated above, Member States enforce regulations that influence the firms' behaviour in rural areas, so RDP is only one of many instruments to cope with climate issues. Secondly, some of the measures under priorities P4 and P5 deal with several policy objectives, beyond climate targets. And thirdly, some of the measures under other RDP priorities have indirect links with Priorities 4 and 5. In particular, in the Netherlands and Valencia, the RDP recognises P5 as an indirect priority of actions included in Focus areas 2a (Farm performance), 3b (Risk management) and Priority 6 (social inclusion and local development). This also means that it is not always possible to isolate the climate-specific actions. And this lack of clear linkage operate in both senses, i.e. it also allows to disguise as climate-oriented actions, measures that are mainly aimed to promote firms' competitiveness.

ACKNOWLEDGMENTS

This team appreciates support received by Climate Smart Agriculture (CSA) Booster, a network of enterprises and organisations that promotes CSA solutions under the Climate-KIC programme.

REFERENCES

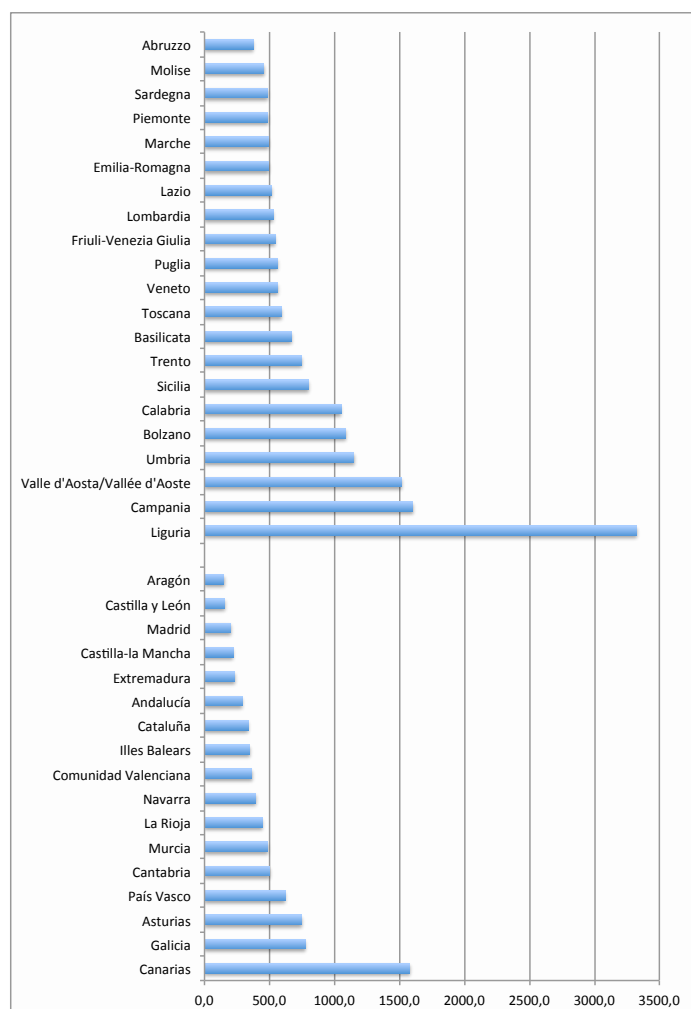
- Benoit, M., le Torre, C.D., 2004: Changement climatique et observation à long terme en unites expérimentales ; évolution des pratiques agricoles et des réponses physiologiques des couverts végétaux. Journées MICCES 2004.
- Desjeux, Y., Dupraz, P., Kuhlman, T., Paracchini, M. L., Michels, R., Maigné, E., & Reinhard, S. (2015). Evaluating the impact of rural development measures on nature value indicators at different spatial levels: Application to France and The Netherlands. *Ecological Indicators*, 59: 41-61.
- European Commission (2009) *White paper adapting to climate change: Towards a European framework for action*. COM (2009) 147 final. Available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF>.
- European Environment Agency (EEA) (2012) *CORINE Land Cover Data*.
- ESPON (2010) *Scientific Dialogue on Cities, Rural Areas and Rising Energy Prices*, First ESPON 2013 Scientific Report. Luxembourg: ESPON.

- EU (2014). EU Regulations 1303 and 1305/2013, Commission Delegated Regulation 807/2014 and Commission Implementing Regulation 808/2014.
- Frelih-Larsen, A., MacLeod, M., Osterburg, B., Eory, A. V., Doley, E., Kätsch, S., Naumann, S., Rees, B., Tarsitano, D., Topp, K., Wolff, A., Metayer, N., Molnar, A., Povellato, A., Bochu, J.L., Lasorella, M.V., Longhitano, D. (2014) *Mainstreaming climate change into rural development policy post 2013*. Berlin: Ecologic Institute,
- Iglesias, A., Garrote, L., Quiroga, S., & Moneo, M. (2012a) A regional comparison of the effects of climate change on agricultural crops in Europe. *Climatic Change*, 112(1): 29-46.
- Iglesias, A., Quiroga, S., Moneo, M., & Garrote, L. (2012b). From climate change impacts to the development of adaptation strategies: challenges for agriculture in Europe. *Climatic Change*, 112(1): 143-168.
- Jones, G.V., Davis, R., 2000. Climate influences on grapevine phenology, grape composition, and wine production and quality for Bordeaux, France. *Am. J. Enol. Viticult.* 51, 249-261
- Hilden, M., Lethtonen, H. 2005. The practice and process of adaptation in Finnish agriculture. FINADAPT Working paper 5, Helsinki, Finnish Environment Institute Mimeographs 335.
- Mathews, A. (2013) Greening agricultural payments in the EU's Common Agricultural Policy. *Bio-based and Applied Economics* 2 (1): 1- 27.
- Menzel, A., 2003. Plant phenological anomalies in Germany and their relation to air temperature and NAO. *Clim. Change* 57, 243.
- Olesen JE (2008) Climate change as a driver for European agriculture. Conference on 'Europe's rural areas in action: facing the challenges of tomorrow,' October 16–17, 2008, Limassol, Cyprus.
- Pierr, A., & Viaggi, D. (2015). The spatial dimension of Public Payments for Rural Development: Evidence on allocation practices, impact mechanisms, CMEF indicators, and scope for improvement. *Ecological Indicators*: 59, 1-5.
- Porter, J.R., Semenov, M.A., 2005. Crop responses to climatic variation. *Phil. Trans. R. Soc. B* 360, 2021-2035.
- Schmidt-Thomé, P., & Greiving, S. (2013). *European climate vulnerabilities and adaptation: a spatial planning perspective*. John Wiley & Sons.
- Tzilivakis, J., Warner, D., Green, A. & Lewis, K.A. (2015) Adapting to climate change: Assessing the vulnerability of ecosystem services in Europe in the context of rural development. *Mitigation and Adaptation Strategies for Global Change*, 20(4): 547-572.
- Van Zanten, B. T., Verburg, P. H., Espinosa, M., Gomez-y-Paloma, S., Galimberti, G., Kantelhardt, J., Kapfer, M., Lefebvre, M., Manrique, R., Pierr, A., Raggi, M., Schaller, L., Targetti, S., Zasada, I., Viaggi, D. (2014) European agricultural landscapes, common agricultural policy and ecosystem services: a review. *Agronomy for sustainable development*, 34(2): 309-325.

Annex 1. Relevant measures (% RDP public budget)

Priority/Focus area	ER	HU	NL	VLC
Priority 4				
AEC	14.7	15.3	30.8	16.8
Organic	8.5	5.0	0.0	3.1
Investments	0.6	0.5	20.5	0.9
Natural constraints	7.6	1.8	0.0	2.2
Forests	0.9	0.2	0.0	9.7
Natura2000-WFD	0.7	4.0	0.0	0.0
Priority 5				
Investments	2.7	11.0	0.0	11.8
Forests	1.7	3.9	0.0	2.3

Source: Rural Development Programmes (2014 – 2020) and authors' calculations.

Annex II. Average RDP expenditure in Priorities P4 and P5 per hectare (Euro/hectare of UAA)

Source: Rural Development Programmes (2014 – 2020), Eurostat and authors' calculations

Annex III. Specific Actions**Emilia-Romagna**

	Share in Budget %	Focus Area	Sub-measure
Biodiversity, extensive practises, buffer strips, Natura 2000, landscapes	14.7	4a, 4b, 4c	10.1
Organic farming	8.5	4b	11.1, 11.2
Compensatory payments mountain areas and other areas	7.6	4a	13.1, 13.2
Permanent afforestation	1.7	5e	8.1
Plants for energy diversification, by-products	1.7	5c	6.4
Water distribution and irrigation investments	1.5	5a	4.1, 4.3
EIP, operational groups and joint actions for climate adaptation and mitigation	1.5	4a, 4b, 4c	16.1, 16.5
Investment for reducing GHG and ammonia	1.1	5d	4.1
Investments for resilient forestry environment	0.9	4a, 4b	8.5
Training and information for efficient water use	0.7	4a, 4b, 4c	1.1, 1.2
Compensatory payments Natura 2000	0.7	4a, 4b, 4c	12.1

Source: Rural Development Programmes (2014 – 2020) and authors' calculations.

Hungary

	Share in Budget %	Focus Area	Sub-measure
Agro-environmental contracts. Preserving genetic resources and live population	15.3	4a, 4b, 4c	10.1, 10.2
Facilities: livestock, grain storage, horticulture, water, wine	9.6	5b	4.1, 4.2
Organic production	5.0	4a, 4b, 4c	11.1, 11.2
Preserving Natura 2000 agriculture and forest	4.0	4a, 4b, 4c	12.1, 12.2
Afforestation, fire prevention, forest management, restauration and ecosystems	3.5	5e	8.1 to 8.5
Reduce soil erosion	1.8	4a, 4b, 4c	13.2
Forest and climate commitments, forest genetic resources	1.2	4a, 4b, 4c	15.1, 15.2
Improving water management	1.0	5a	4.1
Improvements in habitat and water quality	0.5	4b	4.1
Livestock facilities	0.4	5d	4.1
Afforestation, fire prevention, forest management, restauration and ecosystems	0.3	5c	8.1 to 8.5

Source: Rural Development Programmes (2014 – 2020) and authors' calculations.

The Netherlands

	Share in Budget %	Focus Area	Sub-measure
Payments for agro-environmental commitments: birds, wildlife, flora, landscape	30.8	4a, 4b, 4c	10.1
Non-productive investments in water, biodiversity and landscape, nature, and nitrates	20.5	4a, 4b, 4c	4.4

Source: Rural Development Programmes (2014 – 2020) and authors' calculations.

Valencia

	Share in Budget %	Focus Area	Sub-measure
Rice, permanent crops in vulnerable areas, wetlands, indigenous livestock (I)	16.8	4a, 4b, 4c	10.1
Investments for public irrigation infrastructure, wetlands	11.8	5a	4.1, 4.3
Forest fires and natural disasters (prevention)	5.9	4a, 4b, 4c	8.3
Resilient forest ecosystems (forest management, Natura 2000, landscapes)	3.4	4a, 4b, 4c	8.5
Organic farming (I)	3.1	4a, 4b, 4c	11.1, 11.2
Compensatory payments mountain areas and other areas	2.2	4a, 4b, 4c	13.1, 13.2
Organic Farming (II)	1.8	5d	11.1, 11.2
Rice, permanent crops in vulnerable areas, wetlands, indigenous livestock (II)	1.3	5d	10.1
Investments for biomass and other forest products processing and marketing	1.2	5c	8.6
Farm investments reducing GHG emission and ammonia	1.2	5d	4.1

Source: Rural Development Programmes (2014 – 2020) and authors' calculations.