Italian Journal of Agrometeorology
Rivista Italiana di Agrometeorologia

Firenze University Press
www.fupress.com/ijam

Citation: Camilla Chieco, Federica Rossi, Slaven Tadić (2019) How can policy influence innovation: An exploration of climate-smart activities in Emilia-Romagna. *Italian Journal of Agrometeorology* (1): 25-31. doi: 10.13128/ijam-288

Received: February 21, 2019

Accepted: March 02, 2019

Published: June 04, 2019

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

How can policy influence innovation: An exploration of climate-smart activities in Emilia-Romagna

Il supporto politico verso l'innovazione: Le attività climate-smart dell'agricoltura dell'Emilia-Romagna

Camilla Chieco*, Federica Rossi, Slaven Tadić

Institute of Biometeorology, National Research Council, Bologna, Italy
*Corresponding author's e-mail: c.chieco@ibimet.cnr.it

Abstract. Climate change is one of the main issues in agriculture. Considering its involvement in the global anthropogenic emissions (GHG) it is no wonder that research is devising ways on how to reduce such effects. A solution to such problems is climate-smart agriculture (CSA). In this paper, we analysed which are the main opportunities granted by agricultural policies when aimed at sustaining innovative agricultural models. A review of the ongoing 93 Rural Development Projects (RDPs) uncovered potential climate-smart solutions for the identified potential threats. The Ministry of Agriculture, Hunting and Fishing of the Region of Emilia-Romagna in Italy has given importance to RDPs to innovate the agricultural sector through policy measures. We analysed an Operational Group (OG) project as an overview of the work. In the case of Emilia-Romagna, the amount of innovation and solutions that can be achieved if policies invest in CSA is very clear. Emilia-Romagna is on the forefront of technological and practical advancements in the EU by implementing CSA as one of the primary solutions to the aforementioned problems and will continuously work on transitioning its agricultural practices to fight climate change.

Keywords. Climate change, climate-smart agriculture, RDP, innovation, solution, technology.

Riassunto. L'adattamento al cambiamento e alla variabilità climatica sono tra le tematiche maggiormente rilevanti per la agricoltura di oggi. Considerando anche l'entità del contributo di numerose attività produttive agricole alle emissioni antropogeniche (GHG), sono ormai pressanti la ricerca e la applicazioni di strumenti che si indirizzino, in contemporanea e/o in alternativa, verso la mitigazione. Un approccio in questo senso è offerto dalla "Climate-Smart Agriculture" (CSA). Questo lavoro analizza alcune tra le opportunità che le politiche agricole offrano per sostenere e promuovere modelli agricoli innovativi di applicazioni CSA. Una revisione dei 93 Progetti di Sviluppo Rurale (PSR) finanziati in Emilia Romagna dal Ministero dell'Agricoltura, Caccia e Pesca della Regione Emilia-Romagna ha individuato la presenza di numerose soluzioni climate-smart in grado di fronteggiare potenziali minacce climatiche. In particolare, la ricerca si è indirizzata verso le attività dei Gruppi Operativi per l'Innovazione (GOI).

L'analisi ha evidenziato la portata dell'impatto che le politiche possano comportare verso la promozione di una agricoltura CSA. In questo senso, l'Emilia-Romagna si è dimostrata all'avanguardia all'interno dell'Unione Europea come regione promotrice di una attiva transizione delle pratiche agricole verso una sostenibilità in situazioni di cambiamento climatico.

Parole chiave. Cambiamento climatico, agricoltura climate-smart, PSR, innovazione, soluzione, tecnologia.

1. INTRODUCTION

One of the major issues plaguing agriculture that we are facing now is climate change. Considering that agriculture is co-responsible for the global anthropogenic emissions (GHG) it is no wonder that research is devising ways on how to reduce such effects. The world is producing enough food at the moment, yet the estimate of undernourished people has reached a staggering number of 870 million. Currently, FAO predicts that agricultural production will have to increase by approximately 60% by 2050 in order to satisfy the expected one-third increase in the world's population (FAO, 2013). When we consider everything, we realize that if we continue at this pace, agricultural emissions are projected to increase creating major issues for biodiversity and ecosystem services such as water quality and soil protection.

Agriculture must hence transform itself in order to maintain the current population growth and to reduce its overall global impact on climate change. During the 2010 Hague Conference on Agriculture, Food Security and Climate Change, a possible solution was proposed that could manage agriculture and food systems under climate change (FAO, 2013; Lipper *et al.*, 2014; Thornton *et al.*, 2017).

The solution in question is climate-smart agriculture (CSA) that is based on three main objectives: I) sustainable increase of agricultural productivity and income; II) adaptation and resilience to climate change; III) reduction and/or removal of greenhouse gases emissions, whenever possible. CSA tries to identify and operationalize sustainable agricultural development through climate-resilient pathways by increasing local institutional effectiveness, fostering coherence between climate and agricultural policies, and link climate and agricultural financing (Thornton *et al.*, 2017). The attainment of the three CSA objectives simultaneously proves to be difficult. Saj et.al, 2017 consider that research where all three CSA criteria are not taken into account, cannot effectively be considered climate smart. Even though research strives to produce results that try to embrace all of the key pillars, it remains unachievable on a global scale considering the differences in diverse regions and scenarios. CSA must derive locally acceptable solutions through potential synergies and trade-offs between the three pillars that will always be unique depending on the scenario (Lipper *et al.*, 2014). One of the most important policy processes launched, until now, dates in 2014 with the creation of the Global Alliance for Climate Smart Agriculture (GACSA; http://fao.org/gacsa/en/) constituting of many stakeholders including the World Bank, FAO and IFAD.

Research should be responsible for disseminating climate-friendly information that can be useful for policymakers at all levels from national governments and farmers alike, prioritizing climate-smart investment. By now we have gathered the notion that decision-making processes that plan for climate-smart activities are inherently multi-stakeholder, multi-scale and multi-objective (Notenbaert *et al.*, 2017). With that in mind, one of the most important policies on the European level dates back to 1962 as a partnership between agriculture and society, known as the Common Agricultural Policy (CAP). Since then, its objectives to support farmers and agricultural productivity, to ensure a stable income for European farmers, to help tackle climate change and to keep the rural economy alive, have steadily evolved to provide a central and connecting role between the farmer and policymakers (IFPRI, 2018; Recanati *et al.*, 2019). CAP has seen three major reforms that played a key part in its development over the decades. The first was in 1992 (Rio Earth Summit) which incentivized environmentally compatible farming practices through direct payments. The second was in 2003 (Fischler Reform) where the central roles of food quality, environmental protection, animal health and welfare, and rural development in the EU were acknowledged (Brady *et al.*, 2009; Recanati *et al.*, 2019). The last and most recent reform in 2013 saw the widening of CAP from modernizing agriculture, price stability and food accessibility (Erjavec and Erjavec, 2009) towards a multifunctional and sustainable agriculture and rural development (Solazzo *et al.*, 2016). It did so through the direct support to producers in order to achieve long-term objectives reflecting sustainability by way of viable food production, balanced rural development, and sustainable natural resources management and climate action (Policy and Brief, 2013). With the introduction of the CAP 2014-2020, the environmental concerns are tackled via two pillars tightening the gap between them in order to generate a more holistic and integrated approach to policy support.

The CAP is broken down into two pillars, Pillar I that introduced Single Payment Schemes (SPS) and Pillar II that supports the European Union's rural development policy. Pillar I marks a shift from decoupling to a targeting agricultural aid by means of direct payments and market measures for all EU farmers to respond to the 'Polluter-Pays-Principle', thus avoiding agricultural damage (Massot, 2018). Pillar II is created to support rural development policies under Agenda 2000. It is co-financed by the European Agricultural Food for Rural Development (EAFRD) to respond to the 'Provider-Gets-Principle' to remunerate farmers' voluntary choice in contributing to environmental objectives that go beyond legal requirements. The implementation of these policies comes through rural development programmes (RDPs) designed by the Member States. These multiannual programmes create a personalised strategy that coincides with specific needs of the Member States or Regions and relate to at least four of the six EU priorities for rural development policy (EP, 2018).

One of the most important Measures in the Rural Development Programmes (RDPs) is Measure 16 (M16). One of its Sub-Measures, 16.1, provides support for establishing and managing the European Innovation Partnership (EIP) Operational Groups (OGs) and the subsequent planning and realization of projects organized by the OGs. These groups have to consist of partnerships involving an array of stakeholders from farmers, researchers, advisors and businesses. OGs are expected to respond to challenges that require multidisciplinary solutions or to identify new opportunities for improvement by working on new techniques, processes, products, technologies etc. In the end, the dissemination of the results ensures that M16.1 implementation also achieves its objectives of knowledge and technology transfer (EIP, 2017).

Italian territory is largely dedicated to agriculture, with recognized excellence in the agri-food national sector, that poses itself as an engine for the national economy, labour and rural development. Emilia-Romagna, located in the North-East Po plane, is one of the regions in which noticeable high-quality crops are grown, and a traditional farming area due to climate and geographical local features (Fanfani and Pieri, 2017). Such an attitude has been progressively stimulating farmers to cope with climate, and local policymakers to support actions facilitating this. For example, a specific LIFE+ Project (ClimateChangER; http://agricoltura.regione.emilia-romagna.it/climatechanger) has been dedicated to the quantification of the GHG emissions by agricultural activities and a specific report has been produced on CSA (Borsetta *et al.*, 2018). In this paper, we have taken Emilia Romagna as a case study to investigate the potential for innovation through the implementation of RPD actions boosting climate-smart agriculture.

In this case study, we analysed which are the main issues that agriculture in Emilia-Romagna is facing and how the 2014-2020 Rural Development Plan has promoted CSA activities. The main climate-related threats have been categorized through extensive literature reviews and face-to-face meetings with farmers and landowner. A review of the ongoing 93 RDP projects uncovered potential climate-smart solutions for the identified potential threats. The selection criteria for worthy projects was done by reviewing the main issues that the OGs were tackling, the possible solutions to said issues and/or possible innovations from a technological and practical standpoint.

2. MATERIALS AND METHODS

As mentioned, the categorization for the main threats was done based on literature reviews that identified the main problems. In particular, papers from Constantin *et al.*, 2010; Dickie *et al.*, 2014; Iglesias and Garrote, 2015; Lindner *et al.*, 2010; Miraglia *et al.*, 2008; Rojas-Downing *et al.*, 2017; Smith *et al.*, 2011; Rana *et al.*, 2018 comprise a good overview of the general issues and solutions.

An outline of the main threats connected to climate variability and change was done thereafter. Threats identified were:

l) soil deterioration
II) water scarcity
lll) deterioration of water quality
V) shift in vegetative seasons
V) exasperation of pests and diseases
VI) extreme events
VII) GHG increase
VIII) deterioration of livestock conditions

Each category of threat exhibited specific solutions on how to tackle the threat in question. For instance, eight possible solutions have been identified to face soil degradation such as soil erosion control, desertification prevention, soil contamination prevention, improvement of organic matter in the soil etc. The same approach was established for all eight threats. With the categories outlined, the next step was the analysis of the 93 approved RDP projects. Firstly, we sought out to determine how many projects demonstrated climate-smart properties and/or applications in order to fully grasp the range of CSA integration in the RDP. Secondly, an in-depth analysis of the project proposals was completed to determine the quality of the proposal to understand the spectrum of innovation in Emilia-Romagna. With the termination of the analysis, we categorized the projects based on the solutions they provided to the aforementioned threats.

3. RESULTS

3.1 CSA in RDP

An example of an entity that has greatly invested in RDPs is the Ministry of Agriculture, Hunting and Fishing of the Region of Emilia-Romagna in Italy. The Emilia-Romagna RDP relies on an investment of 1 billion and 190 million Euros, which is by far the largest amount ever allocated to rural development in recent regional programming schemes and the largest amount among the northern Italian regions. Compared to previous RDPs, Emilia- Romagna resources have increased to 131 million Euros of total public spending with an additional 100 million Euros of regional co-financing. With such importance given to RDPs to innovate the agricultural sector, it comes to no surprise that Emilia-Romagna is on the forefront of technological and practical advancements in the EU by implementing CSA as one of the primary solutions to the aforementioned problems. For Sub-Measure 16.1, RER has financed 93 projects with nearly 20 million euros in investments. The investment was divided into different focus areas as can be seen in Fig. 1.

Of the 93 projects that have been approved under the Sub-Measure 16.1, 66 of them were oriented towards CSA. By going into detail, we identified that certain projects were offering multiple solutions for a single threat or even tackling multiple threats simultaneously. The project analysis found that the largest amount of funds and projects was financed for the threat of increased gas emissions, with soil deterioration and water scarcity and quality deterioration following closely (Fig. 2).

Another important result is that 14 of the projects are transversal by tackling multiple threats. Projects that were considered transversal had the characteristic of being innovative by managing to offer solutions to multiple threats.

The threat of soil deterioration has seen 12 projects that proposed solutions, 50% of which was dedicated to improving organic matter content in the soil (7 projects) and 30% to controlling soil erosion (Tab. 1). The remaining percentage tackled contamination prevention, biodiversity improvement and carbon enrichment of the soil. A piece of noteworthy information is the lack of projects that provide solutions for desertification, soil salinization and landslides, all of which point to possible future research possibilities. Water scarcity was largely addressed through the modernization of soil irrigation systems (7 projects), water management innovation (5 projects) and reduction of water necessity that managed to obtain 46% of the total financing for the threat. The remaining solutions such as re-usage of wastewater and enhancing the water retention capability of the soil showed that there are potential models to estimate groundwater levels and runoff events, saw one project

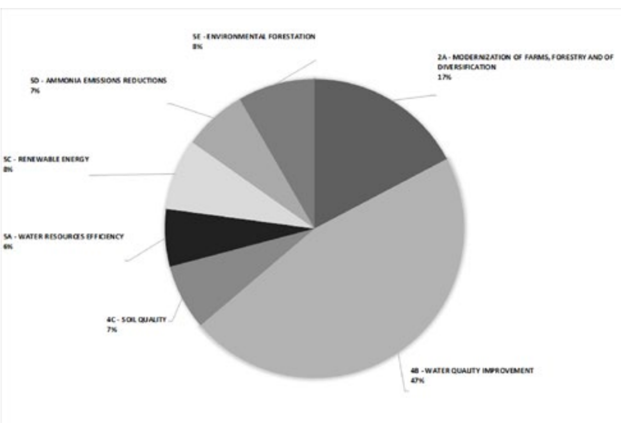

Fig. 1. Investment allocation for the different focus areas.
Fig. 1. Allocazione degli investimenti per le diverse focus area.

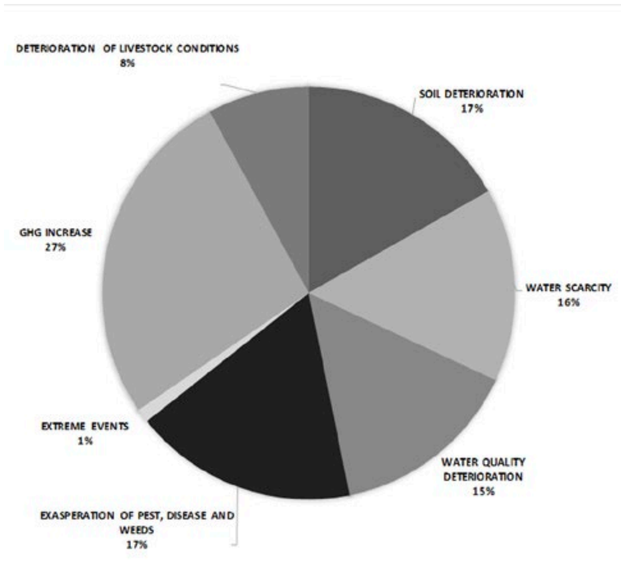

Fig. 2. Percentage of fund allocation.
Fig. 2. Percentuale dell'allocazione dei fondi.

Tab. 1. The analysis of the number of projects that contained solutions for specific threats.
Tab. 1. L’analisi del numero dei progetti che contengono soluzioni per specifiche minacce.

THREAT	SOLUTIONS
SOIL DEGRADATION	
Soil organic matter improvent	7
Soil erosion control	4
Soil contamination prevention	1
Soil biodiversity improvement	1
Carbon enrichment in soil	1
Desertification prevention	/
Decrease in soil salinization	/
Landslide prevention	/
WATER SCARCITY	
Modernization of irrigation system	7
Reduction of water necessity	4
Re-usage of wastewater	1
Enhancement of soil water retention	1
Water management innovation	5
Water harvesting equipment	/
New water efficient crops	/
WATER QUALITY DETERIORATION	
Fertilization efficiency improvement	5
Preservation of water quality	7
EXASPERATION OF PESTS, DISEASES AND WEEDS	
Increase in crop diversification/biodiversity	8
Increase in protection against pests and diseases	5
Promotion of new pest resistant varieties	2
EXTREME EVENTS	
Increased protection against disasters	1
Promotion of new resistant varieties	1
Income diversification	/
Strenghtening of weather forecasts and meteo stations	/
Strenghtening the micro meteorological applications	/
GHG INCREASE	
Increase of carbon sequestration	12
Reduction of GHG emissions	5
Reduction in ammonia (NH3), Nitrous oxide (N2O) and CH4 emission caused by manure storage	5
Reduction of CO2 emission by reducing fossil fuel consumption (e.g. : use renewable energy, improve energy efficiency, use alternative energy sources etc.)	4
Reduction of NH3 and N2O emission from manure and mineral fertilizer distribution	2
Reduction of CH4 from enteric fermentations	1
Reduction of CO2 emission by reducing chemicals (herbicides, pesticides, insecticides)	1
Reduction of CH4 from rice farming	1
DETERIORATION OF LIVESTOCK CONDITIONS	
Preservation of biosecurity	5
Preservation/improvement of quality of pastures	12

each, whereas new water harvesting equipment and water efficient crops are still waiting for a viable idea. Water quality deterioration offered two types of solutions with 55% of the investment gone into improving fertilization efficiency and the remaining 45% towards preserving water quality. As far as exasperation of pests, diseases and weeds, Emilia-Romagna financed a total of 14 projects, 5 of which comprised 46% of the total investment, concentrated on protection against pests and diseases and crop diversification and biodiversity (8 projects). For new pest-resistant varieties, only two projects were discovered that offer a solution. In the extreme events category, two projects were identified each providing its own solution: protection against disasters and promotion of resistant varieties. No viable projects were evidenced for income diversification, strengthening of weather forecasts and meteo stations and micro-meteorological applications. The category of threats that saw the most amount of projects and investments was surely the GHG increase (Fig. 3) with 25 projects in total that offer mitigating solutions such as carbon sequestration in soils, reduction of emissions by reducing fossil fuels, reduction of CO_2, CH_4, NH_3, N_2O etc. Livestock is generally considered for preserving biosecurity (4 projects).

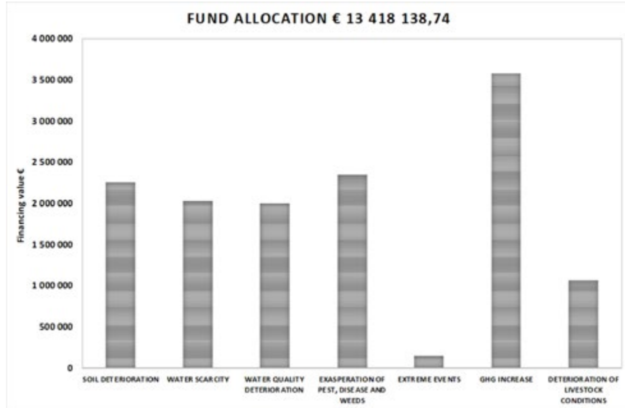

Fig. 3. RDP fund allocation for the different threat categories.
Fig. 3. Allocazione dei fondi del PSR per le diverse categorie di minacce.

3.2 An example of CSA in RDP projects

As an example of how projects offer solutions to certain threats, we analysed an OG project approved by Emilia-Romagna as a case study of the work. ‘*Irrigation system optimization in fruit farming for adaptation to climate change*’ is a project conducted in a pear and apple orchard of the Mazzoni Group at Medelana in the province of Ferrara. A multi-stakeholder project that saw the participation of the Department of Agricultural and Food Sciences of the University of Bologna (UNIBO-DISTAL), the Institute of Biometeorology (IBIMET) and the Consortium for the Emilia-Romagna Channel (CER) as partners. As Bianchi *et al.*, 2017 suggested to increase studies on field irrigation management, the aim of the project was to rationalize the use of irrigation systems by identifying the best practices for water use efficiency (WUE) improvement in drip irrigation and by developing sustainable protocols for orchard cooling irrigation. The activities were organized into four main actions: I) comparison of traditional drip irrigation with micro-sprinkler irrigation on four different scion/rootstock combinations of pear with three different volumes of water supply, II) study of the effects of ultra-low irrigation systems to reduce evaporative water losses, III) definition of specific guidelines for cooling irrigation, IV) establishment of the time for irrigation during the day. After the two-year experimentation, the evidence showed that besides the temperature reduction of the tree organs, the evaporative cooling influences the productivity performance. This type of irrigation could result interesting in case of recurrent heat waves since it has shown the possibility of reducing the temperature by 4°C. If we consider the temperature predictions in the future for northern and central Italy, it comes to no surprise that farmers need to have a backup solution in case of extreme temperatures that may damage tree productivity or even functionality. Cooling irrigation poses itself as a quality solution in order to manage heat stress in tree organs during the central hours of the day. For an even more successful orchard management in high heat, a viable option would be to install a sensor that could activate the cooling treatment as soon as the critical temperature threshold is reached. In that case, it generates small-calibrated intervals of water bursts throughout the day instead of having a continuous stream of water for a single fixed duration. By doing so, it is possible to use the short-term effect of thermic decrement due to the water's lower temperature and the long-term decrement due to water evaporation on the tree organs.

4. CONCLUSIONS

Our primary goal with this study was to give a general overview of how RDP and CSA can function in tune from a policy and a farmer's point of view. In the case of Emilia-Romagna, it is clear on the amount of innovation and solutions that can be achieved if policies invest in CSA. With research and policies collaborating towards a common goal, innovative solutions are much more easily obtainable. RER has financed 93 projects in the RDP, 70% of which are CSA oriented. The Sub-Measure 16.1 '*Operational Groups projects of the European Partnership for Agricultural Productivity and Sustainability*' had financed a total of 800 projects in the EU, which directly translates to Emilia-Romagna having invested the equivalent of 12% of the total European financing for the Sub-Measure. The GO project example is one of many financed by the Region in its struggle to adapt and mitigate climate change, showing the great interest it has into changing the overall image of agriculture as a polluter.

In addition to this, the regional development of climate-smart agriculture has financed further support with the Sub-Measure 16.2 '*Pilot projects and innovation development*' that consider supply chain projects. Of the 25 financed projects in animal production, eight are climate-smart and, of the 30 in plant production, nine are climate smart.

When all is considered, 35% of the projects in Emilia-Romagna have mitigating efforts, 21% are for adaptation, 11% are dealing with carbon sequestration and 33% of the projects have a potential for double action (mitigation and adaptation simultaneously).

We conclude that the RPD efforts of Emilia-Romagna are spearheading the promotion of new forms of resilient, low impact and sustainable agriculture by applying CS standards in their policies. With the newly created CSA Hub in Emilia-Romagna, operating at IBIMET, serving as an interface between research, policy and agriculture, Emilia-Romagna will continuously work on transitioning its agricultural practices to fight climate change.

ACKNOWLEDGEMENTS

We would like to acknowledge the funding provided by the European Institute of Innovation and Technology, Climate Knowledge and Innovation Community (Climate KIC) and the CSAbooster. We thank the Minister of Agriculture, Hunting and Fisheries of Emilia-Romagna, Simona Caselli, the Head of the Cabinet, Nicola Dall'Olio and the Head of Department for the Innovation, Quality, Promotion and Internationalization of Agro-food System, Mario Montanari, for the support provided throughout our research.

REFERENCES

Bianchi, A., Masseroni, D., Thalheimer, M., Medici, L. O. De, and Facchi, A. (2017). Field irrigation management through soil water potential measurements : a review. *Italian Journal of Agrometeorology*, (2), 24-38.

Borsetta, G., Chieco, C., Malavolta, C., Piacente, C., Marandola, D., Colaiacomo, E., Rossi, F., Ponti, F., Montanari, M., Dall'Olio, N., Georgiadis, T. (2018). Case Study: Italian synergies and innovations for scaling-up CSA.

Brady, M., Kellermann, K., Sahrbacher, C., and Jelinek, L. (2009). Impacts of decoupled agricultural support on farm structure, biodiversity and landscape mosaic: Some EU results. *Journal of Agricultural Economics*, *60*(3), 563–585.

Constantin, J., Mary, B., Laurent, F., Aubrion, G., Fontaine, A., Kerveillant, P., and Beaudoin, N. (2010). Effects of catch crops, no till and reduced nitrogen fertilization on nitrogen leaching and balance in three long-term experiments. *Agriculture, Ecosystems and Environment*, *135*(4), 268–278.

Dickie, A., Streck, C., Roe, S., Zurek, M., Haupt, F., Dolginow, A., West, P. (2014). Strategies for Mitigating Climate Change in Agriculture: Abridged report. CEA. California Environmental Associates.

EIP. (2017). EIP Operational Groups, 1–14.

EP. (2018). Second Pillar of the Cap: Rural Development Policy, 1–4.

Erjavec, K., and Erjavec, E. (2009). Changing EU agricultural policy discourses? The discourse analysis of Commissioner's speeches 2000-2007. *Food Policy*, *34* (2), 119-236.

Fanfani, R., and Pieri, R. (2017). *Il Sistema Agro-Alimentare Dell ' Emilia-Romagna*. Retrieved from https://www.ucer.camcom.it/osservatori-regionali/os-agroalimentare/pdf/2017-rapporto-osservatorio-agroalimentare-er.pdf

FAO. (2013). *Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations. Sourcebook on Climate-Smart Agriculture, Forestry and Fisheries.*

IFPRI. (2018). *2018 Global Food Policy Report*.

Iglesias, A., and Garrote, L. (2015). Adaptation strategies for agricultural water management under climate change in Europe. *Agricultural Water Management*, *155*, 113–124.

Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., Marchetti, M. (2010). Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. *Forest Ecology and Management*, *259*(4), 698–709.

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature Climate Change* (4), 1068-1072.

Massot, A. (2018). First pillar of the Common Agricultural Policy (CAP): II — Direct payments to farmers. *Fact Sheets on the European Union*, (1307), 2–6. Retrieved from http://www.europarl.europa.eu/ftu/pdf/en/FTU_3.2.5.pdf

Miraglia, M., Marvin, H. J. P., Kleter, G. A., Battilani, P., Brera, C., Coni, E., Vespermann, A. (2008). Climate change and food safety: An emerging issue with special focus on Europe. *Proceedings of the Annual Conference of the International Speech Communication Association, INTERSPEECH*, *47*(5), 2743-2746.

Notenbaert, A., Pfeifer, C., Silvestri, S., and Herrero, M. (2017). Targeting, out-scaling and prioritising climate-smart interventions in agricultural systems: Lessons from applying a generic framework to the livestock sector in sub-Saharan Africa. *Agricultural Systems*, (151), 153-162.

Policy, A., and Brief, P. (2013). Overview of CAP REFORM, (December 2013).

Rana, G., Muschitiello, C., Ferrara, R. M., Verdiani, G., and Acutis, M. (2018). Modelling the groundwater level by water balance: A case study of a mediterranean karst aquifer of Apulia region (Italy). *Italian Journal of Agrometeorology*, *2018*(1), 35-48.

Recanati, F., Maughan, C., Pedrotti, M., Dembska, K., and Antonelli, M. (2019). Assessing the role of CAP for more sustainable and healthier food systems in Europe: A literature review. *Science of the Total Environment*, *653*, 908–919.

Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., and Woznicki, S. A. (2017). Climate change and livestock: Impacts, adaptation, and mitigation. *Climate Risk Management*, *16*, 145–163.

Saj, S., Torquebiau, E., Hainzelin, E., Pages, J., and Maraux, F. (2017). The way forward: An agroecological perspective for Climate-Smart Agriculture. *Agriculture, Ecosystems and Environment*, *250*(August), 20–24.

Smith, J., Smith, P., Wattenbach, M., Zaehle, S., Hiederer, R., Jones, R. J. A., Ewert, F. (2011). Projected changes in mineral soil carbon of European croplands and grasslands, 1990-2080. *12th International Conference on Indoor Air Quality and Climate 2011*, *2*(June), 2141–2152.

Solazzo, R., Donati, M., Tomasi, L., and Arfini, F. (2016). How effective is greening policy in reducing GHG emissions from agriculture? Evidence from Italy. *Science of the Total Environment*, *573*, 1115–1124.

Thornton, P., Aggarwal, P., and Parsons, D. (2017). Editorial: Prioritising climate-smart agricultural interventions at different scales. *Agricultural Systems*, *151*, 149–152.