Project acronym: SURE-Farm
Project no.: 727520

Start date of project: June 2017
Duration: 4 years

D5.8 Submitted open access papers on comparative analysis of the resilience of farming systems across the EU and their delivery of private and public goods, and the impacts of future scenarios, improved strategies and policy options

WU (P1)

Reidsma, P., W. Paas, F. Accatino, C. Pinsard, H. Herrera, P.H. Feindt, T. Slijper, A. Spiegel, R. Finger, Y. de Mey, K.J.A.M. Termeer, P.M. Poortvliet, M.K. van Ittersum, M. Peneva, J. Urquhart, M. Vigani, J.E. Black, P. Nicholas-Davies, D. Maye, P. Courtney, F. Appel, F. Heinrich, A. Balmann, F. Ollendorf, J. Bijttebier, I. Coopmans, E. Wauters, E. Mathijs, H. Hansson, C.J. Lagerkvist, J. Rommel, G. Manevska-Tasevska, C. Pineau, B. Soriano, I. Bardaji, C. San Martin, S. Severini, S. Senni, C. Zinnanti, C. Gavrilescu, I.S. Bruma, K.M. Dobay, D. Matei, L. Tanasa, D. M. Voicilas, K. Zawalinska, P. Gradziuk, V. Krupin, A. Martikainen, S. Martin, F. Lége, B. Kopainsky, M.P.M. Meuwissen

(pytrik.reidsma@wur.nl)

Due date	11/05/2021
Version/Date	Final 11/05/2021
Work Package	WP 5
Task	T. 5.4
Task lead	WU (P1)
Dissemination level	Public

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

INDEX

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

1 Introduction

Five papers have recently been submitted and/or published, based on Task 5.4 'Integrated impact of improved strategies and policy options'. The first paper is led by Miranda Meuwissen, and has been published in Agricultural Systems. The Covid-19 crisis provided an opportunity to test the SURE-Farm resilience framework. The resilience of all 11 EU farming systems selected as case studies to the shock of Covid-19 was assessed, and compared to pre-Covid findings. This assessment has led to conclusions regarding strategies and policy options that have improved resilience in the short-term, and what is required for the long-term. The paper is part of a Special Issue, in which impacts of Covid-19 on agriculture are assessed for different continents.

The other four papers are based on D5.5 'Report on the impacts of future scenarios on the resilience of farming systems across the EU'. The second paper is led by Wim Paas, and presents a participatory method to assess the future sustainability and resilience of farming systems. Extensive sheep farming in Huesca, Spain, is used as a case study. The declining sustainability and resilience in this case study provides important insights for other EU farming systems. The third paper is based on the same method, and provides a comparative analysis of critical thresholds across 11 EU farming systems. More papers are expected to be written based on this participatory method, focussing on alternative systems, strategies to reach those, and how these can improve sustainability and resilience in different future scenarios. D5.6 'Report on the impacts of improved strategies and policy options on the resilience of farming systems across the EU' has already extended this work.

The fourth paper shows how system dynamics modelling can be used to understand resilience of farming systems, and how different strategies contribute to this. The arable farming system in the Veenkoloniën in the Netherlands is used as a case study here. The fifth paper uses a dynamic nitrogen flow model to assess resilience in the long-term: although many farming systems may seem resilient in the short-term, they may be vulnerable to declining public goods and reduced resource availability. This paper assesses the impact of import declines in three different types of farming systems in France.

References are provided below, and abstracts are included in the next sections. To not interfere with submission processes and copyright issues, this deliverable does not include the papers' full content.

Meuwissen, M.P.M., P.H. Feindt, T. Slijper, A. Spiegel, R. Finger, Y. de Mey, W. Paas, K.J.A.M. Termeer, P.M. Poortvliet, M. Peneva, J. Urquhart, M. Vigani, J.E. Black, P. Nicholas-Davies, D. Maye, F. Appel, F. Heinrich, A. Balmann, J. Bijttebier, I. Coopmans, E. Wauters, E. Mathijs, H. Hansson, C.J. Lagerkvist, J. Rommel, G. Manevska-Tasevska, F. Accatino, C. Pineau, B. Soriano, I.

Bardaji, S. Severini, S. Senni, C. Zinnanti, C. Gavrilescu, I.S. Bruma, K.M. Dobay, D. Matei, L. Tanasa, D. M. Voicilas, K. Zawalinska, P. Gradziuk, V. Krupin, A. Martikainen, H. Herrera, P. Reidsma. 2021. Impact of Covid-19 on farming systems in Europe through the lens of resilience thinking. Agricultural Systems 191, 103152. https://doi.org/10.1016/j.agsy.2021.103152.

Paas, W., B. Soriano, C. San Martin, M.K. van Ittersum, M. Meuwissen, P. Reidsma. 2021. Assessing sustainability and resilience of future farming systems with a participatory method: a case study on extensive sheep farming in Huesca, Spain. Ecological Indicators. Revisions.

Paas, W., F. Accatino, J. Bijttebier, J. E. Black, C. Gavrilescu, V. Krupin, G. Manevska-Tasevska, F. Ollendorf, M. Peneva, C. San Martín, C. Zinnanti, F. Appel, P. Courtney, S. Severini, B. Soriano, M. Vigani, K. Zawalińska, M. K. van Ittersum, M. P.M. Meuwissen, P. Reidsma, 2021. Participatory assessment of critical thresholds for resilient and sustainable European farming systems. Journal of Rural Studies. Submitted.

Herrera, H., L. Schuetz, W. Paas, P. Reidsma, B. Kopainsky, 2021. Understanding resilience of farming systems: insights from system dynamics modelling for an arable farming system in the Veenkoloniën. Ecological modelling. Submitted.

Pinsard, C., S. Martin, F. Lége, F. Accatino. 2021. Robustness to import declines of three types of European farming systems assessed with a dynamic nitrogen flow model. Agricultural Systems. Submitted.

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

2 Impact of Covid-19 on farming systems in Europe through the lens of resilience thinking

Context

Resilience is the ability to deal with shocks and stresses, including the unknown and previously unimaginable, such as the Covid-19 crisis.

Objective

This paper assesses (i) how different farming systems were exposed to the crisis, (ii) which resilience capacities were revealed and (iii) how resilience was enabled or constrained by the farming systems' social and institutional environment.

Methods

The 11 farming systems included have been analysed since 2017. This allows a comparison of pre-Covid-19 findings and the Covid-19 crisis. Pre-Covid findings are from the SURE-Farm systematic sustainability and resilience assessment. For Covid-19 a special data collection was carried out during the early stage of lockdowns.

Results and conclusions

Our case studies found limited impact of Covid-19 on the production and delivery of food and other agricultural products. This was due to either little exposure or the agile activation of robustness capacities of the farming systems in combination with an enabling institutional environment. Revealed capacities were mainly based on already existing connectedness among farmers and more broadly in value chains. Across cases, the experience of the crisis triggered reflexivity about the operation of the farming systems. Recurring topics were the need for shorter chains, more fairness towards farmers, and less dependence on migrant workers. However, actors in the farming systems and the enabling environment generally focused on the immediate issues and gave little real consideration to long-term implications and challenges. Hence, adaptive or transformative capacities were much less on display than coping capacities. The comparison with pre-Covid findings mostly showed similarities. If challenges, such as shortage of labour, already loomed before, they persisted during the crisis. Furthermore, the eminent role of resilience attributes was confirmed. In cases with high connectedness and diversity we found that these system characteristics contributed significantly to dealing with the crisis. Also the focus on coping capacities was already visible before the crisis. We are not sure yet whether the focus on short-term robustness just reflects the higher visibility and urgency of shocks compared to slow

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

processes that undermine or threaten important system functions, or whether they betray an imbalance in resilience capacities at the expense of adaptability and transformability.

Significance

Our analysis indicates that if transformations are required, e.g. to respond to concerns about transnational value chains and future pandemics from zoonosis, the transformative capacity of many farming systems needs to be actively enhanced through an enabling environment.

Graphical abstract

3 Assessing sustainability and resilience of future farming systems with a participatory method: a case study on extensive sheep farming in Huesca, Spain

Finding pathways to more sustainability and resilience of farming systems requires the avoidance of exceeding critical thresholds and the timely identification of viable alternative system configurations. To serve this purpose, the objective of this paper is to present a participatory, indicator-based methodology that leads researchers and farming system actors in six steps to a multi-dimensional understanding of sustainability and resilience of current and future systems. The methodology includes an assessment of current performance (Step 1), identification of critical thresholds (Step 2), impact assessment when critical thresholds are exceeded (Step 3), identification of alternative systems and their expected improved performance of sustainability and resilience (Step 4), identification of strategies to realize those alternative systems (Step 5), and an assessment on the compatibility of alternative systems with future development scenarios to take into account developments of exogenous factors (Step 6). In an application to extensive sheep production in Huesca, Spain, participants in a workshop indicated that their farming system is very close to a decline or even a collapse. Approaching and exceeding critical thresholds in the social, economic and environmental domain is currently causing a vicious circle that includes low economic returns, low attractiveness of the sector and abandonment of pasture lands. More sustainable and resilient alternative systems to counteract the current negative system dynamics were proposed by participants: a semi-intensive system primarily aimed at improving production

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

and a high-tech extensive system primarily aimed at providing public goods. Both alternative systems place a strong emphasis on the role of technology, but differ in their approach towards grazing, which is reflected in the different strategies that are foreseen to realize those alternatives. Although the high-tech extensive system seems most compatible with a future in which sustainable food production is very important, the semi-intensive system seems a less risky bet as it has on average the best compatibility with multiple future scenarios. Overall, the methodology can be regarded as relatively quick, interactive and interdisciplinary, providing ample information on critical thresholds, current system dynamics and future possibilities. As such, the method enables stakeholders to think and talk about the future of their system, paving the way for further discussions and assessments.

4 Participatory assessment of critical thresholds for resilient and sustainable European farming systems

Farming systems in Europe are experiencing multiple stresses and shocks that may push systems beyond critical thresholds after which system change may occur. These critical thresholds may lay in the economic, environmental, social and institutional domain. In this paper we take a participatory, and hence subjective, approach to assess the presence of critical thresholds in 11 European farming systems, and the potential consequence of surpassing those with regard to system sustainability and resilience. First, critical thresholds of main challenges, key system variables and their interactions in the studied farming systems were assessed. Second, participants assessed the potential developments of the key system variables in case critical thresholds for main system challenges would be exceeded. All studied systems were perceived to be close, at or beyond at least one identified critical threshold. Stakeholders were particularly worried about economic viability and food production levels. Moreover, critical thresholds were perceived to interact across system levels (field, farm, farming system) and domains (social, economic, environmental), with low economic viability leading to lower attractiveness of the farming system, and in some farming systems making it hard to maintain natural resources and biodiversity. Overall, a decline in performance of all key system variables was expected by workshop participants in case critical thresholds would be exceeded. For instance a decline in the attractiveness of the area and a lower maintenance of natural resources and biodiversity. Our research shows that concern for exceeding critical thresholds is justified and that thresholds need to be studied while taking into account system variables at field, farm and farming system level across the social, economic and environmental domains. For instance, economic variables at farm level (e.g. income) seem important to timely detect whether a system is approaching critical thresholds of social variables at farming system level (e.g. attractiveness of the area), while in

This Project has received funds from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 727520

multiple case studies there are also indications that approaching thresholds of social variables (e.g. labor availability) are indicative for approaching economic thresholds (e.g. farm income). Based on our results we also reflect on the importance of system resources for stimulating sustainability and resilience of farming systems. We therefore stress the need to include variables that reflect system resources such as knowledge levels, attractiveness of rural areas and general well-being of rural residents when monitoring and evaluating the sustainability and resilience of EU farming systems.

5 Understanding resilience of farming systems: insights from system dynamics modelling for an arable farming system in the Veenkoloniën

For some time, farming systems in Europe have been facing economic, social, environmental and institutional challenges. Highly intensive, climate-exposed, arable farming regions like the Veenkoloniën in the north of the Netherlands are particularly vulnerable to many of these challenges. Since the turn of the last century, the region has lost half of its small and medium sized family farms specialised in cultivating starch potatoes. While starch potato production continues to be stable as the remaining farms are increasing the size of their operation, many are concerned that the farming system in the Veenkoloniën might exceed critical environmental and economic thresholds if no interventions are made. In this paper, we use system dynamics to uncover the structure that drives the behaviour of the starch potato farms in the Veenkoloniën with the aim to identify leverage points that can foster the resilience of the system. Our analysis shows that, so far, farmers active engagement in a processing cooperative has been an important element to their resilience to resent economic and environmental challenges. In practice, the cooperative has been able to act as a buffer and stabilise prices for farmers in the region by implementing strategies that increase the value of their products, open new markets and increase starch potato production. However, the same analysis also shows that this current robustness may limit adaptability and transformability of the system as interdependences between cooperative and farms become stronger and more rigid.

6 Robustness to import declines of three types of European farming systems assessed with a dynamic nitrogen flow model

Context

Agriculture in Western Europe is predominantly input-intensive (fertilisers, water, fuel, pesticides) and relies on feed imports. As a result, it is dependent on oil, which may start to decline in production in the 2020s, thus exposing the industry to potential economic stress, including increased input prices and decreased farmer purchase capacities. Therefore, it is necessary to

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

assess the capacity of European farming systems (FSs) to maintain production levels despite a decline in oil production (i.e., robustness).

Objective

The objective of this study is to model and compare the time variation in the livestock- and crop-sourced production of three French FSs under three scenarios of decreased availability of feed and synthetic fertiliser imports.

Methods

We developed a territorial-scale dynamic model considering nitrogen flows between livestock, plants, and soil compartments. Crop production is a function of soil mineral nitrogen levels, and livestock quantities depend on feed availability. The three FSs are characterised by different crop-grassland-livestock balances: (i) field crop (Plateau Picard), (ii) intensive monogastric (Bretagne Centrale), and (iii) extensive ruminant (Bocage Bourbonnais). The three scenarios consist of different combinations of synthetic fertilisers and feed import availability declines until 2050: decrease in synthetic fertilisers only (Synth-); feed imports only (Feed-) in both external inputs (Synth-Feed-).

Results and conclusions

The first two scenarios highlight the positive role of livestock effluents and permanent grasslands on the robustness of food production. In the Synth-Feed- scenario, the extensive ruminant FS exhibits robustness for 11 years, whereas the field crop FS exhibits robustness for 4 years. In contrast, the intensive monogastric FS shows decreased food production within the first year. The difference between the two crop-livestock FSs can be explained by livestock density and herd composition. In the long term, all three FSs show a decrease in food production between 50–70%.

Significance

Configurational changes in the studied FSs are necessary to improve their robustness to decreased oil availability. Time periods of food production robustness may allow FSs to adapt and transform.

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520