



# Resilience in Agroecosystems

POLICY PAPER



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# **Principles for Building Resilient Agroecosystems in Europe**

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# TABLE OF CONTENTS

|                                                                                             |           |
|---------------------------------------------------------------------------------------------|-----------|
| <b>1. INTRODUCTION – NEED FOR RESILIENT AGRICULTURE</b>                                     | <b>5</b>  |
| <b>2. CURRENT MANAGEMENT PRACTICES</b>                                                      | <b>7</b>  |
| <b>3. KEY CONCEPTS</b>                                                                      | <b>9</b>  |
| 3.1. RESILIENCE                                                                             | 9         |
| 3.2. REGIME SHIFT                                                                           | 9         |
| 3.3. ADAPTIVE MANAGEMENT                                                                    | 9         |
| 3.4. TRANSFORMATION                                                                         | 10        |
| 3.5. SOCIAL-ECOLOGICAL TRAP                                                                 | 10        |
| <b>4. CHALLENGES</b>                                                                        | <b>11</b> |
| 4.1. LOST RESILIENCE                                                                        | 11        |
| 4.2. CLIMATE CHANGE                                                                         | 11        |
| 4.3. MISSING REGULATING ECOSYSTEM SERVICES                                                  | 11        |
| 4.4. NEGATIVE WATER-BALANCE                                                                 | 11        |
| <b>5. PRINCIPLES FOR BUILDING RESILIENT AGRICULTURE</b>                                     | <b>13</b> |
| 5.1. CONNECT SCIENCE AND LANDSCAPE MANAGEMENT FOR ADAPTIVE MANAGEMENT.                      | 13        |
| 5.2. FARMERS SHOULD BE CENTRAL PARTICIPANTS OF DATA COLLECTION AND ANALYSIS.                | 13        |
| 5.3. MONITORING SYSTEM WHERE CAP, FARM YIELD DATA AND ENVIRONMENTAL VARIABLES ARE COMBINED. | 13        |
| 5.4. AGRICULTURE MUST BECOME PART OF THE SOLUTION TO CLIMATE CHANGE.                        | 13        |
| <b>6. RECOMMENDATIONS</b>                                                                   | <b>14</b> |
| 6.1. ADAPTIVE MANAGEMENT IN CAP                                                             | 14        |
| 6.2. RESILIENCE MONITORING DASHBOARD                                                        | 14        |
| 6.3. FUNDING FOR TRANSFORMATION                                                             | 14        |
| 6.4. MICRO-MONITORING OF SLOW VARIABLES                                                     | 14        |



## ABSTRACT

Resilience of European agroecosystems is deteriorating rapidly. The current landscape management strategy is in a rigidity trap which is partly maintained by the CAP. Climate change will rapidly increase the challenges for such rigid systems while climate mitigation and adaptation also require profound technological changes, funding and monitoring schemes of the CAP should be used to increase the resilience of agroecosystems.

CAP need to be adjusted to support adaptive management, participatory monitoring, and active transformation towards a more resilient and sustainable agriculture.

Participatory solutions should be applied to implement resilience building in all aspects of the project: assessing resilience, monitoring, hypothesis testing, management experiments. Science, innovation and research programmes of the EU have to work together to find and implement solutions for a climate friendly and resilient agriculture.



## 1. INTRODUCTION – NEED FOR RESILIENT AGRICULTURE

About 50 % of habitable land is used for agricultural production (Ritchie and Roser 2013) and this area is still growing. Agroecosystems are highly important as they provide us with food, but at the same time agriculture is one of the main contributors to climate change and loss of biodiversity (Steffen *et al.* 2015; Tilman 2001).

Agricultural resilience is an important aspect of climate adaptation and food security in general but in the local context, often it is key to economic success and maintaining community and individual human livelihoods. A shift in the stability of an agroecosystem may lead to economic stress and ultimately migration — most often into urban areas.

Multiple frameworks have been developed to assess resilience (Cabell & Oelofse 2012; Darnhofer *et al.* 2010; O’Connell *et al.* 2019; Resilience Alliance 2010) and most recently a new framework was published by CEEweb to assess specifically agroecosystems. These tools are developed to grasp and describe a complex phenomenon in a non-scientific language with concepts that are accessible to a wide range of stakeholders. Resilience assessments help local stakeholders to have a more grounded discussion about the future of the landscape and to plan viable solutions for challenges that are approaching. Often landscape management generates conflict, with resilience assessments, science-based discussion can help resolve debates or test competing hypotheses.

The last IPCC Assessment report describes clear risks and threats for agricultural systems worldwide and in Europe. More droughts, severe rainfalls, warm winters, and spring frosty days are to be expected as the planet is warming. These changes induce many other, secondary consequences, like aridification, species invasion (IPCC 2021). Resilience is the capacity of a system to cope with



such challenges, to transform to adapt to macro-trends and to cope with harmful events.



## 2. CURRENT MANAGEMENT PRACTICES

Farming strategies in Europe mainly follow the subsidy system, the Common Agricultural Policy (CAP). CAP spends 58 billion EUR each year, while 3.1 % of farming companies manage 50 % of arable land. The current payment schemes support mainly large farming companies, small farms receive little support (Heinrich-Böll-Stiftung *et al.* 2019).

While there are clear environmental goals in CAP on the strategic level, in practice, payments are mainly supporting the economic welfare of farmers, the main logic behind spending is to protect European farmers in a volatile and competitive global food market. This provides stable livelihoods for some and better food security, but since environmental actions and climate adaptation is largely missing from the picture, it propagates a short-sighted vision to farmers in the shadow of great challenges. Even the second pillar of CAP, targeting environmental targets is insufficient to support efforts to increase adaptive capacity or resilience.

CAP is working with the implicit assumption that nature will remain stable in the long run and that no agricultural structural transformation is to be expected. Payments are mainly based on the area of farming and commitment to specific (environment-friendly) practices, but there is no long-term planning or adaptation built in the system. Farmers mostly follow the current best-paying options depending on their context, thus the “tragedy of the commons” scenario that is all too well known in the case of fisheries is also happening in the agricultural sector.

At the same time, agriculture is one of the main sources of CO<sub>2</sub> and other greenhouse gases. CAP in itself could be the single most powerful climate policy in the EU, but it fails to reduce agricultural emissions despite climate mitigation





is one of the official strategic goals of the policy (European Court of Auditors 2021).

The consequences of climate change are already affecting farmers in Europe. Sometimes just costs of production spike, in other cases farm yields drop as well (European Environment Agency 2019). Current policies see these events as “exceptional” and mainly economic compensation is given to affected farmers without considering the structural causes of the problems. High volatility in ecosystem services is a sign of a system losing its resilience and heading towards a collapse. Economic compensation in such a situation only maintains the problematic management structure and shortens the time available for change to a more resilient strategy. Declining average production, volatility in farming costs and crop yields show a system is losing its resilience. Monitoring decreasing resilience and planning agricultural transition accordingly should be one of the key priorities of European agricultural governance.



## 3. KEY CONCEPTS

### 3.1. RESILIENCE

The capacity of a social-ecological system to absorb a shock and still retain its structure and functions (Walker & Salt 2006). A resilient system is not without problems or challenges, but it has a self-organizing capacity to overcome these challenges without external help. There are three levels of resilience: coping, adaptation, and transformation. Coping is covering the losses but does not change how the system operates. Adaptation is accepting the challenge as a part of a new normal and adjusting itself. Transformation is fundamentally changing one or more parts of the system to maintain its key values under new conditions.

### 3.2. REGIME SHIFT

A persistent loss of resilience and the collapse of a stable configuration of a system (Scheffer 2009). Slow variables of the system change permanently thus ecosystem services are lost (maybe other services or disservices emerge) and the system fundamentally changes its functions. The new configuration is stable and gains resilience to maintain this new structure. Dropping water-table, aridification, shrub encroachment or soil salination are examples that occur frequently in agroecosystems.

### 3.3. ADAPTIVE MANAGEMENT

A management strategy that accepts the complex nature of Social-Ecological Systems (Holling 1978). Managers consider themselves as part of the system and acknowledge the impossibility of complete monitoring or understanding. Policies, therefore, are hypotheses that are tested in practice and can be changed based on the response of the system. Adaptive management is interacting with the system instead of trying to control it.



### 3.4. TRANSFORMATION

Intentionally changing the structure of the system to maintain its most important functions, ecosystem services. Transformation may be necessary when a new driver is influencing the system and changes the context of operation significantly. In these cases, change is usually inevitable, transformation is a way to do it intentionally, not losing any important value, even gaining new opportunities sometimes. Examples of transformation may be large-scale land-use changes, the intentional introduction of new knowledge (change to organic farming method or produce higher quality to reach new markets), the introduction of participatory management schemes such as adaptive management or adaptive co-management.

### 3.5. SOCIAL-ECOLOGICAL TRAP

A situation where a social-ecological system has low flexibility to improve its operation. It is either over-controlled to maximize yield, so it has minimal flexibility to adapt (rigidity trap) or lost its stocks of natural capital, so it is not able to use resources for its operation sufficiently (poverty trap). Intensive agriculture is an example of a rigidity trap, aridification or desertification are examples of a poverty trap.



## 4. CHALLENGES

### 4.1. LOST RESILIENCE

The resilience of European agriculture is deteriorating rapidly. Thanks to the industrialization process that was pursued during the 20<sup>th</sup> century, agriculture in our continent is highly specialized, highly dependent on external inputs, and controls. This streamlined, highly efficient and productive farming strategy, combined with CAP became a successful business strategy for big agricultural corporations and smaller-scale farmers (to a lesser extent for the latter). At the same time, the system is now in an over-optimized state that has minimal flexibility to adapt to environmental challenges. The situation can be viewed increasingly as a rigidity trap thus highly vulnerable.

### 4.2. CLIMATE CHANGE

Climate change will increase the strength and frequency of ecosystem variability, it will change disturbance regimes. Agriculture needs more fundamental solutions to adapt to this “new normal” than simple financial solutions for damage control.

### 4.3. MISSING REGULATING ECOSYSTEM SERVICES

As the landscape was homogenized, many elements that were once regarded as unproductive, and redundant were transformed into croplands. Their original functions in stabilizing, regulating ecosystems are now missing and contribute to the low resilience agroecosystems have.

### 4.4. NEGATIVE WATER-BALANCE

The water table is dropping in many areas in Central Europe. Rainfall frequency has gradually changed during the last two decades. Now droughts are more frequent and when rainfall arrives, it is often heavier than optimal. Stagnating water is drained to the main rivers, which is accelerating the arrival of the next



drought. A technological response to this challenge is irrigation, but it is deteriorating soil quality, lowering the water table further and expensive.



## 5. PRINCIPLES FOR BUILDING RESILIENT AGRICULTURE

### 5.1. CONNECT SCIENCE AND LANDSCAPE MANAGEMENT FOR ADAPTIVE MANAGEMENT.

While CAP assumes a rigid vision of agriculture, in other EU programmes (e.g. LIFE, Horizon) many participatory methods are requirements. Lessons learned from conservation and R&D projects should provide the basis for reforming agricultural management.

### 5.2. FARMERS SHOULD BE CENTRAL PARTICIPANTS OF DATA COLLECTION AND ANALYSIS.

Field expertise and personal stake make farmers highly interested in thinking about the future of agricultural policy. While they tend to resist change, when facing challenges, they also often find innovative ways to tackle problems.

### 5.3. MONITORING SYSTEM WHERE CAP, FARM YIELD DATA AND ENVIRONMENTAL VARIABLES ARE COMBINED.

Income volatility, deteriorating yields are among the possible early warnings of ecosystem collapse. Such warning signals could be used to select the most urgent intervention points where landscape management needs to be transformed to save productivity.

### 5.4. AGRICULTURE MUST BECOME PART OF THE SOLUTION TO CLIMATE CHANGE.

End CAP support for low productivity croplands and encourage the establishment of grasslands and wetlands that are net carbon sinks. CAP payments, in general, must reflect the carbon balance of the farming activities to motivate farmers using solutions that are keeping soil healthy carbon storage.



## 6. RECOMMENDATIONS

### 6.1. ADAPTIVE MANAGEMENT IN CAP

Support the establishment of adaptive management institutions formed by farmers, scientists, water management and conservation experts. Depending on the continued operation of these bodies, CAP funds can be directed to recipients not just according to farm performance but reflecting the wider context of their environmental impact and participation in local cooperation.

### 6.2. RESILIENCE MONITORING DASHBOARD

Build an agricultural resilience monitoring dashboard with the combination of CAP payments data, climate monitoring, and remote-sensing information on landscape patterns. Make payments available for transformation based on early warning signals of high vulnerability.

### 6.3. FUNDING FOR TRANSFORMATION

Give funding for farm transformation — from conventional to organic, from cropland to grassland, and so on — to higher resilience, better conservation strategies. Such support should cover investment and education to facilitate a technological transition, while the farmer commits to higher conservation standards in her long-term operations. Increase these funds proportionally if multiple adjacent farmers participate in transformation efforts.

### 6.4. MICRO-MONITORING OF SLOW VARIABLES

Support micro-level ecological monitoring solutions using IoT and local remote sensing solutions. Encourage citizen science solutions in executing and analysing data collection. Micro-level monitoring should focus on slow variables of concern in the local agroecosystem. Integrate the collected information into the resilience monitoring dashboard.





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