Report on revision of project results and methodological aspects

Deliverable D1.5 – v5

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Deliverable 1.5	Report on revision of project results and methodological aspects
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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other
[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

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Table of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 862993.

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1 Executive Summary

This report presents the main outcomes of the revision process of the project development, methodology and achievements. This process was carried out in Task 1.5, under the umbrella of WP1, i.e. the work-package dealing with epistemological, methodological and lexical aspects linked to AGROMIX as a project and as a community of people.

In particular, WP1 has drafted in the starting phase of the project two major methodological references, namely i) **a framework of climate change resilience (D1.1)**, providing common understanding and definitions of the different dimensions (Ecological, Economic and Social) and mechanisms of resilience to climate change of agroforestry (AF) and mixed farming (MF) systems; and ii) **a set of ecological, economic and social indicators of resilience (D1.3)** to be assessed and applied throughout the entire project.

Towards the end of the project, the AGROMIX community **considered the major outcomes** of the project seeking scientific evidence of higher resilience of agroforestry and mixed farming systems to climate change by using the lenses of the two aforementioned references. Through this self-assessment, AGROMIX investigates its strengths and weaknesses through a multicriteria approach of its major outcomes. The process was also intended to identify constraints faced by the AGROMIX consortium to provide useful suggestions for future projects and initiatives on the same topics. To tackle this goal, the leaders of the work packages 2 to 7 were engaged in a SWOT analysis, starting from the individual points of view of the single WP leaders and ending with a consensus analysis defined in a participatory meeting involving key external stakeholders.

Furthermore, in Task 1.5 the WP leaders were invited to reconsider the framework of resilience and the set of resilience indicators based on the achievements of their respective WPs. The aim was to improve the original list of indicators and the original framework by leveraging the practical experience of research teams having worked on different aspects of resilience to climate change of AF/MF systems. The revision processes ended in a final improvement of both the framework and the indicator set, in which external stakeholders were involved during a final online meeting.

Results of the **SWOT analysis** highlighted strengths and challenges in the project implementation:

- **WP2** emphasised the success of a multi-stakeholder network in designing pilot AF/MF case studies, which ensured flexibility and adaptability, especially in overcoming the challenges posed by the COVID-19 pandemic. However, the heterogeneity of stakeholders was identified as a challenge for achieving consensus.
- **WP3** focused on experimental research, leveraged biophysical sampling and modelling to assess AF/MF systems against future climate scenarios and management options. Despite challenges and delays posed by COVID-19, the WP's comprehensive approach was a major strength. A key limitation was the unclear definition of mixed farming in current regulations, which hindered deeper analysis of such systems.
- **WP4** highlighted socio-economic pressures on marginal areas, which are key for expanding AF/MF systems. These pressures may undermine the future potential for AF/MF expansion, particularly due to depopulation and land abandonment.
- **WP5** underscored the resilience of AF/MF systems, with strengths found in the diversification of farm products and the resilience to market fluctuations. New market opportunities, such as carbon credits

and branding schemes, are emerging, although high production and labour costs, particularly in livestock systems, remain a significant weakness.

- **WP6,** could use the new experimental and modelling data created in the project and combine and contrast them with the co-creation of bottom-up policy development to achieve an agroforestry white paper and policy strategy for the EU.
- **WP7**, responsible for communication and dissemination, achieved good results in engaging stakeholders and producing high-quality materials, although there is room to enhance the material for broader public outreach. The COVID-19 pandemic and the rise of AI-driven content creation were identified as threats.

A comprehensive analysis of the entire project revealed strengths such as the heterogeneity of the consortium, its wide regional spread and the adaptability of activities. However, weaknesses included limited external interactions and the challenges posed by the COVID-19 pandemic especially in the critical start-up phase of the project. The project also faced difficulties in defining AF and MF systems clearly and homogeneously, limiting the exploitation of results in the broader context of agroecological transition.

The **review of the resilience framework** indicated a generally high level of clarity and comprehensibility, with a mean score of the index used (min 0, max 1) of 0.83 across the work packages. The framework was well understood by most teams, with WP2, WP4, and WP5 scoring the highest (1.0), while WP3 and WP6 indicated some challenges in its clarity (scoring 0.5).

Analytical Hierarchy Process (AHP) results revealed that the **economic dimension** of resilience was considered the most critical (0.577), followed by the **ecological** (0.289) and **social** dimensions (0.134). This result reflects the importance of economic sustainability for the viability of AF/MF systems, where ecological and social factors support long-term economic resilience. The results suggest that, rather than disproportionately prioritising any one dimension, actions undertaken in the ecological and social dimensions support economic management and resilience when AF/MF systems are practiced.

Additionally, the research identified key **mechanisms to reduce climate change risks** within the AF/MF systems. These mechanisms were categorised across ecological, economic, and social dimensions, and workshops allowed for the integration of these findings into the resilience framework. Notably, it was suggested to include 'non-market' values, such as aesthetic landscape value, in the economic dimension. Mechanisms discussed during the project emphasised the importance of **synergistic actions across dimensions**, such as acting in networks to influence local regulations or integrating suitable species and planting designs for microclimatic effects.

Ecological resilience criteria identified include:

- High functional diversity
- High landscape complexity
- Healthy soil
- Reduced external input use
- Microclimate regulation

Economic resilience criteria include:

- High autonomy from public support
- High marketing diversification
- High income stability
- Reducing risk levels

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Social resilience criteria include:

- Integration in local networks
- Locally adapted advisory/training
- Landscape revitalisation
- Connection with consumers

The **evaluation of resilience indicators** used across the project offered a comprehensive analysis of their applicability in the AF/MF context:

- **Ecological Indicators**: These were mainly applicable in WP2, WP3, and WP6. Key indicators like "Crop species richness" and "Biodiversity" showed favourable outcomes for AF/MF systems, especially in tasks related to water/microclimate resilience and biodiversity enhancement. However, some indicators (e.g., "Vigorous crop species/varieties") were applicable only to specific tasks, particularly in WP6, which focused on current policies. Stakeholder perception also indicated that ecological indicators were considered important, especially by policymakers and local actors.
- **Economic Indicators**: Economic resilience was assessed across WP2, WP5, and WP6. Indicators like income variability, subsidies, and the number of income sources were tested, with notable results. At the **farm level**, indicators such as "Direct sales to consumers" were highly favourable for AF/MF systems, while others like "Debt and loan" showed negative outcomes. At the **value chain level**, similar trends were observed, underscoring the economic viability of AF/MF systems but also pointing to the challenges posed by dependence on external inputs. Stakeholder feedback revealed that economic indicators were highly valued by farmers and industry representatives, highlighting the importance of economic sustainability for the adoption of AF/MF systems.
- **Social Indicators**: Social resilience indicators, such as "Cooperation with other producers" and "Farmer networks", were tested across WP2, WP5, and WP6. At the **farm level**, most indicators gave favourable results, especially in relation to farmer training and collaboration. However, at the **value chain level**, more indicators were favourable, indicating the potential of AF/MF systems to strengthen social resilience. Interestingly, social indicators were perceived as less important by industry stakeholders, pointing to a gap in awareness regarding the social benefits of AF/MF systems.

In the final workshop, participants revisited the indicators based on the resilience framework, adjusting the weighting of criteria and indicators in the **ecological**, **economic**, and **social** dimensions. This revision process resulted in a refined indicator framework that better captures the complex interplay of resilience factors in AF/MF systems. Adjustments were made to ensure that the indicators were more closely aligned with the practical realities of AF/MF practices and the stakeholder needs identified throughout the project.

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2 Expected impact

This report summarises the major results of Task 1.5, which was directly linked to the Tasks 1 and 3 of WP1, but will also impact on the final outcomes of the WPs 2 to 7, and to the project as a whole. According to the GA, Task 1.5 aimed to "*gather main results from all the other WPs and analyse with a participatory, interdisciplinary approach the results achieved in the project in dedicated workshops with WP leaders and stakeholders*". In particular, Task 1.5 analysed "*how the co-designed pilots (WP2), the case studies (WP3) and economics and value chains (WP5) could be evaluated in respect to the resilience framework (task 1.1) and indicators (tasks 1.2 and 1.3)*". The task aimed to provide an interdisciplinary common evaluation of AGROMIX achievements by merging all the major skills and expertise represented in the consortium of AGROMIX. This evaluation includes also the point of view of the stakeholders that were directly (e.g., pilot case representatives engaged in WP2, consumers/retailers interviewed in WP5) or indirectly (e.g., external stakeholders, target stakeholder groups) touched by AGROMIX activities.

As such, this report has the potential to deliver positive impact on the following actor groups:

- **Scientific community members** (either part of AGROMIX consortium, or not): based on the results presented in this report, scientists working on AF/MF and climate change resilience could shape undergoing or future projects and initiatives taking inspiration from AGROMIX flaws and successes. Furthermore, the scientific community can go further in providing better definitions, understanding and methodological tools when tackling similar topics as AGROMIX;
- **Farmers**: farmers who have participated actively to the activities of AGROMIX or that took part of the AGROMIX network may receive an outcome of the project results, especially on dimensions and indicators of resilience that might be exploitable for marketing reasons or simply as communication tools to disseminate the knowledge on the benefits of AF/MF systems. Farmers not applying AF/MF systems can get inspired from the theoretical knowledge generated by the project, which is always a powerful starting point for any transformative design of farming systems;
- **Advisors**: advisors play a crucial role in supporting AF/MF farms as well as in the conversion to AF/MF systems, as these are indeed really complex management systems. Knowing about the dimensions and indicators of resilience that the AGROMIX community value as worth and affordable to be measured at farm or value chain level can provide solid guidelines for advisors to support the decision making process of farmers;
- **Policy-makers (regional, national, EU levels)**: this could be a really valuable impact of the project, that went through also the policy instruments currently on place at different spatial scale to support the maintaining of or the conversion to AF/MF systems. Expectedly, the policy framework of AF/MF systems resulted to be very complex, starting from the issue of definitions of AF/MF systems, that is controversial. Resilience dimensions and indicators could provide solid bases for defining properly AF/MF systems and to define policy instruments able to support such systems based on the most relevant and measurable resilience dimensions;

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- **Agricultural industry members**: AF/MF systems are agroecology-based management systems that rely on complexity. The diversification of such production systems makes it really important to count on technical means and technologies specifically developed or adapted to such systems. The analysis of underperforming resilience indicators of AF/MF system may cause emerging technical difficulties, thus opening the path to development of specific tools;
- **Citizen consumers**: the revision of AF/MF resilience framework and indicators could also provide a comprehensive scheme to disseminate and valorise AF/MF systems among citizens;
- **Value chain actors**: several AGROMIX indicators are about socio-economic aspects operating at value chain level. Their knowledge could be an important lever to improve the resilience of AF/MF-based value chains and to design specific management and marketing strategies;
- **Environmentalists and the environment**: there is a general consensus on the environmental impact of diversified systems based on agroforestry or mixed farming. AGROMIX can provide solid reference to measure the environmental impact of such systems through the resilience framework and set of indicators.

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3 Introduction

3.1 The AGROMIX framework of resilience

In the Task 1.1. of AGROMIX, a framework to describe resilience to climate change of AF/MF systems was delivered (D1.1, further developed in T1.4). Besides conceptual theoretical approach, the framework provides, first of all, operating definitions of the different typologies of agroforestry systems currently available in Europe based on LUCAS (Land Use/Cover Area frame statistical Survey, Eurostat) data (Fig. 1).

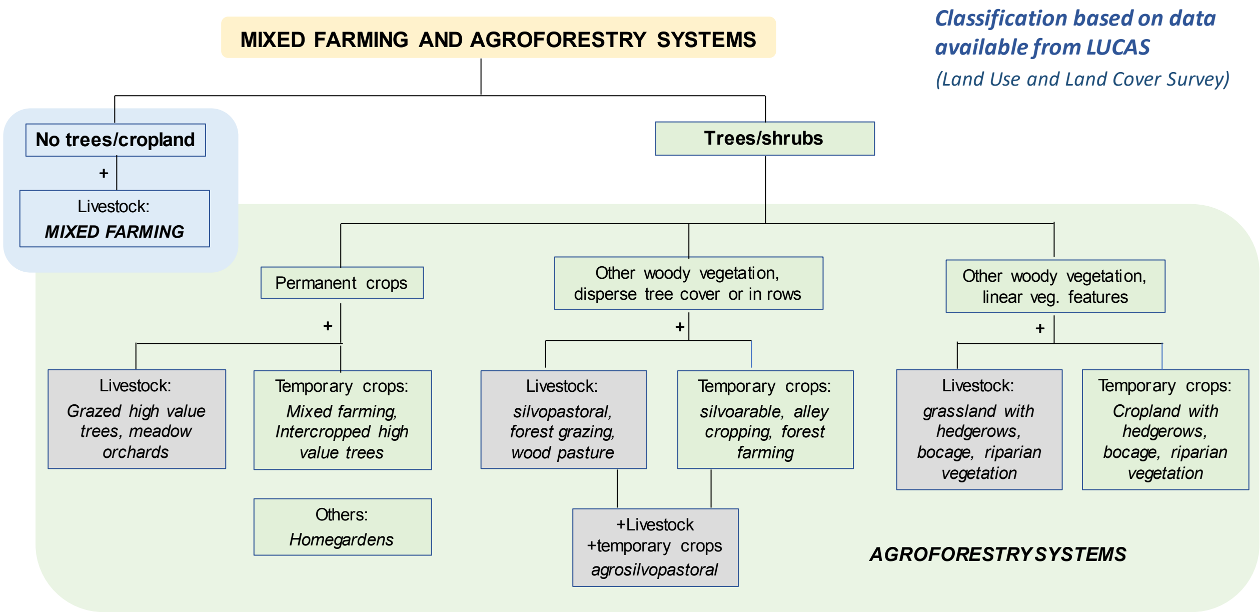

Figure 1 - The classification of AF/MF systems adopted in AGROMIX

Based on ecological and socio-economic literature review, the general concept of farming system resilience to climate change was then defined (Fig. 2).

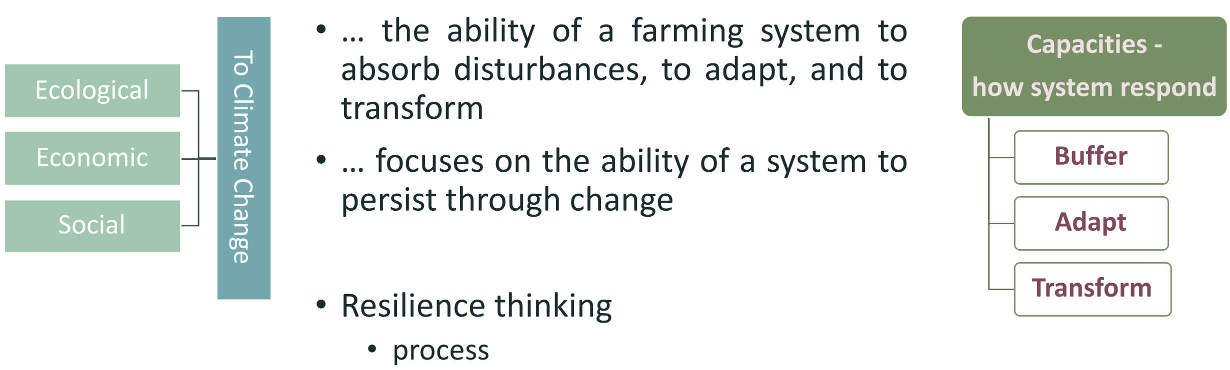

Figure 2 - The concept of resilience to climate change adopted in AGROMIX

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Finally, the three dimensions of resilience (ecological, economic, social resilience) were described in terms of mechanisms and responses, acting at different spatial scales (from local to regional) and mobilising different capacities (Fig. 3).

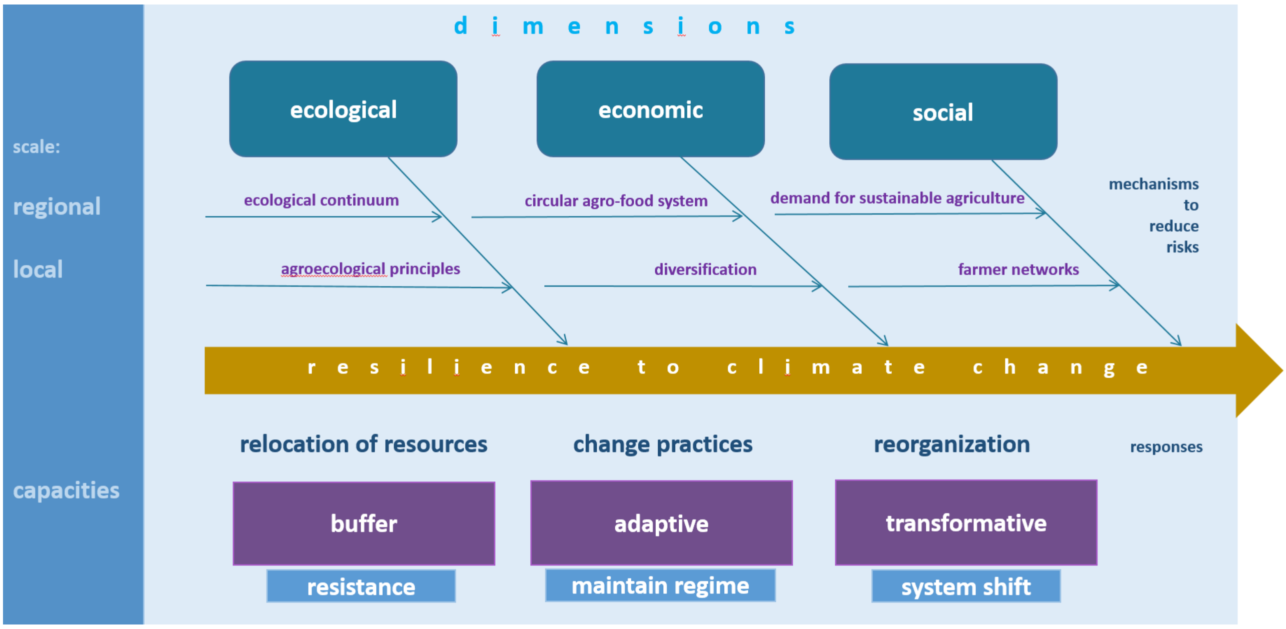

Figure 3 - The framework of resilience dimensions, mechanisms, responses and capacities developed in AGROMIX (from D1.1).

This framework was suggested as a reference knowledge for the entire AGROMIX community, to ensure a common understanding of the terminology and the related concepts.

3.2 The AGROMIX set of resilience indicators

Based on the analysis of the results of literature review and on the framework of resilience developed in Task 1.1, the task 1.3 of the project was deputed to develop a list of indicators of resilience to climate change applicable at AF/MF plot/farm/value chain level (see Deliverable 1.3).

3.2.1 The long list of indicators

A "long list" of 51 indicators of resilience was initially defined by declining in detail the three dimensions of resilience included in the framework.

3.2.1.1 Ecological Indicators

The long list of 27 ecological indicators initially selected in task 1.3 is reported in Table 1.

Table 1 - The long list of ecological indicators of resilience to climate change defined in Task 1.3 of AGROMIX (Source D1.3)

Dimension	Indicator	Link with resilience
Ecological	Crop species richness in time	A more diverse cropping system in time (crop rotation with a variety of crops that help to maintain soil quality, e.g., cover crops) and space (intercropping, agroforestry, landscape elements) leads to a more resilient system due to better soil health, slower pest outbreaks, spreading risks across a larger area and over more different crops.
	Crop-cultivar diversity	A more diverse cropping system making use of more varieties gives risk spreading due to the different degrees of vulnerability to pests and extreme weather events.
	Crop functional diversity in time and space	Crop diversity expressed not only in terms of species richness but also of functionality. Resilient systems are not only based on high number of crops but also of different kinds of crops and genotypes delivering a range of ecosystem services or tolerating the stresses in different ways.
	Vigorous crop species/varieties	Crop species and varieties have different vulnerabilities to pests and weather extremes. Choosing species and varieties that are vigorous, with resistances or high tolerance levels decreases the risks of large losses due to pests and extreme weather.
	Crop health (depending on management)	Managing your crops (and growth conditions) in such a way that they are healthy makes them better capable in dealing with stresses.
	Stability of production (based on variability of production)	The stability of production on a farm over time indicates that the system can adapt to yearly differences in conditions. If a crop or animal is under stress, their productivity reduces. Vice versa, if your system maintains productivity under stresses, it means that the crops/animals are resilient.
	Herd fertility	If an animal is under stress due to changing conditions and weather extremes, their fertility could be negatively influenced, which makes fertility an indicator for resilience.
	Morbidity	A morbidity rate above a certain threshold indicates that some property of the system might be less resilient or that management is poor. Morbidity is an early indicator for mortality.

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Dimension	Indicator	Link with resilience
	Use of preventive antibiotics	Not needing to use antibiotics preventative to maintain acceptable levels of morbidity and productivity could mean that the husbandry system is resilient.
	Multipurpose breeds of animals	A specialised breed is less able to adapt/transform to changing conditions and changing market demands and therefore less resilient to changes.
	Vigorous/robust breeds	Animal breeds have a different vulnerability to weather extremes. Choosing breeds that are vigorous and with high tolerance levels decreases the risk for decreased production or mobility due to extreme weather.
	Animal diversity	Growing more than one breed or types of animals or with different husbandry management can result in stabilisation of animal performances, diversification and robustness.
	Soil cover	Erosion, drought and excess water caused by extreme weather events can be countered by increased soil cover by plants or organic residue, and by doing so, maintaining soil quality and production capacity.
	Access to irrigation systems	Ability to adapt to drought makes the farm more resilient, because the crops are less dependent on rainfall during dry periods.
	Water storage	If enough water can be stored and buffered, the farm can better cope with droughts and by that, improving its resilience.
	Digital support systems	A digital support system (DSS, forecasting) for irrigation and pesticide application helps to act and adapt timely and accurately to events.
	Nutrient cycling	A strong internal and circular nutrient cycling improves resilience, because fewer external nutrients are needed and by that reducing the dependency on external markets. A good nutrient cycling will also benefit soil quality.
	Soil organic matter content	Soil organic matter content is a good indicator for soil quality. In general, soil quality can buffer climate stressors, but also makes it easier to transition to a new production system, for example with new crops.
	Soil compaction	Soil permeability determines whether the system is resilient to excess water and water erosion due to its influence of water infiltration and drainage. It is reduced by soil compaction.
	Soil crusting and cracking	Soil crusting reduces water infiltration thereby increasing runoff and erosion, which leads to poorer soil quality and water holding capacity. Without soil crusting, the system will be more resilient for extreme precipitation events and droughts.
	Soil moisture	If the soil can store more water, it makes the system more resilient to drought since the crops have more water available to stay alive.
	Soil biological quality	A good soil biological quality helps to cope with shocks and stresses by increasing the ability with which the soil can help against pest and diseases and provide nutrients and water.
	Inclusion of banker plants within the parcel (or other forms of habitat provision to natural enemies and/or pollinators)	The system is less vulnerable to pests and diseases; higher functional diversity increases chances of some species being able to counter impacts.
	Plantings to improve the microclimate and waterflows	Landscape elements can mitigate the effects of extreme weather events. For example, windbreaks reduce evaporation due to shade and wind-breaking which helps against drought, contour-planting of beetle banks or tree rows (e.g., agroforestry) can be used for improved infiltration and less runoff.

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Dimension	Indicator	Link with resilience
	Biodiversity (pollinators, natural enemies)	A biodiverse system is less vulnerable to pests and diseases; consequently, a higher functional diversity increases chances of some species being able to counter impacts.
	(Semi-) natural landscape structures	Providing habitat for biodiversity supports natural enemies and reduce the dependency on crop protection products.
	Connectivity of (semi-) natural landscape elements	Agroecosystems with high patchiness and connectedness results in more resilience due to functional diversity and providing a habitat for functional agro-biodiversity.

3.2.1.2 Economic indicators

The long list of 15 economic indicators initially selected in Task 1.3 is reported in Table 2.

Table 2 - The long list of economic indicators of resilience to climate change defined in Task 1.3 of AGROMIX (Source D1.3)

Dimension	Indicator	Link with resilience
Economic	Variability/stability of income/profit	A stable, predictable production and income is an indicator of resilience. Stability of performances over years is linked to management optimised for resource use efficiency and low exposure to risks.
	Market diversification / number of income sources	If more markets are served, the farm is less vulnerable if one of these markets collapse due to a shock or stress.
	% Direct sale to customer	Being less dependent on offtake from whole buyers, gives the farm more space to manoeuvre and find multiple markets for its products. Especially a mix of market channels is a risk mitigation strategy, which can be achieved by partially sell products directly to consumers.
	Contract with retailers	Having a contract to agree offtake of the production for an in advance agreed price assures income, even if the quality is less due to e.g., drought.
	Gross value added from crops	The gross value addition in monetary terms from various crop enterprises measure the performance of the farm. Calculated per ha/year. If this is more, the farm can earn income that can be used as a buffer in bad years.
	Gross value added from livestock	The gross value addition in monetary terms from livestock enterprises measure the performance of the farm. Calculated per ha/year. If this increases, the farm can earn income that can be used as a buffer in bad years.
	Non-farm income	Non-farm income is a measure of the existence of alternative avenues for income and livelihood in rural areas. If there is non-farm income, the enterprise is less vulnerable to highly variable production and income from the farm.
	Machine availability	Having own machinery, farmers can quickly respond to e.g., weather events and by that making sure most produce can be harvested on time.
	Resource use efficiency (productivity)	Being efficient with resources while maintaining productivity, makes the system relatively less dependent on external inputs and availability and prices of these inputs.
	Reliance on subsidies	Dependency on subsidies makes the farm vulnerable in case policies change. Being reliant on subsidies, it might be hard to recover if the subsidy decreases and be a profitable, future proof business.
	Debt and Loan	Being dependent on external capital makes the farm more vulnerable to the shocks or stresses as well as limit the capacity to adapt.

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Dimension	Indicator	Link with resilience
	Preventive investments	Investment on preventive technology (i.e., irrigation) makes the farm less exposed to the climate change.
	Reliance/dependency on external inputs	Self-sufficiency, reliance on natural resources internal to the agroecosystems make it more resilient / If inputs drop out (availability, prices, policies) and the farm is very dependent on them, it will be harder to achieve good production. This is also the case for feed for livestock: Being less dependent on feed from elsewhere, and by that reducing the reliance on external feed. If more own feed is produced, the farm is less vulnerable to markets stresses or crop failures.
	Fair pay for on-farm labour	Dependence on cheap labour can make you vulnerable because this labour is more likely to leave for more profitable opportunities and by that losing good employees.
	Land ownership	Owning the land as opposed to renting it may improve one's willingness to take care of it in the long term, e.g., improve soil quality. A better soil quality improves resilience of the farm, since shocks and stresses can be overcome by crops.

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3.2.1.3 Social indicators

The long list of 9 social indicators initially selected in Task 1.3 is reported in Table 3.

Table 3 - The long list of social indicators of resilience to climate change defined in Task 1.3 of AGROMIX (Source D1.3)

Dimension	Indicator	Link with resilience
Social	Frequency and quality of training	The more training, the better the farmer is aware of threats and the better (s)he can prepare for future changes because the farmer has more knowledge on how to cope with that
	Cooperation/collaboration with other producers / sale organisations	Through cooperation, difficulties can be compensated by a partner, or a group of farmers can be better organised, making them more resilient to changing situations
	Farmer competences	Knowledge, skills and attitude of the farmer determines his/her adaptive capacity and ways to handle difficult periods with shocks and stresses.
	Access to extension service	Good access and use of advisory services indicate that the farmer will be better able to cope with climate change. The advisor can help a farmer prepare to shocks.
	% of area under agriculture insurance	Reflects the back-up support for falling back in case of risk exposure. The insurance can help the farm business to survive a year with difficulties and makes it possible that the farm can adapt to climate changes.
	Level of social organisation	The better organised, the more power the farmers have in negotiations with other value chain parties and policy makers. They can gain from good deals and invest in getting ready for the future.
	Farmer/social networks	More networks stimulate more knowledge/ideas/capacities and improves more resilient. Openness/quality op networks is also important. The more open, the more experiences and knowledge will be shared.
	Inclusion of diverse knowledges and voices in decision making	Diverse knowledge makes the farmer better able to make suitable decisions in the face of climate change, like adapt practices or smart investments.
	Agency of farmer	The extend a farmer can make its own decision, determines if the farmer can adapt to changes or is within a lock-in. The higher the agency, the more adaptive the farmer can behave, the more resilient it will become.

3.2.2 The short list of indicators

The aforementioned indicators were then refined based on the application of the following inclusion criteria:

- *The indicator has a strong link / rationale with resilience. This means that a change in the indicator score, means a change in resilience (in one of the three resilience dimensions: ecological, economic, social).*
- *The indicators score needs to be changeable by management choices on the farm itself within 5 to 10 years.*
- *The indicator must be suitable to be translated into an AMOEBA diagram-model. This requires a categorisation of the indicator's score on ordinal scale of 1 – 5., where 5 mean the highest score, and thus a higher resilience on this aspect.*
- *The indicator needs to have a target value, to be able to link the score to the level of resilience. If no target value was available for relevant, it was drafted together with experts.*

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After the application of the criteria, a final concise list of 17 resilience indicators was defined as it follows (Table 4).

Table 4 – The final list of 17 resilience indicators selected in AGROMIX Task 1.3.

	Nr	Indicator
Ecological	1	Grass species diversity
- farm-specific	2	Arable crop diversity
	3	Animal herd fertility
	4	Animal diversity
Ecological	5	Variability of production
- general	6	Herbaceous soil cover
	7	Soil organic matter
	8	Soil compaction
	9	Plant available water
	10	Trees and shrubs
	11	Sufficient irrigation
Economic	12	Number of income sources
	13	Dependencies on external inputs
	14	Greenhouse gas emissions
Social	15	Memberships to networks and cooperatives
	16	Frequency of training
	17	Short supply chain

3.3 How resilience of AF/MF was tackled in AGROMIX

One of the main objective of AGROMIX was to assess the different dimensions of resilience of AF/MF systems, based on real data coming from a network of experimental core sites (WP3) and a series of pilot case studies, in which AF/MF have been participatorily co-designed (WP2) and co-assessed (WP4) by multi-stakeholder groups. Besides these experimental case studies, AGROMIX also assessed socio-economic resilience of AF/MF systems at the level of value chains (WP5) and evaluated the current and future policy frameworks (WP6). Throughout all these activities, specific and targeted communication activities took place in WP7 to disseminate the acquired knowledge to a broader audience.

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3.3.1 WP2

In WP2, the 12 pilot case studies were co-designed by local multi-stakeholder groups, applying a common methodology. The characteristics of the pilot cases and the process through which these pilots were generated are reported in the Deliverable D2.4. This WP provides a unique opportunity to put scientists in stakeholders' shoes and to get an overview of the different perceptions and weights given by stakeholders to the different dimensions of resilience explained in AGROMIX framework. The co-innovation process followed by WP2 generated also data to evaluate the effectiveness of the set of resilience indicators produced in Task 1.3.

3.3.2 WP3

This WP was the scientific core of the project, where AF/MF systems were deeply studied in terms of ecological resilience to actual and future climate scenarios. The ecological dimension tested in the WP included biophysical indicators of microclimate, crops, soils, animals, as well as non-target biodiversity elements, e.g. birds, bats, soil microflora, spiders, wild flora. Resilience to differing climate scenarios of different AF/MF management options was tested through the use of virtual experiments conducted by a modelling approach. The activities conducted in this WP were particularly important to test the actual ecological resilience of AF/MF and to verify the effectiveness of the ecological resilience indicators selected in Task 1.3.

3.3.3 WP4

The WP conducted a multicriteria participatory assessment of the pilot cases co-designed and co-developed in WP2. The assessment was based on a common multicriteria method, including the most relevant sustainability and resilience indicators, among which also some related to the ones selected in AGROMIX (Task 1.3). This self-assessment of the pilot cases offers the opportunity to test the applicability of AGROMIX indicators in multi-stakeholder co-assessment exercises conducted on AF/MF systems.

3.3.4 WP5

In WP5, a socio-economic evaluation of the resilience of AF/MF systems at the level of value chains was carried out, involving all the major stakeholder groups represented in the value chains. Including WP5 in the revision of AGROMIX outcomes enables assessing the adherence of socio-economic resilience dimensions and indicators defined in WP1 when applied to real AF/MF systems, in their actual socio-economic context.

3.3.5 WP6

WP6 deeply analysed how AF/MF systems are affected or could be affected by, respectively, current and future policy scenarios. Hence, this WP allows to test the performances of both the AGROMIX framework of resilience and the indicators from the point of view of policy makers and relevant actors affected by policies in the AF/MF sector as well as influencing the development of such policy instruments.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 862993.

3.3.6 WP7

WP7 Is the communication and dissemination WP of AGROMIX, which developed a complex communication plan and tools to tackle the challenge of spreading knowledge on AF/MF generalities and impacts based on background and new knowledge generated by AGROMIX. As such, this WP is the bridge between the AGROMIX consortium and the community of its target stakeholders. Analysing WP7 activities may allow also to test the communicability of both the framework and the indicators of resilience across different target groups of stakeholders.

3.4 The aim of Task 1.5

Within WP1, the aims of Task 1.5 were:

1. To revise project outcomes and analyse whether the results support the hypothesis that AF and MF systems are more resilient to climate change than specialised systems
2. To revise through a participatory approach based on evidence collected, the framework of resilience developed at the beginning of AGROMIX in Task 1.1
3. To assess the efficacy of the use of the resilience indicators selected in Task 1.3 and eventually suggest potential improvements for their application to AF/MF systems.

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4 Methodology and Results

4.1 Task 1.5 as a forum for the entire project community

From the GA: “*This task will gather main results from all the other WPs and analyse with a participatory, interdisciplinary approach the results achieved in the project in dedicated workshops with WP leaders and stakeholders. In particular, it will be analysed how the co-designed pilots (WP2), the case studies (WP3) and economics and value chains (WP5) could be evaluated in respect to the resilience framework (task 1.1) and indicators (tasks 1.2 and 1.3). This analysis will be conducted qualitatively (e.g. SWOT analysis) and/or quantitatively (e.g. multi-criteria assessments how the case studies and the pilots relate to each resilience dimension identified in the conceptual framework and using the resilience indicator system). In the light of this analysis, the resilience framework and indicators to be applied to MF/AF systems could be possibly revised and integrated to generate an improved theoretical system fed by real measures and assessments, but also to identify potential new knowledge gaps*”.

In a broader sense, the task was designed to become a sort of forum for the entire AGROMIX community, a place to gather impressions and feedback from the project actors (“bottom-up”) and to host general/theoretical reflections (“top-down” approach) based on which a revision of the framework of resilience and the related list of resilience indicators may occur (Fig. 4).

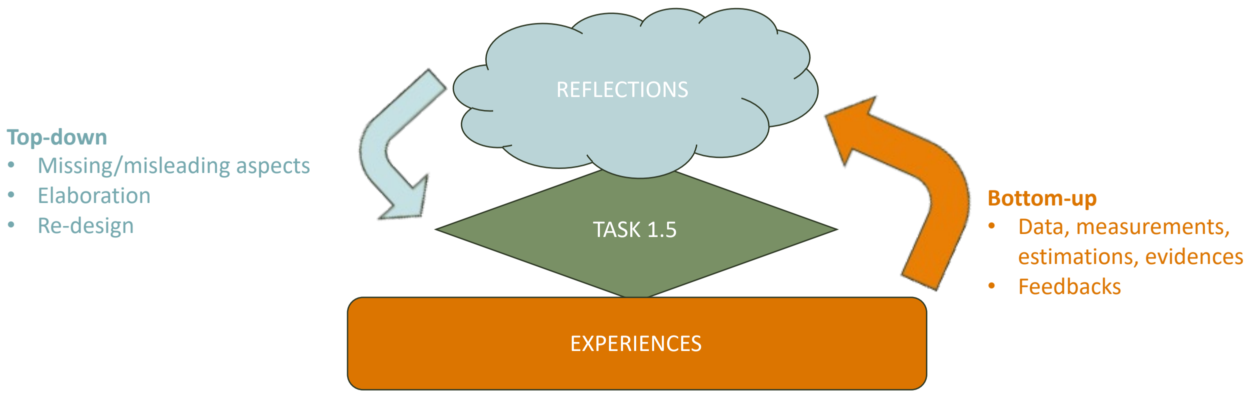

Figure 4 - Task 1.5 as a forum for the entire AGROMIX community

The approach of the task adheres to the multi-actor approach, by engaging the entire AGROMIX community (Fig. 5).

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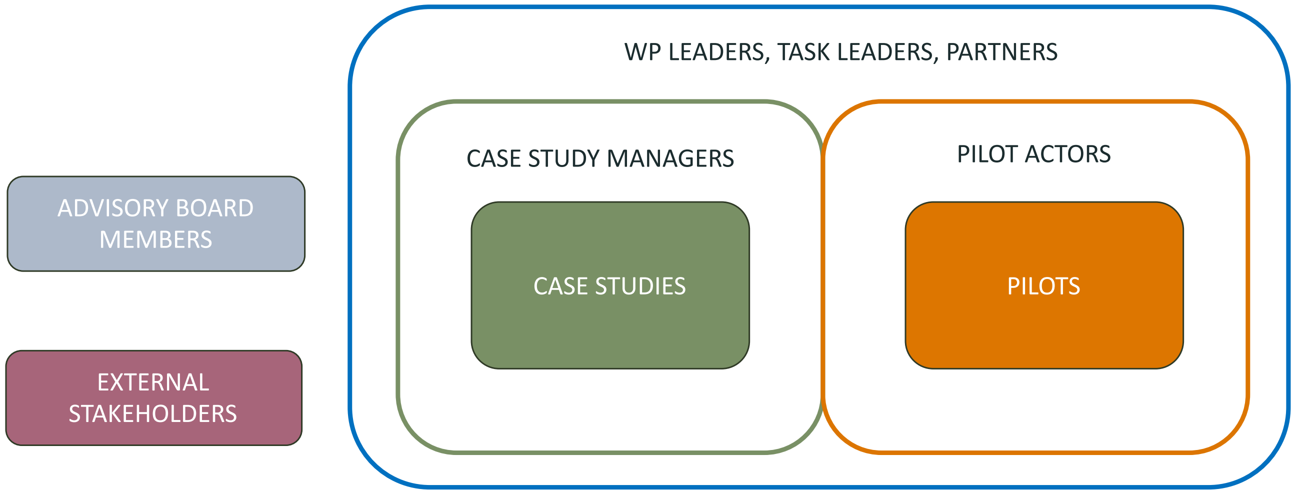

Figure 5 - The AGROMIX community members engaged in the analysis conducted in Task 1.5

The approach followed in Task 1.5 is shown in Figure 6. As a first step, the contribution from WP leaders of AGROMIX was requested to provide feedback on the general development of the project through a SWOT analysis, followed by an assessment of the framework and of the list of resilience indicators originally developed under WP1. The results of this first internal check have been jointly presented to WP leaders and external stakeholders through a dedicated online workshop, aimed to conduct a participatory co-assessment of the project outcomes and to the co-improvement of the framework and the list of indicators.

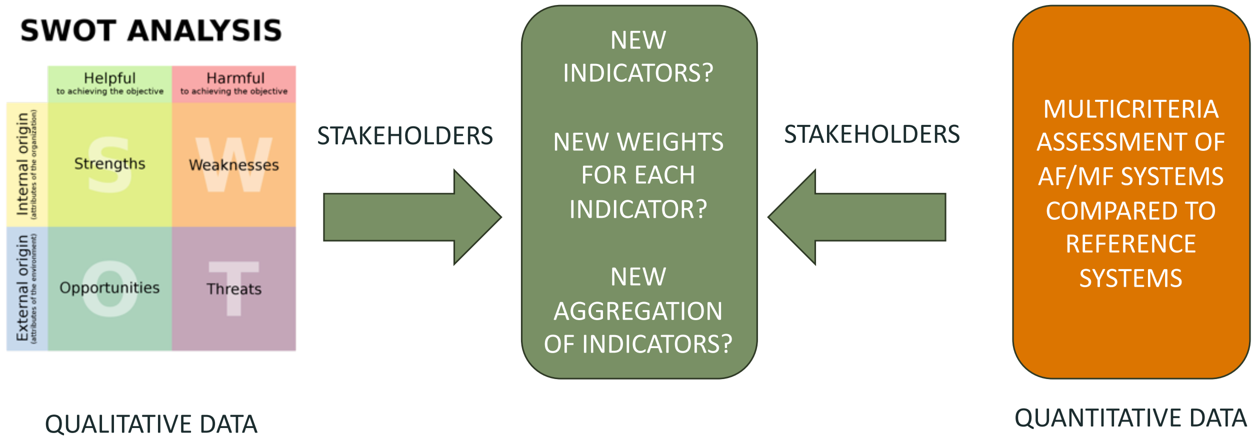

Figure 6 - General approach followed in Task 1.5

The first step followed in the task comprised an online survey conducted on MS-Form in August-September 2024 and addressed to WP leaders (plus eventually key task leaders and WP participants identified by the WP leader). The survey was customised for each WP but included three common sections:

- SWOT analysis: the WP leaders were asked to conduct a personal SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of their own experience in AGROMIX, by filling a MS-PowerPoint template;

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- Assessment of the framework of resilience developed in Task 1.1: this constituted the Section A of the MS-Form sent to each WP leader. The aim of this analysis was to know from the WP leaders whether the framework was well understood and fitted the activities in their respective WP. Furthermore, a pair comparison of the relative importance of the different dimensions of resilience in the specific activities conducted in the WP was conducted. A last series of questions aimed at knowing which mechanisms of resilience were identified in the WP was finally included;
- Assessment of the list of indicators of resilience developed in Task 1.3: this constituted the Section B of the MS-Form sent to each WP leader. This specific section was adapted to the content of each WP.

The survey and the participatory co-assessment of the project outcomes were conducted by tailoring specific tasks and questions according to the different contents and specificities of the WPs.

4.1.1 WP2

Overall, the contribution expected from WP2 "SYSTEMS DESIGN AND SYNERGIES" was as depicted in Fig. 7. Particularly, the WP2 leader was asked to report on which ecological, economic and social resilience indicators included in the short or long list set in T1.3 the participatory design and the assessment of AF/MF pilot cases relied upon. Furthermore, it was asked also why some indicators were discarded or not used in the WP (i.e., because not appropriate or simply not affordable). The WP leader had to report also on the preference of each indicator for each stakeholder category identified (e.g., farmers, processors, retailers, advisors, consumers, policy makers, industry representatives, other actors).

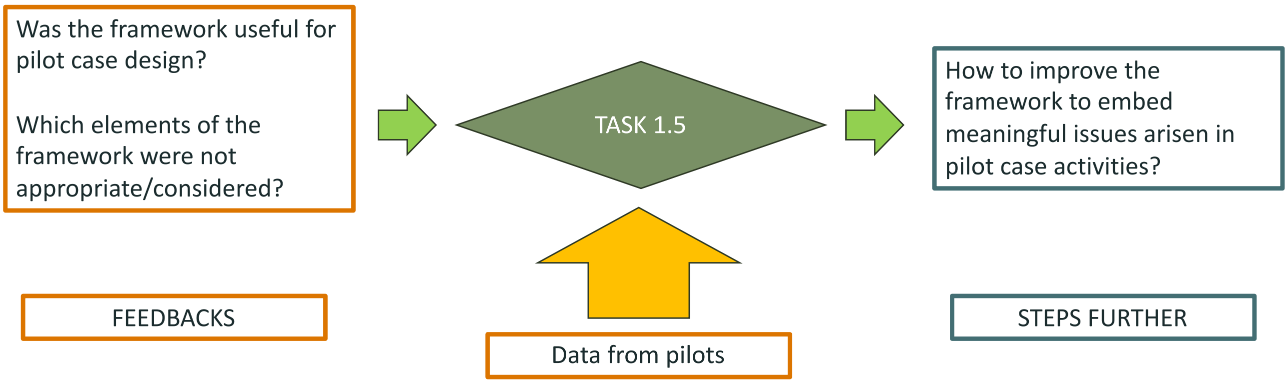

Figure 7 - Expected contribution from AGROMIX WP2

4.1.2 WP3

WP3 "BIOPHYSICAL INDICATORS AND SCENARIOS" is the experimental core of AGROMIX, where the resilience of AF/MF systems was assessed in a network of core experimental sites where field experiments were being carried out. The effect of future climate and AF/MF management scenarios was also assessed in virtual (modelling) experiments. The core site sub-section included questions related to the assessment of the set of ecological resilience indicators, split by:

- water and microclimate resilience;
- environmental resilience;
- biodiversity enhancement.

In addition to the assessment of the use of indicators, for WP3 it was possible also to investigate the trends of the results achieved by applying each indicator in the task.

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As for WP2, it was asked also why some indicators were discarded or not used in the WP (i.e., because not appropriate or simply not affordable). This applied to both core site experiments and virtual experiments. The contribution expected from WP3 is shown in Fig. 8.

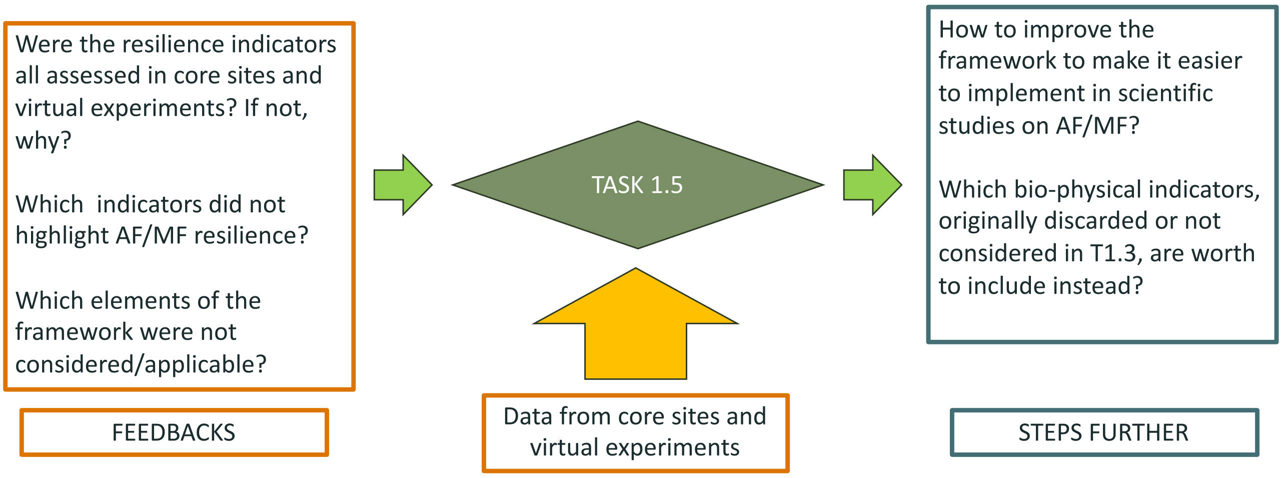

Figure 8 - Expected contribution from AGROMIX WP3

4.1.3 WP4

WP4 "PARTICIPATORY RESEARCH AND TOOLS FOR CLIMATE-SMART TRANSITION" offered the opportunity to test the framework and the set of indicators in the frame of real pilot cases, animated by stakeholders, that were engaged in a multicriteria assessment of the pilot cases (D4.1). The survey addressed to WP4 leader aimed to collect also information on the trend of resilience and sustainability of AF/MF-based pilot cases in ex-ante and ex-post stages, as well as on key stakeholders to engage for the assessment of AF/MF systems. The contribution expected from WP4 is shown in Fig. 9.

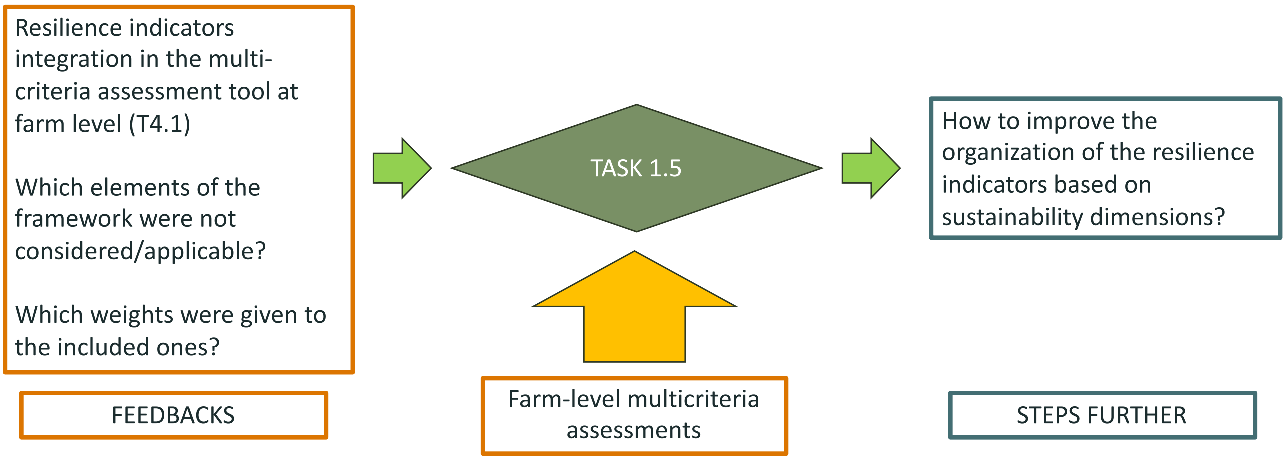

Figure 9 - Expected contribution from AGROMIX WP4

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4.1.4 WP5

WP5 “SOCIO-ECONOMIC, VALUE CHAIN AND NETWORK ASSESSMENT” moved the focus to value chains instead of farm systems. In the survey, the WP5 leader was asked to assess the importance of the economic and social resilience indicators at farm and value chain level, as well as in relation to future policy development.

The contribution expected from WP5 is shown in Fig. 10.

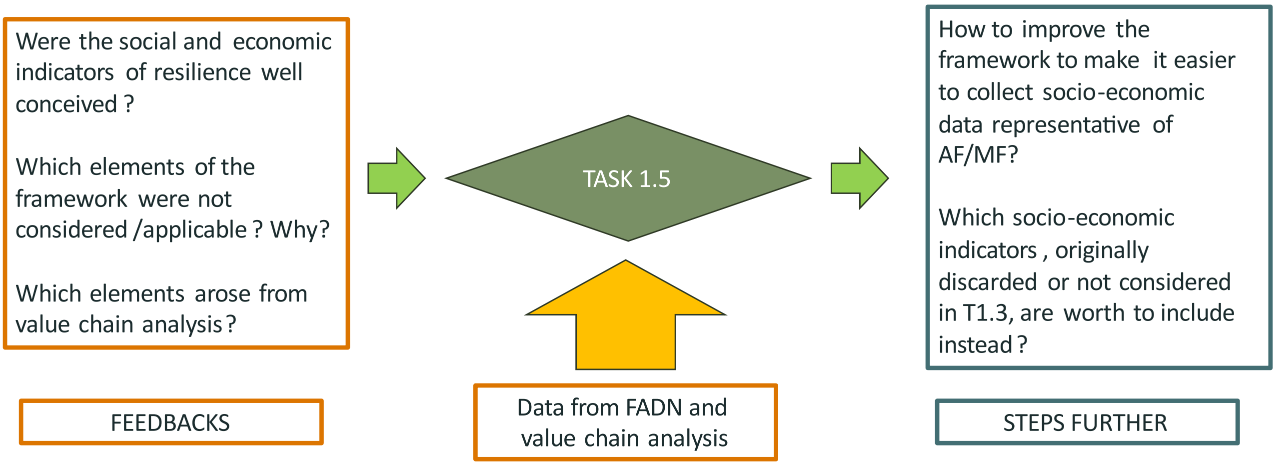

Figure 10 - Expected contribution from AGROMIX WP5

4.1.5 WP6

WP6 “POLICY CO-DEVELOPMENT” focused on current and future policy scenarios, regulating AF/MF systems. In this case, the WP leader was asked to assess the relative importance of each indicator in current and future policies on AF/MF.

The contribution expected from WP6 is shown in Fig. 11.

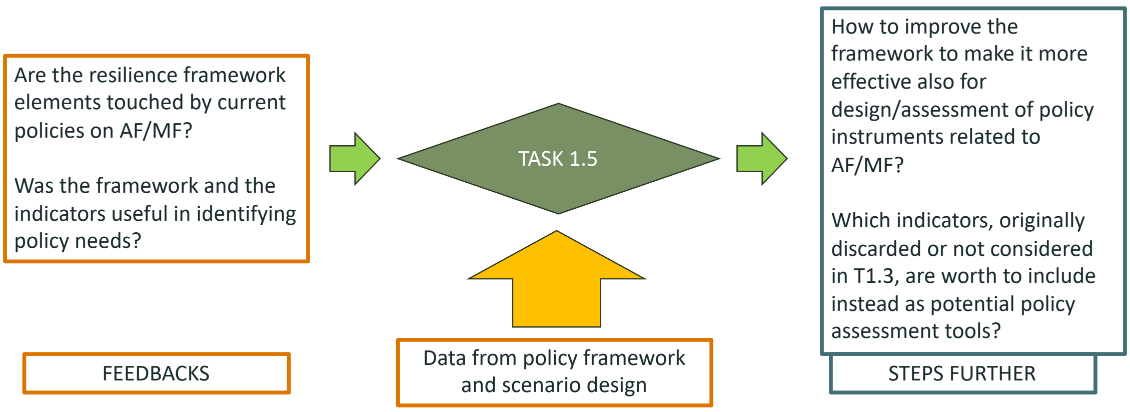

Figure 11 - Expected contribution from AGROMIX WP6

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4.1.6 WP7

WP7 "COMMUNICATION, DISSEMINATION AND EXPLOITATION" is the communication WP of AGROMIX. The aim of the survey in this case it was to know how easy was to communicate each resilience indicator and how they were perceived by the different categories of stakeholders targeted by AGROMIX.
The contribution expected from WP7 is shown in Fig. 12.

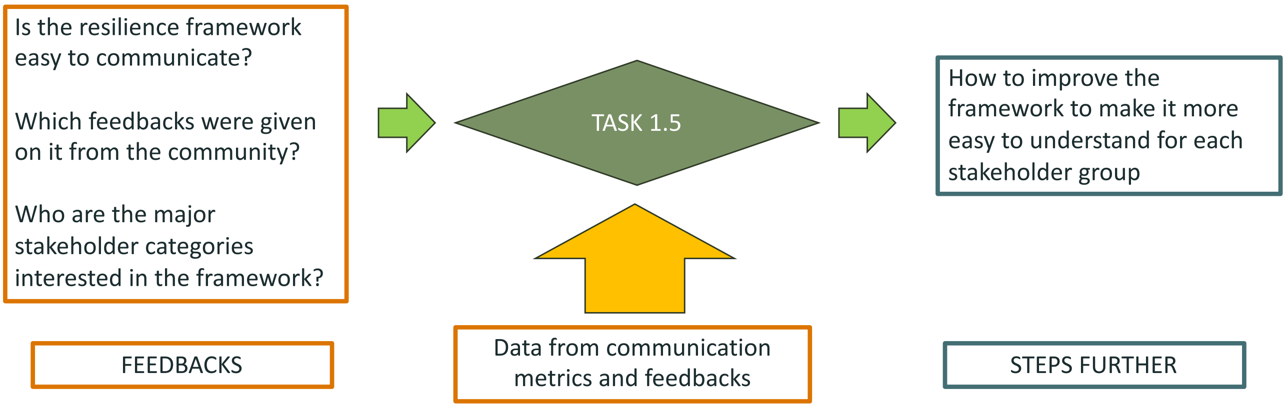

Figure 12 - Expected contribution from AGROMIX WP7

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4.2 SWOT analysis

4.2.1 Methods

One of the aims of Task 1.5 was to let the project consortium assess the achievements of the project and its strengths and weaknesses. To do that, a SWOT analysis was organised by inviting the WP leaders to answer the following guiding questions by entering text in the PowerPoint table:

Template

S	INTERNAL STRENGTHS
1	What was our advantage/ our best expertise?
2	What were we more efficient at?
3	What could we do in less time?
4	What makes us stand out?
5	…
6	
7	

W	INTERNAL WEAKNESSSES
1	Where did we have less/ lack of expertise?
2	Where did we lack efficiency?
3	Where did we waste time and resources?
4	What were we criticized about?
5	…
6	
7	

O	EXTERNAL OPPORTUNITIES
1	What ideas did we get from other WPs or outside the project?
2	What could we create or do better?
3	What new methodology/ technology could we use?
4	…
5	
6	
7	

T	EXTERNAL THREATS
1	Did we experience changes that influenced us?
2	What constraints did we meet?
3	What social changes could threaten us?
4	…
5	
6	
7	

Figure 13 - Guiding questions for the SWOT analysis conducted at each WP level

The answers of the WP leaders were commented and integrated during the task 1.5 meeting held on October 31st, 2024. During the same meeting, the participants were asked to compile strengths, weaknesses, threats and opportunities at whole project level.

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4.2.2 Results

4.2.2.1 WP2

The WP2 leader highlighted the involvement of an extensive multi-stakeholder network as the major trait of the WP. This was considered to be, on one hand, as one of the major strengths of the WP thanks to huge level of collaboration among scientists and the other actors mobilised for the participatory design of pilot AF/MF case studies. This level of collaboration ensured flexibility and the opportunity to overcome the challenges imposed by the COVID-19 pandemic. On the other hand, the high heterogeneity of the stakeholder groups was considered also as a challenge, as it was not an easy task to find solutions suitable for everyone in the local teams. Anyway, the positive current socio-political opinion about AF/MF represents a clear opportunity to develop further such complex systems, accounting also on a strong cooperation of stakeholders.

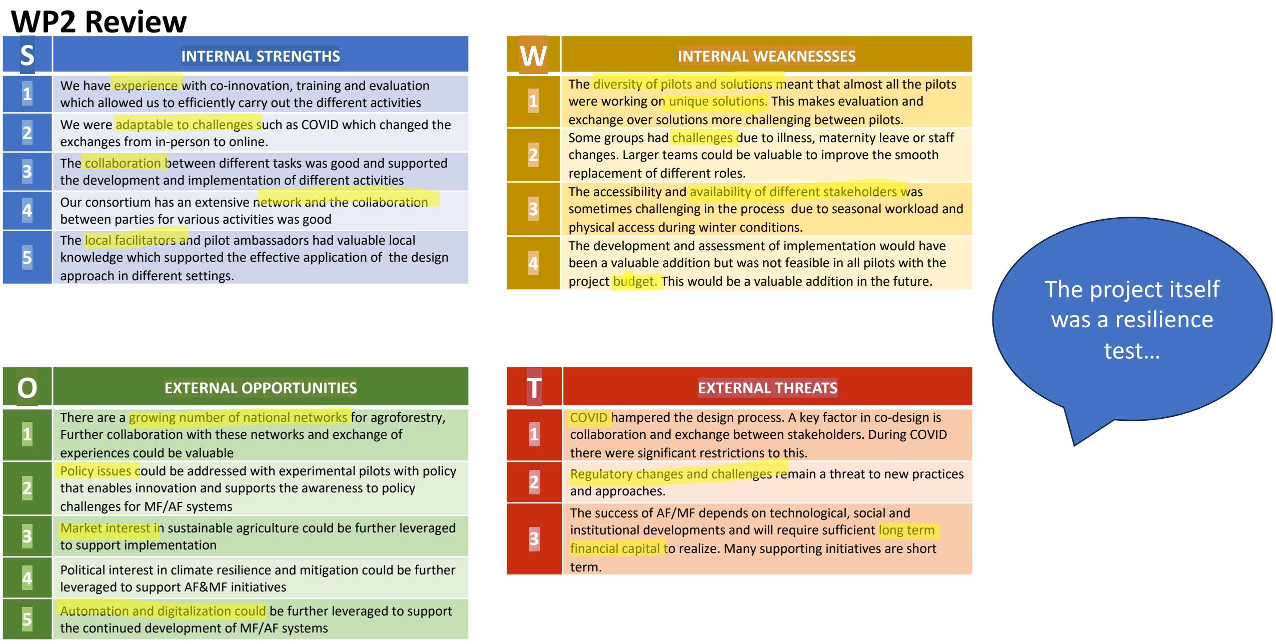

Figure 14 - SWOT analysis conducted by the WP2 leader

4.2.2.2 WP3

The WP3 represented the experimental core of the project. According to its leader, the major strength of the WP was the implementation of a multifaceted approach to the study of AF/MF systems, involving classical biophysical samplings/assessments done on the 8 core sites, coupled with the modelling that allowed for the conduction of virtual experiments to test AF/MF systems against future climate scenarios and to assess the long-term effects on the cycles of carbon and nitrogen that were not possible in the time frame of the project. Also for WP3, the COVID was considered the biggest threat as it hampered the regular access to field experiments and facilities of research team members, but also it weakened the interactions among partners. From a theoretical point of view, the unclear concept of mixed farming provided by the current regulations was considered an obstacle for a deep analysis of such systems in the WP.

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WP3 Review

S	INTERNAL STRENGTHS
1	Eight core sites with long-term empirical data
2	Broad expertise: Animal husbandry, agronomy, forestry, biodiversity, modelling, landscape ecology, climatology,
3	The agroforestry models were further developed and new users actively use them now
4	We managed to empirically test effects of agroforestry on biodiversity and livestock production/animal welfare
5	We provide modelling results on climate resilience in combination with virtual experiments
6	We corroborate the results with expert evaluations on strengths and weaknesses of agroforestry
7	Continental scale results with target regions for agroforestry and an interactive website

W	INTERNAL WEAKNESSSES
1	Mixed farming was poorly covered, also due to its unclear definition
2	The statistical modelling approach remained unclear and didn't trigger much active participation
3	Two PhD students suffered from burnout and were out of work for long periods

Definition of mixed farming unclear…

O	EXTERNAL OPPORTUNITIES
1	There was not much interaction with the other WPs.
2	The modelling workflow that was established could be applied to additional sites and support the co-creation process / the pilots
3	The agroforestry models could be further popularized among students with at additional institutions

T	EXTERNAL THREATS
1	Slow start due to Covid. We had to coordinate research protocols with colleagues that we never met before. It's a major success that we actually managed!
2	Mixed farming is poorly defined. It is unclear also if it is always advantageous. It remained conceptually unclear

Figure 15 - SWOT analysis conducted by the WP3 leader

4.2.2.3 WP4

For WP4, similar thoughts as for WP2 were expressed by the WP leader. Additionally, it was reported how marginal areas, which are considered so far one of the land categories most prone to be used to expand AF/MF systems, are suffering from big environmental and socio-economic pressures that are leading to depopulation and land abandonment. This could lead in the future to a reduction in the estimates of AF/MF expansion.

WP4 Review

S	INTERNAL STRENGTHS
1	Collaboration Between WP4 and WP2
2	Effective Collaboration Among Co-Design Pilots
3	The ability to pivot to online platforms during the pandemic was a notable achievement. Despite the initial challenges of remote working, the project managed to keep momentum through virtual meetings and collaborations
4	A key factor driving the success of the project has been the high level of productivity among participants. Some partners possessed expertise in participatory research methods, sustainability and resilience concepts, which enabled them to support and guide others.

W	INTERNAL WEAKNESSSES
1	The pilots spanned a wide range of farming systems and stakeholder groups, which made it difficult to develop a one-size-fits-all methodology. The varying contexts required constant adaptation of tools and processes, sometimes leading to delays
2	While virtual meetings sufficed for many aspects of the project, the lack of in-person interaction hindered the development of deeper working relationships and reduced opportunities for spontaneous collaboration.
3	Managing relationships with multiple stakeholders simultaneously was a complex task, particularly given their differing priorities and expectations. This added pressure to the research process, requiring careful negotiation and balancing to ensure that all voices were heard and considered, which sometimes delayed decision-making

Marginal areas are a big threat..

O	EXTERNAL OPPORTUNITIES
1	Europe has a rich tradition of agricultural knowledge, which provides a strong foundation for the development of future sustainable agricultural systems.
2	The increasing need for sustainable agricultural systems across the EU offers a timely opportunity for this project. Climate-smart transitions are not only a policy priority but also a societal and environmental imperative.
3	There is a rising interest in mixed farming and agroforestry systems, both recognized for their potential to enhance biodiversity, resilience, and carbon sequestration. The project's focus on these systems aligns well with emerging trends and offers an opportunity to influence future agricultural policies and practices in the EU.

T	EXTERNAL THREATS
1	The limitations imposed by the COVID-19 pandemic, particularly during the initial phases, slowed down some activities and hindered in-person engagements, which are often crucial in participatory research.
2	The lack of a clear and consistent policy direction from the EU Commission regarding climate-smart agriculture has been a significant challenge. Uncertainty in regulatory frameworks and support mechanisms complicates long-term planning and the implementation of sustainable farming systems.
3	One of the major threats to the project impacts lies in the low productivity and economic sustainability of farming in marginal areas. These regions, often the focus of mixed farming and agroforestry systems, face challenges such as limited infrastructure, and financial viability. If these systemic issues are not addressed, the project's long-term impact in these areas could be undermined.

Figure 16 - SWOT analysis conducted by the WP4 leader

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4.2.2.4 WP5

The leader of the socio-economic WP pinpointed in his analysis on the real strengths and weaknesses of the AF/MF systems, rather than of the WP itself. The major strengths were identified in the differentiation of farm products, high human capacity and resilience to market fluctuations. In addition to general policy instruments, AF/MF systems were found to be enhanced also by new emerging market opportunities, such as carbon credits, dedicated certification and branding schemes, supply chains reform and an impulse in short supply chains, which could make consumers more aware about the impact of AF/MF systems. Among weaknesses, the high levels of production, administration and labour costs linked to AF/MF systems were considered the most negative aspect. Interestingly, systems including livestock were found to be more cost-intensive and more efficient integration of livestock in AF systems was claimed. Furthermore, the high heterogeneity among countries was considered to be a potential barrier for the development of common policy instruments at EU level.

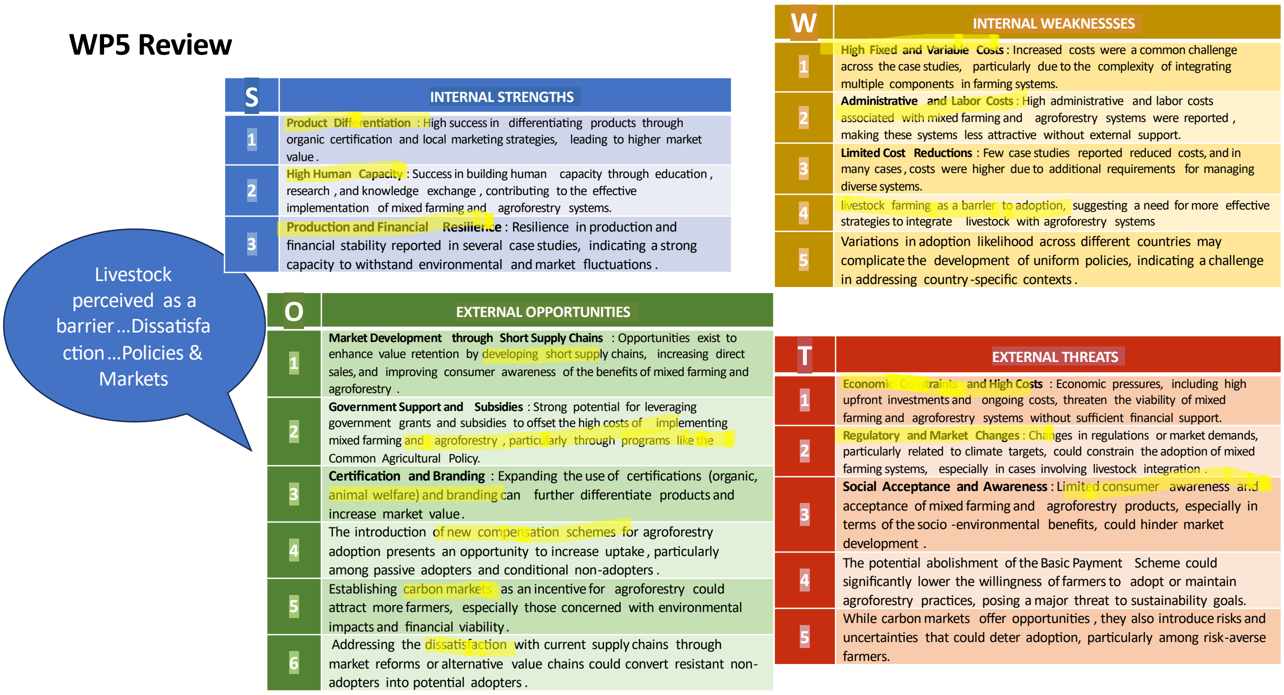

Figure 17 - SWOT analysis conducted by the WP5 leader

4.2.2.5 WP6

The leader of WP6 contributed to the whole project SWOT analysis as the whole project has overall policy relevance (see 5.1.2.7).

4.2.2.6 WP7

In the communication and dissemination WP, there was a good commitment of all the partners, thanks also to the specialisation in communication activities of the WP leading organisation. The good scientific papers and communication/dissemination material produced in the project got good feedback from the external audience and let the project reaching many stakeholders. There is still room for enhancing the communication material through the transformation of the deliverables of the project into material adapted to general audience. COVID-19 pandemic was listed as one of the weakening factors of the project, increasing

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the distance between the project consortium and the target stakeholders. Interestingly, the increasing use of artificial intelligence is seen as a threat to make profitable use of the project outcomes. Social media tendencies were also considered a barrier for science-based material.

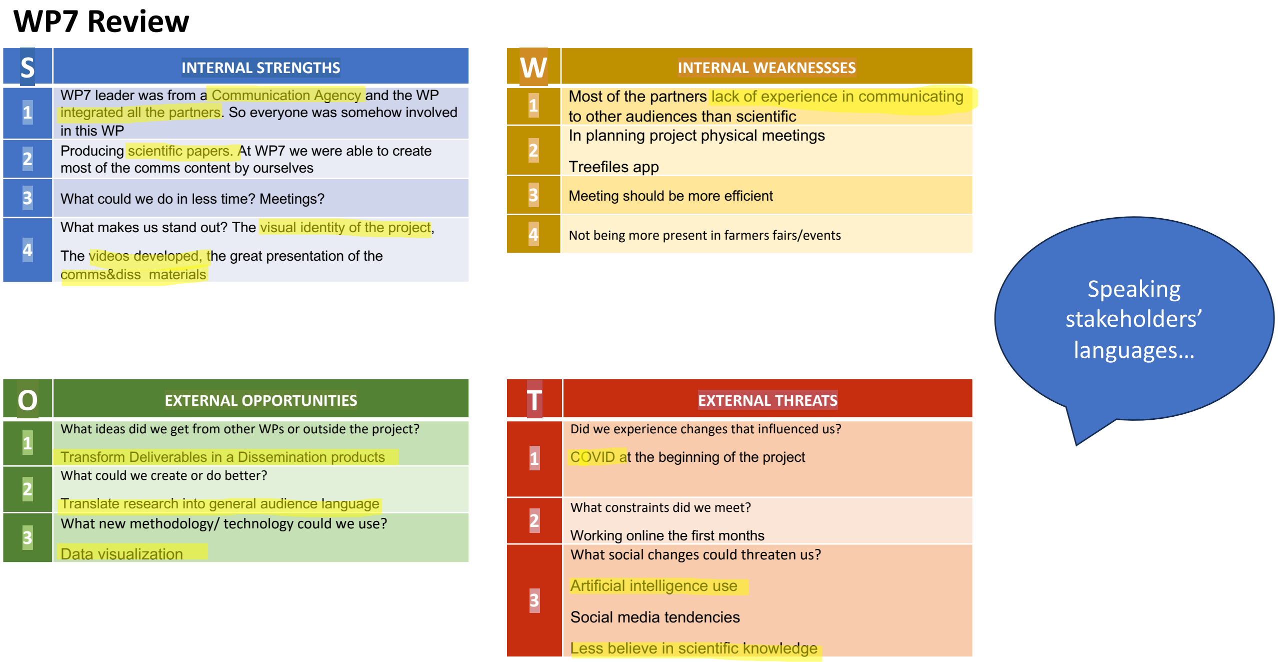

Figure 18 - SWOT analysis conducted by the WP7 leader

4.2.2.7 Whole project analysis

During the final task meeting, the WP leaders and the project leader, together with some stakeholders, made an overall assessment of the project. The major strengths identified were: **i) the heterogeneity of the consortium**, expressed both in terms of type of expertise and locations (i.e., different pedo-climatic and socio-economic contexts); **ii) the complexity of the AF/MF experiences** constituting the experimental network of AGROMIX; **iii) the flexibility and adaptability of many activities**, including the **participatory design** and assessment of AF/MF systems with **pilot cases** actors.

A critical analysis of the project implementation led to identifying also **8 major weakness aspects**. The COVID-19 pandemic was considered to have hampered the structuration of solid and regular interactions among partners and WPs. This happened especially at the beginning of the project, that was considered to be a key moment for a project success. From a theoretical point of view, the difficulties to find ground on clear and common definitions of AF and MF systems were identified as one of the biggest weaknesses of the project. Also the agroecological aspects of AF/MF systems were not clearly defined nor **homogeneously perceived** by all the consortium, leading to limited exploitation of project results in the frame of the agroecological transition of EU farming sector. Another limit of the project was its aim to tackle resilience at different spatial scales along value chains, that was a real challenge due to budget and time constrains. There were also little interactions externally to the project, namely with other similar EU-funded projects, leading maybe to reduced impact of project outcomes because of lack of synergy.

On the opportunities side, the experimental site and stakeholder networks created in AGROMIX were considered as a lever to ensure a legacy of the project and thus would worth further efforts to make them still alive after the project end. Finally, among threats the workshop participants identified in the **short duration of the project** (4 years instead of 5) and in the **limited resources** (stretched over 27 partners) available as factors having affected the final results and achievements of the project. This impacted on less

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intensive research efforts to assess the climate change resilience of MF compared to AF systems. It was also seen as unrealistic in the call text to tackle AF and MF with the same intensiveness and the overall focus of **AGROMIX more on AF, and sister project MIXED more on MF**, may be seen as a beneficial mitigation to this threat coming from the call text. While AGROMIX aimed to monitor the existing long-term agroforestry experimental sites, it only had 2-3 season to do this, therefore a **long-term planned monitoring** of agroforestry was not possible. However, the sites can be further exploited in future projects.

Whole Project Review

S	INTERNAL STRENGTHS
1	When we had possibility to meet in person, it was great opportunity to see AF from different perspectives (>> exp. platform)
2	Different perspectives/opinions/understanding of agroecology and AF/MF agroecological aspects
3	Huge variety of experiences/expertise….lot of training received
4	Flexibility of many activities (e.g. pilot)

W	INTERNAL WEAKNESSSES
1	Mixed farming definition/assessment not covered at all (most people more confortable /familiar working on AF than MF)
2	Low interactions among WPs in working on framework (too theoretical?) and indicators on more regular basis
3	Knowing little about how the results were generated
4	Little interactions with other EU -funded projects dealing with AF
5	Time constraints
6	Difficult to assess resilience at different spatial scale in value chains
7	Difficult to rely on solid and clear definitions of AF/MF
8	Different perspectives/opinions/understanding of agroecology and AF/MF agroecological aspects

O	EXTERNAL OPPORTUNITIES
1	After the finish of AGROMIX, to share with other similar projects to feed them with the project outcomes, experiences and achievements
2	Keeping alive the network of experiments (the experimental platform)
3	Lessons learned useful for future

T	EXTERNAL THREATS
1	Short time funding, no long -term planning for research and stakeholder group
2	Wars, COVID complicated a lot the development of project activities (not prepared for it)
3	Lack of personal interaction at the beginning of the project (e.g., virtual KOM)
4	Unrealistic to tackle AF and MF with same intensiveness
5	Low support by University for research activities (also in terms of resources)
6	Time in between project writing and start (no freedom to adapt the predefined case according to the developing and emerging issues and methodological aspects)

Figure 19 - SWOT analysis conducted by the WP leaders at whole AGROMIX project level

4.3 Improvement of the framework of resilience to climate change

4.3.1 Background and objectives

The main objective of the AGROMIX project was stated as: "Deliver participatory research to drive the transition to resilient and efficient land use in Europe". The project addressed all key dimensions of resilience: ecological, economic, and social. To foster innovation across diverse contexts, the technological dimension was also explored. Within the predefined and overarching topics of the work packages (WPs), the scope of specific tasks was narrowed to focus on more targeted issues within these dimensions.

In developing the theoretical framework for resilience, WP1 proposed conditions under which agroforestry (AF) and mixed farming (MF) systems demonstrate greater resilience to climate change-induced shocks and stresses compared to conventional farming practices. For practical application, WP1 aimed to define specific mechanisms within each resilience dimension to reduce the risks associated with climate change when using AF and/or MF systems.

During the review process, Section A of the T1.5 survey focused on three objectives:

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1. To evaluate the clarity and comprehensibility of the resilience framework developed in WP1 (D1.1).
2. To assess whether the work processes of the WPs were balanced across the three main resilience dimensions—ecological, economic, and social—or if any dimension was disproportionately prioritised.
3. To identify specific mechanisms relevant to reducing climate change risks through AF/MF systems, as derived from the research tasks undertaken by the WPs.

The first objective — ensuring the framework's clarity and comprehensibility — was crucial, as it reflected its usability as a tool for the WPs' work. The second objective sought to evaluate, in general terms, how the scope of resilience dimensions was addressed within the participatory and interdisciplinary approach employed by the WPs in AGROMIX. The third objective aimed to enhance the accuracy and granularity of the resilience framework.

4.3.2 Methods

4.3.2.1 Clarity and comprehensibility of the resilience framework

The framework of resilience is described in Deliverable 1.1:
www.agromixproject.eu/wp-content/uploads/2022/10/D1.1_AGROMIX_Handbook_of_resilience_and_working_definitions_EMU.pdf.

The WP representatives were asked the question: "*Was the AGROMIX WP1 framework of resilience clearly explained and well understood for the development of your WP activities?*". It was a single-choice question with the response options: yes, no, and partly. During the analysis of the results, the answers were assigned scores of 1, 0, and 0.5, respectively. The closer to 1 the score, the better the result.

4.3.2.2 Analytical Hierarchy Process, AHP

To determine whether the work processes of the WPs were balanced across the three main dimensions—ecological, economic, and social—or if any one dimension was prioritised over the others, a simple questionnaire was included in the T1.5 survey (Section A). For a pairwise comparison, WP representatives assessed the relative importance of two dimensions at a time, comparing one dimension against the other. The question posed to respondents was: "*What is the relative importance of the ecological, economic, and social dimensions of resilience in the focus of your WP/Task work?".* Respondents were asked to rate their answers on a scale of 0–10 (or 11–1–11 on the converted scale; see Footnote 3) by comparing the pairs. Note that a value of 5 (or 1 on the converted scale) in the middle represents equal importance, and the scale extends in both directions.

The pairs to compare were:

ecological *vs* economic
ecological *vs* social
economic *vs* social

This is a multicriteria method used to assess the relative importance of alternatives. Specifically, we employed the **Analytical Hierarchy Process (AHP)** technique to analyse the resulting scores. The technique was introduced by T. L. Saaty in the 1980s and has since been further developed. The judgment scale (Table

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5) ranged from 1, representing equal importance, to 11, representing absolute importance, with the intensity scale adopted from Saaty (1990)[3].

Table 5 - Scale of importance used in T1.5 questionnaire Section A.

Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
5	Much more important
7	Very much more important
9	Highly important
11	Absolute importance

The results are presented in Appendix 1, both as original responses and on the converted scale. Due to multiple respondents, individual judgments were aggregated by calculating the geometric mean of the scores for each comparison pair, as suggested by Saaty (2008) for building a group consensus from individual choices. Based on the aggregated results, a pairwise comparison matrix was constructed. In this matrix, the criteria listed on the left (row alternatives) were compared with the criteria listed at the top (column alternatives). For example, the **ecological dimension was 2.7 times more important than the social dimension** (Table 7, aggregated values). The aggregated values were placed in the appropriate positions in the matrix, with their reciprocals inserted in the transposed positions. In this example, the social dimension was 1 / 2.7 = 0.37 times less important than the ecological dimension. Further calculations are presented in detail in the Appendix 1.

4.3.2.3 Mechanisms to reduce risks of climate change

In this part of the survey, we asked respondents to list mechanisms within each dimension that help reduce risks caused by climate change. The task was: "*Please list the mechanisms you identified as relevant for reducing risks related to climate change in AF/MF systems, according to the main resilience dimension(s) you focused on in your WP (ecological, economic, social). Your response will contribute to enhancing the Framework (D1.1, Figure 1, upper section).*"
The scheme of the framework illustrating the question is in Figure 3.

4.3.3 Results

4.3.3.1 Clarity and comprehensibility of the resilience framework

The results of the assessment of the framework's clarity are presented in Table 6. The mean score was 0.83, indicating that the framework was generally well understood.

[3] Saaty's (1990) scale originally ranged from 1 to 9, but an additional score of 11 was included in the converted T1.5 scale. The T1.5 questionnaire used an ascending 0–10 scale (with eleven positions) for technical reasons. To align with Saaty's architecture, this scale was converted to 11–9–7–5–3–1–3–5–7–9–11 for analysis (see Appendix 1). Due to the broad range of this scale, intermediate values were not used in the conversion.

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Table 6 - Assessment of the resilience framework based on scores for clarity and comprehensibility.

WP	Answer	Score
WP2	yes	1
WP3	partly	0.5
WP4	yes	1
WP5	yes	1
WP6u[4]	yes	1
WP6r[4]	partly	0.5
mean		*0.83*

4.3.3.2 Analytical Hierarchy Process, AHP

The AHP results are shown in the Table 7. The expert responses revealed that the economic dimension held the greatest influence (0.577), surpassing the ecological (0.289) and social (0.134) dimensions in the work of the WPs. The consistency ratio was < 0.1 (CR = 0.04), indicating consistency of the pairwise comparison matrix[5].

Table 7 - Pairwise comparison matrix of aggregated values by multiple respondents. Importance of dimensions in AGROMIX research presented as priority weights.

	Ecological dim.	Economic dim.	Social dim.	Priority weights
Ecological dim.	1.00	0.40	2.70	0.289
Economic dim.	2.50	1.00	3.56	0.577
Social dim.	0.37	0.28	1.00	0.134
λ_{max} = 3.05, CI = 0.02, CR = 0.04				

This finding may implicitly reflect the practical reality that, for a farming enterprise to survive, economic sustainability must take precedence. The respondents, primarily scientists, had extensive experience with participatory processes across many WP cases, collaborating closely with farmers and other stakeholders. As a result, they were likely well-equipped to evaluate the criteria from the perspectives of the various actors involved.

The results suggest that, rather than disproportionately prioritising any one dimension, actions undertaken in the ecological and social dimensions support economic management and resilience when AF/MF systems are practiced.

[4] The letters indicate two different persons; the leaders of the WP6 changed during the project.

[5] To measure whether the comparisons were consistent with each other, consistency index (CI) was calculated: CI = (λ_{max} – n) / (n - 1), where λ_{max} is the maximum eigenvalue of the comparison matrix and n, the number of criteria. CI value of 0 indicates perfect consistency, higher values indicate high inconsistency. Consistency ratio was calculated as CR = CI / RI, where the random index RI was defined by Saaty, depending on the number of criteria, n (RI = 0.58 for n= 3).

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4.3.3.3 Mechanisms to reduce risks of climate change

The responses in each resilience dimension provided comprehensive lists of mechanisms, including detailed descriptions and examples. To facilitate analysis, the main ideas were extracted as keywords and organised into logical categories where possible. This format served as the basis for discussions during an online T1.5 workshop held on October 31, 2024, with the participation of multiple WP representatives. The results in the form of keywords and categories agreed upon during the workshop are presented in Appendix 2. In the economic mechanisms, it was suggested during the workshop, to add a category for 'non-market' values. This would include aesthetic values, such as a beautiful landscape, and other appealing characteristics. The survey and the following discussion allowed to improve the resilience framework (D1.1), specifically to elaborate on the mechanisms that will reduce risks to climate change-induced shocks and stresses when practicing agroforestry or mixed farming (Figure 20). Awareness of these mechanisms allow farmers to pursue smart design of AF and / or MF system. For example, for the best microclimatic effect the trees in an AF system should be chosen of a suitable species (e.g., use AGROMIX app), planted at certain distance from each other, and in proper orientation. In best practice, actions in different dimensions would support each other. For example, it will be difficult for a farmer to influence legal regulations alone, while that could be feasible when acting in networks, participating in local and regional decision-making processes. Many of the mechanisms are known generally for any sustainable practice and are well adaptable for AF/MF systems.
During the course of the AGROMIX project, we have reached to an understanding that AF and MF systems, separately defined in the beginning, can well be combined, one not excluding the other.

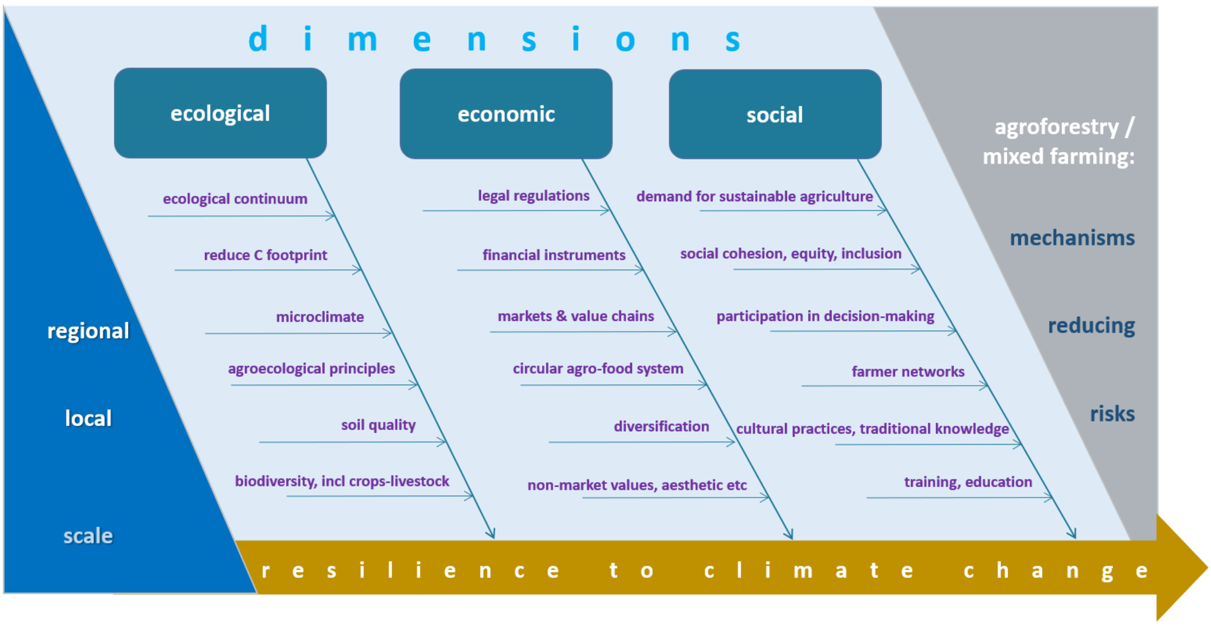

Figure 20 - Practicing agroforestry and mixed farming allows farmers to minimise risks to climate change induced shocks and stresses in all dimensions of resilience. The risks-reducing mechanisms are listed in the sub-branches of the fishbone. The order follows in general, though not strict, regional-to-local scale. The scheme is a development of the Deliverable 1.1 Fig 1, upper part.

In a final step of the workshop, the participants were asked to define, based on these mechanisms of resilience and the adaptation of the framework used in WP4 for the participatory multicriteria assessment of the pilot AF/MF case studies (see deliverable D4.1), the resilience criteria to group and cluster the resilience indicators assessed in task 1.5. The resilience criteria identified were the following:

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4.3.3.4 Ecological resilience criteria

- High functional diversity
- High landscape complexity
- Healthy soil
- Reduced external input use
- Microclimate regulation

4.3.3.5 Economic resilience criteria

- High autonomy from public support
- High marketing diversification
- High stability of income
- Reducing risk levels

4.3.3.6 Social resilience criteria

- Integration in a local network
- Locally adapted advisory/training
- Landscape revitalisation
- Connection with consumers

4.4 Improvement of the list of indicators of resilience to climate change

4.4.1 Methods

In the part B of the survey circulated in preparation to the final task meeting, the WP leaders were asked to indicate:

1. which ecological, economic or social indicators (the type of which depending on the aims of the WP), included in the longer (preliminary) or shorter (final) list of indicators defined in the deliverable D1.3, were actually used in the respective WP or tasks;
2. the reasons why some indicators were not used (because not affordable or not applicable at all);
3. whether additional indicators were used in the WP lifetime.

The results of the survey were used to rank the indicators according to their utility and actual use as related to the WP aims. During the final workshop, the participants were asked to refine the preliminary list of indicators by selecting the 5 most relevant indicators for each of the ecological, economic and social resilience criteria identified (see chapter 5.2.3). For this task, a MS-Form was prepared and filled by the participants, who answers the following question: "*Select the 5 most relevant farm-scale indicators for this criterium (possible to select the same indicator for different criteria)*". If more than five indicators were

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selected by the participants for the same criterium, then a consensus agreement was reached in a participatory discussion.

After the selection of the most effective resilience indicators, the participants were asked to give a certain weight to the resilience criteria and, within each of the criteria, to each related indicator. To do that, an interactive tool was prepared on the Mentimeter platform. Each participant could give a maximum of 100 points to the five pre-selected indicators and criteria, and could decide whether to give equal weights to the criteria/indicators or not. The combination on the weights given to the criteria and to their related indicators allowed to refine the framework of resilience through a mind map designed on the Miro web application.

4.4.2 Results

4.4.2.1 Use of task 1.3 resilience indicators in the WPs

The answers of the WP leaders to the questions included in the part B of the preliminary survey conducted in Task 1.5 allowed to make an overview of the convergence or divergence in the use of the three groups of indicators across the different WPs.

4.4.2.1.1 Ecological indicators

The ecological indicators were especially applicable to three WPs, namely WP2, WP3 and WP6.

Table 8 - Report on the use in WP2, WP3 and WP6 of the ecological resilience indicators selected in task 1.3 of AGROMIX

	WP2	WP3		WP6	
ECOLOGICAL INDICATOR	PILOT DESIGN	CORE SITE ASSESSMENT	VIRTUAL EXPERIMENTS	CURRENT POLICIES	FUTURE POLICIES
1 - Crop species richness in time	APPLIED	APPLIED	APPLIED		
2 - Crop cultivar diversity		NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE		
3 - Crop functional diversity in time and space	APPLIED	APPLIED	APPLIED		
4 - Vigorous crop species/varieties		NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE	APPLIED	
5 - Crop health	APPLIED	APPLIED	APPLIED		
6 - Morbidity	NOT FEASIBLE AND APPROPRIATE	NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE		
7 - Use of preventive antibiotics		NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE	APPLIED	
8 - Multipurpose breeds of animals	APPLIED	NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE		
9 - Vigorous/robust breeds	APPLIED	NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE		
10 - Access to irrigation systems	APPLIED	NOT FEASIBLE			
11 - Water storage	APPLIED				
12 - Digital support systems		NOT FEASIBLE AND APPROPRIATE	NOT FEASIBLE AND APPROPRIATE		
13 - Nutrient cycling	APPLIED	NOT FEASIBLE			
14 - Soil crusting and crackling	APPLIED				
15 - Soil moisture	APPLIED				
16 - Soil biological quality	APPLIED	APPLIED			
17 - Inclusion of banker plants within the parcel	APPLIED		NOT FEASIBLE AND APPROPRIATE		
18 - Planting to improve the microclimate and waterflows	APPLIED	APPLIED	NOT FEASIBLE		APPLIED
19 - Biodiversity (pollinators, natural enemies)	APPLIED	APPLIED	NOT FEASIBLE AND APPROPRIATE		APPLIED
20 - (Semi-)natural landscape structures	APPLIED	APPLIED	NOT FEASIBLE AND APPROPRIATE	APPLIED	APPLIED
21 - Connectivity of (semi-)natural landscape elements	APPLIED	NOT FEASIBLE AND APPROPRIATE	NOT FEASIBLE AND APPROPRIATE		APPLIED
22 - Arable crop diversity	APPLIED	APPLIED	APPLIED		
23 - Grassland species richness	APPLIED				
24 - Herd fertility			NOT FEASIBLE AND APPROPRIATE		
25 - Livestock - Animal diversity	APPLIED	NOT FEASIBLE	NOT FEASIBLE AND APPROPRIATE		
26 - Stability of production	APPLIED	APPLIED	APPLIED		
27 - Herbaceous soil cover	APPLIED		NOT FEASIBLE AND APPROPRIATE		
28 - Soil organic matter	APPLIED				
29 - Soil compaction	APPLIED		NOT FEASIBLE		
30 - Plant available water	APPLIED				
31 - Sufficient irrigation	APPLIED				
32 - Trees and shrubs	APPLIED	APPLIED	APPLIED	APPLIED	APPLIED

NOT FEASIBLE
NOT FEASIBLE AND APPROPRIATE
NOT APPROPRIATE
APPLIED

Among the 32 ecological resilience indicators, only one ("Trees and shrubs") was assessed or considered in all the three WPs, 5 indicators were used only in WP2 and WP3, whereas all the others were used only in some or part of the three WPs. 5 indicators were not considered at all for many reasons. Interestingly, 2 indicators ("Vigorous crop species/varieties" and "Use of preventive antibiotics") were used only in WP6 (task on current policies).

The WP3 leader was also asked to report on the outcomes of the assessment of AF/MF systems for each of the ecological resilience indicators used in the WP to assess the core sites. This analysis was split by specific tasks and subtasks of the WP3, related to the different dimensions of ecological resilience.

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A. Water/microclimate resilience (sub-task 3.1.1)

Two ecological resilience indicators ("Crop species richness in time" and "Biodiversity") resulted in very favourable results for AF/MF systems. Other four indicators ("Crop functional diversity in time and space", "Inclusion of banker plants within parcel", "Stability of production", "Trees and shrubs") led to somewhat favourable results for AF/MF systems and another indicator ("Crop health") gave neutral results (nor positive or negative) for AF/MF systems respect to standard specialised systems.

Table 9 - Results of the use of ecological indicators for the assessment of AF/MF systems in the subtask of WP3 dealing with water and microclimate regulation

ECOLOGICAL INDICATOR	NOT ASSESSED	TOTALLY UNFOURABLE TO AF/MF	NEUTRAL	SOMEWHAT FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Crop species richness in time					
2 - Crop cultivar diversity					
3 - Crop functional diversity in time and space					
4 - Vigorous crop species/varieties					
5 - Crop health					
6 - Morbidity					
7 - Use of preventive antibiotics					
8 - Multipurpose breeds of animals					
9 - Vigorous/robust breeds					
10 - Access to irrigation systems					
11 - Water storage					
12 - Digital support systems					
13 - Nutrient cycling					
14 - Soil crusting and crackling					
15 - Soil moisture					
16 - Soil biological quality					
17 - Inclusion of banker plants within the parcel					
18 - Planting to improve the microclimate and waterflows					
19 - Biodiversity (pollinators, natural enemies)					
20 - (Semi-)natural landscape structures					
21 - Connectivity of (semi-)natural landscape elements					
22 - Arable crop diversity					
23 - Grassland species richness					
24 - Herd fertility					
25 - Livestock - Animal diversity					
26 - Stability of production					
27 - Herbaceous soil cover					
28 - Soil organic matter					
29 - Soil compaction					
30 - Plant available water					
31 - Sufficient irrigation					
32 - Trees and shrubs					

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B. Environmental resilience (sub-task 3.1.2)

In this case, four ecological indicators gave positive results for AF/MF systems, whereas "Crop health" was not useful to highlight any positive behaviour of the AF/MF systems.

Table 10 - Results of the use of ecological indicators for the assessment of AF/MF systems in the subtask of WP3 dealing with environmental resilience

ECOLOGICAL INDICATOR	NOT ASSESSED	TOTALLY UNFOURABLE TO AF/MF	NEUTRAL	SOMEWHAT FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Crop species richness in time					
2 - Crop cultivar diversity					
3 - Crop functional diversity in time and space					
4 - Vigorous crop species/varieties					
5 - Crop health					
6 - Morbidity					
7 - Use of preventive antibiotics					
8 - Multipurpose breeds of animals					
9 - Vigorous/robust breeds					
10 - Access to irrigation systems					
11 - Water storage					
12 - Digital support systems					
13 - Nutrient cycling					
14 - Soil crusting and crackling					
15 - Soil moisture					
16 - Soil biological quality					
17 - Inclusion of banker plants within the parcel					
18 - Planting to improve the microclimate and waterflows					
19 - Biodiversity (pollinators, natural enemies)					
20 - (Semi-)natural landscape structures					
21 - Connectivity of (semi-)natural landscape elements					
22 - Arable crop diversity					
23 - Grassland species richness					
24 - Herd fertility					
25 - Livestock - Animal diversity					
26 - Stability of production					
27 - Herbaceous soil cover					
28 - Soil organic matter					
29 - Soil compaction					
30 - Plant available water					
31 - Sufficient irrigation					
32 - Trees and shrubs					

C. Biodiversity enhancement (sub-task 3.1.3)

In the subtask on biodiversity enhancement only two indicators were applicable and both resulted in favourable results for the AF/MF systems.

Table 11 - Results of the use of ecological indicators for the assessment of AF/MF systems in the subtask of WP3 dealing with biodiversity enhancement

ECOLOGICAL INDICATOR	NOT ASSESSED	TOTALLY UNFOURABLE TO AF/MF	NEUTRAL	SOMEWHAT FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Crop species richness in time					
2 - Crop cultivar diversity					
3 - Crop functional diversity in time and space					
4 - Vigorous crop species/varieties					
5 - Crop health					
6 - Morbidity					
7 - Use of preventive antibiotics					
8 - Multipurpose breeds of animals					
9 - Vigorous/robust breeds					
10 - Access to irrigation systems					
11 - Water storage					
12 - Digital support systems					
13 - Nutrient cycling					
14 - Soil crusting and crackling					
15 - Soil moisture					
16 - Soil biological quality					
17 - Inclusion of banker plants within the parcel					
18 - Planting to improve the microclimate and waterflows					
19 - Biodiversity (pollinators, natural enemies)					
20 - (Semi-)natural landscape structures					
21 - Connectivity of (semi-)natural landscape elements					
22 - Arable crop diversity					
23 - Grassland species richness					
24 - Herd fertility					
25 - Livestock - Animal diversity					
26 - Stability of production					
27 - Herbaceous soil cover					
28 - Soil organic matter					
29 - Soil compaction					
30 - Plant available water					
31 - Sufficient irrigation					
32 - Trees and shrubs					

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D. Virtual experiments

In the tasks on modelling approach to the assessment of AF/MF systems across future climate scenarios, all the 9 indicators of ecological resilience gave neutral to positive outcomes for AF/MF systems.

Table 12 - Results of the use of ecological indicators for the assessment of AF/MF systems in the subtask of WP3 dealing with virtual experiments (modelling) on the effects of future climate scenarios

ECOLOGICAL INDICATOR	NOT ASSESSED	TOTALLY UNFOURABLE TO AF/MF	NEUTRAL	SOMEWHAT FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Crop species richness in time					
2 - Crop cultivar diversity					
3 - Crop functional diversity in time and space					
4 - Vigorous crop species/varieties					
5 - Crop health					
6 - Morbidity					
7 - Use of preventive antibiotics					
8 - Multipurpose breeds of animals					
9 - Vigorous/robust breeds					
10 - Access to irrigation systems					
11 - Water storage					
12 - Digital support systems					
13 - Nutrient cycling					
14 - Soil crusting and crackling					
15 - Soil moisture					
16 - Soil biological quality					
17 - Inclusion of banker plants within the parcel					
18 - Planting to improve the microclimate and waterflows					
19 - Biodiversity (pollinators, natural enemies)					
20 - (Semi-)natural landscape structures					
21 - Connectivity of (semi-)natural landscape elements					
22 - Arable crop diversity					
23 - Grassland species richness					
24 - Herd fertility					
25 - Livestock - Animal diversity					
26 - Stability of production					
27 - Herbaceous soil cover					
28 - Soil organic matter					
29 - Soil compaction					
30 - Plant available water					
31 - Sufficient irrigation					
32 - Trees and shrubs					

E. Modelling on AF/MF options

In the modelling task on the effects of different management options of AF/MF systems, 7 indicators were used and 4 of them were able to discriminate between AF/MF systems and standard specialised systems.

Table 13 - Results of the use of ecological indicators for the assessment of AF/MF systems in the subtask of WP3 dealing with modelling on the effects of different agronomic management options

ECOLOGICAL INDICATOR	NOT ASSESSED	TOTALLY UNABLE TO DISCRIMINATE	NEUTRAL	SOMEWHAT ABLE TO DISCRIMINATE	TOTALLY ABLE TO DISCRIMINATE
1 - Crop species richness in time					
2 - Crop cultivar diversity					
3 - Crop functional diversity in time and space					
4 - Vigorous crop species/varieties					
5 - Crop health					
6 - Morbidity					
7 - Use of preventive antibiotics					
8 - Multipurpose breeds of animals					
9 - Vigorous/robust breeds					
10 - Access to irrigation systems					
11 - Water storage					
12 - Digital support systems					
13 - Nutrient cycling					
14 - Soil crusting and crackling					
15 - Soil moisture					
16 - Soil biological quality					
17 - Inclusion of banker plants within the parcel					
18 - Planting to improve the microclimate and waterflows					
19 - Biodiversity (pollinators, natural enemies)					
20 - (Semi-)natural landscape structures					
21 - Connectivity of (semi-)natural landscape elements					
22 - Arable crop diversity					
23 - Grassland species richness					
24 - Herd fertility					
25 - Livestock - Animal diversity					
26 - Stability of production					
27 - Herbaceous soil cover					
28 - Soil organic matter					
29 - Soil compaction					
30 - Plant available water					
31 - Sufficient irrigation					
32 - Trees and shrubs					

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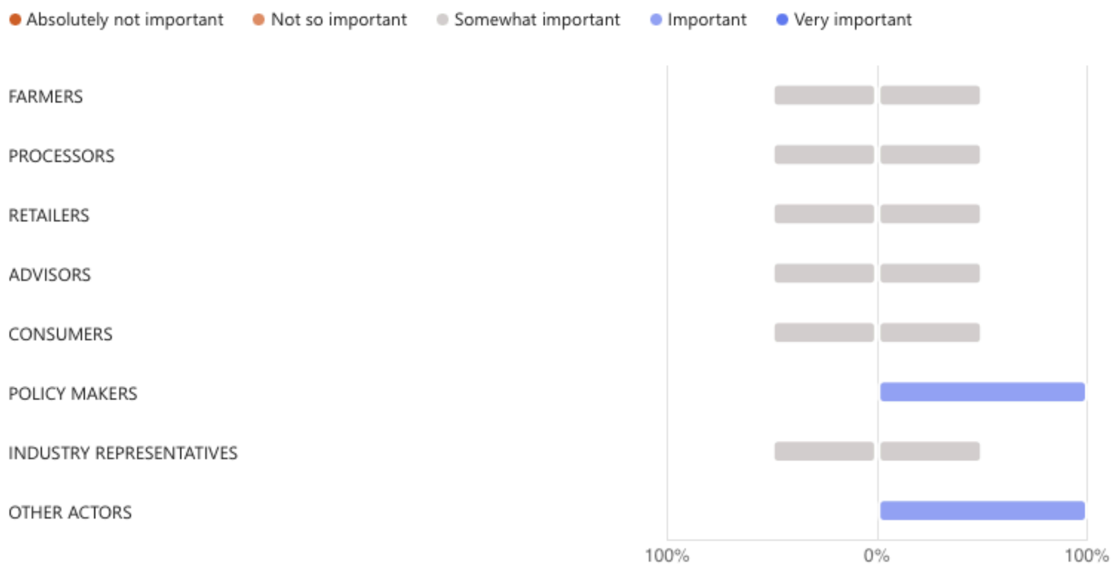
The WP2 leader was asked to report on the importance given to the ecological indicators by different typologies of stakeholders involved in the participatory co-design of pilot AF/MF cases. The question was "Overall, how much important were the ecological resilience indicators reputed by the following categories of stakeholders?". The answer clearly shows how most of the stakeholders perceive the ecological indicators "somewhat important". The level of perceived importance increased in policy makers and other actors locally involved in the pilot case co-design.

Table 14 - Perception of the importance of the ecological indicators selected in Task 1.3 of AGROMIX for the different types of stakeholders engaged in WP2



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4.4.2.1.2 Economic indicators

The economic resilience indicators were tested in WP2, WP5 and WP6. The indicators on variability/stability of income, reliance on subsidies and number of income sources were the only indicators that were tested in WP2, in WP5 at both farm and value chain level, and in WP6, although only for the design of future policy scenarios. The indicator on GHG emissions was not applicable or affordable for being used in WP2 and WP5, whereas it was the only applicable indicator in WP6 both at current and future policy scenarios. The WP5 leader was asked to report on the results obtained by measuring the afore mentioned indicators at farm and value chain level.

Table 15 - Report on the use in WP2, WP5 and WP6 of the economic resilience indicators selected in task 1.3 of AGROMIX

	WP2	WP5		WP6	
ECONOMIC INDICATOR	PILOT DESIGN	FARM LEVEL	VALUE CHAIN LEVEL	CURRENT POLICIES	FUTURE POLICIES
1 - Variability/stability of income/profit					
2 -% Direct sale to consumers					
3 - Contract with retailers					
4 - Gross value added from crops					
5 - Gross value added from livestock					
6 - Non-farm income					
7 - Machine availability					
8 - Resource use efficiency					
9 - Reliance on subsidies					
10 - Debt and Loan					
11 - Preventive investments					
12 - Fair pay for on-farm labour					
13 - Land ownership					
14 - Number of income sources (Market diversification)					
15 - Dependencies on external inputs					
16 - GHG emissions					

NOT FEASIBLE
NOT FEASIBLE AND APPROPRIATE
NOT APPROPRIATE
APPLIED

A. <u>Farm level</u>

The assessment of economic resilience of AF/MF systems at farm level was done by using all the indicators selected in task 1.3. Among them, 1 ("% Direct sale to consumers") gave totally favourable results for AF/MF systems, and 6 gave favourable results. Two indicators ("Debt and loan" and "Dependencies on external inputs") gave instead negative scores for the AF/MF systems.

Table 16 - Results of the use of economic indicators for the assessment of resilience of AF/MF systems at farm level in WP5

ECONOMC INDICATOR	TOTALLY UNFOURABLE TO AF/MF	UNFOURABLE TO AF/MF	NEUTRAL	FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Variability/stability of income/profit					
2 -% Direct sale to consumers					
3 - Contract with retailers					
4 - Gross value added from crops					
5 - Gross value added from livestock					
6 - Non-farm income					
7 - Machine availability					
8 - Resource use efficiency					
9 - Reliance on subsidies					
10 - Debt and Loan					
11 - Preventive investments					
12 - Fair pay for on-farm labour					
13 - Land ownership					
14 - Number of income sources (Market diversification)					
15 - Dependencies on external inputs					
16 - GHG emissions					

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B. Value chain level

Expanding the scale of the assessment to the value chain resulted in quite similar outcomes, thus revealing a high stability of the selected indicators respect to the scale of the assessment. Negative outcomes were also obtained for "Preventive investments" indicator.

Table 17 - Results of the use of economic indicators for the assessment of resilience of AF/MF systems at value chain level in WP5

ECONOMC INDICATOR	TOTALLY UNFOURABLE TO AF/MF	UNFOURABLE TO AF/MF	NEUTRAL	FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Variability/stability of income/profit					
2 -% Direct sale to consumers					
3 - Contract with retailers					
4 - Gross value added from crops					
5 - Gross value added from livestock					
6 - Non-farm income					
7 - Machine availability					
8 - Resource use efficiency					
9 - Reliance on subsidies					
10 - Debt and Loan					
11 - Preventive investments					
12 - Fair pay for on-farm labour					
13 - Land ownership					
14 - Number of income sources (Market diversification)					
15 - Dependencies on external inputs					
16 - GHG emissions					

The WP2 leader was asked to report on the importance given to the economic indicators by different typologies of stakeholders involved in the participatory co-design of pilot AF/MF cases. The question was "Overall, how much important were the economic resilience indicators reputed by the following categories of stakeholders?". In this case, the importance given to the economic indicators was generally higher than ecological indicators, pinpointing to the impact of economic sustainability on economic actors' choices and adoption of AF/MF systems. This was particularly true for farmers and industry representatives, whereas consumers and other local actors were, as expected, more neutral towards economic indicators.

Table 18 - Perception of the importance of the economic indicators selected in Task 1.3 of AGROMIX for the different types of stakeholders engaged in WP2

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4.4.2.1.3 Social indicators

The social resilience indicators were tested in WP2, WP5 and WP6. The indicators "Cooperation/collaboration with other producers/sale organisations" and "Farmer/social networks" were the only ones applied in all the three WPs, although both were not applicable in WP5 at farm level.

Table 19 - Report on the use in WP2, WP5 and WP6 of the social resilience indicators selected in task 1.3 of AGROMIX

	WP2	WP5		WP6	
SOCIAL INDICATOR	PILOT DESIGN	FARM LEVEL	VALUE CHAIN LEVEL	CURRENT POLICIES	FUTURE POLICIES
1 - Frequency and quality of training					
2 -Cooperation/collaboration with other producers/sale organisations					
3 - Farmer competences					
4 - Access to extension services					
5 - % of area under agriculture insurance					
6 - Level of social organisation					
7 - Farmer/Social networks					
8 - Inclusion of diverse knowledge and voices in decision-making					
9 - Agency of farmer					
10 - Membership of farmer networks, cooperatives and projects					
11 - Frequency of training					
12 - Short-supply chain					

NOT FEASIBLE
NOT FEASIBLE AND APPROPRIATE
NOT APPROPRIATE
APPLIED

In WP5, the indicators were used to assess the social resilience of AF/MF systems at farm or value chain level.

A. <u>Farm level</u>

The assessment of social resilience of AF/MF systems at farm level was done by using all the indicators selected in task 1.3. Among them, 5 indicators ("Frequency and quality of training", "Cooperation/collaboration with other producers/sale organisations", "Membership of farmer networks, cooperation and projects", "Frequency of training", "Short-supply chain") gave favourable results for AF/MF systems, and all the rest gave neutral results.

Table 20 - Results of the use of social indicators for the assessment of resilience of AF/MF systems at farm level in WP5

SOCIAL INDICATOR	AF/MF	UNFOURABLE TO AF/MF	NEUTRAL	FAVOURABLE TO AF/MF	AF/MF
1 - Frequency and quality of training					
2 -Cooperation/collaboration with other producers/sale organisations					
3 - Farmer competences					
4 - Access to extension services					
5 - % of area under agriculture insurance					
6 - Level of social organisation					
7 - Farmer/Social networks					
8 - Inclusion of diverse knowledge and voices in decision-making					
9 - Agency of farmer					
10 - Membership of farmer networks, cooperatives and projects					
11 - Frequency of training					
12 - Short-supply chain					

B. <u>Value chain level</u>

At the value chain level, the number of indicators giving favourable results for AF/MF systems increased to 6 and 1 indicator ("Farmer competences") gave even totally favourable results for AF/MF systems.

Table 21 - Results of the use of social indicators for the assessment of resilience of AF/MF systems at value chain level in WP5

SOCIAL INDICATOR	TOTALLY UNFOURABLE TO AF/MF	UNFOURABLE TO AF/MF	NEUTRAL	FAVOURABLE TO AF/MF	TOTALLY FAVOURABLE TO AF/MF
1 - Frequency and quality of training					
2 -Cooperation/collaboration with other producers/sale organisations					
3 - Farmer competences					
4 - Access to extension services					
5 - % of area under agriculture insurance					
6 - Level of social organisation					
7 - Farmer/Social networks					
8 - Inclusion of diverse knowledge and voices in decision-making					
9 - Agency of farmer					
10 - Membership of farmer networks, cooperatives and projects					
11 - Frequency of training					
12 - Short-supply chain					

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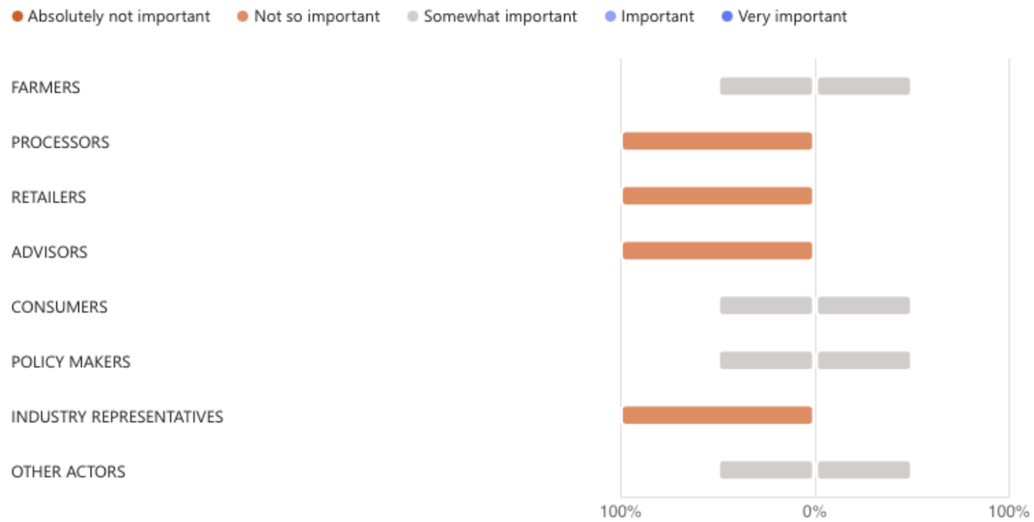
The WP2 leader was asked to report on the importance given to the social indicators by different typologies of stakeholders involved in the participatory co-design of pilot AF/MF cases. The question was "Overall, how much important were the social resilience indicators reputed by the following categories of stakeholders?". Unexpectedly, social indicators were perceived as less important by processors, retailers, advisors and industry representatives, revealing maybe a very low attention given to social aspects in the mainstream market organisations.

Table 22 - Perception of the importance of the social indicators selected in Task 1.3 of AGROMIX for the different types of stakeholders engaged in WP2



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4.4.2.2 Revision of the indicators set based on the AF/MF resilience framework

During the final workshop of the task held on 31st October 2024, the participants were asked to give different weights to each of the criteria identified for the ecological, economic and social dimensions of AF/MF resilience, and afterwards the same happened for the indicators grouped within each of these criteria. The combination of the weights given to the criteria and to their respective indicators allowed to build a new indicator-based framework of resilience. After the completion of the work on each single dimension of resilience, the set of indicators was further discussed with the workshop participants, resulting in some adjustments of their name and concept. The results are quite interesting and are shown in detail in the following three figures (Fig. 21, 22, 23):

Figure 21 - The revised indicator-based framework for the assessment of ecological resilience of AF/MF systems. The percentages are the weights given to the criteria (in capital letters) and to their respective indicators

For the ecological dimension of resilience, the new framework considered the five criteria listed in chapter 5.2.3.4 (Fig. 21, Tab. 23).

For the criterium "High functional diversity", which was given 28% of total weight for ecological dimension, the five indicators selected included two indicators dealing with off-field elements of landscape diversification (i.e., "Trees and shrubs" and "Connectivity of (semi-)natural habitats, that were given both 23% of weight, one indicator describing in-field planned biodiversity ("Crop and grassland functional diversity in time and space", resulting from the expansion of the "Crop functional diversity in time and space" indicator

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to include also grasslands) and two indicators dealing, respectively, with associated biodiversity ("Biodiversity (pollinators, natural enemies") and planned animal diversity ("Livestock - Animal diversity").

The second criterium considered was "High landscape complexity", that was given 27% of total weight, included all the same indicators as the first criteria, but "Livestock - Animal diversity", that was replaced by "(Semi-)natural landscape structures". Nevertheless, the weights given to the indicators in common with the first criteria were slightly different, with "Connectivity of (semi-)natural landscape elements" being given the highest weight (27%) and the others accounting from 14 to 22%.

The 22% weight assigned to the third criterium "Healthy soil" reflects the importance of soil health in the frame of ecological resilience of agroecosystems. Noteworthy, soil health is also one of the 13 principles of agroecology according to Agroecology Europe definition (Wezel et al., 2020). "Soil biological quality" indicator was the one rated with highest importance (29% of total weight), followed by "Soil organic matter" (24%). Among the other three indicators, "Soil structure quality and stability" was introduced by workshop participants and was given 19% of weight because it was considered of relatively high importance respect to climate change adaptation goals (e.g., to reduce water flooding through reduced soil compaction and increased water infiltration). "Nutrient cycling" and "Plant available water" were the other two indicators for the criterium.

Interestingly, the participants rated lower the importance of the other two criteria, with "Reduced external input use" and "Microclimate regulation" being assigned only with 13 and 10% of total weight of the ecological dimension. For the former criterium, "Nutrient cycling" (36%) was the outstandingly most important indicator, followed by "Planting to improve the microclimate and waterflows" (21%), that was included to account for lower crop needs for pesticides and irrigation water, "Crop health" and "Vigorous crop species/varieties" (both accounting for 16% of the weight), and "Use of preventive antibiotics". This latter was given 11% of weight and was considered an effective indicator to describe a situation of animal production system with low reliance on curative methods.

For the last ecological resilience criterium, "Microclimate regulation", there was a constructive discussion during the workshop, with participants seeking for indicators able to describe farm-level effective measures and actions with an impact on microclimate. Besides "Trees and shrubs" (28%), the second important indicator (27%) was "Field/farm Infrastructures to improve the microclimate and waterflows", including measures and land modifications such as swales, terraces, walls, windbreaks. The participants considered also relevant the inclusion of "(Plant) Biomass soil cover" (24%), an indicator aimed to describe the spatial and temporal proportion of soil coverage from living or dead plant or other biomass (e.g., wood chips, organic mulch, compost) material. This indicator was thought to be relevant with respect to microclimate regulation to consider the protective effect of mulch material on soil water evaporation and thermal excursions. "Mean size of field parcel" (14%) and "Availability of weather stations in the farm" (7%) were considered useful to describe, respectively, the real potential of the farmer to impact on microclimate (negatively correlated with the size of each field parcel, due to inter-distance between semi-natural infrastructures) and farmer awareness of the importance of weather data and microclimate regulation.

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Table 23 - The new framework of ecological resilience indicators of AF/MF systems

Dimension	Criterion	%	Indicator	%
ECOLOGICAL RESILIENCE	High functional biodiversity	28	Crop and grassland functional diversity in time and space	23
			Trees and shrubs	23
			Connectivity of (semi-)natural landscape elements	19
			Biodiversity (pollinators, natural enemies)	18
			Livestock – Animal diversity	17
	High landscape complexity	27	Connectivity of (semi-)natural landscape elements	27
			(Semi-)natural landscape structures	22
			Trees and shrubs	20
			Crop and grassland functional diversity in time and space	17
			Biodiversity (pollinators, natural enemies)	14
	Healthy soil	22	Soil biological quality	29
			Soil organic matter	24
			Soil structure quality and stability	19
			Nutrient cycling	16
			Plant available water	14
	Reduced external input use	13	Nutrient cycling	36
			Planting to improve microclimate and waterflows	21
			Crop health	16
			Vigorous crop species/ varieties	16
			Use of preventive antibiotics	11
	Microclimate regulation	10	Trees and shrubs	28
			Field/ farm infrastructures to improve microclimate and waterflows – also opening swales, terraces, walls, windbreaks	27
			Biomass soil cover	24
			Mean size of field parcels	14
			Availability of weather stations on farm	7

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Figure 22 - The revised indicator-based framework for the assessment of economic resilience of AF/MF systems. The percentages are the weights given to the criteria (in capital letters) and to their respective indicators

For the economic dimension of the framework, four criteria were identified (see chapter 5.3.2.2) and ranked in this order of decreasing weight (Fig. 22, Tab. 24):

- "High autonomy from public support" (31%)
- "High marketing diversification" (30%)
- "High stability of income" (25%)
- "Reducing risk levels" (14%) .

The most important indicators for the first criterium included "Reliance on subsidies" (29%), "Stability of income/profit" (21%) and "Number of income sources (Market diversification)" (20%). "% Direct sale to consumers" was also considered an important indicator as a proxy for monetary value retention at farm level. The reliance of farmer on sources of income other than public subsidies are also tackled by the fifth indicator that was "Non-farm income".

The second criterium "High marketing diversification" was clearly related to the indicator "Number of income sources (Market diversification)", that actually was given the highest relative weight (46%). "% Direct sale to consumers" (19%) and "Contracts with retailers" (13%) were selected to represent the two most important alternative market outputs. The remaining two indicators, namely "Stability of income/profit" and "Gross

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value added from crops" were given the same level of relative weight (11%) and were included as descriptors of economic performance of the farms.

The criterium "High stability of income" was dominated in terms of weight by its immediate indicator "Stability of income/profit" (41%), whereas among the other four indicators, noteworthily, also "Fair pay for on-farm labour" was included. This indicator is part of the selection because it was thought to be a good proxy of the farmer's ability to generate fair and stable labour opportunities for employers.

Finally, for the criterium "Reducing risk levels", the participants gave the highest weights to "Security of land tenancy" (28%) and "Farmer insurance" (26%), with the former being selected for its capacity to describe the farmer propension to invest on long-term economic strategies, that is directly connected with the long-lasting availability of the land to manage. "Contracts at fixed price" (19%) and "Financial advisory/knowledge" (18%) were equally important for the workshop participants, whereas "Reduced GHG emissions" (9%) was less relevant but still included to account for higher/lower economic risks for farmers applying or not strategies aimed to reduce GHG emissions. This also would allow farmers to access to carbon credit markets that can stabilise the economic incomes.

Table 24 - The new framework of economic resilience indicators of AF/MF systems

Dimension	Criterion	%	Indicator	%
ECONOMIC RESILIENCE	High autonomy from public support	31	Reliance on subsidies	29
			Stability of income/profit	21
			Number of income sources (Market diversification)	20
			Proportion of direct sale to consumers	19
			Non-farm income	11
	High marketing diversification	30	Number of income sources (Market diversification)	46
			Proportion of direct sale to consumers	19
			Contract with retailers	13
			Cross value added from crops	11
			Stability of income/profit	11
	High stability of income	25	Stability of income/profit	41
			Number of income sources (Market diversification)	19
			Contract with retailers	14
			Fair pay for on-farm labour	14
			Reliance on subsidies	12
	Reducing risk levels	13	Security of land tenancy	28
			Farmers' insurance	26
			Contracts at fixed price	19
			Financial advisory/ knowledge	18
			Reduced GHG emissions	9

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Figure 23 - The revised indicator-based framework for the assessment of social resilience of AF/MF systems. The percentages are the weights given to the criteria (in capital letters) and to their respective indicators

Social resilience dimension (see 5.2.3.3) included four criteria. “Integration in a local network” (42%) and “Locally adapted advisory/training” (30%) owned most of the relative weight, with “Landscape revitalisation” (21%) and “Connection with consumers” (only 7%) gaining lower consensus (Fig. 23, Table 24).
For the most important criterium, the biggest importance was acknowledged to those indicators able to describe the farmers’ propension to establish relationships with their peers or other actors in the value chains (e.g., “Farmer/Social networks”, “Cooperation/collaboration with other producers/sale organisations”, “Membership of farmer networks, cooperatives and projects” together accounting for 47% of relative weight).
The quality of advisory and the level of training were reflected, in the second criterium, besides the general “Access to extension services” (29%) and “Frequency and quality of training” (19%) indicators, also by the other indicators reflecting social role and activity of the farmers (i.e., “Membership of farmer networks, cooperatives and projects” and “Farmer/social networks” that together accounted for 35% of relative weight), or their attitude to be open-minded (“Inclusion of diverse knowledge and voices in decision-making”).
Some indicators included in the other criteria were also represented in “Landscape revitalisation” one (e.g., “Farmer/Social networks”, “Membership of farmer networks, cooperatives and projects”). In this criterium, “Farmer competences” was added as new indicator to bring in the assessment also the peculiarity and the

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skills of the farmers, that were considered somewhat important (22%) in shaping farmers relations with other local actors.

This last indicator was also included by the workshop participants also in the last criterium of "Connection with consumers" and was given 15% of weight. "Short supply chain" was the most relevant indicator (35%) in the category, followed by "Participatory guarantee systems (PGS)", a new indicator introduced during the final discussion, which represent an alternative to third-party certification for locally focused quality assurance systems whereby the producers are certified based on active participation of stakeholders. Further info on PGS is found here: **www.ifoam.bio/our-work/how/standards-certification/participatory-guarantee-systems**. "Produce quality assurance processes" was also included as a complementary indicator to assess more common situations of farms being applying strict and standardised self-assurance quality schemes and processes. These two last indicators accounted together for 34% of relative weight.

Table 25 - The new framework of social resilience indicators of AF/MF systems

Dimension	Criterion	%	Indicator	%
SOCIAL RESILIENCE	Integration in local network	42	Farmer/ Social networks	24
			Cooperation/collaboration with other producers/sale organisations	23
			Membership of farmer networks, cooperatives and projects	22
			Inclusion of diverse knowledge and voices in decision-making	17
			Access to extension services	13
	Locally adapted advisory/ training	30	Access to extension services	29
			Farmer/ Social networks	19
			Frequency and quality of training	19
			Inclusion of diverse knowledge and voices in decision-making	17
			Membership of farmer networks, cooperatives and projects	16
	Landscape revitalisation	21	Farmer competences	22
			Farmer/ Social networks	22
			Membership of farmer networks, cooperatives and projects	20
			Cooperation/collaboration with other producers/sale organisations	18
			Inclusion of diverse knowledge and voices in decision-making	18
	Connection with consumers	7	Short-supply chain	35
			Participatory guarantee systems (PGS)	19
			Social networks	16
			Farmer competences	15
			Produce quality assurance processes	15

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5 Conclusions

Task 1.5 offered the occasion for the AGROMIX consortium and part of its network of stakeholders to make a reflection, not only on the achievements of the projects and their potential impacts from an overarching perspective, but also to identify threats and weaknesses that impeded to reach all the original targets.

This exercise was very useful because it gave the consortium the possibility to gather impressions and reflections. Unfortunately, the effects of the COVID-19 pandemic on the development of project activities, with some significant delays in the completion of key experimental activities at some partner institution, cascaded also onto Task 1.5, that developed slowly and was too end-loaded with final activities in November outside of the project time-sheeting. This was however, perceived by all partners involved as a useful circumstance, as it allowed the task participants to have a precise overview of all the project activities and to make a clearer the overall assessment with the main project research work already done.

On the other hand, due to the time limitations, the task partially could not engage effectively the **wider community** of AGROMIX stakeholders, as only some members of the partner institutions actively contributed to the task by participating to the final workshop on 31 October 2024 and the follow-up activities in the months afterwards. These persons were among those not directly involved in the key experimental activities of the project and provided an external opinion in the task 1.5. The active involvement of many different stakeholders in the development of the project activities (above all for the co-design of AF/MF pilot cases in WP2 and for their multicriteria co-assessment in WP4) allowed the consortium to bring very relevant information from the ground, mixing a “top-down” to a “bottom-up” approach.

The analysis of the project development, implemented through a **SWOT analysis**, allowed identifying potentialities to increase the impact of the project outcomes after its end, and also can contribute to improve the quality of further research projects on similar topics.

Another achievement of the task was the **theoretical reflection on the dimensions**, mechanisms and criteria of resilience, when applied to AF and MF systems. We are aware that the contribution of AGROMIX to the topic could maybe considered as only a smaller step forward, but it is noteworthy that some critical aspects were clearly identified as knowledge gaps and starting points for future research initiatives. The complexity and variability of local experiences of AF/MF systems in Europe was clearly perceived as a barrier for the development of “win-win” common protocols and policy recommendations. On top of that, the lack of+ shared understanding on clear definitions of AF and MF systems both in the scientific community and at policy level was identified as a gap to tackle in the future to allow more solid assessments and political support to these systems.

Finally, we consider the **framework of resilience based on indicators** as a **tool to be tested** and improved in future research projects. The complexity of the set of indicators used in AGROMIX, the multidisciplinary analysis of their effectiveness and the possibility we had to test part of them together with the stakeholders are the major strengths of this framework. More extensive contribution of stakeholders and an active engagement of policy makers in further validation and improvement efforts are claimed to make a real step forward in bridging science, practice and policy initiatives aimed to develop further AF and MF systems.

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6 References

Berne, C., Desaint, B., Marie, F., Böhmer, J., Re, M., Burbi, S., Mantino, S., Pulido Fernández, M., Gaspar García, P., Giannitsopoulos, M.L., Burgess, P.J., Graves, A., Bracke, J., Willekens, K., Dawson, A., Smith, J., Tomás, A., Palma, J., Jäger, M., Chiarini, F., Bondesan, V., Roganović, D., Milinković, M. (2024). *Multicriteria assessment of co-designed future farming systems report based on pilots' data. D4.1 of the AGROMIX project funded under the Grant Agreement 862993 of the H2020 EU programme. Document available at:* ***https://agromixproject.eu/project/#how-we-work***

Bracke, J., de Jong, D., Dawson, A., van Haperen, A., Willekens, K., Reubens, B., Böhmer, J., Ambu, Z., Desaint, B., Tavares, O., Jäger, M., Kay, S., Re, M., Mantino, A. (2022). Experiences from the first round of RID Pilots. D2.4 of the AGROMIX project funded under the Grant Agreement 862993 of the H2020 EU programme. Document available at: ***https://agromixproject.eu/project/#how-we-work***

Püttsepp Ü., Schnabel S., Antichi D., Chiron G., Dehnen-Schmutz K., Heinsoo K., Kauer K., Mele M., Ots M., Pechenart E., Tali K., Venn R., Verstand D. (2022) Handbook of resilience and working definitions. D1.1 of the AGROMIX project funded under the Grant Agreement 862993 of the H2020 EU programme. Document available at: ***https://agromixproject.eu/project/#how-we-work***

Saaty T. L. 1990. How to make a decision: The analytic hierarchy process. Eur J Oper Res 48 (1), 9-26, doi.org/10.1016/0377-2217(90)90057-I

Saaty T. L. 2008. Decision making with the analytic hierarchy process. Int. J. Services Sciences, Vol. 1 (1).

Verstand, D., Houben, S., Selin Norén, I. (2021). Farm-level indicators for resilience to climate change stressors. D1.3 of the AGROMIX project funded under the Grant Agreement 862993 of the H2020 EU programme. Document available at: ***https://agromixproject.eu/project/#how-we-work***

*Wezel, A., Herren, B.G., Kerr, R.B. et al. Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. Agron. Sustain. Dev.**40**, 40 (2020). https://doi.org/10.1007/s13593-020-00646-z*

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Appendix 1

SCALING, AHP

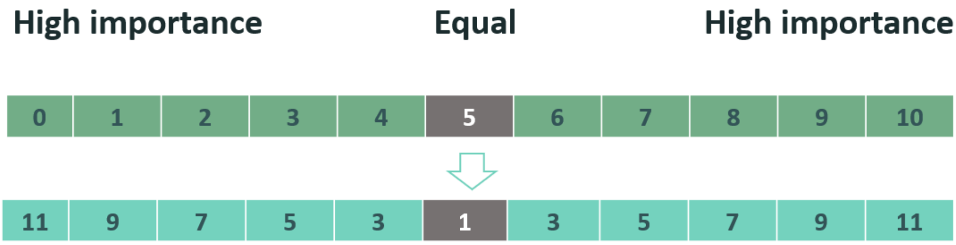

Figure 24 - Conversion of the scale in the T1.5 questionnaire Section A, to the one used in AHP analysis

Table of scores obtained from the WP representatives, and converted:

Original

respondent		0	1	2	3	4	5	6	7	8	9	10	
WP2	Ecol						5						Econ
WP3	Ecol									8			Econ
WP4	Ecol						5						Econ
WP5	Ecol								7				Econ
WP6u	Ecol						5						Econ
WP6r	Ecol									8			Econ
WP2	Ecol				3								Soc
WP3	Ecol	0											Soc
WP4	Ecol						5						Soc
WP5	Ecol								7				Soc
WP6u	Ecol				3								Soc
WP6r	Ecol									8			Soc
WP2	Econ				3								Soc
WP3	Econ		1										Soc
WP4	Econ						5						Soc
WP5	Econ				3								Soc
WP6u	Econ					4							Soc
WP6r	Econ					4							Soc

Converted

respondent		11	9	7	5	3	1	3	5	7	9	11	
WP2	Ecol						1						Econ
WP3	Ecol									7			Econ
WP4	Ecol						1						Econ
WP5	Ecol								5				Econ
WP6u	Ecol						1						Econ
WP6r	Ecol									7			Econ
WP2	Ecol				5								Soc
WP3	Ecol	11											Soc
WP4	Ecol						1						Soc
WP5	Ecol								5				Soc
WP6u	Ecol				5								Soc
WP6r	Ecol									7			Soc
WP2	Econ				5								Soc
WP3	Econ		9										Soc
WP4	Econ						1						Soc
WP5	Econ				5								Soc
WP6u	Econ					3							Soc
WP6r	Econ					3							Soc

CALCULATIONS, AHP

Table 1 a, b, c. Importance of dimensions in AGROMIX research.

a) pairwise comparison matrix of aggregated values by multiple respondents. Sums of the column values in the bottom row.

Dimensions (dim.)	Ecological dim.	Economic dim.	Social dim.
Ecological dim.	1.00	0.40	2.70
Economic dim.	2.50	1.00	3.56
Social dim.	0.37	0.28	1.00
Sum	3.87	1.68	7.26

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b) normalised pairwise matrix was calculated by dividing the values in the cells by the corresponding sum of the column. Priority weights were calculated by averaging all the normalised values in the row. The priority weights sum to 1.

Dimensions (dim.)	Ecological dim	Economic dim.	Social dim.	Sum of weights	Priority weights (Sum of weights / 3)
Ecological dim.	1 / 3.87 = 0.258	0.40 / 1.68 = 0.238	2.70 / 7.26 = 0.372	0.868	0.289
Economic dim.	2.50 / 3.87 = 0.65	1.0 / 1.68 = 0.59	3.56 / 7.26 = 0.49	1.730	0.577
Social dim.	0.37 / 3.87 = 0.096	0.28 / 1.68 = 0.167	1.0 / 7.26 = 0.14	0.401	0.134

c) To calculate the Consistency Index, the values in the original matrix were multiplied column-wise by the corresponding priority weights, then summed up row-wise.

Priority weights	0.289	0.577	0.134		
Criteria	**Ecological**	**Economic**	**Social**	**Weighted Sum**	**Divide by priority weights**
Ecological	1.00 * 0.289 = 0.289	0.40 * 0.577 = 0.2308	2.70 * 0.134 = 0.3618	0.8816	0.8816 / 0.289 = 3.0505
Economic	2.50 * 0.289 = 0.7225	1.00 * 0.577 = 0.577	3.56 * 0.134 = 0.477	1.7765	1.7765 / 0.577 = 3.0789
Social	0.37 * 0.289 = 0.107	0.28 * 0.577 = 0.1616	1.00 * 0.134 = 0.134	0.4026	0.4026 / 0.134 = 3.00448
λ_{max}					3.045

where λ_{max} is the consistency vector, that is, the averaged value of each of calculated eigenvectors

Calculation of Consistency Ratio (CR):

n = 3

CI = (3.045 – 3) / (3 – 1) = 0.0225

RI = 0.58

CR = 0.0225 / 0.58 = 0.039

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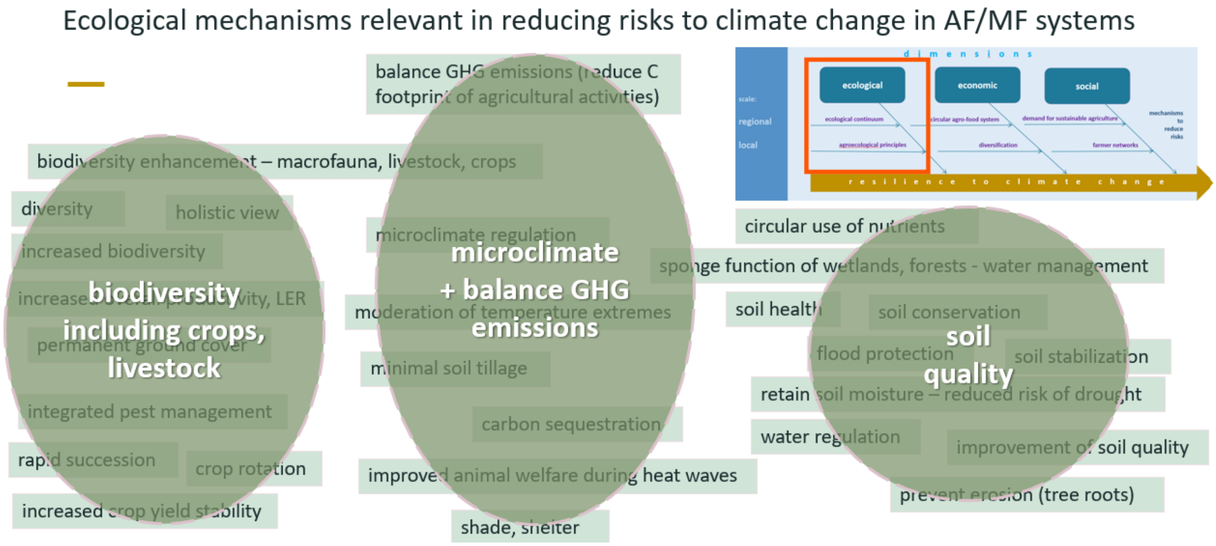
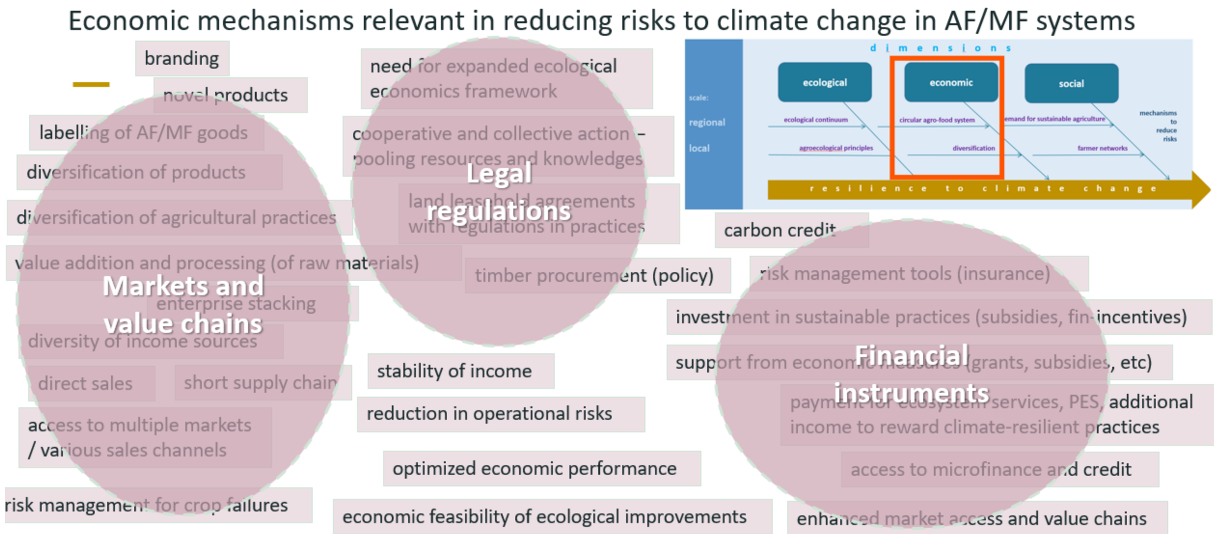
Appendix 2

MECHANISMS TO REDUCE RISKS OF CLIMATE CHANGE



Ecological mechanisms relevant in reducing risks to climate change in AF/MF systems. The keywords are organised into regions based on similarity, with category names. The diversity or similarity of the keywords allowed for only broad categorisation, with some overlaps.



Economic mechanisms relevant in reducing risks to climate change in AF/MF systems. The keywords are organised into regions based on similarity, with category names. The diversity or similarity of the keywords allowed for only broad categorisation, with some overlaps

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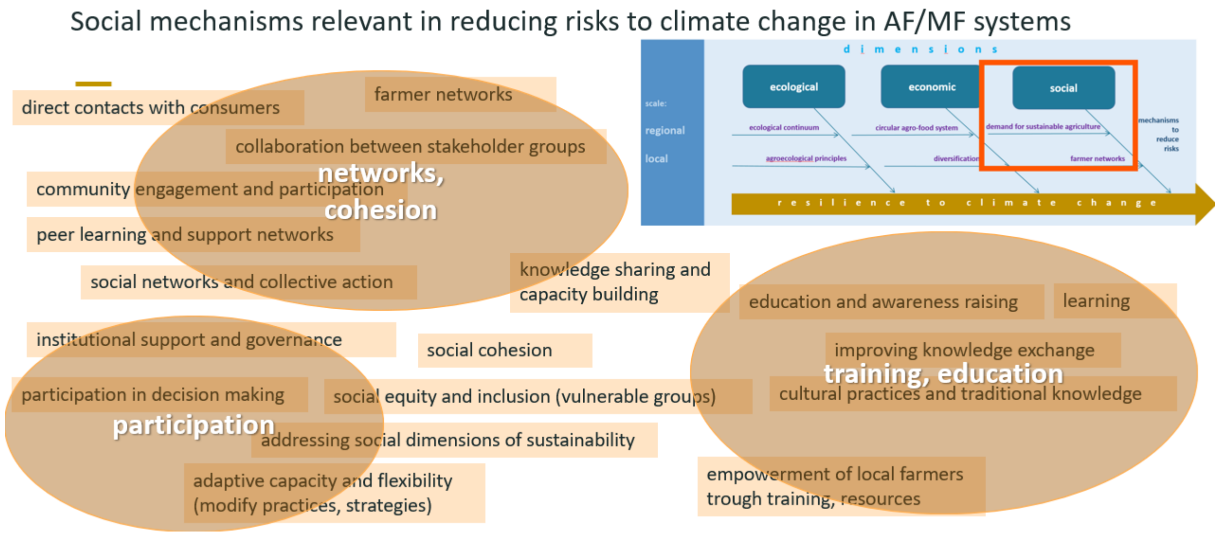

Social mechanisms relevant in reducing risks to climate change in AF/MF systems. The keywords are organised into regions based on similarity, with category names. The diversity or similarity of the keywords allowed for only broad categorisation, with some overlaps

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