PIISA

Piloting Innovative Insurance Solutions for Adaptation

D3.8 Insurance services for the Mediterranean region

Authors: Sheetal Saklani, Nadia Milders, Laura Grassi, Luca Carrai, Ángel G. Muñoz

Funded by the European Union

Disclaimers

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Artificial Intelligence (AI) was used to enhance the clarity of certain aspects in this document. "The AI tool used in this document is ChatGPT-4. AI was used in sections of Introduction and Conclusion, and some parts of others. The purpose was to simply refine the content in terms of language and structure. The authors retain full accountability for the content and its accuracy.

Funded by the European Union

Document information

Grant Agreement	n°101112841
Project Title	Piloting Innovative Insurance Solutions for Adaptation
Project Acronym	PIISA
Project Coordinator	Hilppa Gregow, Finnish Meteorological Institute
Project Duration	1.6.2023 – 31.5.2026 (36 months)
Related Work Package	WP3
Deliverable Title	Insurance services for the Mediterranean region
Related Task(s)	Task 3.3
Lead Organisation	Barcelona Supercomputing Centre
Contributing Partner(s)	Politecnico di Milano
Authors	Sheetal Saklani, Nadia Milders, Laura Grassi, Luca Carrai, Ángel G. Muñoz
Due Date	30 May 2025
Submission Date	30 May 2025
Dissemination level	PU – Public

History

Date	Version	Submitted by	Reviewed by	Comments
05/05/2025	First	BSC-CNS	Polimi	
16/05/2025	Second	BSC-CNS	FMI	

Funded by the European Union

Table of contents

List of figures

Funded by the European Union

List of tables

Funded by
the European Union

Summary

This report (Deliverable 3.8) under the PIISA project explores the feasibility and design of parametric insurance solutions for addressing climate risks in the agricultural sector of the Mediterranean region, a climate change hotspot. Traditional indemnity-based insurance is often considered costly, complex, or unavailable, contributing to a significant crop insurance protection gap. Through a combination of farmer surveys in Italy and Spain, and a focused pilot study on olive cultivation in Jaén, Spain, the report analyses farmers' perceptions of climate risks, existing risk management strategies, as well as barriers to climate insurance, including index-based insurance (IbI), uptake. The findings show that there is limited awareness of IbI, but a strong potential for adoption if solutions are simplified, better explained, and supported by public incentives. The report also introduces the CoDepi tool, a participatory and demand-driven framework for co-designing IbI products tailored to local crops and climate thresholds. This work lays the foundation for scaling innovative climate insurance solutions in Mediterranean agriculture, and beyond in Europe.

Keywords

Parametric insurance, index-based insurance, climate risk, agricultural insurance, olive cultivation, insurance protection gap, CoDepi tool, climate adaptation, Mediterranean agriculture, farmer perceptions

Abbreviations and acronyms

Acronym	Description
ASAJA	Asociación Agraria de Jóvenes Agricultores (Agrarian Association of Young Farmers)
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
ECMWF	European Centre for Medium-Range Weather Forecasts
IbI	Index-based insurance
IPCC	Intergovernmental Panel on Climate Change
WP	Work Package
EEA	European Environment Agency
EIOPA	European Insurance and Occupational Pensions Authority
EMEA	Europe, Middle East, and Africa
ESFS	European System of Financial Supervision
SRI	Swiss Re Institute
IRI	International Research Institute for Climate and Society
GDPR	General Data Protection Regulation

Funded by the European Union

1 Introduction

Economies in the European Union (EU) face increasing climate and weather-related risks, exacerbated by the impact of climate change. Data from the European Environment Agency (EEA) indicate that weather- and climate-related hazards caused overall economic losses of assets estimated at €738 billion during 1980 - 2023 in the EU, with over €162 billion (22%) between 2021 and 2023. This is tied to the fact that recent years have seen many long-standing climate records broken in Europe. Europe is also facing more and stronger climate hazards, including heat waves and prolonged droughts, heavy precipitation and sea level rise, leading to floods. According to recent climate risk assessments, most climate hazards in Europe will further increase during the 21st century, even under optimistic scenarios compatible with the Paris Agreement. A pessimistic scenario suggests that economic damages related to coastal floods alone might exceed €1 trillion per year by the end of the century in the EU (EEA, 2024).

Specifically, the EU agricultural sector is facing unprecedented environmental challenges, due to increasing pressures from climate change (EC, 2023). Climate change and natural climate variability already has and is projected to continue having significant impact throughout the 21st century due to, for example, increased heat, drought, floods, pests, diseases and the decreasing health of soils. Some impacts are expected to produce substantial losses in agricultural production in terms of lower crop yields, as well as a reduction in suitable areas for crop cultivation. The southern regions of Europe will be hit the hardest due to heat and water shortage. While in the north of Europe higher temperatures may open up new areas for warm-season crops, these gains won't offset the losses in other regions (EC, n.d.). These challenges present an urgent need for adaptive strategies to foster sectoral resilience and safeguard food security across the EU.

One such adaptive strategy is for farmers to take insurance coverage against climate risks. Approximately 60% of the global insurable value of crop production was unprotected against climate risks in 2022, highlighting a substantial crop insurance protection gap. In monetary terms, the global crop protection gap stands at an estimated $113 billion in USD premium equivalent terms in 2022, up from $88 billion in 2016. Compared to the year 2016, the global crop protection gap increased by 4.2% on average per year. The Crop Insurance Resilience Index developed by the Swiss Re Institute (SRI), which is a measure of how well the crop sector is protected against financial losses due to nature risks, reveals that resilience in advanced EMEA declined from year 2016 to 2022, as sums insured rose less than the value of crops in some markets, notably Spain and Italy, and France saw several years of poor crop yields. Correspondingly, the protection gap in terms of USD billion, rose from 10 to 21 during the same period (SRI, 2023).

One of the key drivers of the crop insurance protection gap is that traditional (indemnity-based) insurance is often too costly, complex, or simply unavailable. As an alternative or complementary tool, index-based insurance (IbI), also known as parametric insurance, can help bridge the gap not only by offering accessible coverage for risks that may be otherwise uninsurable, but also by triggering timely payouts, allowing farmers to take early action for

Funded by the European Union

damage mitigation and prevention. In this context, we investigate the feasibility of implementing parametric insurance in the agricultural sector of the Mediterranean region. This report, Deliverable 3.8 of the PIISA project, details the work carried out under the Food and Agriculture pilot within Task 3.3 of Work Package 3. Specifically, it outlines the progress made in loop 2 of the pilot, which pertains to the Mediterranean region. The Mediterranean has been identified as a climate change hotspot by the Intergovernmental Panel on Climate Change (IPCC). The region faces increased vulnerability to climate variability and extreme weather events, such as prolonged droughts, heatwaves, unseasonal frosts, and erratic rainfall patterns, all of which pose serious threats to crop yields and farmers' livelihoods.

Surveys have been conducted in both Italy and Spain to gather farmers' perspectives on climate risk and insurance, covering both traditional indemnity-based models and parametric alternatives. The aim of these surveys has been to better understand how farmers perceive climate-related risks, the challenges they face due to extreme weather events, and their demand for insurance, with particular emphasis on parametric solutions, examining the barriers to and incentives for their adoption. They also explore the climate risk management strategies that the farmers currently use, including both insurance-based and non-insurance approaches, and assess their perceived effectiveness, from which inferences can be made regarding the current insurance protection gap. In parallel, to test the practical application of parametric insurance in the agricultural sector, a pilot case study is being conducted. For parametric insurance to be effective, it must be tailored to local climate conditions and specific crop types. Therefore, this pilot focuses on olive cultivation in southern Spain—a crop and region particularly vulnerable to climate variability.

2 Parametric insurance—a proactive approach to risk management

As climate risks intensify and extreme weather events become more frequent, traditional indemnity-based insurance models often fall short of meeting the evolving needs of the agricultural sector. These models provide compensation only after physical damage has been assessed, so that by the time a payout occurs, the damage has already been done. Moreover, long delays and complex claim verification processes offer little support for farmers in preventing or mitigating losses.

In contrast, IbI represents a more proactive approach to risk management. By triggering payouts based on predefined thresholds in a timely manner, it provides farmers with the necessary funds to be able to take preventive or mitigative actions before the full extent of damage unfolds. This not only reduces losses during the bad years but also provides farmers with greater certainty and confidence to invest in productivity-enhancing but higher-risk practices, such as adopting improved seeds, fertilizers, or irrigation systems, during a typical year, i.e. a year without extreme climate events. In case of indemnity, there is a persistent uncertainty around loss compensation which discourages productive investments even in normal years, as farmers remain risk-averse due to the possibility of future production and

Funded by the European Union

income shocks. IbI, by reducing this uncertainty, empowers farmers to break free from subsistence-level strategies and build long-term resilience.

2.1 Parametric versus indemnity insurance

The main difference between parametric and indemnity insurance lies in the basis for claims. The former relies on the occurrence of predefined events as measured by indices, while the latter is triggered by verifiable physical damage and loss. For example, in case of drought insurance, under a parametric policy a farmer would receive a payout automatically if rainfall index is lower than a predefined threshold, regardless of actual damage, whereas in the indemnity policy, the farmer would need to file a claim, and the damage would be verified through on-site assessment before any payout is received. This has implications across various product dimensions. Parametric models benefit from simplified underwriting, reduced moral hazard and adverse selection, as well as greater policy transparency. Importantly, claim settlement is expedited as it eliminates the need for loss assessments. The simplicity and flexibility in product design can further reduce informational frictions and transaction costs, making it a viable tool even in areas with weak institutional capacity.

However, these advantages come with trade-offs. Parametric insurance introduces basis risk, that is the risk that payouts do not align with actual losses on the ground, particularly in regions with sparse or unreliable data. Basis risk not only negatively affects trust but also adds significantly to the product premium. The effect of basis risk on product price is further pronounced from the reliance of insurance companies on reinsurance companies to cover covariate risks who, due to their lack of understanding of the local context, uncertainty aversion and higher bargaining power, considerably drive up the premium rates. Moreover, while indemnity insurance is well-integrated within existing regulatory frameworks, the regulations for parametric insurance may be poorly defined and/or understood in the case of countries where the insurance law has not yet adapted to index-based products. Another limitation is the persistent lack of awareness and understanding of these products among potential users, which can hinder uptake. Addressing these issues will require investment in data infrastructure, stakeholder engagement, supportive policy, and raising awareness.

2.2 Market structure for parametric insurance

According to Lin & Kwon (2020), parametric insurance market is classified across three tiers:

1. **Micro-risk insurance** targets individuals and smallholders, often within donor-supported microinsurance schemes or through private sector initiatives for small businesses. Products are characterized by low premiums and simplified coverage structures.
2. **Meso-risk insurance** is tailored for intermediaries or “risk aggregators” such as cooperatives, banks, and local governments. These policies provide financial protection against intermediate-scale losses, with triggers designed to match institutional exposure.

Funded by the European Union

3. **Macro-risk insurance** is employed at the national or sub-national level, where governments purchase coverage to manage the fiscal impact of large-scale disasters. These instruments can support emergency response, infrastructure rehabilitation, and the continuity of public services.

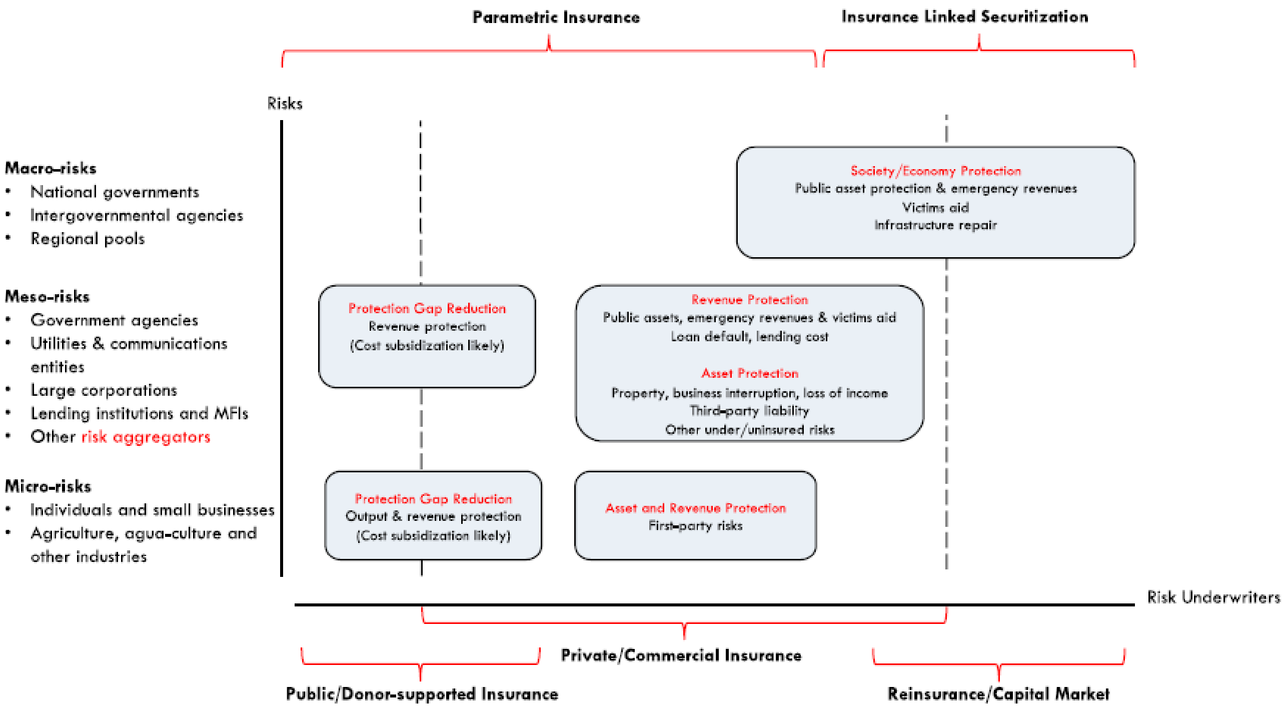


Figure 1: Market structure for IbI (Lin & Kwon, 2020)

2.3 Limitations and way forward

While parametric insurance offers a potentially cost-effective and scalable alternative to indemnity-based insurance, several key concerns limit its widespread adoption. The primary issue pertaining to IbI is that of basis risk, i.e. the mismatch between payouts and actual losses experienced by farmers. This discrepancy can lead to situations where farmers suffer substantial losses without receiving compensation, undermining trust in the product (Carter et al., 2017; Jensen & Barrett, 2016). Other significant barriers include the high cost of premiums, liquidity constraints, poor understanding of insurance principles among farmers, low trust in providers, and limited financial literacy. Behavioral responses, such as ambiguity aversion, further reduce demand for IbI, especially when its probabilistic nature is poorly understood or when payouts are inconsistent with perceived needs (Carter et al., 2017).

To overcome these challenges, researchers suggest multiple strategies, such as improving contract design, including fail-safe mechanisms, e.g. audit-triggered payouts, or combining indices with satellite and field data to reduce basis risk. Additionally, bundling IbI with other products such as stress-tolerant seeds, input loans, or savings tools can enhance its value and uptake (Carter et al., 2017). Basis risk can also be minimized by splitting a region into

Funded by the European Union

homogenous units based on similarity in climate conditions (Lehmann, Krauer, & Vroege, 2021). Building trust through local engagement, transparent communication, and timely payouts is also key. From a policy perspective, public investment in quality standards, better data infrastructure, and impact evaluations improve product reliability and reduce information gaps (Jensen & Barrett, 2016). Overall, the success of IbI depends on multiple factors related to the technical, cultural, behavioral and policy dimensions of climate risk management.

3 Index insurance regulation in the EU

The primary step in understanding the governance of IbI in the EU is identifying the relevant regulatory authorities. In general, financial supervision within the EU operates under the European System of Financial Supervision (ESFS), introduced in 2010 as part of the post-financial crisis reforms initiated by the European Commission (EC).

The supervisory architecture of ESFS comprises the following tiers:

- The European Systemic Risk Board (ESRB), which monitors systemic risks to financial stability.
- Three European Supervisory Authorities (ESAs), namely
    - the European Banking Authority (EBA), based in Paris,
    - the European Securities and Markets Authority (ESMA), also based in Paris,
    - the European Insurance and Occupational Pensions Authority (EIOPA), located in Frankfurt.

Focusing on insurance, EIOPA is the central regulatory authority at the European level established by EU Regulation 1094/2010/EU. EIOPA plays a vital role in ensuring consumer protection, financial stability, and the consistent application of regulatory standards across the insurance and occupational pensions sectors. It also supports innovation in insurance markets, including the development of non-traditional products like parametric insurance. The authority acts within the powers conferred by the EU Regulation 1094/2010/EU and within the scope of several EU directives, including all directives, regulations and decisions based on those acts and of any further legally binding EU Act that confers tasks on the authority (European Parliament and Council, 2010).

At a national level, the government bodies regulating the (re)insurance industry are the national supervisory authorities in each respective EU member state. The extent of their powers is determined by Solvency II Directive and national insurance supervisory law (CMS, 2020). These national bodies are responsible for the direct supervision of insurers operating within their jurisdictions and for implementing EU-level directives and regulations into national legislation. These national regulatory bodies are listed on the EC website, with the caveat that some of the entries are outdated, i.e. they mention bodies that have since been restructured and/or renamed. It is also important to note that they more generally list the regulatory bodies dealing with insurance and pension. For cross-validation, a list of national authorities that are

Funded by the European Union

part of the International Association of Insurance Supervisors (IAIS) is published on their official website. Lastly, each body has detailed information on their objectives and operations on their individual websites.

Country	Regulatory Body & Other sources of Information
Croatia	Croatian Financial Services Supervisory Agency (Hanfa)
Cyprus	Insurance Companies Control Service (ICCS)
France	Autorité de Contrôle Prudentiel et de Résolution (ACPR) *EN: Prudential Supervision and Resolution Authority*
Greece	Bank of Greece
Italy	Istituto per la vigilanza sulle assicurazioni (IVASS) *EN: Insurance Supervision Agency*
Malta	Malta Financial Services Authority (MFSA)
Portugal	Autoridade de Supervisão de Seguros e Fundos de Pensões (ASF) *EN: Insurance and Pension Funds Supervisory Authority*
Slovenia	Agencija za Zavarovalni Nadzor (AZN) *EN: Insurance Supervision Agency*
Spain	Dirección General de Seguros y Fondos de Pensiones (DGSFP) *EN: Directorate general of Insurance and Pensions Funds*

Table 1: National regulatory authorities of EU member states in the Mediterranean
Note: This table presents the national-level insurance sector regulatory bodies of the EU member states in the Mediterranean region.
Data Source: European Commission, ASF official website, iclg official website, ACPR official website, ICCS official website, IAIS official website

Some of the above-mentioned regulatory bodies issue industry reports. These reports are issued routinely, typically on an annual basis, which allows tracking over time the changes in the policy pertaining to the insurance sector. The European Insurance Overview is the annual industry report published by EIOPA. The latest version as of 2023, however, does not contain information about regulations for index-based insurance. Among the other institutions outside of ESFS, Insurance Europe stands out as the European insurance and reinsurance federation. They released the 2022–2023 Annual Report, which outlines the European insurance industry's position on current insurance-related matters. However, the report also does not include any information specific to the parametric insurance sector. Industry reports also originate from other types of institutions, including consulting firms, government departments,

Funded by the European Union

and financial think tanks, among others. However, these are often commissioned with restricted access and therefore, less accessible.

To conclude, for obtaining detailed information on regulations pertaining to index-based insurance (IbI) within the EU, it is advisable to consult the official websites of the relevant regulatory bodies, particularly the national authorities, which are responsible for implementing and supervising insurance regulations within their respective jurisdictions. Accessing these national regulators' websites can offer insights into local regulatory frameworks and any specific provisions related to IbI. It's important to note that, in general, the regulatory framework governing IbI aligns with that for traditional insurance products, as they fall under the same overarching directives, such as Solvency II and Insurance Distribution Directive (IDD). Therefore, while this section does not enumerate any specific regulations for IbI across the EU, stakeholders are encouraged to refer to the national authorities' official publications and websites for the most accurate and up-to-date information.

4 Farmer Surveys

4.1 Survey of Italian farmers

Climate change has increasingly emerged as a systemic global risk, with environmental hazards intensifying both in frequency and severity over the past decades. According to the Global Risk Report 2025[1] environmental risks have worsened significantly since 2006. In particular, extreme weather events are ranked as the second most critical global risk over the next two years, and the most severe risk over a ten-year horizon.

Among the sectors most vulnerable to climate change, agriculture occupies a central position. The agricultural sector is highly exposed to climate-related hazards through multiple channels: from the direct impact of rising temperatures and changing precipitation patterns on crop yields, to physical damage caused by extreme weather events such as droughts, floods, and storms. Ultimately, these phenomena directly affect the price, quantity, and quality of agricultural production, with significant repercussions on farm income and market dynamics (European Environment Agency, 2019).

In this context, climate change and natural climate variability adaptation strategies at the farm level are essential not only for ensuring environmental sustainability but also for safeguarding economic viability. A wide range of well-established adaptation measures already exists — including improved soil and water management, crop diversification, and innovative farming techniques — aimed at sustaining resilient production systems and reducing vulnerability to climate hazards. However, adaptation at the farm level, in many cases, does not take place

[1] World Economic Forum, Global Risk Report (2025): https://reports.weforum.org/docs/WEF_Global_Risks_Report_2025.pdf

Funded by the European Union

because of a lack of awareness and understanding of climate-related risks, limited financial resources, insufficient institutional support, and restricted access to knowledge and technical solutions. Consequently, a better understanding of farmers' current exposure to climate risks, their perceptions, and the strategies they are adopting represents a necessary step for designing effective policies and tools aimed at fostering climate resilience in agriculture.

The objective of this Section is to explore the current situation of Italian farmers in relation to climate change, focusing on two core aspects:

- their exposure and awareness to natural hazard-related risks
- the adaptation strategies currently implemented

Understanding this initial situation is essential to design targeted and effective support measures — including educational programs, government incentives, and innovative technological and financial solutions — aimed at enhancing the resilience of the agricultural sector.

The report deep-dives in the Italian situation, a Mediterranean country of strong interest for the PIISA Project Objective. Despite agriculture accounting for a relatively small share of Italy's GDP (approximately 2% of value added), the sector plays a stabilizing and strategic role in the Italian economy, 3.4% of employed Italians work in the agricultural sector. Over recent years, the value of exported agricultural products has increased by nearly 40%, while domestic agriculture provides more than 70% of the inputs required by the agro-industrial sector and nearly all inputs for the hospitality and food service industries. The agro-industrial sector itself accounts for 3% of national GDP and 9% of total exports. Italians are also very careful about the quality of the food; indeed, agricultural products represent over 80% of final household consumption in Italy. Consequently, fluctuations in the quality, quantity, and prices of agricultural production have a direct impact on consumers' welfare and on the stability of connected sectors (Bank of Italy, 2023).

Given the sector's economic importance and vulnerability to climate risks, this Section devotes particular attention to the role of climate change adaptation and in particular of insurance and parametric insurance as a potential tool for supporting climate change adaptation among Italian farmers. Insurance solutions play a dual role: on the one hand, they protect farmers from the financial consequences of adverse events; on the other, they can act as incentives for risk reduction and adaptation. Recent events, such as the floods that impacted Emilia Romagna in 2023 — affecting approximately 42% of the region's agricultural area and causing estimated damages of €1.5 billion — highlight the growing relevance of risk transfer mechanisms like insurance in agricultural adaptation strategies.

Building on the insights produced from Deliverable D3.7, this study assesses the Italian farmers' interest in insurance and parametric insurance products. It also analyses the obstacles that limit insurance adoption, alongside the factors that could stimulate wider uptake of these solutions.

This chapter will be structured as follows, in section 4.1.1 we illustrate the methodology, in 4.1.2 we evaluate farmers' exposure to specific natural hazards related risks. In section 4.1.3, we then assess their current and future perception of these risks. We then explore their knowledge of climate change adaptation measures and the strategies currently in use (section 4.1.4). Finally, in section 4.1.5 and 4.1.6 we assess farmers' knowledge of insurance and parametric insurance solutions to protect against these risks along with the associated incentives and barriers to purchasing these policies.

4.1.1 Methodology

This report investigates the current situation of farmers in relation to climate change, with a specific focus on their perceptions, exposure to natural hazards-related risks, as well as the climate adaptation strategies they are implementing. Particular attention is given to the role of insurance solutions, including the adoption and potential of parametric insurance instruments.

Consistently with the deliverable D1.4 we took in consideration natural hazards-related risks delineated by the EU Disaster Risk Management Knowledge Centre classification (Poljanšek et al., 2017). According to this classification, natural hazards can be broadly divided into three main types of phenomena:

1. Geophysical phenomena that include the following natural hazard: earthquakes
2. Hydrological phenomena that include the following natural hazards: floods and landslides.
3. Meteorological phenomena that include the following natural hazards: storms, rainstorm, hailstorm.
4. Climatological phenomena that include the following natural hazards: wildfires, extreme temperatures and drought.

To this end, an online survey (Computer Assisted Web Interviewing – CAWI) was conducted, targeting farmers operating in four representative Italian agricultural regions: Lombardy, Emilia Romagna[2], Tuscany, and South Italy. These areas were selected to capture geographical variability, as well as differences in agricultural practices across the country.

The sampling of respondents was based on the ATECO classification system, the Italian standard for coding economic activities[3]. Specifically, the focus was placed on farmers registered under Ateco code A.01 – Agricultural cultivation and production of animal products, hunting and related services. Within this broad category, the analysis was further restricted to the subcategories A.01.1 (Cultivation of non-permanent crops) and A.01.2 (Cultivation of permanent crops). This selection allowed the exclusion of other agricultural activities such as

[2] Regione Emilia-Romagna: https://notizie.regione.emilia-romagna.it/comunicati/2023/maggio/alluvione-agricoltura-le-prime-stime-il-42-della-superficie-agricola-colpito-dagli-eventi-64-mila-lavoratori-interessati-danni-per-miliardi

[3] ISTAT, ATECO Code: https://www.istat.it/non-categorizzato/ateco-2007-aggiornamento-2022/

Funded by the European Union

plant reproduction, livestock farming, and post-harvest processing, ensuring that the target population was limited exclusively to crop cultivation activities.

In total, Politecnico di Milano had 626 valid responses. The final sample included a diverse range of farms in terms of both geographical location and farm size. Consistent with the most recent agricultural census conducted by ISTAT[4] (2022), the sample was mainly composed of small-scale farms, with 60% of respondents managing agricultural land of 20 hectares or less (see Figure 2).

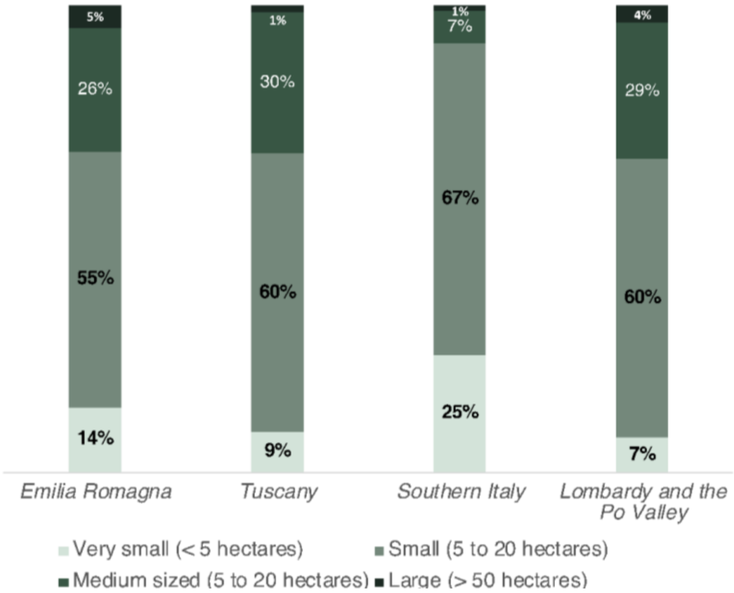


Figure 2: Sample composition. Source: Proprietary data on 626 Italian farmers

The questionnaire was initially developed in English and subsequently shared with the PIISA project consortium partners for review. Feedback enabled to identify potential weaknesses and refine the questionnaire design, ensuring relevance and clarity. Following this, the final version was translated into Italian and pre-tested with the support of one Professor and four PhD students from Politecnico di Milano. The pre-test aimed to verify the clarity, logic, and internal consistency of the questionnaire, while also identifying any possible sources of misunderstanding or bias.

Data was collected anonymously over a specified period, with participation being voluntary. Respondents were informed of the survey's purpose, their rights, and assured that their responses would remain confidential. Descriptive statistics (e.g., percentages and means) were employed to summarize the main findings related to farmers' exposure to climate risks, their risk perceptions, and the adaptation strategies adopted, particularly in relation to

[4] ISTAT, General Census of Agriculture: https://www.istat.it/it/files/2022/06/REPORT-CENSIAGRI_2021-def.pdf

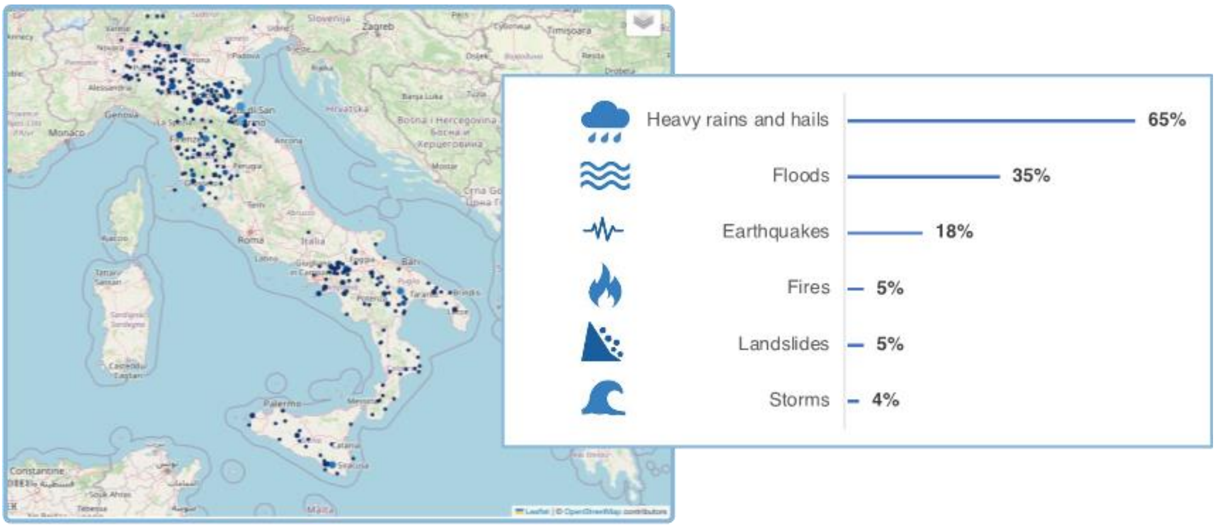
Funded by the European Union

insurance solutions and parametric insurance. In addition, inferential statistical tests, such as chi-square tests, were applied to assess the significance of observed differences.

4.1.2 Risk exposure

Let's now have a look at the current exposure of Italian farmers to natural hazard-related risks across different regions of the country. To capture this dimension, farmers were asked to report whether their production areas were located in proximity to specific risk-prone zones, such as areas susceptible to flooding, landslides, seismic activity, or other natural phenomena. This approach allows for an initial mapping of the geographical exposure of farms within our sample, providing a useful overview of the distribution and typology of risks faced by Italian farmers. The results show that only one out of three farmers consider their farm to be completely unexposed to natural hazards, while the remaining 63% report being exposed to at least one natural hazard related risk.

Among those reporting exposure, the most frequently mentioned risks relate to weather-related phenomena, particularly heavy rainfall and hailstorms, which affect 65% of the exposed farmers (Figures 3). This type of risk appears to be relatively homogeneous across the different geographical areas covered by the analysis, highlighting the widespread vulnerability of Italian agriculture to meteorological events. Flood risk represents another relevant threat, reported by 35% of exposed farmers, especially among those whose farms are located in proximity to rivers or watercourses (Figure 3). Lastly, seismic risk is reported by 18% of exposed farmers (Figure 3).



Funded by the European Union

Figure 3: Geography of farmers exposed to natural hazards. Source: proprietary data on 395 Italian farmers

This exposure is not just perception, as 82% of the farmers have actually experienced at least one natural hazard in the past five years, and among these, 53% have suffered an economic loss. Meteorological hazards, notably heavy rain (65% already impacted), hail (57%) and storms (40%), and on the other side climatological hazards such as extreme temperatures (50%) and drought (42%) are the most diffused one (Figure 4)

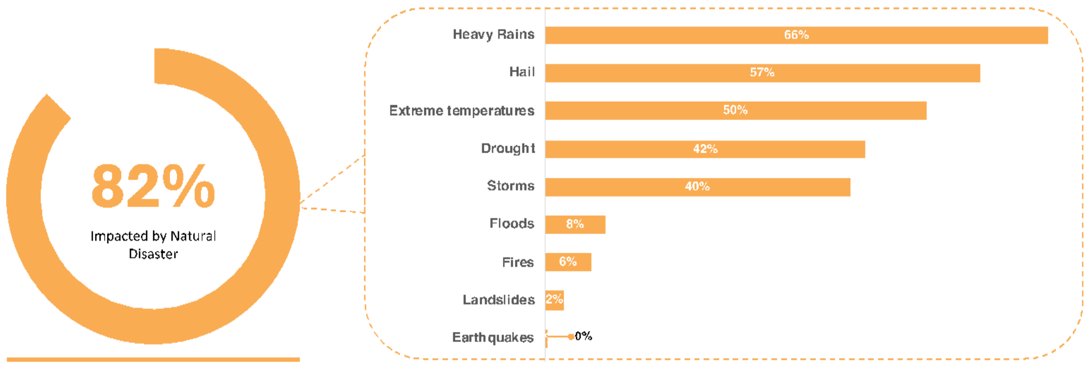


Figure 4: Natural hazard impact on farmers in the past five years. Source: proprietary data on 626 Italian framers

Funded by the European Union

4.1.3 Risk perception

While the previous section provided an overview of the objective exposure of Italian farmers to natural hazard-related risks — based on the geographical location of their production areas — exposure alone does not offer a complete understanding of farmers' vulnerability to climate risks. Indeed, the presence of risk in a specific area does not necessarily translate into farmers' awareness or concern regarding that risk. Here, therefore, we shift the focus from objective exposure to subjective perception of risk. Investigating risk perception is essential to capture the extent to which farmers are aware of and concerned about the potential threats posed by climate and environmental hazards, regardless of their actual geographical exposure. This distinction is crucial, as risk perception influences the willingness to adopt adaptation measures — including insurance solutions. Indeed, the extant academic literature confirms that the more an individual perceives a risk, the more willing they are to acquire an insurance policy (Botzen et al., 2009).

This section, therefore, explores farmers' perceptions of the main natural hazards-related risks with the objective to highlight how these perceptions may affect their attitudes toward insurance adoption. The first result emerged is that as of today, 51% of farmers are concerned about climate change. This means that nearly half of the farmers either do not perceive or have a low perception of the risks associated with climate change (see Figure 5).

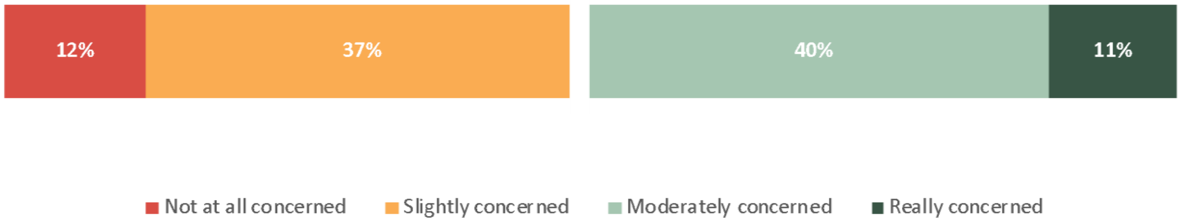


Figure 5: Level of current concern expressed by farmers about climate change. Source: proprietary data on 626 Italian framers

However, when looking into the future, the situation changes slightly (see Figure 6). In fact, two out of three farmers believe that climate change will increase the frequency and severity of extreme events in their production areas.

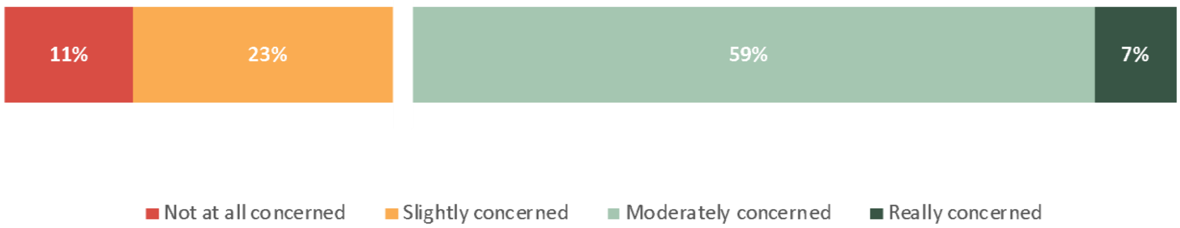


Figure 6: Level of concern on the future increase in frequency and severity of climate change. Source: proprietary data on 626 Italian farmers

Funded by the European Union

It is then interesting to examine how current and future concerns relate one to another (see Figure 7). Among those not at all concerned in the present, the vast majority (84%) tends to remain unconcerned in the future. The scenario changes for those who already express some level of concern—whether slight or significant. Specifically, among those who state they are slightly concerned about the current climate change situation, 45% confirm that this concern will persist in the future, while 51% report an increase in their concern, indicating they will be moderately concerned. Among those who are moderately concerned, the majority (86%) remain moderately concerned in the future with just a 2% reporting to be more concerned for the future. Finally, among those who are highly concerned today, 46% indicate a slight decrease in concern (though still remaining moderately concerned), while 54% continue to be deeply concerned, anticipating an aggravation in both the frequency and impact of climate change.

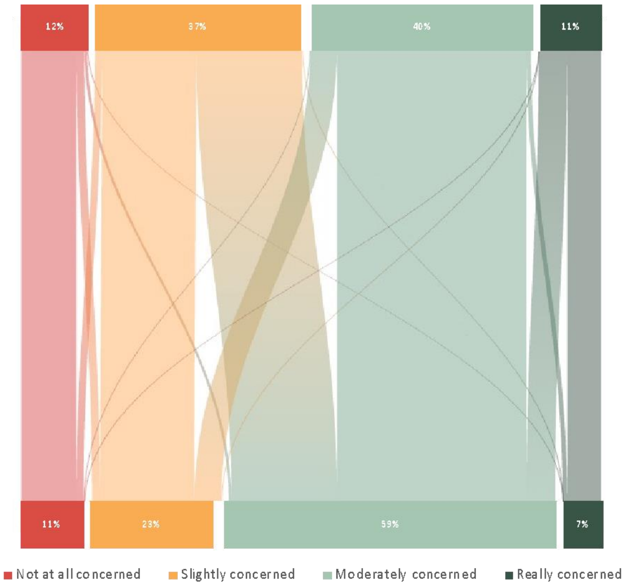


Figure 7: Relation between current concern level and future perception on the increase in frequency and severity of climate change. Source: proprietary data on 626 Italian farmers

Further, their perceived concern is mainly related to specific natural hazards (see Figure 8). Therefore, natural hazards such as (i) extreme temperatures (both frosts and heatwaves), (ii) drought phenomena, (iii) storms - often associated with heavy rains and hail and (iv) floods are commonly perceived as riskier natural hazards. On the other hand, hazards such as landslides, earthquakes, and fires are also perceived as risky, but with a lower degree of concern compared to the aforementioned hazards.

Funded by the European Union

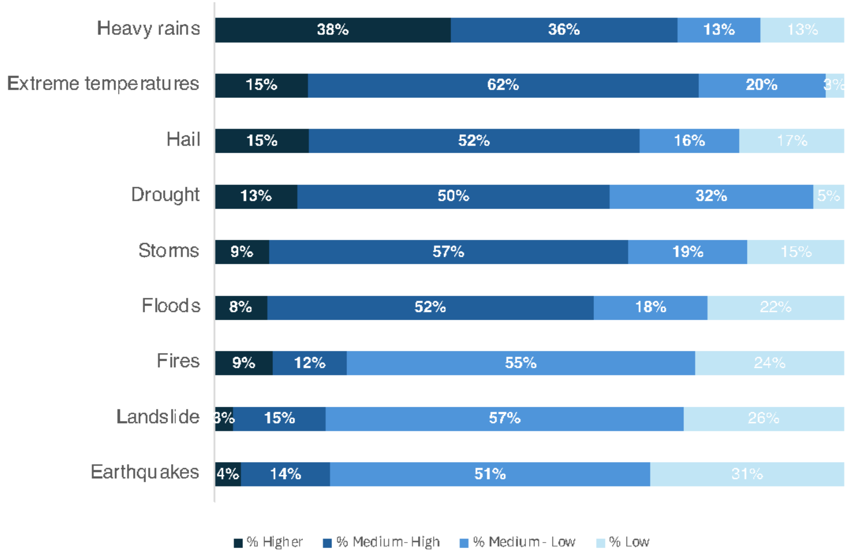


Figure 8: Perceived current concern levels to specific natural hazards. Source: proprietary data on 626 Italian farmers

4.1.4 Climate change and variability adaptation

If we now move to actions of adaptation to these perceived risks, in terms of ecological, social, and economic solutions, 89% of Italian farmers in our sample have already implemented climate adaptation measures. In general, farmers in our sample primarily rely on modifying agricultural practices (48%) and investing in technologies (27%). Considering just those investing in these measures, we see how more than half is working on changing agriculture practices (see Figure 9). In addition, a portion of farmers also rely on market instruments, such as joining government programs (18%) and acquiring insurance policies (17%).

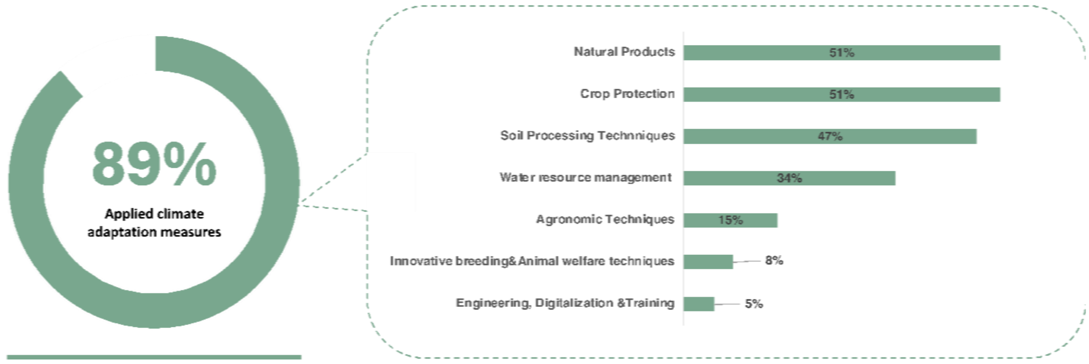


Figure 9: Climate change adaptation measures implemented by Italian farmers. Source: proprietary data on 626 Italian farmers

Funded by the European Union

Although the percentage of farmers not adopting these measures is relatively small (11%), it is still interesting to explore the main barriers preventing them from implementing climate change adaptation measures. Among those who have not taken action, the barriers can be broadly divided into two categories: i) lack of awareness, and ii) an inadequate environment for implementation. Specifically, regarding the first category, 93% report a lack of information or resources on how to implement adaptation measures, and 94% indicate difficulties in accessing the necessary technical or financial support. In the second category, 99% report both perceiving regulatory or political constraints and feeling that there is limited space or inadequate conditions for effective implementation.

Finally, around 85% of farmers indicate that they would be potentially interested in receiving incentives to increase their willingness to implement adaptation measures. However, a detailed analysis reveals that this openness is largely superficial (Figure 10): for 74% of them, the primary incentive is financial in nature—such as grants, subsidies, or tax deductions—while only a minority are interested in incentives that offer benefits beyond the economy. In fact, just the 30% would prefer to receive more information on how these measures can protect against specific risks, choosing to invest only after fully understanding the benefits; moreover, 10% desire greater awareness of the tangible environmental benefits that these actions could yield; and 8% would appreciate the availability of specific, customized insurance policies to safeguard the solutions implemented. Notably, another 24% rely on a differ form of financial incentives stating that it would increase their investments in adaptation measures if they could benefit from insurance premium discounts.

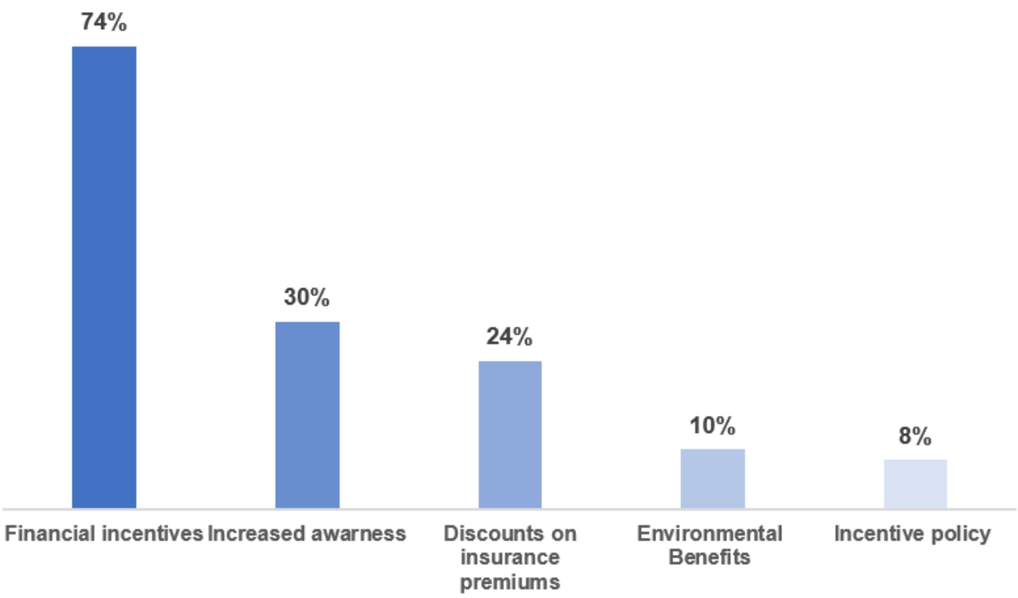


Figure 10: Incentives enhancing farmers' willingness to adopt climate adaptation measures. Source: proprietary data on 537 Italian farmers

Funded by the European Union

4.1.5 Insurance

The final objective of this report is to analyse the relationship between insurance and climate change and specifically, how farmers are using insurance solutions to adapt to the consequences of climate change. Indeed, insurance can play a crucial role in climate change adaptation. As illustrated in the PIISA Project's D1.1 report[5], insurance not only provides financial security but also incentivizes proactive risk management and supports the adoption of innovative, sustainable solutions that enhance resilience against the increasing impacts of climate change.

Insurance can serve a dual role by functioning both as a risk transfer mechanism and as a means of risk reduction. While traditional insurance schemes do not reduce the underlying level of risk, they enable farmers and SMEs to mitigate the consequences of risk by transferring it or sharing it through risk pooling. In this system, insurers cover many different clients located in various places, each facing different risks. However, even though the primary function of insurance is risk sharing, a residual risk remains, and it could be exacerbated by changing climatic conditions. Consequently, insurers are increasingly incentivizing agents (farmers, individuals, SMEs, etc.) to invest in risk reduction measures, as reducing the underlying risk level would improve the terms of insurance policies and enhance the resilience of both insurance markets and society at large (Botzen et al., 2010; Surminski, 2018).

Given this fundamental role of insurance, it is important to assess the extent to which farmers are insured against emerging natural hazards. The general picture shows that the majority of farmers (86%) are insured against at least one natural hazard. However, a deeper analysis of insurance levels for specific climate risks reveals a more concerning scenario. The hazards most commonly insured are hail and fires, yet only half of the farmers have coverage for these risks (see Figure 11). For other natural hazards, the situation is even more worrisome: only 33% of farmers are insured against heavy rainfall, and for events such as storms, droughts, and floods, coverage drops to just 20%. This significant insurance gap leaves farmers highly exposed to the increasing frequency and impact of natural hazards.

[5] PIISA Project, D1.1 - Insurance in climate adaptation: https://piisa-project.eu/assets/delivrables/D1.1_Insurance%20in%20climate%20adaptation_31.5.2024.pdf

Funded by the European Union

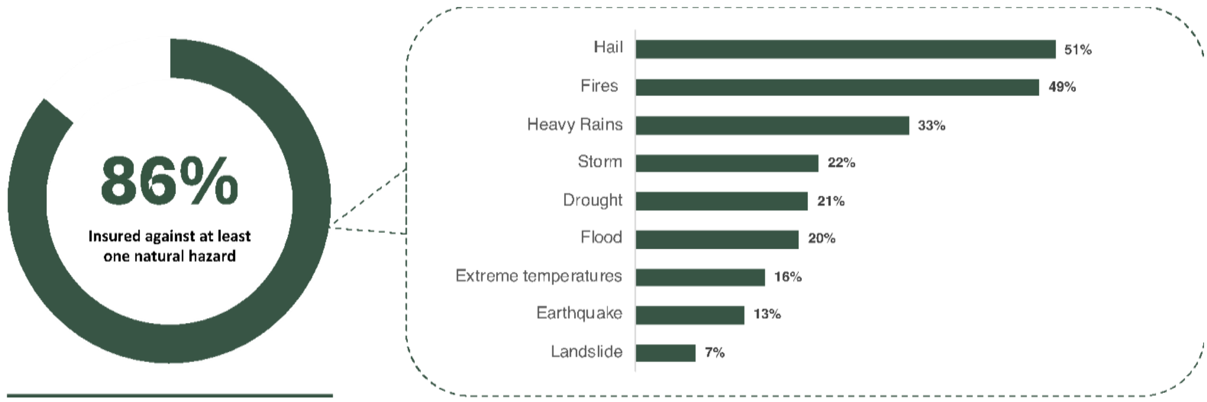


Figure 11: Insurance policies adopted by farmers against emerging natural hazards. Source: proprietary data on 626 Italian farmers

It is also important to note that the low diffusion of insurance among farmers is not due to a lack of insurance solutions. An analysis of the insurance offer for farmers reveals a variety of solutions currently available on the market. The Italian insurance market provides policies in both traditional and parametric (or index-based) forms to protect against damages affecting crop yields, agricultural enterprises, livestock activities, and agricultural machinery. In particular, these policies primarily cover assets against damages arising from: i) atmospheric events (i.e. hail, frost, drought, strong winds (at least 50 km/h), floods, excessive rainfall…), ii) fires, iii) catastrophic events (i.e. earthquakes, landslides, and floods).

Considering the widespread availability of insurance offerings, it is essential to understand why coverage for risks associated with natural hazards remains so limited. One primary explanation may lie in the risk perception toward specific natural hazards. As mentioned earlier in Section 1.2 (Risk Perception), risk perception plays a crucial role in the willingness to purchase an insurance policy, and our survey data confirm this. Our analysis – which includes a chi-square test – shows a significant relationship between the likelihood of purchasing a hazard-specific insurance policy and the level of perceived risk (see Table 2). Farmers with higher risk perceptions are significantly more likely to buy insurance, reinforcing the idea that risk aversion drives insurance uptake.

Funded by the European Union

Natural Hazard	p-value
Temperature	0.046
Landslides	0.000
Earthquake	0.000
Flood	0.000
Drought	0.000

Natural Hazard	p-value
Storm	0.000
Hail	0.000
Heavy rainfall	0.000
Wildfire	0.000

Table 2: Chi-square test between risk perception and insurance status respect to specific risk

The analysis reveals a relationship between risk perception and the decision to purchase insurance. The findings confirm that farmers with higher levels of perceived risk are more likely to purchase insurance coverage, whereas those who perceive the risk as lower show a decreased likelihood of subscribing to a policy. This finding is consistent with previous studies (e.g., Kunreuther, 1996), which suggest that risk aversion drives the demand for insurance.

Additionally, when analyzing insurance levels in relation to risk perception for specific natural hazards, we confirm that farmers with high-risk perception (Likert levels 3 and 4) are more inclined to purchase insurance. Indeed, data reveal that insurance diffusion increases among those farmers who perceive a higher risk of a particular natural hazard (see Figure 12).

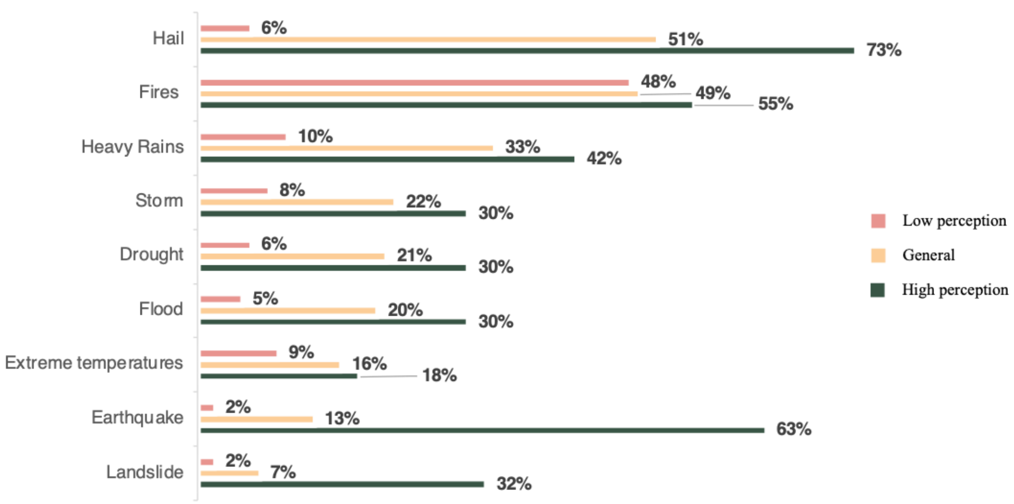


Figure 12: Relationship between risk perception for specific natural hazards and decision to purchase insurance. Source: proprietary data on 626 Italian farmers

Funded by the European Union

Given the evident gap in coverage for specific natural hazards, it is also important to understand the barriers that prevent higher insurance uptake. The primary obstacles relate to the characteristics of the insurance policies themselves. For instance, 31% of farmers report trust issues toward insurance companies, and approximately one-quarter are concerned about the complexity and cost of these policies (see Figure 13). This suggests that although many farmers are aware of the existence of insurance products, their perception is negatively affected by fears that companies will not pay out in the event of damage, or by the belief that these policies are too complicated to be understood and too expensive.

A further significant barrier is a lack of awareness: 18% of farmers admit they do not know where to purchase these specialized policies, who offers them, or where to seek advice on selecting the most appropriate option. These obstacles underscore the necessity to work on insurance awareness but also the need to improve both the accessibility of information and the reputation of insurance providers, making the process less complex and more reliable for farmers.

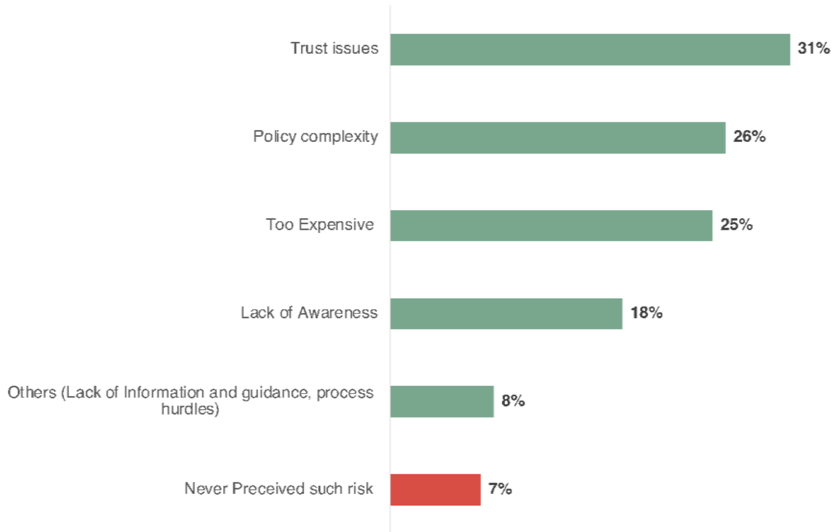


Figure 13: Barriers preventing higher uptake of insurance for natural hazards. Source: proprietary data on 610 Italian farmers

However, these barriers also represent an opportunity. If effectively addressed, they can serve as incentives for farmers to adopt insurance measures (see Figure 14). In fact, 28% of farmers indicate they would be more inclined to purchase a policy if the premium were lower, while 23% would invest more in adaptation measures if provided with clearer information about the benefits and procedures involved. Additionally, 25% would be more motivated to buy insurance if the government could offer a guarantee of compensation, helping to overcome trust issues toward insurance companies. Finally, about 45% of the sample expressed a

Funded by the European Union

preference for policies without limitation or exclusion clauses, stating they would be more willing to purchase insurance if it covered the full value of any damage.

In summary, while trust, complexity, and a lack of awareness currently limit insurance uptake among farmers, these challenges also highlight areas where targeted improvements and incentives could significantly enhance the adoption of insurance solutions, contributing to stronger climate adaptation measures

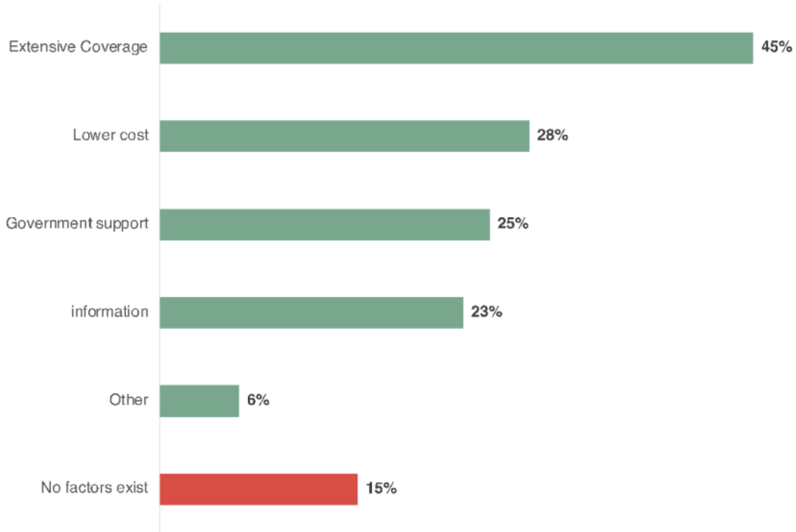


Figure 14: Incentives to increase insurance adoption among farmers. Source: proprietary data on 626 Italian farmers

4.1.6 Parametric insurance

From the previous sections we saw that a significant insurability gap exists for natural hazard-related risks. This gap is symptomatic both of a lack of awareness and of insurance instruments that are not well suited to farmers as we have seen from the barriers such as trust issues and policy complexity.

Bridging this gap requires action on two fronts: first, it is essential to work on enhancing awareness about climate change to ensure that farmers fully understand their climatic situation and the real risks they face (especially given the strong relationship between risk perception and the decision to insure), and second, it is fundamental to boost innovation in the insurance sector to overcome the current barriers perceived by farmers and promote innovative and clients' tailored insurance solutions.

In addition to this, the increase in severe natural events - intensified by climate change - can give rise to a broad spectrum of insured losses under conventional insurance frameworks (Van Nostrand & Nevius, 2011). Consequently, there is an urgent need to design and implement innovative, insurance-linked risk management instruments that can provide rapid

Funded by the European Union

liquidity to facilitate immediate response and recovery following climate-related disasters. It is precisely in this context that insurance companies introduced parametric insurance.

A parametric insurance product can be defined as an insurance contract where the final payment or contract settlement is determined by a weather or geological observation or index (e.g., temperature, rainfall, earthquake, windstorm, etc.). Rather than being based on individual loss assessments, parametric payouts are determined according to the measurement of a (highly correlated) index (Ibarra & IL Securities, 2010).

The IbI approach offers different advantages over traditional indemnity-based insurance models. The main benefit is the ability to provide rapid compensation following a natural hazard-related event. Since payouts are triggered by predetermined, objectively measurable parameters such as rainfall levels or wind speeds, claims are settled within days, significantly streamlining the claim management process and reducing the need for extensive documentation. Unlike traditional insurance, which necessitates post-event assessments, parametric insurance also eliminates procedural delays. Another key advantage is enhanced precision in risk definition and underwriting; by incorporating parametric triggers directly into the contract, the number of uncertain variables is reduced, thereby increasing policyholder trust and transparency (Van Nostrand & Nevius, 2011).

Despite these advantages, parametric insurance policies also present challenges. The complexity of the policy structure and its specialized terminology can hinder market comprehension and acceptance. In practice, one challenging task is choosing a trigger threshold that is both technically sound and intuitively fair: the index must track the specific natural hazard, reflect local conditions, and rely on specific measurements. When the threshold is set too high, many farmers may suffer crop losses yet receive no payout; set too low, and the insurer risks frequent, disproportionate disbursements. Crafting that “right” line requires detailed data, hazard-frequency studies, and stakeholder inputs

Additionally, parametric insurance is subject to "basis risk", the discrepancy between the model-based payout and the actual losses experienced by the insured. This risk arises from inherent uncertainties in catastrophe modelling and may lead to perceptions of insufficient compensation. However, basis risk tends to diminish when the insured events are rare and severe, making parametric insurance particularly well suited for large-scale disasters such as earthquakes (Van Nostrand & Nevius, 2011). Finally, for some reasons and in some cases, the effects of the event can be unrelated with the magnitude measured by the identified index.

Given that parametric insurance is an innovative insurance solution, it is not surprising that knowledge among farmers remains limited. Only 14% of farmers can accurately explain what parametric insurance policies are, 39% have merely heard about them, and approximately half of them (47%) have never heard of them (Figure 15).

Funded by the European Union

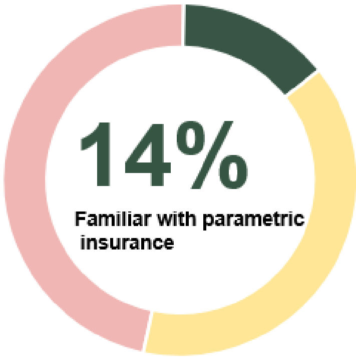


Figure 15: Knowledge about Parametric Insurance among Italian farmers. Source: proprietary data on 626 Italian farmers

This contrasts with traditional insurance, where there is generally greater familiarity. Indeed, the reality is that this is a "new" solution for the Italian insurance market, first introduced in 2019 (IVASS, 2019), and as a result, 86% of farmers are unaware of its specific characteristics and benefits.

Nevertheless, despite its limited diffusion and low awareness, around 6% of farmers have already purchased a parametric insurance solution (see Figure 16).

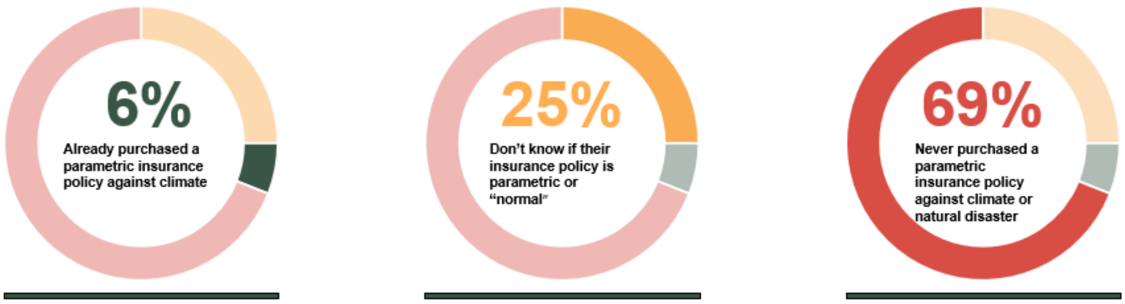


Figure 16: Adoption of Parametric Insurance among Italian farmers. Source: proprietary data on 626 Italian farmers

In contrast, another figure shows that 25% of farmers do not even know the details of the policy they hold – whether it is parametric or not – and they should ask their insurance agent to understand the features of the policy itself.

The main barrier to the adoption of parametric insurance is the lack of awareness (Figure 17). Fifty percent of farmers reported that they were not even aware of the existence of a parametric insurance policy designed to protect against climate change-related risks. Among those who are aware (i.e., the remaining 50%), 35% find these policies too complex, failing to grasp their functioning compared to traditional insurance. Furthermore, 31% of the aware group continue to distrust these policies, fearing that insurance companies will not pay out in the event of damage. This is a clear sign of misunderstanding how a parametric policy works, given that it triggers a payout whenever a predetermined parameter exceeds a set threshold.

Funded by the European Union

Additionally, 20% of the farmers who're aware still have concerns regarding the costs required to activate these policies, while about 20% of them report that they have never perceived a risk that would justify the need for such coverage.

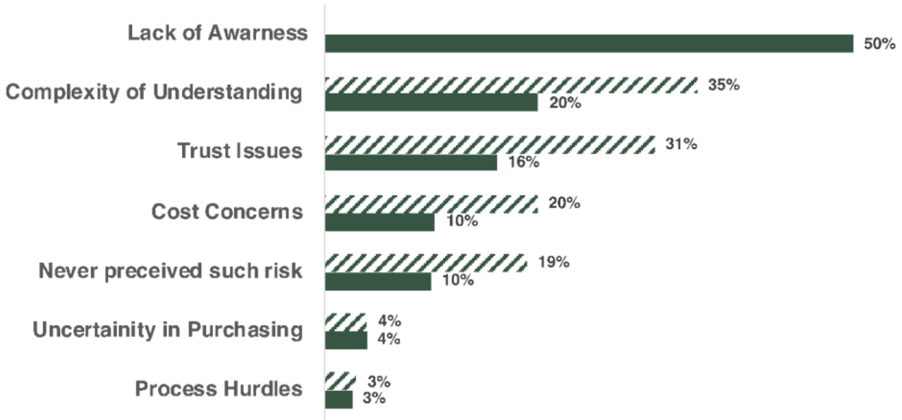


Figure 17: Adoption barriers to parametric insurance among aware and unaware (solid bars) farmers. Source: proprietary data on 433 Italian farmers

Despite these barriers, 78% of farmers indicate that certain factors could influence their decision to purchase a parametric insurance policy for managing climate risks (see Figure 18). The primary incentives include an additional government guarantee to back the instrument, more comprehensive information regarding the functioning and benefits of parametric policies, and cost discounts. In fact, 47% of farmers state that they would only purchase such a policy if it were supported by a government guarantee of compensation. This is coherent with Section 4, where 45% of the sample expressed a preference for policies that ensure full reimbursement of damages. Moreover, 40% say they would buy these policies only after gaining a clear understanding of how they work by attending dedicated informational sessions on the characteristics, benefits and procedures to activate a parametric policy, and 34% would be attracted by a reduction in costs. A smaller group (12%) would be influenced to purchase a parametric policy if they could access personalized support or if the acquisition process were simplified and expedited.

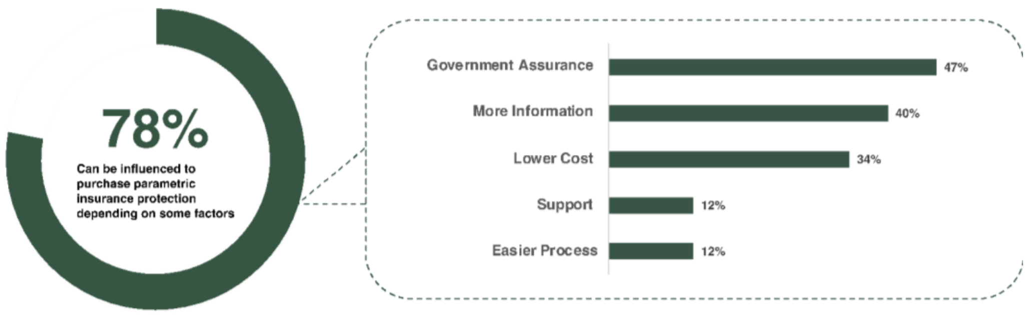


Figure 18: Factors influencing farmers to adopt Parametric Insurance. Source: proprietary data on 626 Italian farmers

Funded by the European Union

Another relevant finding is that, as of today, only 8% of farmers are willing to change their current insurance policy in favour of parametric policies (see Figure 19). Although 84% do not outright reject this change opportunity, their decision largely depends on other factors. For instance, 52% of them state that their choice would depend on the amount of compensation the parametric policy guarantees, once again highlighting a focus on economic aspects rather than on the operational advantages of parametric insurance. In reality, parametric policies do not necessarily offer higher payouts than traditional policies but rather, they guarantee that the payout will be made automatically when predetermined climatic parameters exceed set thresholds. Additionally, 38% mention that they would consider switching based on the penalties incurred for changing policies, and another 32% say their decision would depend on the cost of the parametric policy, emphasizing economic benefits over intrinsic features such as certainty and speed of reimbursement. Only 35% express genuine interest in the characteristics of a parametric policy, indicating they would only switch after verifying the conditions that trigger the parametric payout.

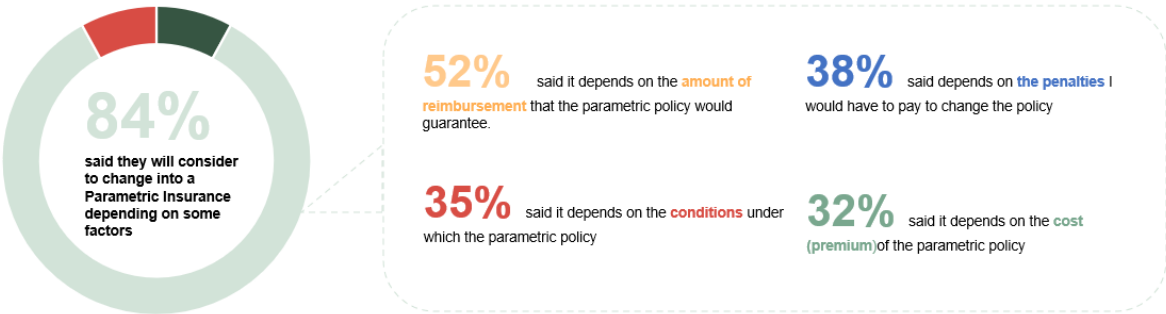


Figure 19: Conditions influencing farmers' willingness to change to parametric insurance. Source: proprietary data on 156 Italian farmers

Finally, in line with these observations, only 30% of farmers report that the current climate change scenario may influence their decision to purchase a parametric insurance policy (see Figure 20). In contrast, 33% declare that they are not influenced at all by the current situation, and 38% say they are only slightly influenced.

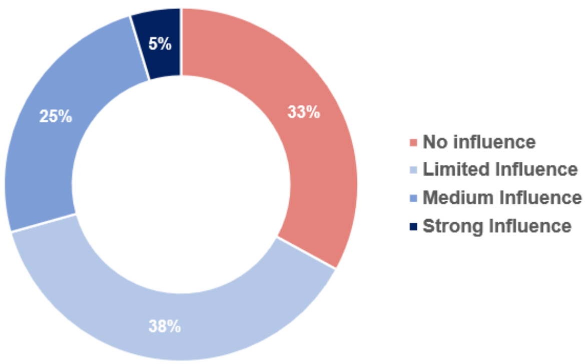


Figure 20: Influence of the current climate change situation on farmers' willingness to purchase parametric insurance. Source: proprietary data on 470 Italian farmers

Funded by the European Union

4.2 Survey of Spanish farmers - to be implemented

Over the last decade, the urgency of developing climate adaptation strategies has grown considerably across Europe, particularly in agriculture. Spain, as one of the key agricultural producers in the Mediterranean region, is especially vulnerable to the intensifying impacts of climate variability. The country's farming systems are increasingly exposed to prolonged droughts, erratic rainfall, and extreme heat events, which negatively affect crop yields, farm infrastructure, and rural livelihoods. In this context, understanding how Spanish farmers perceive climate risks, what coping strategies they employ, and how open they are to innovative insurance tools is essential to designing effective, farmer-centric resilience measures.

This chapter focuses on the results of a structured farmer survey conducted in Spain as part of the PIISA project's broader research agenda. The survey aims to provide an evidence-based foundation for advancing climate adaptation solutions, especially in the domain of insurance, and to inform both policy design and product innovation. The survey explores multiple aspects: farmers' demographic and farm-level characteristics; their exposure and sensitivity to climate events; current adaptation practices and sources of finance; and their awareness, use, and perceptions of traditional and index-based climate insurance.

The insights gathered will inform the development of demand driven and targeted insurance products and identify barriers to adoption, including issues of trust, affordability, and access to information. Importantly, the survey also includes a co-design component, inviting farmers to express their specific needs and preferences regarding ideal features of IbI products, including trigger thresholds, acceptable basis risk, and desired compensation structures. This participatory approach ensures that future insurance models are not only technically sound but also grounded in real-world farmer needs and expectations.

The remainder of this chapter is organized as follows: Section 4.2.1 provides an overview of the survey methodology and structure. Additional sections would be filled upon the collection of survey responses, which are still due.

4.2.1 Methodology and expected results

The survey is structured into eight core sections, shown in Figure 21. These range from collecting basic demographic and farm-level information to in-depth questions about climate impacts, risk mitigation practices, insurance usage, and preferences for IbI product design. Respondents are also invited to participate in the co-design of index-based solutions, enabling them to shape potential policies according to their operational realities and risk perceptions.

The survey explores:

- Demographics and Farm Characteristics – age, education, farm size, type, and income.

Funded by the European Union

- Climate Vulnerability – impacts of droughts, floods, and other weather events on crops and buildings.
- Historical Losses – frequency, severity, and context of climate-related damage in recent years.
- Current Adaptation Measures – assessment of on-farm strategies for managing climate risks and their effectiveness.
- Use and Awareness of Climate Insurance – perceptions of traditional schemes and experience with Agroseguro.
- Use and Awareness of Index-Based Insurance – perceived advantages, barriers, and levels of interest.
- Co-Design of IbI Products – preferred triggers, compensation types, tolerance for basis risk, and affordability.

Figure 21: Structure of the survey for Spanish farmers

The survey will be administered in spring 2025 and targets a wide cross-section of farmers, with special attention to diverse geographic regions and farm types. The information collected will help identify regulatory, informational, and financial gaps that hinder the adoption of climate risk insurance. The collection of responses is being done using ASAJA Jaen's network of farmers. The aim is to receive at least 50-100 responses to enable a robust analysis. Lastly, the survey fully complies with the EU General Data Protection Regulation (GDPR). All responses are anonymous, and no personally identifiable information will be shared or linked to published findings. Data is securely stored and managed solely by the research team at BSC-CNS.

Funded by the European Union

Although this report does not include the survey results, the survey forms a critical component of the broader effort to understand local needs and inform EU-level and national policy on climate insurance. Insights gathered will guide both regulatory dialogue and market innovation in index-based insurance tailored to the agricultural sector in Spain.

5 Case study of olive farmers in Spain

5.1 Context

Spain is the world's leading olive producer, with the majority of its olive cultivation dedicated to olive oil production. Olive production in Spain is predominantly concentrated in the region of Andalusia in southern Spain, which accounts for approximately 75% of the country's total olive production. Within Andalusia, the province of Jaén has the most hectares of agricultural ground dedicated to olive production, approximately 588,095 Ha (www.juntadeandalucia.es). As part of the Food and Agriculture pilot, BSC is working together with the stakeholder ASAJA-Jaén, a farmers' association in Jaén.

ASAJA stands for the Agrarian Association of Young Farmers. It is a national organization in Spain that advocates for farmers' rights and promotes sustainable agricultural practices. ASAJA-Jaén is a regional branch of ASAJA, specifically focused on the province of Jaén. ASAJA-Jaén works on local issues, supports farmers in Jaén, and focuses on region-specific agricultural challenges, especially those related to olive cultivation. ASAJA, was established in 1989 and is the largest agricultural organization in Spain, representing more than 350,000 members (www.asajajaen.com). Its mission is to protect family-owned farms, advocate for the inclusion of youth in agriculture, and actively participate in both national and international policy dialogues. ASAJA plays a crucial role in negotiating with the Spanish government and the agro-industrial sector, ensuring that the interests of farmers are well-represented. Additionally, ASAJA is an influential voice in European agricultural forums, where it works to shape policies that support sustainable farming practices and the agricultural community.

The aim of this case study is working together with ASAJA-Jaén and local farmers to assess the feasibility of weather insurance solutions that will assist farmers in managing climate-related risks. This process involves several key steps:

1. Understanding the farmer's climatic needs: By working together directly with the farmers the specific challenges and needs related to climate variability and change can be identified.

2. Obtaining feedback: Valuable insights and feedback from the farmers are gathered to understand their concerns and the potential barriers they face with their crop regarding weather hazards.

3. Co-developing an Index-based Insurance (IBI) product: Using the information gathered from the farmers, a tailored parametric insurance product can be developed which aligns with the unique needs of the olive farmers in the province of Jaén, to determine the feasibility of financial protection against the identified climate hazards.

Funded by the European Union

This collaborative effort aims to empower the local farmers with the tools they need to mitigate the financial impacts of climate risks and build resilience in their agricultural practices.

5.2 Farmer workshop results

An in-person workshop with local olive farmers was conducted in Jaén in collaboration with ASAJA-Jaén, as part of the co-production for the development of the tailored IBI product. The goal of the workshop was to understand the current climate challenges the farmers are facing and determine specific climate thresholds which cause crop damage and losses.

A total of 12 farmers and agricultural technicians attended the workshop held in Jaén on the 8th April 2025, including two representatives of ASAJA-Jaén. The workshop included several interactive sessions to obtain information on the agricultural practices of the farmers and get feedback on past climate events which affected their crops. Information from the farmers was gathered through means of a Mentimeter questionnaire carried out on their mobile phones, written responses on adhesive notes and informal discussions.

Figure 22. Photos taken during the farmers workshop in the office of ASAJA-Jaén. Source: Ángel G. Muñoz

Funded by the European Union

5.2.1 Mentimeter

During the farmer workshop, we organised an ice-breaking session structured around a live Mentimeter exercise. The interactive format allowed farmers to respond anonymously to a sequence of questions designed to facilitate a deeper understanding of their local context. The Mentimeter tool provided a dynamic way to capture these inputs in real time, creating a shared basis for dialogue during the session. The insights generated in this session, though limited in scope, provide valuable qualitative context to the broader survey data and help illustrate the specific challenges faced by the olive producers in South of Spain in adapting to climate risks.

The responses to the question on which months are most important each year for the participating olive farms reveal a clear seasonal concentration of critical activity, as in the Figure 23. The majority of responses were clustered around March, April, and May, indicating that this spring period is particularly significant for on-farm operations, likely due to key stages in the olive production cycle such as flowering, early fruit development, and initial pest and disease management. A few responses also pointed to January, suggesting that certain preparatory or maintenance tasks may take place during the winter. This information helps to contextualize farmers' sensitivity to weather variability during specific times of the calendar year.

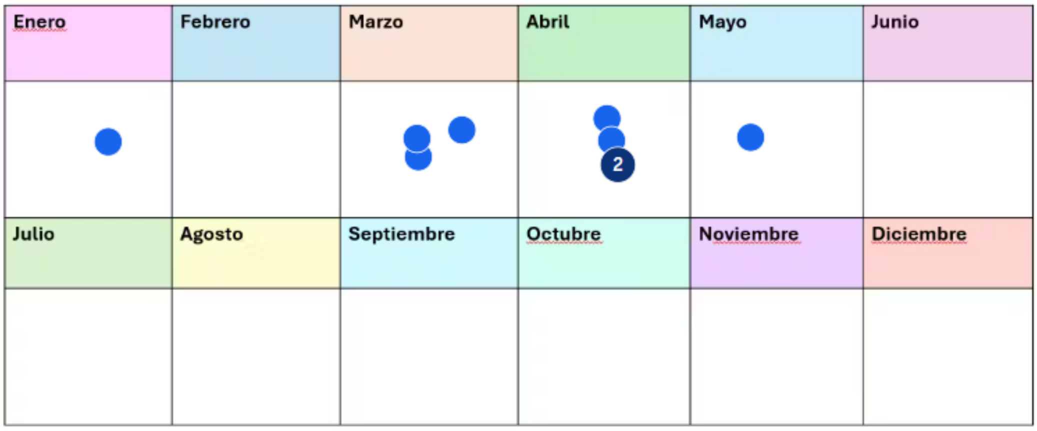


Figure 23: Critical months in a year for Olive production

Next, Figure 24 sheds light on some of the main factors that olive farmers perceive as influencing their agricultural production. The strongest level of agreement was with the statement that price fluctuations significantly affect farm profitability, with an average score of 4.7 out of 5. This suggests that market volatility remains a key concern for these producers. Climate-related issues were also seen as critical: participants largely agreed that climate phenomena make olive production risky (average 4.0) and that extreme weather events are increasingly common on their farms (average 3.8). Finally, there was notable agreement (4.1) with the idea that global political issues—such as wars, tariffs, and trade disruptions—are having a growing impact at the local farm level. These insights reflect that both environmental and geopolitical risks affect farming.

Funded by the European Union

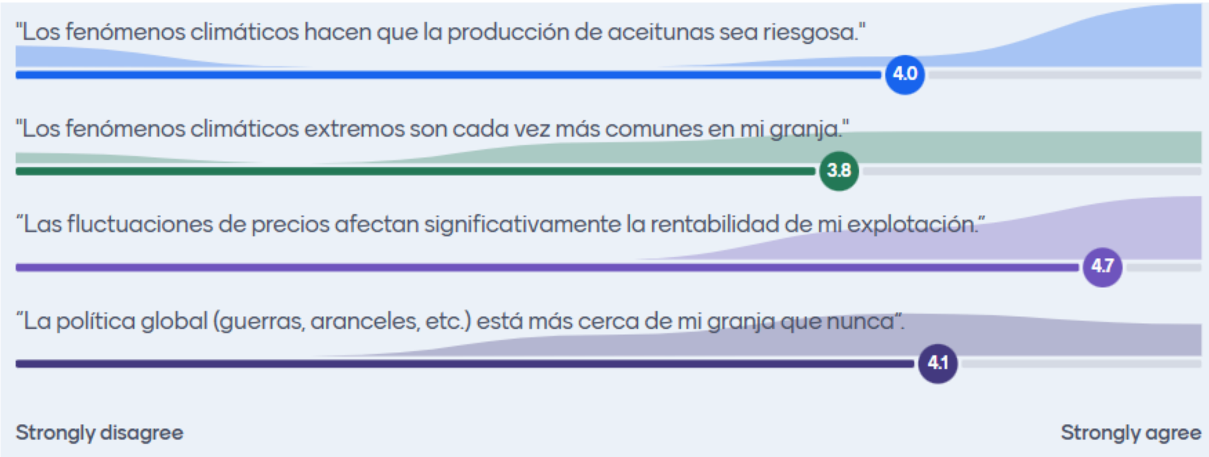


Figure 24: Key factors affecting Olive farm production

Note: The statements in Spanish translate as follows:

1. *"Climate phenomena make olive production risky."*
2. *"Extreme climate events are becoming more common on my farm."*
3. *"Price fluctuations significantly affect the profitability of my farm."*
4. *"Global politics (wars, tariffs, etc.) is closer to my farm than ever before.*

Responses are on a 1–5 scale, from Strongly disagree to Strongly agree.

The word cloud generated from participants' responses offers a revealing glimpse into the emotional and practical associations farmers have with climate impacts in agriculture, as represented in Figure 25. The most prominent words are uncertainty and drought, which reflect a sense of vulnerability, specifically pertaining to below normal rainfall and drought conditions. These were followed by terms such as profitability, low yields, fear, ruin, and risk, indicating the economic pressure and emotional stress tied to climate variability. Climate-specific terms like frost, heat, and climate change were also mentioned, alongside more contextual phrases such as politics and affects production. Overall, the responses convey that for these farmers, the concept of climate impact is strongly linked to both environmental stressors and their broader consequences for financial stability, economic wellbeing and decision-making under uncertainty. Importantly, there seems to be a general sense of anxiety towards the uncertain and potentially detrimental impact of extreme climate events.

Funded by the European Union

Figure 25: Keywords farmers associate with climate impact in agriculture
Note: The text entries in the word cloud are in Spanish. Key translations include: incertidumbre (uncertainty), sequía (drought), afecta a la rentabilidad (affects profitability), afecta a la producción (affects production), cambio climático (climate change), bajas producciones (low yields), ruina (ruin), miedo (fear), riesgo (risk), heladas (frost), calor (heat), agua (water), política (politics), hierba (grass), and cachondeo (chaos or disorder, colloquial).

Responses to the open-ended question about the most damaging climate phenomenon affecting olive groves in recent years revealed a clear consensus among participants. Eight out of twelve respondents identified drought as the most significant issue. Other responses included isolated mentions of hailstorms, high temperatures, and early-season heat. One participant gave a general response, simply stating “climate,” which may reflect a broader concern regarding climate risks. These answers emphasize the importance of addressing drought risk in future adaptation and insurance strategies for the olive sector.

The responses to the open-ended question about how a climate event altered production plans reveal a wide range of coping strategies used by olive farmers. Several farmers mentioned modifying agricultural practices to deal with drought, such as increasing irrigation, reducing or halting fertilization due to lack of rain, and making cost-saving changes in pruning and harvesting techniques. Others reported taking financial or operational measures, including securing agricultural insurance, reducing energy use in processing, or exploring alternative methods to lower input costs. Some responses were more generic, including phrases like "hold on" or "do not forget" pointing to a general sense of resilience and caution. These results show how climate events not only affect yields but actively shape farm management decisions. They also seem to have a significant emotional impact on the farmers.

The responses to the question about the drivers behind olive sector price volatility reflect a complex web of structural, climatic, and market-related factors, as reflected in Figure 26. Several farmers pointed to climate-related impacts such as drought, rainfall shortages, and lack of water infrastructure as primary contributors to supply fluctuations, which in turn affect prices. Others highlighted broader market dynamics, including overproduction, imbalance between supply and demand, uncontrolled sales, and the influence of global trade. Concerns were also raised about the role of large operators in controlling the market, as well as the lack of collective action within the sector to defend prices and promote products. Additional factors mentioned include rising production costs, insufficient modernization, and regulatory pressures. Altogether, the responses suggest that price instability is seen not as the result of a single issue, but as a consequence of multiple, often overlapping challenges.

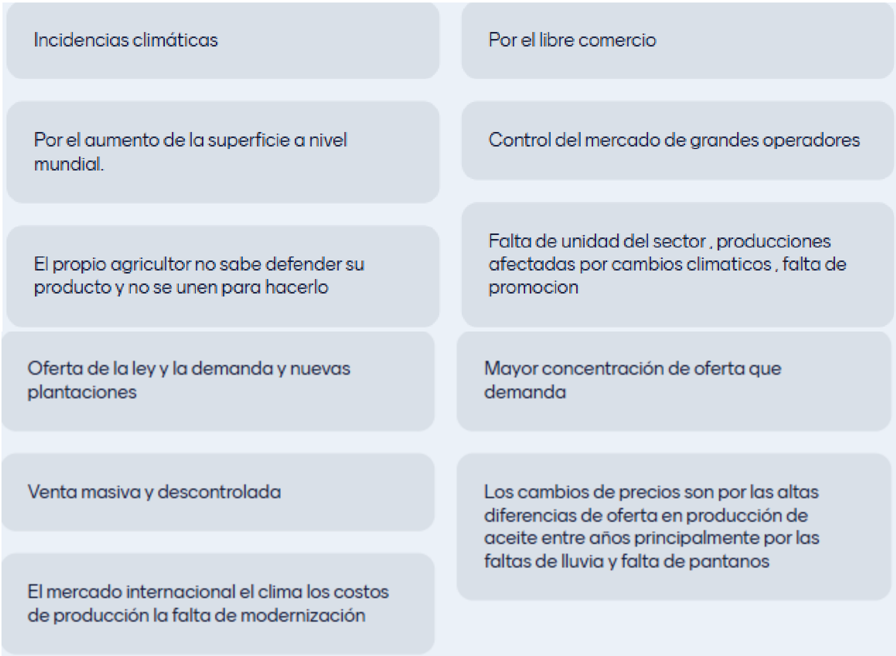


Figure 26: drivers behind olive sector price volatility

The responses to the question about the impact of U.S. tariffs on Spanish olives show that most participants felt directly affected. Most participants just responded “yes.” One participant stated that the U.S. is a major importer of olive oil and that rising prices due to tariffs would likely reduce consumption. Another mentioned that future sales would be more difficult due to higher prices. Only one response explicitly stated “no,” suggesting limited or no direct effect. Overall, the feedback reflects a widespread perception that international trade measures such as U.S. tariffs can have tangible and immediate consequences on local producers, particularly in export-oriented sectors like olive farming.

The responses to the question on how to strengthen the future resilience of olive farms revealed structural, financial, and technological needs. The most frequently mentioned concept was reconversion, suggesting a desire for major transformation or adaptation of farming systems. Farmers also emphasized the importance of direct subsidies, parametric insurance, mechanization, and modernization as potential solutions. Other suggestions included simplifying bureaucracy, enhancing irrigation systems, supporting generational renewal, and improving the business model. Taken together, these inputs reflect a demand for integrated support, both from public policy and innovation. These results are presented in Figure 27.

Funded by the European Union

Figure 27: Building future resilience of olive farms

Note: Spanish words in the word cloud refer to resilience strategies such as reconversion (farm restructuring), ayudas directas (direct subsidies), seguro paramétricos (parametric insurance), mecanización (mechanization), modernización (modernization), and relevo (generational renewal). Other terms mention riego (irrigation), menos burocracia (simplifying administration), and support measures like subvenciones (subsidies) and reforzar las ventas (strengthening sales).

To conclude, the Mentimeter session with olive farmers in Jaén offered valuable qualitative insights into how producers perceive and respond to climate risks. Drought emerged as the most frequently cited and pressing concern, reflecting its dominant impact on yields and farmer vulnerability. Beyond climatic threats, farmers also expressed concerns about market instability, rising input costs, and inadequate institutional support. Despite these challenges, there was openness to innovative solutions such as parametric insurance and farm reconversion. This ice-breaking session started an active discussion amongst the participants, which was instrumental in leading the rest of the interaction in the workshop.

5.2.2 A typical calendar year

As part of the workshop, participants were asked to identify the agricultural activities they undertake annually to gain deeper insight into farmers' practices. This information helps to map out what their typical calendar year looks like, highlighting periods around which farm management decisions are made. These critical windows could serve as strategic points for intervention for adapting to climate risks. For instance, they could be target periods to deliver climate information, such as seasonal forecasts, enabling farmers to assess risks and consider possible action choices. Farmers may also seek insurance coverage for these periods or just preceding them, allowing time for early measures for damage mitigation. In the case of olive farmers in Jaén, the most frequently reported practices, illustrated in Figure 28, include fertilizing the soil, fumigating to control pests, irrigating, pruning trees, and harvesting the crop.

Distinct seasonal patterns emerge across all farming practices. During the winter months, January, February, and March farmers typically focus on soil fertilization and tree pruning.

Funded by the European Union

Pest control through fumigation also begins in winter and continues into the spring. Irrigation is applied from March through to October, with summer being the period when it is often the sole agricultural activity. In autumn, farmers resume fumigation and soil fertilization, mirroring the activities of spring. Harvesting primarily takes place in November, December, and January, though one instance was reported as early as September. In addition to these five main practices, the application of herbicides and fungicides was also reported during the spring and autumn seasons. Moreover, in the month of March, land management practice was reported including vegetative groundcover, generally used to protect the topsoil from erosion and drought.

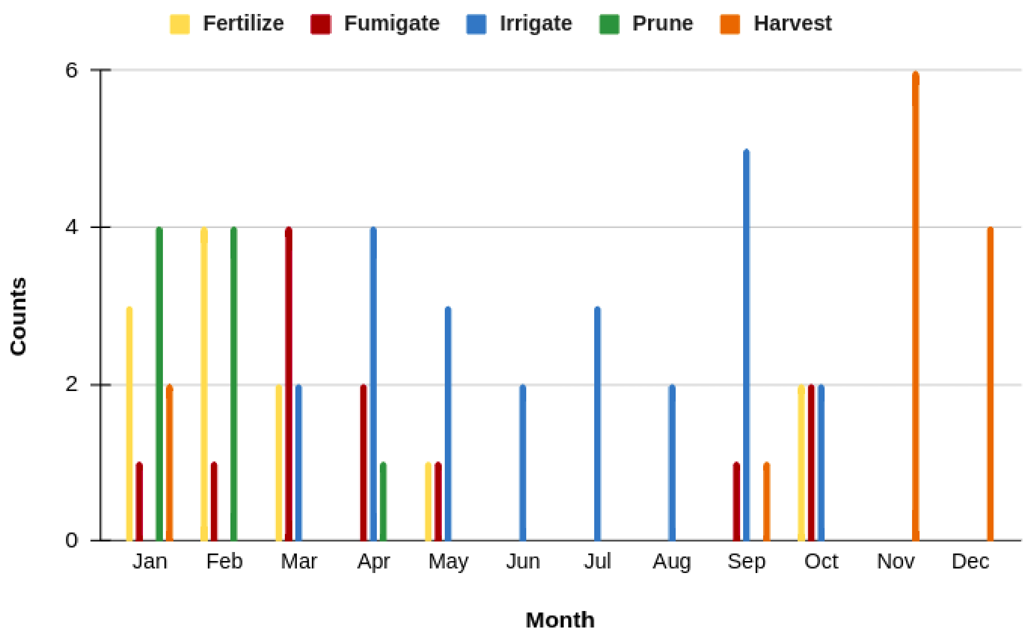


Figure 28. An overview of the main agricultural practices reported by the olive farmers, expressed as the number of times each were reported for a given month.

5.2.3 Worst years reported by farmers

As part of the study, farmers were asked to point out which years over the past three decades were the worst in terms of climate impacts. All the bad years reported were due to drought, although winter ground frost was also mentioned for some years. Farmers additionally highlighted that extreme high temperatures can negatively affect both crop yield and quality. The events identified as bad years by the farmers were cross-checked against historical meteorological data for verification. Table 3 shows the seven worst years between 1995 and 2024, as reported by the farmers.

Funded by
the European Union

Rank	Year	Climatic reason
1	1995	Drought (worst year on record)
2	2023	Drought and ground frost
3	2022	Drought
4	2012	Drought
5	2014	Drought
6	2000	Drought
7	2005	Drought and ground frost

Table 3. The ranking of the worst seven years reported by the farmers for the period 1995 to 2024, with rank 1 indicating the worst.

Reported bad years were verified using two complementary data sources, depending on the climate variable. For temperature extremes, the ERA5-Land dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF) was used. ERA5-Land is a high-resolution global land surface reanalysis, produced under the Copernicus Climate Change Service, providing hourly land variable data from 1950 to the present at approximately 9 km resolution. In the case of precipitation the CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) dataset was used. CHIRPS is a high-resolution, global rainfall dataset developed by UC Santa Barbara, providing precipitation data from 1981 to near real-time at a ~5 km resolution, covering land areas between 50°S and 50°N.

Figure 29 presents data from CHIRPS, illustrating the total annual and monthly precipitation in the province of Jaén, for the period 1995 to 2024. Precipitation patterns in figure 29a show pronounced interannual variability, with certain years such as 1996, 1997, and 2010 having experienced considerably higher rainfall. In contrast, 1995, 2005 and 2023 stand out as years in which the rainfall was significantly below the average (indicated by the horizontal dotted line), aligning with the reports that label them as the worst years on record. The reported bad years are highlighted in figure 30a as red horizontal lines

The distribution of rainfall throughout the year is also an important factor to consider. A distinct seasonal pattern is evident in the monthly total rainfall displayed in figure 29b, rainfall is minimal during the summer months, with the majority occurring in winter. According to the farmers, sufficient rainfall in the spring, as early as March, is crucial for the olive trees. Looking at the monthly distribution of rainfall in the year 1995, reported as the worst year for drought, it can be seen that the rainfall during the first half of the year was exceptionally low compared to other years.

Funded by the European Union

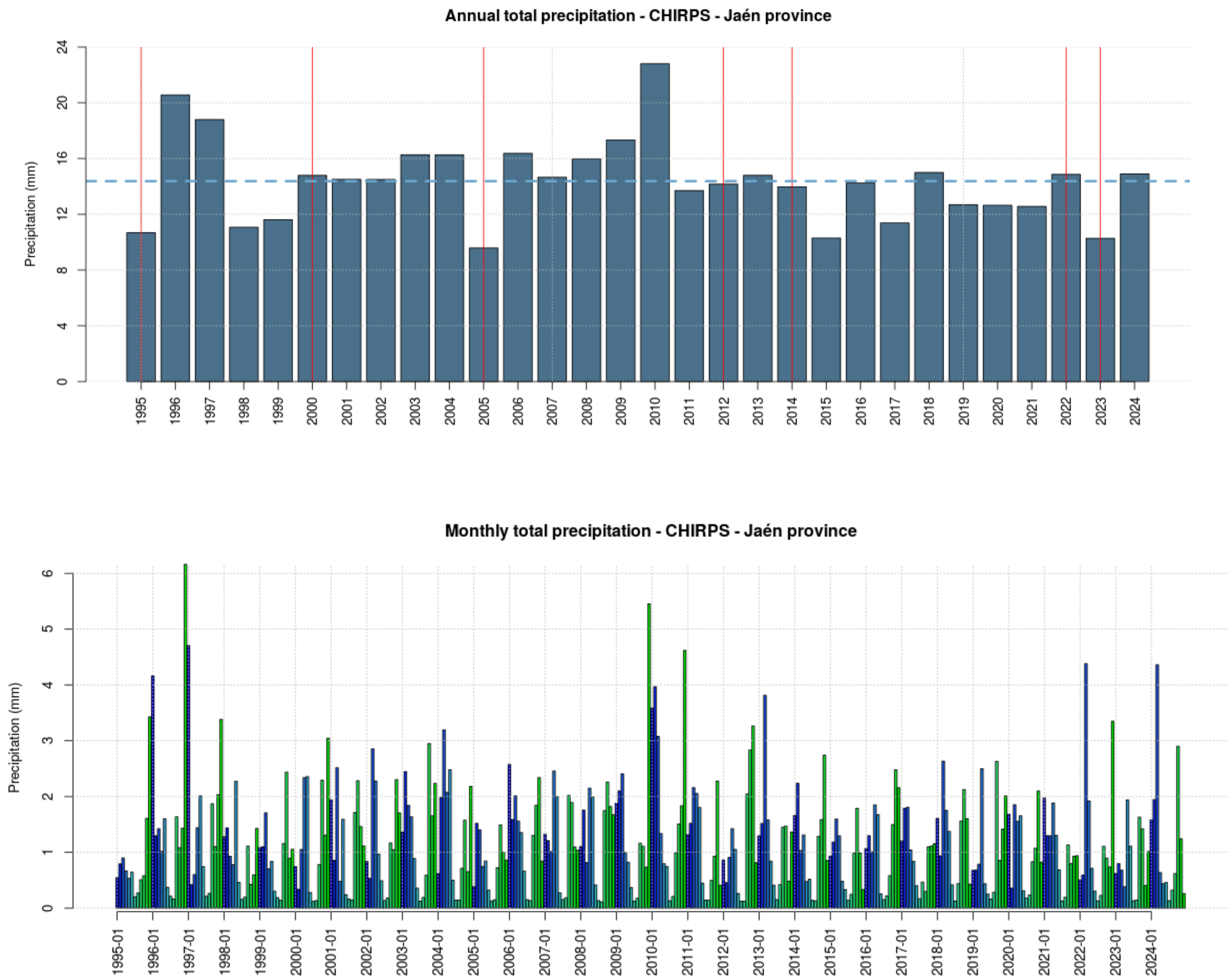


Figure 29 The interannual variability of precipitation in the province of Jaén from 1995 to 2024, with data obtained from the CHIRPS dataset. a) (top) Shows the total rainfall for each year, with the blue horizontal dotted line indicating the average annual rainfall over the 30-year period. The reported bad years with a red vertical line. b) (below) Shows the total rainfall which fell during each individual month, demonstrating the annual variability.

In contrast to precipitation, temperature in the Jaén province shows much less interannual variability as seen in figure 30, representing the average monthly minimum and maximum temperatures. However, a subtle long-term trend of rising average temperatures is evident, as shown by the dotted lines in the figure. The region experiences a wide seasonal temperature range, with average winter minimums approaching 0ºC and average summer maximums reaching up to 35ºC, particularly in more recent years.

Farmers' reports of ground frost during the reported bad years are supported by the data for 2005, which shows average minimum temperatures below 0ºC in January and February. However, in the other reported case, 2023, no such pattern appears in the data. This is likely because the dataset reflects monthly average minimum temperatures, which may not capture short periods of frost. Even a few cold days can harm crops, but their impact may be masked

Funded by the European Union

if the rest of the month experienced milder temperatures. To be able to verify such reports, it would be necessary to analyse data on a daily timescale rather than the monthly average. Additionally, to improve the verification of the reported bad years several different data sources can be used, ideally also including data from local meteorological stations.

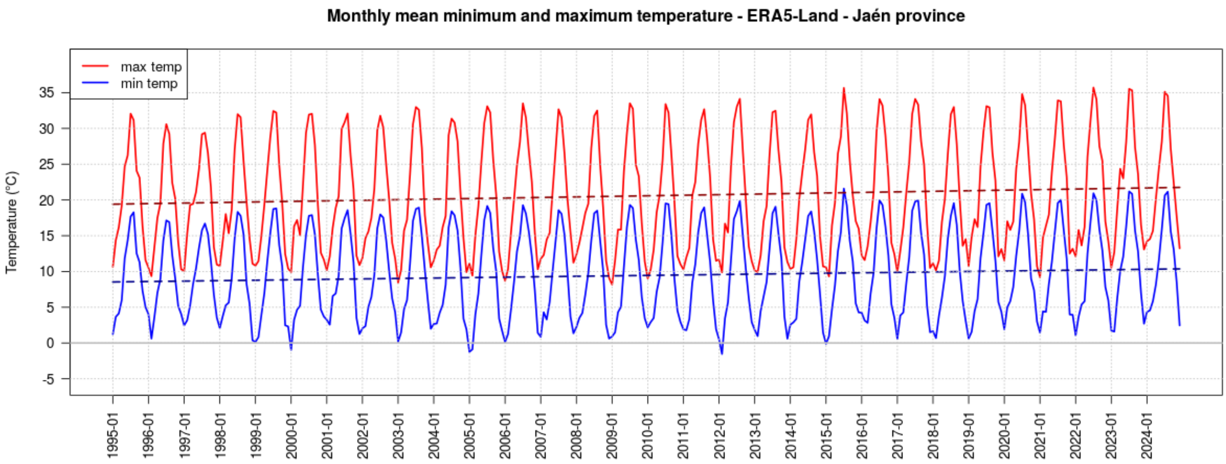


Figure 30 The average monthly minimum and maximum temperatures for the region, obtained from the reanalysis ERA5, calculated as the average of the maximum and minimum temperature of each day of the month. The dotted lines represent the trend of the average temperatures.

5.2.4 Climate thresholds defined by farmers

The final part of the workshop focused on identifying key climatic thresholds in relation to the climate hazards that pose a threat to olive cultivation. Table 4 presents an overview of these thresholds, as defined by the participating farmers. These thresholds represent climate conditions beyond which damage or losses to the olive crop are expected. These thresholds are important to be able to provide a tailored index-based insurance product for the olive crops in the region of Jaén.

Climate variable	Months	Threshold	Duration
Precipitation	annual	< 300 mm	year
	Mar-Apr-May	< 150 mm	season
	March	50% 150 mm	month
	Sept-Oct-Nov	< 150 mm	season
	September	100 mm	month
	October	100 mm	month
	November	100 mm	month
Maximum	April-May	≥ 35°C	3 days

Funded by the European Union

temperature			
		≥ 40ºC	2 day
Minimum temperature	Dec-Jan-Feb	< 0ºC	3 days
	Dec-Jan-Feb	< -8ºC	1 day

Table 4. An overview of the climate thresholds defined by the farmers during the workshop.

5.2.5 Olive field visit

During the workshop, a field visit to olive farms was organized by ASAJA Jaén, providing valuable insights into olive production in the region. We observed that there are three main types of olive farms:

1. Traditional: Characterized by large, widely spaced trees.
2. Superintensive (SI): Consist of smaller plantations planted closely.
3. Mixed: A combination of the two types.

In traditional farms, there is more space between olive trees because the trees have long, spreading roots and compete for resources. In contrast, SI farms require more resources, as the plantations are smaller and planted closer together. Local authorities typically only sanction these types of farms after confirming the availability of sufficient resources, e.g. water for irrigation. In case of multiple consecutive years of drought, the authorities may prohibit SI farming—something that has occurred in the past. The effect of climate can also vary across these two types of farms. While the impact of heat is the same for both types, SI farms are more susceptible to cold temperatures. This is likely because the smaller and younger plantations cannot moderate temperature fluctuations as well as mature trees.

Funded by the European Union

Figure 31. ASAJA Jaen olive farm visit during farmer workshop. Source: Ángel G. Muñoz

Overall, SI farms offer more efficiency compared to traditional farms. Traditional farms typically have around 100 trees per hectare, whereas SI farms can have up to 1,200 plantations per hectare. In SI farms, farmers must wait five years before the first growing season, compared to eight years in traditional farms; after the first growing season, olives are harvested annually in both systems. In terms of harvesting, SI farms use mechanical methods operated by a single labourer, offering greater efficiency. In contrast, traditional farms rely on manual methods such as beating trees with sticks or shaking and collecting fallen fruit using simple equipment, making the process more labour-intensive. Additionally, manual harvesting requires post-processing of the produce. The labour cost for mechanical harvesting is €0.05 per kilo, compared to €0.20 per kilo for manual methods. This makes SI harvesting more cost-effective, especially in light of the fact that the farmers in Jaén are currently facing labour supply shortages. For these reasons, Jaén's farmers are slowly transitioning traditional farms into mixed farms. On one hand, they want to retain existing trees to avoid the five-year waiting period for new plantations; on the other, they seek improved efficiency and cost-effectiveness. Since making such a transition would increase farmer's risk in the short run, by temporarily reducing yields and increasing sensitivity to climate risks (younger plants are more climate sensitive), the public sector has a key role to play by potentially subsidising insurance during the transition period to cover the increased climate risks.

5.3 CoDepi: A tool for co-designing parametric insurance

The main objective of the Food and Agriculture pilot in the PIISA project is to co-develop a co-design application for insurance companies to support the design of IbI products that are not only commercially viable but also aligned with farmers' needs. The main idea is that apart from being technically sound and feasible for business, they should, importantly, be based on the specific requirements and preferences of farmers, i.e. they should be demand-driven. To achieve this, we conducted multiple rounds of stakeholder engagement with the farmers' association ASAJA Jaén, including participatory activities during the farmer workshop with the olive farmers from that region. The application enables the design of tailored IbI products

Funded by the European Union

by aligning historical payouts with farmers' actual experiences, through adjustments in key model parameters. It also assists in setting appropriate premium prices and understanding trade-offs. In the future, a more user-friendly version of the tool could also support farmers in visualizing the trade-offs between coverage and affordability. While the current version of the application is tailored to olive farmers in southern Spain, it has the potential to be adapted to other regions with different climatic conditions, crop types, and trigger thresholds.

Figure 32. CoDepi logo. Source: BSC

This co-design application is CoDepi (Co-designing Parametric Insurance)—a participatory tool developed for olive farmers in southern Spain to collaboratively design a climate IbI that works for them. Built in alignment with the methodology developed by the International Research Institute for Climate and Society (IRI), CoDepi incorporates their best practices, particularly the “convergence of evidence” approach, iterative parameter adjustment, and participatory validation with end-users, in this case the olive farmers of Jaen.

5.3.1 Core methodology

The cornerstone of CoDepi’s approach is convergence of evidence. This validation strategy involves triangulating the performance of the proposed index against multiple independent data sources to ensure that payouts would have occurred in years that were genuinely bad for farmers. Specifically:

- Historical index payouts are simulated using satellite data or local weather station data over a sufficiently long time period.
- These are cross-checked against alternative sources of climate information.
- Farmer memory of “bad years” is collected through structured participatory methods and then matched against the historical payouts.
- Where inconsistencies arise (e.g., payouts in non-bad years or no payouts in bad years), the index base parameters are adjusted to increase the alignment.

The goal is to reach a high level of agreement between scientific datasets and farmers' lived experience, building both technical accuracy and user trust. Ensuring that farmers receive payouts during bad years is crucial for the effectiveness and uptake of the index-based insurance product created through the use of this approach.

Funded by
the European Union

5.3.2 Base parameters

CoDepi uses a set of base parameters that define how climatic data is converted into insurance payouts. Each parameter plays a distinct role in shaping the sensitivity, reliability, and agronomic relevance of the contract. The parameters are described as:

- Contract Windows: These are defined periods within the agricultural calendar year when the crop is most vulnerable to climatic conditions, typically covering flowering and early fruit development in the case of olives. The window marks the start and end dates during which an index is measured for the purposes of triggering payouts. Currently, CoDepi allows for a single contract window, but can be extended to include multiple contract windows. Potentially, each window could be assigned a weight based on its relative importance to final yield.
- Trigger and Exit Thresholds: In index-based insurance, the trigger and exit thresholds define the boundaries of the payout function. These thresholds are not arbitrary values but are grounded in the farmers' self-reported threshold values as well as the historical distribution of the chosen climate index variable and calibrated to match actual loss conditions experienced by farmers.
    - The trigger threshold is the point at which the index value becomes extreme enough to indicate the start of agronomic stress. In case of drought protection, for example, if the measured index (e.g., total rainfall during the contract window) remains above the trigger, the season is considered normal or non-damaging, and no payout is made. However, if the measured index falls below the pre-identified threshold value, then payout is automatically triggered.
    - The exit threshold is the point at which the index value is so extreme that it reflects severe loss conditions. To take the previous example, when the rainfall index falls below this level, the insurance pays out 100% of the insured value. No more payout is made beyond this point, as the maximum payout value is reached.

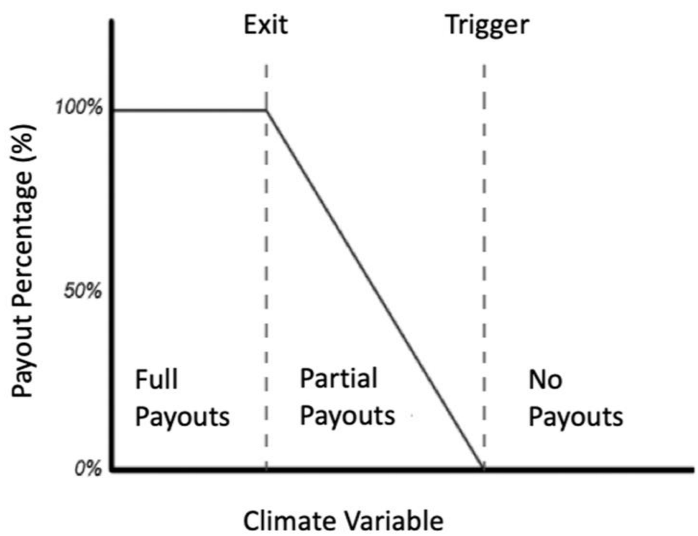


Figure 33. Trigger and exit thresholds, payout zone and slope for IbI. Source: IRI

Funded by the European Union

- Payout Zone: The range between the trigger and exit is called the payout zone. Within this zone, payouts increase as the gap between the trigger threshold and the index value increases. This relationship is typically modeled with a linear payout function, where each unit of the climate variable deficit or surplus corresponds to a proportional increase in payout.

- Payout Slope: This refers to the shape of the payout function between the trigger and exit thresholds. In CoDepi, a linear slope has been used. This function is standard in the literature and minimizes complexity. In advanced applications, non-linear functions can be explored.

- Payout Frequency: Payout frequency refers to how often an index insurance contract is expected to result in a payment to the insured party. This is not about how many times the contract allows payouts per season (e.g., monthly vs. seasonal), but rather how the design of the index influences the likelihood of payouts over time. It is a strategic decision that reflects the balance between offering protection against more frequent, moderate losses versus less frequent, severe ones.

  If a contract is designed to trigger often, it will result in more frequent but typically smaller payouts. This can offer reassurance and continual engagement with the insurance product, but it also increases the cost of the premium. On the other hand, setting the trigger lower will lead to less frequent payouts, only in very dry years, but allows for larger compensation amounts when they do occur and keeps premiums more affordable. Deciding the preferred payout frequency is a trade-off that must be considered carefully in consultation with farmers. Some prefer a product that acts more like a safety net for rare disasters, while others may want smaller but more consistent relief from regular climate stress. The frequency also influences how farmers perceive the value and fairness of the insurance over time.

- Caps: To prevent distortions caused by extreme but ineffective climate events, a cap is applied to the amount of a climate variable measured, say rainfall, that can be counted per unit of time, say per day or per dekad (10-day period) in the index calculation over the contract period, say a month. For example, a cap of 30 mm/dekad ensures that any rainfall above that threshold is excluded from index measurement. This is especially useful in Mediterranean climates, where short, intense rainstorms may not contribute meaningfully to crop water needs. Applying a cap helps improve the agronomic relevance of the index by filtering out favourable climate events that do not actually benefit the crop.

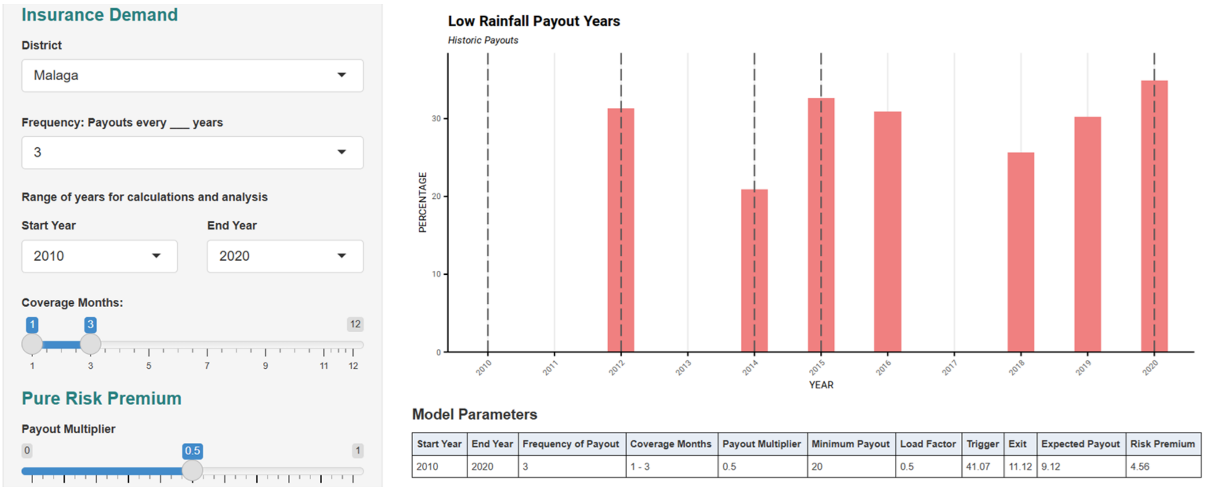
5.3.3 Historical payout validation

Once the index structure and base parameters are co-defined with the farmers, CoDepi is built to run a back-testing simulation of payouts over the historical data record, as shown in Figure 34. The results are visually compared to:

1. Farmer memory of "bad years."
2. Other sources of climate information for further verification.

Funded by the European Union

Payouts are graphed against this timeline, and mismatches are flagged. For example, if 2005 is consistently reported as a severe drought year but the index pays nothing, the index design should be re-evaluated. This iterative re-evaluation process is carried out by adjusting contract windows, exit and trigger thresholds, payout frequency, or testing alternate datasets. This process is termed as "iterative convergence," emphasizing that multiple rounds of adjustment are often required. Additionally, it is also possible to integrate seasonal monitoring into the validation process. This involves tracking real-time risk exposure and index performance throughout the season using field data, crowd-sourced observations, satellite imagery, and meteorological reports, so that the IbI product can be refined during its lifetime.



Start Year	End Year	Frequency of Payout	Coverage Months	Payout Multiplier	Minimum Payout	Load Factor	Trigger	Exit	Expected Payout	Risk Premium
2010	2020	3	1 - 3	0.5	20	0.5	41.07	11.12	9.12	4.56

Figure 34. Historical payout validation for a location in Spain. Source: CoDePi

As an extension to the current version of the tool, CoDepi will quantify the alignment between historical payouts and farmers' bad years using a "match ratio" (e.g., % of bad years with payouts), which can potentially be shown to farmers during future co-design sessions of farmer workshops. Farmers would then be invited to provide feedback and suggest further parameter adjustments. They would get the opportunity to not only provide the relevant inputs for the IbI, but also interact directly with the tool to foster a sense of ownership and transparency. In this manner, farmers' feedback is and will continue to be documented and used to shape revisions.

6 Conclusion and way forward

This report has shown that while climate risks are growing rapidly across the Mediterranean, the insurance sector, particularly risk-transfer instruments such as index-based insurance, still has some catching up to do. Traditional insurance models are often seen as too slow, costly, or complex, especially for small farmholders. Our findings suggest that a fair percentage of farmers are open to new solutions like parametric insurance, provided these are easier to understand, transparent, and supported by strong institutional frameworks. The

Funded by the European Union

case study in Jaén, alongside the Italian and Spanish surveys, has made it clear that farmers are not just passive recipients of risk but are actively, perhaps even anxiously, looking for ways to protect their livelihoods. What is missing is a better match between what is available and what farmers actually need, especially when considering that more often than not the parametric insurance product are designed unilaterally by insurance companies using general (or not tailored) tools and thresholds, taken from other locations, case studies or literature, without necessarily contrasting it with the local farmers who are the ones who will buy the product

The participative approach described in this document, successfully implemented with ASAJA Jaén, including tools like CoDepi, represent a promising way to close that gap. By involving farmers directly in the design of insurance products, and by making sure these products are tailored to the realities of local crops and climate, we can significantly improve both trust and usability. The work with olive farmers in Jaén has demonstrated that co-designing insurance around real thresholds and lived experience, not just statistical models, has the potential to offer improved protection to the farmers. It also highlighted that many farmers are already adapting to climate challenges, but they need stronger backing and are open to new solutions. Furthermore, as the tool will evolve through iterative testing and feedback, it will not only improve its precision for the Mediterranean context, but by establishing a replicable framework, it holds the potential to be upscaled and adapted to other EU regions facing similar climate risks.

Beyond insurance, the pilot acknowledges the broader role of climate services in fostering resilience. Climate services, such as early warning systems and Forecast-based Financing (FbF) or Action (FbA), tend to provide actionable information to farmers, enabling optimized decision-making and reducing vulnerability. These complementary services can amplify the impact of IbI, creating a comprehensive ecosystem of financial tools that support agricultural and economic resilience. However, building such an ecosystem of climate services (González-Romero et al., 2025) requires sustained public investment and policy support. As seen in many index insurance pilots, initial funding often relies heavily on donors, with private insurers hesitant to enter the market due to high development costs, uncertain demand, and the perception of these expenses as sunk costs (Jensen and Barrett, 2016).

Policy can therefore play a pivotal role in advancing IbI and the broader suite of climate services. Governments can subsidize premiums, reducing entry barriers and encouraging uptake. Clear regulatory frameworks, product certification standards, and consumer protection measures can enhance trust and product quality. Public investment in data infrastructure, extension services, and digital platforms will further strengthen the foundation for effective insurance and climate information systems. Finally, by facilitating public-private partnerships and aligning these initiatives with national climate adaptation and rural development agendas, policy can turn fragmented pilots into harmonized solutions, thereby ensuring that IbI and climate services become reliable tools for agricultural resilience.

We have laid out the next steps in the Food and Agriculture pilot in the PIISA project that aim to meet some of the objectives that emerge from this discussion, as outlined in the Roadmap

Funded by
the European Union

in Figure 35. Continuing our focus on Loop 2 of the pilot, we plan to analyse the results of the survey for Spanish farmers, which would directly complement and inform the co-design of the index insurance proof of concept. Based on the climate indicators and critical threshold values we have obtained from the farmer workshop in Andalucía, as well as the farmer survey, the CoDepi tool would be contextualised for the olive farmers in south of Spain. Specifically, we propose to focus on tailored climate variables for drought for two locations in Andalucía (Jaén, specifically), for which the context-specific threshold values would serve as a starting point for concept development. These threshold values, along with other base index parameters would then be suitably adjusted to strike a match between expected payouts and farmers' bad years. Furthermore, the concept(s) thus developed would be reviewed with insurance product experts to ensure technical soundness and assess business feasibility. In loop 3 of the pilot, we will assess the potential for applying these concepts in other regional contexts. Essentially, the tool's adaptability to different climatic conditions and crop types will be explored, as well as the guidelines for such applications would be clearly laid out. Shifting our focus to the climate services and financial instruments related to IbI, we will provide the farmers in Andalucia with seasonal climate information, and potentially develop an early warning system (EWS) for supporting their climate adaptation efforts, if resources permit.

Task 3.3 Roadmap	LOOP 1 (M6-M19)	LOOP 2 (M19-M25)	LOOP 3 (M25-M33)	Legacy of PIISA
Tool development	1. Stakeholder mapping for the Mediterranean case study 1. Agroseguros 2. ASAJA Jaen – farmer association in Andalucía 3. Explore AXAC contacts for the Mediterranean region	1. Field visit to ASAJA Jaen 2. Workshop of Andalucía's olive farmers 3. Development of co-design tool: CoDepi (**Co-De**signing **P**arametric **I**nsurance) 1. Identify trigger and exit thresholds with ASAJA Jaen 2. Ensure business feasibility with insurance experts (AXAC)	1. Launch of first version of CoDepi 2. Development of seasonal predictions for ASAJA 3. Exploring EWS for ASAJA 4. Development of climate change projections (FMI)	Hosting, development, and maintenance is carried out
Piloting	1. Farmer survey for the Boreal region (LocalTapiola) 2. Summary report on the regulations for index-based insurance in the EU	1. Farmer survey in Italy (Polimi) 2. Agriculture pilot webinar 3. Farmer survey in South of Spain 4. Potential integration of ESG metrics in the pilot with Amigo SRL	1. Operationalisation of climate services developed in the pilot	More EU regions implement demand-driven insurance solutions based on farmer needs
Upscaling	1. Research insurance framework for other EU countries to assess the applicability of index-based insurance	1. Identify other regions in the EU for replication of CoDepi 2. Identify key stakeholders (e.g., insurance companies, farmer associations) 3. Outreach plan for loop 3	1. Publicize CoDepi to key stakeholders in the EU 2. Guidance documents for replication of CoDepi 3. Best practices and lessons learned from the pilot	Recognized tool for insurance companies and farmers to co-design index-based insurance
	D3.7	D3.8	D3.12	

Figure 35. Food and agriculture pilot roadmap

The index insurance concept thus developed explores the potential of future implementation of IbI products in the Spanish insurance market. A potential barrier in introducing such a product would be the existing stronghold of Agroseguros in the insurance sector. Agroseguro is a management entity for agricultural insurance offered by insurance companies that are part of its co-insurance pool. Its main activities include managing and processing insurance

Funded by the European Union

policies - issuance and collection of receipts to and from policyholders, as well as receiving claim statements from insured parties and carrying out adjustment procedures, assessment and payment of claims on behalf of the co-insurers. It also conducts studies for insurance tariffs, arranges and manages premium payments for reinsurances, and collects subsidies from the National Agricultural Insurance Agency and regional governments, among other functions. Currently, they offer indemnity insurance covering a comprehensive range of nature-related risks faced by Spanish farmers.

During the development phase of this policy, however, the olive farmers from the Andalucía region were unrepresented, as reported by ASAJA. This indicates that stakeholders may not have been properly involved in formulating this policy. The generic nature of the policy reinforces the idea that the current insurance product is not sufficiently demand-driven and tailored to different contexts. While this reflects a gap in the market, bridging it without Agroseguros' cooperation may be challenging. Early-phase interactions in this pilot, however, did not seem to spark their interest in active participation in the co-development process. This could be due to several factors, including loss adjusters losing relevance and past experience with IbI.

Another challenge in implementing an IbI solution in Spain is ensuring its business feasibility. The demand from the olive farmers in southern Spain partly emanates from their previous experience with IbI, which proved to be positive due to more payouts triggered. While this effectively covered their risks, the product failed to be profitable for the insurance company offering it and was ultimately discontinued. This underscores the importance of setting base parameters that balance local demand with long-term business viability. Developing a sustainable solution would give farmers confidence in its reliability, rather than leaving them worried about potential market failure and discontinuation.

7 Acknowledgements

We would like to thank the ASAJA Jaén team, especially Luis Carlos Valero -head of ASAJA Jaén- and Pedro Reca -head of insurance at ASAJA Jaén- for his invaluable collaboration with the case study on the Spanish Food and Agriculture pilot, and for making it possible to carry out the workshop in Jaén with the local farmers. We would also like to express our appreciation to all the people who attended the workshop and shared their valuable expertise and knowledge with us to provide the information necessary for this case study. ÁGM was partially supported by the Grant RYC2021-034691-I, funded by MCIN/AEI/10.13039/501100011033 and the European Union NextGenerationEU/PRTR.

Bibliography

Bank of Italy, (2023). https://www.bancaditalia.it/pubblicazioni/qef/2023-0756/QEF_756_23.pdf?language_id=1

Botzen, W. J. W., Van den Bergh, J. C. J. M., & Bouwer, L. M. (2010). Climate change and increased risk for the insurance sector: a global perspective and an assessment for the Netherlands. Natural hazards, 52, 577-598.

Botzen, W. J., Aerts, J. C., & van den Bergh, J. C. (2009). Dependence of flood risk perceptions on socioeconomic and objective risk factors. Water resources research, 45(10).

Carter, M., de Janvry, A., Sadoulet, E., & Sarris, A. (2017). Index insurance for developing country agriculture: A reassessment. *Annual Review of Resource Economics, 9*, 421–438.

CMS. (2020, June 29). *Q&A: Insurance & Reinsurance Regulation in European Union*. Lexology. https://www.lexology.com/library/detail.aspx?g=70416753-828b-428d-b5e0-373c7a1dec57

European Commission. (2023). *EU agricultural outlook for markets, 2023–2035*. Directorate-General for Agriculture and Rural Development.

European Commission. (n.d.). *Consequences of climate change*. Retrieved April 26, 2025, from https://climate.ec.europa.eu/climate-change/consequences-climate-change_en

European Environment Agency, (2019). https://www.eea.europa.eu/en/analysis/publications/cc-adaptation-agriculture

European Environment Agency. (2024). *Economic losses from climate-related extremes in Europe*. https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related

European Environment Agency. (2024, March 11). *European climate risk assessment* (EEA Report No. 01/2024). https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment

European Parliament and Council. (2010). *Regulation (EU) No 1094/2010 establishing EIOPA*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010R1094

Ibarra, H., & Securities, I. L. (2010). Parametric insurance: general market trends and perspectives for the African insurance sector. Insurance Linked Securities.

IVASS, (2019). https://www.ivass.it/pubblicazioni-e-statistiche/pubblicazioni/relazione-annuale/2020/RELAZIONE_IVASS_2019.pdf

Jensen, N., & Barrett, C. B. (2016). Agricultural index insurance for development. *Applied Economic Perspectives and Policy, 0*(0), 1–21.

Kunreuther, H. (1996). Mitigating disaster losses through insurance. Journal of risk and Uncertainty, 12, 171-187.

Lehmann, N., Krauer, B., & Vroege, W. (2021). *Product innovation: Index insurance*. AXA XL.

Lin, X., & Kwon, W. J. (2020). Application of parametric insurance in principle-compliant and innovative ways. *Risk Management and Insurance Review, 23*(1), 1–30.

Surminski, S. (2018). Flood insurance and flood risk reduction. In Oxford Research Encyclopedia of Natural Hazard Science.

Swiss Re Institute. (2023). Restoring resilience: The need to reload shock-absorbing capacity (sigma No. 2/2023). Swiss Re.

Van Nostrand, J. M., & Nevius, J. G. (2011). Parametric insurance: using objective measures to address the impacts of natural disasters and climate change. Environmental Claims Journal, 23(3-4), 227-237.

Funded by the European Union