

EGU24-1992, updated on 19 Mar 2025

<https://doi.org/10.5194/egusphere-egu24-1992>

EGU General Assembly 2024

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Assessing matches and mismatches between modelling and stakeholders' needs to support the adaptation of grain legumes to climate change in Europe

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Diversifying cropping systems with grain legumes has been identified as a key measure to achieve the objectives set by European policies in terms of sustainability and protein self-sufficiency. Because grain legumes are sensitive to numerous biotic and abiotic stresses, expanding their production area in the context of climate change will require the implementation of adaptation strategies.

The objectives of this study are to shed light on what knowledge is needed by stakeholders to adapt grain legume cultivation to climate change and to assess matches and mismatches between these needs and crop-climate modelling. To this aim, we performed (i) a systematic literature review (n=83) to summarise recent simulation studies that assessed the impact of climate change and adaptation on grain legume performances in Europe, and (ii) interviews with 30 stakeholders involved in different stages of the value chain in France (cooperatives, seed breeders, extension services) to identify their needs.

Stakeholders' information needs could be grouped into three categories: (i) information on profitability (including crop yield, pre-crop effect, and economic margin) and risks associated with growing grain legumes (including yield stability and risk of crop failure) and comparison of these variables with major crops like cereals, (ii) agroclimatic indicators such as rainfall distribution, heat waves, and frost days, that can be used to adjust crop management and identify climatic constraints to the introduction of new grain legume species (e.g., chickpea and soybean), and (iii) climate change impacts on diseases, pests, and their natural enemies. The appropriate time and spatial scales at which this information is relevant depend on the stakeholder. Stakeholders supporting farmers (e.g., extension services) expressed a need for short-term (up to 10 years) and local information, whereas cooperatives and stakeholders engaged in R&D were also interested in medium-term (up to 30 years) information at multiple spatial scales (from the cooperative's supply area to the national and European scale).

When comparing these needs with our literature review, several mismatches were identified. Although stakeholders expressed a need for short to medium-term information, the reviewed studies focused mainly on the second half of the 21st century. The predominance of global-scale studies (63% of studies) contrasted with the need for local and regional data. We also highlight a

lack of simulation studies assessing the impact of climate change on yield stability and economic indicators, especially relative to major crops like cereals. The impact of climate change on diseases, pests, and their natural enemies remains a blind spot, even though biotic pressure was identified as a growing concern for the stakeholders. Finally, although the majority of adaptation strategies identified by stakeholders (e.g., irrigation, changes in sowing date and density) have been studied in the literature, options such as substituting spring-sown crops with winter-sown crops and switching grain legume species have hardly been assessed (only one study).

Our results outline priority avenues for further research, considering the needs of stakeholders to support the development of grain legumes in Europe in the context of climate change.