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RESEARCH ARTICLE



The importance of the messenger in climate change communication to farmers

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ABSTRACT

Agriculture needs to mitigate its impacts and adapt to new environmental conditions. To this end, communicating climate change to farmers is essential but remains a challenge, since many stakeholders (e.g. public administration, sectoral stakeholders, environmentalists) engage with farmers, conveying diverse messages about climate change and the role of agriculture. Here we aim to analyse farmers' perceptions of climate change and how these relate to their trust in different stakeholders. We conducted a survey with 167 livestock farmers across Spain, gathering data about their perceptions on climate change severity and origin, and to what extent its importance has been exaggerated. We also analysed farmers' trust in different information sources, including farmers associations (i.e. breed associations, farmer organisations and cooperatives), agricultural organisations, technical publications, veterinarians, agricultural firms, government agencies, scientists, environmentalists, animal activists, and the media. Our results show that farmers believe climate change exists but a high proportion are sceptical about its origin and severity. Farmers' trust in information sources influences their perception of climate change. Farmers who trust public institutions, environmentalists, animal activists, and the media are more likely to view climate change as human-driven and perceive its impacts as severe, rejecting claims of exaggeration. In contrast, those who trust veterinarians, cooperatives, agricultural firms, and farmer organisations tend to see climate change as a hybrid human-natural process and believe its impacts are overstated. The results highlight the need to improve the science-policy-farmers dialogue to make farmers more aware of the potential consequences of climate change on farming and trigger adaptation.

HIGHLIGHTS

- Many farmers (~60%) are sceptical about climate change origin
- Farmers trust sectoral stakeholders and scientists, and mistrust public administration, the media, and environmental activists
- Farmers mistrust in public administration, the media, and environmental activists is linked to scepticism about climate change

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Introduction

Despite scientific consensus on the origin and effects of climate change (Cook et al. 2016; IPCC 2022), public perception is heterogeneous and influenced by socio-cultural context, political identities and other socio-economic factors (McCright and Dunlap 2011; Bliuc et al.

2015; Marquart-Pyatt 2015; Poortinga et al. 2019). These factors sometimes lead social groups to discredit climate change evidence (Huber et al. 2022), hampering the implementation of effective policies and individual mitigation actions. Agriculture is responsible for 13% of global anthropogenic greenhouse gases emissions, or 18% if

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land use, land use change and forestry are considered (FAO, 2024; IPCC, 2019) and, at the same time, it is one of the sectors most affected by climate change, which increasingly limits its ability to meet human needs (IPCC 2022).

Previous research has shown that many farming communities are sceptical about climate change (Kuehne 2014; Davidson et al. 2019) and recent farmer protests throughout Europe show that a share of European farmers are reluctant to implement measures to reduce the environmental impact of their farms (No autor(s) 2024). Understanding farmers' positions and perceptions towards climate change and how they are shaped by social trust is key to design effective policies for adaptation and mitigation in agriculture (Mills et al., 2017; van Valkengoed and Steg 2019). This is especially relevant since sustainable practices in agriculture have the potential to sequester carbon (Bhattacharyya et al. 2021), which could be further promoted through effective communication strategies.

In this regard, higher awareness about environmental problems is linked to more environmentally friendly actions and greater acceptance of sustainability (Hansla et al. 2008; Eyster et al. 2022). Moreover, the level of trust in the source recommending or designing such sustainability actions facilitates farmers' uptake of these practices (Sutherland et al. 2013; Muñoz-Ulecia et al. 2025). Here we examine the link between farmer trust in various agricultural and non-agricultural stakeholders (veterinarians, farmers' associations, public administration, environmentalists, scientists, and the media) and their perceptions regarding climate change. We hypothesised that farmers' perceptions of climate change are shaped by the stakeholders they trust. For this purpose, we included a wide range of livestock systems (small and large ruminants, dairy and meat orientation, and degree of feeding intensification) across the Spanish geography.

Material and methods

Data collection and study area

Farmers from four different ruminant farming systems in Spain were surveyed as part of two research projects (see acknowledgements). The questionnaires used in the projects had two common sections, which included the questions analysed in this study. The first section analysed farmers' perceptions of climate change and its impact. Specifically, farmers were asked to rate their level of agreement with a set of statements regarding their beliefs about climate change and its causes using a 6-points Likert scale. The statements included: "Climate change is

not happening", "There is not enough evidence to know with certainty whether climate change is occurring or not", "Climate change is happening and is mainly caused by natural processes", "Climate change is happening and is caused by both natural processes and human activity", or "Climate change is happening and is mainly caused by human activity". Then, farmers were asked, using the same scale, to what extent they thought that "the importance of climate change had been exaggerated". Finally, participants were asked to rate the current severity of climate change (from 1 – not a serious problem at all, to 10 – an extremely serious problem) using the EU's Eurobarometer polling instrument (European Commission 2020). The second section analysed social trust of farmers on different information sources, including livestock farmers associations (i.e. breed associations, farmer organisations and cooperatives), individual farmers, livestock farming magazines, veterinarians, farming companies, government agencies, scientists, environmentalists, animal activists, and the media. Farmers were asked their level of trust in those stakeholder views and advice on farming issues, using a scale of 1 to 6, where 1 represents total mistrust and 6 represents total trust.

We considered four case studies, each of them focusing on a different ruminant farming system, selected to represent key farming systems across diverse agroecosystems in Spain (Figure 1). These included dairy cattle (i.e. Holstein-Friesian breed in northern central Andalusia), dairy sheep (i.e. Manchega breed in La Mancha region), meat sheep (i.e. Rasa Aragonesa breed in Aragon region), and dairy goat farms (i.e. Florida breed in the southwestern Andalusia and southern Extremadura regions). These areas are already experiencing the effects of climate change, with high-temperature events and droughts and floods becoming more frequent and extreme. It is predicted that temperatures will continue to rise, and precipitation will decrease, particularly during the summer season (IPCC 2022). As a result, climate-related hazards are having and will continue to have a direct and indirect impact on the productivity of the livestock sector in the case study areas (Lacetera et al. 2013).

In the four case studies, a total of 167 face-to-face surveys were conducted between November 2019 and September 2021 (for further information about the survey see Martin-Collado et al. 2024). The survey included 38 dairy cattle farmers, 43 dairy sheep farmers, 45 meat sheep farmers and 41 dairy goat farmers.

Data analysis

First, a descriptive analysis of farmers' perceptions of climate change and social trust was carried out and the

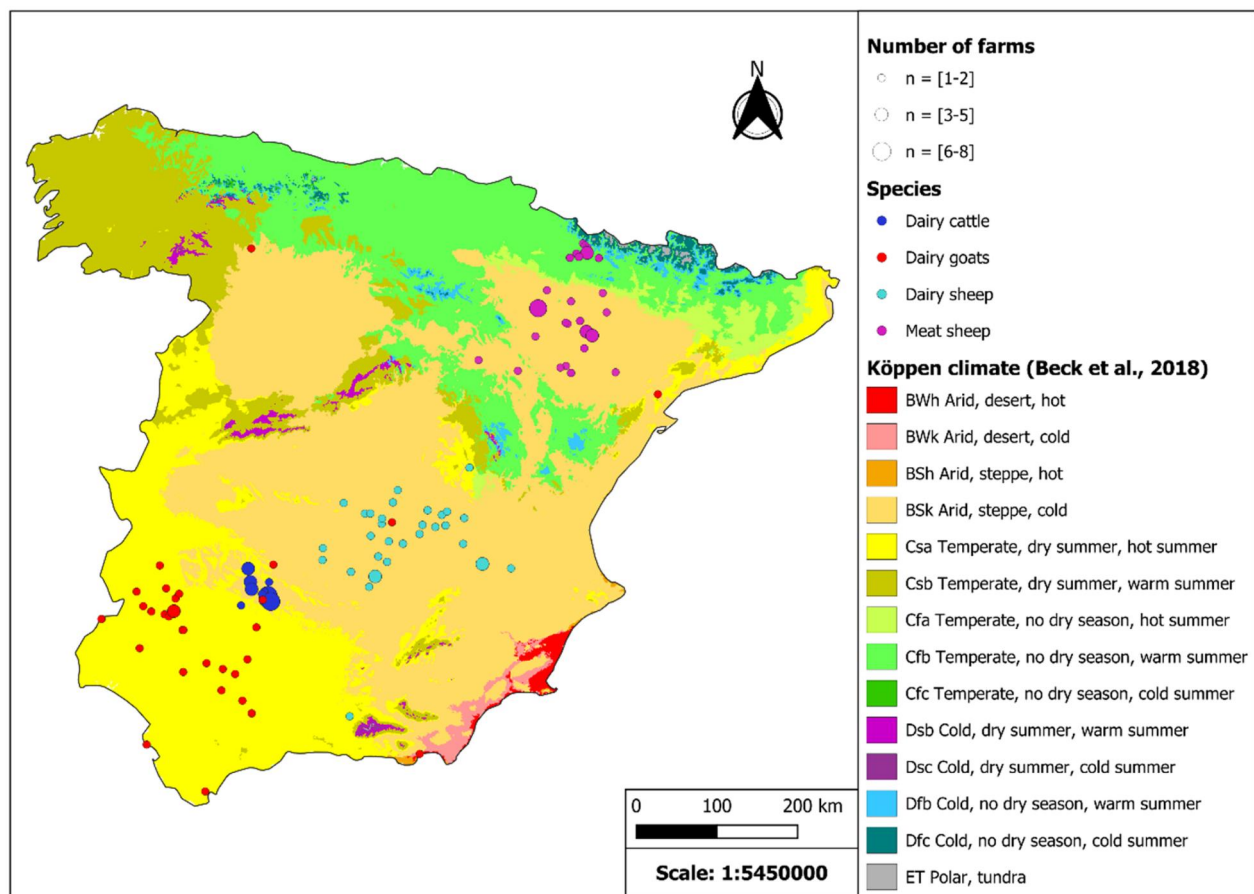


Figure 1. Location of the surveyed farms on a köppen climate classification map of Spain. Reused with permission and modified from (Martin-Collado et al. 2024).

results compared across case studies. Differences in farmers' perceived severity of climate change and their level of trust on the different stakeholders were analysed using ANOVA and Tukey's Honestly Significant Difference test. Differences in farmers' beliefs regarding the causes of climate change were analysed using Chi-squared tests. Second, given the large number ($n = 12$) of variables related to farmers' social trust (one per stakeholder group) we used a multivariate approach. A Principal Component Analyses (PCA) was conducted on the variables related to farmers' trust. Variables related to climate change perception were added as supplementary variables to the social trust factorial spaces. The position of the supplementary variables with respect to the factorial axes is interpreted in the same way as the variables used in the PCA (Graffelman and Aluja-Banet 2003). All statistical analyses were performed using R software (R Core Team, 2019).

Results and discussion

We found limited differences between the four farming systems studied (Supplementary Information, Table S1),

suggesting that our results are generalisable for the Spanish ruminant livestock sector rather than specific to each region or farming system. We believe that similar patterns are likely in livestock farming systems of other regions with comparable socio-economic and agricultural contexts, such as other Western societies. Nonetheless, generalisations beyond Spain should be made with caution, as cultural, political, and environmental differences may shape farmers' perceptions and behaviours.

Farmers' perception of the origin of climate change

The opinion of farmers about the origin of climate change splits between being caused by humans ($\approx 40\%$ of responses) and being a hybrid human-natural process ($>50\%$ of responses) (Figure 2A). The rest of farmers consider climate change is a natural process ($<5\%$) or that there is no evidence that it is occurring ($<5\%$) (Figure 2A). Almost half of the farmers believe that the importance of climate change has been exaggerated (Supplementary Information, Figure S1). These results suggest that although farmers show

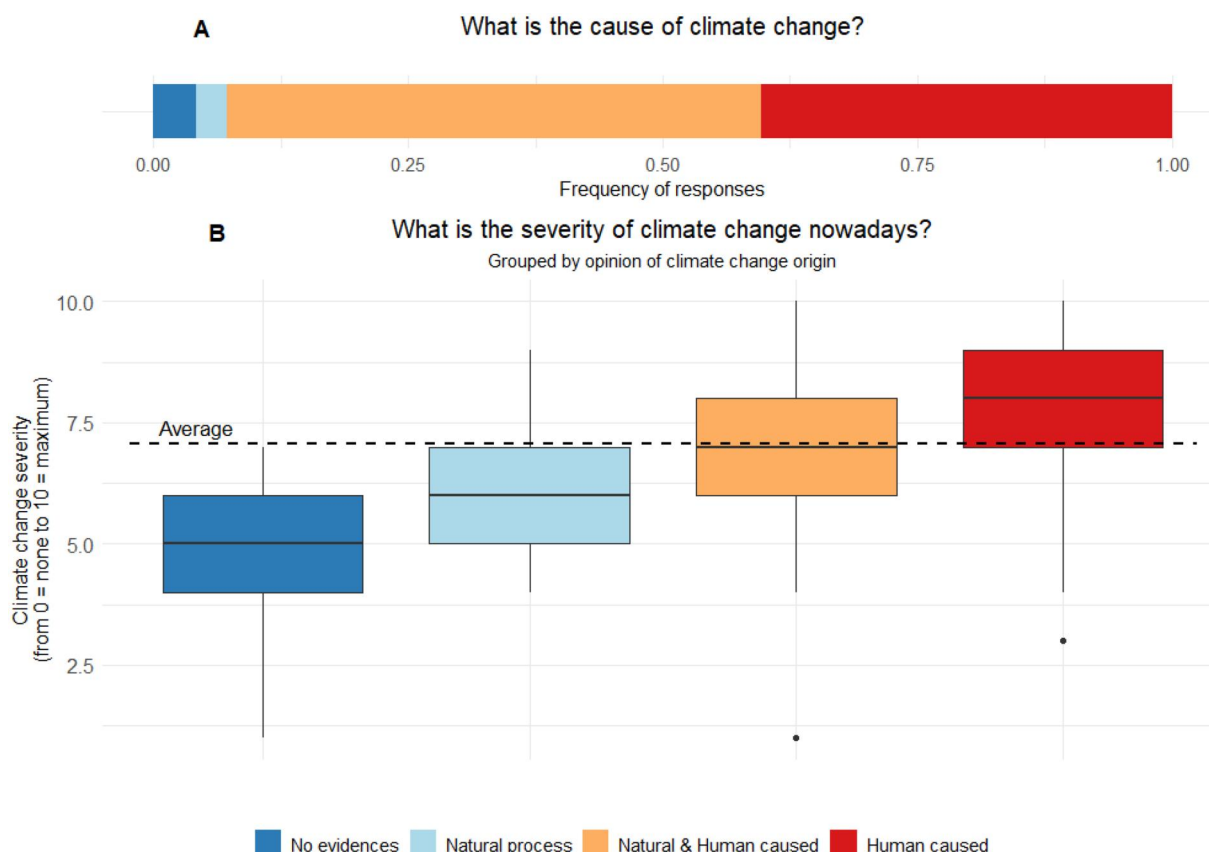


Figure 2. Farmers' belief of climate change origin and severity. Figure 2A represents the frequency of beliefs of the origin of climate change. Figure 2B represents the perceived severity of climate change grouped by Figure 2A. The dashed line represents the overall average. $N = 167$ farmers.

high levels of trust on scientists, in line with the European and Spanish societies (Cologna et al. 2024), the dissemination of scientific evidence on climate change to farmers seems to be failing. Yet, the misperception that climate change is a hybrid human-natural process is shared by a large share of the European society (Lübke 2022), rather than a particularity of the Spanish agricultural sector.

On average, farmers rate the severity of climate change to be 7.1 (Figure 2B), which is almost one point below the Spanish (8.1) and European (7.9) averages (European Commission 2021). Additionally, the perceived severity of climate change significantly differs according to farmers' belief on the origin of climate change (Figure 2). Those who believe that climate change is human-driven rate its severity higher (7.9) than those who believe it is a hybrid natural-human process (6.7) (Kruskal-Wallis p -value < 0.001) (Figure 2B). This may also indicate that some farmers acknowledge partial responsibility for climate change, while others may perceive it as a problem caused by other sectors but that they endure.

Therefore, our results suggest that when the scientific message (i.e. climate change as a human-driven process) reaches farmers their concern about its severity increases. It derives that a better-informed agricultural sector might be more willing to engage in climate change mitigation (Saari et al. 2021). However, the scepticism of a large share of farmers warns about the need to improve the science-policy-farmers dialogue. The fact that a group of farmers believe that the impact of climate change is severe (Figure 2B) but do not believe it is caused by human activities may underlie their willing to implement adaptation, but not mitigation practices (Martin-Collado et al. 2024). Therefore, these farmers understand the need to adapt to an existing challenge, not the need to mitigate a problem for which they do not have a sense of responsibility or are unaware of their contribution. This resonates with the 2021 Special Eurobarometer, where respondents perceiving they were well-informed about climate change assigned a higher severity to its impacts (European Commission 2021). Moreover, respondents with higher perception of

agriculture being a cause of climate change were more likely to impute farmers the responsibility for climate action (Tosun et al. 2024).

Farmers' trust in stakeholders

Farmers interact with multiple stakeholders leading to an exchange of ideas and information, either supporting or questioning own's visions on shared concerns. Farmers trust the information given by sectoral stakeholders (i.e. veterinarians, breed associations, farming magazines, cooperatives, agricultural firms, other farmers, and farmer organisations) and scientists (Figure 3). Conversely, farmers mistrust the public administration, the media, and environmental and animal activists (Figure 3). Animal activists, environmentalists and some media openly criticise specific farming practices for their negative environmental impact. These critics can be perceived by farmers as a threat or limitation to their freedom, increasing their reactance towards the message carriers (Reynolds-Tylus 2019). This reaction could also create or reinforce the feeling of unfair allocation of responsibility of GHG emissions (10%) when compared to other sectors like industry (38%) or transport (21%) in Europe (Peyraud and MacLeod 2020).

The case of public administration deserves particular attention. In the European Union, farmers are heavily supported by the Common Agricultural Policy (CAP), in some cases representing the largest share of their incomes (Bernués et al. 2011; Scown et al. 2020;

Muñoz-Ulecia et al. 2021). The CAP increasingly conditions payments to the implementation of pro-environmental practices, which can be perceived by farmers as a top-down restriction to their freedom of choice (Trimmel et al. 2024). Moreover, the increased bureaucracy and paperwork and the evidence of unfairly allocated resources strengthen farmers' dismissal of the public administration (FAO et al. 2021), which might influence farmers' views on public institutions' positions on climate change.

Linking farmers' climate change perception and their trust in stakeholders

Farmers' trust in stakeholders and their opinion on the origin and impact of climate change are also related. Farmers that mistrust all stakeholders tend to believe that climate change is a natural process or that there is no evidence (Figure 4 Dim. 1). This denial is rare both in our study and European population, but it is commonly held by anti-mainstream groups opposed to societal changes and wishing to maintain traditional views and structures (Lübke 2022).

Farmers that trust the public administration, environmentalists, animal activists and the media tend to think that climate change is human driven and are opposed to the idea that it is a hybrid human-natural process (Figure 4 Dim. 2). These farmers have also higher concerns in terms of climate change severity, opposing the idea that its impact has been

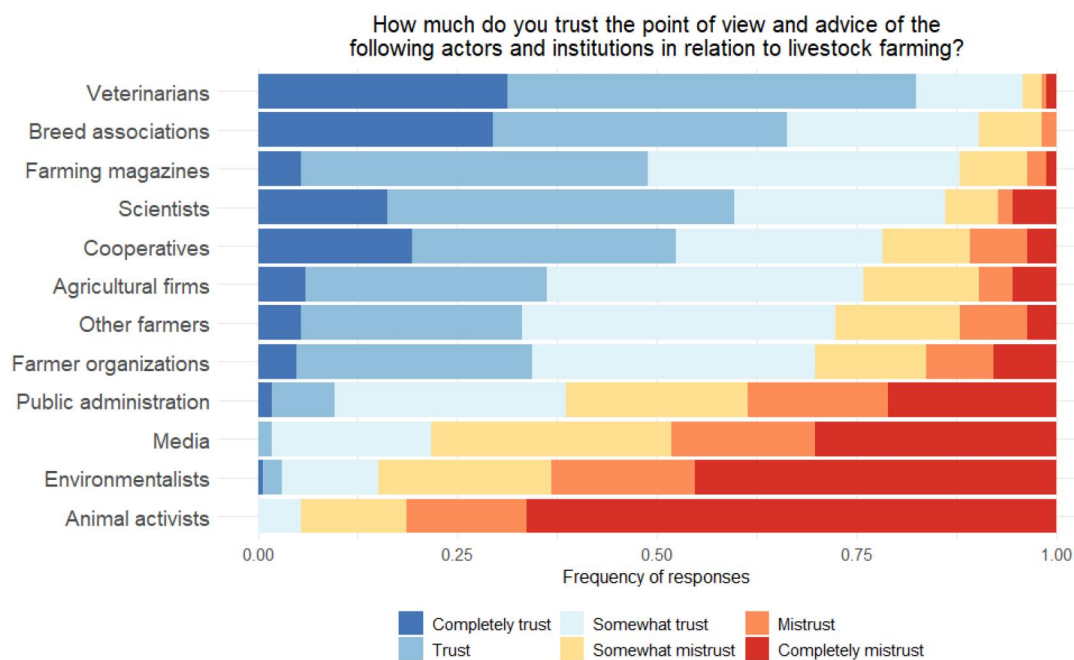


Figure 3. Farmers' trust in different stakeholders. Data depicts farmers' responses to a 6-point question. $N = 167$ farmers (see methods). Partial results included in this figure have already been published elsewhere (Martin-Collado et al. 2024).

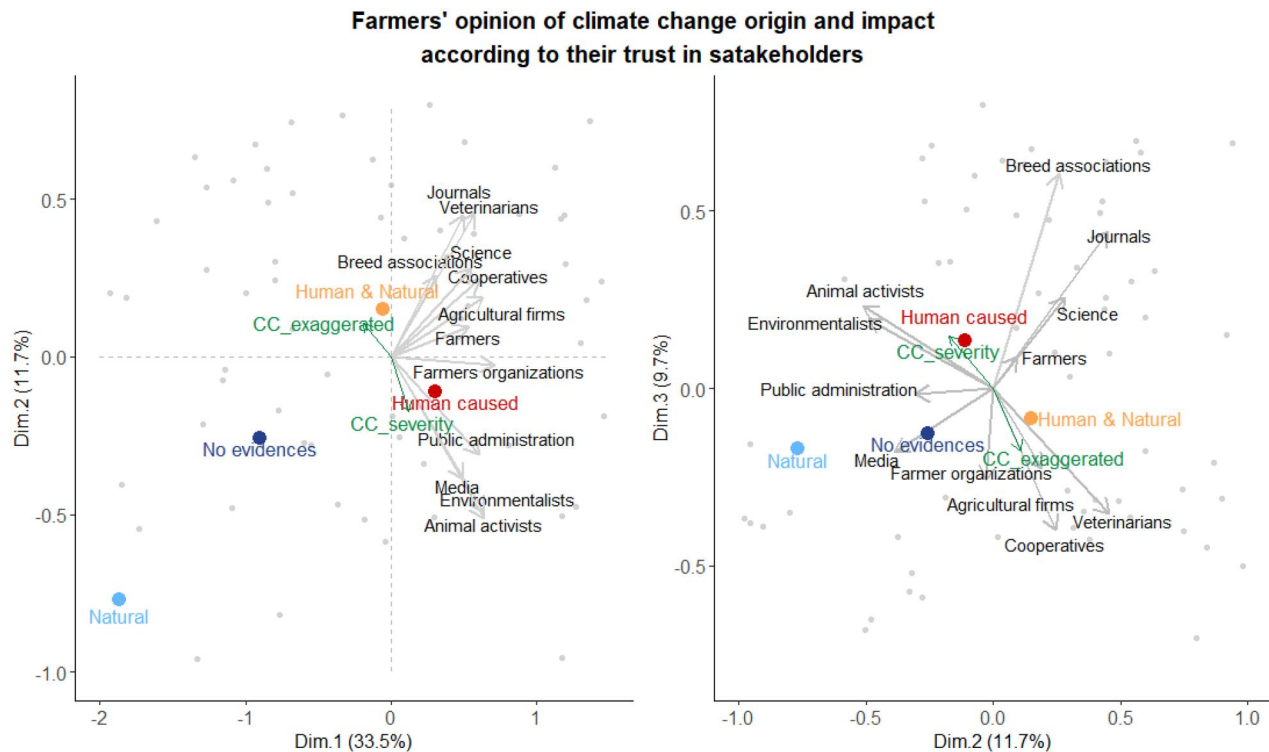


Figure 4. Relationship between farmers' trust in social groups and their perception towards climate change. Principal component analysis plots of the 12 variables related to farmers' trust on stakeholder groups. The resulting principal components are presented in [supplementary information Tables S2 and S3](#). Variables related to climate change perception are added as supplementary variables to the factorial space. Farmers' opinion about climate change being exaggerated (6-levels likert scale; CC_exaggerated), and perceived severity of climate change (1 to 10 scale; CC_severity) were added as continuous variables (green). Farmers' opinion of the origin of climate change was added as a qualitative variable, with the dot indicating the barycenter of the individuals who believe in alternative origins of climate change (shared colours with Figure 2). $N = 167$ farmers (see methods).

exaggerated (Figure 4). Alternatively, farmers that trust veterinarians, cooperatives, agricultural firms, and farmer organisations, tend to believe that climate change is a hybrid human-natural process and that its impact has been exaggerated (Figure 4). Previous research has shown that farmers' trust in public authorities and environmental organisations is associated with higher readiness to uptake adaptation measures, while farmers' trust in actors representing the agricultural industry points at the opposite direction (Arbuckle et al. 2013; Azadi et al. 2019).

When forming attitudes towards science, it is not only the reliability of the content ("what to believe") that is important, but the trustworthiness on the messenger ("whom to believe") (Huber et al. 2022; Toomey 2023). Therefore, comprehending how farmers perceive the rest of society, and vice versa, can help optimise the communication of scientific evidence and enhance the implementation of effective climate policies.

The relation between the message, the messenger, and the receiver is intricate. A listener's mistrust on the message carrier increases the reactance or dismissal of the message itself (Fairbrother 2017; Boenke

et al. 2022). Besides, disbelief in the message (e.g. climate change origin) increases when it threatens the receiver interests (Lübke 2022), which helps explain farmers' reactance to implementing mitigation actions. Furthermore, the perception of the credibility of the message underlies the judgement of the source's credibility (Asplund 2018), even leading to perceive the messenger as a betrayer (Huber et al. 2022). The perception of social institutions (politicians and decision makers, NGOs and the media) as a mainstream or cosmopolitan elite can increase climate change disbelief (Lübke 2022), eventually turning communication campaigns from those institutions into the opposite outcomes (Byrne and Hart 2009; Reynolds-Tylus 2019).

Our results suggest that these phenomena are potentially taking place among Spanish livestock farmers, and probably in other farming communities. Further research is needed to identify whether (i) it is farmers' generalised mistrust in public and social institutions what drives their perception of climate change severity and origin; (ii) agricultural stakeholders are failing to properly communicate the scientific evidence of climate change to farmers; (iii) farmers feel they are

unfairly pointed as triggering climate change, leading them to disbelief in the message and mistrust the messengers. In any case, improving communication about climate change between stakeholders appears as a necessary step for better action.

Implications for communication with farmers

The fact that some farmers' trust in scientists but maintain a sceptical position towards climate change has implications for the role of scientists in communicating the links between climate change and agriculture. Scientists usually struggle to connect their findings with farmers' worldviews (Velado-Alonso et al. 2024), thus failing to communicate the implications of climate change for agriculture. As well-known precedents have illustrated (Oreskes and Conway 2011), this communication gap is filled by other sectoral stakeholders who develop their own narratives and messages to protect their interests (Farrell et al. 2019). In certain situations, there may be a deliberate tactic of discrediting the message by attacking the messenger (Oreskes and Conway 2011; Elsasser and Dunlap 2013). We urge for the integration of scientists as legitimate stakeholders in the current debate of translating adaptation and mitigation policies into agriculture.

To design successful agri-environmental policies further efforts are needed to improve the communication of scientific evidence to farmers. Given farmers' greater trust in sectoral stakeholders and how this trust can facilitate the uptake of sustainable practices in agriculture (Muñoz-Ulecia et al. 2025), strengthening the relation between scientists, farmer organisations and farmers could be a promising option. Using clear narratives about scientific outcomes, rather than just presenting facts could engage a larger proportion of target audiences (Toomey 2023; Velado-Alonso et al. 2024). Importantly, these narratives should avoid focusing on win-win scenarios, which are unlikely, and acknowledge the fact that, for example, mitigation and adaptation practices and farm profitability trade-off against each other. Highlighting these trade-offs through participative processes where farmers' values, emotions and interests are taken into account could increase farmers' feeling that their position is being heard, which would in turn increase the trust in the messengers and the reach of the message (Toomey 2023).

Conclusion

Most Spanish livestock farmers across a sample of different farming systems (dairy cattle, dairy sheep, meat

sheep and dairy goat) recognise the severity of climate change, although their concern is lower than the reported for the general Spanish and European populations. A majority of these farmers ($\approx 60\%$) believe that the origin of climate change has a hybrid human-natural cause, a natural cause, or that climate change does not exist. The remaining $\approx 40\%$ believe that climate change is caused by human action.

Farmers generally trust the information provided by sectoral stakeholders (i.e. veterinarians, breed associations, farming magazines, cooperatives, agricultural firms, other farmers, and farmer organisations) and scientists, while mistrust the information from public administration, the media, and environmental and animal activists. Farmers who trust the latter groups tend to be more aware about the origin and severity of climate change.

Strengthening the science-policy-farmers dialogue and disseminating knowledge using sectoral stakeholders as message carriers could enhance farmers' awareness of the potential impacts of climate change on farming and trigger adaptation actions.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical approval

The research protocol, questionnaire content and all methods were carried out according to the guidelines and

approval of the Ethics Committee of the Agrifood Research and Technology Centre of Aragon, Spain (No. CEISH_2019_1 & CESIH_2022_4). The authors have not stated any conflicts of interest.

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Data availability statement

Data is available at <http://hdl.handle.net/10532/6957>.

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