

Extended Abstract

Please do not add your name or affiliation

Paper/Poster Title	Plant diversity to cope with increased drought risk in grasslands
---------------------------	--------------------------------------------------------------------------

Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

27th – 29th March 2023

Abstract	<i>200 words max</i>
<p>Grasslands are essential for the global milk and meat production and for the provision of other crucial ecosystem services. With climate change and the increased likelihood of extreme weather events, the stability of the provision of those ecosystem services is expected decrease. In this paper, we study theoretically and empirically how plant diversity can function as a natural insurance against increased drought risk in grasslands. The theoretical framework, which uses a portfolio perspective to describe plant diversity, shows how plant diversity may provide insurance value against increased drought risk. In the empirical application we aim to evaluate this natural insurance value from plant diversity for different levels of drought exposures by using experimental grassland data. We will test if the insurance value changes under different drought frequency scenarios. The results are relevant to both policy and industry, as plant diversity can provide a sustainable adaptation to climate change and complement or substitute traditional financial insurance against droughts.</p>	
Keywords	Plant diversity, drought, insurance value, risk, biodiversity
JEL Code	Land Ownership and Tenure; Land Reform; Land Use; Irrigation; Agriculture and Environment Q150, Valuation of Environmental Effects Q510, Ecological Economics: Ecosystem Services; Biodiversity Conservation; Bioeconomics; Industrial Ecology Q570
Introduction	<i>100 – 250 words</i>
<p>Grasslands are essential for the global production of milk and meat and the provision of other crucial ecosystem services, covering more than 60% of all agricultural lands (FAO, 2021; Lopez et al., 2022). Climate change and increasing occurrence of extreme weather events threaten agriculture and grassland-based farming systems, often resulting in lower and more variable yields for farmers (Orlowsky & Seneviratne, 2012). To cope with these extreme events, farmers can implement various risk management strategies on their fields and farms. We here investigate the economic potential of natural insurance strategies in grassland-based farming systems that use plant diversity to manage drought risks.</p> <p>The literature on the interrelation of extreme weather events and the potential of diversity as natural insurance against such occurrences provides mixed results (Haughey et al., 2018; Hofer et al., 2016; Van Ruijven & Berendse, 2010; Vogel et al., 2012). To shed light on this ambiguity, we propose a new approach using a</p>	

portfolio perspective to describe plant diversity and considering droughts as increasing the overall background risk.

In this paper, we study the economic choice of farmers for natural insurance (i.e., plant diversity) in grassland under increasing drought risk. We provide new theoretical and empirical insights to address the question: how can plant diversity offer insurance value against an increase in drought risk and what is the relative importance of the different mechanisms driving this insurance value (i.e., ecological interactions between species vs statistical effect due to temporal complementarity between species)?

Methodology

100 – 250 words

To address the overarching question, we implement two connected methodologies. Firstly, we develop a theoretical framework to shed light on the potential of plant diversity to cope with higher drought induced risk exposure. Plant diversity is modeled as a natural risk insurance using a portfolio perspective and droughts frequency as increasing the overall background risk. This portfolio approach (Kirwan et al., 2009; Connolly et al., 2013), allows us to distinguish between mechanisms derived from ecological interactions between species and mechanisms derived from temporal complementarity between species (Koellner & Schmitz, 2006). Our model is based on ecological theory, such as assumptions about the production and stability of ecosystem services under higher diversity. Second, we provide an empirical application to quantify the impact of plant diversity on yield variability under different levels of drought risk exposures. To this end, experimental field data will be used. We will first conduct different regressions based on Just and Pope production functions to establish a relationship between plant diversity and yield variability. Based on regression results, we will conduct bio-economic simulations to derive the insurance value under different drought risk exposures.

Results

100 – 250 words

Our theoretical model highlights two sources leading to insurance value from plant diversity. Specifically, the model shows that even when ecological interactions of plant diversity alone cannot stabilize yield and thus income under drought, greater plant diversity can be a viable risk management strategy when drought frequency is considered to be increasing the overall background risk (i.e., the total yield variance observed in recent years). It is the case due to temporal complementarity between plant species, resulting from having a diverse portfolio. The insurance value from plant diversity can therefore be broken down in two different effects: the ecological effect derived from interactions between species and the statistical effect due to temporal complementarity between species.

Initial results show that the total effect of plant diversity on yield variance remains negative for higher drought risk exposures, indicating that plant diversity still provides natural insurance value. However, the magnitude of the effect of plant diversity on yield variance decreases for higher drought risk exposures, suggesting that plant diversity explains less of the variance when drought risk is higher and thus provides less natural insurance value. Further analysis will be conducted to derive the importance of the two mechanisms leading to insurance value (i.e., ecological interactions between species vs statistical effect due to temporal complementarity between species) and different methods will be considered for more robust results.

Discussion and Conclusion

100 – 250 words

The theoretical framework shows how plant diversity can be a viable option for ensuring grassland yields against an increase in drought frequency by describing two different mechanisms driving this potential insurance value. In a broader framework, biodiversity as a natural insurance is especially interesting since it provides both private benefits to farmers and public benefits due to additional increase in other ecosystem services (Isbell et al., 2011). Understanding the role that biodiversity can play in buffering yield losses during drought is therefore key to creating sustainable food production systems (Tilman et al., 1996). The overall interpretations of the results are valuable to policy-makers. Policies that encourage the use of plant diversity as natural insurance in grasslands can create win-win scenarios by reducing farmers' production risk under extreme climate events such as drought and by increasing the production and stability of ecosystem services provision. Implementing subsidies to increase the diversity of productive grasslands could be an option for this purpose. A further area of policy focus shall be on the interrelation of formal insurance systems and their subsidization and the use of natural insurance studied here. Depending on their interrelationship (i.e., substitutes or complements), subsidizing formal insurance may diminish the potential of natural insurance and thus have an adverse effect on total welfare.