Diversifying cropping systems is essential for the transition to agroecology

As the global population grows from 8.2 billion today to an expected 10 billion by 2050, the pressure on our food systems continues to grow. Feeding everyone sustainably without accelerating climate change or ecological breakdown has become one of the most urgent challenges of our time. At the same time, human activities linked to industrial agriculture, with high use of fossil fuel, synthetic fertilizers and pesticides, and with large land-use change effects, have played a major role in pushing the Earth beyond six of the nine established planetary boundaries. These include critical thresholds related to climate change, biodiversity loss, chemical pollution and disruptions to nitrogen and phosphorus cycles. Crossing these boundaries endangers the stability of Earth's life-support systems. The consequences are becoming increasingly clear: frequent climate extremes, declining soil health, and widespread biodiversity loss are undermining crop productivity and food security. This brings us to a crucial question: *How can we produce enough food for a growing population while addressing the environmental, social, and economic challenges linked to current (industrial) agricultural systems?*

One promising pathway is crop diversification, the practice of growing multiple types of crops in a given area simultaneously (e.g., intercropping or mixed cropping) or sequentially over time through crop rotations. Crop Diversification is a core principle of agroecology, which is a holistic approach to farming that applies ecological knowledge to agricultural systems. Agroecology emphasizes working with natural processes, reducing dependency on external chemical inputs, promoting biodiversity at multiple levels, and involving farmers and communities in the design and management of sustainable food systems.

Over the past two or three decades, a growing body of research have highlighted several benefits of crop diversification, however its adoption remains limited especially in high-input farming systems of the Global North. Key knowledge gaps still remains in understanding the mechanisms and their effects on crop performance, resource efficiency, biodiversity, and socio-economic outcomes.

In this lecture, I will present my research on crop diversification, with a focus on integrating legumes into current cropping systems. I will share findings on how legumes influence crop yield, suppress weeds, and support biodiversity. I will also introduce a novel concept I am currently exploring called '*ecological precision agriculture'*. This concept builds on the idea that diverse crop mixtures can better respond to variability within fields, such as differences in soil texture, nitrogen availability, and moisture levels. By fostering facilitative interactions among plant species, these mixtures can enhance the overall performance and resilience.

However, agronomic studies alone are not sufficient to understand or implement crop diversification at scale. To address this, I combine natural-science research with broader systems-level approaches. I will also present insights from my work using multi-criteria assessment frameworks and co-innovation workshops to evaluate the environmental, social, and economic implications of crop diversification in real-world contexts.

My approach integrates rigorous scientific inquiry with practical collaboration. It is grounded in the belief that solving complex agricultural challenges requires systemic thinking and transdisciplinary engagement. As we confront increasing climatic and economic uncertainty, we must shift away from a production system that depletes natural resources and undermines long-term resilience. Instead, we need farming systems that regenerate soil, support biodiversity, strengthen communities, and secure food for future generations. Crop diversification which is rooted in agroecological principles, offers a compelling path forward which connects productivity with sustainability and regeneration.