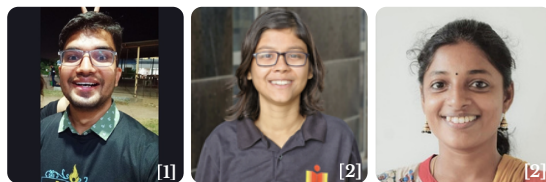


Growing a Greener Future: Exploring Sustainable Agriculture Through Science and Technology

KID: 20260207



Background

Climate and agriculture have always been linked. It relies on rainfall, temperature, soil, water and healthy ecosystems, but farming itself also influences the environment. As farmers face changing weather patterns, increasing pressures on resources and the need to sustain food production, this relationship is becoming increasingly important. Rice is a particularly interesting crop in this context as its cultivation involves complex interactions among water, soil, nutrients and crop management. Studies have shown that rice systems can be important sources of methane and nitrous oxide, with fertilizer and water management playing an important role in determining emissions.

At IIT Hyderabad, we are addressing these challenges through a tool we have developed called CarbonKrishi. Developed by members of the GREENS Lab, CarbonKrishi is a research initiative that integrates agriculture, environmental assessment, data science, and geospatial technologies. The larger goal is to gain a better understanding of the impact of various agricultural methods on environmental results and how scientific information can finally be translated into useful insights for sustainable farming. The work is being developed around rice cultivation but keeping the possibility of application of the research approach to other agricultural systems in the future.

Understanding agriculture beyond a single indicator
When we talk about sustainable agriculture, we often fixate on a single measure, such as greenhouse gas emissions. But agricultural systems are far more complicated. One environmental impact of a farming practice may be reduced, but another may be affected.

Fertilizer use, for example, is important to keep crop productivity up, but the environmental outcomes are influenced by fertilizer type and amount, soil conditions, irrigation practices and crop management. One of the scientific approaches we use to understand these interactions is Life Cycle Assessment (LCA). LCA is a systematic method for assessing the environmental impacts of a product or process throughout its life cycle.

The methodology is internationally standardized by ISO 14040 and ISO 14044, which provide the principles, framework, requirements and guidelines for LCA studies. LCA provides us with a basis to look at agricultural systems with a range of environmental indicators rather than just looking at climate impact. We are investigating alternate rice production practices and examining how modifications in inputs and management can affect environmental performance.

Bringing data and technology into the picture

One of the problems with detailed environmental assessment is that it can require a lot of data, computing effort and technical expertise. Here is where our interest in data-driven approaches comes in. We are investigating how Machine Learning (ML) and other computational methods can enhance traditional environmental assessment. Agricultural systems produce a wide variety of data sets, such as fertilizer, irrigation, soil, weather and crop information. Machine Learning offers the chance to find patterns in these datasets and to examine links between conventional agricultural methods and environmental results.

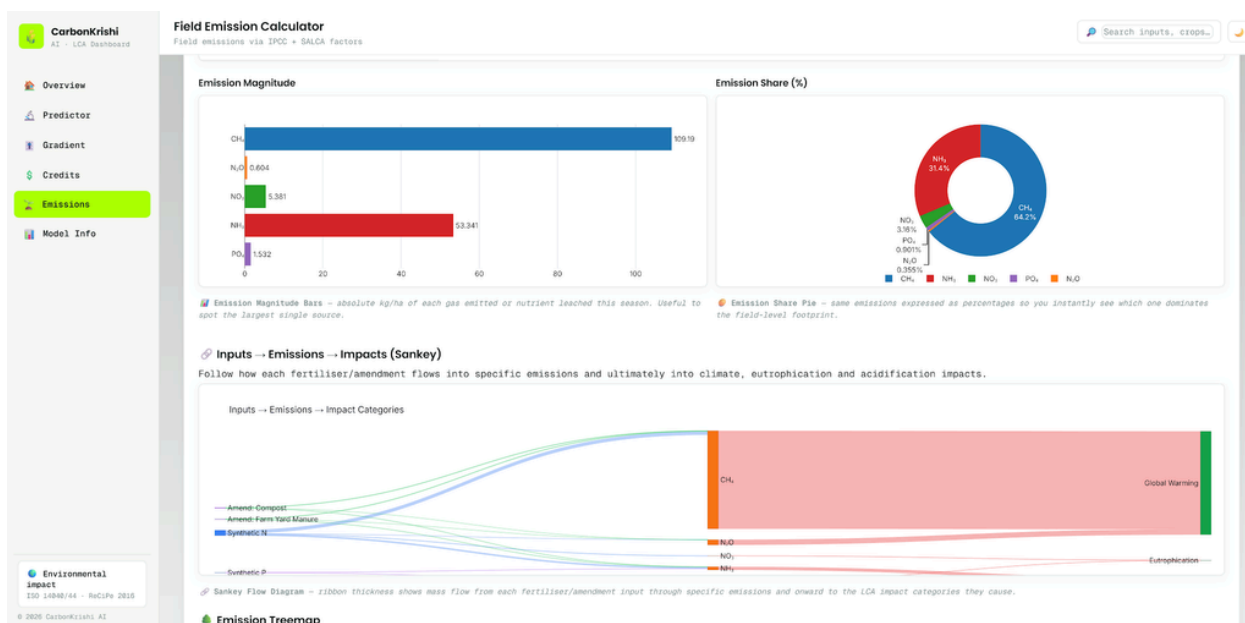


Figure 1. CarbonKrishi Portal

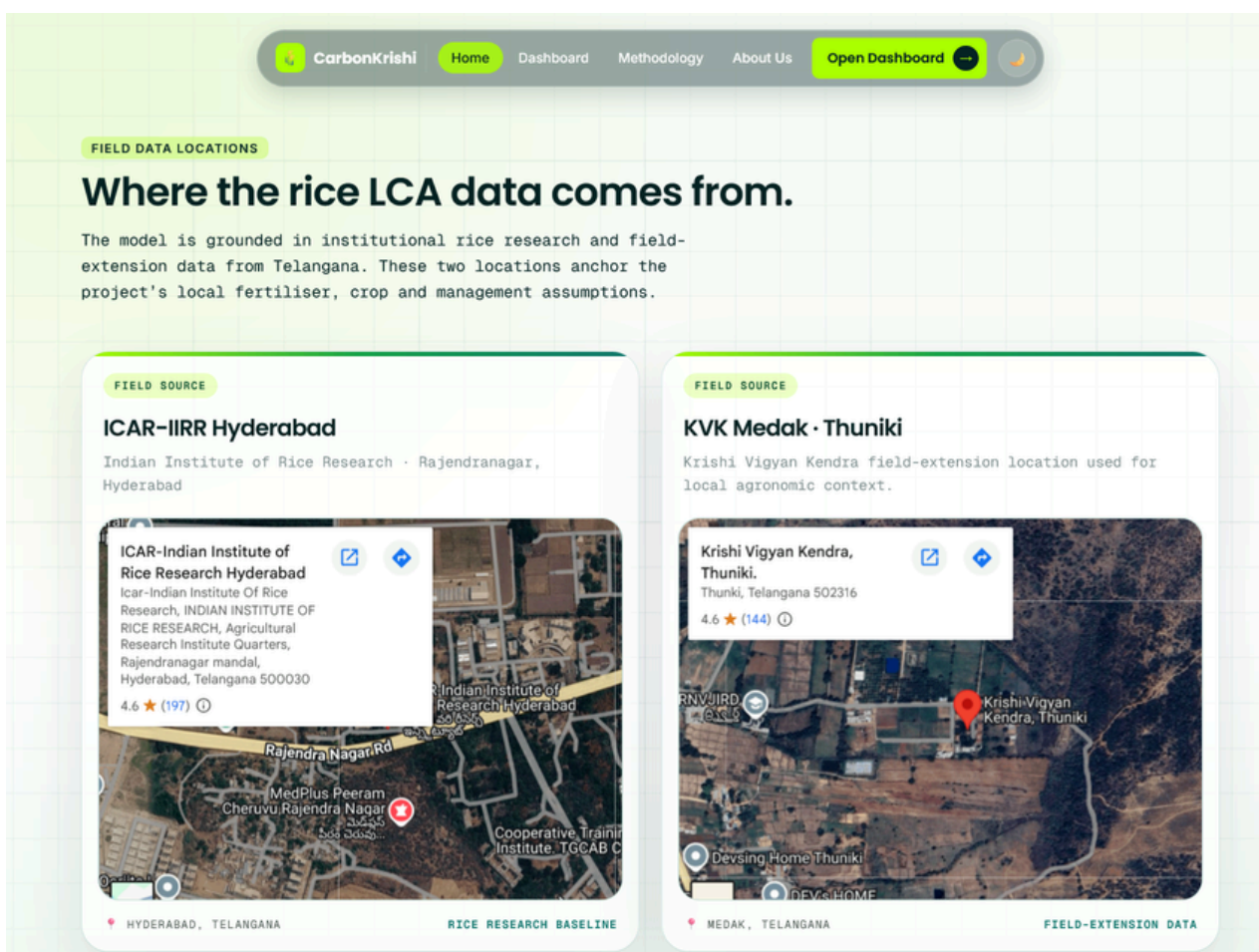


Figure 2. Data Sources for the model development

We are currently focused on building and testing the underlying research framework. We are looking at different data sets, environmental assessment methods and computational approaches to figure out what information is most useful and how these different parts can be put together. The emphasis is on the development of sound scientific knowledge rather than the use of technology as a substitute for field knowledge. Field-based knowledge is vital because agricultural systems are highly variable depending on local soil, climate, water availability and management practices. We are working with ICAR-Indian Institute of Rice Research (ICAR-IIRR), Hyderabad and Krishi Vigyan Kendra (KVK) Medak to incorporate field based information into our research and using Geographic Information System (GIS) tools to understand the spatial context of conventional agricultural methods.

From environmental assessment to better understanding: The main idea of CarbonKrishi is to bring environmental research and the actual decisions that farmers make. Farmers and the people who help them make decisions about things like fertilizers and irrigation and how to manage their crops. They think about how money these things cost and whether they can get them. They also think about the conditions. What about the effect on the environment? This is also very important when making these decisions. So, we do research to see how the environment and farming and money are all connected. We want to understand the ways that farmers manage their land.

This is especially important for people who grow rice. The way they use nutrients and water can affect the air and the environment. It can also depend on the conditions where they are farming like the local weather and soil. CarbonKrishi is really focused on this because it can make a difference, in how rice is grown.

CarbonKrishi is an evolving research effort at IIT Hyderabad, bringing together environmental science, agricultural data, and emerging technologies to better understand sustainable farming practices. While our current focus is on rice, we hope this work will contribute to broader efforts towards climate-resilient, resource-efficient, and sustainable Indian agriculture.

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