1. **INTRODUCTION**

In modern India's economy agriculture plays a pivotal role. More than 58% of rural households depend on jobs in the agricultural sphere as the principal means of livelihood. Moreover, 80% of these households are smallholder farmers with less than 2 hectares of farmland, from which more than a fifth is below poverty.

World population keeps growing. It's estimated that there will be 9.7 billion people by 2050. Food demands are expected to grow anywhere between 59% to 98%.

Climate change effects are predicted to impact everything across the food and farm systems, from productivity to livelihoods, predicting a 4% to 26% loss of net income for farmers by the end of the century.

Covid-19 pandemic has greatly highlighted the vulnerabilities and fragility of our food supply chains, telling us that we need a more resilient food system and that we can't forget about marginalized communities or smallholder farmers.

All these reasons call for a revamp of the entire mechanism that brings food from farms to our plates. It's more important, now than ever, that we develop and adopt innovative methodologies and technologies that can help bolster countries against food supply challenges and shocks.

In this contest we propose our solution for the Telangana food system, the 11th largest state in India with a geographical area of 112 077 km^2 and 35 193 978 residents.

1.1. **Purpose**

Our goal will be to design and develop a community-centric system that will support the agricultural community via a data-driven approach, bolstering both production and welfare of the farmer population.
Stakeholders of this project will be of three main categories:

- Farmers in the Telangana region. They will be aided in their work from the data that will be available to them. By accessing weather forecasts and critical information when necessary they will be able to both ease their work and get more in return.
- Agronomist involved in aiding farmers in the Telangana region. They will be aided in the organization of their daily visits and in responding to help requests, permitting more mirated and specific work on needing farmers.
- Policy makers in the Telangana region. By seeing specific performance data they will be able to check the results of the rule they applied, and through a direct connection to the farmers they will be able to quickly publish new advice and rules.

1.2. **Scope**

DREAM system will bolster Telangana state against food supply shocks and challenges, thanks to the involvement of multiple stakeholders. This will be translated into greater production in order to face the problem of increasing food demand and climate adversities, but also in a way of helping farmers to achieve a better life outside of poverty.

In order to reach greater resilience to meteorological adverse events farmers have access to short and long term forecasts, and also to some "best practices" identified by those farmers who demonstrated to be resilient. Personalized suggestions carry in the same direction, helping to increase both resistance and production. In addition the system also

assists farmers to help each other through discussion forums and to request for support and suggestions among themself and to agronomists.

Telangana state is indeed divided into zones assigned to experts (agronomist) exploiting a daily plan to visit the farms of the assigned area (at least twice a year each farm) considering their needs. DREAM system also helps agronomists to visualize and update their plan and analyze the best performing farmers in their area.

All those data, from production to best practices and meteorological resilience, are collected by policy makers, which use them in order to assign special incentives to worthy farmers and to understand if the steering initiatives carried out by agronomists with the help of good farmers produce significant results.

1.2.1. *Phenomena*

- *General Phenomenon*
  User login (user can be a farmer, a policy maker and a agronomist) [W S]
  User registration [W S]
  Check username and password [M N]

- *Farmer phenomenon*
  Visualize weather forecasts [W S]
  Visualize personalized suggestions [W S]
  Insert data about production (and problems) [W S]
  Request for help and suggestions by agronomists and other farmers [W S]
  Get notification for help answers [M S]
  Respond to a request for suggestions and help [W S]
  Create discussion forums with other farmers [W S]
  Read a discussion forum [W S]
  Respond in a discussion forum [W S]
  Get notification from forum answers [M S]
  Receive requests of best practises [M S]
  Send best practises to policy makers [W S]
  Work on the crops [W N]
  Get notification for new blog post [M S]
  Read blog post [W S]
  Receive incentive notification [M S]

- *Agronomist phenomenon*
  Choose responsibility area [W S]
  Receive help requests from farmers [M S]
  Respond with suggestions to farmers [W S]
  Visualize weather forecast in the area [W S]
  Visualize farmer performance data [W S]
  Visualize daily visit plan [W S]
  Modify daily visit plan (before the confirmation) [W S]
  Confirm the execution of the plan [W S]
  Specify deviations from the plan [W S]

Visit farmers [W N]

- *Policy maker phenomenon*
  Visualize farmers performance data [W S]
  Request best practices to the “resilient” farmers [W S]
  Receive best practices [M S]
  Publish best practice on a blog [W S]
  Decide and send special incentives [W S]
  Visualize crops performance data [W S]

1.2.2. *Goals*

- G1: Increase the overall welfare and production of the Telangana region.
  By facilitating the communication and the collaboration between farmers, policy makers, and agronomists the aim is to increase the wellbeing of farmers inhabiting the Telangana region.
- G2: Aid policy makers in the decisional process.
  Policy makers can see production data in order to decide the incentives for farmers, or whether the current policies are performing well or should be changed (in order to constantly improve Telangana’s production).
- G3: Aid the farmers in the management of their productions.
  Farmers will receive personalized suggestions and best practices, and they will also have the possibilities to ask for help to both other farmers (by lending/renting equipment or giving advice) or to agronomists.
- G4: Aid agronomist works to help farmers and check crops production.
  Creating and modifying a daily plan will help them organize their visits and maximize their help in a well-specified zone of expertise.

1.3. **Definitions, Acronyms, Abbreviations**

1.3.1. *Definitions*

Farmer = a person who cultivates crops.

Resilient farmer = A farmer whose production is good despite meteorological adverse events.

Agronomist = an expert in the science of soil management and crop production.

Policy maker = a person in charge of formulating policies, related to the food system.

Production = total crops-output generated. Could be related to a single farmer, a zone or the entire Telangana’s state.

Personalized suggestions = Indication directly focused on a specific farmer, such as specific crops to plant or specific fertilizers to use based on location and type of production.

Welfare = Overall well-being of farmers which translates into the reduction of poverty and simplification of work (discussion with other farmers, suggestions, personalized data based on location, …).

Best practices = Cultivation procedure that has been shown by experience to produce optimal results (not only in terms of achieved final production but also in terms of resilience to adversities) and that should be proposed for widespread adoption.

Responsibility area = Zone of which an agronomist is in charge of, with the purpose of increasing its welfare and production.

Visit = It refers to the agronomist going to a specific farm of his competence, and is identified by a date, a variable timeslot (deviations may occur) and a reason.

Notification = Alert that a certain event has occurred. Could be an email or an automated message sent to the smartphone when the app is not running.

1.3.2. *Acronyms*

1.3.3. *Abbreviations*

1.4. **Revision history**

December x, 2021: version 1.0 (first release)

1.5. **Reference Documents**

- Specification document: "R&DD Assignment A.Y. 2021-2022"
- Course slides
- Alloy official documentation: https://alloytools.org/documentation.html
- Paper: "Jackson and Zave: the world and the machine"
- UML official specification https://www.omg.org/spec/UML/
- BPMN official specification https://www.omg.org/spec/BPMN/2.0/

1.6. **Document Structure**

Chapter 1: Introduction. This section provides an overall description of the system scope and purpose, together with some information about this document.

Chapter 2: Overall Description. This section offers a summary description about the overall organization of the system, and it also contains a description of all the features offered by the application, and of the actors who use it.

Chapter 3: Specific Requirements. This section goes into detail about functional and nonfunctional requirements, also providing typical scenarios and use cases.

Chapter 4: Formal Analysis using Alloy. This section includes a presentation of the main objectives driving the formal modeling activity, as well as a description of the model itself, what can be proved with it, and why what is proved is important given the problem at hand.