Agriculture Resilience: linking Insurance and Technology

Consultant's Final Report

TA 6663-PAK: Strengthening Food Security Post-COVID-19 and Locust Attacks: Supporting crop insurance in Pakistan

STRENGTHENING POST-COVID-19 FOOD SECURITY AND LOCUST ATTACKS, PAKISTAN IN COLLABORATION WITH PATCO AND RDF

Sustainable Agriculture Resilience: linking Insurance and Technology (Pakistan)

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FINAL REPORT

PREPARED FOR THE ASIAN DEVELOPMENT BANK

BY

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Abbreviations

ADB	Asian Development Bank
ERDAS	Earth Resources Data Analysis System
GEE	Google Earth Engine
GIS	Geographic Information System
GP	Gram Panchayat
GPS	Global Positioning System
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
LGP	Length of Growing Periods
NDVI	Normalized Difference Vegetation Index
PATCO	ADB consultant under TA 6663-PAK
RDF	Research and Development Foundation
SMT	Spectral Matching Techniques

1 INTRODUCTION

1. Government of Pakistan with support of Asian Development Bank [1] plans to assess yield using different technologies including satellite technologies and other biophysical parameters.

2. This study mainly focussed on linking Insurance and Technology. The study will use comprehensive exiting environmental, weather and management data along with satellite derived crop spatial data. This information will be modelled using crop models to assess crop yield assessment at gram panchayat (GP) and required spatial information generated from near real time high resolution satellite images.

3. As part of above objective, crop classification maps are highly needed for further study and analysis. The activities were conducted by ICRISAT: a) Preparing Crop Classification maps b) Training program on mapping Geospatial products

4. This document is the Final Report of the activities undertaken by ICRISAT to support the linking of insurance and technology

2 PROJECT BACKGROUND

5. Strengthening Post-COVID-19 Food Security and Locust Attacks, Pakistan, in collaboration with PATCO (ADB consultant under TA 6663-PAK, Islamabad, Pakistan) and RDF (Research and Development Foundation, an NGO, Hyderabad, Pakistan)

6. As a support of above initiation, the following activities were implemented

7. Initially, the project is being implemented in five districts of Pakistan, preparing crop classification maps for understanding the agriculture ecosystem of the study areas

8. Followed by training the local government officials on usage of geospatial applications and preparing geospatial spatial products

3 ACTIVITIES

9. Mapping Crop Classification for selected districts
10. Virtual hands-on training program on mapping Geospatial products

4 CROP CLASSIFICATION

4.1 Study Areas

11. The preliminary study was conducted for 4 districts (Table 1).
12. The study districts are selected based on diverse agri-ecological zones found in Pakistan (Figure 1)

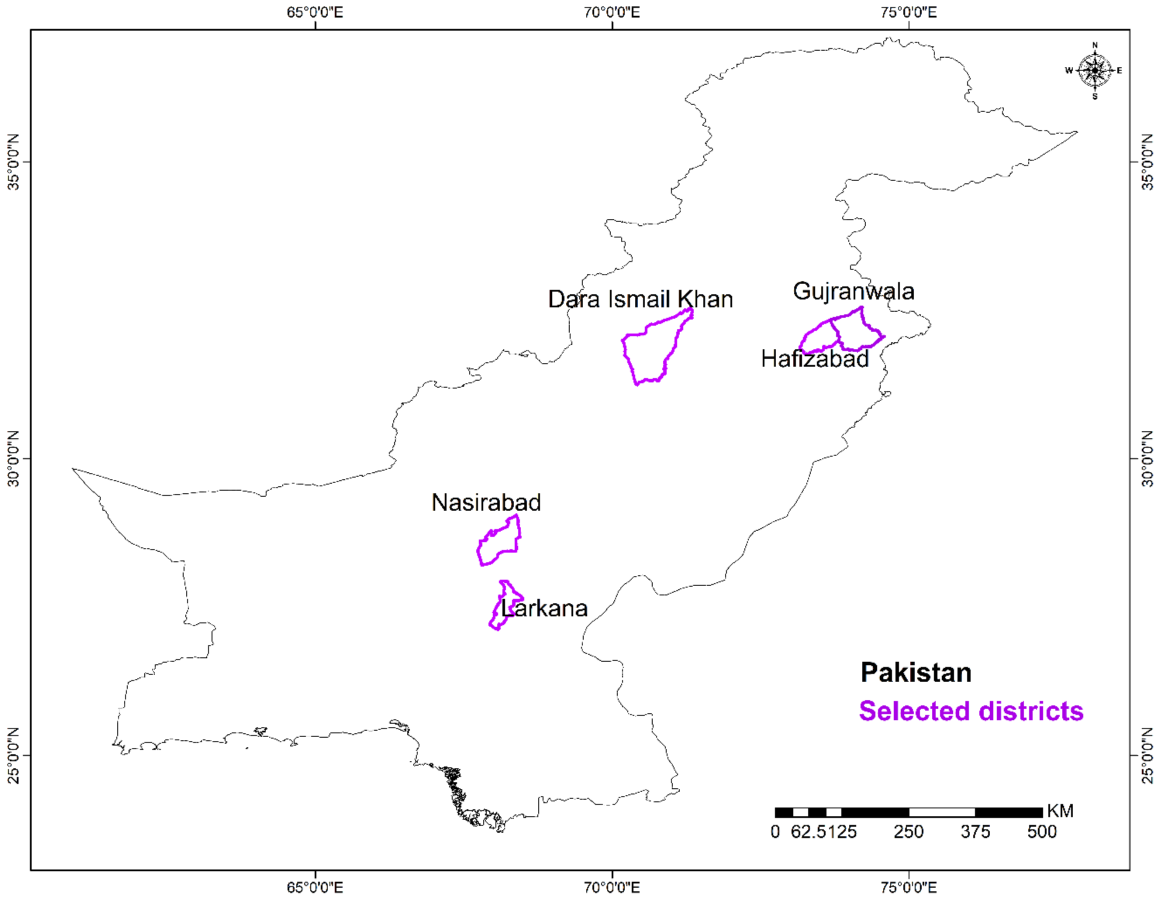


Figure 1: *Selected study districts in Pakistan*

Table 1: *Allocated districts for the study*

S.no	Districts
1	Dera Ismail Khan
2	Hafizabad
3	Larkhana
4	Balochistan
5	Gujranwala

13. Also considered the recommendations given by local government officials and statistics provided

4.2 Crop mapping – Methodology

14. The process began with preparing NDVI maximum images for every 15 days of every month for total crop year and stacked together in Google earth platform and eliminate the cloud pixels if any available [2,3].

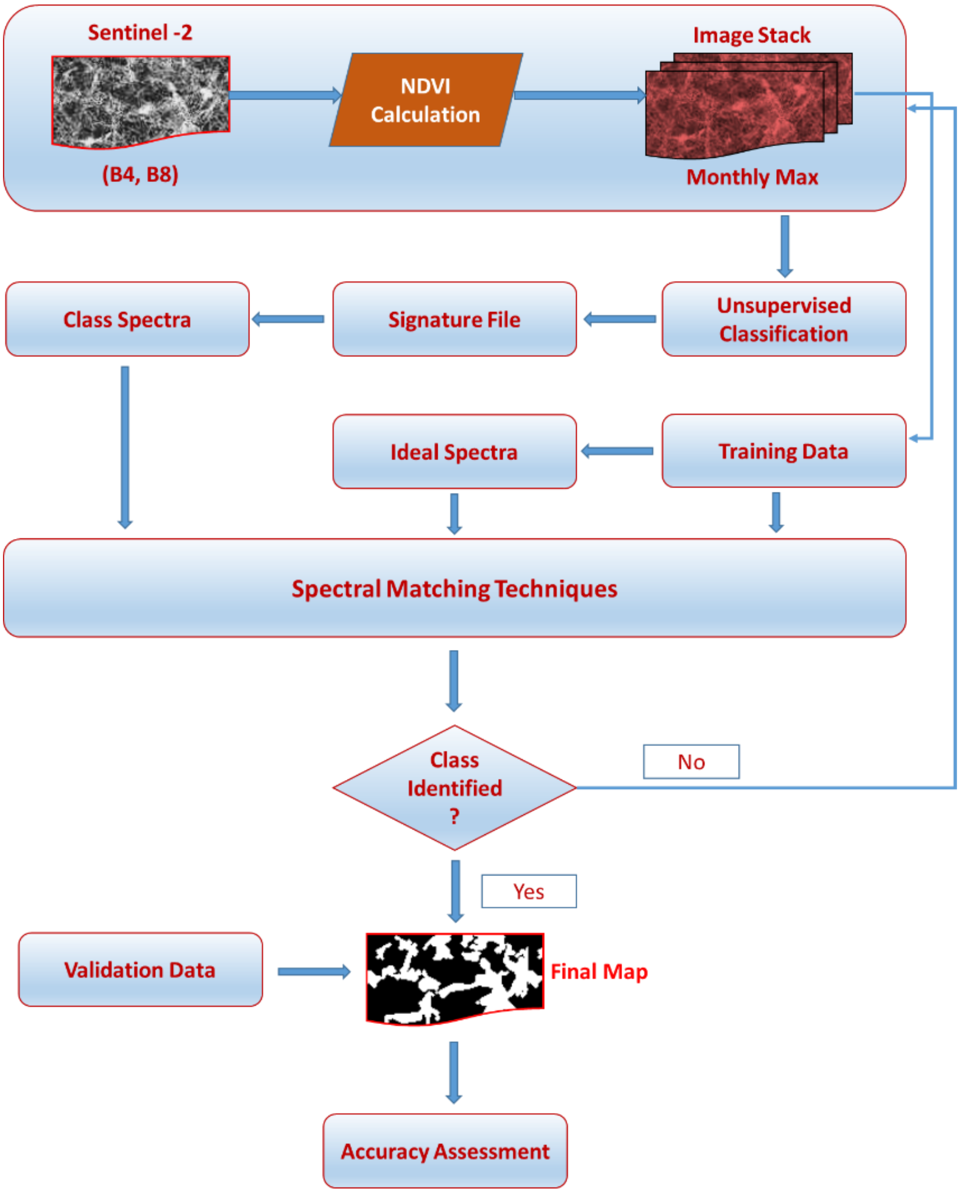


Figure 2: *Methodology followed for crop type mapping*

15. The NDVI images was prepared using normalised difference of Near Infrared (NIR) and Red (R) bands of Sentinel 2.

16. Then Sentinel-2 NDVI stack was downloaded for classification using Spectral Matching Techniques (Fig 1).

4.3 Spectral Matching Techniques

17. The stacked image downloaded from GEE consists of every 15 days for entire *crop year*. Unsupervised classification was used to generate initial classes. The unsupervised ISOCLASS cluster algorithm (ISODATA in ERDAS Imagine 2018) run on the stack generated an initial 40 classes, with a maximum of 40 iterations and convergence threshold of 0.99. Use of unsupervised techniques is recommended for large areas that cover a wide and unknown range of vegetation types, and where landscape heterogeneity complicates identification of homogeneous training sites. Identification of training sites is particularly problematic for small, heterogeneous irrigated areas [3-5].

18. Land use/land cover classes were identified based on temporal signatures along with ground survey data. We observed crop growth stages including length of growing periods (LGPs) and cropping pattern from temporal signatures, such as (a) onset of cropping season (e.g., monsoon and winter); (b) duration of cropping season such as monsoon and winter; (c) magnitude of crops during different seasons and years (e.g., water stress and normal years); and (d) end of cropping season [6].

19. The process of labelling and class identification was done based on spectral matching techniques (SMTs). Initially, 40 classes from the unsupervised classification were grouped based on spectral similarity or closeness of class signatures. Each group of classes was matched with ideal spectral signatures and ground survey data, and assigned class names. Classes with similar time series and land cover were merged into a single class, and classes showing significant mixing, e.g., homogeneous irrigated areas and forest, were masked and reclassified using the same ISOCLASS algorithm. This resulted in following classes for each district. We employed a user-intensive method that incorporates both ground survey data and high resolution imagery in order to avoid lumping classes that might be spectrally similar but have distinct land cover.

20. Following are the crop type classification images for all study districts (Fig 2):

4.4 Crop Classification Maps

21. The crop classification maps shows the cropping pattern as well as crop distribution across the study districts.

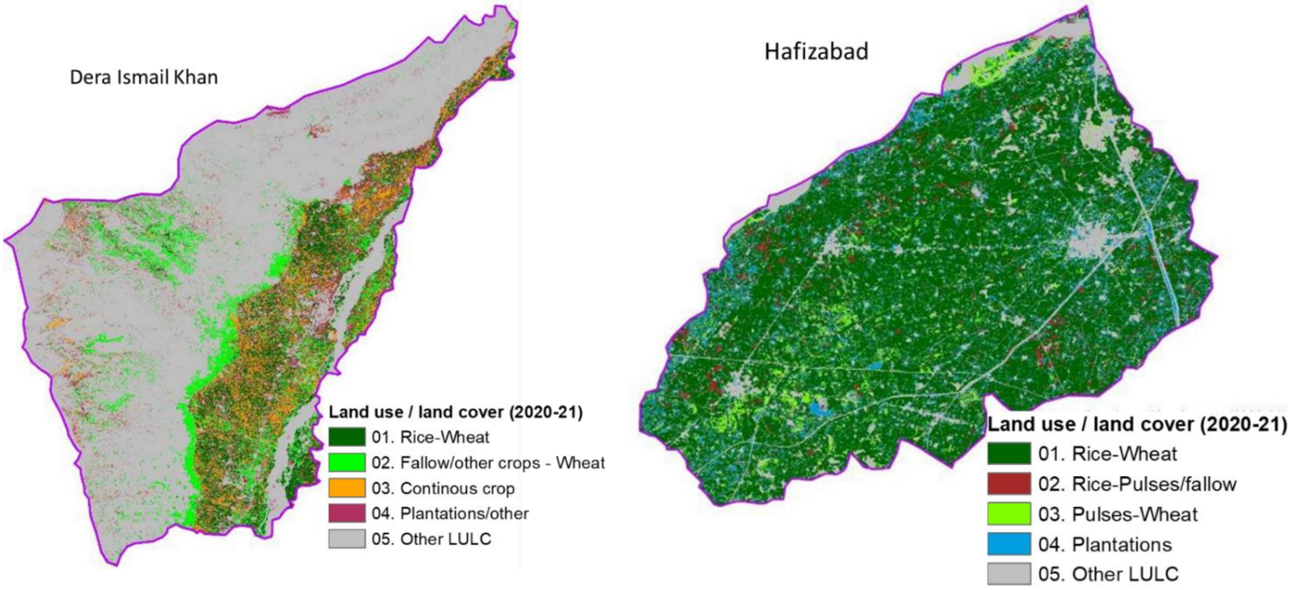
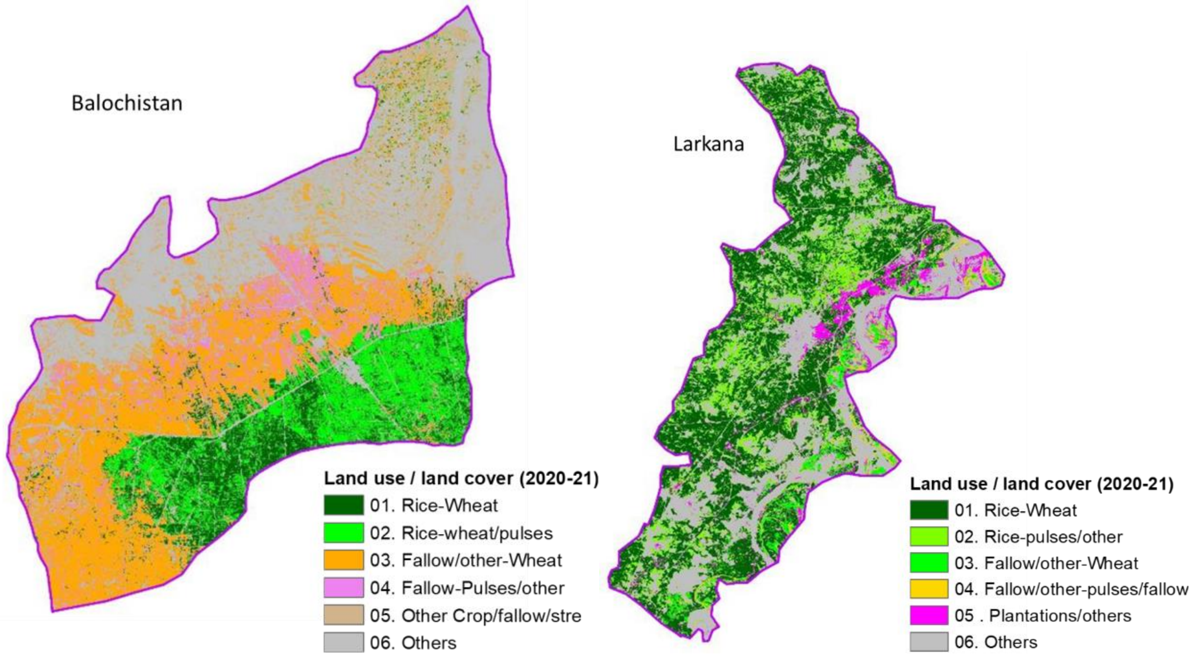


Figure 3: *Crop Classification Maps for Dera Ismail Khan and Hafizabad*

22. Figure 3 shows the cropping pattern in Dera Ismail Khan and Hafizabad, Rice, pulses and Wheat are the two major crops and also there is domination of plantations in some areas



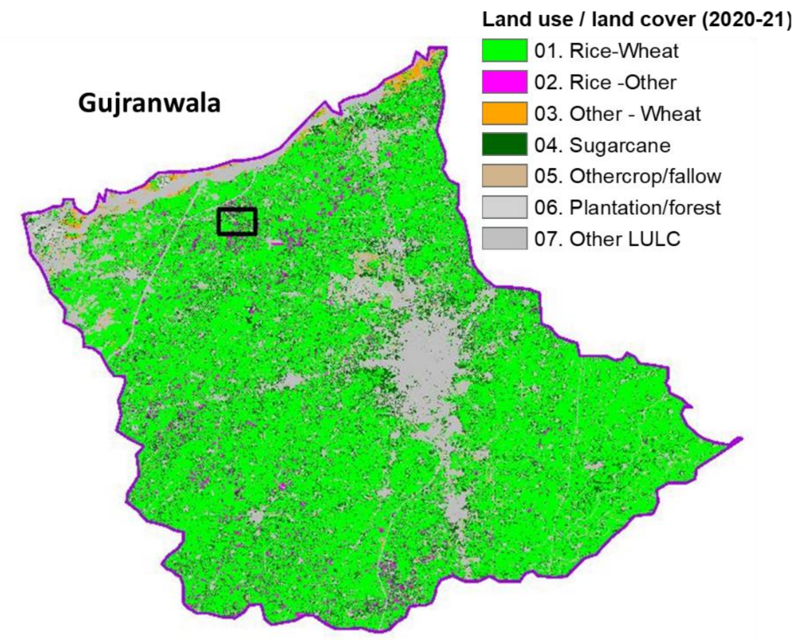


Figure 4: *Crop Classification Maps for Balochistan, Larkhana and Gujranwala*

23. Figure 4 shows the crop distribution in Balochistan, Larkhana and Gujranwala. There is Rice followed by wheat domination in Gujranwala district and Larkhana district whereas in Balochistan, there are significant extent of areas with fallow during first crop season followed by wheat or pulses.

5 TRAINING PROGRAM ON MAPPING GEOSPATIAL PRODUCTS

5.1 Overview

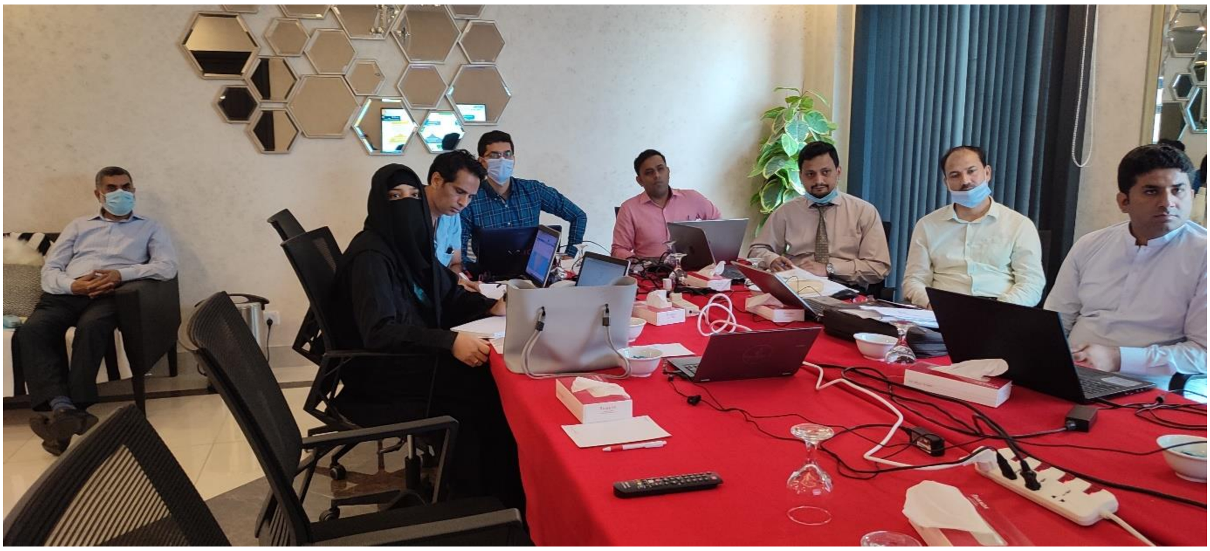
24. The virtual hands-on training program on mapping Geospatial products for supporting insurance products using Google Earth Engine [7] as well as Semi-automatic techniques was conducted as a Part of "Strengthening Post-COVID-19 Food Security and Locust Attacks, Pakistan, in collaboration with PATCO (ADB consultant under TA 6663-PAK, Islamabad, Pakistan) and RDF (Research and Development Foundation, an NGO, Hyderabad, Pakistan) from 27 – 29 July 2021 (3-day course). The training was conducted by Geo-spatial and Big Data Sciences – Cluster, ICRISAT as a part of the project objectives. This course is targeted towards persons interested in remote sensing and GIS technology and applications in the field of natural resources, water resources management, agriculture, and social scientists. Participants from Technical group of PATCO, Pakistan, Crop Reporting Service – Punjab and Sindh, Pakistan attended the training program.

5.2 Objectives

25. To introduce the applications of Geo-spatial Technologies (GIS, Remote Sensing and GPS Systems) its potential applications in Crop insurance.
26. To familiarize with various Geospatial Software tools, Google Earth Engine, and specific modules applicable to agricultural applications.
27. To Share experiences of innovative practices in the use of Geo-Spatial Technology Applications in agriculture.

5.3 Participants and Training activities

28. Participants from Technical group of PATCO, Pakistan, Crop Reporting Service – Punjab and Sindh, Pakistan attended the training program (Figure 5). Some are aware of the subject related to training session whereas others have minimum knowledge. So, planned to conduct the training from basic level
29. The three day virtual training sessions taken from 27 to 29 July 2021 with planned day wise activities



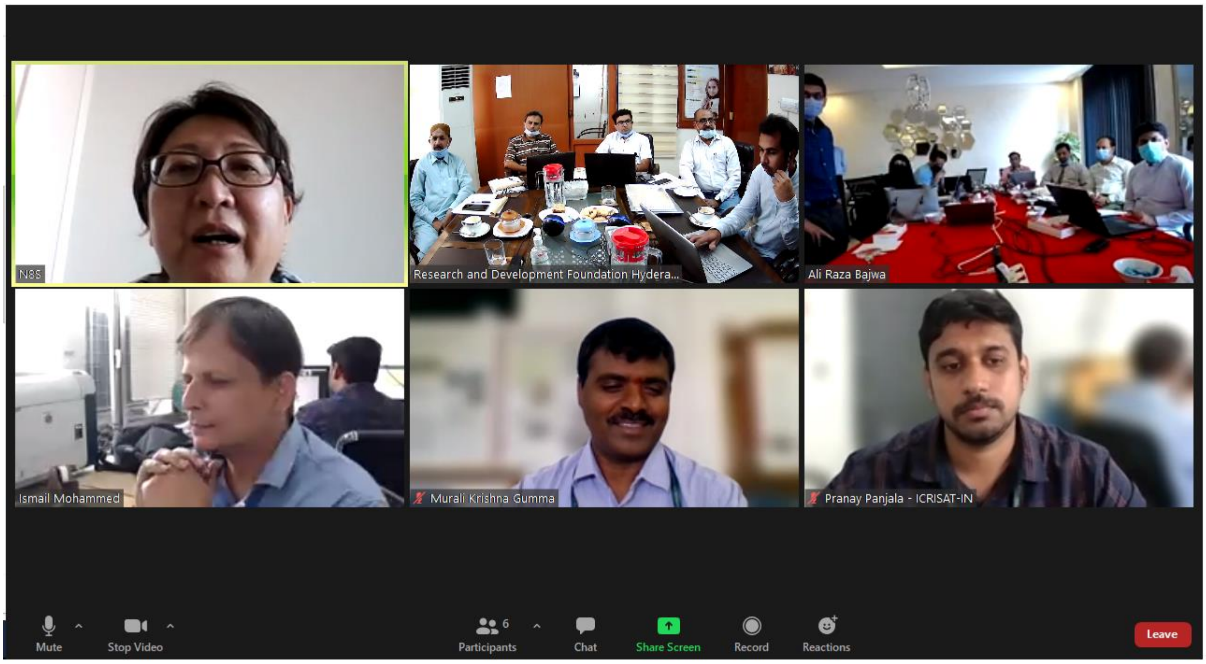


Figure 5: *Participants from the PATCO technical team and crop reporting service teams from Punjab and Sindh in Pakistan attend the training on developing remote-sensing products. Photo: Nauman Ul Haq*

30. **Day wise activities:**

Day1: Introduction of remote sensing, Remote sensing products and utilization of products and Introduction to Java and GEE

Day2: Basic concepts and Classification using GEE

Day3: Classification using Semi-Automatic techniques (Spectral Matching Techniques)

31. Participants were provided with copies of recommended reading material and relevant published papers.

5.4 Results

32. With the knowledge of concepts taught in training program, the following map (Figure 6) was generated. In order to show the importance of the remote sensing and its validation, on participants choice, Dera Ismail Khan District has selected for case study and did all the processing and crop classification using sentinel-2 time series data and spectral matching techniques for crop year 2020-21 (Figure 6). With the help of the participants and their local knowledge, the classes were identified.

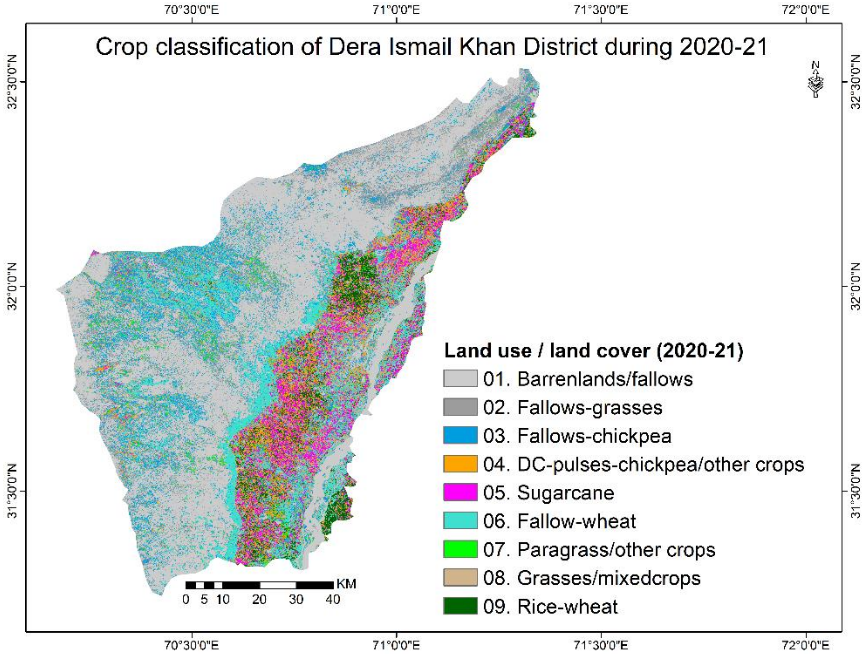


Figure 6: *Crop Classification of Dera Ismail Khan District*

5.5 Participants Feedback about Training

33. A semi-structured questionnaire was used to get training participants' feedback about training design, logistics and facilities, training execution, training relevance, and how they plan to use the learnings around crop area estimation. Participants were also probed to highlight things they liked and did not like about training and what additional support they foresee to take the training learnings further.

34. Major conclusions drawn from feedback as per questionnaire. In terms of Training Design, received very positive feedback in terms of objectives but somewhat negative feedback about time allocation. In terms of Training Execution, got very positive feedback about trainers, but neutral feedback on reaching objectives, this feedback mainly due to less time allocation. In terms of Training Relevance to the Participants Work and Utility, and Training Logistics and Facilities, got very positive feedback. Overall training objectives were met to some extent and increasing of time allocation will be better.

6 KEY FINDINGS AND NEXT STEPS

35. Further steps for the ADB's TA, to support crop insurance include 1) preparation of spatial products using near real time Remote Sensing satellite imagery for crop area estimation, crop stress monitoring for every 15 days during crop season 2) Crop Yield assessment using crop models and remote sensing technology and 3) Strengthening national organizations by conducting trainings.

36. Physical hands-on training is highly recommended with sufficient time allocation

37. The salient features from the study are

- Provides comprehensive insurance coverage against crop loss on account of non-preventable natural risks, thus helping in stabilizing the income of the farmers and encourage them for adoption of innovative practices.
- Increased risk coverage of Crop cycle – pre-sowing to post-harvest losses.
- Area approach for settlement of claims for widespread damage. Notified Insurance unit has been reduced to Village/Village Panchayat for major crops.

7 LIST OF REFERENCES

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