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## IMPROVE AGRICULTURE MONITORING SYSTEMS THROUGH SATELLITE IMAGERY FOR IRAN

April 2020

SDGs:



Countries:

Islamic Republic of Iran

Project Codes:

TCP/IRA/3603

FAO Contribution

USD 489 000

Duration:

1 March 2017 – 31 December 2019

Contact Info:

FAO Representation in the Islamic Republic of Iran

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### Implementing Partners

Ministry of Agriculture Jihad (MAJ) - Department of Planning and Economy - Bureau of Statistics and Information Technology (BSIT).

### Beneficiaries

Government officials; technical staff at provincial level; and farmers.

### Country Programming Framework (CPF) Outputs

Government priority 1: Environmental Sustainability of Agricultural and Rural Development Management Practices is ensured.



### BACKGROUND

In the Islamic Republic of Iran, more frequent extreme climate events, such as floods, drought and frosts, are adversely affecting agricultural production in the country. Changes in precipitation amounts, seasonality, intensity and distribution are impacting rainfed agriculture, and warming temperatures are changing growing seasons. In the face of this environmental complexity, there is a need for a comprehensive, systematic and accurate agricultural monitoring system. Against this background, the Ministry of Agriculture Jihad (MAJ) requested that FAO provide assistance in setting up an improved agriculture monitoring system, based on the integral use of advanced geospatial technologies, to support the development of the techniques, policy and investment conditions required to achieve sustainable agricultural development under climate change, with a geographic focus on three pilot areas: Mazandaran and Zanjan provinces and south of Kerman Province. The current project was foreseen as a precursor to a larger project, which would focus on applying the methodological approaches developed during this project for country crop area and yield estimation.

### IMPACT

The project contributed to strengthening national agriculture monitoring and production systems, and assisting the Government in adopting improved strategies for increasing and diversifying production potential.

### ACHIEVEMENT OF RESULTS

A series of activities was carried out to assess and review the existing agriculture monitoring and field data collection methodologies in the three pilot areas: Mazandaran and Zanjan Provinces and the south of Kerman Province, in order to identify gaps and limitations, and develop sustainable methods and tools for crop area and yield estimation through the integration of remote sensing (RS). The project interventions comprised the introduction of crucial approaches and tools for agricultural production in the country; as well as the preparation of valuable materials, including guidelines, analyses and reports (please see Documents and Outreach Products Section below).

An agricultural survey improvement methodology was defined by FAO (Climate, Biodiversity, Land and Water Department [CBDS] and headquarters); and a land cover/cropland map was developed, based on the recent satellite imagery and FAO approach for the target provinces. This was carried out by the FAO CBDS group in Zanjan Province, and repeated in the other two pilot areas by national consultants. Cropland information was generated, based on MAJ data, and including the main crop types and seasonal crop dynamics for the target provinces. In addition, alternative approaches for the monitoring of crop growth were developed.

Crop masks were produced for the main agricultural areas, based on the integration of the RS. In addition, a statistical analysis on acreage was conducted on one of the targeted provinces, based on 2018 data. A second analysis including the acreage and yield estimation of all three pilot regions was subsequently carried out, based on 2019 data. Considering the request from MAJ to add county boundaries to the stratification process, with the objective to derive county-specific acreage and yield estimates, the 2019 field data collection was performed using an improved stratification, sampling design and increased number of ground data. Guidelines to the methodology were developed in English and Farsi, as well as a detailed technical report for area estimation.

Assessments were carried out in selected provincial crop reporting services on capacities to utilize remotely sensed satellite imagery, field and other data, for producing and making available to the public timely market-oriented reports on crop estimation and forecasts. Methodologies prepared under Outputs 1 and 2 were adapted for the selected provinces.

Capacity building was a major component of the project. Distance training or on-the-job-training sessions were undertaken at national level to enhance provincial capacity to develop reports/bulletins based on satellite-based estimates of area of crops, vegetation information, agricultural inputs, and crop yield estimates of main crops for different seasons. Guidelines were also developed for the preparation of reports/bulletins. In addition, a workshop on “Advanced assessment and planning technologies for Transformative Agriculture Adaptation and Mitigation” was organized, to support public and private sector decision-makers to assess climate change risks, identify and assess gaps and needs of the available tools, and forge collaboration among stakeholders, for increased resilience and transformative adaptation and mitigation in agriculture. Distance learning was also provided, through webinars in RS, on agriculture monitoring and crop area and yield estimation.

### IMPLEMENTATION OF WORK PLAN

The implementation of project activities was delayed by several administrative and technical issues. As a result of these delays, data collection was undertaken well after the harvest period, making yield data collection impossible. A 14-month no-cost extension was requested and approved, in order to complete project activities. All the activities were implemented within the planned budget.



### FOLLOW-UP FOR GOVERNMENT ATTENTION

It is recommended that funding be sought to implement these follow-up actions: i) preparing a larger project to extend the activities in other provinces; ii) providing technical support on using mobile application and other innovative tools for field data collection; iii) conducting new data collection in 2020 (given that it was not possible to carry out yield data collection during the current project); iv) upgrading the platform on agricultural monitoring; v) providing technical support to the MAJ for the implementation of the next agricultural monitoring activities; vi) developing forecasting procedures for crop area and yield estimation; vii) organizing additional training sessions on the project methodology for provincial offices, to enable them to carry this out without assistance; and viii) further developing vegetation indices showing crop growth patterns, as well as information on the status of other natural resources and agricultural inputs.

In addition, the reporting system should be established through the development of a regularly scheduled series of actionable crop production reports, enhanced by the agriculture provincial offices that fully utilize area-yield survey data, together with remotely sensed information (linked to Outputs 1 and 2).

### SUSTAINABILITY

#### 1. Capacity development

MAJ staff at national level are familiar with the project’s proposed method, and relevant expertise exists in the country for the future use of the Ministry.

The proposed collaborative platform is a flexible, informal system, and therefore offers an easy entry point for more provincial offices to join. The in-country partners already on board indicated that they wished to stay engaged and informed.

#### 2. Gender equality

Although this was not specifically highlighted in the project document, and needs and priorities were not specified, it was addressed during the project, ensuring that gender equality was taken into account when building national teams.





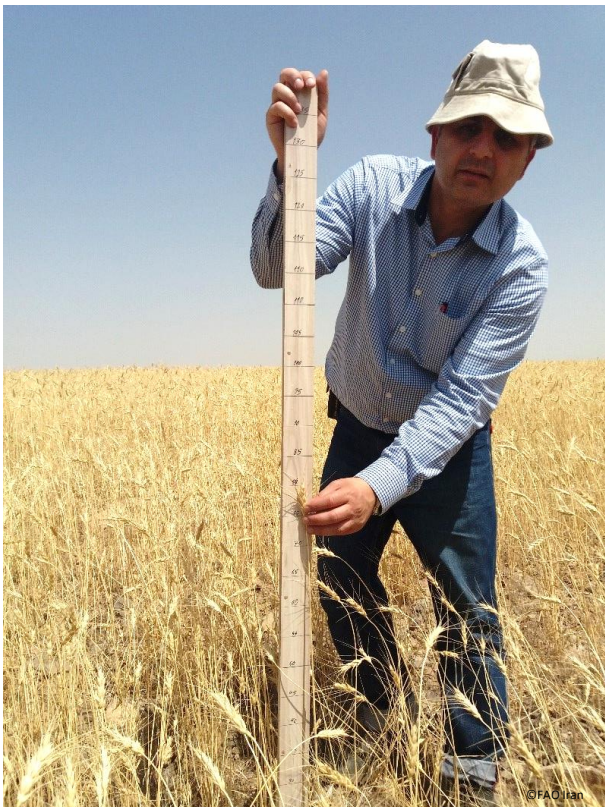
### 3. Technological sustainability

The project introduced important approaches and tools for the country, and a reasonable number of MAJ staff were familiarized with these. At national level, MAJ can pursue the project activities using national experts.

However, it was not possible to provide very high resolution (VHR) satellite imagery, as envisaged in the project proposal, owing to sanctions imposed in the country. The project was implemented using open source satellite images. The required resources are not necessarily available in the country.

### 4. Economic sustainability

Although budgetary constraints exist, the products are not unaffordable. However, MAJ's capacity to conduct regular agricultural survey and monitoring is still limited. This affects the implementation of agricultural survey methods, including the method developed by this project.



## DOCUMENTS AND OUTREACH PRODUCTS

- ❑ Posters on Agricultural Monitoring System in Iran. 2018.
- ❑ Conferences on Agriculture Monitoring system – conference booklet, banner, branding, flash drive. 2018 and 2019.
- ❑ Analysis of Ground Survey Data Collected in Zanjan and South Kerman Provinces. E. Carfagna. Rome, March 2019. 8 pp.
- ❑ Ground Data Collection - Agricultural and Natural Resources Engineering Organization. November 2019. 14 pp.
- ❑ Report on Agriculture Monitoring System in Iran. B. Panahbehagh, M. Varzi and P. Ziaei. Tehran, December 2019. 16 pp.
- ❑ Area Frame Sampling for Agricultural Monitoring System. P. Jafary, B. Panahbehagh. Tehran, December 2019. 56 pp.
- ❑ Field Data Collection Guidelines for Area Frame Sampling in Iran. M. Varzi, P. Jafary, K. Keshavarz, M. Henry and S. Gogo. Tehran, December 2019. 22 pp.
- ❑ Field Data Digitizing and Entry. P. Jafary, K. Keshavarz and A. Fadaei. Tehran, December 2019. 4 pp.
- ❑ Final Report. M. Varzi, B. Panahbehagh, P. Jafary, S. Gogo, A. Fadaei, M. Henry, and K. Keshavarz. Tehran, December 2019. 36 pp.
- ❑ Report on the statistical data analysis and recommendations for surveys conducted in 2018 and 2019. E. Carfagna. Rome, December 2019. 28 pp.
- ❑ Land Cover Map Production in Three Pilot Regions using Object-Based Techniques. P. Jafary. Tehran, December 2019. 31 pp.
- ❑ Quality control field work for Area Frame Sampling in Iran. M. Henry and M. Varzi. Tehran, December 2019. 3 pp.
- ❑ Recommendations for the Agricultural Monitoring System of Iran: objectives, design and operationalization. K. Keshavarz, M. Henry and M. Varzi. Tehran, December 2019. 8 pp.
- ❑ Satellite Image Classification in Mazandaran Province using Collected Field Data in 2019. P. Jafary. Tehran, December 2019. 15 pp.
- ❑ Crop Yield Estimation for Iran, A Recommendation Note. M. Varzi. Tehran, December 2019. 8 pp.
- ❑ Land Use (LU)/Land Cover (LC) maps of pilot regions using object-based classification approach.
- ❑ Guidelines in Farsi on processing satellite imagery to create sample areas and sample selection.
- ❑ Area frame methodology.
- ❑ Ground data collection guidelines for enumerators in Farsi.

## ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

<b>Expected Impact</b>	<b>National agriculture monitoring and production system are strengthened and Government adopts improved strategies for increasing and diversifying production potentials</b>	
<b>Outcome</b>	Established national and operational agriculture monitoring system that improves quality of agriculture information and reporting based on geospatial technology	
	<b>Indicators</b>	<ol style="list-style-type: none"> <li>1. Number of existing agriculture monitoring and field data collection methodologies assessed.</li> <li>2. Sustainable methods and tools for crop area and yield estimation of the major crops through integration of RS and sampling in the field developed.</li> <li>3. Number of crop status monitoring, area estimates and yield forecasting methodology improved.</li> <li>4. Number of regularly scheduled series of actionable crop production reports developed by the agriculture provincial offices.</li> </ol>
	<b>Baseline</b>	<ol style="list-style-type: none"> <li>1. Need for improved agriculture monitoring strategies to support decision-making.</li> <li>2. Inadequate data collection, analysis and dissemination methodologies for timely uptake and utilization of data.</li> <li>3. Institutions have weak capacities to produce agriculture statistics through integral use of RS technology.</li> <li>4. Weak capacities of provincial crop reporting services to produce and disseminate to the public regular crop production reports.</li> </ol>
	<b>End Target</b>	<ol style="list-style-type: none"> <li>1. Existing agriculture monitoring methodology, gaps, and weaknesses are analysed.</li> <li>2. New approaches and strategy for improving are proposed, developed and agreed on by stakeholders.</li> <li>3. National cropland map/database (DB) for selected provinces, including the main crop types and the main seasonal crop dynamics, as well as crop masks based on integration of the RS are produced.</li> <li>4. Statistical analysis for acreage and yield estimation and forecasting for the sampling areas are developed and methodology/guidelines developed.</li> <li>5. Reports/bulletin that provide satellite-based crops, vegetation information and crop yield and production estimates of different seasons are published.</li> <li>6. Selected agriculture provinces have fully functional operational units capable of: i) providing agricultural crop statistics derived from the integration of ground truth data and RS technology; and ii) producing and disseminating regular crop production reports to users.</li> </ol>
	<b>Comments and follow-up action to be taken</b>	It is recommended that funding be sought to implement these follow-up actions: i) preparing a larger project to extend the activities in other provinces; ii) providing technical support on using mobile application and other innovative tools for field data collection; iii) upgrading the platform on agricultural monitoring; and iv) providing technical support to the MAJ for the implementation of the next agricultural monitoring activities.

<b>Output 1</b>	Innovative, up-to-date and complementary agriculture monitoring systems enabling the integration of satellite remotely-sensed data are developed. The baseline of current approaches, gaps and limitations of current procedures are established		
	Indicators	Target	Achieved
	Number of existing agriculture monitoring and field data collection methodologies assessed.	<ul style="list-style-type: none"> <li>- Existing agriculture monitoring methodology, gaps, and weaknesses are analysed.</li> <li>- New approaches and strategy for improving are proposed, developed and agreed on by stakeholders.</li> </ul>	Yes
<b>Baseline</b>	Need for improved agriculture monitoring strategies to support decision-making.		
<b>Comments</b>	One methodology was assessed. MAJ survey methodology is not published in its annual agricultural statistics bulletin. The method was comprehensively explained in an FAO report before the implementation of this project. During the project, MAJ methodology was assessed again, and existing data were added to MAJ's online database.		
<b>Activity 1.1</b>	Stakeholders' workshop/meeting for the identification of the main current methods and tools		
	Achieved	Yes	
	Comments	Workshops and meetings were carried out.	
<b>Activity 1.2</b>	Assess the current crop area and yield estimation methodology and identify the most appropriate approach		
	Achieved	Yes	
	Comments	Agricultural survey improvement methodology was defined by FAO CBDS – headquarters.	
<b>Activity 1.3</b>	Assess the current frame methodology and identify the most appropriate type of frame development/migration and/or multiple frame		
	Achieved	Yes	
	Comments	Existing data were added to MAJ's online database.	
<b>Activity 1.4</b>	Assess the existing data collection methodology and identify the most suitable methodology		
	Achieved	Yes	
	Comments	This activity was performed under Activity 1.2	
<b>Activity 1.5</b>	Establish a baseline of current approaches, gaps and limitations of current procedures and identify areas for improvement		
	Achieved	Yes	
	Comments	Current approaches, gaps and limitations were reviewed and technical recommendations were provided (sampling, quality control, data analysis).	
<b>Activity 1.6</b>	Collect all kinds of available existing agriculture, statistics, geographic, geospatial, administrative and other socio-economic information and introduce in a database		
	Achieved	Yes	
	Comments	One online web platform, embedded in the MAJ platform, was developed, integrating existing statistics, administrative layers, and the results from this project.	
<b>Activity 1.7</b>	Develop land cover/cropland map based on the recent satellite imagery and FAO approach for the selected provinces		
	Achieved	Yes	
	Comments	This was performed in FAO CBDS group for Zanjan Province, and repeated for other pilot areas by national consultants.	
<b>Activity 1.8</b>	Generate cropland information, including the main crop types and the main seasonal crop dynamics for the selected provinces		
	Achieved	Yes	
	Comments	This was performed at FAO headquarters, based on MAJ data.	
<b>Activity 1.9</b>	Develop alternative approaches for monitoring of crop growth		
	Achieved	Yes	
	Comments	This was carried out at FAO headquarters	

<b>Output 2</b>	Sustainable methods and tools for crop area and yield estimation through integration of remote sensing and sampling in the field to identify appropriate sites for yield estimation and crop cutting exercise and to be used as a calibrator for the area frame are developed in selected provinces as a demonstrator for the larger UTF		
	Indicators	Target	Achieved
	Sustainable methods and tools for crop area and yield estimation of the major crops through integration of RS and sampling in the field developed.	<ul style="list-style-type: none"> <li>- National cropland map/DB for selected provinces, including the main crop types and the main seasonal crop dynamics, as well as crop masks based on integration of the RS are produced.</li> <li>- Statistical analysis for acreage and yield estimation and forecasting for the sampling areas are developed, and methodology/guidelines developed.</li> </ul>	Yes
<b>Baseline</b>	Inadequate data collection, analysis and dissemination methodologies for timely uptake and utilization of data.		
<b>Comments</b>	<ul style="list-style-type: none"> <li>- Crop masks were produced.</li> <li>- A statistical analysis of one province was performed for 2018 data (by international consultant).</li> <li>- A statistical analysis (acreage and yield) of all three pilot provinces was performed (by national consultant).</li> <li>- Recommendations for improved statistical framework and analysis were provided (by international consultant under the Letter of Agreement with University of Bologna).</li> <li>- Guidelines to methodology were developed (in Farsi).</li> <li>- A technical review document on forecasting procedures for crop area and yield estimation was prepared.</li> </ul>		
<b>Activity 2.1</b>	Select the recent high resolution geospatial information (i.e. Sentinel 1 and Sentinel 2) to be used for the testing of the major crops of Iran for area and yield estimation		
	Achieved	Yes	
	Comments	Performed in FAO headquarters and by national consultants.	
<b>Activity 2.2</b>	Estimate area and yield of the sampling sites to define statistically based yield procedures		
	Achieved	Partially	
	Comments	<ul style="list-style-type: none"> <li>- Area data was collected and analysed (by national consultant).</li> <li>- Data collection was undertaken well after harvest, making yield data collection impossible. New data collection should be conducted in 2020.</li> </ul>	
<b>Activity 2.3</b>	Develop monthly Normalized Difference Vegetation Index (NDVI) indicators and crop/non-crop map		
	Achieved	Yes	
	Comments	This was carried out by a national consultant.	
<b>Activity 2.4</b>	Develop crop masks for the main crops in the selected areas based on RS and prepare methodological guidelines		
	Achieved	Yes	
	Comment	Main agricultural areas were classified (crop types are not defined in the maps).	
<b>Activity 2.5</b>	Develop stratification for the area frame based on cropland map and RS indicators (NDVI)		
	Achieved	Yes	
	Comments	Performed cooperatively by national consultant and international consultant.	
<b>Activity 2.6</b>	Prepare a detailed technical report for area estimation		
	Achieved	Yes	
	Comments	Guidelines (in Farsi) and a project final report were prepared.	
<b>Activity 2.7</b>	Develop a detailed project proposal for a UTF project for improving crop status monitoring, area estimates and yield forecasting extended at national level		
	Achieved	No	
	Comments	As described in follow-up actions section in this terminal report.	
<b>Activity 2.8</b>	Workshop with the stakeholders		
	Achieved	Yes	
	Comments	The final workshop/meeting with stakeholders to review and discuss the findings of the assessment and validate the methodology proposed for the crop area and yield estimation was conducted.	

<b>Output 3</b>	Provincial crop reporting capability to provide crop area and yield estimations to the public through regular and timely market-oriented reports containing actionable information useful for decision-making by farmers and other interested in the crop market are improved in selected provinces as a demonstrator for the larger UTF		
	Indicators	Target	Achieved
	Number of crop status monitoring, area estimates and yield forecasting methodology improved.	Reports/bulletin that provide satellite-based crops, vegetation information and crop yield and production estimates of different seasons are published.	Yes
<b>Baseline</b>	Institutions have weak capacities to produce agriculture statistics through integral use of RS technology.		
<b>Comments</b>	The provincial offices were trained on the project methodology; however, in order to independently perform project methodology, more training sessions are required.		
<b>Activity 3.1</b>	Assessments of provincial crop reporting services (for some selected provinces)		
	Achieved	Yes	
	Comments	Assessments were carried out of selected provincial crop reporting services on their capability to utilize remotely-sensed satellite imagery, field and other data for producing and making available to the public timely market-oriented reports on crop estimation and forecasts.	
<b>Activity 3.2</b>	Prepare guidelines for reporting and development of bulletin		
	Achieved	Partially	
	Comments	Methodologies prepared under Outputs 1 and 2 were adapted for the selected provinces; and guidelines were prepared for the preparation of the reports/bulletins, relying on satellite-based crops information. Vegetation indices showing crop growth patterns, as well as information on the status of other natural resources and agricultural inputs should be further developed.	
<b>Activity 3.3</b>	Enhance/improve existing crop forecasting reports of selected provinces		
	Achieved	Yes	
	Comments	The existing crop forecasting and reporting system at a provincial level was enhanced. It is necessary that the reporting system be established through the development of a regularly scheduled series of actionable crop production reports, enhanced by the agriculture provincial offices that fully utilize area-yield survey data, together with remotely sensed information (linked to Outputs 1 and 2).	
<b>Activity 3.4</b>	Set-up of fully functional operational units in selected provincial agriculture offices		
	Achieved	Yes	
	Comments	The planned functional operational units in selected provincial agriculture offices were set up.	
<b>Activity 3.5</b>	Establish the system of agricultural experts at national and provincial level		
	Achieved	Yes	
	Comments	The planned agriculture experts geographically dispersed system at national and provincial level was developed.	



Output 4	Capacity development through transfer of relevant methods, good practices and learning materials and, exchange of development solution through South-South Cooperation on agriculture monitoring optimized by use of geospatial technology are achieved		
	Indicators	Target	Achieved
	Number of regularly scheduled series of actionable crop production reports developed by the agriculture provincial offices.	Selected agriculture provinces have fully functional operational units capable of: i) providing agricultural crop statistics derived from the integration of ground truth data and RS technology; and ii) producing and disseminating regular crop production reports to the users.	Partially
Baseline	Weak capacities of provincial crop reporting services to produce and disseminate to the public regular crop production reports.		
Comments	The provincial offices were trained on the project methodology; and training materials and guiding documents were provided in Farsi. More capacity development is required, in particular for quality control and use of the mobile app for the field data collection.		
Activity 4.1	Exchange of development solution through South-South Cooperation		
	Achieved	Yes	
	Comments	To enhance the capacity building of national counterparts, the project facilitated the participation of two agriculture and geospatial experts from the MAJ in a workshop on “Advanced assessment and planning technologies for Transformative Agriculture Adaptation and Mitigation”. The purpose of this workshop was to identify ways to strengthen data/information and advanced tools and systems, to support public and private sector decision-makers to assess climate change risks, identify and assess gaps and needs of the available tools, and forge collaboration among stakeholders, for increased resilience and transformative adaptation and mitigation in agriculture over different time scales. A number of good presentations and open discussions took place during the workshop, which was evaluated very positively by the national counterparts.	
Activity 4.2	Provide support and undertake Training of Trainers and distance learning		
	Achieved	Partially	
	Comments	<ul style="list-style-type: none"> <li>- The project did not undertake Training of Trainers.</li> <li>- Distance learning through webinars in RS for agriculture monitoring and crop area and yield estimation was conducted.</li> </ul>	
Activity 4.3	Provide support and undertake on-the-job-training		
	Achieved	Yes	
	Comments	The project organized on-the-job-training sessions for MAJ experts in the use and integration of satellite imagery information, and approaches for land cover and agriculture surveys and monitoring, through regular skype meetings and several missions conducted by CBDS in the country.	
Activity 4.4	Study Tour for MAJ staff in Rome and Islamabad		
	Achieved	Yes	
	Comments	<ul style="list-style-type: none"> <li>- The planned study tour for two agriculture and geospatial experts of MAJ was replaced with a workshop on “Advanced assessment and planning technologies for Transformative Agriculture Adaptation and Mitigation” in Thailand, Bangkok.</li> <li>- A one-week study tour was organized for one agriculture senior expert of the MAJ to FAO headquarters, Rome.</li> </ul>	
Activity 4.5	Develop (e)-learning and curriculum material		
	Achieved	Yes	
	Comments	The project web page was developed by the CBDS.	
Activity 4.6	Improve provincial capacity to develop reports/bulletins based on satellite-based estimates		
	Achieved	Partially	
	Comments	Distance training or on-the job-training sessions were undertaken at national level to enhance capacity to develop reports/bulletins based on satellite-based estimates of area of crops, vegetation information, agricultural inputs, and crop yield estimates of main crops for different seasons.	
Activity 4.7	Develop guidelines, manual, methodological and training materials		
	Achieved	Yes	
	Comments	As per Activity 2.6.	
Activity 4.8	Closure workshop		
	Achieved	Yes	
	Comments	The project organized a closure workshop for the presentation of the results of the project to the stakeholders.	

**Partnerships and Outreach**

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