

REQUEST FOR PROPOSALS

for Academic researcher(s) for preliminary research of an AI Proof-of-Concept Program in the field of Remote sensing and AI in Agriculture for Soil property prediction

The Project for Promoting Artificial Intelligence Ecosystem in the Hashemite Kingdom of Jordan

December 9, 2024

Japan Development Service Co., Ltd. (JDS)

Section 1. Summary Sheet of the Instructions to Applicants

1. Name of the assignment	Academic researcher(s) for preliminary research of an AI Proof-of-Concept Program in the field of Remote sensing and AI in Agriculture for Soil property prediction
2. Method of selection	QCBS (Quality and Cost Based Selection)
3. JDS's officer in charge	Najlaa Salloum (Ms.) c/o JICA Project office, Ministry of Digital Economy and Entrepreneurship Address: Ministry of Digital Economy and Entrepreneurship 8th Circle Bayader Wadi Al Seer Telephone: + 96265805700 Facsimile: + 96265861059 E-mail: ai-jaies@modee.gov.jo
4. Pre-proposal conference	A pre-proposal conference will be held: No
5. Type of contract	Lump-sum
6. Proposal submission deadline	Date: December 22, 2024 Time: 16:00 Jordan Time
7. Proposal submission address	same as the above 3. JDS's officer in charge
8. Expected date for the commencement of the Services	End of December, 2024

Section 2. Instructions to Applicants

A. General Provisions

- 1. Introduction** 1.1 Applicants should submit a CURRICULUM VITAE (CV) for academic researcher(s) on Remote sensing in Agriculture and AI who should conduct preliminary research for the preparation of a future planned PoC program which is described in the attached ToR (Terms of Reference). Note that researcher(s) in this assignment will not conduct the target PoC, but instead should conduct the preliminary research in order to determine the scope and methodology of the target future PoC program.

B. Preparation of Proposals

- 2. General Considerations** 2.1 In preparing the Proposal, the Applicant is expected to examine the attached Terms of Reference (ToR) in detail. Material deficiencies in providing the information requested in the ToR may result in rejection of the Proposal.
- 2.2 CV and quotation shall be prepared and submitted by filling out the forms and documents provided under Clause 5. Each of the forms shall be completely filled in digitally as files and send back to the Project.
- 3. Cost of Preparation of Proposal** The Applicant shall bear all costs associated with the preparation and submission of its Proposal, and JDS shall not be responsible or liable for those costs, regardless of the conduct or outcome of the selection process. JDS is not bound to accept any proposal, and reserves the right to annul the selection process at any time prior to Contract award, without thereby incurring any liability to the Applicant.
- 4. Language** CV and quotation, as well as all correspondence and documents relating to the Proposal exchanged between the Applicant and JDS, shall be written in English.
- 5. Documents Comprising the Proposal** CV and quotation shall comprise the documents and forms listed below;
PDF file protected by a password:
(1) TECH-1
(1) FIN-1
- 6. Description of Academic AI Researcher** CV of the academia AI researcher(s) should include affiliation, title, experiences in the research of similar fields of this assignment, etc.

- 7. Proposal Validity** The proposal must remain valid for 30 calendar days after the Proposal submission deadline.
- 8. Quotation**
- 8.1 Quotation shall list all costs associated with the assignment, including (a) remuneration (researcher assignment costs), (b) reimbursable expenses (other costs) indicated in the Financial Proposal Forms.
- 8.2 The Applicant is responsible for meeting all tax liabilities arising out of the Contract.
- 8.3 The Applicant shall express the price for its Services in US dollars.

C. Submission, Opening and Evaluation

- 9. Submission of Proposals and their passwords**
- 9.1 The Applicant shall submit a signed proposal comprising the documents and forms in accordance with Clause 5 (Documents Comprising the Proposal). A legally valid digital signature (such as digitally signed PDF by Adobe Acrobat) is also acceptable.
- 9.2 The submitted files must not contain visible traces of modifications (such as strike-through characters or revision histories). Since all the documents and forms must be digital files, they must be clean, final files.
- 9.3 The signed Proposal shall be sent to the email address: ai-jaies@modee.gov.jo in following two steps:
- Step 1. Submission of CV and quotation, in files in PDF format protected with a password before the proposal submission deadline described in Section 2. **Do not send passwords for the two PDF files at this moment.** If the applicant sends unprotected PDF files or sends password at this point, **the applicant will be disqualified.**
- Step 2. The Applicant shall send a password for CV and quotation after the proposal submission deadline described in Section 2 in a separate e-mail. The password shall be sent after 16:00 Jordan time on the same day of the proposal submission deadline, or within the next day of the proposal submission deadline at the latest.
- 9.4 In case the size of a submission file (a password-protected PDF file) exceeds 10MB, it shall be sent by using a **secure online storage service** such as Google drive or One drive with appropriate secure access control. The applicant shall send the link to access the file by email.

9.5 The Proposal must be sent to the address and received by JDS no later than the deadline indicated in **Section 1. Summary Sheet of the Instruction to Applicants**. Any Proposal received by JDS after the deadline shall be declared late and rejected.

10. Confidentiality

From the time the Proposals are opened to the time the Contract is awarded, the Applicant should not contact JDS on any matter related to its CV and/or quotation. Information relating to the evaluation of Proposals and award recommendations shall not be disclosed to the Applicants who submitted the Proposals or to any other party not officially concerned with the process, until the publication of the Contract award information.

11. Evaluation

11.1 The evaluation shall be made by calculating a total score by weighting a Technical Score and a Financial Score as per the formula and instructions stated below.

[Technical Score (S_t)]

JDS shall evaluate the CV(s) and make a Technical Score.

[Financial Score (S_f)]

The lowest evaluated quotation price (F_m) among all Applicants' proposals is given the maximum financial score (S_f) of 100.

The formula for determining the financial scores (S_f) of all other Applicants' Financial Proposals is as following:

$$S_f = 100 \times F_m / F$$

where " S_f " is the financial score, " F_m " is the lowest price, and " F " the price of the proposal under consideration.

[Combined Score]

The weights given to the Technical (W_t) and Financial (W_f) Proposals are:

$$W_t = \underline{70\%}, \text{ and}$$

$$W_f = \underline{30\%}$$

Proposals are ranked according to their combined technical score (S_t) and financial score (S_f) using the weights as following:

$$S = S_t \times W_t + S_f \times W_f$$

11.2 There is an absolute ceiling of budget allocated to the periluminally research of PoC Program. Any Applicant with Financial Proposal price that exceeds this ceiling price will be immediately disqualified regardless of its technical score or financial score.

11.3 The Applicant that offers quotation price within the absolute ceiling price and achieving the highest combined technical and financial score will be invited for negotiations.

D. Negotiations and Award

- 12. Negotiations** The negotiations will be held shortly after notification to successful/ unsuccessful Applicant(s) with the successful Applicant's representative(s).
- 13. Conclusion of Negotiations**
- 13.1 The negotiations are concluded with a review of the finalized draft Contract, which then shall be initiated by JDS and the Applicant's authorized representative.
- 13.2 If the negotiations fail, JDS shall terminate the negotiations informing the Applicant of the reasons for doing so and will invite the next-ranked Applicant to negotiate a Contract.
- 14. Award of Contract**
- 14.1 After completing the negotiations JDS shall award the Contract to the selected Applicant and promptly notify the other shortlisted Applicants. Technical Proposals of those Applicants who were unsuccessful shall be disposed.
- 14.2 The Applicant is expected to commence the assignment on the date specified in **Section 1. Summary Sheet of the Instruction to Applicants.**

Section 4. Proposal Forms

Checklist of Required Forms

Form	Description	Page Limit
TECH-1	Curriculum Vitae (CV) for AI Researcher(s)	3 / person (max 2 persons)
FIN-1	QUOTATION OF COST	1

Form TECH-1

CURRICULUM VITAE (CV) FOR AI RESEARCHER

Position Title	{e.g., Researcher in the field of AI/Agriculture }
Name of Person:	{Insert full name}
Date of Birth:	{day/month/year}
Country of Citizenship / Residence	

Education: {List college/university or other specialized education, giving names of educational institutions, dates attended, degree(s)/diploma(s) obtained}

Record of relevant experiences to the assignment:

{Starting with present position, list in reverse order. Please provide dates, name of involving research organization, titles of positions held, types of activities performed and location of the assignment, and contact information of representative person or research organization(s) who can be contacted for references. Past experiences that are not relevant to the assignment should not be included, or it would result in the reduction of evaluation score.}

Period	Assigned organization and your title/position. Contact info for references	Country	Summary of activities performed relevant to the Assignment
[e.g., May 2005-present]	[e.g., University of, advisor/consultant to... For references: Prof. Hbbbb, Faculty of AI] Tel...../E-mail.....;		

Membership in Research Associations and Publications:

Language Skills (indicate only languages in which you can work):

Person's contact information: (e-mail, phone)

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience, and I am available to undertake the assignment in case of an award. I understand that any misstatement or misrepresentation described herein may lead to my disqualification or dismissal by JICA.

Researcher

Signature

Date {day/month/year}

FORM FIN-1

QUOTATION OF COST

TOTAL COSTS OF (1), (2) AND (3) : *{insert: total estimate cost}*

Remuneration					
No.	Name	Field in charge in this assignment	Person-month Remuneration Rate (US\$ / Month)	Time input in person/month (Months)	Cost (US\$)
	Academic Researcher				
1		[e.g., Remote sensing in Agriculture, etc.]		1.0 (max)	
2		[e.g., AI, etc.]		1.0 (max)	
Total of (1)					

Reimbursable Items if any					
	Type of Reimbursable expenses	Unit	Unit Cost	Quantity	Cost (US\$)
1	[e.g., Commuting expense, etc.]				
2					
3					
4					
5					
Total of (2)					

Total Costs of (1)+(2)	
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Indirect Local Tax Estimates		
1	GST	
2	Other TAX	
3		
4		
Total Estimate for Indirect Local Tax (3)		

Section 5. Terms of Reference (TOR)

Academic researcher(s) for preliminary research of an AI Proof-of-Concept Program in the field of Remote sensing and AI in Agriculture for Soil property prediction

1. Background

Artificial Intelligence (AI) plays a crucial role in fostering comprehensive social and economic development across various sectors. By harnessing the potential of AI technology, we can effectively achieve the objectives of sustainable development and adapt to the challenges of the fourth industrial revolution. Embracing AI enables us to stay abreast of rapid technological advancements and leverage the abundant opportunities it offers to boost economic growth and enhance the performance of governmental entities. AI also creates new job opportunities, contributing to the labor market and fosters an environment conducive to innovation and entrepreneurship. Moreover, AI implementation enhances the efficiency, quality, and accessibility of public services while reducing associated costs. These ensure that all segments of society can benefit from improved services and experiences.

The Ministry of Digital Economy and Entrepreneurship (MoDEE) of Jordan has developed and published “AI Strategy and Implementation Plan (2023-2027)” (hereinafter referred to as “the AI Strategy”) with the vision of making Jordan a regional leader in the field of AI and providing a unique and attractive technological and entrepreneurial environment for AI to be effective, supportive and an essential component of the national economy.

Under these circumstances, Japan International Cooperation Agency (JICA) has started an international cooperation project with MoDEE titled “The Project for Promoting Artificial Intelligence Ecosystem in the Hashemite Kingdom of Jordan”. JICA is dispatching a consultant team to provide technical advice and assistance with the project implementation. The project purpose is to operationalize a **Public-Private-Academia platform** for promoting use of emerging technologies (especially AI) in Jordan. To achieve the project purpose, two major activities are being implemented. One is to establish and improve the capacity of the said platform. Another is to implement PoC (Proof of Concept) programs to promote AI use in real society by means of **Public-Private-Academia consortium**.

The National AI Steering Committee has been established for supervising the implementation of the AI Strategy and Implementation Plan (2023-2027) and takes role to discuss and monitor its progress with selected high-level members from the government (MoDEE), academia, and industry. The JICA project is working closely with the Committee, and the PoC program described in this ToR is selected based on the discussions of the Committee. A Project Secretariat has also been established to help implementation of the project including the PoC program.

This ToR document outlines the requirements for academic researcher(s) to conduct preliminary research for a future PoC program in the field of Utilization of remote sensing and AI in agriculture for

soil property prediction.

2. Description of the future PoC program

This Terms of Reference (ToR) refers to requirements of academic researcher(s) on utilization of remote sensing and AI in agriculture for soil property prediction who should conduct preliminary research for the preparation of a future planned PoC program. Please do not misunderstand but the researcher(s) in this ToR will not conduct the target PoC program, but instead should conduct the required preliminary research in order to determine the scope and methodology of the target future PoC program.

Below is the description of the target future PoC program (not the description of work for academic researcher(s) in this ToR).

2.1 Title of the target PoC program

Determining soil fertility for agriculture with water saving using satellite imagery and AI

2.2 Background and overview of the target PoC program

The agricultural sector in Jordan faces significant challenges related to soil fertility and water scarcity. The use of advanced technologies such as satellite imagery and artificial intelligence (AI) can provide a comprehensive and scalable solution for assessing soil properties, enabling efficient water usage and informed agricultural practices. This PoC aims to develop and test an AI model capable of predicting essential soil properties required for agriculture including soil moisture using satellite imagery correlated with ground-truth data. This PoC also aims to develop another AI model (or the same AI model as above) capable of predicting appropriate water irrigation timings of agricultural land using satellite imagery by learning past water irrigation routine data of farmers.

2.3 Objectives of the target PoC program

- To train an AI model using pairs of following data to find a correlation between satellite imagery data and soil properties (including soil moisture).
 - Soil property data (either measured in the past survey or newly measured during the PoC) at several locations in Jordan.
 - Satellite images (or drone imagery) of the same location as the soil property data taken in the same date as soil property.
- Target soil properties are at least, but not limited to, the followings.
 - NPK (Nitrogen, Phosphorus, Potassium)
 - pH
 - Electrical Conductivity (EC)
 - Soil moisture
- Target sites to conduct the PoC are: the Jordan Valley and Upland areas. The exact location of the PoC sites will be determined by discussion with stakeholders.

- To train another AI model (or simple machine learning method) by using the past dates that farmers performed water irrigations and the same satellite imagery so that the AI model would be able to predict appropriate water irrigation timing of farmland from the satellite imagery. The AI model could also be merged into the AI model for soil property prediction.

The figure below illustrates the overview of the target future PoC program.

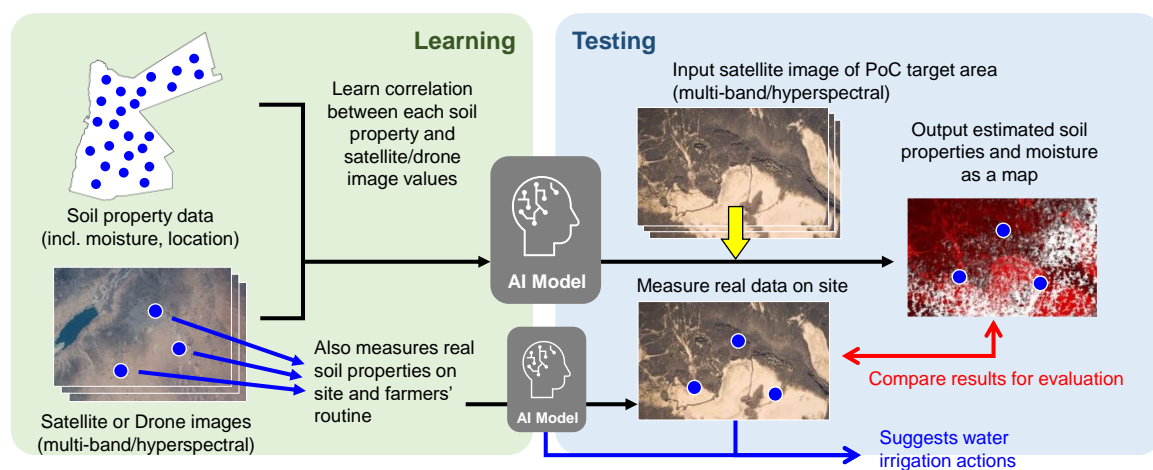


Figure 1: Overview of the target future PoC program

3. Scope of Work (SoW) of this ToR

The researcher(s) of this ToR should perform the following tasks.

1. The duration of this preliminary research work is one month. The duration cannot be extended, and the research must finish within this period.
2. Elaborate the latest research papers (approximately since the year 2010) and available technical information related to agricultural soil property prediction using satellite imagery (especially for multi-band and hyperspectral imagery) and application of AI technologies in this field. Analyze and evaluate the papers.
3. Survey availability of resources and information in the government, industry, and academia in Jordan for the following topics.
 - Existing commercial products and services for determining/predicting soil properties using satellite imagery and their prices/cost.
 - Available data, technologies, equipment and their cost in Jordan that are required for implementing the target PoC program such as:
 - Satellite images (either multi-band or hyperspectral) that can be purchased or downloaded from local or international providers
 - Drone-based multi-band/hyperspectral imagery for agriculture (as a service or as an equipment rental)

- Soil property data in Jordan (either open source or commercial)
 - Soil property analysis service, Soil property measurement equipment, Soil property monitoring post (IoT-based or with data storage)
 - Existing AI models for similar purposes
4. Identify the target PoC program’s requirements such as whether to use drones or satellite imagery, the type of satellite imagery required, the number of samples, etc.
 5. Define the expected outputs from the target PoC program.
 6. Propose possible KPIs (Key Performance Indicators) with threshold values to evaluate the performance of AI model in the target PoC program.
 7. Identify the potential social and economic impacts of the target PoC program on agriculture in Jordan including how the government and farmers could benefit from its implementation.
 8. Propose a recommended content and methodologies (combination of technologies, data, equipment, etc.) to implement the target PoC program with rough cost estimation.

Important Note: The target PoC program is not a full-scale development program. As the scheme implies (Proof-of-Concept), the program must be as compact and cost-effective as possible to “prove” the effectiveness of proposed method. It is not guaranteed to adopt the recommended content and methodologies in the target PoC program due to the predefined budget ceiling of the JICA project.

9. Conduct necessary meetings with stakeholders as shown in the table below.

Meeting	Timing	Expected Content	Expected Stakeholders
Kick-off meeting	At the beginning of assignment	Introduction of stakeholders, schedule of research, etc.	MoDEE, MoA*, JICA expert team, AI Steering Committee members
Progress meeting	2 nd week of assignment	Progress of the research	MoDEE, JICA expert team
Progress meeting	3 rd week of assignment	Progress of the research	MoDEE, JICA expert team
Final presentation	At the end of assignment	Presentation of final report on the result of preliminary research	MoDEE, MoA, JICA expert team, AI Steering Committee members

*MoA: Ministry of Agriculture

10. Write a final report on the research result including all topics listed above.

4. Technical considerations and information for the research work

There are following technical considerations and available information for the preliminary research so far. The researcher(s) in this ToR should start the research based on these then extend the research.

4.1 Satellite images

The figure below illustrates an overview of available satellite images and its relation to PoC program.

This does not mean that all these satellite images are required, and there are many other satellites in the world, so the researcher(s) in this ToR must explore the best possible options for the satellite image.

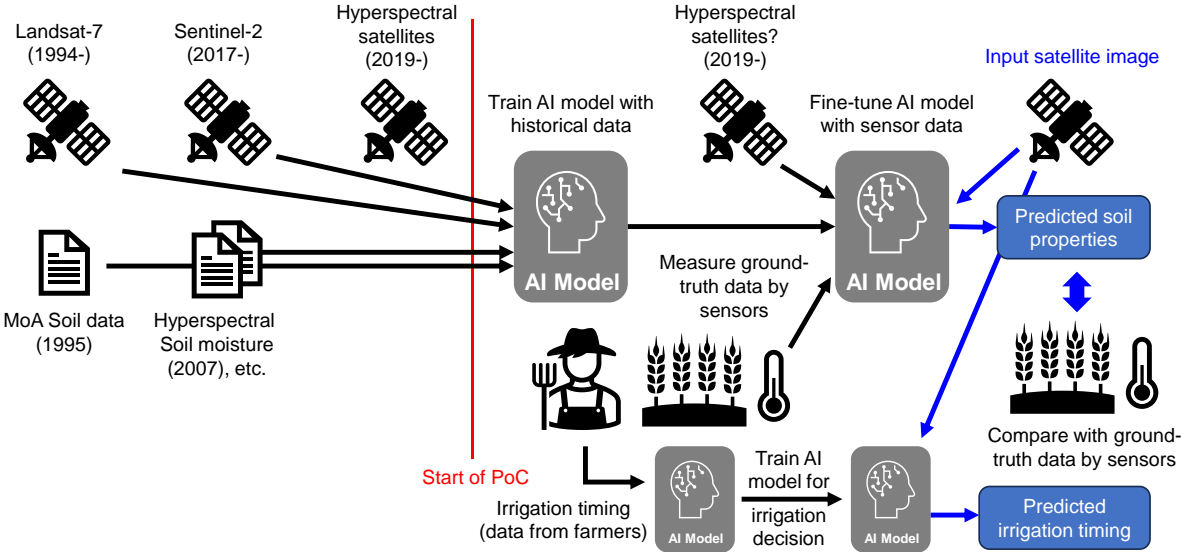


Figure 2: Popular satellite images and their relation to PoC program

There are the following considerations for the satellite image.

- Each satellite normally employs different types of sensors and there are virtually no identical satellites that are fully compatible in terms of sensors (except for satellites in the same series of deployment). Therefore, the satellite to be used in the PoC program must be carefully chosen.
- The researcher(s) in this ToR should explore available satellite imagery for the target PoC program with cost information (per specific area, minimum purchase amount, etc.). The minimum requirements of the satellite imagery are as follows.
 - More than 10 multi-band or hyperspectral bands ranging from near ultra-violet to near infra-red.
 - Spatial resolution: 50 m or better (finer)
 - Revisiting cycle (the period of visiting the same location): 1 week or less
 - Must cover target PoC sites in Jordan
- Ideally, a satellite with hyperspectral sensor is the best option for this PoC. In order to correctly predict soil properties from the image, large number of different narrow-spectrum images are considered required. So, the more the number of narrow bands in a specific image area, the better the expected accuracy (see this¹ and this²). However, hyperspectral satellites are rather new and there are not so many choices available. The cost of satellite images is significantly higher than multi-band satellite images. Since the target PoC program has a very limited budget,

¹ https://en.wikipedia.org/wiki/Hyperspectral_imaging

² <https://www.eoport.org/other-space-activities/hyperspectral-imaging>

it is not recommended to use too costly satellite.

- One possible candidate of hyperspectral satellite imagery is OHS³ which has the following technical specifications:
 - Data available since: April 2018
 - Total 32 bands ranging from 460~940 nm
 - Spatial resolution: 10 m
 - Product Type: raw 32-band (from blue to near infra-red) with RPCs
 - Data Source: archive
 - Minimum Order Size: 2,500 sq km
 - Price Per Sq Km: \$1.50
- Though the spectrum resolution is not as high as hyperspectral images, multi-spectral images with more than 10 bands can also be used in the target PoC program. For example, there are many agricultural satellite imagery services in the world using ESA (European Space Agency)'s Sentinel-2⁴ satellite imagery because of the following benefits.
 - Data available since: June 2015 / March 2017 (two satellites)
 - Total 12 bands ranging from 442~2202 nm (central wavelength)
 - Spatial resolution: 10~60 m depending on the band
 - Two identical satellites are continuously taking images so that the revisiting cycle of a location is 5 days or less.
 - Data is open to the public through “Registry of Open Data on AWS”⁵ for free of charge.
- Satellite imagery has “revisiting cycle” so that a satellite typically flies over the same location only once in several days (typically 5~7 days). This means that ground-truth soil properties data must be measured at the same time (same day) as the satellite takes the images. It is therefore required to plan the date(s) that the chosen satellite will take an image and perform ground-truth soil properties measurement on the same date(s).

4.2 Drone images

Drone with hyperspectral camera could complement or replace the needs of satellite images. The advantages and disadvantages of using drone image are as follows:

[Advantages]

- Has much higher spatial resolution up to centimeters instead of meters of the satellite.
- Can employ on demand basis and can get images at any time (no restriction of “revisiting cycle” of the satellite images).
- Can take images of soils under non-clear (cloudy or even rainy) weather conditions. On the

³ <https://apollomapping.com/ohs-satellite-imagery>

⁴ <https://en.wikipedia.org/wiki/Sentinel-2>

⁵ <https://registry.opendata.aws/sentinel-2/>

other hand, satellite images with clouds have no use for the soil property predictions.

[Disadvantages]

- Availability of drone-based hyperspectral / multi-band camera in Jordan is unknown. The researcher(s) in this ToR must conduct research on this topic as described in the SoW.
- Purchasing such drone with hyperspectral / multi-band camera could be even more costly than purchasing hyperspectral satellite images. Therefore, it should be an equipment rental or drone-imaging service.

4.3 Choice of satellite imagery or drone images

The researcher(s) of this ToR should examine and compare the advantages/disadvantages of using satellite imagery and drone imagery as described above and should recommend appropriate method for the target PoC program (whether to use either of them, or to combine them, for example).

Important Note: Sustainability of such proposed method should be well considered when the method will be applied to all agricultural lands in Jordan in the future. It might not be cost-effective to apply drones to all agricultural lands, for example, so the proposed method should clearly address the appropriate condition when and where to use drone images.

4.4 Available past soil properties data

- MoA (Ministry of Agriculture) has historical data of soil fertility parameters (NPK, pH, EC) across 35,000 locations throughout Jordan measured in 1995. However, there are very few choices for satellite images taken at the same time period of the data (such as Landsat 7 with only 8 spectrum bands⁶), and the number of bands might not be sufficient for the purpose of this PoC program. There might be a possibility, however, to determine the correlation between old satellite imagery (by Landsat 7) and newer satellite imagery so that this old data could be utilized in the PoC program.
- There are several potential datasets for training AI model available on the internet such as the followings. (Note: The first two datasets are not directly downloadable and communication with the dataset owners is necessary. The communication will be initiated by JICA expert team if it's considered necessary.) The researcher(s) in this ToR should explore more existing datasets like these on the internet.
 - AI for Earth Observation: Seeing Beyond the Visible⁷
 - DKRZ: Dataset Details⁸
 - Hyperspectral benchmark dataset on soil moisture⁹

⁶ https://en.wikipedia.org/wiki/Landsat_7

⁷ <https://platform.ai4eo.eu/seeing-beyond-the-visible/data>

⁸ <https://b2find.dkrz.de/dataset/89fb17b7-dd23-543c-8c4a-8dbbdb9dd99c>

⁹ <https://zenodo.org/records/1227837>

- Database of hyperspectral images of phosphorus in soil¹⁰

4.5 Measuring new soil properties data for the PoC program

- In the target PoC program, there is a need to measure new soil properties for the training and testing of AI models. Purchasing (or renting) soil property sensor to physically measure soil properties at the target PoC sites is required.
- One traditional option is to get soil samples at the planned locations (60 locations in the target area, for example) and send them to the soil property analysis service.
- However, now there are inexpensive sensors to measure required soil properties automatically. So, the researcher(s) in this ToR should explore available options and costs for these sensors.
- One option of soil property measurement in the target PoC program is to conduct the measurement manually by visiting multiple locations and measuring the soil properties by the sensor one by one. In this case, one hand-held sensor equipment is required to measure all locations.
- Another possible option is to deploy permanent monitoring post like this¹¹ to measure the soil properties continuously (at least for the target PoC program's testing period ~ 3 months). This option would be possible only if the physical security of the sensor is ensured so that the monitoring post would not be stolen. The cost of purchasing these posts for multiple locations would be another limiting factor.
- There may be other options for the procedures of physical measurement of soil properties at PoC locations. The researcher(s) in this ToR should compare and evaluate possible measurement methods/procedures for their advantages/disadvantages with required cost and time.
- **Important Node:** There is no need for the researcher(s) in this ToR to physically visit the target PoC measurement locations since the locations are not determined yet. The comparison and evaluation of measurement methods and procedures should be done on an estimation basis.

4.6 Training of AI model

- The current idea of training AI model in the target PoC program is to train an AI model by using historical ground-truth data first. Since the spectral / spatial resolution of historical satellite images are less than the hyperspectral satellite, interpolation techniques and adjustment of image data may be required to produce consistent output.
- Then fine tune the same AI model by using the ground-collected soil property data matched with the hyperspectral satellite / drone imagery.
- There is also a need to train another AI model that is trained by satellite images and farmers' manual irrigation operation dates to learn correlation between satellite image and the farmers'

¹⁰ <https://data.mendeley.com/datasets/fvgswvt5ws/3>

¹¹ <https://www.aliexpress.com/item/1005007008597915.html>

irrigation practices (timings).

- The researcher(s) of this ToR should examine the training procedures of AI model as described above, and comment or propose improved or new procedures if applicable.

4.7 Testing of AI model

- The current idea of testing the AI model is to carefully plan scheduled testing dates when the satellite image will be available (i.e. the satellite will be flying over the testing location, and the weather would be clear with no clouds).
- Then collect ground-truth soil properties data at the same or different locations as in 4.4. The different locations are important to evaluate the accuracy of AI predictions at arbitrary locations and to ensure the usefulness and impact of the result of the target PoC program.
- Then purchase satellite images of the corresponding testing locations on the same date as the above ground-truth measurement. Deploy and test the trained AI model using the newly acquired satellite image to predict the soil properties from the image. Then validate and evaluate the model's performance by comparing the predicted soil properties by AI model with the newly measured ground-truth soil property data from these sites.
- The researcher(s) of this ToR should examine the testing procedures of AI model as described above and propose improved or new procedures if applicable.

4.8 Consideration of Key Performance Indicators (KPI)

There are some considerations of determining KPIs for AI model performance as follows.

- The performance heavily depends on the type of satellite images to use and available ground-truth data. So, the threshold values should not be theoretical ideal values of AI but should be realistic values based on the selected satellite(s) and ground-truth datasets.
- The researcher(s) should refer to existing KPIs and thresholds values for consideration that are available in the past research, if any.

5. Requirements of academic researcher(s) to conduct this preliminary research

The applicant(s) of this ToR should satisfy the following requirements.

1. Must be a local researcher in Jordan at a university, a research institute, or a local company in the field of:
 - Remote sensing in agriculture
 - AI utilization on geographical data / geographical image analysis
 - Soil properties analysis for agriculture
 - Or related research fields to the content of target PoC program
2. The researcher(s) can be a person who has experiences in all above fields, or a team of two researchers to cover all above fields (for example, one for remote sensing in agriculture and

another for AI, or one for AI with remote sensing and another for soil property expert in agriculture, etc.)

3. Minimum three (3) years' experience as a researcher with one (1) year in the field of academic research of related field.
4. Must be able to work with stakeholders including MoDEE, MoA, and JICA expert team.
5. Must commit to the ethics of artificial intelligence (Jordan AI code of Ethics)

6. Duration and expected timeline

The duration of this preliminary research is one (1) month from the beginning of assignment at maximum. The expected starting time of the assignment is late in December 2024. The assigned work must be completed and must not exceed the end of January 2025.

7. Confidentiality and Intellectual Property

- a. The applicant(s) should respect the confidentiality of shared information and should agree on the handling of intellectual property rights as outlined in a separate agreement.
- b. Intellectual Property of the research result belongs to the applicant(s), but MoDEE, MoA, and JICA have right to use the result for any purpose in the future.

8. Budget and Important Contract Conditions

- a. Budget for this preliminary research will be allocated, managed, and disbursed by JICA according to the JICA's procurement rule.
- b. The contract of this preliminary research will be a sub-contract of JICA through JICA consultant team of Japan Development Service Co., Ltd.
- c. There will be no Jordanian parties involving in the contract.
- d. The law that governs the contract will be the law of Japan.
- e. There will be no advance payment.

9. How to apply

Please refer to RFQ (Request for Quotation) document for the detail of application procedures.

(End of ToR)