Miljø- og Fødevareministeriet
Landbrugsstyrelsen

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Specification of Requirements and the Supplier Solution Description

Satellite image analyses for agricultural control 2018

Contents:

1. Introduction

Each year the Danish Agricultural Agency and the Swedish Board of Agriculture make Green direct payments to the farmers. The green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various practices that benefit the environment and the climate. These practices require actions each year:

- diversifying crops
- maintaining permanent grassland
- dedicating 5% of arable land to 'ecologically beneficial elements' ('ecological focus areas').

The overall aim with this tender is to control if farmers meet their crop diversification requirement under the greening obligations. Depending on the total cultivated area of a farm there is a requirement that there must be a crop diversification of at least 2-3 different crops on the farm. A satellite based crop classification and detection of homogeneity is performed in order to check if farmers fulfil this requirement. The selection of farms for the crop diversification inspection is partly based on a number of risk parameters and partly based on random selection. The controls are area-based and therefore specifically related to what there expectantly is within the individual field parcels. The Danish Agricultural Agency and the Swedish Board of Agriculture receive this information each year in spring when the farmers have to plot in the field parcels polygons and enter associated field data, such as main crop, into a WebGIS system called IMK (Internet Markkort in Denmark). The Danish deadline for plotting the fields is April 21, 2018. At this time, approximately 98 % of the fields are registered in IMK. The Swedish Board of Agriculture have a similar setup for the yearly inspection campaign, however the deadline for plotting the fields in Sweden is April 12, 2018.

On May 1 The Danish Agricultural Agency & The Swedish Board of Agriculture will deliver a shapefile from each country with the field polygons that are available for analysis.

2. Description of the analyses tasks

The tender for "satellite image analyses for agricultural control 2018" consists of two analyses tasks, Task 1 is a crop classification for areas located in Denmark and Sweden while task 2 is about detecting the homogeneity of the crop classified fields. The Crop classification task (task 1) consists of three subtasks (1.1, 1.2 & 1.3). Subtask 1.3 is a subsequent crop classification that includes satellite images until 31 August, 2018. All subtask must be performed within the same areas of interest, which cover approximately 13,000 km2 (13 zones) across Denmark and app. 9,500 km2 (10 zones) across Sweden. These areas of interest are Danish and Swedish agricultural subsidy control zones. These areas are confidential and may not be exposed publically.

Task 1) Crop Classification

- Subtask 1.1) May 15, 2018 (Minimum Requirement):

The first subtask is a preliminary classification of overall crop types based on satellite images (Sentinel-2, Landsat-8 and Sentinel-1) from March 1 - May 8. The fields for this task can be divided into different overall crop types classes such as spring crops, winter crops, winter rape, and grass. If a field is registered with a winter crop, but no vegetation is detected on the satellite images from April/May, then the field probably is incorrectly applied registered with a winter crop. An early classification of incorrectly registered fields, could therefore serve as a useful tool for prioritizing the thorough physical field inspections so that these visits have the largest beneficial effect. It is expected that an early classification can classify and distinguish at least four overall crop type classes from each other, or more if it is possible.

- Subtask 1.2) June 12, 2018 (Minimum Requirement):

The second subtask is the full classification of crops, which is included as results in our control systems. This task includes satellite images (Sentinel-2, Landsat-8 and Sentinel-1) from March 1 - June 8, 2018. The field classification must cover as many as possible of the most common crop types within each of the subsidy control zones. Preferably, more than 8 different crop types per zone should be classified if it is considered possible. However, the possible number of different classified crop types must be determined for each zone in cooperation with the Danish Agricultural Agency & The Swedish Board of Agriculture before delivery. For this subtask it is important that at least one Sentinel-2 image is acquired later than May 15, 2018 and included in the classification.

- Subtask 1.3) September 14, 2018 (Minimum Requirement):

Based on satellite imagery (Sentinel-2, Landsat-8 and Sentinel-1) from March 1 – 31 august, 2018 a full field crop type classification result is to be delivered again. The field classification must cover the same common crop types within each of the subsidy control zones as in subtask 1.2.

The Danish Agricultural Agency and the Swedish Board of Agriculture will not conduct fieldwork in order to provide training data for the classifications, but experience shows that farmers report approximately 90-95 % of crops correctly. It is expected that the supplier perform a critical assessment of the data before using it in the analysis.

Task 2) Use of Sentinel-2 for automated detection of homogeneity

- Task 2) June 12, 2018 (Minimum Requirement):

The main purpose of the satellitebased detection of homogeneity is to replace or minimize the existing manual screening processes needed in relation to the greening requirements. In 2017, a visual screening of field homogeneity was conducted in Denmark using VHR images recorded in April and May. In this screening, fields are determined as being homogenous when only one crop covers the whole extent within the field parcel polygons. This is a difficult and time-consuming task and the manual screening process therefore has to be begin late May or early June in order for the screening process to deliver the results in time, so it can aid the other subsequent control processes. The detection of homogeneity of fields is needed in order to accept task 1 as a valid approach for crop classification. The field homogeneity analysis could also help to further ensure that the crop classification from task 1 actually represent the whole field and to pinpoint heterogeneous fields for further visual inspection.

Sentinel-2 or similar data must be used for the automated detection of the homogeneity of the fields, by investigating different spectral value statistics (for example standard deviations, contrast etc.) on the pixels within the respective field parcel polygons. The result would then be a division of the fields into "approved homogenous fields" and "heterogenic fields". Heterogenic fields will subsequently be screened manually or appointed directly to an on-site physical inspection, both tasks will be conducted by the Danish Agricultural Agency and the Swedish Board of Agriculture.

A more ambitious approach could include an analysis of field homogeneity with an estimate of the areal coverage of the main crop type on each field, e.g. in the following four classes:

Class	Interval - % of the field which is homogenous
1	~100 %
2	100 % < > 90 %
3	90 % < > 80 %
4	< 80 %

For instance, if a field is given a class 2 homogeneity result, then 90 % of the field can be included in the decision of whether a farmer meets the crop diversification requirement or not.

The delivery date is June 12. The area of interest is the same as in task 1 and it covers app. 13,000 km2 across Denmark and app. 9,500 km2 across Sweden. The information about the areas in this task must therefore also be treated confidentially.

3. Presentation: Webviewer and Report

- Webviewer) June 12, 2018 (Minimum Requirement):

Results from all the satellite image analyses must be delivered on a SFTP as both shapefiles and Excel tables. In addition to these results a webviewer portal with user management, which shows all satellite images used in task 1 and 2 along with the field parcel polygons is required. The viewer portal should contain a feature that enables the user to search for individual fields, using a unique ID, farmer/ applicant id. which is supplied along with the field parcels. Relevant information on each field such as

registered crop, classified early crop class, and classified crop type, field homogeneity etc. should be present in the viewer as well. The viewer must be accessible at June 12, 2018 the latest and subsequently satellite data must be made available on the portal, no later than 5 working days after the images are available from ESA. The viewer should include satellite images until August 31. The exhibited satellite images in the webviewer must spatially match the field parcel layer. The viewer must be available to The Danish Agricultural Agency and the Swedish Board of Agriculture for audit of the results for 2 years. All optical images must be available as NDVI, RGB and CIR versions. The Danish Agricultural Agency will provide VHR images from the Danish areas of interest in May 2018 depending on when the agency receives them from the European Commission. The Danish VHR images must also be displayed in the viewer as NDVI, RGB and CIR products. The webviewer platform shall include user management which makes it possible to limit the users access to information in Denmark and Sweden separately. Potentially also internally in Sweden to individual counties.

- Combined report) October 1, 2018 (Minimum Requirement):

One combined report including description of the applied methods, an overview of the results and an evaluation of results/classification quality must be submitted to The Danish Agricultural Agency and the Swedish Board of Agriculture respectively no later than October 1, 2018. The report must be in a word or PDF format and it should at least contain the following chapters:

- Overview of available and used images and data
- Image processing
- Description of used software
- Detailed description of classification methods used
- Results of the classifications
- Accuracy of classifications
- Detailed description of homogeneity methods used
- Results of the homogeneity analysis
- Webviewer description
- Conclusion
- Recommendations

4. The customer's minimum requirements

By submitting a tender, the supplier must be able to meet the minimum requirements listed in this section. The customer has listed a list of minimum requirements (MR). The supplier should be aware if they cannot answer "yes" to a minimum requirement, then the customer will assess this a reservation causing the bid to be a non-compliant bid.

MR	The supplier agrees that all results from the remote sensing analyses are delivered as shapefiles and as excel files from the supplier's sftp.	*[To be filled by the Supplier with a yes or no]*
MR	The supplier agrees that 3 separate crop classifications for all fields within the areas of interest (app. 22,500 km2) must be delivered by May 15 12:00, 2018, June 12, 12:00 2018 September 14 12:00 2018 respectively.	*[To be filled by the Supplier with a yes or no]*
MR	The supplier agrees that, results from a field homogeneity analysis must be delivered by June 12, 12:00 2018	*[To be filled out by the Supplier with a yes or no]*

MR	The supplier agrees that a report (word or pdf format) containing applied methodology and evaluation of results for the three crop classifications and field homogeneity analysis has to be handed in by October 1, 2018	*[To be filled by the Supplier with a yes or no]*
MR	The supplier agrees on providing a webviewer where all the optical satellite images used for task 1 and 2 is displayed along with the field parcel polygons. This viewer must contain functions allowing the user to search for individual fields and applicants and the viewer should also contain info such as applied crop and classification results. The viewer must be accessible at June 12, 2018	*[To be filled by the Supplier with a yes or no]*
MR	The supplier agrees to provide a user management which ensures a country specific limited access to results on the sftp and to the webviewer.	*[To be filled by the Supplier with a yes or no]*
MR	The supplier must have experience with download and pre-processing of Sentinel-1 and -2, and optionally, other satellite images.	*[To be filled by the Supplier with a yes or no]*
MR	The supplier must have knowledge of the theory of spectral data and SAR	*[To be filled by the Supplier with a yes or no]*
MR	The supplier agrees to sign a confirmation certificate as enclosed in appendix 3 if a contract is awarded.	*[To be filled by the Supplier with a yes or no]*