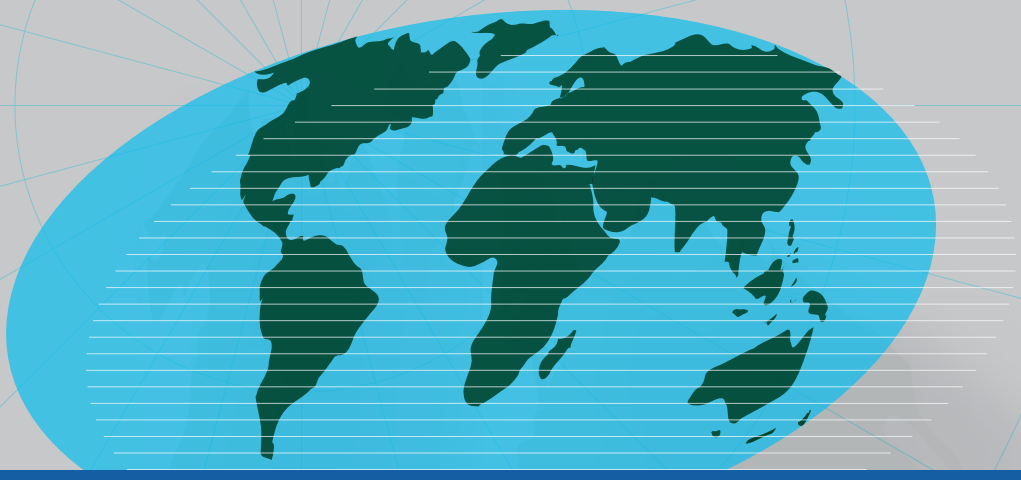
GAEZ
Global Agro-ecological Zones



GAEZ v3.0

Global Agro-ecological Zones

User's Guide

International Institute
for Applied
Systems Analysis

Food and Agriculture
Organization of the
United Nations

Global Agro-Ecological Zones (GAEZ v3.0)

GAEZ Data Portal

- User's Guide -

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Acknowledgements and citation
Full acknowledgement and citation in any materials or publications derived in part or in whole from GAEZ data is required and must be cited as follows:

IIASA/FAO, 2012. Global Agro-ecological Zones (GAEZ v3.0). IIASA, Laxenburg, Austria and FAO, Rome, Italy.

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Acronyms

A1FI	IPCC scenario. Detailed description: http://www.grida.no/climate/ipcc/emission/098.htm
A2	IPCC scenario. Detailed description: http://www.grida.no/climate/ipcc/emission/094.htm
B1	IPCC scenario. Detailed description: http://www.grida.no/climate/ipcc/emission/094.htm#1
B2	IPCC scenario. Detailed description: http://www.grida.no/climate/ipcc/emission/095.htm
CGCM2	The second generation of atmosphere-ocean coupled general circulation model
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSIRO Mark2	CSIRO global coupled ocean-atmosphere-sea-ice model
DM	Dry matter
ECHAM4	Modified global forecast model developed by ECMWF
ECMWF	European Centre for Medium-Range Weather Forecasts
FAO	Food and Agriculture Organization of the United Nations
fct	constraint factor
GAEZ	Global Agro-Ecological Zones
GCM	Global Circulation Model
HadCM3	Hadley Centre Coupled Model, version 3
IIASA	International Institute for Applied Systems Analysis
LC	Land Cover classes
LGP	Length of Growing Period
LUT	Land Utilization Type
MS	Moderately suitable (40-60% of maximum attainable yield)
mS	Marginally suitable (20-40% of maximum attainable yield)
NS	Not suitable (<5% of maximum attainable yield)
PC	Protection Class
PDF	Portable Document Format
PET	Potential evapotranspiration
PNG	Portable Network Graphics
S	Suitable (60-80% of maximum attainable yield)
VmS	Very marginally (5-20% of maximum attainable yield)
VS	Very suitable (80-100% of maximum attainable yield)

Part 1: Introduction

Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA) have been continuously developing the Agro-Ecological Zones (AEZ) methodology over the past 30 years for assessing agricultural resources and potential. Rapid developments in information technology have produced increasingly detailed and manifold global databases, which made the first global AEZ assessment possible in 2000. Since then global AEZ assessments have been performed every few years. With each update of the system, the issues addressed, the size of the database and the number of results have multiplied. This is the most ambitious assessment yet and the goal is to make publicly available the entire database and all results of this assessment. This amounts to many terabytes of data covering five thematic areas:

- Land resources, including soil resources, terrain resources, water resources, land cover, protected areas and selected socio economic and demographic data;
- Agro-climatic resources, including a variety of climatic indicators;
- Suitability and potential yields for up to 280 crops/land utilization types under alternative input and management levels for historical, current and future climate conditions;
- Downscaled actual yields and production of main crop commodities, and
- Yield and production gaps, in terms of ratios and differences between actual yield and production and potentials for main crops.

The GAEZ database provides the agronomic backbone for various applications including the quantification of land productivity. Results are commonly aggregated for current major land use/cover patterns and by administrative units, land protection status, or broad classes reflecting infrastructure availability and market access conditions.
With this large amount of data, a new system had to be created to make the data accessible to a variety of users. The result is the new GAEZ Portal, an interactive data access facility, which not only gives access and allows visualization of data but GAEZ Global Agro-Ecological Zones but also provides the user with various analysis and download options

1.1 GAEZ data overview

The GAEZ Portal provides thematically structured access to major results of the GAEZ assessment. It includes many terabytes of 5 arc-minute resolution map data and tables aggregated from the gridded data to global, regional, national and sub-national administrative levels. Figure 1 and 2 present an overview of major GAEZ assessment steps and associated data available in the GAEZ Portal.

The prominent spatial global datasets (“Compilation of Land Resources Database”) for climate, soil and terrain are used to compile agronomically meaningful climate resources inventories including quantified thermal and moisture regimes in space and time (see Appendix 3 for a list of available data).

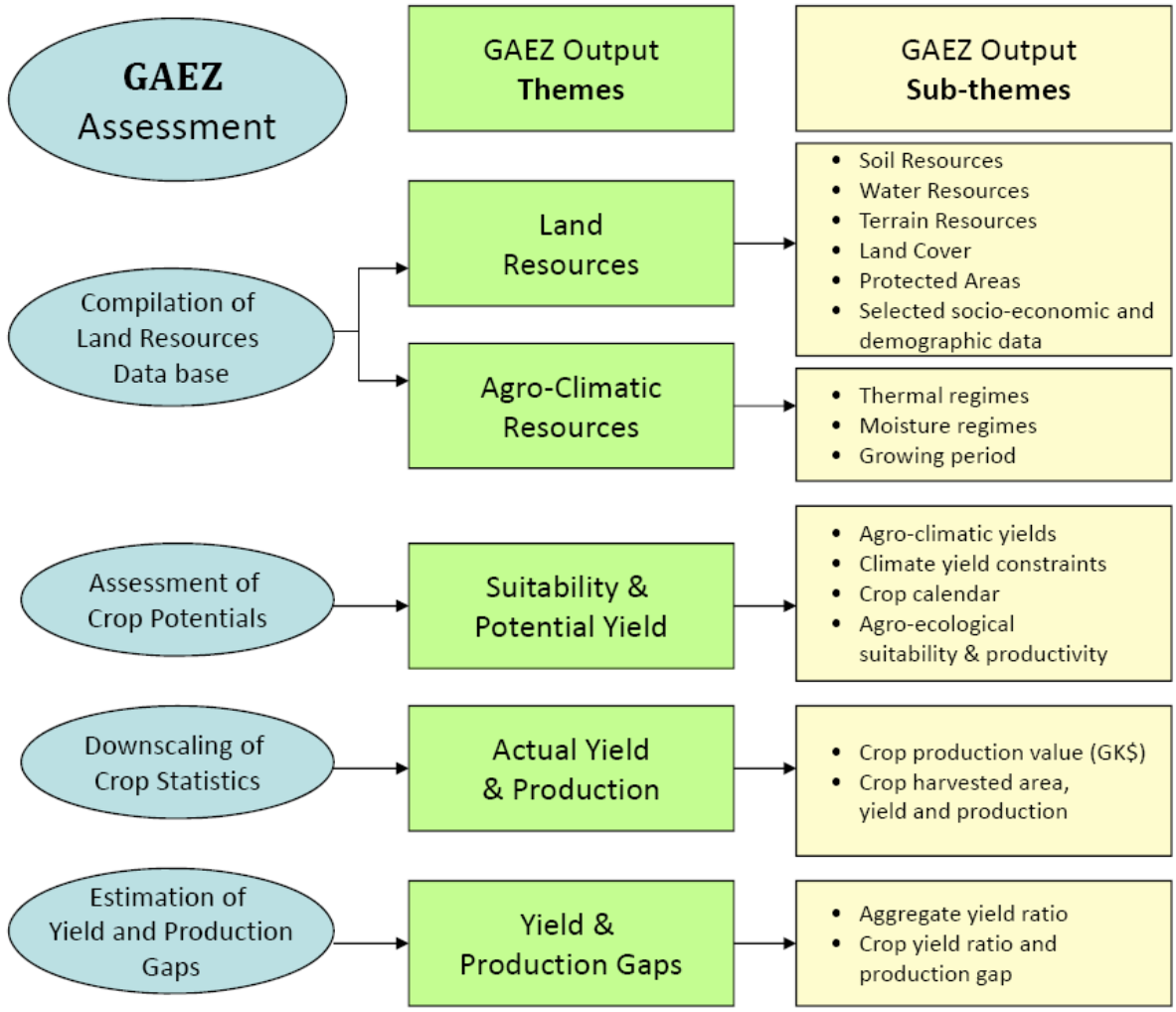


Figure 1 GAEZ Assessment theme overview

The "Assessment of Crop Potentials" estimates suitability and potential yields of 280 individual crop/land utilization types subsequently aggregated in 92 crop types, 49 crops and 11 crop groups Appendix 4 describes all available data and crops.

The "Downscaling of Crop Statistics" of the main crops in rain-fed and irrigated cultivated land provides distributions of current yield and production for 23 major commodities. The "Estimation of Yield and Production Gaps" provides ratios and differences between actual yield and production and potentials for 17 major crops (see Appendix 5).

The GAEZ modeling framework for crop potential assessment (Figure 2) uses detailed agronomic-based knowledge to assess land suitability, potential attainable yields and potential production of crops for specified management assumptions and input levels, both for rain-fed and irrigated conditions. This domain provides maps and tabular information on agro-climatic yields, yield constraints, crop calendars, and potential production estimates at three basic levels of inputs (high, intermediate, low). Productivity estimates were made for different water supply systems: (i) rain-fed production; (ii) rain-fed production with water conservation; and (iii) irrigated production including a specification for irrigation types (gravity, sprinkler and drip irrigation systems). Results presented include agro-climatically attainable yields, climate yield constraints, crop calendar data and agro-ecological suitability and productivity assessment data.

Model results account for temperature and moisture constraints affecting growth and development and yield reducing effects caused by pests, diseases and weeds as well as climate related workability

constraints. These estimated yields are referred to as agro-climatically attainable yields. Yield constraints are determined by individual land utilization types (LUTs). The quantified constraint factors include temperature constraints (fc1), moisture constraints (fc2) agro-climatic constraints (fc3) and a resulting overall yield reduction factor (fc0). LUT-specific constraints related to soil and terrain conditions (fc4) as well as water deficits (WD) are provided under this heading.

Yield calculations, repeated for all possible growth cycle starting days during the prevailing growing period, determine an optimum crop calendar in terms of attainable potential yield. Information provided includes the start and duration of the LUT growth cycle reflecting the period from crop emergence to full maturity.

The agro-climatically attainable yields combined with an agro-edaphic assessment determine agro-ecological suitability and productivity for Individual land utilization types (LUTs). Soil and slope distributions within a 5 arc-minute grid-cell on the one hand, and crop, environment and management specific fallow period requirements on the other hand are used to estimate suitability distributions and the aggregate potential productivity of crops.

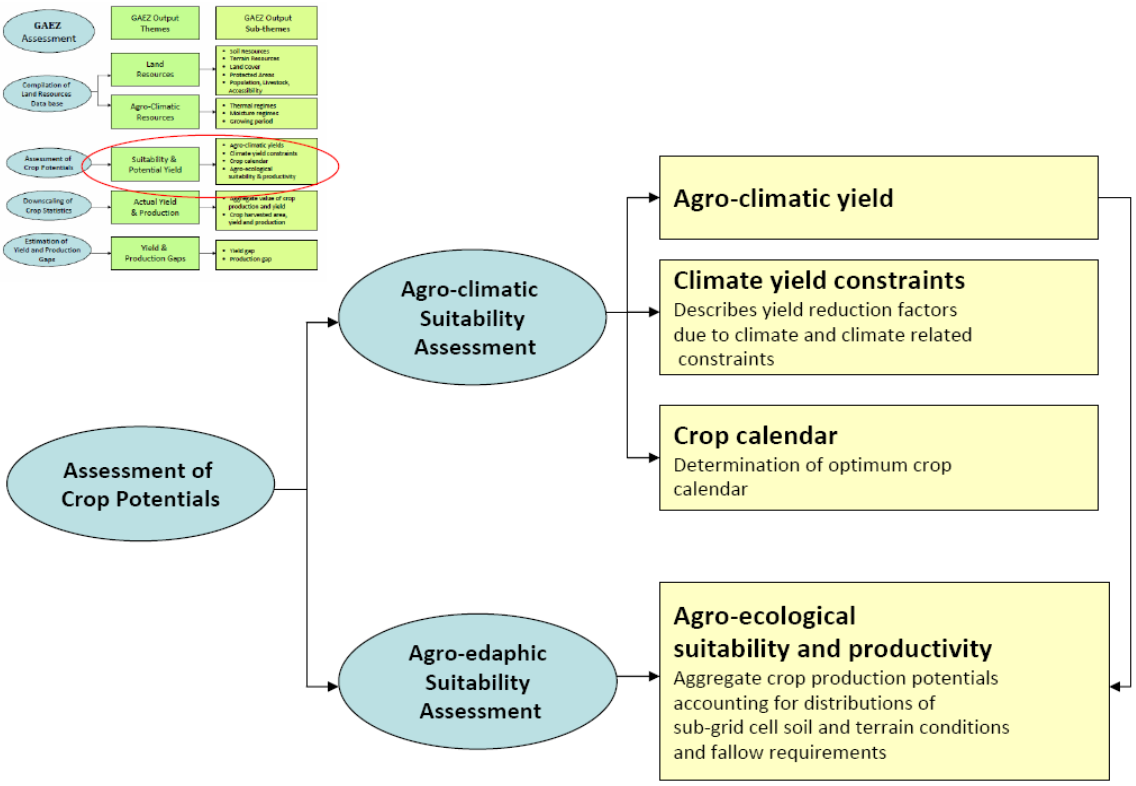


Figure 2 Suitability and Potential Yield theme overview

1.2 Accessing GAEZ data

The GAEZ Portal can currently be accessed from the home page of the IIASA ESM Program (http://www.iiasa.ac.at/Research/LUC/index.html), or directly through the following internet location (URL): http://www.iiasa.ac.at/Research/LUC/GAEZv3.0. The mirrored GAEZ data interface will also be available on the web site of FAO.

The link will open the web page shown in Figure 3:

Figure 3 Start page of the GAEZ Portal

The following options and documents are available online:

- Data access – (I.e., access to the GAEZ Portal);
- Data Portal User's Guide (pdf format);
- News and recent changes (GAEZ status update and news)
- Model Documentation – (pdf format), and
- Research Report – Global Agro-ecological Zones: Methodology and Results (pdf format).

By selecting **GAEZ Portal** the user enters the web interface of GAEZ.

1.3 GAEZ Portal technical implementation overview

The underlying technical implementation of the AEZ Web Interface consists of three primary elements:
1. GAEZ Data Portal;
2. GAEZ web server
3. GAEZ data base

The portal uses html forms and javascript and communicates with java servlets on the web server. The servlets are used to dynamically create html pages and send it to the user's browser, to communicate with the database and extract the requested data, and to prepare the results in the requested format. If the user chooses to view an interactive map of the requested data, the data is sent to GeoServer, which prepares the data to be displayed on the website using OpenLayers. The GeoServer was modified and customized to the functionality of the GAEZ implementation.
A schematic representation of the implementation is shown in Figure 4 below:

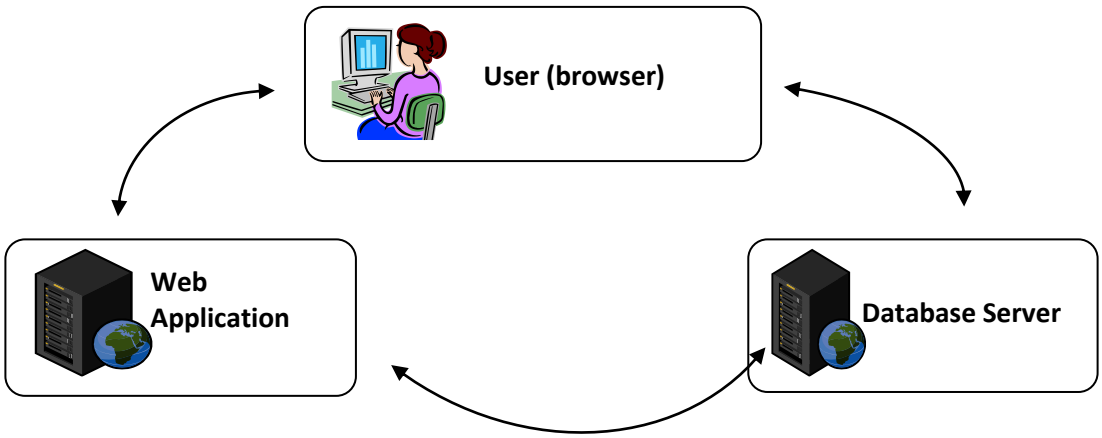


Figure 4 Technical implementation of the GAEZ Portal

1.4 Hardware and software requirements

A recent web browser capable of running JavaScript is required to use the GAEZ Portal. The PC does not require any further capabilities for accessing GAEZ data. The portal is designed to function with any of the major browsers and has developed in Firefox. The system is being adapted to also function with: Internet Explorer ver. 7 and 8, Safari, Opera and Opera Mobile.
Although the GAEZ Portal will run on lower screen resolutions, a minimum screen resolution of 1024 x 768 is recommended. Hard disk drive space is only necessary to download data and the required disk space depends on how much data is downloaded and in what format.
Access is free for non-commercial uses. Registration and signing of a user agreement (Appendix 1) is required to download data. Results can be viewed using an interactive Map Tool with basic GIS features. In addition viewing of maps is possible within Google Earth™ for which system requirements outlined in Appendix 2 are recommended.

Part 2: Accessing the GAEZ Portal

2.1 Login and registration

Before using the GAEZ Portal the first time, login is required with an email address and selected password. Prior to the first login, a one-time registration is required. On the registration page, users are requested to provide full name, email address and password of their own choice (
Figure 55). The User Agreement containing basic GAEZ usage policy, disclaimer and correct citation is available at the registration page, which must be read and accepted before proceeding with the registration. The User Agreement is available in full in Appendix 1.

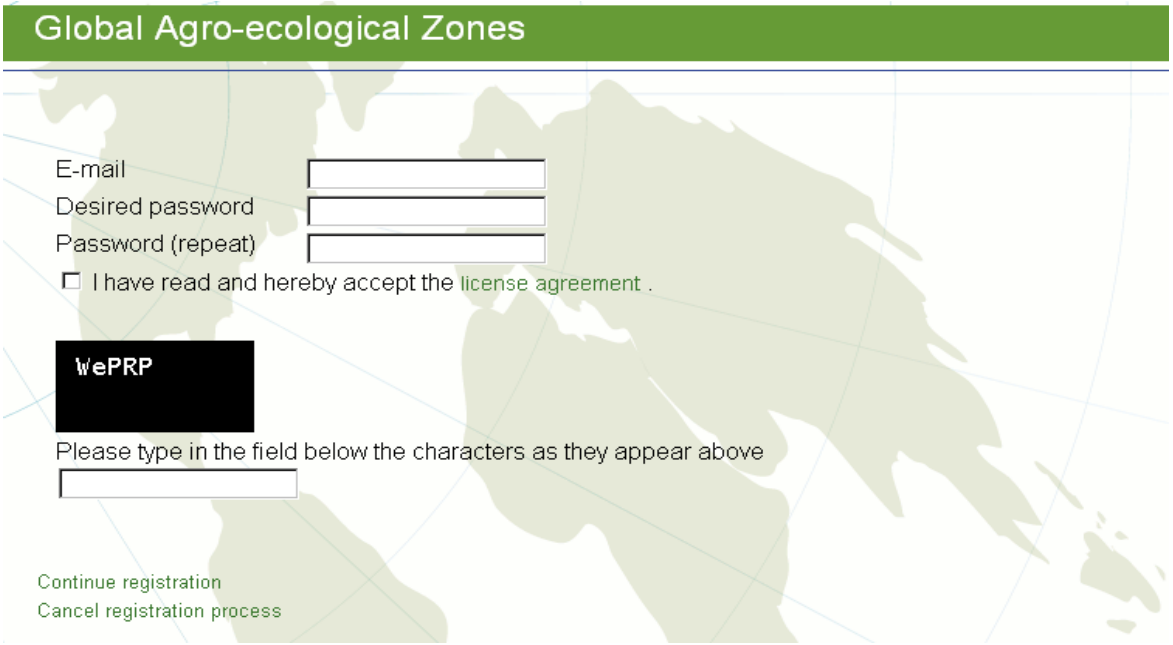


Figure 5 GAEZ Registration page

By submitting the registration page, an email is sent to the email address provided, which contains a link that leads the user back to the GAEZ Portal, confirming the registration. After this process, the username (email address) and password will be required each time the GAEZ Portal is accessed (see Figure 6 below).

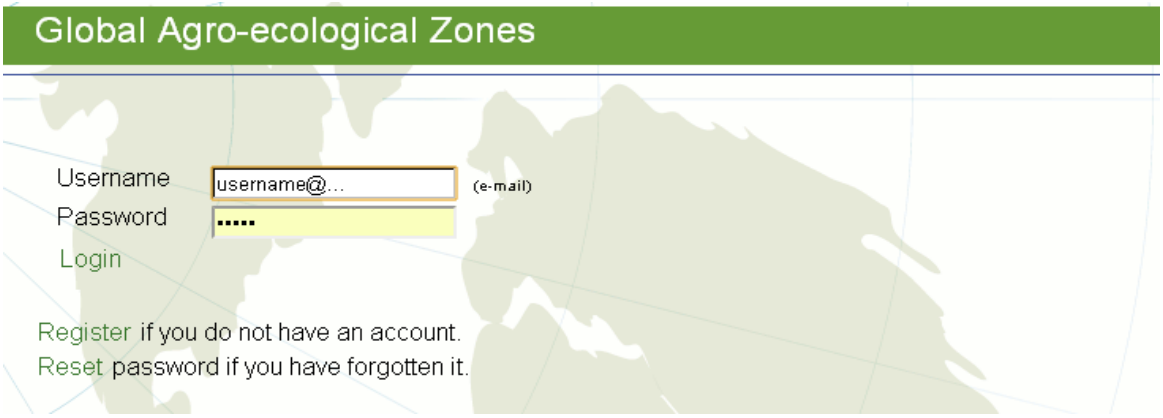


Figure 6 Login

Should the user forget his/her password, by clicking the **Reset** link an email can be requested with the user's password.

Registration for non-commercial purposes is free. If data is used for commercial purposes, please contact: GAEZ-info@iiasa.ac.at

2.2 Data interface

The GAEZ Portal is an interactive data access facility. When entering the data portal the welcome screen appears (Figure 7).

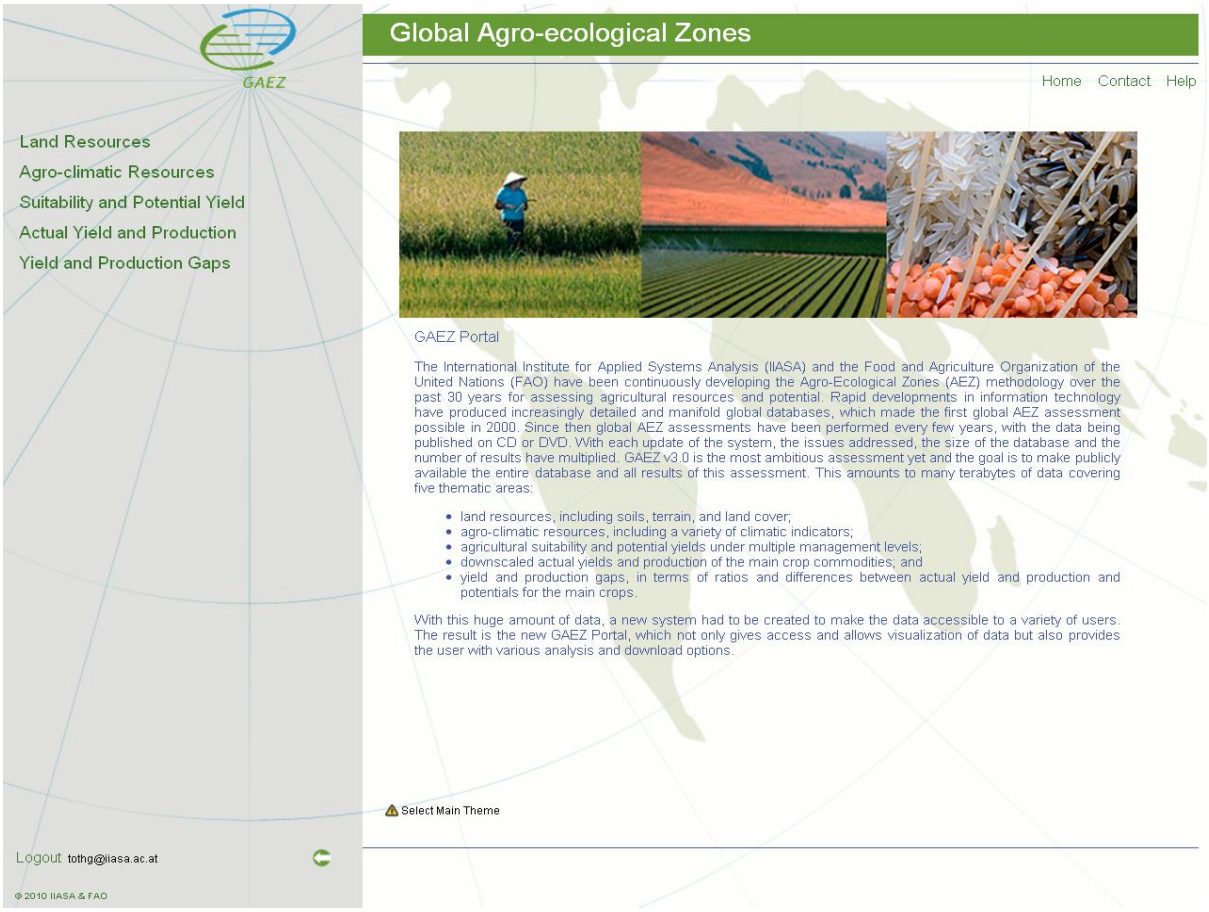


Figure 7 Welcome page of the GAEZ Portal

Data access is initiated by selecting one of the five GAEZ themes in the grey shaded menu bar and the user enters the GAEZ selection menu (Figure 8). Various components of the menus and their functions are described below.

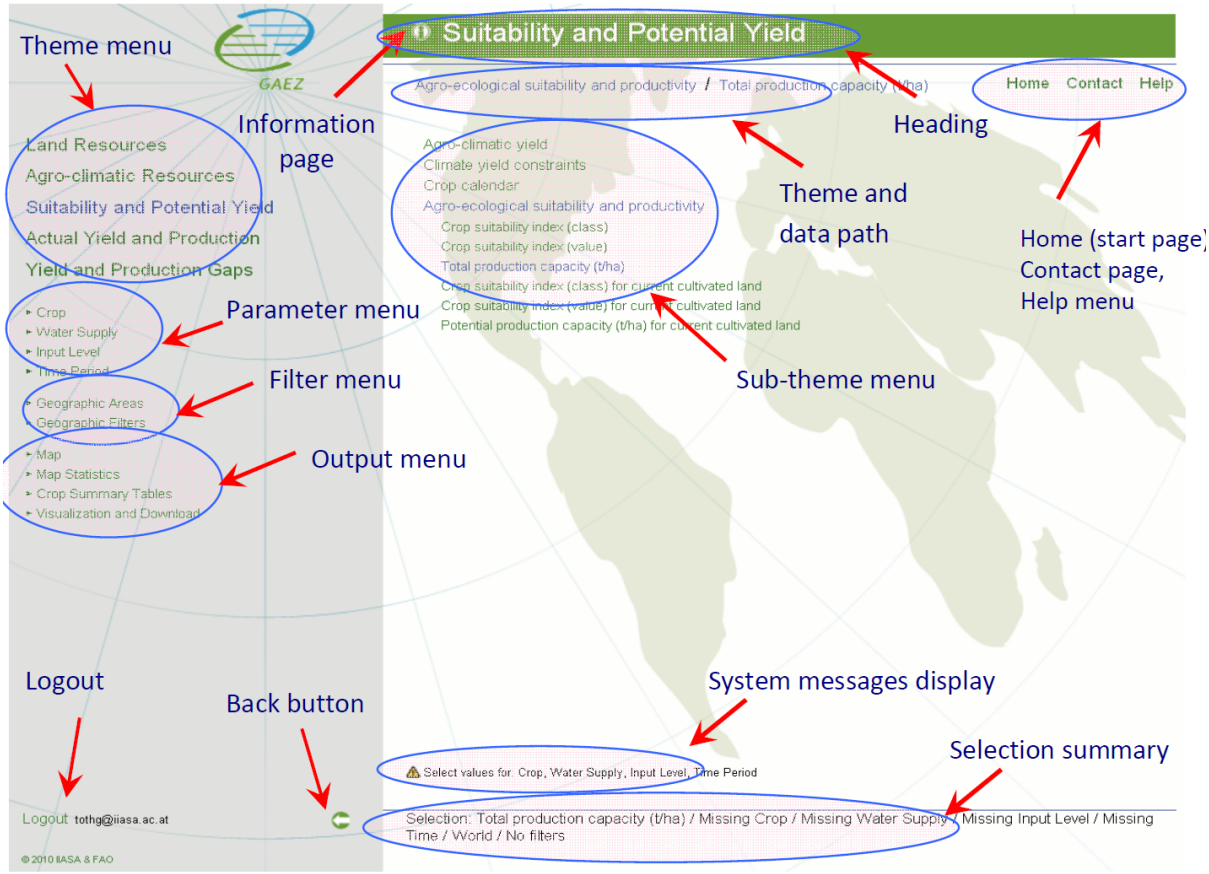


Figure 8 Selection menu

2.2.1 Selecting options and features

The heading of the GAEZ Portal at the top of the page displays the selected theme. Next to it is an information button, which provides descriptions of the themes and sub-themes selected. A path bar directly below the title bar lists the selected sub-theme and dataset combination. This path bar contains on its right hand side a **Help** button opening a menu providing technical information to support the user.

A *back button* is shown below the menu items to return the user to the previous page; a button in the centre of the logo which returns the user to the opening page; hints that appear when pointing the cursor to an item and "*Abouts*" providing descriptions of the current theme, sub theme or menu items. All selectable items are displayed in **green** text and turn **blue** when selected or active.

The status bar on the bottom of the white area records the **selection summary,** i.e. the currently selected themes and items. It also indicates missing specifications for the selected data query. Only when the status bar indicates no more missing specifications data output can be generated!

The **system messages display** highlights important information for the user, such as missing parameter specifications.

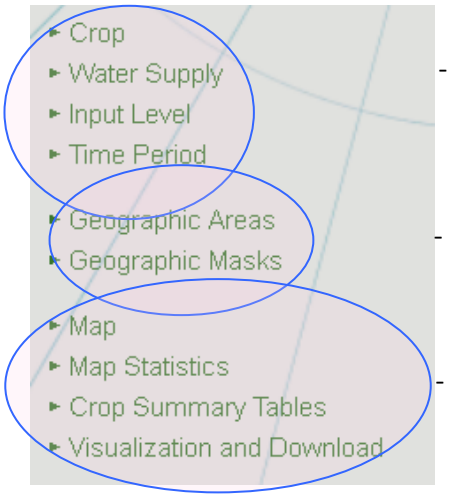
Five menus (theme menu, sub-theme menu, parameter menu, mask menu and output menu) allow for interactive data access and specification of results tailored for the specific needs of the user as described below.

Part 3: Data and query selection

3.1 Selecting a theme and parameters

The main entry point in the GAEZ Portal are the five thematic areas (Land Resources, Agro-climatic Resources, Potential Yield and Production, Actual yield and Production and Yield and Production Gaps) displayed at the top left side of the screen (Theme menu). Once a theme is selected, a sub-theme menu appears in the centre part of the screen. See section 1.2 for an overview of available themes and sub-themes.

By selecting a sub-theme a number of data items available for the particular sub-theme unfold. Once an item has been selected additional menu items appear for selection in the grey shaded area. These are organized in the following three sub-menu blocks:



- Parameter menu (see Section 3.2)

- Filter menu (see Section 3.3)

- Output menu (see Section 4)

- *Parameter menu* allows for the selection of crops, agronomic management options (water supply systems and input level) and time period; Available options depend on the data selected for the particular query (see Section 3.2).
- *Mask menu* offers the user to limit the displayed result by specifying geographic areas and geographic masks (see Section 3.3).
- *Output menu* provides data output options including maps and tabular output aggregated for countries or regions (see Section 4).

No default selections are applied when starting a new query; however the system will remember selected themes, sub-themes and sub-menu parameters. Selection can be cleared by clicking the GAEZ icon.

3.2 Selecting crops, management, time period (Parameter menu)

Sub-menu 1 items allow the user to select crop, water supply system, and level of input and time period of interest. Available parameters depend on the selected theme and sub-theme. Table 1 provides an overview of selection parameters with details being described in the following. A detailed data availability matrix table for the available GAEZ themes is available in Appendix 9 and a special data availability table for Suitability and Potential Yield is available in Appendix 10.

Table 1 Overview of Sub-menu 1 options available for Themes and Sub-them

Themes and sub-themes		Crop/commodity[1]	Time period[2]	Input level	Water supply[5]
1. Land resources		*not applicable*	*not applicable*	*not applicable*	*not applicable*
2. Agro-climatic resources	2.1 Thermal regimes 2.2 Moisture regimes 2.3 Growing period	*not applicable*	Historical Baseline Future[3]	*not applicable*	*not applicable*
3. Suitability and potential yield	3.1 Agro-climatic yields	280 crop/LUTs 92 crop types 49 crops 11 crop groups	Historical Baseline	low intermediate high	Rain-fed Rain-fed water conservation[6] Irrigated
	3.2 Climate yield constraints	92 crops types 49 crops	Future[4]	low intermediate high	Rain-fed Irrigated
	3.3 Crop calendar				
	3.4 Agro-ecological suitability and productivity	49 crops 11 crop groups	Baseline	low intermediate high	Rain-fed Rain-fed water conservation[6] Irrigation by type[7] Irrigated[8]
			Future[4]	low intermediate high	Rain-fed Irrigation by type[7] Irrigated[8]
4. Actual yield and production	4.1 Aggregate values of crop production and yield	*not applicable*	Year 2000/2005	*not applicable*	**Rain**-fed Irrigated Rain-fed + irrigated
	4.2 Crop harvested area, production and yield	23 commodities	Year 2000/2005	*not applicable*	
5. Yield and production gaps	5.1 Yield gap 5.2 Production gap	17 crops/crop groups	Year 2000/2005	low	

[1] A total of 280 crop/LUTs are used in GAEZ v3.0. These are subsequently aggregated into 92 crop-types, 49 crops and 11 crop-groups. For details see crop lists in Appendix 4.

[2] Note that some items in certain sub-themes are not applicable for historical or future climates and therefore results are not available

[3] Climate change impacts were calculated for three time horizons, 2020s, 2050s and 2080s, for 11 combinations of GCMs and IPCC emission scenarios

[4] Climate change impacts were calculated for three time horizons, 2020s, 2050s and 2080s, for 11 combinations of GCMs and IPCC emission scenarios, with and without CO_2 fertilization effects.

[5] Irrigated potentials assessed only for intermediate and high input levels

[6] Results for rain-fed crop production with assumed water conservation practices applied are provided for a subset of crops; see Appendix 5. Note that results are only available for Baseline climate.

[7] Irrigation types include Gravity, Sprinkler and Drip Irrigation systems.

[8] Here Irrigated provides results for one of the irrigation types with the following order in selection being applied: (1) sprinkler irrigation, (2) gravity irrigation and (3) drip irrigation. Note that results here are provided only for land with irrigation infrastructure in place (i.e. all grid cells showing at least one percent irrigation).

3.2.1 Crop

'Crop' can be selected in the themes 'suitability and potential yields', 'actual yield and production', and 'yield and production gaps'. A hierarchical menu allows the user to select "all" crops, or select among 11 crop groups, 49 crops, 92 crop types, and 280 crop subtypes (see list in Appendix 4 for detailed crop lists).

All crop groups including the detailed 280 crop sub-types, so called land utilization types (LUTs), are included in the 'Agro-climatic yields' sub-theme category. The extensive 280 crops/LUTs are only provided for baseline and historic climatic time periods.

'Agro-ecological suitability and productivity' data are available for 49 crops and 11 crop groups.

Depending on available statistical data the spatially explicit 'Actual Yield and Production' for the year 2000 and 2005 has been estimated via downscaling procedures for 23 commodity groups as 'Yield and production gaps' is available for 17 crops (see Appendix 5 for crop lists). The latter correspond with FAOSTAT crop groups.

3.2.2 Water Supply

For three themes; 'Suitability and Potential Yields', 'Actual Yield and Production', and 'Potential Yield and Production Gap' the user can tailor results to mode of water supply systems. This includes:

- Rain-fed conditions
- Rain-fed with water conservation measures
- Irrigation

For the latter different irrigation systems can be selected, namely

- Gravity irrigation systems
- Sprinkler irrigation systems
- Drip irrigation

Since not all irrigation systems are applicable for all crops, irrigation system options depend on the chosen crops. When more than one irrigation system is applicable for a particular crop the option 'irrigation' provides results only for one of the irrigation types applying the following order in selection being applied: (1) sprinkler irrigation, (2) gravity irrigation and (3) drip irrigation.

The implementation of irrigation infrastructure depends first and foremost on water availability and also on soil and terrain conditions. The 'Agro-ecological suitability and productivity' assessment results have only been provided for areas with current irrigation infrastructure (i.e. all grid cells showing at least one percent irrigation).

'Actual Yield and Production' and 'Yield and Production Gaps' provide results separately for rain-fed and irrigated conditions as well as for all areas (i.e. rain-fed + irrigated).

3.2.3 Input Level

The following input levels are available in the GAEZ assessment:

1. *Low-level inputs/traditional management*

Under the low input/traditional management assumption, the farming system is largely subsistence based and not necessarily market oriented. Production is based on the use of traditional cultivars (if improved cultivars are used, they are treated in the same way as local cultivars), labor intensive

techniques, and no application of nutrients, no use of chemicals for pest and disease control and minimum conservation measures.

2. *Intermediate-level inputs/improved management*

In the case of intermediate input/improved management assumption, the farming system is partly market oriented. Production for subsistence plus commercial sale is a management objective. Production is based on improved varieties, on manual labor with hand tools and/or animal traction and some mechanization. It is medium labor intensive, uses some fertilizer application and chemical pest, disease and weed control, adequate fallows and some conservation measures.

3. *High-level inputs/advanced management*

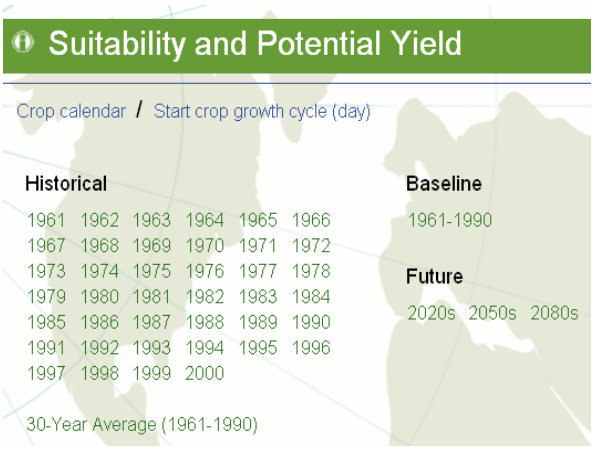
For the high input/advanced management assumption, the farming system and management is mainly market oriented with commercial production being the management objective. Production uses improved high yielding varieties, is fully mechanized with low labor intensity and uses optimum applications of nutrients and chemical pest, disease and weed control.

4. *Mixed level of inputs*

Under mixed level of inputs the best land is assumed to be used for high level input farming, moderately suitable and marginal lands are assumed to be used at intermediate or low input and management systems.

High, intermediate, low and mixed input levels can be selected for Suitability and Potential Yields theme and high intermediate and low input levels for the Potential Yield and Production Gaps theme. The evaluation procedures for gravity irrigation suitability cover the dryland crops and wetland rice, at both intermediate and high levels of management and input circumstances.

3.2.4 Time Period



Climate input data determine three types of time period: historical, baseline and future.

Historical periods consist of individual years from 1961 to 2000. The baseline period reflects average climatic conditions for the period 1961-1990. The 30-year average time period option provides the cumulative average of individual year averages. Finally, three future time periods (2020s, 2050s, and 2080s) can be selected with additional options for selecting among GCMs and IPCC emissions scenarios.

Future climates represent 30 year averages, i.e. 2020 average refers to the 2010 to 2030 average. Future periods require selection of global circulation model/emission scenario combination and, where applicable, CO2 fertilization effect can be switched “ON” or “OFF”.

3.3 Selecting geographic areas and masks (Mask menu)

The mask menu allows the user to select a geographic area of interest and apply geographic masks, which limit the data result according to selected criteria.

3.3.1 Geographic Area Selection

Geographic area selection allows the user to produce query results only for specified countries or regions. Very small countries with extents of less than 10 pixels at 5 arc-minute resolutions (approx. < 100 km^2) are aggregated in the category *Rest of the World*. For Russia, USA, China, Brazil, India, Australia and Canada first level sub-national divisions (provinces) can be selected as well. Figure 9 displays the screen appearance. Individual countries, regions or the world can be ticked on or off. By Clicking on the arrow to the right of the region, underlying countries or provinces appear. Appendix 6 provides detailed region and country list and for the 8 large countries province lists.

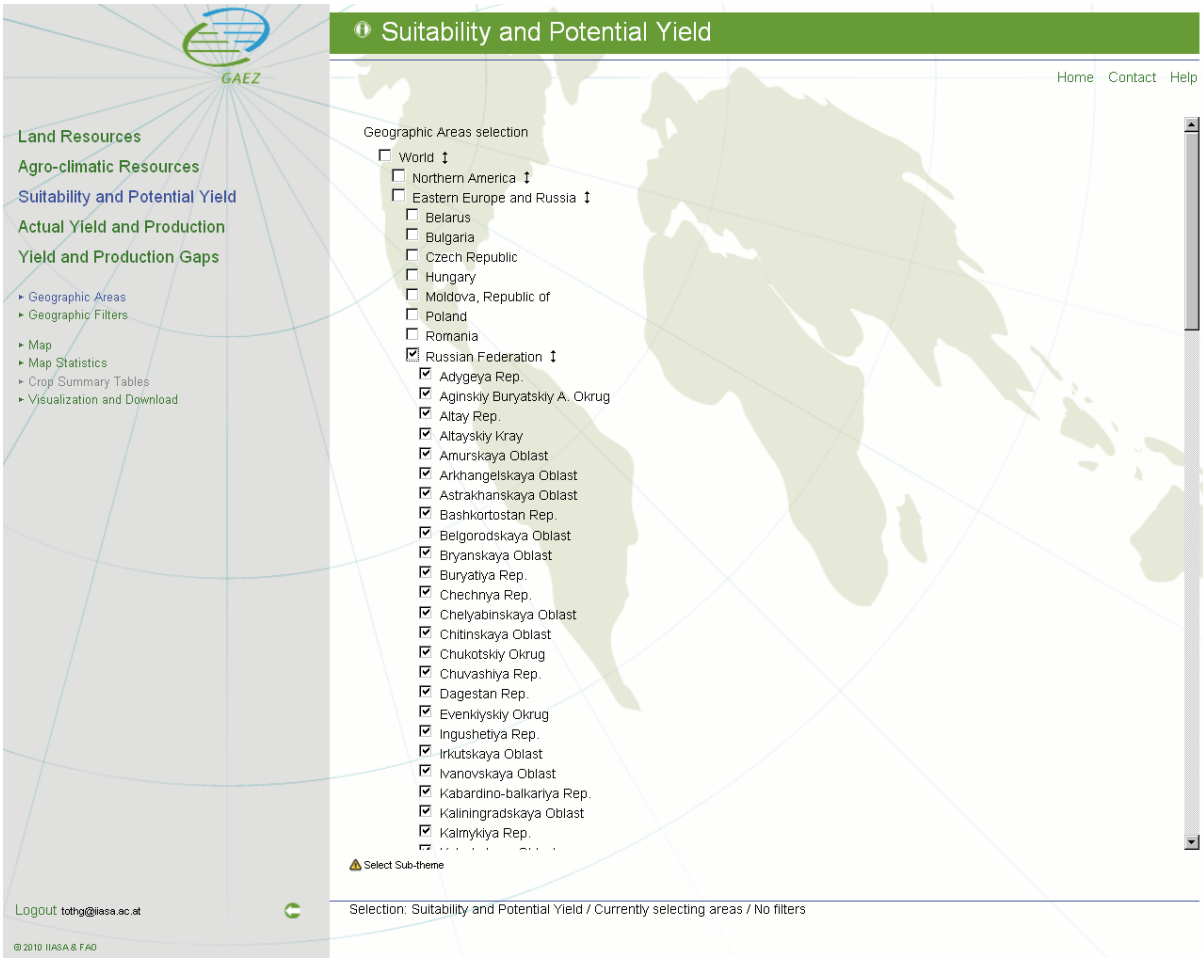


Figure 9 Select Administrative Unit

3.3.2 Geographic masks

Geographic masks perform database queries by selection and masking features in order to display only those 5 arc minute grid cells that match the selected criteria. The GAEZ Portal includes options to use geographical masks containing land cover, protected areas, climatic zones, soil and terrain slope conditions, population density, distance to market and transport cost to port of exit (see list in Appendix 7).
Multiple masks can be used for complex queries. An additional mask is added by clicking '+' and deleted by clicking '–', as shown in Figure 10. Once the mask selection process is complete and the user leaves the mask selection screen, the geographic mask specification is shown in the *Selection summary bar* at the bottom of the screen.

An example for mask selection is demonstrated below:
In order to select and map areas where downscaled rain-fed wheat yields are estimated to be between 3 - 5 t/ha, and where more than 50% of the grid cell has slopes between 2-8%, the following steps have to be applied (see also Figure 10):

1. From the menu, select the theme 'Actual Yield and Production,' the sub-theme 'Crop harvested area, yield, and production (2000),' and the parameter 'Yield.' Select the crop, 'Cereals' / 'Wheat', and the water supply, 'Rain-fed.' Then click 'Geographic Masks'
2. Click the box below the word 'Mask' and select the 'Map value' mask.
3. Click the box below 'Oper.' and select '>'.
4. In the box below 'Value', enter the number '3'.
5. Click the '+' to the right of the value box to add a new mask line.
6. Repeat steps 2-4, but select '<' in the operator list and type in '5' in the value box this time
7. Click '+' again to add another mask, select the 'Terrain slope 2-8%' mask, the '>' operator, and type in a value of 50 in the value box.
8. The selection information at the bottom of the screen is updated whenever a link is clicked, so information on your last mask selection will be shown as soon as you select an output option. If you wish to check your selection by updating the selection information before leaving the mask screen, click 'Geographic Masks' in the menu once again to update the selection.
9. Select 'Map' from the menu on the left to view the interactive map with the selection's results.

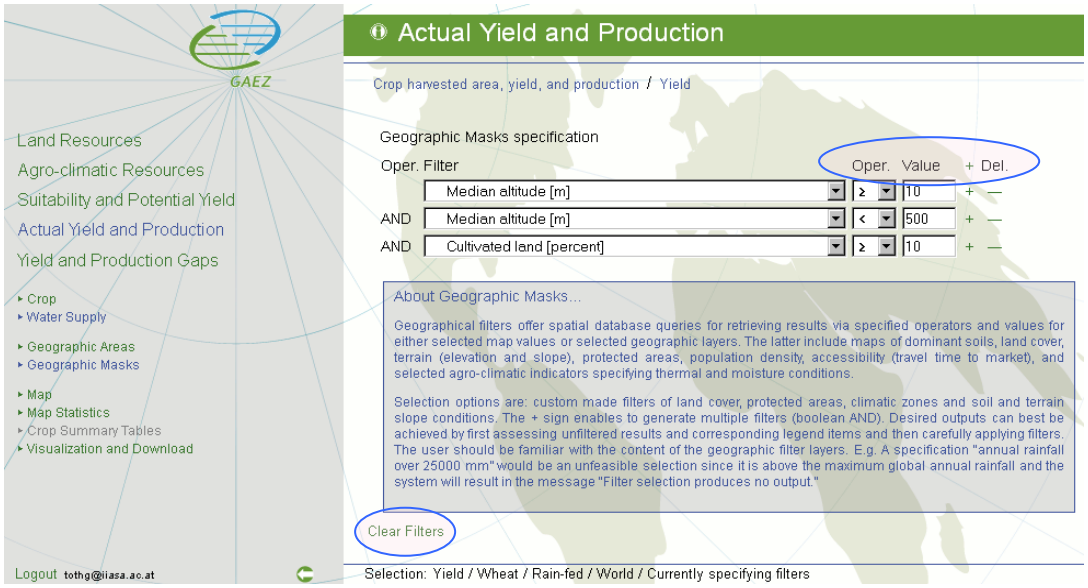


Figure 10 Example of geographic mask definition

When masking by parameter classes, acronyms or numbers corresponding to the desired class mask as specified in Table 2 must be inserted in the 'Value' field. Desired results can best be achieved by first assessing unmasked results and corresponding legend items before carefully applying masks. Future versions of the GAEZ Portal will provide a drop-down list of possible value selections.
Note geographic masks remain active for subsequent output selections until they are cleared. By selecting 'Clear' below the active masks, geographic mask specifications are removed. Clicking on the GAEZ logo at the top of the page clears all active selections, resetting the system.

Table 2 Mask options by parameter classes

Dominant soil classes	Protection Classes	Thermal climate classes
Acrisols Soils [AC]	1. IUCN Ia Strict Nature Reserve	1.Tropics, lowland
Alisols Soils [AL]	2. IUCN Ib Wilderness Area	2.Tropics, highland
Andosols Soils [AN]	3. IUCN II National Park	3.Subtropics, summer rainfall;
Arenosols Soils [AR]	4. IUCN III Natural Monument	4.Subtropics, winter rainfall;
Anthrosols Soils [AT]	5. IUCN IV Habitat/Species Management Area	5.Subtropics, low rainfall;
Chernozems Soils [CH]	6. IUCN V Protected Landscape/ Seascape	6.Temperate, oceanic;
Calcisols Soils [CL]	7. IUCN VI Managed Resource Protected Area	7.Temperate, sub-continental;
Cambisols Soils [CM]	8. Ramsar (Wetlands) Convention	8.Temperate, continental;
Fluvisols Soils [FL]	World Heritage Convention	9.Boreal, oceanic;
Ferralsols Soils [FR]	9. World Heritage Convention	10.Boreal, sub-continental;
Gleysols Soils [GL]	10. UNESCO-MAB Biosphere Reserves	11.Noreal, continental;
Greyzems Soils [GR]	11. ASEAN Heritage	12.Arctic
Gypsisols Soils [GY]	12. Natura 2000 /restricted agricultural use	
Histosols Soils [HS]	13. Natura 2000 strict protection	
Kastanozems Soils [KS]	14. National (non-forest habitat)	
Leptosols Soils [LP]	15. National (forest habitat)	
Luvisols Soils [LV]		
Lixisols Soils [LX]		
Nitisols Soils [NT]		
Podzoluvisols Soils[PD]	**Protection Classes (restrictions for agricultural use)**	**Reference permafrost zones**
Phaeozems Soils [PH]		
Planosols Soils [PL]	1. Limited agricultural use;	1.Continuous
Plinthosols Soils [PT]	2: No agricultural use.	2.Discontinuous
Podzols Soils [PZ]		3.Sporadic
Regosols Soils [RG]		4.No permafrost
Solonchaks Soils [SC]		
Solonetz Soils [SN]		
Vertisols Soils [VR]		

Part 4: Data output formats (Output menu)

Sub-menu 3 provides options for the specification of data output formats. Items include Maps, Map statistics tables, Crop summary tables and Data visualization and download options. Spatial data available for each of the five GAEZ themes can be checked in the table provided in Appendix 9 (a special table for Suitability and Potential Yield in Appendix 10), and scrutinized prior to query selection. Data output can only be generated when all required parameters for the selected data have been specified. Otherwise a warning appears at the bottom of the white area: 'Cannot produce results' and an indication, which parameters have not yet been selected.

4.1 Map

Results can be viewed using an Interactive Map Tool, which provides basic GIS features enabling the user to zoom in/out, pan, tilt, enable or disable administrative boundary overlays, and displaying the long/lat coordinates of the cursor on the map. Shortcut buttons at the bottom allow the download of maps in various output formats. A sample image of the map tool is shown in Figure 11:

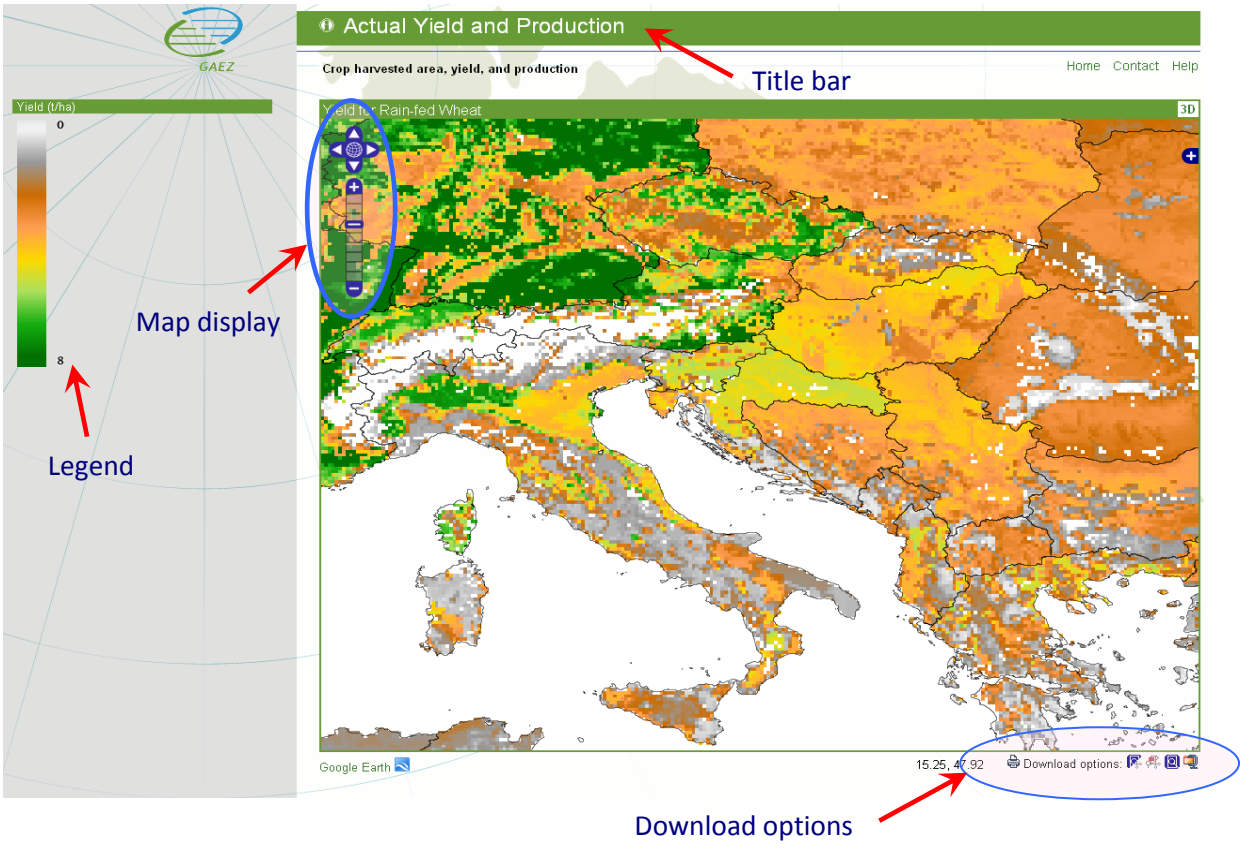


Figure 11 Interactive map of the GAEZ Portal

Map tool and procedures are listed below:

1. **Legend:** The map legend is shown in the left margin. The legend title bar displays the units of the data.
2. **Titles:** The title bar displays the thematic category of data displayed, while the map title bar below shows the detailed data selected for the map.
3. **Map Display:** The map display allows several interactions:
    a. **Zoom:** The map can be zoomed in and out by selecting '-'or '+' on the scale bar at the top left or by using the scroll wheel on the mouse.

b. **Pan:** The map can be moved by holding the left mouse button and dragging the map or by using the arrow buttons on the top left of the map display. The centre button returns the map to a full view.

c. **Pixel data:** The data value of any grid cell can be obtained by clicking the left mouse button while the cursor is at the desired location. The value is shown below the map and coordinates are displayed.

d. **Administrative overlay:** Administrative boundaries can be activated or deactivated by selecting the '+' sign on the upper right side of the map.

e. **Selection summary** is shown below the map.

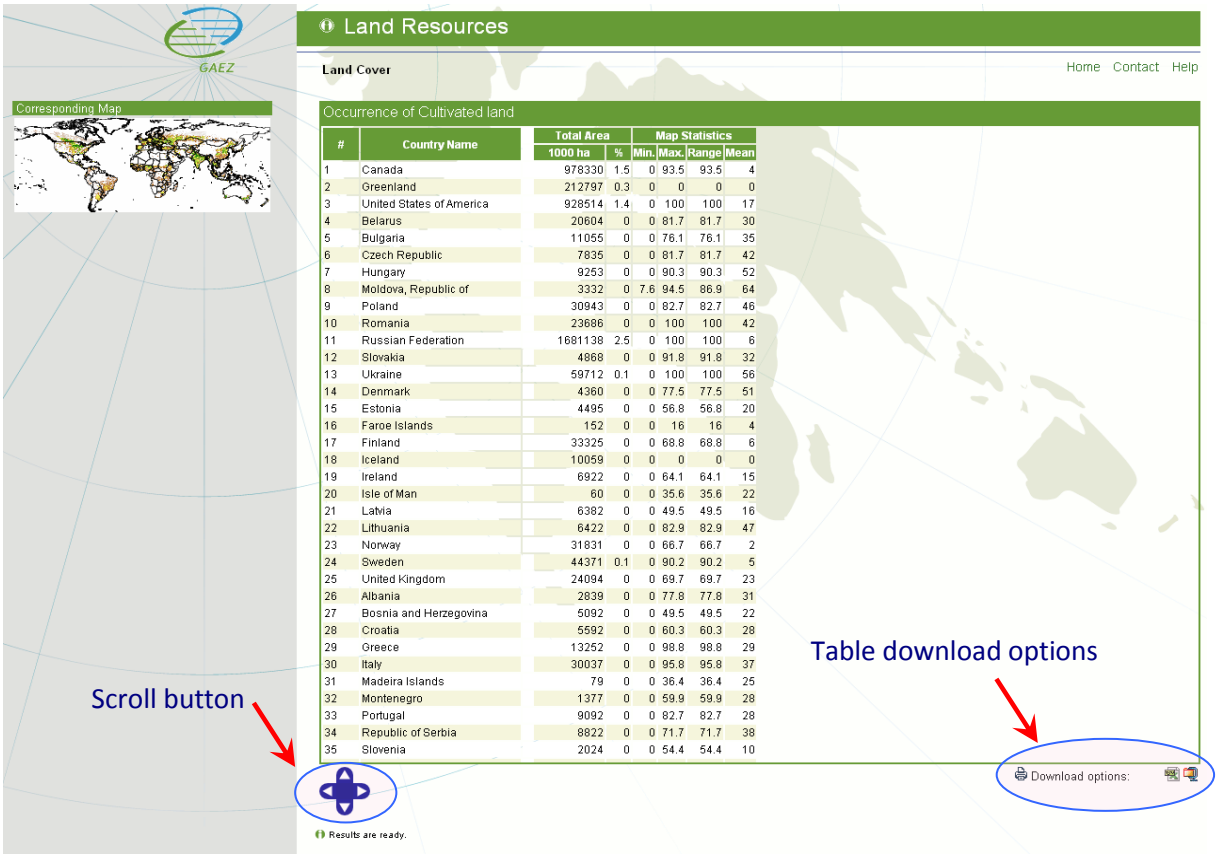
4. **Information Display Area:** The area just below the map area is used to display information about the current cursor location (in longitude/latitude) and shortcut buttons for map and legend download in several formats. These will be discussed in detail in the *Visualization and download* chapter.

5. The selection can be modified by clicking back to the selection menu using the  button.

4.2 Map statistics

This type of table is automatically generated by the system and provides aggregations over the pixel data according to the options selected.

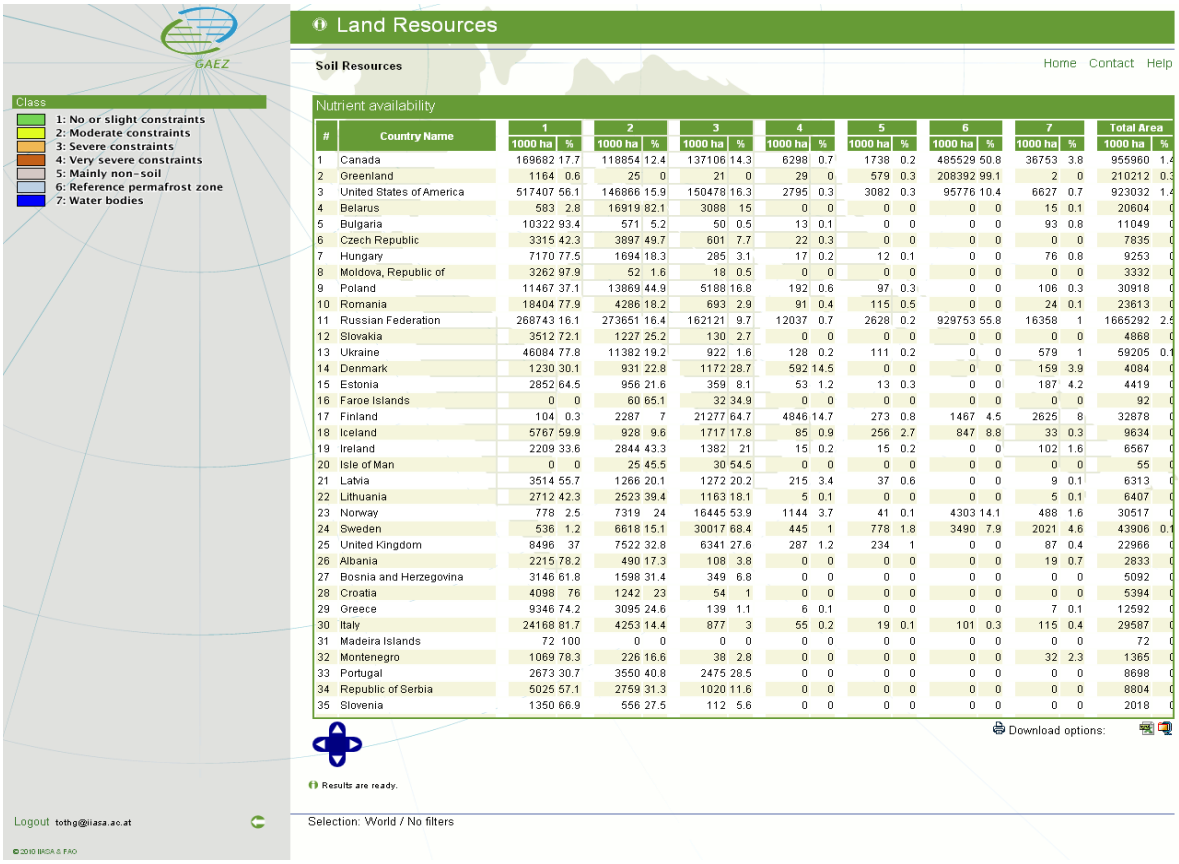
There are two types of tables for map statistics. One table is used when the selected data consist of continuous grid cell values (Figure 12). The table includes: (i) the total area in each geographic unit of non-zero values of the selected output; and (ii) map statistics over all non-zero values including minimum, maximum, range, mean, standard deviation and coefficients of variation.



#	Country Name	Total Area 1000 ha	%	Map Statistics Min.	Max.	Range	Mean
1	Canada	978330	1.5	0	93.5	93.5	4
2	Greenland	212797	0.3	0	0	0	0
3	United States of America	928514	1.4	0	100	100	17
4	Belarus	20604	0	0	81.7	81.7	30
5	Bulgaria	11055	0	0	76.1	76.1	35
6	Czech Republic	7835	0	0	81.7	81.7	42
7	Hungary	9253	0	0	90.3	90.3	52
8	Moldova, Republic of	3332	0	7.6	94.5	86.9	64
9	Poland	30943	0	0	82.7	82.7	46
10	Romania	23686	0	0	100	100	42
11	Russian Federation	1681138	2.5	0	100	100	6
12	Slovakia	4868	0	0	91.8	91.8	32
13	Ukraine	59712	0.1	0	100	100	56
14	Denmark	4360	0	0	77.5	77.5	51
15	Estonia	4495	0	0	56.8	56.8	20
16	Faroe Islands	152	0	0	16	16	4
17	Finland	33325	0	0	68.8	68.8	6
18	Iceland	10059	0	0	0	0	0
19	Ireland	6922	0	0	64.1	64.1	15
20	Isle of Man	60	0	0	35.6	35.6	22
21	Latvia	6382	0	0	49.5	49.5	16
22	Lithuania	6422	0	0	82.9	82.9	47
23	Norway	31831	0	0	66.7	66.7	2
24	Sweden	44371	0.1	0	90.2	90.2	5
25	United Kingdom	24094	0	0	69.7	69.7	23
26	Albania	2839	0	0	77.8	77.8	31
27	Bosnia and Herzegovina	5092	0	0	49.5	49.5	22
28	Croatia	5592	0	0	60.3	60.3	28
29	Greece	13252	0	0	98.8	98.8	29
30	Italy	30037	0	0	95.8	95.8	37
31	Madeira Islands	79	0	0	36.4	36.4	25
32	Montenegro	1377	0	0	59.9	59.9	28
33	Portugal	9092	0	0	82.7	82.7	28
34	Republic of Serbia	8822	0	0	71.7	71.7	38
35	Slovenia	2024	0	0	54.4	54.4	10

Figure 12 Map statistics table type 1

A second type of map statistics table is used when the selected output are discrete data (Figure 13). Then the table provides aggregate map statistics indicating area coverage (in 1000 ha) for each class. Area totals for each geographic unit and the percentage of each geographic unit in the total area selected are provided for reference as well.



#	Country Name	1		2		3		4		5		6		7		Total Area	
		1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%
1	Canada	169682	17.7	118854	12.4	137106	14.3	6298	0.7	1738	0.2	485529	50.8	36753	3.8	955960	1.4
2	Greenland	1164	0.6	25	0	21	0	29	0	579	0.3	208392	99.1	2	0	210212	0.3
3	United States of America	517407	56.1	146866	15.9	150478	16.3	2795	0.3	3082	0.3	95776	10.4	6627	0.7	923032	1.4
4	Belarus	583	2.8	16919	82.1	3088	15	0	0	0	0	0	0	15	0.1	20604	0
5	Bulgaria	10322	93.4	571	5.2	50	0.5	13	0.1	0	0	0	0	93	0.8	11049	0
6	Czech Republic	3315	42.3	3897	49.7	601	7.7	22	0.3	0	0	0	0	0	0	7835	0
7	Hungary	7170	77.5	1694	18.3	285	3.1	17	0.2	12	0.1	0	0	76	0.8	9253	0
8	Moldova, Republic of	3262	97.9	52	1.6	18	0.5	0	0	0	0	0	0	0	0	3332	0
9	Poland	11467	37.1	13869	44.9	5188	16.8	192	0.6	97	0.3	0	0	106	0.3	30918	0
10	Romania	18404	77.9	4286	18.2	693	2.9	91	0.4	115	0.5	0	0	24	0.1	23613	0
11	Russian Federation	268743	16.1	273651	16.4	162121	9.7	12037	0.7	2628	0.2	929753	55.8	16358	1	1665292	2.5
12	Slovakia	3512	72.1	1227	25.2	130	2.7	0	0	0	0	0	0	0	0	4868	0
13	Ukraine	46084	77.8	11382	19.2	922	1.6	128	0.2	111	0.2	0	0	579	1	59205	0.1
14	Denmark	1230	30.1	931	22.8	1172	28.7	592	14.5	0	0	0	0	159	3.9	4084	0
15	Estonia	2852	64.5	956	21.6	359	8.1	53	1.2	13	0.3	0	0	187	4.2	4419	0
16	Faroe Islands	0	0	60	65.1	32	34.9	0	0	0	0	0	0	0	0	92	0
17	Finland	104	0.3	2287	7	21277	64.7	4846	14.7	273	0.8	1467	4.5	2625	8	32878	0
18	Iceland	5767	59.9	928	9.6	1717	17.8	85	0.9	256	2.7	847	8.8	33	0.3	9634	0
19	Ireland	2209	33.6	2844	43.3	1382	21	15	0.2	15	0.2	0	0	102	1.6	6567	0
20	Isle of Man	0	0	25	45.5	30	54.5	0	0	0	0	0	0	0	0	55	0
21	Latvia	3514	55.7	1266	20.1	1272	20.2	215	3.4	37	0.6	0	0	9	0.1	6313	0
22	Lithuania	2712	42.3	2523	39.4	1163	18.1	5	0.1	0	0	0	0	5	0.1	6407	0
23	Norway	778	2.5	7319	24	16445	53.9	1144	3.7	41	0.1	4303	14.1	488	1.6	30517	0
24	Sweden	536	1.2	6618	15.1	30017	68.4	445	1	778	1.8	3490	7.9	2021	4.6	43906	0.1
25	United Kingdom	8496	37	7522	32.8	6341	27.6	287	1.2	234	1	0	0	87	0.4	22966	0
26	Albania	2215	78.2	490	17.3	108	3.8	0	0	0	0	0	0	19	0.7	2833	0
27	Bosnia and Herzegovina	3146	61.8	1598	31.4	349	6.8	0	0	0	0	0	0	0	0	5092	0
28	Croatia	4098	76	1242	23	54	1	0	0	0	0	0	0	0	0	5394	0
29	Greece	9346	74.2	3095	24.6	139	1.1	6	0.1	0	0	0	0	7	0.1	12592	0
30	Italy	24168	81.7	4253	14.4	877	3	55	0.2	19	0.1	101	0.3	115	0.4	29587	0
31	Madeira Islands	72	100	0	0	0	0	0	0	0	0	0	0	0	0	72	0
32	Montenegro	1069	78.3	226	16.6	38	2.8	0	0	0	0	0	0	32	2.3	1365	0
33	Portugal	2673	30.7	3550	40.8	2475	28.5	0	0	0	0	0	0	0	0	8698	0
34	Republic of Serbia	5025	57.1	2759	31.3	1020	11.6	0	0	0	0	0	0	0	0	8804	0
35	Slovenia	1350	66.9	556	27.5	112	5.6	0	0	0	0	0	0	0	0	2018	0

Figure 13 Map statistics table type 2

Both types of tables have a scroll button below them, which should make navigation within the table easier. Alternatively, the tables can be downloaded as tab separated values files and viewed in e.g. Excel by clicking the icon below the table. Alternatively, by clicking the icon, the selection will be downloaded as a standard bundle in a zipped archive format (see Figures 12-13 above). Download options are discussed in detail in *Chapter 3.4 Visualization and download.*

4.3 Crop summary table

The crop summary tables provide standardized information on crop potentials and are based on distributions of crop suitability and crop yield data within the grid cells, distribution within a grid cell result from sub-grid cell information on soil and terrain. Crop summary tables provide more detailed information than the map statistics tables described above.

Note that crop summary tables can only be accessed for the Variable "**Total Production Capacity** (t/ha)" included in Sub-theme "Agro-Ecological Suitability and Productivity" of the Theme "Suitability and Potential Yield". Crop summary tables have been generated for baseline climate and future climate change scenarios.

When a crop summary table is selected from the Output menu a new page for selection will appear on the screen (Figure 14).

The crop summary output format allows the user to apply masks by selecting land cover and protected area types. For information the selected crop type is also displayed. Note that only when a single country has been selected in the geographic area mask, the user can select the button “All available crops“.

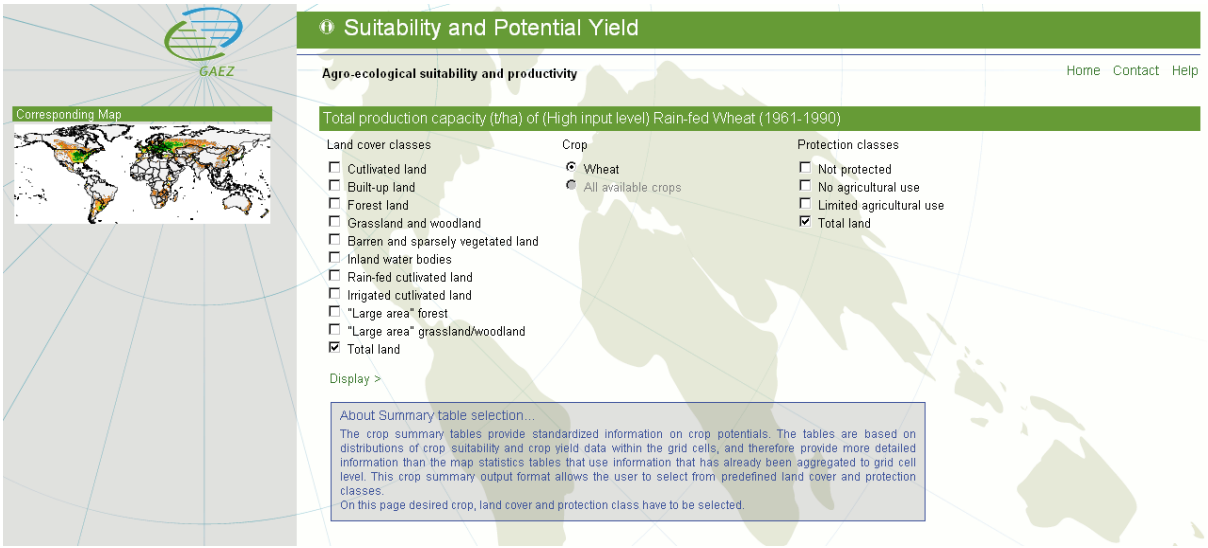
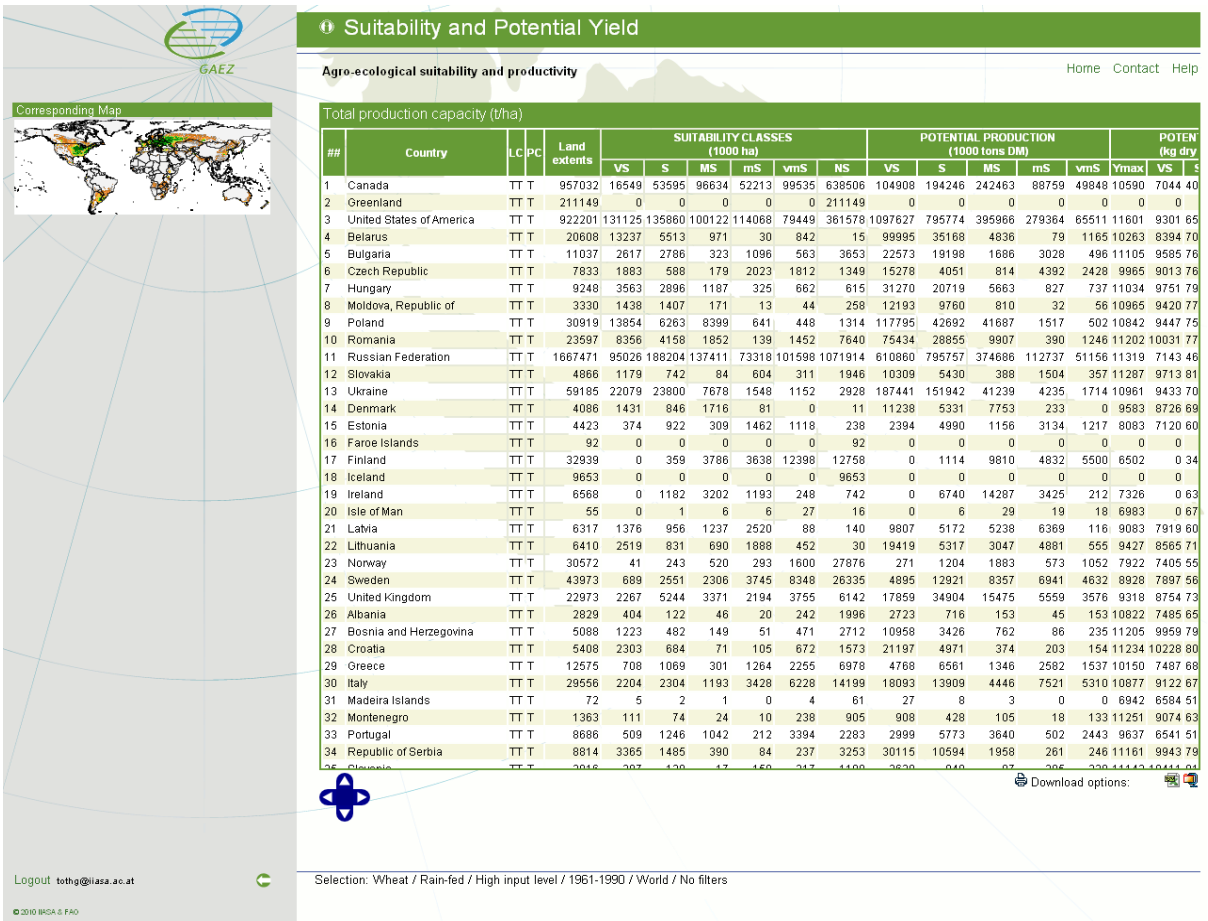


Figure 14 Crop summary table output options

Once the crop, land cover and protection class have been selected, the Display link will open the crop summary table (Figure 15).



##	Country	LC	PC	Land extents	SUITABILITY CLASSES (1000 ha)						POTENTIAL PRODUCTION (1000 tons DM)						POTEN (kg dry	
					VS	S	MS	mS	vmS	NS	VS	S	MS	mS	vmS	Ymax	VS	S
1	Canada	TT	T	957032	16549	53595	96634	52213	99535	638506	104908	194246	242463	88759	49848	10590	7044	40
2	Greenland	TT	T	211149	0	0	0	0	0	211149	0	0	0	0	0	0	0	
3	United States of America	TT	T	922201	131125	135860	100122	114068	79449	361578	1097627	795774	395966	279364	65511	11601	9301	65
4	Belarus	TT	T	20608	13237	5513	971	30	842	15	99995	35168	4836	79	1165	10263	8394	70
5	Bulgaria	TT	T	11037	2617	2786	323	1096	563	3653	22573	19198	1686	3028	496	11105	9585	76
6	Czech Republic	TT	T	7833	1883	588	179	2023	1812	1349	15278	4051	814	4392	2428	9965	9013	76
7	Hungary	TT	T	9248	3563	2896	1187	325	662	615	31270	20719	5663	827	737	11034	9751	79
8	Moldova, Republic of	TT	T	3330	1438	1407	171	13	44	258	12193	9760	810	32	56	10965	9420	77
9	Poland	TT	T	30919	13854	6263	8399	641	448	1314	117795	42692	41687	1517	502	10842	9447	75
10	Romania	TT	T	23597	8356	4158	1852	139	1452	7640	75434	28855	9907	390	1246	11202	10031	77
11	Russian Federation	TT	T	1667471	95026	188204	137411	73318	101598	1071914	610860	795757	374686	112737	51156	11319	7143	46
12	Slovakia	TT	T	4866	1179	742	84	604	311	1946	10309	5430	388	1504	357	11287	9713	81
13	Ukraine	TT	T	59185	22079	23800	7678	1548	1152	2928	187441	151942	41239	4235	1714	10961	9433	70
14	Denmark	TT	T	4086	1431	846	1716	81	0	11	11238	5331	7753	233	0	9583	8726	69
15	Estonia	TT	T	4423	374	922	309	1462	1118	238	2394	4990	1156	3134	1217	8083	7120	60
16	Faroe Islands	TT	T	92	0	0	0	0	0	92	0	0	0	0	0	0	0	
17	Finland	TT	T	32939	0	359	3786	3638	12398	12758	0	1114	9810	4832	5500	6502	0	34
18	Iceland	TT	T	9653	0	0	0	0	0	9653	0	0	0	0	0	0	0	
19	Ireland	TT	T	6568	0	1182	3202	1193	248	742	0	6740	14287	3425	212	7326	0	63
20	Isle of Man	TT	T	55	0	1	6	6	27	16	0	6	29	19	18	6983	0	67
21	Latvia	TT	T	6317	1376	956	1237	2520	88	140	9807	5172	5238	6369	116	9083	7919	60
22	Lithuania	TT	T	6410	2519	831	690	1888	452	30	19419	5317	3047	4881	555	9427	8565	71
23	Norway	TT	T	30572	41	243	520	293	1600	27876	271	1204	1883	573	1052	7922	7405	55
24	Sweden	TT	T	43973	689	2551	2306	3745	8348	26335	4895	12921	8357	6941	4632	8928	7897	56
25	United Kingdom	TT	T	22973	2267	5244	3371	2194	3755	6142	17859	34904	15475	5559	3576	9318	8754	73
26	Albania	TT	T	2829	404	122	46	20	242	1996	2723	716	153	45	153	10822	7485	65
27	Bosnia and Herzegovina	TT	T	5088	1223	482	149	51	471	2712	10958	3426	762	86	235	11205	9959	79
28	Croatia	TT	T	5408	2303	684	71	105	672	1573	21197	4971	374	203	154	11234	10228	80
29	Greece	TT	T	12575	708	1069	301	1264	2255	6978	4768	6561	1346	2582	1537	10150	7487	68
30	Italy	TT	T	29556	2204	2304	1193	3428	6228	14199	18093	13909	4446	7521	5310	10877	9122	67
31	Madeira Islands	TT	T	72	5	2	1	0	4	61	27	8	3	0	0	6942	6584	51
32	Montenegro	TT	T	1363	111	74	24	10	238	905	908	428	105	18	133	11251	9074	63
33	Portugal	TT	T	8686	509	1246	1042	212	3394	2283	2999	5773	3640	502	2443	9637	6541	51
34	Republic of Serbia	TT	T	8814	3365	1485	390	84	237	3253	30115	10594	1958	261	246	11161	9943	79

Figure 15 Crop summary table

Columns of the crop summary table above contain information for selected geographic units:

Land Cover class (Column **LC**):

Code	Land cover class
CU	Cultivated land
BU	Built-up land
FR	Forest land
GR	Grassland and woodland
NV	Barren and sparsely vegetated land
WB	Inland water bodies
CR	Rain-fed cultivated land
CI	Irrigated cultivated land
LF	"Large area" forest land (i.e. forest share in grid cell > 33%)
LG	"Large area" grassland/woodland (i.e. grassland/woodland share in grid cell > 33%)
TT	Total land

Protection Class (column **PC**);

Code	Protection class
N	Not protected
S	Protected (no agricultural use)
P	Protected (limited agricultural use)
T	Total land

Land extents – describes the total land area for the selected land cover and protection class (1000 ha);

CO_2 fertilization effect:

r - rain-fed with CO2 fertilization effect
r0 - rain-fed without CO2 fertilization effect
I - irrigated with CO2 fertilization effect
i0 - irrigated without CO2 fertilization effect

Suitability classes – given in 1000 ha, in various levels:

- VS very suitable (80-100% of maximum attainable yield)
- S suitable (60-80% of maximum attainable yield)
- MS moderately suitable (40-60% of maximum attainable yield)
- mS marginally suitable (20-40% of maximum attainable yield)
- vmS very marginally (5-20% of maximum attainable yield)
- NS not suitable (<5% of maximum attainable yield)

Suitability classes are defined at LUT level, i.e. when the yield of a chosen LUT in a given grid-cell falls in the ranges 80-100%, 60-80%, 40-60%, etc., the suitability class of that grid-cell is determined as respectively VS, S, MS, etc.

Potential production – given in tons of the selected produce in (DM) and provides grid cell output. Estimates shown as potential production by suitability class account for fallow requirements.

Potential yield – shows the maximum yield (Ymax) for the selected areas and the average potential yields (kg DM/ha) for the different suitability classes described above. Estimates shown as potential yield by suitability class are not reduced for fallow requirements. Net yields including fallow requirements are calculated as potential production.

Constraint factors applied to the agro-climatic yields are shown for each suitability classes. They include:

- fc1 - thermal constraints
- fc2 - moisture constraints
- fc3 - agro-climatic constraints
- fc4 - soil and terrain constraints

Each constraint factor indicates the reduction factor applied to the agro-climatic yields due to the specific constraint environment. Values are provided in percentage of the agro-climatic yield * 100. For example an fc2 of 7500 means that yields can only reach 75% of the agro-climatic attainable yield due to moisture constraints.

Constraint factors are cumulative with the combined constraint factor being:

fct = 10000 * (fc1/10000)*(fc2/10000)*(fc3/10000)*(fc4/10000).

A **cultivation factor** is provided by suitability class. It indicates fallow period requirements for sustainable production and depends on temperature and moisture regime and soil type. The value is given in percentage * 100 with the maximum being 9000. For example a cultivation factor 9000 indicates a crop can be cultivated in 90% of the period considered, i.e. 9 years cultivation and 1 year fallow. A cultivation factor 2000 indicates a crop can be cultivated in 20% of the period considered, i.e. either one year cultivation and 4 years fallow or 2 years cultivation and 8 years fallow.

Water deficit (mm) is provided by suitability class VS, S, MS, mS, VmS with average, minimum and maximum levels over all grid-cells in the particular suitability class. Water deficit indicates the difference between rain-fed water supply and optimal crop water needs in the particular environment. It is thus a quantification of irrigation water requirements.

Finally the crop summary tables provide Area, Production and Yield of the following combined suitability classes: VS + S; VS + S + MS; and VS + S + MS + mS.

4.4 Visualization and download

Display options include viewing with the GAEZ Portal's interactive maps or tables or viewing maps within the Google Earth™ application. Data can be downloaded in standard GIS formats and map images can be printed from the interactive map screen. Download options are available for all types of visualization formats.

4.4.1 Visualization

Visualization options are accessible by selecting display options indicated with the following icons below the interactive map:

- **(PNG) –**displays the entire map as a png file, which can then be saved using the normal features of the browser for saving images;
- **(PNG) –** displays the selected part of the map as a png file;
- **(PDF) –** displays the map in a pdf file;
- **(PDF) –** displays the selected part of the map in a pdf file;
- **(PNG) –** Map legend as png image;

Images can also be printed directly from the interactive map screen, by clicking the (print) icon.

4.4.2 Download

Download options for maps and tables can be accessed by:

1. Selecting display options indicated with the following icons below the interactive map and selecting the "*Save as…*" option;
2. Selecting the *"Visualization and download*" option in Sub-menu 3, which provides further display and download options in addition to the ones discussed above:
    -  Viewing maps within the Google Earth™ application. Here maps can be downloaded by selecting *Save image as…* from the File menu of the application;
    -  Download raw data in ZIPped standard ASCII Grid format;
    -  Standard bundle archive in a ZIP file. This contains a text file with the selection criteria, a map statistics file, the map and its legend in PNG format, and the map data in ASCII Grid format;
    -  Selection summary as tab separated values file;
    -  Map statistics as tab separated values file.

APPENDIXES

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Appendix 2: Operating system requirements for display with Google Earth™

PC System Configuration

Minimum:

- Operating System: Windows 2000, Windows XP, or Windows Vista
- CPU: Pentium 3, 500Mhz
- System Memory (RAM): 256MB
- Hard Disk: 400MB free space
- Network Speed: 128 Kbits/sec
- Graphics Card: 3D-capable with 16MB of VRAM
- Screen: 1024x768, "16-bit High Color" - DirectX 9 (to run in Direct X mode)

Recommended:

- Operating System: Windows XP or Windows Vista
- CPU: Pentium 4 2.4GHz+ or AMD 2400xp+
- System Memory (RAM): 512MB
- Hard Disk: 2GB free space
- Network Speed: 768 Kbits/sec
- Graphics Card: 3D-capable with 32MB of VRAM
- Screen: 1280x1024, "32-bit True Color"

Mac System Configuration

Minimum:

- Operating System: Mac OS X 10.4.0
- CPU: 1 GHz
- System Memory (RAM): 256MB
- Hard Disk: 400MB free space
- Network Speed: 128 Kbits/sec
- Graphics Card: 3D-capable with 16MB of VRAM
- Screen: 1024x768, "Thousands of Colors"

Recommended:

- Operating System: Mac OS X 10.5.2
- CPU: G4 1.2Ghz
- System Memory (RAM): 512MB
- Hard Disk: 2GB free space
- Network Speed: 768 Kbits/sec
- Graphics Card: 3D-capable with 32MB of VRAM
- Screen: 1280x1024, "Millions of Colors"

2.3 Linux System Configuration

Minimum:

- Kernel: 2.4 or later
- glibc: 2.3.2 w/ NPTL or later
- XFree86-4.0 or x.org R6.7 or later
- CPU: Pentium 3, 500Mhz
- System Memory (RAM): 256MB
- Hard Disk: 400MB free space
- Network Speed: 128 Kbits/sec
- Graphics Card: 3D-capable with 16MB of VRAM - Screen: 1024x768, "16-bit High Color" screen

Recommended:

- Kernel 2.6 or later
- glibc 2.3.5 w/ NPTL or later
- x.org R6.7 or later
- System Memory (RAM): 512MB
- Hard Disk: 2GB free space
- Network Speed: 768 Kbits/sec
- Graphics Card: 3D-capable with 32MB of VRAM
- Screen: 1280x1024, 32 bit color

NOTE: Tested on Ubuntu version 6.06.

Appendix 3: Land resource and agro-climatic resource data

Table A3-1 Land Resources data available in the GAEZ Portal

Soil resources	Dominant soil Nutrient availability Nutrient retention capacity Rooting conditions Oxygen availability Excess salts Toxicities Workability Rainfed soil suitability (low inputs) Rainfed soil suitability (high inputs) Rainfed soil and terrain suitability (low inputs) Rainfed soil and terrain suitability (high inputs)
Terrain resources	Median altitude Median terrain slope class Terrain slope index Terrain slope 0-0.5% (share) Terrain slope 0.5-2% (share) Terrain slope 2-5% (share) Terrain slope 5-8% (share) Terrain slope 8-16% (share) Terrain slope 16-30% (share) Terrain slope 30-45% (share) Terrain slope >45% (share) Terrain slope 0-2% (share) Terrain slope 2-8% (share) Terrain slope 0-8% (share) Terrain slope 0-16% (share) Terrain slope >16% (share) Terrain slope >30% (share)
Land Cover	Dominant land cover pattern Cultivated land Rain-fed cultivated land Irrigated cultivated land Forest land Grassland & wood land Barren and sparsely vegetated land Built-up land Water bodies
Water Resources	Major river basins Water scarcity Irrigated cultivated land Water collecting sites
Land Cover	Dominant land cover pattern Cultivated land Rain-fed cultivated land Irrigated cultivated land Forest land Grassland & woodland Barren and sparsely vegetated land Built-up land Water bodies
Protected Areas	Protected area types Protected areas – Restrictions for agricultural use
Selected socio-economic data	Population density (year 2000) Ruminant livestock (year 2000) Accessibility (about 2000)

The soil resources assessment is based on the Harmonized World Soil Data Base (HWSD).

The global terrain slope and aspect database has been compiled using elevation data from the Shuttle Radar Topography Mission (SRTM). The SRTM data is publicly available as 3 arc second (approximately 90 meters resolution at the equator) DEMs (CGIAR-CSI, 2006).

The SRTM data cover globe areas up to 60° latitude. For the remaining area elevation data from GTOPO30 (USGS, 2002) were used.

Additional Data documentation on terrain slope and aspect data is available from the HWSD web page (http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/global-terrain-doc.html).

Table A3-2 Agro-climatic Resource data available in the GAEZ Portal

Thermal regime	Mean annual temperature Annual temperature range Thermal climates Thermal zones Temperature growing period Frost-free period Tsum during temperature growing period Tsum during frost-free period Air frost number Snow-adjusted air frost number Reference permafrost zones
Moisture conditions	Annual precipitation Annual precipitation (1961-90) CV (%) Annual precipitation (1961-90) SD (mm) Fournier index Fournier index (1961-90) CV (%) Fournier index (1961-90) SD (mm) Reference evapotranspiration Annual P/PET ratio Annual P/PET ratio (1961-90) CV (%) Annual P/PET ratio (1961-90) SD (ratio) Seasonal P/PET ratio (April to September) Seasonal P/PET ratio (October to March) Quarterly P/PET ratio (January to March) Quarterly P/PET ratio (April to June) Quarterly P/PET ratio (July to September) Quarterly P/PET ratio (October to December)
Growing period	Reference length of growing period Reference length of growing period zones Reference length of growing period CV (%) Reference length of growing period SD (days) Net primary production (rainfed) Net primary production (irrigated)

Appendix 4: Suitability and Potential Yield Assessment Data

Data in the Suitability and Potential Yield theme have been organized in the following categories:

Table A4-1 Suitability and Potential Yield data available in the GAEZ Portal

Agro-climatic yield	Agro-climatically attainable yield Crop/LUT selection by grid-cell Crop-specific actual evapotranspiration (mm) Crop-specific accumulated temperature SD of agro-climatically attainable yield (1961-90) CV of agro-climatically attainable yield (1961-90)
Climate yield constraints	Temperature constraint factor Moisture constraint factor Agro-climatic constraints factor Combined climate-related constraints factor Crop water deficit (mm)
Crop calendar	Start crop growth cycle (day) Length of crop growth cycle (days)
Agro-ecological suitability and productivity	Crop suitability index (class) Crop suitability index (value) Total production capacity (t/ha) Crop suitability index (class) for current cultivated land Crop suitability index (value) for current cultivated land Potential productions capacity (t/ha) for current cultivated land

Depending on sub-theme and data selected suitability and potential yield data are available for 11 major crop groups (Table A4-1), 49 major crops (Table A4-2), 92 crop sub-types (LUT groups) (Table A4-3), and 280 crop/land utilization types (LUTs) (Table A4-4).
Table 1 (in Section 3.1) provides an overview of crop availability for the different sub-themes.

Table A4-2 Crop groups

Code	Crop group
1	Cereals
2	Roots and tubers
3	Sugar crops
4	Pulses
5	Oilcrops
6	Vegetables
7	Fruits
8	Fibre crops
9	Narcotics and stimulants
10	Fodder crops
11	Bioenergy feedstocks

Table A4-3 Crops

Code	Common name	*Scientific name*	Crop group
1	Wheat	*Triticum spp.*	Cereals
2	Wetland rice	*Oryza sativa*	Cereals
3	Dryland rice	*Oryza sativa*	Cereals
4	Maize	*Zea mays*	Cereals
5	Barley	*Hordeum vulgare*	Cereals
6	Sorghum	*Sorghum bicolor*	Cereals/Sugar crops
7	Rye	*Secale cereale*	Cereals
8	Pearl millet	*Pennisetum glaucum*	Cereals
9	Foxtail millet	*Setaria italica*	Cereals
10	Oat	*Avena sativa*	Cereals
11	Buckwheat	*Fagopyrum esculentum*	Cereals
12	White potato	*Solanum tuberosum*	Roots and tubers
13	Sweet potato	*Ipomoea batatas*	Roots and tubers
14	Cassava	*Manihot esculenta*	Roots and tubers
15	Yam and Cocoyam	*Dioscorea spp. and Colocasia esculenta*	Roots and tubers
16	Sugarcane	*Saccharum spp.*	Sugar crops
17	Sugar beet	*Beta vulgaris L.*	Sugar crops
18	Phaseolus bean	*Phaseolus vulgaris and Ph. lunatus*	Pulses
19	Chickpea	*Cicer arietinum*	Pulses
20	Cowpea	*Vigna unguiculata*	Pulses
21	Dry pea	*Pisum sativum L.*	Pulses
22	Gram	*Vigna radiata*	Pulses
23	Pigeonpea	*Cajanus cajan*	Pulses
24	Soybean	*Glycine max*	Oil crops
25	Sunflower	*Helianthus annuus*	Oil crops
26	Rape	*Brassica napus*	Oil crops
27	Groundnut	*Arachis hypogaea*	Oil crops
28	Oil palm	*Elaeis oleifera*	Oil crops
29	Olive	*Olea europaea*	Oil crops
30	Jatropha	*Jatropha curcas.*	Bioenergy feedstocks
31	Cabbage	*Brassica oleracea*	Vegetables
32	Carrot	*Daucus carota*	Vegetables
33	Onion	*Allium cepa*	Vegetables
34	Tomato	*Lycopersicon lycopersicum*	Vegetables
35	Banana/Plantain	*Musa spp.*	Fruits
36	Citrus	*Citrus Sinensis*	Fruits
37	Coconut	*Cocos nucifera*	Fruits
38	Cacao	*Theobroma cacao*	Narcotics and stimulants
39	Cotton	*Gossypium hirsutum.*	Fibre
40	Flax	*Linum usitatissimum*	Fibre crops
41	Coffee	*Coffea arabica*	Narcotics and stimulants
42	Tea	*Camellia Sinenses var. Sinensis*	Narcotics and stimulants
43	Tobacco	*Nicotiana tobacum*	Narcotics and stimulants
44	Alfalfa	*Medicago sativa*	Fodder crops
45	Pasture legume	*various*	Fodder crops
46	Grass	*various*	Fodder crops
47	Miscanthus	*Miscanthus spp*	Bioenergy feedstocks
48	Switchgrass	*Panicum virgatum*	Bioenergy feedstocks
49	Reed canary grass	*Phalaris arundinacea*	Bioenergy feedstocks

Table A4-4 Crop types

Code	Common name	*Scientific name*	Crop group
1	Winter wheat	*Triticum spp.*	Cereals
2	Spring wheat	*Triticum spp.*	Cereals
3	Wheat (subtropical cultivars)	*Triticum spp.*	Cereals
4	Wheat (tropical cultivars)	*Triticum spp.*	Cereals
5	Japonica wetland rice	*Oryza japonica*	Cereals
6	Indica wetland rice	*Oryza indica*	Cereals
7	Indica dryland rice	*Oryza sativa*	Cereals
8	Maize (tropical lowland cultivars)	*Zea mays*	Cereals
9	Maize (tropical highland cultivars)	*Zea mays*	Cereals
10	Maize (temperate and subtropical cult.)	*Zea mays*	Cereals
11	Silage maize (temperate and subtropical cult.)	*Zea mays*	Fodder crops
12	Winter barley	*Hordeum vulgare*	Cereals
13	Spring Barley	*Hordeum vulgare*	Cereals
14	Barley (subtropical cultivars)	*Hordeum vulgare*	Cereals
15	Barley (tropical cultivars)	*Hordeum vulgare*	Cereals
16	Sorghum (tropical lowland cultivars)	*Sorghum bicolor*	Cereals
17	Sorghum (tropical highland cultivars)	*Sorghum bicolor*	Cereals
18	Sorghum (temperate and subtropical cult.)	*Sorghum bicolor*	Cereals
19	Sweet sorghum (temperate and subtropical cult.)	*Sorghum bicolor*	Sugar crops
20	Winter rye	*Secale cereale*	Cereals
21	Spring rye	*Secale cereale*	Cereals
22	Pearl millet	*Pennisetum glaucum*	Cereals
23	Foxtail millet	*Setaria italica*	Cereals
24	Spring oat	*Avena sativa*	Cereals
25	Buckwheat	*Fagopyrum esculentum*	Cereals
26	White potato	*Solanum tuberosum*	Roots and tubers
27	Sweet potato	*Ipomoea batatas*	Roots and tubers
28	Cassava	*Manihot esculenta*	Roots and tubers
29	White yam	*Dioscorea spp.*	Roots and tubers
30	Greater yam	*Dioscorea spp.*	Roots and tubers
31	Yellow yam	*Dioscorea spp.*	Roots and tubers
32	Cocoyam	*Colocasia esculenta*	Roots and tubers
33	Sugarcane	*Saccharum spp.*	Sugar crops
34	Sugar beet	*Beta vulgaris L.*	Sugar crops
35	Phaseolus bean (tropical lowland)	*Phaseolus vulgaris and Ph. lunatus*	Pulses
36	Phaseolus bean (tropical highland)	*Phaseolus vulgaris and Ph. lunatus*	Pulses
37	Phaseolus bean (temperate and subtropical cult.)	*Phaseolus vulgaris and Ph.lunatus*	Pulses
38	Chickpea	*Cicer arietinum*	Pulses
39	Chickpea (cold tolerant)	*Cicer arietinum*	Pulses
40	Cowpea	*Vigna unguiculata*	Pulses
41	Dry pea	*Pisum sativum L.*	Pulses
42	Gram	*Vigna radiate*	Pulses
43	Pigeonpea	*Cajanus cajan*	Pulses
44	Soybean (tropical and subtropical cult.)	*Glycine max*	Oilcrops
45	Soybean (temperate and subtropical cult.)	*Glycine max*	Oilcrops
46	Sunflower (tropical and subtropical cult.)	*Helianthus annuus*	Oilcrops
47	Sunflower (temperate and subtropical cult.)	*Helianthus annuus*	Oilcrops
48	Winter rape	*Brassica napus*	Oilcrops
49	Spring rape	*Brassica napus*	Oilcrops
50	Rabi rape	*Brassica napus*	Oilcrops
51	Groundnut	*Arachis hypogaea*	Oilcrops

Code	Common name	*Scientific name*	Crop group
52	Oilpalm	*Elaeis oleifera*	Oilcrops
53	Olive	*Olea europaea*	Oilcrops
54	Jatropha	*Jatropha curcas*	Oilcrops
55	Cabbage	*Brassica oleracea*	Vegetables
56	Carrot (temperate and subtropical cultivars)	*Daucus carota*	Vegetables
57	Carrot (temperate and subtropical cultivars)	*Daucus carota*	Vegetables
58	Carrot (tropical cultivars)	*Daucus carota*	Vegetables
59	Onion (temperate and subtropical cultivars)	*Allium cepa*	Vegetables
60	Onion hibernating cultivar	*Allium cepa*	Vegetables
61	Onion (tropical cultivars)	*Allium cepa*	Vegetables
62	Tomato (temperate and subtropical cultivars)	*Lycopersicon lycopersicum*	Vegetables
63	Tomato (tropical and subtropical cultivars)	*Lycopersicon lycopersicum*	Vegetables
64	Banana/Plantain	*Musa spp.*	Fruits
65	Citrus	*Citrus sinensis*	Fruits
66	Coconut 1 (tall)	*Cocos nucifera*	Fruits
67	Coconut 2 (hybrid tall)	*Cocos nucifera*	Fruits
68	Coconut 3 (dwarf)	*Cocos nucifera*	Fruits
69	Cacao (comun)	*Theobroma cacao*	Narcotics and stimulants
70	Cacao (hybrid)	*Theobroma cacao*	Narcotics and stimulants
71	Cotton (tropical cultivars)	*Gossypium spp.*	Fibre crops
72	Cotton (temperate and subtropical cult.)	*Gossypium spp.*	Fibre crops
73	Flax	*Linum usitatissimum*	Fibre crops
74	Coffee arabica	*Coffea arabica*	Narcotics and stimulants
75	Coffee robusta	*Coffea robusta*	Narcotics and stimulants
76	Tea (china tea)	*Camellia Sinenses var. Sinensis*	Narcotics and stimulants
77	Tea (hybrid tea)	*Sinensis and Assamica*	Narcotics and stimulants
78	Tea (assam tea)	*Camellia sinensis* var. *assamica*	Narcotics and stimulants
79	Tobacco (tropical cultivars)	*Nicotiana tobacum*	Narcotics and stimulants
80	Tobacco (temperate and subtropical cult.)	*Nicotiana tobacum*	Narcotics and stimulants
81	Alfalfa (temperate and subtropical cult.)	*Medicago sativa*	Fodder crops
82	Alfalfa (tropical cultivars)	*Medicago sativa*	Fodder crops
83	Pasture legumes (temp. and subtropical cult.)	*various*	Fodder crops
84	Pasture legumes (tropical and subtropical cult.)	*various*	Fodder crops
85	Pasture grasses (C3/I cultivars)	*various*	Fodder crops
86	Pasture grasses (C3/II cultivars)	*various*	Fodder crops
87	Pasture grasses (C4/II cultivars)	*various*	Fodder crops
88	Pasture grasses (C4/I cultivars)	*various*	Fodder crops
89	Miscanthus (C4/II)	*Miscanthus spp*	Bioenergy feedstocks
90	Miscanthus (C4/I)	*Miscanthus spp*	Bioenergy feedstocks
91	Switchgrass	*Panicum virgatum*	Bioenergy feedstocks
92	Reed canary grass	*Phalaris arundinacea*	Bioenergy feedstocks

Table A4-5 Crop/LUTs

Code	Crop type	Growth cycle	Harvested part
1	Winter wheat	35+105 days	Grain
2	Winter wheat	40+120 days	Grain
3	Winter wheat	45+135 days	Grain
4	Winter wheat	50+150 days	Grain
5	Spring wheat	90 days	Grain
6	Spring wheat	105 days	Grain
7	Spring wheat	120 days	Grain
8	Spring wheat	135 days	Grain
9	Spring wheat	150 days	Grain
10	Wheat (subtropical cultivars)	105 days	Grain
11	Wheat (subtropical cultivars)	120 days	Grain
12	Wheat (subtropical cultivars)	135 days	Grain
13	Wheat (subtropical cultivars)	150 days	Grain
14	Wheat (tropical highland cultivars)	100 days	Grain
15	Wheat (tropical highland cultivars)	115 days	Grain
16	Wheat (tropical highland cultivars)	130 days	Grain
17	Wheat (tropical highland cultivars)	145 days	Grain
18	Wheat (tropical highland cultivars)	160 days	Grain
19	Wheat (tropical highland cultivars)	175 days	Grain
20	Wheat (tropical highland cultivars)	190 days	Grain
21	Japonica wetland rice	105 days	Grain
22	Japonica wetland rice	120 days	Grain
23	Japonica wetland rice	135 days	Grain
24	Japonica wetland rice	150 days	Grain
25	Indica wetland rice	105 days	Grain
26	Indica wetland rice	120 days	Grain
27	Indica wetland rice	135 days	Grain
28	Indica wetland rice	150 days	Grain
29	Indica dryland rice	105 days	Grain
30	Indica dryland rice	120 days	Grain
31	Indica dryland rice	135 days	Grain
32	Maize (tropical lowland cultivars)	90 days	Grain
33	Maize (tropical lowland cultivars)	105 days	Grain
34	Maize (tropical lowland cultivars)	120 days	Grain
35	Maize (tropical lowland cultivars)	135 days	Grain
36	Maize(tropical highland cultivars)	120 days	Grain
37	Maize (tropical highland cultivars)	150 days	Grain
38	Maize (tropical highland cultivars)	180 days	Grain
39	Maize (tropical highland cultivars)	210 days	Grain
40	Maize (tropical highland cultivars)	240 days	Grain
41	Maize (tropical highland cultivars)	270 days	Grain
42	Maize (tropical highland cultivars)	300 days	Grain
43	Maize (temperate and subtropical cultivars)	90 days	Grain
44	Maize (temperate and subtropical cultivars)	105 days	Grain
45	Maize (temperate and subtropical cultivars)	120 days	Grain
46	Maize (temperate and subtropical cultivars)	135 days	Grain
47	Maize (temperate and subtropical cultivars)	150 days	Grain
48	Maize (temperate and subtropical cultivars)	165 days	Grain
49	Maize (temperate and subtropical cultivars)	180 days	Grain
50	Silage maize (temperate and subtropical cultivars)	105 days	Fodder
51	Silage maize (temperate and subtropical cultivars)	120 days	Fodder
52	Silage maize (temperate and subtropical cultivars)	135 days	Fodder
53	Silage maize (temperate and subtropical cultivars)	150 days	Fodder

Code	Crop type	Growth cycle	Harvested part
54	Silage maize (temperate and subtropical cultivars)	165 days	Fodder
55	Silage maize (temperate and subtropical cultivars)	180 days	Fodder
56	Winter barley	35+105 days	Grain
57	Winter barley	40+120 days	Grain
58	Winter barley	45+135 days	Grain
59	Winter barley	50+150 days	Grain
60	Spring barley	90 days	Grain
61	Spring barley	105 days	Grain
62	Spring barley	120 days	Grain
63	Spring barley	135 days	Grain
64	Barley (subtropical cultivars)	90 days	Grain
65	Barley (subtropical cultivars)	105 days	Grain
66	Barley (subtropical cultivars)	120 days	Grain
67	Barley (subtropical cultivars)	135 days	Grain
68	Barley (tropical highland cultivars)	100 days	Grain
69	Barley (tropical highland cultivars)	115 days	Grain
70	Barley (tropical highland cultivars)	130 days	Grain
71	Barley (tropical highland cultivars)	145 days	Grain
72	Barley (tropical highland cultivars)	160 day)	Grain
73	Barley (tropical highland cultivars)	175 days	Grain
74	Barley (tropical highland cultivars)	190 days	Grain
75	Sorghum (tropical lowland cultivars)	90 days	Grain
76	Sorghum (tropical lowland cultivars)	105 days	Grain
77	Sorghum (tropical lowland cultivars)	120 days	Grain
78	Sorghum (tropical lowland cultivars)	135 days	Grain
79	Sorghum (tropical highland cultivars)	120 days	Grain
80	Sorghum (tropical highland cultivars)	150 days	Grain
81	Sorghum (tropical highland cultivars)	180 days	Grain
82	Sorghum (tropical highland cultivars)	210 days	Grain
83	Sorghum(tropical highland cultivars)	240 days)	Grain
84	Sorghum (tropical highland cultivars)	270 days	Grain
85	Sorghum (tropical highland cultivars)	300 days	Grain
86	Sorghum (temperate and subtropical cultivars)	90 days	Grain
87	Sorghum (temperate and subtropical cultivars)	105 days	Grain
88	Sorghum (temperate and subtropical cultivars)	120 days	Grain
89	Sorghum (temperate and subtropical cultivars)	135 days	Grain
90	Sorghum (temperate and subtropical cultivars)	150 days	Grain
91	Sorghum (temperate and subtropical cultivars)	165 days	Grain
92	Sorghum (temperate and subtropical cultivars)	180 days	Grain
93	Sweet sorghum (temperate and subtropical cultivars)	90 days	Supra
94	Sweet sorghum (temperate and subtropical cultivars)	105 days	Supra
95	Sweet sorghum (temperate and subtropical cultivars)	120 days	Supra
96	Sweet sorghum (temperate and subtropical cultivars)	135 days	Supra
97	Sweet sorghum (temperate and subtropical cultivars)	150 days	Supra
98	Sweet sorghum (temperate and subtropical cultivars)	165 days	Supra
99	Sweet sorghum (temperate and subtropical cultivars)	180 days	Supra
100	Winter rye	30+90 days	Grain
101	Winter rye	35+105 days	Grain
102	Winter rye	40+120 days	Grain
103	Winter rye	45+135 days	Grain
104	Spring rye	90 days	Grain
105	Spring rye	105 days	Grain
106	Spring rye	120 days	Grain
107	Spring rye	135 days	Grain
108	Pearl millet	70 days	Grain

Code	Crop type	Growth cycle	Harvested part
109	Pearl millet	90 days	Grain
110	Foxtail millet	75 days	Grain
111	Foxtail millet	90 days	Grain
112	Foxtail millet	105 days	Grain
113	Foxtail millet	120 days	Grain
114	Spring oat	90 days	Grain
115	Spring oat)	105 days	Grain
116	Spring oat	120 days	Grain
117	Buckwheat	75 days	Grain
118	Buckwheat	90 days	Grain
119	White potato	90 days	Tuber
120	White potato	105 days	Tuber
121	White potato	120 days	Tuber
122	White potato	135 days	Tuber
123	White potato	150 days	Tuber
124	White potato	165 days	Tuber
125	White potato	180 days)	Tuber
126	Sweet potato	120 days	Tuber
127	Sweet potato	135 days	Tuber
128	Sweet potato	150 days	Tuber
129	Sweet potato	165 days	Tuber
130	Cassava	perennial	Root
131	White yam	195 days	Tuber
132	White yam	225 days	Tuber
133	Greater yam	240 days	Tuber
134	Greater yam	270 days	Tuber
135	Yellow yam	330 days	Tuber
136	Cocoyam	330 days	Tuber
137	Sugarcane	330 days	Sugar
138	Sugar beet	120 days	Sugar
139	Sugar beet	135 days	Sugar
140	Sugar beet	150 days	Sugar
141	Sugar beet	165 days	Sugar
142	Sugar beet	180 days	Sugar
143	Sugar beet	195 days	Sugar
144	Sugar beet	210 days	Sugar
145	Phaseolus bean (tropical lowland cultivars)	90 days	Grain
146	Phaseolus bean (tropical lowland cultivars)	105 days	Grain
147	Phaseolus bean (tropical lowland cultivars)	120 days	Grain
148	Phaseolus bean (tropical lowland cultivars)	135 days	Grain
149	Phaseolus bean (tropical lowland cultivars)	150 days	Grain
150	Phaseolus bean (tropical highland cultivars)	120 days	Grain
151	Phaseolus bean (tropical highland cultivars)	135 days	Grain
152	Phaseolus bean (tropical highland cultivars)	150 days	Grain
153	Phaseolus bean (tropical highland cultivars)	165 days	Grain
154	Phaseolus bean (tropical highland cultivars)	180 days	Grain
155	Phaseolus bean (temperate and subtropical cultivars)	90 days	Grain
156	Phaseolus bean (temperate and subtropical cultivars)	105 days	Grain
157	Phaseolus bean (temperate and subtropical cultivars)	120 days	Grain
158	Phaseolus bean (temperate and subtropical cultivars)	135 days	Grain
159	Phaseolus bean (temperate and subtropical cultivars)	150 days	Grain
160	Chickpea	90 days	Grain
161	Chickpea	105 days	Grain
162	Chickpea	120 days	Grain
163	Chickpea (cold tolerant)	150 days	Grain

Code	Crop type	Growth cycle	Harvested part
164	Chickpea (cold tolerant)	165 days	Grain
165	Chickpea (cold tolerant)	180 days	Grain
166	Cowpea	80 days	Grain
167	Cowpea	100 days	Grain
168	Cowpea	120 days	Grain
169	Dry pea	90 days	Grain
170	Dry pea	105 days	Grain
171	Dry pea	120 days	Grain
172	Green gram	60 days	Grain
173	Green gram	80 days	Grain
174	Green gram	100 days	Grain
175	Pigeon pea	135 days	Grain
176	Pigeon pea	150 days	Grain
177	Pigeon pea	165 days	Grain
178	Pigeon pea	180 days	Grain
179	Pigeon pea	195 days	Grain
180	Soybean (tropical and subtropical cultivars)	105 days	Grain
181	Soybean (tropical and subtropical cultivars)	120 days	Grain
182	Soybean (tropical and subtropical cultivars)	135 days	Grain
183	Soybean (temperate and subtropical cultivars)	105 days	Grain
184	Soybean (temperate and subtropical cultivars)	120 days	Grain
185	Soybean (temperate and subtropical cultivars)	135 days	Grain
186	Sunflower (tropical and subtropical cultivars)	135 days	Seed
187	Sunflower (tropical and subtropical cultivars)	150 days	Seed
188	Sunflower (temperate and subtropical cultivars)	105 days	Seed
189	Sunflower (temperate and subtropical cultivars)	120 days	Seed
190	Sunflower (temperate and subtropical cultivars)	135 days	Seed
191	Sunflower (temperate and subtropical cultivars)	150 days	Seed
192	Winter rape	35+105 days	Seed
193	Winter rape	40+120 days	Seed
194	Winter rape	45+135 days	Seed
195	Winter rape	45+150 days	Seed
196	Spring rape	105 days	Seed
197	Spring rape	120 days	Seed
198	Spring rape	135 days	Seed
199	Spring rape	150 days	Seed
200	Rabi rape	135 days	Seed
201	Rabi rape	150 days	Seed
202	Groundnut	90 days	Kernel
203	Groundnut	105 days	Kernel
204	Groundnut	120 days	Kernel
205	Oil palm	perennial	Oil
206	Olive	perennial	Oil
207	Jatropha	perennial	Oil
208	Cabbage	90 days	Head
209	Cabbage	105 days	Head
210	Cabbage	120 days	Head
211	Cabbage	135 days	Head
212	Cabbage	150 days	Head
213	Cabbage	165 days	Head
214	Carrot (fresh-early) (temperate and subtropical cultivars)	60 days	Root
215	Carrot (fresh-early) (temperate and subtropical cultivars)	75 days	Root
216	Carrot (fresh-early) (temperate and subtropical cultivars)	90 days	Root
217	Carrot (storage-late) (temperate and subtropical cultivars)	135 days	Root
218	Carrot (storage-late) (temperate and subtropical cultivars)	165 days	Root

Code	Crop type	Growth cycle	Harvested part
219	Carrot (storage-late) (temperate and subtropical cultivars)	195 days	Root
220	Carrot (fresh) (tropical cultivars)	75 days	Root
221	Carrot (fresh) (tropical cultivars)	90 days	Root
222	Carrot (fresh) (tropical cultivars)	105 days	Root
223	Onion (temperate and subtropical cultivars)	120 days	Bulb
224	Onion (temperate and subtropical cultivars)	135 days	Bulb
225	Onion (temperate and subtropical cultivars)	150 days	Bulb
226	Onion (temperate and subtropical cultivars)	165 days	Bulb
227	Onion (temperate and subtropical cultivars)	180 days	Bulb
228	Onion (hybernating) (temperate and subtropical cultivars)	45+105 days	Bulb
229	Onion (hybernating) (temperate and subtropical cultivars)	60+120 days	Bulb
230	Onion hybernating) (temperate and subtropical cultivars)	75+135 days	Bulb
231	Onion (tropical cultivars)	90 days	Bulb
232	Onion (tropical cultivars)	105 days	Bulb
233	Onion) (tropical cultivars)	120 days	Bulb
234	Onion (tropical cultivars)	135 days	Bulb
235	Tomato (temperate and subtropical cultivars)	90 days	Fruit
236	Tomato (temperate and subtropical cultivars)	105 days	Fruit
237	Tomato (temperate and subtropical cultivars)	120 days	Fruit
238	Tomato (temperate and subtropical cultivars)	135 days	Fruit
239	Tomato (tropical and subtropical cultivars)	105 days	Fruit
240	Tomato (tropical and subtropical cultivars)	120 days	Fruit
241	Tomato (tropical and subtropical cultivars)	135 days	Fruit
242	Banana/Plantain	perennial	Fruit
243	Citrus	perennial	Fruit
244	Coconut 1 (tall)	perennial)	Copra
245	Coconut 2 (hybrid tall)	perennial	Copra
246	Coconut 3 (dwarf)	perennial	Copra
247	Cacao (comun)	perennial	Beans
248	Cacao (hybrid)	perennial	Beans
249	Cotton (tropical cultivars)	135 days	Fiber
250	Cotton (tropical cultivars)	150 days	Fiber
251	Cotton (tropical cultivars)	165 days	Fiber
252	Cotton (tropical cultivars)	180 days	Fiber
253	Cotton (temperate and subtropical cultivars)	135 days	Fiber
254	Cotton (temperate and subtropical cultivars)	150 days	Fiber
255	Cotton (temperate and subtropical cultivars)	165 days	Fiber
256	Flax	90 days	Fiber
257	Flax	105 days	Fiber
258	Flax	120 days	Fiber
259	Coffee arabica	perennial	Green beans
260	Coffee robusta	perennial	Green beans
261	Tea china tea (*camelia sinenses*)	perennial	Leaves
262	Tea hybrid (*sinensis and assamica*)	perennial	Leaves
263	Tea assam tea (*camelia sinenses var. assamica*)	perennial	Leaves
264	Tobacco (tropical cultivars)	105 days	Leaves
265	Tobacco (tropical cultivars)	120 days	Leaves
266	Tobacco (tropical cultivars)	135 days	Leaves
267	Tobacco (temperate and subtropical cultivars)	150 days	Leaves
268	Tobacco (temperate and subtropical cultivars)	165 day)	Leaves
269	Alfalfa (temperate and subtropical cultivars)	perennial	AGB
270	Alfalfa (tropical cultivars)	perennial	AGB
271	Pasture legumes (C3/I species)	perennial	AGB
272	Pasture legumes (C3/II species)	perennial	AGB
273	Pasture grasses (C3/I species)	perennial	AGB

Code	Crop type	Growth cycle	Harvested part
274	Pasture grasses (C3/II species)	perennial	AGB
275	Pasture grasses (C4/II species)	perennial	AGB
276	Pasture grasses (C4/I species)	perennial	AGB
277	Miscanthus (C4/II type)	perennial	AGB
278	Miscanthus (C4/I type)	perennial	AGB
279	Switchgrass	perennial	AGB
280	Reed canary grass	perennial	AGB

Appendix 5: Actual Yield and Production Data

Table A5-1 lists the data available in the theme Actual Yield and Production. Crop production are expressed in Geary-Khamis Dollar (GK$).

Table A5-1 Actual Yield and Production data available in the GAEZ Portal

Crop production value (GK$)	Total crop production value (by 5 min latitude/longitude grid cell) Cereal production value (by 5 min latitude/longitude grid cell) Oil crops production value (by 5 min latitude/longitude grid cell) Root & tubers production value (by 5 min latitude/longitude grid cell) Total crop production value per hectare Cereal production value per hectare
Crop harvested area, yield and production	Harvested area Yield Production

Actual Yield and Production data is available for 23 major crops/commodities (Table A5-2), which correspond with FAOSTAT data.

Table A5-2 Major crops/commodity groups available for actual yield and production

Code	Crop/commodity	Crops
1	Wheat	Wheat
2	Rice	Rice
3	Maize	Maize
4	Sorghum	Sorghum
5	Millet	Millet
6	Other cereals	Barley, Rye, Oat and minor other cereals
7	Tubers	Potato, Sweet potato
8	Roots	Cassava, Yams, other Roots and Plantain
9	Sugar beet	Sugar beet
10	Sugarcane	Sugarcane
11	Pulses	Pulses
12	Soybean	Soybean
13	Rape	Rapeseed
14	Sunflower	Sunflower
15	Groundnut	Groundnuts in shells
16	Oil palm	Oil palm
17	Olive	Olive
18	Cotton	Cotton
19	Cash crops 1	Banana, Coconut
20	Vegetables	Vegetables
21	Cash crops 2	Coffee, Tea, Cocoa
22	Fodder	Fodder
23	Residual	Other crops not listed: mainly fruit, nuts, spices, tobacco, fiber crops, other oil crops

Appendix 6: Yield and Production Gap Data

Data in the Yield and Production Gaps theme are listed in Table A6-1.

Table A6-1 Yield and Production Gap data available in the GAEZ Portal

Aggregate yield ratio	Ratio of actual and potential yield, Main crops Ratio of actual and potential yield, Cereal crops Ratio of actual and potential yield, Oil crops Ratio of actual and potential yield, Roots and tubers
Production gap	Ratio of actual and potential yield Difference of actual and potential production

Yield and Production Gaps are provided for 18 major crops:

Table A6-2 Major crops/commodity groups

Code	Crop/commodity	Crops
1	Wheat	Wheat
2	Rice	Rice
3	Maize	Maize
4	Sorghum	Sorghum
5	Millet	Millet
7	Tubers	Potato, Sweet potato
8	Roots	Cassava, Yams, other Roots and Plantain
9	Sugar beet	Sugar beet
10	Sugarcane	Sugarcane
11	Pulses	Pulses
12	Soybean	Soybean
13	Rape	Rapeseed
14	Sunflower	Sunflower
15	Groundnut	Groundnuts in shells
16	Oil palm	Oil palm
17	Olive	Olive
18	Cotton	Cotton

Table A6-3 List of commodities and unit/price relationships for downscaling and yield gap assessments

COMMODITIES FOR DOWNSCALING AND YIELD GAP ASSESSMENTS									
Commodities		FAOSTAT (HARVESTED WEIGHT)				GAEZ (DRY WEIGHT)			FAOSTAT-GAEZ
Code	Name	Commodities	Produce	Unit	Price (GK$/t)	Crop/LUTs	Produce	Unit	Conversion factor
1	Wheat	Wheat	grain	tons	155	Wheat LUTs	grain	tons	0.875
2	Rice	Rice	grain	tons	200	Wetland rice LUTs	grain	tons	0.875
3	Maize	Maize	grain	tons	125	Grain maize LUTs	grain	tons	0.87
4	Sorghum	Sorghum	grain	tons	130	Sorghum LUTs	grain	tons	0.88
5	Millet	Millet	grain	tons	140, 170	Pearl millet and foxtail millet LUTs	grain	tons	0.9
6	Other cereals	Other cereals	grain	tons	92 - 250	Barley, rye, oat, buckwheat, dry rice LUTs	grain	tons	0.875-0.9
7	Tubers	Potato, Sweet potato	tuber	tons	105, 85	Potato and sweet potato LUTs	tuber	tons	0.25, 0.3
8	Roots	Cassava, Yams, other roots and Plantain	root	tons	75, 95, 120	Cassava, yam, cocoyam and plantain LUTs	root	tons	0.35
9	Sugar beet	Sugar beet	root	tons	32	Sugar beet LUTs	sugar	tons	0.14
10	Sugarcane	Sugar cane	stalk	tons	20	Sugarcane LUT	sugar	tons	0.1
11	Pulses	Pulses	grain	tons	235 - 500	Ph. bean, chickpea, cowpea, dry pea, grams, pigeon-pea LUTs	grain	GK$	1
12	Soybean	Soybean	grain	tons	250	Soybean LUTs	grain	tons	0.9
13	Rape	Rapeseed	seed	tons	330	Rape LUTs	seed	tons	0.9
14	Sunflower	Sunflower	seed	tons	300	Sunflower LUTs	seed	tons	0.9
15	Groundnut	Groundnuts in shells	grain	tons	436	Groundnut LUTs	grain	tons	0.67
16	Oil palm	Oilpalm	fruit	tons	75	Oil palm LUT	oil	tons	0.225
17	Olive	Olive	fruit	tons	500	Olive LUT	oil	tons	0.22
18	Cotton	Cotton	seed + lint	tons	525, 1430	Cotton LUTs	lint	tons	0.35
19	Cash crops 1	Banana, Coconut	fruit	tons	150, 105	Banana & coconut LUTs	fruit, copra	GK$	0.35, 0.175
20	Vegetables	Vegetables	various	tons	100 - 1650	Vegetables LUTs (cabbage, carrot, oinion, tomato)	various	GK$	0.125-0.175
21	Cash crops 2	Coffee, Tea, Cocoa	beans, leaves	tons	1000, 1500, 750	Coffee LUTs, tea LUTs, cocoa LUTs	beans, cd. leaves	GK$	0.35, 0.3, 0.5
22	Fodder	Fodder	AGB	tons	25	Fodder LUTs	AGB	GK$	0.1
23	Residual	Other crops not listed above	various	tons	90 - 4500	n.a.	n.a.	n.a.	n.a.

Yield and production gap assessments

Pulses in FAOSTAT include: Dry beans, Dry broad beans, Dry peas, Chick-peas, Cow peas, Pigeon peas, Lentils, Bambara beans, other pulses.

AGB = Above ground biomass

Appendix 7: List of regions/countries/sub-national divisions

Table A7-1 List of GAEZ regions

RG1 code	REGION 1
11	Northern America
21	Eastern Europe and Russian Federation
22	Northern Europe
23	Southern Europe
24	Western Europe
31	Caribbean
32	Central America
41	South America
51	Australia & New Zealand
52	Pacific Islands
61	Eastern Africa Sudano-Sahelian Africa
62	Central Africa
63	Northern Africa
64	Southern Africa
65	Western Africa
66	Gulf of Guinea
71	Western Asia
81	South-eastern Asia
82	Southern Asia
84	Eastern Asia
85	Central Asia
90	Antarctica

RG2 code	REGION 2
10	Northern America
20	Europe and Russian Federation
30	Central America and Caribbean
40	South America
50	Oceania
60	Sub-Saharan Africa
70	Northern Africa & Western Asia
80	Central, South, South-eastern and eastern Asia
90	Antarctica

Table A7-2 List of regions and countries

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
1	Canada	11	Northern America	10	North America	High income
2	Greenland	11	Northern America	10	North America	High income
3	United States of America	11	Northern America	10	North America	High income
4	Belarus	21	Eastern Europe	20	Europe	Upper middle income
5	Bulgaria	21	Eastern Europe	20	Europe	Upper middle income
6	Czech Republic	21	Eastern Europe	20	Europe	High income
7	Hungary	21	Eastern Europe	20	Europe	High income
8	Moldova, Republic of	21	Eastern Europe	20	Europe	Upper middle income
9	Poland	21	Eastern Europe	20	Europe	High income
10	Romania	21	Eastern Europe	20	Europe	Upper middle income
11	Russian Federation	21	Eastern Europe	20	Europe	Upper middle income
12	Slovakia	21	Eastern Europe	20	Europe	High income
13	Ukraine	21	Eastern Europe	20	Europe	Lower middle income
14	Denmark	22	Northern Europe	20	Europe	High income
15	Estonia	22	Northern Europe	20	Europe	High income
16	Faroe Islands	22	Northern Europe	20	Europe	High income
17	Finland	22	Northern Europe	20	Europe	High income
18	Iceland	22	Northern Europe	20	Europe	High income
19	Ireland	22	Northern Europe	20	Europe	High income
20	Isle of Man	22	Northern Europe	20	Europe	High income
21	Latvia	22	Northern Europe	20	Europe	Upper middle income
22	Lithuania	22	Northern Europe	20	Europe	Upper middle income
23	Norway	22	Northern Europe	20	Europe	High income
24	Sweden	22	Northern Europe	20	Europe	High income
25	United Kingdom	22	Northern Europe	20	Europe	High income
26	Albania	23	Southern Europe	20	Europe	Upper middle income
27	Bosnia and Herzegovina	23	Southern Europe	20	Europe	Upper middle income
28	Croatia	23	Southern Europe	20	Europe	High income
29	Greece	23	Southern Europe	20	Europe	High income
30	Italy	23	Southern Europe	20	Europe	High income
31	Madeira Islands	23	Southern Europe	20	Europe	High income
32	Montenegro	23	Southern Europe	20	Europe	Upper middle income
33	Portugal	23	Southern Europe	20	Europe	High income
34	Republic of Serbia	23	Southern Europe	20	Europe	Upper middle income
35	Slovenia	23	Southern Europe	20	Europe	High income
36	Spain	23	Southern Europe	20	Europe	High income
37	The frm Yug Rep of Macedonia	23	Southern Europe	20	Europe	Upper middle income
38	Austria	24	Western Europe	20	Europe	High income
39	Belgium	24	Western Europe	20	Europe	High income
40	France	24	Western Europe	20	Europe	High income
41	Germany	24	Western Europe	20	Europe	High income
42	Luxembourg	24	Western Europe	20	Europe	High income

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
43	Netherlands	24	Western Europe	20	Europe	High income
44	Switzerland	24	Western Europe	20	Europe	High income
45	Bahamas	31	Caribbean	10	North America	High income
46	Cuba	31	Caribbean	10	North America	Upper middle income
47	Dominica	31	Caribbean	10	North America	Upper middle income
48	Dominican Republic	31	Caribbean	10	North America	Upper middle income
49	Guadeloupe	31	Caribbean	10	North America	High income
49	Guatemala	32	Central America	10	North America	Lower middle income
50	Haiti	31	Caribbean	10	North America	Low income
51	Jamaica	31	Caribbean	10	North America	Upper middle income
52	Martinique	31	Caribbean	10	North America	High income
53	Netherlands Antilles	31	Caribbean	10	North America	High income
54	Puerto Rico	31	Caribbean	10	North America	High income
55	Trinidad and Tobago	31	Caribbean	10	North America	High income
56	Belize	32	Central America	10	North America	Lower middle income
57	Costa Rica	32	Central America	10	North America	Upper middle income
58	El Salvador	32	Central America	10	North America	Lower middle income
60	Honduras	32	Central America	10	North America	Lower middle income
61	Mexico	32	Central America	10	North America	Upper middle income
62	Nicaragua	32	Central America	10	North America	Lower middle income
63	Panama	32	Central America	10	North America	Upper middle income
64	Argentina	41	South America	40	South America	Upper middle income
65	Bolivia	41	South America	40	South America	Lower middle income
66	Brazil	41	South America	40	South America	Upper middle income
67	Chile	41	South America	40	South America	Upper middle income
68	Colombia	41	South America	40	South America	Upper middle income
69	Ecuador	41	South America	40	South America	Upper middle income
70	Falkland Islands (Malvinas)	41	South America	40	South America	N/A
71	French Guiana	41	South America	40	South America	High income
72	Guyana	41	South America	40	South America	Lower middle income
73	Paraguay	41	South America	40	South America	Lower middle income
74	Peru	41	South America	40	South America	Upper middle income
75	Suriname	41	South America	40	South America	Upper middle income
76	Uruguay	41	South America	40	South America	Upper middle income
77	Venezuela	41	South America	40	South America	Upper middle income
78	Australia	51	Australia and New Zealand	50	Oceania	High income
79	New Zealand	51	Australia and New Zealand	50	Oceania	High income
80	Fiji	52	Melanesia	50	Oceania	Lower middle income
81	New Caledonia	52	Melanesia	50	Oceania	High income
82	Papua New Guinea	52	Melanesia	50	Oceania	Lower middle income
83	Solomon Islands	52	Melanesia	50	Oceania	Lower middle income
84	Vanuatu	52	Melanesia	50	Oceania	Lower middle income
85	Burundi	61	Eastern Africa	60	Sub-Saharan Africa	Low income
86	Comoros	61	Eastern Africa	60	Sub-Saharan Africa	Low income

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
87	Djibouti	61	Eastern Africa	60	Sub-Saharan Africa	Lower middle income
88	Eritrea	61	Eastern Africa	60	Sub-Saharan Africa	Low income
89	Ethiopia	61	Eastern Africa	60	Sub-Saharan Africa	Low income
90	Ilemi triangle	61	Eastern Africa	60	Sub-Saharan Africa	Low income
91	Kenya	61	Eastern Africa	60	Sub-Saharan Africa	Low income
92	Madagascar	61	Eastern Africa	60	Sub-Saharan Africa	Low income
93	Malawi	61	Eastern Africa	60	Sub-Saharan Africa	Low income
94	Mozambique	61	Eastern Africa	60	Sub-Saharan Africa	Low income
95	Rwanda	61	Eastern Africa	60	Sub-Saharan Africa	Low income
96	Somalia	61	Eastern Africa	60	Sub-Saharan Africa	Low income
97	North Sudan	63	Northern Africa	70	North Africa & Western Asia	Lower middle income
97	South Sudan	63	Northern Africa	70	North Afr. & West. Asia	Lower middle income
98	Uganda	61	Eastern Africa	60	Sub-Saharan Africa	Low income
99	United Republic of Tanzania	61	Eastern Africa	60	Sub-Saharan Africa	Low income
100	Zambia	61	Eastern Africa	60	Sub-Saharan Africa	Lower middle income
101	Zimbabwe	61	Eastern Africa	60	Sub-Saharan Africa	Low income
102	Angola	62	Middle Africa	60	Sub-Saharan Africa	Lower middle income
103	Cameroon	62	Middle Africa	60	Sub-Saharan Africa	Lower middle income
104	Central African Republic	62	Middle Africa	60	Sub-Saharan Africa	Low income
105	Chad	62	Middle Africa	60	Sub-Saharan Africa	Low income
106	Congo	62	Middle Africa	60	Sub-Saharan Africa	Low income
107	Dem Republic of the Congo	62	Middle Africa	60	Sub-Saharan Africa	Lower middle income
108	Equatorial Guinea	62	Middle Africa	60	Sub-Saharan Africa	Low income
109	Gabon	62	Middle Africa	60	Sub-Saharan Africa	Upper middle income
110	Sao Tome and Principe	62	Middle Africa	60	Sub-Saharan Africa	Lower middle income
111	Algeria	11	Northern Africa	70	North Africa & Western Asia	Upper middle income
112	Egypt	63	Northern Africa	70	North Africa & Western Asia	Lower middle income
113	Hala'ib triangle	63	Northern Africa	70	North Africa & Western Asia	Lower middle income
114	Libyan Arab Jamahiriya	63	Northern Africa	70	North Africa & Western Asia	Upper middle income
115	Ma'tan al-Sarra	63	Northern Africa	70	North Africa & Western Asia	Upper middle income
116	Morocco	63	Northern Africa	70	North Africa & Western Asia	Lower middle income
117	Tunisia	63	Northern Africa	70	North Africa & Western Asia	Upper middle income
118	Western Sahara	63	Northern Africa	70	North Africa & Western Asia	Lower middle income
119	Botswana	64	Southern Africa	60	Sub-Saharan Africa	Upper middle income
120	Lesotho	64	Southern Africa	60	Sub-Saharan Africa	Lower middle income
121	Namibia	64	Southern Africa	60	Sub-Saharan Africa	Upper middle income
122	South Africa	64	Southern Africa	60	Sub-Saharan Africa	Upper middle income
123	Swaziland	64	Southern Africa	60	Sub-Saharan Africa	Lower middle income
124	Benin	65	Western Africa	60	Sub-Saharan Africa	Low income

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
125	Burkina Faso	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
126	Cote d'Ivoire	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
127	Gambia	65	Western Africa	60	Sub-Saharan Africa	Low income
128	Ghana	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
129	Guinea	65	Western Africa	60	Sub-Saharan Africa	Low income
130	Guinea-Bissau	65	Western Africa	60	Sub-Saharan Africa	Low income
131	Liberia	65	Western Africa	60	Sub-Saharan Africa	Low income
132	Mali	65	Western Africa	60	Sub-Saharan Africa	Low income
133	Mauritania	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
134	Niger	65	Western Africa	60	Sub-Saharan Africa	Low income
135	Nigeria	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
136	Senegal	65	Western Africa	60	Sub-Saharan Africa	Lower middle income
137	Sierra Leone	65	Western Africa	60	Sub-Saharan Africa	Low income
138	Togo	65	Western Africa	60	Sub-Saharan Africa	Low income
139	Cyprus	71	Western Asia	70	North Africa & Western Asia	High income
140	Iraq	71	Western Asia	70	North Africa & Western Asia	Lower middle income
141	Israel	71	Western Asia	70	North Africa & Western Asia	High income
142	Jordan	71	Western Asia	70	North Africa & Western Asia	Upper middle income
143	Kuwait	71	Western Asia	70	North Africa & Western Asia	High income
144	Lebanon	71	Western Asia	70	North Africa & Western Asia	Upper middle income
145	Oman	71	Western Asia	70	North Africa & Western Asia	High income
146	Qatar	71	Western Asia	70	North Africa & Western Asia	High income
147	Saudi Arabia	71	Western Asia	70	North Africa & Western Asia	High income
148	Syrian Arab Republic	71	Western Asia	70	North Africa & Western Asia	Lower middle income
149	Turkey	71	Western Asia	70	North Africa & Western Asia	Upper middle income
150	United Arab Emirates	71	Western Asia	70	North Africa & Western Asia	High income
151	West Bank	71	Western Asia	70	North Africa & Western Asia	Lower middle income
152	Yemen	71	Western Asia	70	North Africa & Western Asia	Lower middle income
153	Brunei Darussalam	81	South-Eastern Asia	80	Asia (excl. Western Asia)	High income
154	Cambodia	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Low income
155	Indonesia	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
156	Lao People's Dem Republic	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
157	Malaysia	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Upper middle income
158	Myanmar	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Low income
159	Philippines	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
160	Thailand	81	South-Eastern Asia	80	Asia (excl. W. A)	Lower middle income
161	Timor-Leste	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
162	Viet Nam	81	South-Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
163	Afghanistan	82	Southern Asia	80	Asia (excl. Western Asia)	Low income
164	Bangladesh	82	Southern Asia	80	Asia (excl. Western Asia)	Low income
165	Bhutan	82	Southern Asia	80	Asia (excl. Western Asia)	Lower middle income
166	India	82	Southern Asia	80	Asia (excl. Western Asia)	Lower middle income
167	Iran (Islamic Republic of)	82	Southern Asia	80	Asia (excl. Western Asia)	Upper middle income
168	Jammu Kashmir	82	South Asia	80	Asia (excl. Western Asia)	N/A
169	Nepal	82	Southern Asia	80	Asia (excl. Western Asia)	Low income
170	Pakistan	82	Southern Asia	80	Asia (excl. Western Asia)	Lower middle income
171	Sri Lanka	82	Southern Asia	80	Asia (excl. Western Asia)	Lower middle income
172	Aksai Chin	84	Eastern Asia	80	Asia (excl. Western Asia)	N/A
173	Arunashal Pradesh	84	Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
174	China	84	Eastern Asia	80	Asia (excl. Western Asia)	Upper middle income
175	China/India	84	Eastern Asia	80	Asia (excl. Western Asia)	N/A
176	Dem People's Rep of Korea	84	Eastern Asia	80	Asia (excl. Western Asia)	Low income
177	Hong Kong	84	Eastern Asia	80	Asia (excl. Western Asia)	High income
178	Japan	84	Eastern Asia	80	Asia (excl. Western Asia)	High income
179	Kuril islands	84	Eastern Asia	80	Asia (excl. Western Asia)	Upper middle income
180	Mongolia	84	Eastern Asia	80	Asia (excl. Western Asia)	Lower middle income
181	Republic of Korea	84	Eastern Asia	80	Asia (excl. Western Asia)	High income
182	Armenia	85	Central Asia	80	Asia (excl. Western Asia)	Lower middle income
183	Azerbaijan	85	Central Asia	80	Asia (excl. Western Asia)	Upper middle income
184	Georgia	85	Central Asia	80	Asia (excl. Western Asia)	Lower middle income
185	Kazakhstan	85	Central Asia	80	Asia (excl. Western Asia)	Upper middle income

GAEZ #	RG3 (country) name	RG2 code	RG2 name	RG1 code	RG1 name	Income level
186	Kyrgyzstan	85	Central Asia	80	Asia (excl. Western Asia)	Lower middle income
187	Tajikistan	85	Central Asia	80	Asia (excl. Western Asia)	Low income
188	Turkmenistan	85	Central Asia	80	Asia (excl. Western Asia)	Low income
189	Uzbekistan	85	Central Asia	80	Asia (excl. Western Asia)	Lower middle income
190	Rest of World*					

* **Rest of World** countries in GAEZ consist of countries with fewer than 10 pixels (except for Antarctica and Fr. South and Antarctic Territories) and comprise of the following countries: Heard Isl and McDonald Isl, S.Georgia and S.Sandwich Isl, Fr South and Antarctic Ter., Baker Island, Kingman Reef, Saint Pierre et Miquelon, Howland Island, Jarvis Island, Johnston Atoll, Midway Island, Navassa Island, Palmyra Atoll, Gibraltar, Holy See, Dhekelia and Akrotiri SBA, Guernsey, Jersey, Andorra, Malta, Liechtenstein, Glorioso Island, Monaco, Anguilla, Antigua and Barbuda, Aruba, Barbados, Cayman Islands, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia, St Vincent and the Grenadines, Turks and Caicos islands, United States Virgin Islands, Bird Island, Nauru, American Samoa, Cook Islands, Guam, Kiribati, Micronesia (Fed States of), Niue, Northern Mariana Islands, Palau, Tonga, Wallis and Futuna, Tokelau, Tuvalu, Wake Island, Bassas da India, Mayotte, Seychelles, Saint Helena, British Indian Ocean Territory, Juan de Nova Island, Tromelin Island, Ashmore and Cartier Islands, Cocos (Keeling) Islands, Scarborough Reef, Liancourt Rock, Macau, Senkaku Islands, Bouvet Island, Bermuda, San Marino, Clipperton Island, British Virgin Islands, Bahrain, Gaza Strip, Norfolk Island, Marshall Islands, Pitcairn, Christmas Island, Singapore, Maldives, Paracel Islands, Spratly Islands

Table A7-3 List of first level sub-national divisions for eight large countries

Australia	Russian Federation	United States of America
Australian Capital Territory	Adygeya Rep.	Alabama
New South Wales	Aginskiy Buryatskiy A. Okrug	Alaska
Northern Territory	Altay Rep.	Arizona
Other Territories	Altayskiy Kray	Arkansas
Queensland	Amurskaya Oblast	California
South Australia	Arkhangelskaya Oblast	Colorado
Tasmania	Astrakhanskaya Oblast	Connecticut
Victoria	Bashkortostan Rep.	Delaware
Western Australia	Belgorodskaya Oblast	District Of Columbia
Brasil	Bryanskaya Oblast	Florida
Acre	Buryatiya Rep.	Georgia
Alagoas	Chechnya Rep.	Hawaii
Amapa	Chelyabinskaya Oblast	Idaho
Amazonas	Chitinskaya Oblast	Illinois
Bahia	Chukotskiy Okrug	Indiana
Ceara	Chuvashiya Rep.	Iowa
Distrito Federal	Dagestan Rep.	Kansas
Espirito Santo	Evenkiyskiy Okrug	Kentucky
Goias	Ingushetiya Rep.	Louisiana
Maranhao	Irkutskaya Oblast	Maine
Mato Grosso	Ivanovskaya Oblast	Maryland
Mato Grosso Do Sul	Kabardino-balkariya Rep.	Massachusetts
Minas Gerais	Kaliningradskaya Oblast	Michigan
Para	Kalmykiya Rep.	Minnesota
Paraiba	Kaluzhskaya Oblast	Mississippi
Parana	Kamchatskaya Oblast	Missouri
Pernambuco	Karatchayevo-cherkesiya Rep.	Montana
Piaui	Karelya Rep.	Nebraska
Rio De Janeiro	Kemerovskaya Oblast	Nevada
Rio Grande Do Norte	Khabarovskiy Kray	New Hampshire
Rio Grande Do Sul	Khakasiya Rep.	New Jersey
Rondonia	Khanty-mansyiskiy Okrug	New Mexico
Roraima	Kirovskaya Oblast	New York
Santa Catarina	Komi Rep.	North Carolina
Sao Paulo	Komi-permyatskiy Okrug	North Dakota
Sergipe	Koryakskiy Okrug	Ohio
Tocantins	Kostromskaya Oblast	Oklahoma
Canada	Krasnodarskiy Kray	Oregon
Alberta	Krasnoyarskiy Kray	Pennsylvania
British Columbia	Kurganskaya Oblast	Rhode Island
Manitoba	Kurskaya Oblast	South Carolina
New Brunswick	Leningradskaya Oblast	South Dakota
Newfoundland and Labrador	Lipetskaya Oblast	Tennessee
Northwest Territories	Magadanskaya Oblast	Utah
Nova Scotia	Mariy-el Rep.	Vermont
Nunavut	Mordoviya Rep.	Virginia
Ontario	Moskovskaya Oblast	Washington
Prince Edward Island	Moskva	West Virginia
Quebec	Murmanskaya Oblast	Wisconsin
Saskatchewan	Name Unknown	Wyoming

Canada cont'd	Russian Federation cont'd	India
Yukon Territory	Nenetskiy Okrug	Andaman & Nicobar
China	Nizhegorodskaya Oblast	Andhra Pradesh
Anhui Sheng	Novgorodskaya Oblast	Arunachal Pradesh
Beijing Shi	Novosibirskaya Oblast	Assam
Chongqing Shi	Omskaya Oblast	Bihar
Fujian Sheng	Orenburgskaya Oblast	Delhi (Union Territory)
Gansu Sheng	Orlovskaya Oblast	Goa
Guangdong Sheng	Penzenskaya Oblast	Gujarat
Guangxi Zhuangzu Zizhiqu	Permskaya Oblast	Haryana
Guizhou Sheng	Primorskiy Kray	Himachal Pradesh
Hainan Sheng	Pskovskaya Oblast	Karnataka
Hebei Sheng	Rostovskaya Oblast	Kerala
Heilongjiang Sheng	Ryazanskaya Oblast	Madhya Pradesh
Henan Sheng	Sakha Rep.	Maharashtra
Hubei Sheng	Sakhalinskaya Oblast	Manipur
Hunan Sheng	Samarskaya Oblast	Meghalaya
Jiangsu Sheng	Sankt-peterburg	Mizoram
Jiangxi Sheng	Saratovskaya Oblast	Nagaland
Jilin Sheng	Severnaya Osetiya-alaniya Rep.	Orissa
Liaoning Sheng	Smolenskaya Oblast	Punjab
Nei Mongol Zizhiqu	Stavropolskiy Kray	Rajasthan
Ningxia Huizu Zizhiqu	Sverdlovskaya Oblast	Sikkim
Qinghai Sheng	Tambovskaya Oblast	Tamil Nadu
Shaanxi Sheng	Tatarstan Rep.	Tripura
Shandong Sheng	Taymyrskiy Okrug	Uttar Pradesh
Shanghai Shi	Tomskaya Oblast	West Bengal
Shanxi Sheng	Tulskaya Oblast	
Sichuan Sheng	Tverskaya Oblast	
Taiwan Sheng	Tyumenskaya Oblast	
Tianjin Shi	Tyva Rep.	
Xinjiang Uygur Zizhiqu	Udmurtiya Rep.	
Xizang Zizhiqu	Ulyanovskaya Oblast	
Yunnan Sheng	Ustordynskiy Buryatskiy Okrug	
Zhejiang Sheng	Vladimirskaya Oblast	
	Volgogradskaya Oblast	
	Vologodskaya Oblast	
	Voronezhskaya Oblast	
	Yamalo-nenetskiy Okrug	
	Yaroslavskaya Oblast	
	Yevreyskaya A. Oblast	

Appendix 8: Geographic masks

Table A7-4 List of geographic masks

Parameter
Soil and Elevation
Dominant soil (class)
Median altitude (m)
Terrain slope occurrence
• 0-2%,
• 0-8%,
• 2-8%,
• 0-16%,
• 8-16%,
• >16%,
• 16-30%,
• >30%.
Land cover
Cultivated land (percent)
Rain-fed cultivated land,(percent)
Irrigated cultivated land (percent)
Forest land (percent)
Grassland and woodland (percent)
Barren and sparsely vegetated land (percent)
Built-up land (percent)
Water bodies (percent)
Legal protection
Protected areas - Restrictions for agricultural use (class)
Protected area types (class)
Population density, accessibility, livestock density
Population density (year 2000)(persons/km2)
Accessibility (about 2000)(minutes)
Ruminant livestock (year 2000)(TLU/km2)
Thermal and moisture conditions
Thermal climates (class)
Temperature growing period (days)
Frost-free period (days)
Reference permafrost zones (class)
Annual precipitation (mm)
Annual P/PET ratio, annual (percent)
Reference length growing period days (days)

Appendix 9: Spatial Data Availability for GAEZ Themes

GAEZ Data Portal						
	Time period					
	none	Historical	30 years	Baseline	Future	2000
Land Resources Theme						
(i) Soil Resources:	v					
Dominant soil	v					
Nutrient availability	v					
Nutrient retaining capacity	v					
Rooting conditions	v					
Oxygen availability	v					
Excess salts	v					
Toxicities	v					
Workability	v					
Rain-fed soil suitability (low inputs)	v					
Rain-fed soil suitability (high inputs)	v					
Rain-fed soil and terrain suitability (low inputs)	v					
Rain-fed soil and terrain suitability (high inputs)	v					
(ii) Water Resources						
Major river basins	v					
Water scarcity	v					
Irrigated cultivated land	v					
Water collecting sites	v					
(iii) Terrain Resources						
Median altitude	v					
Median terrain slope class	v					
Terrain slope index	v					
Terrain slope 0-0.5%	v					
Terrain slope 0.5-2%	v					
Terrain slope 2-5%	v					
Terrain slope 5-8%	v					
Terrain slope 8-16%	v					
Terrain slope 16-30%	v					
Terrain slope 30-45%	v					
Terrain slope >45%	v					
Terrain slope 0-2%	v					
Terrain slope 2-8%	v					
Terrain slope 0-8%	v					
Terrain slope 0-16%	v					

Terrain slope >16%	v					
Terrain slope >30%	v					
(iv) Land Cover						
Dominant land cover pattern						v
Cultivated land						v
Rain-fed cultivated land						v
Irrigated cultivated land						v
Forest land						v
Grassland &woodland						v
Barren and sparsely vegetated land						v
Built-up land						v
Waterbodies						v
(v) Protected Areas*						
Protected area types						
Protected areas - Restrictions for agricultural use						
(vi) Selected socio economic and demographic data						
Population density (year 2000)						v
Ruminant livestock (year2000)						v
Accesibility (about 2000)						v
Agro–climatic Resources Theme						
(i) Thermal regimes:						
Mean Annual temperature		v		v	v	
Annual temperature range				v	v	
Thermal climates				v	v	
Thermal zones				v	v	
Temperature growing periods		v		v	v	
Frost-free period		v		v	v	
Tsum during temperature growing period		v		v	v	
Tsum during frost free period		v		v	v	
Air frost number,		v		v	v	
Snow adjusted air frost number				v	v	
Reference permafrost zones				v		
(ii) Moisture regimes						
Annual Precipitation		v		v	v	
Annual Precipitation (1961-90) CV (%)		v		v	v	
Annual Precipitation (1961-90) SD (mm)		v		v	v	
Fournier index		v		v	v	
Fournier index (1961-90) CV (%)		v		v	v	
Fournier index (1961-90) SD (mm)		v		v	v	
Reference evapotranspiration		v		v	v	
Annual P/PET ratio		v		v	v	

Annual P/PET ratio (1961-90) CV (%)		**v**		**v**	**v**	
Annual P/PET ratio (1961-90) SD (ratio)		**v**		**v**	**v**	
Seasonal P/PET ratios (2)		**v**		**v**	**v**	
Quaterly P/PET ratios (4)		**v**		**v**	**v**	
(iii) Growing period						
Reference length of growing period		**v**		**v**	**v**	
Reference length of growing period zones		**v**		**v**	**v**	
Reference length of growing period (1961-90) CV (%)		**v**		**v**	**v**	
Reference length of growing period (1961-90) SD (days)		**v**		**v**	**v**	
NPP (rain-fed)		**v**		**v**	**v**	
NPP (irrigated)		**v**		**v**	**v**	
Suitability and Potential Yield Theme						
(i) Agro-climatic yield	See SPY (Appendix 10)					
Agro-climatically attainable yields						
Crop LUT selection						
Crop actual evapotranspiration						
Crop specific accumulated temperature						
SD of agro-climatically attainable yields						
CV of agro-climatically attainable yields						
(ii) Climate yield constraints						
Temperature constraint factors						
Moisture constraint factors:						
Agro-climatic constraint factor						
Combined climate related constraint factor						
Crop water deficit						
(iii) Crop calendar						
Start crop growth cycle						
Length of crop growth cycle						
(iv) Agro-ecological suitability and productivity						
Crop suitability index (class)						
Crop suitability index (value)						
Total production capacity (t/ha)						
Crop suitability index (class) for current cultivated land						
Crop suitability index (value) for current cultivated land						
Potential production capacity (t/ha) for current cultivated land						
Actual Yield and Production Theme						
(i) Crop production Value (GK$)						
Total crop production value (by 5 arc-minute grid-cell)						**v**

Cereal production value (by 5 arc-minute grid-cell)						**v**
Oil crop production value (by 5 arc-minute grid-cell)						**v**
Roots &tubers production value (by 5 arc-minute grid-cell)						**v**
Total crop production value per hectare						**v**
Cereal production value per hectare						**v**
(ii) Crop Harvested area, Yield and Production						
Harvested area (23 crops/commodities)						**v**
Yield (23 crops/commodities)						**v**
Production (23 crops/commodities)						**v**
Yield and Production Gap Theme						
(i) Aggregate Yield Ratio						
Ratio of actual over potential yield, Main crops						**v**
Ratio of actual over potential yield, Cereals						**v**
Ratio of actual over potential yield, Oil crops						**v**
Ratio of actual over potential yield, Roots&tubers						**v**
(ii) Crop Yield and Production Gap						
Ratio of actual over potential yield (17 crops/commodities)						**v**
Differenceof potential and actual production (17 crops/commodities)						**v**
* WDPA 2009 and Natura 2000						

Appendix 10: Spatial Data Availability for Suitability and Potential Yield Assessment

Agroclimatic Yield															
Attainable Yield Rain-fed Crop					Attainable Yield Rain-fed Crop type					Attainable Yield Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H	√	√	√	√	H	√	√	√	√	H	√	√	√	
I			√	√	I			√	√	I			√	
L			√	√	L			√	√	L			√	
Attainable Yield Irrigated Crop					Attainable Yield Irrigated Crop type					Attainable Yield Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H			√	√	H			√	
I			√	√	I			√	√	I			√	
L					L					L				
Crop LUT selection Rain-fed Crop					Crop LUT selection Rain-fed Crop type					Crop LUT selection Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H		√	√	√	H		√	√	√	H	not applicable			
I			√	√	I			√	√	I				
L			√	√	L			√	√	L				
Crop LUT selection Irrigated Crop					Crop LUT selection Irrigated Crop type					Crop LUT selection Irrigated Crop/LUT				

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

input	Time period			
	Historical	30 years	Baseline	Future
H	not applicable			
I				
L				

Crop specific actual evapotranspiration
Rain-fed
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop specific actual evapotranspiration
Rain-fed
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop specific actual evapotranspiration
Rain-fed
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	
I			√	
L			√	

Crop specific actual evapotranspiration
Irrigated
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop specific actual evapotranspiration
Irrigated
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop specific actual evapotranspiration
Irrigated
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H			√	
I			√	
L				

Crop specific acumulated temperature
Rain-fed
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop specific acumulated temperature
Rain-fed
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop specific acumulated temperature
Rain-fed
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	
I			√	
L			√	

Crop specific acumulated temperature
Irrigated
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop specific acumulated temperature
Irrigated
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop specific acumulated temperature
Irrigated
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H			√	
I			√	
L				

SD and CV of attainable yields Rain-fed Crop					SD and CV of attainable yields Rain-fed Crop type					SD and CV of attainable yields Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H		√			H		√			H		√		
I					I					I				
L					L					L				
SD and CV of attainable yields Irrigated Crop					SD and CV of attainable yields Irrigated Crop type					SD and CV of attainable yields Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H					H					H				
I					I					I				
L					L					L				
Climate yield constraints														
Temperature constraints Rain-fed Crop					Temperature constraints Rain-fed Crop type					Temperature constraints Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H		√	√	√	H		√	√	√	H		√	√	
I			√	√	I			√	√	I			√	
L			√	√	L			√	√	L			√	
Temperature constraints Irrigated Crop					Temperature constraints Irrigated Crop type					Temperature constraints Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H			√	√	H			√	
I			√	√	I			√	√	I			√	
L					L					L				

Moisture constraints Rain-fed Crop					Moisture constraints Rain-fed Crop type					Moisture constraints Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H	√	√	√	√	H	√	√	√	√	H	√	√	√	
I			√	√	I			√	√	I			√	
L			√	√	L			√	√	L			√	
Moisture constraints Irrigated Crop					Moisture constraints Irrigated Crop type					Moisture constraints Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H		√	√	√	H		√	√	√	H		√	√	
I			√	√	I			√	√	I			√	
L					L					L				
Agro-climatic constraints Rain-fed Crop					Agro-climatic constraints Rain-fed Crop type					Agro-climatic constraints Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H			√	√	H			√	
I			√	√	I			√	√	I			√	
L			√	√	L			√	√	L			√	
Agro-climatic constraints Irrigated Crop					Agro-climatic constraints Irrigated Crop type					Agro-climatic constraints Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H			√	√	H			√	
I			√	√	I			√	√	I			√	
L					L					L				

Combined constraints
Rain-fed
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Combined constraints
Rain-fed
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Combined constraints
Rain-fed
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	
I			√	
L			√	

Combined constraints
Irrigated
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Combined constraints
Irrigated
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Combined constraints
Irrigated
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H			√	
I			√	
L				

Crop water deficits
Rain-fed
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop water deficits
Rain-fed
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	√
I			√	√
L			√	√

Crop water deficits
Rain-fed
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H		√	√	
I			√	
L			√	

Crop water deficits
Irrigated
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop water deficits
Irrigated
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Crop water deficits
Irrigated
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H			√	
I			√	
L				

Crop calendar												
Start and length of growth cycle* Rain-fed Crop					Start and length of growth cycle* Rain-fed Crop type					Start and length of growth cycle* Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H			√	√	H			√	
I			√	√	I			√	√	I			√	
L			√	√	L			√	√	L			√	
Start and length of growth cycle* Irrigated Crop					Start and length of growth cycle* Irrigated Crop type					Start and length of growth cycle* Irrigated Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H					H					H				
I					I					I				
L					L					L				
*** Crop calendar: (i) Annual crops only. (ii) Length of growth cycle only for crops and crop types**														
Agro-ecological suitability and productivity														
Crop suitability index (class and value) Rain-fed (all land) Crop					Crop suitability index (class and value) Rain-fed (all land) Crop type					Crop suitability index (class and value) Rain-fed (all land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L			√	√	L					L				

Crop suitability index (class and value) of current cultivated land Rain-fed Crop					Crop suitability index (class and value) of current cultivated land Rain-fed Crop type					Crop suitability index (class and value) of current cultivated land Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L			√	√	L					L				
Crop suitability index (class and value) Irrigated* (irrigated cultivated land) Crop					Crop suitability index (class and value) Irrigated* (irrigated cultivated land) Crop type					Crop suitability index (class and value) Irrigated* (irrigated cultivated land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L					L					L				
Crop suitability index (class and value) Irrigated Gravity*(irrigated cultivated land) Crop					Crop suitability index (class and value) Irrigated Gravity*(irrigated cultivated land) Crop type					Crop suitability index (class and value) Irrigated Gravity*(irrigated cultivated land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L					L					L				
Crop suitability index (class and value) Irrigated Sprinkler*(irrigated cultivated land) Crop					Crop suitability index (class and value) Irrigated Gravity*(irrigated cultivated land) Crop type					Crop suitability index (class and value) Irrigated Gravity*(irrigated cultivated land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L					L					L				

Crop suitability index (class and value) Irrigated Drip*(irrigated cultivated land) Crop					Crop suitability index (class and value) Irrigated Drip*(irrigated cultivated land) Crop type					Crop suitability index (class and value) Irrigated Drip*(irrigated cultivated land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L					L					L				
*** If applicable for crop**														
Total production capacity Rain-fed (all land) Crop					Total production capacity Rain-fed (all land) Crop type					Total production capacity Rain-fed (all land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L			√	√	L					L				
Total production capacity of current cultivated land Rain-fed Crop					Total production capacity of current cultivated land Rain-fed Crop type					Total production capacity of current cultivated land Rain-fed Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L			√	√	L					L				
Total production capacity Irrigated* (irrigated cultivated land) Crop					Total production capacity Irrigated* (irrigated cultivated land) Crop type					Total production capacity Irrigated* (irrigated cultivated land) Crop/LUT				
input	Time period				input	Time period				input	Time period			
	Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future		Historical	30 years	Baseline	Future
H			√	√	H					H				
I			√	√	I					I				
L					L					L				

Total production capacity
Irrigated Gravity*(irrigated cultivated land)
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Total production capacity
Irrigated Gravity*(irrigated cultivated land)
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Total production capacity
Irrigated Gravity*(irrigated cultivated land)
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Total production capacity
Irrigated Sprinkler*(irrigated cultivated land)
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Total production capacity
Irrigated Sprinkler*(irrigated cultivated land)
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Total production capacity
Irrigated Sprinkler*(irrigated cultivated land)
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Total production capacity
Irrigated Drip*(irrigated cultivated land)
Crop

input	Time period			
	Historical	30 years	Baseline	Future
H			√	√
I			√	√
L				

Total production capacity
Irrigated Drip*(irrigated cultivated land)
Crop type

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Total production capacity
Irrigated Drip*(irrigated cultivated land)
Crop/LUT

input	Time period			
	Historical	30 years	Baseline	Future
H				
I				
L				

Inputs	
H	High Inputs
I	Intermediate Inputs
L	Low Inputs

Time Period	
Historical	Historical Individual Years
30 years	1961-1990 time series
Baseline	Baseline Climate
Future	Future Climates

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