Experimental Organization

The Experimental Organisation menu contains information about the experimental resources including projects, experiments, installations, plants, germplasm, devices, events, phenotypic and environmental variables and object tracking tools.

### Projects

#### What are projects?

A research project is the higher level of organisation in PHIS. It is generally the object of a contract or a grant agreement between the laboratory performing the research activities and funding agencies providing the financial support. A project can hold many experiments from various experimental campaigns. Besides, several projects can participate to the same experimentation.

#### What are project properties?

Projects fact sheets are all public, i.e. visible for every PHIS user, including those unrelated to them. However, experimental data included in a project is also necessarily related to a given experiment. This data is accessible only to users who belong to a group (either owner or guest) authorized to access the experimentation it is related to: access rights are managed by experiment and not by project. Please see the Restrictions to a group section of this documentation for further details on data access matters.

The complete list of projects is available in the Projects menu, accessible from PHIS top navigation bar. The projects list is preceded by a research bar enabling the user to filter projects by their acronym, their main source of funding, and their start and end dates. There's no need to use the same case as the expected results: a lowercase search returns every results matching the characters, disregarding whether those match
are lowercase or uppercase. Further information on a given project is available on its information sheet, accessed to from the projects list through the eye-icon on the right-hand side of this project row.

Create a project

Within the Projects menu, one can create a new project with the Create Project button. Tool tips are provided for most fields: they appear on the left hand side when one drags the pointer on those fields.

The mandatory fields, followed by a red asterisk, are:

- acronym
- name
- date (start / end)

However, it is highly recommended to fill every field. If possible, fields requiring plain text (keywords, description) should be answered to in English.

URI. The project URI is automatically created using the acronym provided by the user. The URI creation respects the w3 recommandations.

Acronym. Short and meaningful, the acronym will be the preferred way to refer to the created project. The acronym provided here is usually the one of the research project. A project acronym cannot include spaces. Once the project created, its acronym can no longer be modified.

Name. Full name of the project, it will seldom be refered to but allows a project creator to explicit the acronym. For instance, RAPeSeed Oil content anD Yield under low Nitrogen input would be an adequate name for the project whose acronym is RAPSODYN.

Subproject Of. If the new project is part of an existing project (requisitly known to PHIS), one can select the name of the given mother-project within the exhaustive list of projects registered to the PHIS instance where the new project is created.
Subproject Type. The subproject type can optionally be provided. It can be either an existing type to be selected from the list of proposed project types, either a new type provided by the user. In the later case, one has to type the new subproject type (e.g. phd thesis or internship) in the search field of Subproject Type and then click on the newly proposed type.

Objective. A short synthesis of the project objectives is to be provided in plain text, preferably in English. A more complete description will be asked in the Description field.

Financial Support. Organism, institution or funding agency providing the financial support of the research project. Only one organism supporting financially the project can be cited for now. Same as the Subproject Type field, the answer can be both from a predefined list or a new one (the user has to type the new organism name and then click on the search result matching the organism name).

Financial Name. As indicated in the tool tip, this field is meant for the user to provide the identification of the financial support document (e.g. a grant agreement number).

Date Start and Date End are to be provided in the format YYYY-MM-DD (year-month-day), directly or through the calendar view. If the end date of the project is unknown, the start date can be used also as Date End temporarily.

Scientific Contacts. Email addresses of the scientists involved in the project. The email addresses refer uniquely to persons existing on PHIS. If unavailable in the predefined list, emails can be added to PHIS from the Persons menu, prior to the new project creation. Please see the Persons section of this documentation for further details.

Administrative Contacts. Email addresses of the administrative personnel linked to the project (e.g. human resources people). The email addresses refer uniquely to persons existing on PHIS.

Project Coordinators. Email addresses of the project coordinators. The email addresses refer uniquely to persons existing on PHIS.

Website. If available, URL of the website of the project.

Keywords. Keywords, preferably in English, characterizing the project. Each keyword should be separated by a comma and not include any capital letter, e.g. drought, maize.

Description. Complete plain text description of the project, preferably provided in English language. Additionally to the description, additional information can be provided as uploaded files, after the project has been created.
Infrastructure

The Infrastructure menu contains information about the different Infrastructure including, European, National and Local Infrastructure, and information about the different Installations.

Information associated to each infrastructure can be explored. For instance information about the Local Infrastructure M3P (http://www.phenome-fppn.fr/m3p) and events concerning this infrastructure can be browsed:
Annotations and events can be associated to each object by using the Add annotation and Add event buttons.

Experiments

What are experiments?

Field plant phenotyping experimentations are referred to in PHIS as Experiments. Experiments in PHIS form self-sustained organizational units occurring in a delimited and known time frame. Every scientific objects and environmental data stored in PHIS field have to be related to an experiment. Experiments include both raw and cleaned data. The data types found in PHIS experiments are including but not limited to:

- phenotypic data
- environmental data
- analysis, workflows and their associated results documents
- giving a deeper understanding of the experiments

What are experiment properties?

Contrary to projects, experiments information sheets are not public, but accessible only to the PHIS members which are part of the groups involved in these experiments. Please go to Access rights for further details on this matter.

From the Experiments menu, a PHIS user has access to the list of experiments it has the rights to access to. Every experiment on this list is characterized by:
• its **URI** which identifies it uniquely its  
• **Alias**, a short internal denomination  
• its start and end dates  
• the experimental installation in which it has been performed  
• the campaign it is part of, i.e. the year

From **Home / Experiments**, one can click on the eye icon on the right to see a given experiment information sheet.

Further information on the experiment is provided on its information sheet, such as the groups of users that have been given access to the experiment’s data. For more detail on experimental data access restrictions, see the section **Restrictions to a group.**

On top of the experiment information sheet, several buttons are displayed. The buttons **Map Visualization** and **Generate Map** enable the visualization of the scientific objects (e.g. plots) of the experiment on a map centered on the experiment installation location. Jump to the section **Map Visualization** for more information.
on experiment maps. The use of the other buttons, Update and Add document, is described at the end of the next section entitled Create an experiment.

Create an experiment

Within the Experiments menu, a PHIS user (not available for guests) can create a new experiment with the Create Experiment button.

Tool tips are provided for some fields: they appear on the left hand side when one drags the pointer on those fields.

The mandatory fields, followed by an asterisk, are:

- projects date
- (start / end)
- campaign

However, it is highly recommended to fill every field. If possible, fields requiring plain text (keywords, description) should be answered to in English.

URI. The project URI is automatically created by PHIS web service which uses the acronym of the PHIS instance from where the experiment is created (e.g. DIA for Diaphen) and the campaign provided by the user (e.g. 2018).

Alias. Internal name of the experiment, usually provided in all caps.

Projects. Name of the project(s) the new experiment is part of. A single experiment can be linked to several projects. One can select the name of the given projects only within the exhaustive list of projects registered to the PHIS instance where the new experiment is created.

Date Start and Date End are to be provided in the format YYYY-MM-DD (year-month-day), directly or through the calendar view. It is compulsory to give a value to the Date End field in order to create an experiment. If the end date of the experiment is unknown, the start date can be reused in the Date End field. Typical Date Start values correspond to a sowing date, while Date End typically concur with an harvesting date.
**Installation.** Name or ID of the installation where the experiment is carried. No specific format is yet required for submitting an installation name. *todo.*

**Campaign.** Year (format YYYY) in which the experiment has been carried, or the year of the harvest/end of the experiment in case it has been carried on several years (*to be confirmed*). Once the experiment created, the information on the campaign in which it has been carried can no longer be modified.

**Place.** Locality or town name used internally to situate the installation location. This field will later be removed in the upcoming developments of PHIS.

**Scientific supervisors.** Email adresses of the experiment supervisor(s). The email adresses refer uniquely to persons existing on PHIS. If unavailable in the predefined list, emails can be added to PHIS from the *Persons* menu, prior to the new project creation. Please see the *Persons* section of this documentation for further details.

**Technical supervisors.** Email adresses of the technicians and scientists (including phd students, interns, etc.) involved in the experiment implementation. The email adresses refer uniquely to persons existing on PHIS.

**Crop Species.** Common name of the crop species which are the object of the experiment. Each crop species names must be separated by a comm. Preferably provided in English, without any capital letters. A link to the internal ontology is under development.

**Groups.** List of the PHIS users groups authorized to access the new experiment. This field is crucial when creating an experiment. Only a PHIS user belonging to at least one of the groups specified in this field will be authorized to access the newly created experiment. An experiment assigned to no group is by default set as public. Please go to *Access rights* for further details on this matter.

**Objective.** A short synthesis of the experiemnt objectives is to be provided in plain text, preferably in English. A more complete description will be asked in the *Comment* field.

**Keywords.** Keywords characterizing the experiment. Each keyword, should be separated by a comma and not include any capital letter, e.g. *nitrogen use efficiency, rapeseed.*

**Comment.** Complete plain text description of the experiment, preferably provided in English language. Additionally to the description, detailed knowledge on the experimentation can be provided through uploaded files, but only after the experiment has been created.

Completing the experiment creation within PHIS is then achieved by clicking on the *Create* button.

From *Home / Experiments*, one can click on the eye icon on the right to see the newly created experiment information sheet.

The *Add document* button at the top of the experiment sheet remains orange until a first document has been added, e.g. an experimental design. See the *Documents* section below for further information on documents.
Once created, the experiment specifics can be modified with the Update button.

Map visualization

Objects selection

scientific objects associated with a given experiment, for example plots, can be displayed on a map, thanks to their geopositioning informations. In PHIS, a map refers to a dynamic map where all the scientific objects of a given experiment are represented.

After having imported scientific objects linked to an experiment, the map associated with this experiment is created within the Experiments menu through the Generate Map button.

Once the map of an experiment has been created, there's no need to re-create it if no new scientific object has been linked to this experiment. In such cases, the access to the experiment map is realized within the Experiments menu through the Map Visualization button.

The map of an experiment is dynamic: one can zoom in and out with the + and - sign at the top left corner of the map, or simply using the mouse wheel. The map visualization also works with a touchscreen. Map rotation is performed pressing Alt + Shift while dragging the mouse pointer. Selecting multiple contiguous scientific objects is performed pressing Ctrl + Left Click and then dragging the mouse pointer (still holding the mouse left click).

When scientific objects of a map are selected, their attributes (alias within the experiment, crop specied, variety, modality, repetition) are displayed in a table under the map.
Graphics from datasets

Another feature provided by the Map Visualization menu is the possibility to plot graphics from datasets associated to an experiment. A first step is to select on the map scientific objects (e.g. plots) as explained above. In order to create clear graphics, one should avoid selecting too many objects at the same time. At that point, a new section, Dataset(s) Visualization (On selected plot(s)), appears under the map where the objects have been selected. The second step is to select the variable of the dataset from which a graphic should be produced. An optional filter for the graphic creation enables the user to use only data from a specific time window to produce the desired graphic.

Quantitative Variable. Mandatory field. Here is selected a variable of interest from a predefined list of all the variables defined in a given PHIS instance. Variables can be selected only one at a time. If the selected variable is associated to no dataset linked to the present experiment, then no graphic is plotted. In the next PHIS developments, variables associated to a given project or experimentation will be declared at the level of the project/experimentation.

Date Start. Optionnal. First date from which variable values are used to produce a graphic. Variable values associated to a previous date will not appear in the graphic.

Date End. Optionnal. Last date at which variable values are used to produce a graphic. Variable values associated to a later date will not appear in the graphic.

The last step is to press the Search button, which will lead to the creation of a graphic displaying according to a time axis the variable values associated to:
• the scientific objects selected on the map
• the variable selected in the Quantitative Variable field
• potentially the time window between Date Start and Date End if those fields have been filled out

On the new graphic, the time is displayed on the abscissa axis and the variable on the ordinate axis. Each points of the same color are associated to the same scientific object which is identified below the graphic by its URI. In future PHIS developments, objects alias instead of URIs will be used as curve labels. Variable values and curve associated to an scientific object can be masked by clicking on its associated curve label which at this point changes from black to grey. Clicking a second time on the label as the effect to show again the previously hidden curve.

Documents

What are PHIS documents?

In order to ease the comprehension of projects and experiments, it is possible to upload various documents PHIS and connect them to projects or experiments. The same document can be linked to several projects and experiments. A document can be related to no project nor experiment, but this is not recommended. Documents that could help persons understand a project are typically (research) contract, phd (or master) thesis, or various multimedia content such as photos or beamer presentations. Similarly, one could expect knowledge about an experimentation to be provided through documents that could be protocols, experimental designs, technical or scientific files, data files, research papers, etc. Examples of document formats are PDF, txt, csv, png images, etc. However, large files are not yet supported by PHIS: a document cannot exceed 2MB.

The documents uploaded to PHIS through the Documents section are meant for human consultation. However, metadata (intelligible to machines) must be provided for every new document. These metadata contain the document properties:

• title
• creator
• language
• creation date
• document type

Information of a document can later be changed, while the document itself cannot be modified.

Metadata are specified with Dublin Core recommendations. Metadata enables the documents to be stored in the PHIS triplestore. The expression of Dublin Core metadata using the Resource Description Framework is described Here.

Upload a document

Within the Documents menu, as well as from a project or experimentation information sheet, any PHIS user can upload a new document and specify its metadata with the Create Document button. No admin rights are required from a PHIS user to add a new document.

Title. Title of the uploaded document. No specific naming convention is required for filling this field. A document title does not have to match the name of the uploaded file it is imported from.
Creator. Name(s) of the document creator(s), separated by commas. No specific naming convention is required for filling this field.

Language. Language in which the document is provided. In accordance to the Dublin Core Element Set v1.1 document, the value of the language element is defined by RFC 1766 which includes a two-character language code taken from the ISO639 standard. The language code should be provided in lower case (e.g. fr for French, en for English, etc.).

Creation Date. Date of the document creation. If unknown, the current date (i.e. the date at the moment of the document upload into PHIS) can be used.

Concerned Projects. Project(s) for which the document is relevant. One can select the name of the given project(s) only within the exhaustive list of projects registered to the PHIS instance where the new document is uploaded.

Concerned Experimentation. Experiment(s) for which the new document is relevant. A PHIS user can select the name of the given experiment(s) only within the exhaustive list of experiments it has access to.

Document Type. The nature of the document's content. A single type has to be selected from a predefined list. Only one document type can be selected. PHIS controlled vocabulary of document types is defined in PHIS ontology. If an element seems to be missing from the proposed predefined list, please contact PHIS managers (see README.md for PHIS managers contact).

File. This field enables PHIS users to upload the new document from their computer through the Browse button. Only one document at a time can be created, since every document is identified uniquely through an automatically generated URI. The uploaded file cannot be empty (it has to exceed 0B). For now, a document cannot exceed 2MB, due to technical problems encountered with Apache server.

Once the file has been uploaded, do not click on the Upload button but Create underneath, only when all fields have been completed. The upload button is bound to be abandoned in the following PHIS development.

Comment. Complete plain text description of the new document, preferably provided in English language.
Click on the Create button to complete the document creation, i.e. the document upload and the specification of its metadata with Dublin Core standards.

The list of documents a given user has access to is available from the navigation bar through the Tools > Documents menu. From Home / Documents, one can click on the eye icon on the right to see a given document information sheet (metadata). From there, the document cannot be modified or deleted (in PHIS current version). However, the document can be downloaded with the Download button, and its metadata can be modified with the Update button.

### Scientific Objects

#### Object types

Plant phenotyping experiments all revolve around one entity of interest: plants! PHIS experiments are focused on a given type of elements: **Scientific objects**, which are no more than declinations of plants, at various scales:

- **plant organ**: part of a given plant
- **plant**: single individual, displaying a single genotype, which is referred to as a variety plot:
- smallest spatial unit, a.k.a micro-plot (one treatment maximum can be applied on a plot)
- **block**: combination of plots, generally forming an environmentally homogeneous entity **field**
- **field**: large spatial unit that includes plots and potentially blocks

These scientific objects, forming the basic units of experimentations, are observed through time, and consequently constitute the origin of phenotypic data. A given scientific object is required to be associated with one experiment, and one only. Phenotypic data created in an experiment, whether it is directly measured, calculated or estimated, is necessarily linked to scientific objects.

Every scientific object is uniquely identified through a standardized URI. Metadata is associate to objects under the form of attributes: alias, experiment modality, etc. The data associated with these objects correspond with the values of phenotypic variables associated.

The complete list of scientific objects is available in the scientific Object Tracking menu, accessible from PHIS top navigation bar.
Scientific objects information can also be accessed through the Experiments menu. After having selected an experiment, the scientific objects linked to field experiments can be displayed on a map. Moreover, selecting objects on such a map provides additional information on the attributes of these objects. See the Map Visualization section for more information on that matter.

Variables

Variables properties

PHIS variables characterize scientific objects or their environment. Variables characterizing scientific objects are phenotypic variables, while variables characterizing the environment in which those scientific objects are studied are referred to as environmental variables. PHIS variables can be either directly measured by a sensor, either computed from one or several variables.

Every variable produced by an experiment must have been previously created in PHIS, and every variable created in PHIS has to be defined unambiguously. Consequently, when a user refers to a variable in an experiment, there is no ambiguity about the concept he is referring to. Moreover, the usage of unequivocal variables in experiments is a necessary step towards a more intelligible, reliable and reproducible Science.

PHIS variables are listed in the Variables menu.

Variable definition is based on the Crop Ontology guidelines. Therefore, PHIS variables are all unequivocally characterized by the following triplet:

- a single trait, either a phenotypic trait or an environmental feature, which is the subject of the new variable
- a single method of measurement or computation of the trait
- a single unit in which is expressed the value of the trait
Further information on a given variable is available on its information sheet, accessed to from the variables list through the eye-icon on the right-hand side of this project row.

A variable information sheet provides knowledge on this variable, but also on the three elements that define it, namely the **trait**, **method** and **unit** related to this variable. The variable and those three defining features all display a **label**, that should be meaningful and unique, but does not have to be so, an **URI** which is however unique, a **Definition** (or **Comment**) meant for human comprehension, and **related references** meant for Semantic Web applications. Reference to external ontologies is achieved through **SKOS** standards

Create variables, traits, methods and units

Every variable found on PHIS has been previously created by a PHIS user. Within the **Variables** menu, one can create a new project with the **Create Variable** button.

**Variable label.** This field is automatically produced with the concatenation of the trait, method and unit labels, separated by underscores. The resulting variable label is not necessarily unique, but it would be better if it was. On the contrary, the automatically generated URI (not shown in the **Create Variable** menu) is unique.

**Trait.** If the trait associated to the new variable has already been created in PHIS, one can select it through the predefined list of the **Trait label** field. Otherwise, it has to be created, which can be achieved by clicking on the + green icon on the right-hand side of the **Trait label** field.

In the case of a new trait, do not fill the **Trait label** field but the **Internal label** one, below the - red icon that replaced the + green icon. This new trait label should be if possible meaningful, distinct from other trait labels, and underscores "_" should be avoided since trait, method and unit labels are concatenated to generate the new variable name with the format **Trait_Method_Unit**.

A **Comment** should be added, preferably in English, in order to explicit the trait specifics as clearly as possible.
Method. If the method associated to the new variable has already been created in PHIS, one can select it through the predefined list of the **Method label** field. Otherwise, it has to be created, which can be achieved by clicking on the + green icon on the right-hand side of the **Method label** field.

In the case of a new method, do not fill the **Method label** field but the **Internal label** one, below the red icon that replaced the + green icon. This new method label should be if possible meaningful, distinct from other method labels, and underscores "_" should be avoided.

A **Comment** should be added, preferably in English, in order to explicit the method specifics as clearly as possible.

Unit. If the unit associated to the new variable cannot be found on the **Unit label** predefined list, a new unit has to be created. This can be achieved by clicking on the + green icon on the right-hand side of the **Unit label** field. In the case of a new unit, do not fill the **Unit label** field but the **Internal label** one, below the - red icon that replaced the + green icon. This new unit label should be if possible meaningful, distinct from other unit labels, and underscores "_" should be avoided.
Otherwise, if the appropriate unit is already register in PHIS, then one only has to select it from the Unit label field, without clicking on the + green icon (or clicking on the - red icon if the + green icon had previously been clicked on).

![Create Variable](image)

**Related References.** In order to unambiguously define the new variable, semantic relations are established by the user between the new variable and concepts already defined in reliable ontologies existing on the world wide web. These relations to external ontologies are established using **SKOS** (Simple Knowledge Organization System). **Entity** refers to the PHIS entity that will be associated to a concept found in an ontology. This **Entity** be either the new variable, trait, method or unit. It is not required to specify related concepts for traits, methods and units, however it is recommended. **Relation** refers to the nature of the relation between the entity and the concept defined in an ontology. This semantic relation is provided using SKOS. The entity can either be, compared to an ontology concept, an exact match, a close match, narrower or broader.

SKOS mapping properties, **skos:closeMatch** and **skos:exactMatch**, are used to state alignment links between SKOS concepts, as indicated in the w3 SKOS Mapping properties web page:

- **exactMatch**: used to link two concepts, indicating a high degree of confidence that the concepts can be used interchangeably across a wide range of information retrieval applications. **skos:exactMatch** is a transitive property, and is a sub-property of **skos:closeMatch**. **Example**: `<MyNewNDVIVariable> skos:exactMatch <CO_322:0000880>` asserts that the variable 'MyNewNDVIVariable' created in PHIS refers to the exact same concept as does the variable 'NDVI_M_idx' already defined in the Crop Ontology and uniquely identified as 'CO_322:0000880'.

- **closeMatch**: used to link two concepts that are sufficiently similar that they can be used interchangeably in some information retrieval applications. In order to avoid the possibility of "compound errors" when combining mappings across more than two concept schemes, **skos:closeMatch** is not declared to be a transitive property. **Example**: `<MyNewLAIVariable> skos:closeMatch <http://www.cropontology.org/rdf/CO_321:0001254>` asserts that the variable 'MyNewLAIVariable' created in PHIS is very similar to the variable 'LAI_Calc_Idx' already defined in the Crop Ontology and uniquely identified as 'CO_321:0001254'.

SKOS hierarchical properties **skos:broader** and **skos:narrower** are used to assert a direct hierarchical link between two SKOS concepts, as indicated in the w3 Semantic Relations web page:

```xml
<http://www.cropontology.org/rdf/CO_321:0001254> skos:broader <http://www.cropontology.org/rdf/CO_321:0001337> skos:narrower <http://www.cropontology.org/rdf/CO_321:0001338>
```
- **broader** (label=has broader) : a triple `<A> skos:broader <B>` asserts that `<B>`, the object of the triple, is a broader concept than `<A>`, the subject of the triple. **Example:** `<MyNewPlantHeightTrait> skos:broader <CO_322:0000994>` asserts that the trait 'MyNewPlantHeightTrait' created in PHIS refers to a concept that has a broader one: which is the concept refered to by the trait 'Plant height' already defined in the Crop Ontology and uniquely identified as 'CO_322:0000994'.

- **narrower** (label=has narrower) : a triple `<C> skos:narrower <D>` asserts that `<D>`, the object of the triple, is a narrower concept than `<C>`, the subject of the triple. skos:broader is owl:inverseOf the property skos:narrower. **Example:** `<MyNewStageEstimationMethod> skos:narrower <http://www.cropontology.org/terms/CO_322:0000905/>` asserts that the method 'MyNewStageEstimationMethod' created in PHIS refers to a concept that has a narrower one, which is the concept refered to by the method 'Silking date - Estimation' already defined in the Crop Ontology and uniquely identified as 'http://www.cropontology.org/terms/CO_322:0000905'/

By convention, skos:broader and skos:narrower are only used to assert a direct (i.e., immediate) hierarchical link between two SKOS concepts. This provides applications with a convenient and reliable way to access the direct broader and narrower links for any given concept. Note that, to support this usage convention, the properties skos:broader and skos:narrower are not declared as transitive properties.

**Reference URI** refers to the URI of the concept found on ontologies such as the ones suggested in the short list above the Related References field. The URI provided here is not necessarily the URL of the web page of the ontology on which the targeted concept is defined. Indeed, the URI of a given concept does not necessarily match with the URL of the web page where this concept has been found. **Hyperlink** (optionnal) refers to the URL where are located the related concept whose URI has been provided in the previous field.

When a variable is created, multiple references using SKOS can be stated, using the + white icon.

![Ontologies References](image)

The main ontologies differ on the following features:

The **AgroPortal** project aims to offer a reference ontology repository for agronomy, reusing the NCBO BioPortal technology, as stated on the [FAO website](https://www.fao.org). The scientific outcomes and the experience of the biomedical domain are thus exploited and transposed into the agronomy domain, including plants, food, environment and possibly animal sciences.

**AGROVOC** is a controlled vocabulary covering all areas of interest of the United Nations Food and Agriculture Organization (FAO), including food, nutrition, agriculture, fisheries, forestry, environment, etc. It is published by the FAO and edited by a community of experts. More information is provided on the [FAO website](https://www.fao.org).
The Plant Ontology (PO) is a structured vocabulary and database resource that links plant anatomy, morphology, growth and development to plant genomics data. The URL provided here redirects visitors to the Planteome website since PO is developed by the Planteome Project, alongside with other reference ontologies listed in the Planteome Ontologies webpage.

The Planteome project is a centralized platform where reference ontologies for plants will be used to access plant genomics data.

The Crop Ontology (CO) current objective is to compile validated concepts along with their interrelationships on anatomy, structure and phenotype of crops, on trait measurement and methods, as well as on germplasm with the multi-crop passport terms.

The Unit Ontology gathers metrical units for use in conjunction with PATO (Phenotype And Trait Ontology), which is a phenotypic quality ontology.

**Variable Definition.** Text defining clearly the concept underlying the new variable. This definition should ideally be provided in English.

**Devices**

The Devices menu contains information about the different devices (environmental sensors, cameras and actuators) declared in the information system.

Different filters including URI, Device Alias, Device Type, Position and Variable allow to refine search.
Detailed information of each device including the brand, model, together with technical documentation and events associated to each device (e.g. calibration, dysfunction) can be accessed by clicking on the eye icon placed on the right. Outputs of sensors can also be visualised.
RDF triples can be explored including the events and environmental variables associated to each sensor.
Germplasm

Germplasm menu allows searching for the different genetic material declared in PHIS. Different filters based on mathematical operators allow refining the search by applying different constraints.
For instance, the query of maize genotypes displaying $\text{leaf area} > 0.8 \text{ m}^2$ gives two results:

Further, by clicking on one of the results (e.g. genotype iPG234) the user can visualise those plants corresponding to this genotype, and those that validate the search criteria (i.e. $\text{leaf area} > 0.8 \text{ m}^2$) are highlighted in green:
Multiple search criteria is supported, for instance, the query search for genotype **iPG082** displaying leaf area > 0.4 m² and biovolume > 400g displays all plants corresponding to this genotype validating these two criteria:
