

## The Sweetpotato Ontology

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### 1. Introduction

The sweetpotato ontology is part of a community effort to establish a set standard nomenclature to describe crop development and agronomic traits to facilitate analyzing and sharing of phenotypic and genotypic information. The development and adoption of data standards is vital to the interoperability of sweetpotato data (Simon et. al. 2014). Phenotype ontologies are controlled, hierarchically-related phenotypic descriptions that enable large-scale computation among individuals, populations, and even multiple species (Hoehndorf et al., 2013). The International Potato Center (CIP) is currently pursuing the development of standards for plant phenotyping data in collaboration with other interested groups.

The advantage of ontology is that both humans and software applications can understand a data domain. This will allow the application of numerical or data mining techniques that may help to uncover previously unknown correlations. Building on previous draft versions, here we focus on traits important to breeding.

### 2. Materials and Methods

Through collaborations under the Generation Challenge Program, compatibility data is consolidated by ontologies. Descriptors used in morphology were taken from Huaman (2001). Descriptors used in evaluations were previously standardized (Grüneberg et al., 2009). Additionally, we used descriptors from the Catalogue of Orange-fleshed sweetpotato varieties for Sub-Saharan Africa (Kapinga et al., 2010).

We used the Crop Trait Dictionary Upload Template Version 4 to update the information in the web crop ontology. Terms in ontology were organized in the form of a tree. The nodes of the tree represent entities at greater or lesser levels of detail (Smith, 2004). The branches connecting the nodes represent the relation between two entities (ej. radicle emergence stage is a child of the parent term germination stage). Individual stages of a scale are then parts that can be related to the whole by their order of appearance during plant growth. Each term carries an unique identifier and strictly specified relationships between the terms allow systematic ordering of data within a database, this in turn improves input and retrieval of information (Bard and Rhee, 2004; Harris et al., 2004).

### 3. Results and Observations

The sweetpotato ontology currently describes 109 traits (Table 1). These include: morphological (28), agronomical performance (28), biochemical (23), reaction to biotic stress (7) and quality traits (23). These traits describe phenotypic variability for characteristics needed for crop improvement. We anticipate further refinements and cross-checks.

TABLE1. Frequency of sweetpotato ontology

Variable	Frequency absolute	Frequency relative
Agronomical traits	28	0.26
Morphological traits	28	0.26
Biochemical traits	23	0.21
Quality traits	23	0.21
Biotic stress	7	0.06
<b>Total</b>	109	1

The ontologies are managed in spreadsheets for ease of transfer from existing data dictionaries. The first version of sweetpotato ontology can be found online.<sup>1</sup>

The screenshot displays the sweetpotato ontology web interface. On the left, a hierarchical tree shows the structure of traits under the ontology ID 'CO\_331'. The tree includes categories like 'Morphological traits', 'Flower color', and 'Plant Type', with sub-traits such as 'Abaxial Leaf Vein Pigmentation', 'Distribution of Secondary Flesh color', 'Observation of flower color', 'General Outline of the Leaf', 'Ground Cover', 'Immature Leaf Color', 'Observation of immature leaf color', 'Intensity of Predominant Skin color', 'Latex Production in Storage Roots', 'Leaf Lobe Number', 'Leaf Lobes Type', 'Mature Leaf Color', 'Mature Leaf Size', 'Oxidation in Storage Roots', 'Petiole Pigmentation', and 'Plant Type'. On the right, a detailed view of the 'Observation of flower color' trait is shown, including its identifier (CO\_331:0000047), description ('Visual categorization'), name ('Observation of flower color'), creation date ('Mon Jun 16 08:40:50 UTC 2014'), and a bibliographic reference: 'CIP, AVRDC, IBPGR. 1991. Descriptors for Sweet Potato. Huamán, Z., editor. International Board for Plant Genetic Resources, Rome, Italy'.

FIG 1: Sweetpotato trait ontology structure trait group relationships

#### 4. Conclusions

The goal of ontologies is to construct a set of clearly defined vocabularies that can be used to construct queries between different crops linking the phenotypic and genetic data useful for integrated breeding through data annotation. In addition, the ontologies should enhance future

<sup>1</sup> [http://www.croponology.org/ontology/CO\\_331/Sweet%20potato](http://www.croponology.org/ontology/CO_331/Sweet%20potato)

efforts to explore the relationships among phenotypic similarity, gene function, and sequence similarity in plants, and to make genotype-to-phenotype predictions relevant to plant biology, crop improvement, and potentially even human health.

The use of ontological methods to organize biological knowledge is an active area of research and development. The definition of a set of common terms in sweetpotato is contributing in the development of the BioMart database. The datamart of sweetpotato is organized using the sweetpotato ontology.

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