

## Enhanced Agriculture Ontology with Images to Effectively Retrieve Pest and Disease Knowledge

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User-centered agriculture ontology has been developed in a previous study for Sri Lankan context, which represents domain knowledge in agriculture such as crops, pests, diseases, and fertilizers. Even though, this is a solution for farmers that they can access scattered knowledge in one place, the represented knowledge is in only the textual format without supported meta information such as images, video, and annotations. Thus, it is difficult for farmers to understand the information/knowledge provided through the ontology. Considering this fact, the necessity of ontology enhancement with meta-information was identified. In this study, as an initial step, pest and disease management was selected. After several field visits and the literature analysis, the ontology representation was extended by defining symptoms' events with the relevant images. Ontology design patterns to represent N-ary relationship were adapted to handle the relationships among the concepts which have associations more than two concepts. To make the retrieval process efficient, the image-annotations were introduced with the support of experts and annotated them with images. This enables farmers to query knowledge by uploading images and tagging keywords. Then, the ontology provides the knowledge with supported images. The validity of content of the ontology has been assessed manually with respect to the answers and images of the questions related to the diseases given by the experts and the reliable sources. Finally, a system was implemented to demonstrate the feasibility of accessing information through the enhanced ontology. The Protégé tool and OWL API were used to model the ontology and connected it to the system respectively. The Stanford CoreNLP and WordNet APIs were adopted to check the similarity between the farmers' input-keywords and the ontology annotations. In future, the system will be improved with a decision tree to resolve the conflicting answers generated by the ontology.

**Key words:** *Ontology enhancement, Image-annotation, Ontology design patterns, Agriculture*

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