1. **Ontology and System Requirements Specification Document**

|  |  |
| --- | --- |
| 1 | **Purpose** |
|  | * 1. To provide a knowledge model that captures plant disease and pest knowledge and produces a standard domain ontology.   2. To allow building a knowledge-based system to assist in the diagnosis of diseases and pests and treatments or recommendations that help counteract these diseases and pests. |
| 2 | **Scope** |
|  | The system will focus on providing diagnosis based on apparent symptoms and treatment or trusted recommendations, also preventive practices to control main pests and diseases that affect date palms in Saudi Arabia. |
| 3 | **Implementation Language** |
|  | * 1. The ontology will be implemented in OWL language.   2. To overcome the problem arising from the fact that two or more diseases can share some symptoms, a set of rules based on SWRL may develop to sort symptoms that have a higher priority/ rank. |
| 4 | **Intended End-Users** |
|  | * 1. Farmers who are looking to identify diseases and pests early to prevent their spread and obtain suitable treatments or recommendations on control methods to reduce the impact of pests and diseases on date palms crops.   2. Advisors who are responsible for supporting farmers and advising them about appropriate treatments. They need support to recognize the relationship between abnormalities and diseases and the relationship between diseases and treatment. Without intelligent systems, they rely on experience and intuition and need to memorize all complex relationships.   3. Researchers and students to support them in their research activities; since the ontology identifies diseases based on apparent symptoms, students and researchers can utilize this functionality to investigate different relationships between symptoms and pathogens and simulate specific scenarios for their study or research. |
| 5 | **Intended Uses** |
|  | * 1. Find possible diseases or pests, both explicit and implicit diseases corresponding to a set of symptoms or observations, as the ontology will employ machine reasoning to consider the logical relationships to identify the disease or pests.   2. Find all possible control measures, as the ontology contains all possible controls for pests and disease based on the knowledge defined and stored in the knowledge base and employment of logical reasoning.   3. To find instructions of control methods applying and treatment usage (such as the best time to apply control measures). This ensures that users such as farmers are able to apply a particular treatment or control method correctly.   4. Find possible symptoms or abnormalities of a given disease: as the ontology can return all possible abnormal appearances on a date palm plant if it is infected by a particular disease. This enables users to compare their observations with the retrieved results and make a better decision.   5. Find the main causes of a particular disease, mainly environmental conditions and living entities. This allows users to be aware of the environmental conditions that promote the emergence of a specific disease or the propagation season of some insect pests, thus taking proactive actions aiming to avoid the spread of the disease.   6. Find explanation and evidence to support a specific recommendation and reference to phytopathology documents related to the disease or pest diagnosed by the system. |
| 6 | **System Requirements** |
|  | **6.1 Non-Functional Requirements** |
|  | 1. The ontology must be developed in the following languages: English, and Arabic. all classes will be described in English and we will use *rdfs:label* and *rdfs:comment* for Arabic. 2. The ontology must be based on W3C and OWL standards and follow ontology design best practices (such as each class in ontology should be associated with a human-readable definition in both English and Arabic ...etc). |
|  | **6.2 Functional Requirements: Groups of Competency Questions** |
|  | CQ1: What are the possible diseases or pest when a date palm has a symptom X?  CQ2: What are the possible diseases or pest when a date palm has symptoms X, Y…etc?  CQ3: What are the possible symptoms of a disease X?  CQ4: What are the possible symptoms of a pest X?  CQ5: What are the possible controls or treatments should be used to  limit the impact of a disease X?  CQ6: What are the possible controls or treatments should be used to limit the impact of a pest X?  CQ7: What measures should be applied to prevent the spread of a disease or pest?  CQ8: What combination of factors causes a disease or pest?  CQ9: What weather conditions promote the spread of a disease or pest?  CQ10: What instructions should be followed to apply the suggested control methods or treatment usage correctly?  CQ11: What evidence supports a recommendation or treatment to control a disease or pest? |

1. **Plan for Ontology development**

**Step1: we need to determine all areas in the domain of knowledge:**

* Plant structures or parts that are exposed to pests and diseases.
* Plant growth stages.
* Plant pathology) living entities and the environmental conditions that cause disease in date palms).
* Plant diseases (disease name, disease damage, disease symptoms and relevant controls).
* Plant pests (pest name, pest damage, pest symptoms and relevant controls).
* ***AGROVOC***
* ***Plant Protection Ontology (PPOntology)***
* ***Agriculture Activity Ontology (AAO)***
* ***AGROVOC***
* ***Trait Ontology (TO)***
* ***Plant Disease Ontology (PDO)***
* ***National Agricultural Library Thesaurus (NALT)***
* ***AGROVOC***
* ***Trait Ontology (TO)***
* ***Plant Disease Ontology (PDO)***
* ***National Agricultural Library Thesaurus (NALT)***
* ***AGROVOC***
* ***Plant Ontology (PO)***
* ***Trait Ontology (TO)***
* ***AGROVOC***
* ***Plant Ontology (PO)***

*Fig1: Plant disease and pest areas of knowledge with existing related ontologies*

* We will start by creating TBox ( the terminological component that describes each one of these modules in terms of classes and properties).
* After completing TBox creation we will start creating ABox (refers to the instances of the concepts established in the TBox).

**Step2: for each one of these modules:**

* Collect domain knowledge sources.

* Extract related terms to each of these modules by analyzing domain knowledge sources.
* Classify these terms for each one of these modules in hierarchical relationships.
* After extracting all related terms for each module, search for them in other ontologies to reuse them by analyzing exiting ontologies. Avoid defining these terms by self as much as possible since it contributes to the interoperability of ontology modules and other ontologies or information systems that these modules support.
* Start developing our ontology in Protégé.

**Step 3: Specify and describe relations between these classes.**

**Step 4: After developing the necessary classes, create one complete scenario.**

**Step 5: Examination and documentation should take place simultaneously with each step.**