# A Methodology for Building a Generic Treatment  Model

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## 1 Introduction

The aim of this document is to present a methodology for building a generic treatment model. The generic model would serve both the developers/designers of a treatment expert system and the implementers of an expert system tool. The primary goal for developing this methodology, and consequently a tool based on it, is to facilitate the rapid development of a treatment subsystem by offering the system builder a template that can be easily filled   To do so, we have aimed to identify and capture all knowledge that is related to the treatment task of the vegetables regardless of the crop, and identify concepts that vary from one crop to another. It is significant to mention that all example shown in this document are from tomato crop.

## 2 Built in/Required Concepts

### 2.1 Plant Related (Plant Ontology)

#### 2.1.1 soil

Name: Soil
Properties:

| Name | Ec |
|---|---|
| Description | soil salinity |
| Source of Value | user |
| Type | Real |
| Value range | Number-range($1.0e\text{-}5$,1000) |

#### 2.1.2 Water

Name: water
Properties:

| Name | Eciw |
|---|---|
| Description | Electronic conductivity of irrigation water (Ds/m) |
| Source of Value | DB |
| Type | Real |
| Legal values | Number-range(0,3) |

#### 2.1.3 climate

Properties:

| Name | حالة المناخ 'temp-status |
|---|---|
| Prompt | ماهى حالة المناخ؟" , |
| Source of Value | user |
| Type | Nominal |
| Legal value | متوسطة , منخفضة , عالية |

## 2.1.4 plant

Properties:

| Name | Age |
|---|---|
| Description | Plant age |
| Source of Value | Relation (plant_age) |
| Type | Integer |
| Value range | Number-range(0,20) |

| Name | Growth_stage |
|---|---|
| Description | Plant growth stage |
| Source of Value | Relation (growth stage) (from diagnosis) |
| Type | Nominal/single |
| Legal values | نمو خضرى , نمو ثمري |

| Name | [1]Crop-type |
|---|---|
| Prompt | , "اختار نوع المحصول" |
| Source of Value | user |
| Type | Nominal/single |
| Legal –values | 'طماطم الشيرى','طماطم' |

## 2.1.5 plantation

| Name | Date |
|---|---|
| Source of Value | user |
| Type | Date |
| Prompt | ما هو تاريخ الزراعة |

| Name | [2]current_f_date |
|---|---|
| Source of Value | Relation(Current-date) |
| Type | Date |
| | |

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[1] the crop concept of tomato is converted to property in plant concept

[2] This property is moved from concept plant to concept plantation

| Name | [2]current_s_date |
|---|---|
| Source of Value | Relation(Current-date) |
| Type | Date |
| Prompt | ما هو تاريخ الزراعة |

| Name[1] | irrigation_method |
|---|---|
| Description | |
| Source of Value | User/DB |
| Type | Nominal/single |
| Legal values | تنقيط, غمر |

| Name | النوع Type |
|---|---|
| Prompt | ما هى نوع المزرعة ؟ |
| Source of Value | User |
| Type | Nominal/single |
| Legal value | //احقل مكشوف, اصوب, انفاق// |

| Name | last_f_material_exist |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/single |
| Legal values | Yes/No |

| Name | last_f_material_used |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/single |
| Legal values | Any of material names |

| Name | last_s_material_exist |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/single |
| Legal values | Yes/No |

| Name | last_s_material_used |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/single |
| Legal values | Any of material names |

### 2.2  Crop Related (Crop *Ontology)*

In the agriculture domain, we can classify the plants into three main categories: Crops, Vegetables, and Trees. Under each of these categories we have several plants. For each of these plants, we can find different disorders and their treated operations. This document represents the treatment task for vegetable which includes:

- Bean (B)
- Cucumber (Cu)
- Melon (Me)
- Strawberry (Str)
- Tomato (To)

### 2.2.1   Treat_op

Properties:

| Name | Treated-disorder |
|---|---|
| Description | List of disorders that are treated by this treatment operation |
| Source of Value | Relation |
| Type | Nominal/multi |
| Legal values | |

| Name | Obligatory-material-name |
|---|---|
| Description | Some disorders need a specified set of materials that should be used to treat them. |
| Source of Value | Relation |
| Type | Nominal/multi |
| Legal values | All materials |

| Name | Optional-material-name |
|---|---|
| Description | Some disorders can be treated using alternatives of materials. The user can select one of these material. |
| Source of Value | Relation |
| Type | Nominal/multi |
| Legal values | All materials |

| Name | Flag |
|---|---|
| Description | This flag is used to determine if this treatment operation has been visited or not |
| Source of Value | Relation |
| Type | Nominal |
| Legal values | 0-1(Default=0) |

| Name | Material-qty |
|---|---|
| Description | The quantity of the material |

| Source of Value | Relation |
|---|---|
| Type | Float |
| Range | |

| Name | **Qty-Unit** |
|---|---|
| Description | The unit of the quantity of the material |
| Source of Value | Relation |
| Type | Nominal |

| Name | **Method** |
|---|---|
| Description | The method used in applying the treatment operation |
| Source of Value | Relation |
| Type | Nominal |
| Value range | |

| Name | **mode_entry** |
|---|---|
| Description | |
| Source of Value | Relation |
| Type | Nominal |
| Legal values | |

| Name | **Application-time** |
|---|---|
| Description | |
| Source of Value | Relation |
| Type | Nominal/single |
| Legal values | |

| Name | **Date** |
|---|---|
| Description | |
| Source of Value | Relation |
| Type | Date |
| Legal values | |

| Name | **Tool** |
|---|---|
| Description | |
| Source of Value | Relation |
| Type | Nominal |
| Legal values | |

| Name | **Advice** |
|---|---|
| Description | |

| | | |
|---|---|---|
| Source of Value | | Relation |
| Type | | Nominal/multi |
| Legal values | | |

| | | |
|---|---|---|
| **Name** | | **number** |
| Description | | The priority of treatment operation |
| Source of Value | | Relation |
| Type | | Number |
| Value range | | 1-10 |

| | | |
|---|---|---|
| **Name** | | **Used-material-flag** |
| Description | | This flag is set if the material is used as obligatory or selected by user |
| Source of Value | | Relation |
| Type | | Number (0-1default zero) |

[1]Treatment-operation Taxonomy

#### 2.2.1.1 Treat-op- fungal
Sub-type of: treat-op

2.2.1.1.1    *Root-rot-treat-op1*

2.2.1.1.2    *Root-rot-treat-op*

2.2.1.1.3    *late_blight_treat_op1*

2.2.1.1.4    *late_blight_treat_op2*

2.2.1.1.5    *late_blight_treat_op3*

2.2.1.1.6    *late_blight_treat_op4*

2.2.1.1.7    *early_blight_treat_op1*

2.2.1.1.8    *early_blight_treat_op2*

2.2.1.1.9    *early_blight_treat_op3*

#### 2.2.1.2 Treat-op-insects
Sub-type of: treat-op

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[1]  Each disorder should have number of treatment operation = number of treatment materials

*2.2.1.2.1    grass_hopper_treat_op_1*

| Name | Choose_method |
|---|---|
| Description | The method used in applying the treatment operation |
| Source of Value | User |
| Type | Nominal |
| Prompt | اختار طريقة لمعالجة النطاط |
| Value range | 'رش كيميائى','طعم سام' |

*2.2.1.2.2    aphids_treat_op_1*


*2.2.1.2.3    potato_tuber_moth_ treat_op_1*


*2.2.1.2.4    cut_worm_treat_op_1*


*2.2.1.2.5    mole_crickets_ treat_op1*


*2.2.1.2.6    white_fly_treat_op1*


*2.2.1.2.7    leafminer_treat_op1*


*2.2.1.2.8    tomato_fruit_worm_treat_op1*


*2.2.1.2.9    white_grubs_treat_op_1*


*2.2.1.2.10   jassid_treat_op1*


### 2.2.1.3      Treat-op-virus
Sub-type of: [treat-op](treat-op)

### 2.2.1.4      Treat-op-nutrition-deficiency
Sub-type of: [treat-op](treat-op)

### 2.2.1.5      Treat-op-spiders
Sub-type of: [treat-op](treat-op)

### 2.2.1.6      Treat-op-environmental
Sub-type of: [treat-op](treat-op)

### 2.2.1.7          Treat-op-nematode
Sub-type of: [treat-op](treat-op)

### 2.2.1.8      Treat-op-bacterial
Sub-type of: [treat-op](treat-op)

## 2.2.2 Disorder

Disorder Taxonomy

**2.2.2.1    fungal**
Sub-type of: <u>disorder</u>

**2.2.2.2    insect**
Sub-type of: <u>disorder</u>

**2.2.2.3    virus**
Sub-type of: <u>disorder</u>

**2.2.2.4    nutrition-deficiency**
Sub-type of: <u>disorder</u>

**2.2.2.5    spiders**
Sub-type of: <u>disorder</u>

**2.2.2.6    environmental**
Sub-type of: <u>disorder</u>

**2.2.2.7    nematode**
Sub-type of: <u>disorder</u>

**2.2.2.8    bacterial**
Sub-type of: <u>disorder</u>

| Name | **Confirmed** |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/multi |
| Legal values | All disorders names |

| Name | **infection** |
|---|---|
| Description | |
| Source of Value | User |
| Type | Nominal/single |
| Legal values | منخفضة,متوسطة,'مرتفعة' |

| Name | **percentage_infection** |
|---|---|
| Description | The percentage of the disorder infection |
| Source of Value | User |
| Type | Number |
| Value range | > 0 |

### 2.2.3 leaves

| Name(t) | phosphorus_level |
|---|---|
| Prompt | "مستوى الفسفور بالأوراق |
| Source of Value | User |
| Type | Nominal/multi |
| Legal value | "منخفض','منخفض جدا','غيرمعروف |

| Name(t) | potassium_level |
|---|---|
| Prompt | "مستوى البوتاسيوم بالأوراق |
| Source of Value | User |
| Type | Nominal/multi |
| Legal value | "منخفض','منخفض جدا','غيرمعروف |

| Name(t) | magnesium_level |
|---|---|
| Prompt | "مستوى الماغنسيوم بالأوراق |
| Source of Value | User |
| Type | Nominal/multi |
| Legal value | "منخفض','منخفض جدا','غيرمعروف |

| Name(t) | excess_nitrogen_level<br>مستوى زيادة النتروجين |
|---|---|
| Prompt | قم بتحليل الاوراق بالمعمل و حدد مستوى زيادة النتروجين |
| Source of Value | User |
| Type | Nominal/multi |
| Legal value | "مرتفع','مرتفع جدا','غيرمعروف |

| Name(t) | nitrogen_level |
|---|---|
| Prompt | "مستوى النتروجين بالأوراق |
| Source of Value | User |
| Type | Nominal/multi |
| Legal value | "منخفض','منخفض جدا','غيرمعروف |

| Name(t)[1] | no_of_mines_on_leaf<br>نسبة الثقوب |
|---|---|
| Prompt | "ما هى نسبة الثقوب على الأوراق ؟ |
| Source of Value | User |
| Type | Number |
| Legal value | >0 |

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[1] The holes_on_leaves concept of tomato is considered as property holes_ percentage

## 3 Required Relationships

In the following sub-sections, the list of relationships that are required for using the generic treatment  model, will be detailed.  For each relation, a description as well as the required output will be described. Though, in some cases an input might also be outlined, the expert system designer is free not to use that particular input, or to use other inputs as long as the specified output results from the relation.

### 3.1 Treatment Operation Related (Operation Ontology)

#### 3.1.1 Specify treat-operation

*Relation* name: specify-treat-op
*Type: **User-defined***
*Description:*

> This relation is used to determine the required treatment operation used  to treat confirmed disorder such that for each disorder class, a rule cluster is developed as shown in the examples from the tomato subsystem.
>
> *Relation input:* confirmed disorders,  *plant observations*

*Relation output*:  The specified treatment operation(s) for each disorder

1-Specify-fungal-materials of tomato

| Relation | Description |
|---|---|
| Rule1 | ```IF```<br>```(Disorder.confirmed==``` أمـراض الـذبـول ```\|\|```<br>```Disorder.confirmed== '```عفن الجذور`')`<br>```THEN```<br>```Disorder.confirmed =X;```<br>```Root-rot-treat-op1.treated-disorder = X;```<br>```Root-rot-treat-op1. obligatory_material_name =``` 'نوبسن<br>٧٠%+ريـزولـكس ت ٥٠%'<br>```Root-rot-treat-op1. method=``` 'رش على الـتربـة'<br>```Root-rot-treat-op1.date= current_s_date;```<br>```Root-rot-treat-op1.number =1;```<br>```Root-rot-treat-op2. treated-disorder = X;```<br>```Root-rot-treat-op2.obligatory_material_name =```<br>نوبسن ٧٠%+اكسيكلوريد الـنحاس٥٠%'<br>```Root-rot-treat-op1. method=``` 'رش على الـتربـة'<br>```Root-rot-treat-op2. date= current_s_date+15;```<br>```Root-rot-treat-op2.number =2;``` |
| Rule2 | ```IF```<br>```Disorder.confirmed==``` الـندوة المـتأخرة<br>```THEN```<br>```late_blight_treat_op1.Treated-disorder =``` الـندوة<br>المـتأخرة```;```<br>```late_blight_treat_op1.obligatory_material_name =```<br>'كـوبـرا انـتراكـول<br>```late_blight_treat_op1.method=```رش كيـميـائـى<br>```late_blight_treat_op1.date= current_f_date```<br>```late_blight_treat_op1.number =1```<br>```late_blight_treat_op2.Treated-disorder =``` الـندوة<br>المـتأخرة```;``` |

| | |
|---|---|
| | late_blight_treat_op2.obligatory_material_name = 'نحاس+ميلدوربر'<br>late_blight_treat_op2.method=كيميائى رش<br>late_blight_treat_op2.date= current_f_date+7<br>late_blight_treat_op2.number =2 |
| Rule3 | **IF**<br>الندوة المتأخرة !&& Disorder.confirmed!=<br>(<br>Disorder.confirmed== 'عفن الأوراق'\|\|<br>Disorder.confirmed== 'العفن الرمادى'\|\|<br>Disorder.confirmed== 'الأنثراكنوز ' \|\|<br>Disorder.confirmed=='عفن الساق الأبيض'<br>)<br>**THEN**<br>disorder.confirmed== X;<br>late_blight_treat_op1. Treated-disorder =X;<br>late_blight_treat_op1.obligatory_material_name = 'كوبرااانتراكول'<br>late_blight_treat_op1.method=كيميائى رش<br>late_blight_treat_op1.date= current_f_date<br>late_blight_treat_op1.number =1<br><br>late_blight_treat_op2.obligatory_material_name= رينولان ٥٠%<br>late_blight_treat_op2.method=كيميائى رش<br>late_blight_treat_op2.date= current_f_date+7<br>late_blight_treat_op2.number =2<br><br>late_blight_treat_op3.obligatory_material_name= 'ايوبارين'<br>late_blight_treat_op3.method=كيميائى رش<br>late_blight_treat_op3.date= current_f_date+14<br>late_blight_treat_op3.number =3 |
| Rule4 | **IF**<br>الندوة المتأخرة &&== Disorder.confirmed<br>(<br>Disorder.confirmed== 'عفن الأوراق'\|\|<br>Disorder.confirmed== 'العفن الرمادى'\|\|<br>Disorder.confirmed== 'الأنثراكنوز ' \|\|<br>Disorder.confirmed=='عفن الساق الأبيض'<br>)<br>**THEN**<br>Disorder.confirmed== X;<br>late_blight_treat_op3. Treated-disorder =X;<br>late_blight_treat_op3.obligatory_material_name= رينولان ٥٠%<br>late_blight_treat_op3.method=كيميائى رش<br>late_blight_treat_op3.date= current_f_date<br>late_blight_treat_op3.number =1<br><br>late_blight_treat_op4.obligatory_material_name= 'ايوبارين'<br>late_blight_treat_op4.method=كيميائى رش<br>late_blight_treat_op4.date= current_f_date+7<br>late_blight_treat_op4.number =2 |

| | |
|---|---|
| Rule5 | ```
IF
&&الـنـدوة المـتـأخرة=!Disorder.confirmed
&&'عفن الأوراق'=!Disorder.confirmed
&&'الـعفن الـرمـادى '=!Disorder.confirmed
&& 'الأنـثراكـنـوز '=!Disorder.confirmed
&&'عفن الـساق الأبـيض'=!Disorder.confirmed
(
||'الـنـدوة المـبـكرة'==Disorder.confirmed
||'تبقع الأوراق الألـترنـارى'==Disorder.confirmed
||'تبقع رأس المـسمـار'==Disorder.confirmed
'الـبـيـاض الـدقـيـقـى'==Disorder.confirmed
)
THEN
Disorder.confirmed== X;
early_blight_treat_op1. Treated-disorder =X;
early_blight_treat_op1.obligatory_material_name =
'كـوبـراانـتراكـول
early_blight_treat_op1.method=رش كـيـمـيـائـى
early_blight_treat_op1.date= current_f_date
early_blight_treat_op1.number =1
early_blight_treat_op2.Treated-disorder = Ẋ;
early_blight_treat_op2.obligatory_material_name =
'اكـسيـكلـوريـد الـنحاس ٥٠%ء'
early_blight_treat_op2.method=رش كـيـمـيـائـى
early_blight_treat_op2.date= current_f_date+10
early_blight_treat_op2.number =2
``` |
| Rule6 | ```
IF
(
||الـنـدوة المـتـأخرة ==Disorder.confirmed
|| 'عفن الأوراق'==Disorder.confirmed
||'الـعفن الـرمـادى'==Disorder.confirmed
' الأنـثراكـنـوز ' ||==Disorder.confirmed
'عفن الـساق الأبـيض'==Disorder.confirmed
)&&
(
||'الـنـدوة المـبـكرة'==Disorder.confirmed
||'تبقع الأوراق الألـترنـارى'==Disorder.confirmed
||'تبقع رأس المـسمـار'==Disorder.confirmed
'الـبـيـاض الـدقـيـقـى'==Disorder.confirmed
)
THEN
Disorder.confirmed== X;
early_blight_treat_op3.treated-disorder = Ẋ;
early_blight_treat_op3.obligatory_material_name =
'اكـسيـكلـوريـد الـنحاس ٥٠%ء'
early_blight_treat_op3.method=رش كـيـمـيـائـى
early_blight_treat_op3.date= current_f_date
early_blight_treat_op3.number =1
``` |

2-Specify-insect-materials of tomato

| Relation | Description |
|---|---|
| | |

| Rule1 | ```
IF
Disorder.confirmed== 'النطاطات'
grass_hopper_treat_op_1.chosse_method = 'رش كيميائى'
THEN
grass_hopper_treat_op_1.treated disorder='النطاطات' ;
grass_hopper_treat_op_1.obligatory_material_name =
'سيثيون ٥٠%ء'
grass_hopper_treat_op_1.Method='رش كيميائى' ';
grass_hopper_treat_op_1.Date= current_f_date;
grass_hopper_treat_op_1.number=1
``` |
|---|---|
| Rule٢ | ```
IF
Disorder.confirmed== 'النطاطات'
grass_hopper_treat_op_1.chosse_method = 'طعم سام'
THEN
grass_hopper_treat_op_1.treated disorder='النطاطات' ;
grass_hopper_treat_op_1.obligatory_material_name =
'عسل أسود+هوستاثيون ٤٠%+رده '
grass_hopper_treat_op_1.Method='طعم سام' ';
grass_hopper_treat_op_1.Date= current_date;
grass_hopper_treat_op_1.number=1
``` |
| Rule٣ | ```
IF
Disorder.confirmed== 'المن'&&
(المن'.infection = 'مرتفعة'||
المن'.infection ='متوسطة')
THEN
aphids_treat_op_1.obligatory_material_name = [ملاثيون ٥٧'
[%ء'
aphids_treat_op_1.treated disorder='المن' ;
aphids_treat_op_1.Method='رش كيميائى'
aphids_treat_op_1.Date= current_f_date
aphids_treat_op_1.number=1;
``` |
| Rule4 | ```
IF
Disorder.confirmed== 'المن'&&
المن'.infection = 'منخفضة'
THEN
aphids_treat_op_1.optional_material_name = [ سوبر'
'سوبر رويال','كزد اويل',ماسرونا']
aphids_treat_op_1.treated disorder='المن' ;
aphids_treat_op_1. Method='رش كيميائى'
aphids_treat_op_1. Date= current_f_date
aphids_treat_op_1.number=1;
``` |
| Rule5 | ```
IF
Disorder.confirmed== 'فراشة درنات البطاطس'
THEN
potato_tuber_moth treat_op_1.obligatory_material_name =
'سيليكرون ٧٢%';
potato_tuber_moth_treat_op_1.Method='رش كيميائى''
potato_tuber_moth_treat_op_1.Date= current_f_date
potato_tuber_moth_treat_op_1.number=1;
``` |
| Rule6 | ```
IF
Disorder.confirmed== 'الحفار' &&
Disorder.confirmed!= 'الدودة القارضة'
THEN
mole crickets 1.optional material name   = + ذرة، مسحوق'
``` |

| | |
|---|---|
| | مارشال ٢٥% + ماء','مسحوق ذرة+هوستاثيون ٤٠%+ماء'<br>mole_crickets_treat_op_1.treated disorder='الحفار';<br>mole_crickets_treat_op_1. Method='طعم سام'<br>mole_crickets_treat_op_1. Date= current_date<br>mole_crickets_treat_op_1.number=1; |
| Rule7 | **IF**<br>Disorder.confirmed== 'الدودة القارضة'&&<br>Disorder.confirmed!= 'الحفار'<br>**THEN**<br>cut_worm_treat_op_1.optional_material_name = 'ردة +<br>مارشال ٢٥% + ماء','رده+هوستاثيون ٤٠%+ماء'<br>cut_worm_treat_op _1.treated disorder='الدودة القارضة;<br>cut_worm_treat_op _1. Method='طعم سام'<br>cut_worm_treat_op _1.Date= current_date<br>cut_worm_treat_op _1.number=1; |
| RuleΛ | **IF**<br>Disorder.confirmed== 'الدودة القارضة'&&<br>Disorder.confirmed== 'الحفار'<br>**THEN**<br>cut_worm_treat_op _1.optional_material_name = 'ردة +<br>مارشال ٢٥% + ماء','رده+هوستاثيون ٤٠%+ماء'<br>cut_worm_treat_op_1.treated disorder= 'الدودة القارضة<br>و'الحفار;<br>cut_worm_treat_op _1. Method='طعم سام'<br>cut_worm_treat_op _1.Date= current_date<br>cut_worm_treat_op _1.number=1; |
| Rule9 | **IF**<br>Disorder.confirmed== 'صانعات الأنفاق'&&<br>no_of_mines_on_leaf >=3 .'صانعات الأنفاق''<br>**THEN**<br>leafminer_treat_op1.obligatory_material_name = 'فيرتيميك +<br>كزد أويل'<br>leafminer_treat_op1.treated disorder='صانعات الأنفاق'' ;<br>leafminer_treat_op1.Method='رش كيميائى'<br>leafminer_treat_op1.Date= current_f_date<br>leafminer_treat_op1.number=1; |
| Rule10 | **IF**<br>Disorder.confirmed== 'صانعات الأنفاق'&&<br>no_of_mines_on_leaf <3 .'صانعات الأنفاق''<br>**THEN**<br>leafminer_treat_op1.obligatory_material_name = "none" |
| Rule11 | **IF**<br>Disorder.confirmed== 'الذبابة البيضاء'&&<br>Plant.growth-stage != 'fruit stage'&&<br>(Plant.month != 12;<br>Plant.month!= 1;<br>Plant.month != 2)<br>**THEN**<br>white_fly_treat_op1.optional_material_name = 'أدمير ٥٠<br>[%','أوسكاب ٥٠%'','ريلدان ٥٠%'','تريبون ٥٠%'','سيليكرون ٧٢%'<br>white_fly_treat_op1.treated disorder='الذبابة البيضاء'' ;<br>white_fly_treat_op1.Method='رش كيميائى'<br>white_fly_treat_op1.Date= current_f_date<br>white_fly_treat_op1.number=1; |

| | |
|---|---|
| Rule12 | IF<br>Disorder.confirmed==  'الذبابة البيضاء'&&<br>Plant.growth-stage = 'fruit stage'&&<br>(Plant.month= 12||<br>Plant.month= 1||<br>Plant.month= 2)<br>THEN<br>white_fly_treat_op1.obligatory_material_name = "none" |
| Rule13 | IF<br>Disorder.confirmed==  'دودة ثمار الطماطم'&&<br>'دودة ثمار الطماطم'. percentage_infection < 0.5;<br>THEN<br>tomato_fruit_worm_treat_op1.obligatory_material_name =<br>none |
| Rule14 | IF<br>Disorder.confirmed==  'دودة ثمار الطماطم'&&<br>'دودة ثمار الطماطم'. percentage_infection > 0.5;<br>THEN<br>tomato_fruit_worm_treat_op1.optional_material_name = [<br>'لانيت ٩٠%ء''نيودرين ٩٠%ء'<br>tomato_fruit_worm_treat_op1.treated disorder= دودة ثمار<br>الطماطم';<br>tomato_fruit_worm_treat_op1.Method='رش كيميائى'<br>tomato_fruit_worm_treat_op1.Date= current_f_date<br>tomato_fruit_worm_treat_op1.number=1; |
| Rule15 | IF<br>Disorder.confirmed==  'دودة ورق القطن'&&<br>'دودة ورق القطن'. percentage_infection > 0.5;<br>THEN<br>cotton_leaf_worm_1.optional_material_name = [٩٠ 'نيودرين'و<br>'لانيت ٩٠%ء''%,ء%٥٠ ريلدان'<br>cotton_leaf_worm_treat_op1.treated disorder= دودة ورق<br>'القطن'';<br>cotton_leaf_worm_treat_op1. Method='رش كيميائى'<br>cotton_leaf_worm_treat_op1. Date= current_f_date<br>cotton_leaf_worm_treat_op1.number=1; |
| Rule14 | IF<br>Disorder.confirmed==  'دودة ورق القطن'&&<br>cotton_leaf_worm_treat_op1. percentage_infection < 0.5;<br>THEN<br>cotton_leaf_worm_treat_op1.method= 'يدويا' |
| Rule15 | IF<br>Disorder.confirmed==  'الجعال' ;<br>Disorder.confirmed!=  'الديدان السلكية' ;<br>THEN<br>white_grubs_treat_op_1.obligatory_material_name = none |
| Rul116 | IF<br>Disorder.confirmed==  'الديدان السلكية' ;<br>THEN<br>white_grubs_treat_op_1.method= 'يدويا' |
| Rule17 | IF<br>Disorder.confirmed==  جاسيد' ; |

```
                            THEN
                            jassid_treat_op_1.obligatory_material_name = none
```

## 3.1.2  Specify advice

[1]*Relation* name: specify advice
*Type: **User-defined***
Description:

> *This relation is used to determine the advice required in the treatment of specific disorder*
>
> *Relation input: treatment operation, lant observations ,lantation.type, Plant.crop-type plant.growth_stage, climate.temp-status, Water.eciw, soil.ec, disorder.infection*
>
> *Relation output:  treatment-operation.advice*

| Relation | Description |
|---|---|
| Rule1 | IF<br>(Root-rot-treat-op1.treated disorder='عفن الجذور'\|\|<br>Root-rot-treat-op2.treated disorder='الذبول')<br>THEN<br>Root-rot-treat-op1.advice = 'قم باضافة ٢٥.لتر من الخليط لكل نبات'<br>Root-rot-treat-op2.advice = 'قم باضافة ٢٥.لتر من الخليط لكل نبات' |
| Rule٢ | IF<br>Treat_op. treated_disorder='البياض الدقيقى';<br>(Plantation.type= 'صوب'\|\|<br>Plant.crop-type = 'طماطم الشيرى'<br>)<br>THEN<br>Treat_op('البياض الدقيقى).advice = 'قم باضافة ٢٥.لتر من الخليط لكل نبات' |
| Rule٣ | IF<br>(Treat_op. treated_disorder='الأنثراكنوز'\|\|<br>Treat_op. treated_disorder='العفن الرمادى'\|\|<br>Treat_op. treated_disorder='عفن الأوراق'\|\|<br>Treat_op. treated disorder='عفن الساق الأبيض');<br>(Plantation.type= 'صوب'!\|\|<br>Plant.crop-type = 'طماطم'<br>)<br>THEN<br>Treat_op.advice = 'خفض كمية المياه' |
| Rule4 | IF<br>(Treat_op.treated disorder='الأنثراكنوز'\|\|<br>Treat_op. treated disorder='العفن الرمادى'\|\|<br>Treat_op. treated disorder='عفن الأوراق'\|\| |

---

[1] The advice is added to the treatment operation(s) of the affected disorder like in the first rule i.e the developer should know the number of treatment operation for each affected disorder then add advice to each one.

| | |
|---|---|
| | Treat_op. treated disorder='''عفن الساق الأبيض');<br>(Plantation.type= 'صوب'\|\|<br>Plant.crop-type = 'طماطم الشيرى'<br>)<br>**THEN**<br>Treat_op.advice = 'قم بالتهوية'و'خفض كمية المياه'' |
| Rule5 | **IF**<br>Treat_op. treated disorder= viral disorders &&<br>Plant.growth-stage != 'fruit stage'<br>**THEN**<br>Treat_op.advice =                        ('تحكم فى الحشرات التى تنقل الفيروس')<br><br>('اجمع النباتات المصابة و قم بحرقها)<br>('بعد جمع النباتات المصابة''قم بغسل يديك بالصابون قبل لمس باقى النباتات') |
| Rule6 | **IF**<br>Treat_op. treated disorder= fungal disorders &&<br>Treat_op. Method = 'رش كيميائى'<br>**THEN**<br>Treat_op.advice = ('قم بجمع الثمار قبل الرش' |
| Rule7 | **IF**<br>Treat_op. treated disorder= viral disorders &&<br>Plant.growth-stage = 'fruit stage'<br>**THEN**<br>Treat_op.advice = ' الوقت متأخر للسيطرة على المرض' |
| Rule8 | **IF**<br>Treat_op. treated disorder= 'التقرح البكتيرى'\|\|'<br>Treat_op. treated disorder= 'التبقع البكتيرى'<br>**THEN**<br>Treat_op.advice = 'تحكم فى الرى' |
| Rule9 | **IF**<br>(Treat_op. treated disorder= 'نقص الفسفور'\|\|<br>Treat_op. treated disorder= 'نقص الحديد'\|\|<br>Treat_op. treated disorder= 'نقص الماغنيسوم'\|\|<br>Treat_op. treated disorder= 'نقص الزنك')&&<br>climate.temp-status = 'منخفضة'&&<br>(Plantation.type= 'صوب'\|\|<br>Plant.crop-type = 'طماطم الشيرى'<br>)<br>**THEN**<br>Treat_op.advice = 'قم بتدفئة الصوبة' |
| Rule10 | **IF**<br>Material. treated disorder= 'نقص النيتروجين'<br>**THEN**<br>Treat_op.advice = 'التزم بجدول الرى الصحيح' |
| Rule23 | **IF**<br>Treat_op.treated disorder=nutrition deficiency disorders&&<br>Water.eciw > 0.5<br><br>**THEN**<br>Treat_op.advice = 'قلل ملوحة مياه الرى' |

| | |
|---|---|
| Rule24 | **IF**<br>(Treat_op.treated disorder='نقص البوتاسيوم'\|\|<br>Treat_op.treated disorder= 'نقص الكالسيوم'\|\|<br>Treat_op.treated disorder= 'نقص الماغنيسوم'\|\|<br>Treat_op.treated disorder= 'نقص الحديد')&&<br>soil.ec > 2<br>**THEN**<br>Treat_op.advice = 'قلل ملوحة مياه الرى' |
| Rule25 | **IF**<br>Treat_op.treated disorder='زيادة ملوحة'<br>**THEN**<br>Treat_op.advice= 'حسن نظام الصرف و قلل كمية السماد الكيماوى' |
| Rule26 | **IF**<br>Treat_op.treated disorder='رى غير منتظم'<br>**THEN**<br>Treat_op.advice='تحكم فى الرى' |
| Rule27 | **IF**<br>Treat_op.treated disorder='اصابة كيماوية'&&<br>(Plantation.type= 'صوب'\|\|<br>Plant.crop-type = 'طماطم الشيرى'<br>)<br>**THEN**<br>Treat_op.advice='قم بالتهوية' |
| Rule28 | **IF**<br>Treat_op.treated disorder='اصابة كيماوية'<br>**THEN**<br>Treat_op.advice='زود مياه الرى بــ ٢٥% لثلاث ريات متتالية,<br>'قم بغسيل النباتات المصابة بالماء,<br>'و أوقف رش المبيدات لمدة ٥أيام من آخر رشة' |
| Rule29 | **IF**<br>Treat_op.treated disorder='زيادة الرى'<br>**THEN**<br>Treat_op.advice='قلل مياه الرى' |
| Rule30 | **IF**<br>Treat_op.treated disorder=' الصقيع'&&<br>الصقيع'.infection = 'مرتفعة'<br>**THEN**<br>Treat_op.advice='قلل مياه الرى' |
| Rule31 | **IF**<br>Treat_op.treated disorder=' الصقيع'<br>الصقيع'.infection = 'منخفضة'<br>Plantation.type != 'صوب'&&<br>Plant.crop-type = طماطم'<br>**THEN**<br>Treat_op.advice=' يجب أن يغطى النبات بقش الأرز ،قم برى النبات' |
| Rule32 | **IF**<br>Treat_op.treated disorder=' الصقيع'<br>الصقيع'.infection = 'منخفضة'&&<br>(Plantation.type = 'صوب'\|\| |

| | |
|---|---|
| | `Plant.crop-type = '`طماطم الشيرى`'`<br>`)`<br>**THEN**<br>`Treat_op.advice=`قم، يجب أن يغطى النبات بقش الأرز'<br>برى النبات'و'أضف حمض الفسفوريك لمياه الرى' |
| Rule33 | **IF**<br>`Treat_op.treated disorder='`العطش`'`<br>**THEN**<br>`Treat_op.advice=` خفض كمية مياه الرى تدريجيا حتى المعدل<br>الطبيعى' |
| Rule34 | **IF**<br>`Treat_op.treated disorder='`لسعة الشمس`'&&`<br>`Plantation.type= '`حقل مكشوف`'`<br>**THEN**<br>`Treat_op.advice='`غطى النبات بقش الأرز' |
| Rule35 | **IF**<br>`Treat_op.treated disorder='`لسعة الشمس`'&&`<br>`(Plantation.type = '`صوب`'||`<br>`Plant.crop-type = '`طماطم الشيرى`'`<br>`)`<br>**THEN**<br>`Treat_op.advice=''`رش الغطاء البلاستك من الخارج بالسبيداج' |
| R38 | **IF**<br>`Treat_op.treated disorder='`صانعات الأنفاق`'&&`<br>`Leaves.no_of_mines_on_leaf < 3&&`<br>`Plant.age > 30`<br>**THEN**<br>`Treat_op.advice='`انزع الأوراق المصابة و قم بحرقها' |
| R39 | **IF**<br>`Treat_op.treated disorder='`صانعات الأنفاق`'&&`<br>`Leaves.no_of_mines_on_leaf <3&&`<br>`Plant.age <= 30`<br>**THEN**<br>`Treat_op.advice='`اضغط على اليرقة أو العذراء باليد' |
| R40 | **IF**<br>`Treat_op.treated disorder='`الذبابة البيضاء`'&&`<br>`Plant.growth-stage ='fruit stage'&&`<br>`(Current-date.month =12||`<br>`Current-date.month =1||`<br>`Current-date.month =2`<br>`)`<br><br>**THEN**<br>`Treat_op.advice=` علاج الذبابة البيضاء فى هذه الفترة غير مجدى'<br>إقتصاديا') |

## 3.2 Plant Related (*Plant Ontology*)

### 3.2.1 growth_stages

*Relation* name: growth_stages

*Type: **User-defined***
Description:
> *This relation is used to determine the plant's growth stages. This relation varies from crop to*

Relation input: *whatever is appropriate*
Relation output: *plant.growth-stage*

# 4   Required Tables

## 4.1   Treatment Operation Related (Operation Ontology)

### 4.1.1   Specify material-qty

Table name: specify material qty
*Type: **User-defined***
Table input: treatment-operations
Table output: treat-op.material_qty

Description:
> *This table is used to determine the required materials quantity*
>
> *table n input: treatment-operations, , plantation.growth-stage, ,plantation.type*
> *Relation output:  material qty, unit, mode entry of the treatment-operations*

| I/P | O/P | |
|---|---|---|
| **Treat-op. material_name** | **Treat-op. material_qty** | **Treat-op. qty_unit** |
| 'سوبر ماسرونا' | 1.5 | 'لتر / ١٠٠ لتر' |
| 'حديد مخلبى' | 20 | 'جرام / ١٠٠ لتر' |
| 'كزد أويل' | 1.5 | 'لتر / ١٠٠ لتر' |
| 'سوبر رويال' | 1.5 | 'لتر / ١٠٠ لتر' |
| 'سوبر فوسفات' | 250 | 'جرام / ١٠٠ لتر' |
| 'فوسفات الأمونيوم الثنائى' | 50 | 'جرام / ١٠٠ لتر' |
| 'نيرون ٥٠%ء' | 200 | 'ملليلتر / ١٠٠ لتر' |
| 'أكتيلك ٥٠%ء' | 300 | 'ملليلتر / ١٠٠ لتر' |
| 'نترات الكالسيوم' | 250 | 'جرام / ١٠٠ لتر' |
| 'كلوريد الكالسيوم' | 100 | 'جرام / ١٠٠ لتر' |
| 'كبريتات الزنك' | 100 | 'جرام / ١٠٠ لتر' |
| 'صابون سائل' | 250 | 'ملليلتر / ١٠٠ لتر' |
| 'كزد اويل' | ١,٥ | 'لتر / ١٠٠ لتر' |

| I/P | O/P | | |
|---|---|---|---|
| **Treat-op. material_name** | **Treat-op. material_qty** | **Treat-op. qty_unit** | **Treat-op. mode_entry** |
| 'توبســـــــــــــــن ٧٠ %+ريـزولـكس ت ٥٠%ء' | '١٠٠ + ١٥٠' | 'جرام / ١٠٠ لتر' | 'جهازى' |
| 'توبســـــــــــــــن ٧٠ %+ اكـــــــــــيكلوريد الـنحاس٥٠%ء ' & | '١٠٠ + ١٥٠' | 'جرام / ١٠٠ لتر' | 'جهازى - تلاصق' |

| material_name | qty | unit | type |
|---|---|---|---|
| ' اكسيكلوريد النحاس ٥٠%ء ' | 250 | 'جرام / ١٠٠ لتر' | 'تلاصقى' |
| 'ريدوميل+نحاس' | 250 | 'جرام / ١٠٠ لتر' | جهازى |
| 'كوبراانتراكول' | 250 | 'جرام / ١٠٠ لتر' | 'تلاصقى' |
| 'ايوبارين' | 250 | 'جرام / ١٠٠ لتر' | 'تلاصقى' |
| 'سيليكون ٧٢%ء' | 200 | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'سيليكون ٧٢%ء' | 200 | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'موكاب محبب ١٠%ء' | 5 | 'gm/plant' | 'جهازى' |
| 'نيودرين ٩٠%ء' | 75 | 'جرام / ١٠٠ لتر' | 'تلاصقى' |
| 'سيثيون ٥٠%ء' | 400 | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'ريلدان ٥٠%ء' | 250 | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'ملاثيون ٥٧%ء' | 250 | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'لانيت ٩٠%ء' | 75 | 'جرام / ١٠٠ لتر' | 'تلاصقى' |
| 'أدمير ٥٠%' | **125** | 'ملليلتر / ١٠٠ لتر' | 'جهازى' |
| 'أوسكاب ٥٠%' | **300** | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'تريبون ٥٠%' | **١٠٠** | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'نيورون ٥٠% + كزد أويل' | '200+150' | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'كوميت ٥٠% + كزد أويل' | '150+150' | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'بريد +كزد أويل' | '65+150' | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |
| 'مارشال ٢٥%' | **٢٥** | 'جرام / ١٠٠ متر مربع' | 'تلاصقى' |
| 'أورتيس ٥٠% + كزد أويل' | '50+150' | 'ملليلتر / ١٠٠ لتر' | 'تلاصقى' |

| I/P | | O/P | |
|---|---|---|---|
| Treat-op. material_name | Plant.growth-stage | Treat-op. material_qty | qty_unit |
| 'كبريتات ماغنسيوم' | !'fruit stage' | 50 | 'جرام / ١٠٠ لتر' |
| 'كبريتات ماغنسيوم' | 'fruit stage' | 100 | 'جرام / ١٠٠ لتر' |
| 'نترات البوتاسيوم' | !'fruit stage' | 50 | 'جرام / ١٠٠ لتر' |
| 'نترات البوتاسيوم' | 'fruit stage' | 100 | 'جرام / ١٠٠ لتر' |
| 'بوركس' | !'fruit stage' | 10 | 'جرام / ١٠٠ لتر' |
| 'بوركس' | 'fruit stage' | 20 | 'جرام / ١٠٠ لتر' |

| I/P | | | O/P | |
|---|---|---|---|---|
| Treat-op. material_name | Plant.growth-stage | Treat-op. Treated-disorder | Treat-op. material_qty | Treat-op.qty_unit |
| 'كبريتات البوتاسيوم' | !'fruit stage' | 'نقص البوتاسيوم' | 150 | 'جرام / ١٠٠ لتر' |
| 'كبريتات البوتاسيوم' | 'fruit stage' | 'نقص البوتاسيوم' | 250 | 'جرام / ١٠٠ لتر' |
| 'فوسفات ثلاثى' | !'fruit stage' | 'نقص الفسفور' | 100 | 'جرام / ١٠٠ لتر' |
| 'فوسفات ثلاثى' | 'fruit stage' | 'نقص الفسفور' | 150 | 'جرام / ١٠٠ لتر' |
| 'منجنيز مخلبى' | !'fruit stage' | 'نقص المنجنيز' | 25 | 'جرام / ١٠٠ لتر' |
| 'منجنيز مخلبى' | 'fruit stage' | 'نقص المنجنيز' | ٥٠ | 'جرام / ١٠٠ لتر' |
| 'نترات النشادر' | !'fruit stage' | 'نيماتودا تقرح الجذور' 'نقص النيتروجين' | ١٠٠ | 'جرام / ١٠٠ لتر' |

| | 'fruit stage'! | 'النيماتودا الكلوية'و 'نقص النيتروجين' | ١٠٠ | 'جـــــرام / ١٠٠ لتر' |
|---|---|---|---|---|
| | 'fruit stage'! | 'نيماتودا التقصف'و 'نقص النيتروجين' | ١٠٠ | 'جـــــرام / ١٠٠ لتر' |
| | 'fruit stage'! | 'نيماتودا تعقد الجذور', 'نقص النيتروجين' | ١٠٠ | 'جـــــرام / ١٠٠ لتر' |
| 'يوريا' | 'fruit stage'! | 'نقص النيتروجين' | ٥٠ | 'جـــــرام / ١٠٠ لتر' |

| I/P | | O/P | |
|---|---|---|---|
| **Treat-op.Material_name** | **Plantation-type** | **Treat-op. material_qty** | **Treat-op. qty_unit** |
| 'هوستاثيون ٤٠%ء' | 'حقل مكشوف' | 1.25 | 'لتر / فدان' |
| 'هوستاثيون ٤٠%ء' | 'صوب' | 32 | 'ml/100sqm' |
| 'هوستاثيون ٤٠%ء' | 'أنفاق' | 32 | 'ml/100sqm' |
| 'مسحوق ذرة' | 'حقل مكشوف' | 25 | 'كجم / فدان' |
| 'مسحوق ذرة' | 'صوب' | 625 | 'جرام / ١٠٠ متر مربع' |
| 'مسحوق ذرة' | 'أنفاق' | 625 | 'جرام / ١٠٠ متر مربع' |
| رده | 'حقل مكشوف' | 25 | 'كجم / فدان' |
| رده | 'صوب' | 625 | 'جرام / ١٠٠ متر مربع' |
| رده | 'أنفاق' | 625 | 'جرام / ١٠٠ متر مربع' |
| 'عسل أسود' | 'حقل مكشوف' | 5 | 'كجم / فدان' |
| 'عسل أسود' | 'صوب' | 200 | 'جرام / ١٠٠ متر مربع' |
| 'عسل أسود' | 'أنفاق | 200 | 'جرام / ١٠٠ متر مربع' |
| 'ماء' | 'حقل مكشوف' | ١٥ | 'لتر / فدان' |
| 'ماء' | 'صوب' | 750 | 'مللبلتر / ١٠٠ متر مربع' |
| 'ماء' | 'أنفاق | | 'مللبلتر / ١٠٠ متر مربع' |

| | I/P | O/P | |
|---|---|---|---|
| **Treat-op. material_name** | **Plantation-type** | **Treat-op. material_qty** | **Treat-op.qty_unit** |
| 'مسحوق ذرة+هوستاثيون ٤٠%+ماء' | 'حقل مكشوف' | '15 + 1.25 + 25' | 'كجم / فدان - لتر / فدان - كجم / فدان' |
| 'مسحوق ذرة+هوستاثيون ٤٠%+ماء' | 'صوب | '750 + 32 + 625' | 'جرام / ١٠٠ متر مربع - مللبلتر / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'مسحوق ذرة+هوستاثيون ٤٠%+ماء' | 'أنفاق' | '750 + 32 + 625' | 'جرام / ١٠٠ متر مربع - مللبلتر / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'رده+هوستاثيون ٤٠%+ماء' | 'حقل مكشوف' | '15 + 1.25 + 25' | 'كجم / فدان - لتر / فدان - كجم / فدان' |
| 'رده+هوستاثيون ٤٠%+ماء' | 'صوب | '750 + 32 + 625' | 'جرام / ١٠٠ متر مربع - مللبلتر / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'رده+هوستاثيون ٤٠%+ماء' | 'أنفاق' | '750 + 32 + 625' | 'جرام / ١٠٠ متر مربع - مللبلتر / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'مسـحوق ذرة + مارشـال ٢٥ % + ماء' | 'حقل مكشوف' | '15 + 1 + 25' | 'كجم / فدان - كجم / فدان - لتر / فدان' |

| 'مسحوق ذرة + مارشال ٢٥ % + ماء' | 'صوب' | '625 + 25 + 750' | 'جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
|---|---|---|---|
| 'مسحوق ذرة + مارشال ٢٥ % + ماء' | 'أنفاق' | '625 + 25 + 750' | 'جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'ردة + مارشال ٢٥% + ماء' | 'حقل مكشوف' | '1 + 1 + 25' | 'كجم / فدان - كجم / فدان - لتر / فدان' |
| 'ردة + مارشال ٢٥% + ماء' | 'صوب' | '625 + 25 + 750' | 'جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |
| 'ردة + مارشال ٢٥% + ماء' | 'أنفاق' | '625 + 25 + 750' | 'جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع - جرام / ١٠٠ متر مربع' |

## 4.1.2 Specify application-time

*Relation* name: specify application time
*Type: **User-defined***
Description:

> *This relation is used to determine the material application time*
>
> *Relation input: used material, climate.temp-status*
>
> *Relation output:  material application time*

| Input | | | | Output |
|---|---|---|---|---|
| Treat-op. method | Treat-op.treated disorder | Climate. temp_status | Treat-op. material.name | Treat-op. .Application-time |
| 'رش كيميائى' | fungalو insects | 'مرتفعة' | | 'تجنب الحرارة العالية اثناء الرش' |
| 'رش كيميائى' | fungalو insects | 'متوسطة' | | 'تجنب الحرارة العالية اثناء الرش' |
| 'رش كيميائى' | fungalو insects | 'منخفضة' | | 'أثناء النهار' |
| | mites | 'مرتفعة' 'متوسطة' | | 'تجنب الحرارة العالية اثناء الرش' |
| | Mites | 'منخفضة' | | 'أثناء النهار' |
| | 'الحفار' | | | 'بعد غروب الشمس' |
| 'طعم سام' | 'الحفار' | | | 'أثناء النهار' |
| | nematode | | 'موكاب محبب ١٠%' | 'قبل الرى مباشرة' |

## 4.1.3 Specify tool

*Relation* name: specify tool
*Type: **User-defined***
Description:

> *This relation is used to determine the treatment operation  tool*

*Relation input:* Treatment operation , Plantation.irrigation-method
*Relation output*: Treat-op. tool

| Input | | | Output |
|---|---|---|---|
| Treat-op.method | Plantation. irrigation-method | Treat-op. Material_name | Treat-op. tool |
| 'رش كيميائى' 'تسميد ورقى' | | | 'رشاش' |
| 'نثرا على التربة' | 'تنقيط' | 'فايدت ٢٤ء%' | 'خلال مياه الرى' |
| 'نثرا على التربة' | 'غمر' | !'فايدت ٢٤ء%' | 'يدويا' |

## 5 Required functions

### 5.1 Plant Related (*Plant Ontology)*

#### 5.1.1 Plant_age

*function* name: Calculate_plant_age
Description:

> *This function is used to calculate the age of the plant according to the plantation date (or sometimes is called seedling date) and the current date.*

Function input: (plantation.date|| plantation.seedling_date) && system.date
Function output: plant.age
Function body:
plant.age = system.date- (plantation.date||plantation.seedling_date)

## 6 Required Procedure

### 6.1 Treatment Operation Related (Operation Ontology)

#### 6.1.1 Select material

*Procedure-name:* **select material**
*Type: build-in*
Description: This procedure is used to determine the required material for treatment operations. For optional materials, the system selects the most used material by more than treatment operation. For the remainder treatment operations, the material list is applied to the user so that she/he selects one of them such that this list satisfies the following constraints:
    –Materials are not used as obligatory for other confirmed disorders.
    –One of the material in this list has been chosen before.
**For each treat-op OP do**
        **{**
            **Verify treat-op ;**
            **Check obligatory material;**
            **Determine most-used optional material;**
        **}**

# Verify treat-op

```
{
    Verify that treat-op is not visited before(Check treat-op . flag);
        If  treat-op . flag ==1 then treat_op is visited        Else If  treat-op . flag
==0 then treat_op is not visited
}
```

## Check obligatory material

```
{
        Get the obligatory material M of OP;
        For each of the remainder treatment-ops do
        {
                Verify treat-op;
                if treat_op. obligatory-material-name != empty then
                {
                     M1 = treat_op. obligatory-material-name;
                     If (M=M1) then
                     {
                          Append treat-op.treated-disorder to OP.treated-disorder
                          set treat-op.flag to 1
                     }
                }
                if treat_op. optional-material-name list != empty then
                {
                     OPL= the optional-material-name list of treat_op
                     if material M is member  of OPL
                     {
                          Append treat-op.treated disorder to OP.treated-disorder
                          set treat-op.flag to 1
                     }
                }
        }
}
```

## Determine most-used optional material

```
{
     Create optional material table;
     Sort optional material table (descending);
     M\ =The material name M\ of the first row of the table;
     Set material M\  in corresponding treat-op(s);
      For each unvisited treat_op do
      {
      Display optional material for treat_op disorders;
      Get user choice M\\;
      Set material M\  in corresponding treat-op(s);
      }
}
```

## Create optional material table

```
{
this table consists of the following fields:
[[material name], [Treat-op name(s)], [disorder name(s)], [num- of-disorders]]
}
```
## Set material M\  in corresponding treat-op(s)

```
{
        TOPs= Get the Treat-op name(s) field of M\Op1= first element of TOPs;
        append the disorder name(s) field of M\  to Op1.treated-disorder;
```

```
                    set M\   as obligatory material in Op1;
                    set all TOPs.flag to 1;
                    set Op1.used_material_flag to 1;
            }
```

## 6.1.2   Order Treatment schedule

> *Procedure-name order*
> *Type: build-in*
> Description:
> > Relation input: Treat-op, treated-before table
> > Relation output: Ordered Treat-op.

```
Proc_Order (List of Treat-op, treated-before table)
{
    Get all Treat-op.number;
    N = maximum number;
    For I=1 to I = N Do
    {
        Get all treat-op[I]
        For each treat-op[I] do
        {
        1-   satisfy-treated-before-constraints
        2-   satisfy-shift-3-days constraints
        }
    }
}

satisfy-treated-before constraints (TOPL= List of treatment operations, TB-table )
{
    /*sort the TOPL according to the treated before table */
            Length = length of TOPL
            for (int i=0; i<Length; i++)
                    for (int j=0; j< Length  ; j++)
                  {
                      D1= Tr[j].treated-disorder ;
                      D2= Tr[j+1].treated-disorder ;
                      if(D1 treated before D2)           {              temp= Tr[j+1]
                         Tr[j+1]= Tr[j];
                          Tr[j]=temp;
                      }}


}
```

satisfy-shift-3-days constraints(TOPL)
```
    {
            /*If the two treatment operation have the same method, there should be a 3 days shift between
        each operation*/

            Length = length of TOPL
            for (int i=0; i<Length; i++)
                    for (int j=0; j< Length  ; j++)
                {
                    M1= Tr[j].method ;
                    M2= Tr[j+1].method ;
                    if(M1 == M2)                    Tr[j+1].date = Tr[j].date +3;
                    else
                    {
                        if (Tr[j+1].date  < Tr[j].date )
                            Tr[j+1].date = Tr[j].date
                    }
                }
```

## 7   Domain scheme

| Relation name | Relation type | Input | output |
|---|---|---|---|
| Soil_type | Rule cluster | Soil.texture | Soil_type |
| Determine_growth_stage | Rule cluster | User_defined | Plant.growth_stages |
| Specify-material | Rule cluster | User_defined | List of suggested treatment opearions |
| Specify Advice | Rule cluster | User_defined | treatment opearions.advice |
| Specify material qty | Table | User_defined | treatment opearions .material-qty, treatment opearions .material-unit treatment opearions .mode-entry |
| Specify tool | Table | User_defined | treatment opearions.tool |
| Specify application time | Table | User_defined | Treatment opearions.application-time |
| Calculate_plant_age | Function | (plantation.date\|\| plantation.seedling_date) && system.date | Plant.age |

## 8   Task Layer

| Procedure Name | Execute-Treatment |
| --- | --- |
| **Description** | This is the main procedure for the treatment |
| **Input** | A set of confirmed disorders<br>Plantation specifications |
| **Output** | Treatment schedule |
| **Pre-Conditions** | The user must enter a correct plantation date and a set of confirmed disorders to start the treatment task |
| **Comment** | - The whole task is called when the set of treated disorder is selected by user except for virus and environmental classes. In this case the task begin at the ninth step "Specify advice".<br>- This should also be considered in the final screen i.e, in this case of virus and environmental classes the output screen contains only the disorder name and advice related to this disorder.  Otherwise the complete treatment schedule appears. |
| **Called Procedures (sequential)** | 1.   Calculate-plant-age (build-in)<br>2.   Determine-plant-growth-stage<br>3.   Get-treated-disorder (build-in)<br>4.   Specify treat-op<br>5.   Select material (build-in)<br>6.   Specify material qty<br>7.   Specify application-time, tool<br>8.   Order treatment schedule (build-in)<br>9.   Specify advice<br>10. Display the treatment schedule (build-in) |

| Procedure Name | Calculate-plant-age | |
| --- | --- | --- |
| **Description** | This procedure  is used to determine the plant age | |
| **Input** | *Concept* | *Property* | *Source of value* |
| | *Plantation* | *Plantation.date* | *user* |
| | *System* | *Date* | *system* |
| **Output** | Plant.age | |
| **Pre-Conditions** | None | |
| **Called Procedures** | *Play Inference* (calculate_plant_age)<br>If plant.age > X then (calculate_plant_age )<br>Else {<br>Display-message" There can not be any infected disorders at this age"<br>exit<br>} | |

| Procedure Name | Determine-plant-growth-stage |
|---|---|
| Description | This procedure is used to determine the plant growth stage according to plant age. This procedure may be called in some crops and may be not used in others. |
| Input | *User defined* |
| Output | Plant.growth_stage |
| Pre-Conditions | *This procedure is crop dependant, in some crops only one relation is used while in others(like in cucumber) a group of relation is called* |
| Called Procedures | growth-stage model |

| Procedure Name | Get-treated-disorder | | |
|---|---|---|---|
| Description | This procedure is used to allow user to select the treated disorder | | |
| Input | *Concept* | *Property* | *Source of value* |
| | *Disorder* | *Confirmed* | *user* |
| Output | List of confirmed disorders | | |
| Pre-Conditions | None | | |
| Called Procedures | Display the disorder taxonomy to the user to select a disorder (screen1) IF the selected disorder belongs to the class of { virus and environmental } then go to the last step (These classes of disorders doesn't have treated material, they have only treated advice and application time) Else go to the next step | | |

| Procedure Name | Specify treat-op |
|---|---|
| Description | This procedure is used to specify the treatment operations used to treat each disorders. We have two types of treated materials: 1-Obligatory materials (should be applied to plant) 2-Optional materials (the user can select one of them to be applied to plant). |
| Input | *Disorder.confirmed* *Disorder.percentage_infection* *Disorder.infection* |
| Output | Set of treatment operation for each affected disorder |
| Pre-Conditions | None |
| Called Procedures | Specify materials models |

| Procedure Name | Select material |
|---|---|
| Description | This procedure  is used to ask the user about the available material to be used  in treating each affected disorder |
| Input | *Confirmed disorder* <br> *Set of treatment operation* |
| Output | Set of  treatment operation |
| Pre-Conditions | For optional materials only, apply material  list to the user so that she/he select one of them such that this list satisfies the following constraints: <br> –Materials are not used as obligatory for other confirmed disorders. <br> –One of the material in this list has been chosen before. |
| Called Procedures | *Select material* |

| Procedure Name | Specify material qty |
|---|---|
| Description | This procedure  is used to determine the  quantity and unit of each treatment operation |
| Input | List of treatment operations |
| Output | Table contains each materials and it associated quantity and unit |
| Pre-Conditions | For only the treatment operations that has the property used-material-flag  is set to 1 <br> (This flag is set in two cases <br> 1-obligatory material <br> 2-selected optional material by the user <br> ) |
| Called Procedures | Specify qty model |

| Procedure Name | Specify application-time |
|---|---|
| Description | This relation is used to determine the   application-time   to treat disorder |
| Input | User defined |
| Output | Treatment operation application time and tool |
| Pre-Conditions | For only the treatment operations that has the property used-material-flag  is set to 1 |
| Called Procedures | Specify-application-time <br> Specify-tool model |

| Procedure Name | Order treatment schedule |
|---|---|
| Description | This procedure is used to order the treatment operations |
| Input | Treatment operations<br>Constrain table that contains which disorder should be treated before the others |
| Output | Treatment schedule |
| Pre-Conditions | 1- For only the treatment operations that has the property used-material-flag is set to 1<br><br>2-We have two types of constraints:<br> a) treated before table (some disorders have to be treated before others)<br> b) If the method is the same then, shift application date by 3 days, otherwise the two treatment operations can be used at the same date |
| Called procedure | Order |

| Procedure Name | Specify advice |
|---|---|
| Description | This relation is used to determine the advice to treat disorder |
| Input | User defined |
| Output | Material Advice |
| Pre-Conditions | None |
| Called Procedures | Specify-advice Model |

| Procedure Name | Display |
|---|---|
| Description | This procedure is used to display the treatment schedule |
| Input | Ordered Treated operations |
| Output | treatment schedule |
| Pre-Conditions | The output screen may contain complete or partially completed information about the treatment operations. Partially complete information mean that we have only the disorder name and the advice. This happen in two cases:<br>1- virus and environmental classes<br>2- some disorders of other classes.<br>So before display the final screen, we have to check the attributes of the treatment operation to find if it contains partial or complete information |
| Called Procedures | Display |

## 9    User Interface

Figure1(select-affected-disorder)
This is the first screen to appear to the user. He/she should select one or more disorders to be treated.

Figure2(optional-operation-selection)

Some of the treatment operation may have more than one alternative materials  that can be used in the treatment. The user can select the availabe material to him. This screen has two icons,

1-                       جدول العلاج

Which leads to figure 3 that contains the ordered treatment operations

2-                       نصائح عامة

Which lead to a generated reports that has two fields:

1-   Name of treated disorder
2-   Advice about applying the treatment operation

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|---|---|---|

خروج

تفاصيل العملية