

**Local knowledge about *Thaumatococcus daniellii* (Benn.)
Benth. in Ghana.**

**A GUIDE TO USING THE AGROECOLOGICAL
KNOWLEDGE TOOLKIT (AKT5)**

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This guide uses an approach to introduce first time users of AKT5 pioneered in Ghana (Moss *et al*, 2001) and subsequently used in Thailand (Pagella *et al*, 2002), Lesotho (Waliszewski *et al*, 2003) and South Africa (Waliszewski *et al*, 2003). The template for this document was used by kind permission of the authors of these previous documents.

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1. Introduction

1.1 Local knowledge and knowledge based systems approaches

There is an increasing awareness that local knowledge and practices should be recognized in development initiatives aimed at sustaining and improving the livelihoods of farming communities and the environment. Interest amongst institutions involved in research, education and development in investigation and documentation of local knowledge has grown significantly over the last few years.

The University of Wales, Bangor is a leading institution in the development of a knowledge-based systems (KBS) methodology to acquire and use local knowledge in research and development. The university spearheaded the development of this novel approach to acquire, store and use local ecological knowledge about agroecosystems in collaboration with various national and international research institutions in Asia, Africa and Latin America. It promotes systematic collection and collation of ecological knowledge from farmers and development professionals. The Agroecological Knowledge Toolkit (AKT5) is a tailor-made computer software package that enables representation of knowledge in a computer readable form facilitating exploration of local ecological knowledge using computer based search and reasoning facilities.

Work so far has revealed that rural people often have sophisticated knowledge of ecological processes occurring in their environment and that local knowledge is largely complementary to scientific knowledge, but is often not taken into account when planning research and development. While knowledge differs to some extent between communities, common frameworks and terminology may occur across large distances and people with similar agroecological circumstances in different geographical and cultural contexts may have similar perceptions.

1.2 What is the purpose of this guide?

The instructions that follow will guide you through a knowledge base about *ego*, *Thaumatococcus daniellii* (Benn.) Benth. created from interviews with local people conducted by Wojtek Waliszewski and Seth Oppong. By following the instructions set out in this guide you will be introduced gradually to the AKT software, while at the same time learning about local people's knowledge about *ego*.

This guide was designed to assist new users of the AKT5 package to explore local knowledge that has already been documented by others. It is not intended to guide users through the creation of their own knowledge bases. The methodology for creating new knowledge bases is set out in a comprehensive user manual available electronically or on paper (Dixon *et al*, 2001). The principles underlying knowledge base creation are explained in Sinclair and Walker (1998) and Walker and Sinclair (1998) and the approach is discussed in the context of natural resource management in Sinclair and Walker (1999) and Sinclair and Joshi (2000). The software and manual can be downloaded from the AKT website at <http://www.akt5.bangor.ac.uk>

1.3 Consulting Knowledge Bases

Local knowledge can help researchers and development workers explain the rationale behind farmers' actions and can contribute to making more effective decisions in developing appropriate solutions to development problems. Knowledge bases can be consulted in four main ways:

- by viewing sets of statements about particular topics,
- by searching for statements that contain particular *terms* or words,
- by representing statements as a *diagram* and then investigating chains of causation , and
- by using customized *tools* supplied with AKT to interrogate and reason with knowledge.

1.4 The Agroecological Knowledge Toolkit (AKT5)

1.4.1 What is AKT5?

AKT5 is a methodology and software package that enables users to create *knowledge bases* about chosen *domains*. A knowledge base *domain* is defined both by the subject area it covers, such as 'ego', and by whose knowledge it is that has been represented, for example 'users of ego in Ghana'. Creating a knowledge base involves collating knowledge from various *sources* that may include knowledgeable people, such as farmers, scientists and extension workers, or documents such as extension manuals and scientific literature. AKT5 has been used primarily as an analytical research tool to explore the extent and nature of local agro-ecological knowledge and how this compares with conventional scientific and professional information. This has led to profound changes in the way that research and extension are planned in areas of Africa (Kenya, Tanzania, Ghana and Cameroon), Asia (Nepal, Thailand, Sri Lanka and Indonesia) and Latin America (Colombia, Costa Rica and Nicaragua), as well as forming the basis for successful participatory crop improvement and the development of decision support tools for the production of extension materials tailored to farmer circumstances. The tool is also in active use in projects in Brazil, China, Peru, Vietnam and Southern Africa, as well as amongst a network of research and development workers in the Philippines. Some

examples of the use of the tool are discussed in Sinclair and Walker (1999), current activities are outlined in the AKT5 newsletter and are posted on the website (see Section 1.2 above). When local knowledge is explicitly stored within a knowledge base, it can then be consulted by natural resource scientists, policy makers and development workers in a variety of ways to help them meet their own objectives.

1.4.2 What is knowledge?

To define *knowledge* is to enter a philosophical minefield; nevertheless an explicit definition is required in this context. For the purposes of AKT, *knowledge* is seen as the outcome of the interpretation of data, independent of the interpreter. Data are recorded sets of observations that may be either qualitative or quantitative. Knowledge is distinct from understanding, which is a result of the interpretation of knowledge or data and is specific to the interpreter. These definitions are more fully discussed in Sinclair and Walker (1999).

1.4.3 What is a knowledge base?

A *knowledge base* is a store of knowledge. In AKT5, this consists of a collection of *statements* together with *object hierarchies* that represent taxonomic relationships. Each *statement* is associated with information about whose knowledge it represents - the *source* of the knowledge, which is generally either a person or a document, although each statement may have a number of sources. The knowledge is organised in two main ways.

- *Topics* comprise knowledge about specific subject areas or from specific sources e.g. 'Harvesting ego produce' or 'Propagating ego'. *Topic hierarchies* gather similar topics under broader headings. For example, the above topics both fall under the more general topic of 'Management of ego'.
- *Object hierarchies* represent local taxonomic relationships amongst terms. For example 'asase_fitā, asase_tuntum, and ntetie' are all types of soil and therefore fall under the more general object label 'soil'.

2. The ego knowledge base – Context of the Study

2.1 The importance of *Thaumatococcus daniellii*

Thaumatococcus daniellii, a robust rhizomal understorey forest herb, found throughout the Guineo-Congolian rain forest (Waliszewski *et al.*, in press) is the raw material for the intense protein sweetener thaumatin, the sweetest naturally occurring substance in the world (McWhirter, 1983). Thaumatin, used in the beverage, confectionary, and pharmaceuticals industries, is an internationally traded commodity with a market value of £4000 kg⁻¹ (S. Cuthbert, Overseal Foods, Swadlincote, UK, pers. comm.).

Currently *T. daniellii* fruit is collected solely from the natural resource by local collectors in Ivory Coast and Ghana, to provide arils for the processing of thaumatin. Whilst the plant is abundant and appears to be resilient to local harvesting there has been no work done to specifically quantify this effect. Research during the 1970s and 1990s focussed on agronomic studies of *T. daniellii* (Summerfield *et al.* 1977; Most *et al.* 1978; Onwueme *et al.* 1979) and biochemical analyses of the activation and nature of the thaumatin proteins (Mackenzie *et al.*, 1985; Cusack *et al.*, 1991).

With the thaumatin market ripe for expansion increased pressure is expected on the natural resource. Interest has since grown in its sustainable harvesting and management. A small scale processing facility for thaumatin is being established in Ghana to produce the product locally and export it.

This output, together with the ego knowledge base, (*ego* is the local *twi* name for *T. daniellii*), is the result of a local knowledge study into the agro-ecology of the plant.

2.2 Methodology

2.2.1 Location

Interviews were conducted in eleven villages within a 30 km radius of Samerboi, in the moist evergreen rain forests of south west Ghana, and two villages further north in different forest zones – Kwapanin and Adwenase.

2.2.2. Definition of the knowledge domain

Following a period of reconnaissance and discussion with villages in the study area, selection of key informants occurred. During this stage the purpose of the study was explained and a preliminary evaluation of local people's knowledge was made. Following this work and discussion with Samartex the domain was defined as the agro-ecology of *T. daniellii* with relevance to sustainable harvesting and its propagation.

2.2.3 Stratification of key informants

Interaction with *T.danielli* determined the basis of stratification with the following groups of users being identified:

Table 1 Location and description of strata groupings (Waliszewski, 2002)

Defined strata	Gender involvement	Comments and activity with <i>T. daniellii</i>	Strata villages
Leaf collector	Female	Collection of leaves from cocoa farms, secondary fallows and virgin forest. Located around Samreboi.	Amuaku, Samreso, Krofrom, Mrebenini
Fruit collector	Female and Male	Collection of fruits from secondary fallows and virgin forest	Nsuakyir, Jerusalem, Susaan
Farmer	Predominantly Male	The main interaction with <i>T. daniellii</i> was controlling it as it was a weed of cocoa.	Oda, Adam, Krofrom, Mrebenini
Cultivator	Female and Male	People that had or were cultivating <i>T. daniellii</i> for either fruit or leaves.	Samreboi, Enchi, Susaan, Kwapanin, Adwenase

2.2.4 Compilation of the knowledge base

Interviews with key informants were held in the field where possible (Figure 1, below) and lasted no more than an hour, unless the informant was keen to continue. The interviews were informal and semi structured, using non leading questions in order to elicit the informants' knowledge, rather than influence answers.



Figure 1: Interviews conducted in the field allowed the interviewer to gain a better insight into the collection method. In this photograph red fruit are seen on the forest floor.

Interviews were recorded and then knowledge was documented from subsequent analysis of the recordings. This allowed an easy flow of conversation during the interview without too many distractions. Recording of interviews made transcription of interviews easier. Transcribed interviews were broken down into unitary statements and input into the knowledge base software following guidelines set out in the AKT5 methodology. This involved using a formal grammar to develop an unambiguous representation of the informant's environmental knowledge. Automated reasoning techniques were then used with this representation to help view, evaluate and analyse the knowledge. Evaluation of the knowledge base as it developed led to the identification of the need for further questions to clarify some aspects, resolve apparent inconsistencies and so develop a comprehensive picture of local knowledge about the domain.

2.3 The ego knowledge base

The 'ego' knowledge base was constructed to investigate and document local knowledge on the agro-ecology of *T. daniellii* held by local people in the study area. This focused on Management actions pertaining to its harvesting and production, the structure of the

plant, the environment in which it grows and interactions it has with other species and factors that impact on its growth.

This information has been grouped together in the following topic hierarchies:

- Plant structure
- Management of ego
- Soil
- Water
- Light
- Weeds and weediness
- Ego growth

3. How to consult knowledge bases

3.1 Using the guide:

A number of instruction sheets are included in this package that is aimed at enabling you to consult the knowledge bases provided. It is suggested that you start with '**A quick sightseeing tour around AKT5**' to familiarise yourself with the different functions of the software. Once this is completed you can then move on to consulting the knowledge bases on particular topics that interest you.

After completing the **Quick sightseeing tour around AKT5** the user will be able to consult knowledge bases by using topics, searching for terms and exploring diagrams. These skills are reinforced and developed by the **User Manual** (Dixon *et al*, 2001) which provides a comprehensive guide to the software and the creation of knowledge bases, there are also a series of other guides that have been produced to help consult knowledge bases on various topics and contexts (Moss *et al*, 2001; Joshi *et al*., 2001; Pagella *et al*, 2002; Waliszewski *et al*, 2003).

3.2 A quick sightseeing tour around AKT5

This quick tour around AKT with the **ego** knowledge base is designed to familiarise you with the AKT software and with the ways of manipulating knowledge bases. The breeding knowledge base can be consulted and explored using the methods outlined within this and the guides outlined above.

Getting Started:

1. Load the AKT program onto your computer by clicking on the appropriate icon from the start menu.
2. Once the AKT program is open select OK
3. From the main menu (File, KB, Diagram, Tools, Help) select KB.
4. Open the **ego.kb** by choosing **Open Kb...**
5. You will find the veld KB, together with other KBs in a window. Highlight veld and click on **Open**.
6. The ego KB will now open and you will see the **Welcome Dialogue Box**

3.2.1 Welcome Dialogue Box

Read the welcome dialogue box to get an idea of what the knowledge base is about. Note that some panels contain more information than is displayed and can be scrolled down to reveal more. Press **Further Details** to find out more about where, when and how the knowledge base was made. Click on **Pictures/Diagrams**. If pictures are available view each picture by selecting it from the list, and then clicking on **Select**. When you have finished with each picture or diagram,

click on the X at the top right hand corner to close it. These diagrams provide some background information about the rangelands. Click on **Close** to return to the Welcome screen.

Now press **Topics**

3.2.2 Topic hierarchies

Topics are ways of organizing information around particular subject areas e.g. **Plant Structure and Management of ego**. In **Topic Hierarchies** information about specific subject areas is arranged under a more general subject label e.g. **'Harvesting ego', 'Locating ego' and 'Propagating ego'** all fall under the general topic hierarchy of **'Management of ego'**.

On the left you can see a list of topic hierarchies in the knowledge base below which is an empty dialogue box termed 'Topics in selected hierarchy'. Highlighting any of the topic hierarchies will produce a new dialogue box to the right of the original box and display the topics in the 'Topics in selected hierarchy' dialogue box. Select **'Management of ego'**. you will see a list of all the topics in the topic hierarchy and a new dialogue box to the right with a column containing a list of all topics in this topic hierarchy, **'Management of ego'** highlighted in blue and immediately below all the subtopics under it.

Click on **View Tree** and scroll down the page. This shows you the full topic hierarchy. Click on **Close**. Select **'Picking ego fruit'** in the 'Topics in hierarchy list. You will see that it now appears in the 'Topic' box with **'Management of ego'** specified as the supertopic above it and **'Ego fruit location', 'Fruit picking season' and 'Yield of fruit'** as the specified subtopics below it.

Click close to close the dialogue box on the right hand side of the screen, leaving the original dialogue box.

Highlight in turn each topic hierarchy listed in the Topic Hierarchies dialogue box

Question: What topics does the topic hierarchy 'Ego growth' include?

Press **Close** on all dialogue boxes to return to the Welcome Memo and **Close** again to arrive at the main menu.

3.2.3 Sources

Go to the main menu (top left) and select **KB → Sources...**

Sources tell you the origin of the information contained in a statement. All statements have a source, which can be of two types: an interview with a person e.g. a **leaf collector, fruit collector, cocoa farmer** or a **cultivator**, or a reference to a written document e.g. a journal reference.

On the left is a list of all the sources interviewed for the knowledge base. Let us look at one of them. Highlight the name ‘**Adwoa Nkrumah Amuaku 2002a**’ the second in the list of sources. The the ‘**a**’ in ‘**2002a**’ in the first entry for ‘**Adwoa Nkrumah**’ reflects that this was the first interview with her. The second entry for her has the suffix ‘**b**’ attached to ‘**2002**’, signifying the second interview. **Amuaku** is the name of the village that she lives in.

Now press **Details**. A dialog box appears giving you the name of the interviewers, interviewees, and the date of the interview. You are also given the gender, the type of herder of their age and the name of the location where the interview took place. If you press **Memo**, you will be given any further details that the person who developed the knowledge base felt was important.

Press Close on all three dialogue boxes.

3.2.4 Topics

From the main menu select **KB → Topics...**

This gives you the list of all the topics in the knowledge base. Highlight ‘**Weediness and weeds**’ and press **Details/Edit**. In the dialogue box that appears you will see in the ‘Boolean Search String’ how the topic was created- it is a search for any of the following words- ‘**weed or ego_weed or weeding or wraps_around**’.

Click on the ‘**Show use in statements**’ at the bottom of the dialogue box and a list of all the statements on ‘**Weediness and weeds**’ will appear. There are 67 statements in all. **Close** the list of statements and the topic details.

Try the same thing with the topic ‘**Yield of fruit**’ the last topic in the list.

Question: How many statements are there on ‘Yield of fruit’?

Knowledge is represented as *statements* – these are the basic units of the knowledge base. There are four different types of statements. **Attribute statements** tell you about the properties (attributes) of something – they are descriptive. **Causal statements** give you information about causal relationships. **Comparison statements** compare the properties of two objects. **Link statements** represent knowledge that cannot be represented by the other type of statements. Please be aware, when using the program, that AKT5 automatically generates a natural language translation in stylised English.

Close all open dialogue boxes and return to the main menu.

3.2.5 Object hierarchies

From the main menu select **KB→ Object Hierarchies...**

On the left you can see a list of the object hierarchies in the knowledge base. Highlight ‘**soil**’. On the right you will see a long column containing a list of all the objects in the hierarchy, to the

right of this you will see **'soil'** highlighted in blue and immediately below all the sub-objects under it.

Click on View Tree and scroll down the page. This shows you the full object hierarchy **'soil'**.

Click on **Close** to close the tree that you have just viewed.

Now select **'asase_denden'** in the 'objects in hierarchy' list that you can see in the larger of the two boxes on the screen. You will see it now appears, highlighted in blue, in the 'Object' box with **'soil'** specified as the superobject above it and **'ntetie'** specified as a subobject below it.

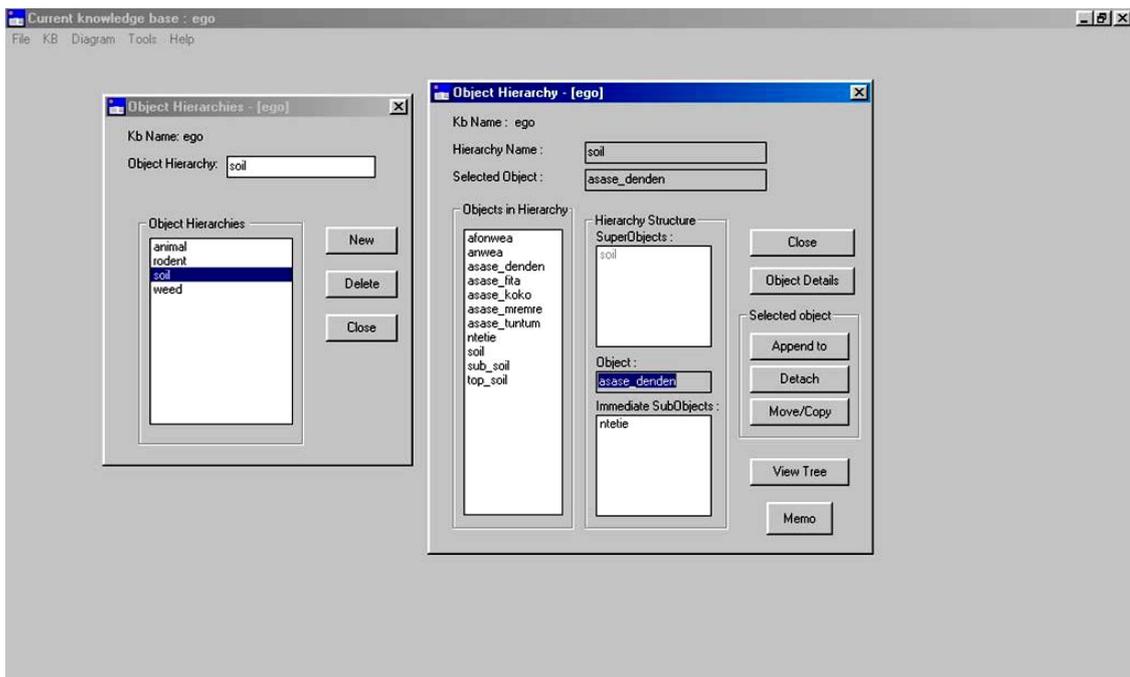


Figure 1: The object hierarchy diseases, showing the Object (krimpsiekte), the Immediate SubObjects and diseases as the SuperObject.

Objects are words used to refer to physical or conceptual items e.g. **ego, soil, weeds, rodent**. Object hierarchies represent classifications that people use to organize their knowledge by arranging some objects as specific 'types' of more general objects e.g. **'asase_fit**a, **asase_denden, asase_koko**' are all types of **soil**. These are, therefore, subobjects of the more general object **'soil'**, and, **'soil'** is a superobject of the objects **asase_fit**a, **asase_denden, asase_koko**'. All statements that refer to the superobject are inherited by all its subobjects.

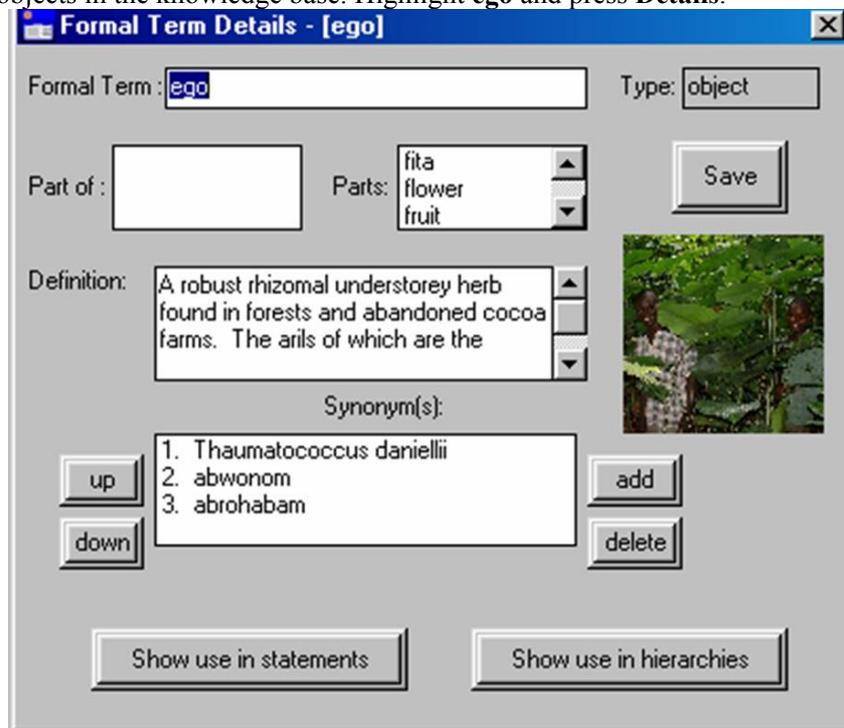
Now **Close** all dialogue boxes.

3.2.6 Formal Terms

From the main menu select **KB→ Formal Terms...**

Formal terms are the key components of statements. **Objects** are one type of formal term. Other types include **actions** – human activities *e.g.* **harvesting** or **collecting**, and natural **processes** such as **growth** or **flowering**. You will notice that underscores are used to connect words that make up a single term *e.g.* **asase_denden**. Words that require a capital letter are written in quotation marks *e.g.* **'Odwuma'**.

Press the downward arrow on “Type” next to the word ‘all’ to see the different types of formal terms. Select **object**. All the objects in the knowledge base are now listed. Scroll down and get an idea of the objects in the knowledge base. Highlight **ego** and press **Details**.



The screenshot shows a dialog box titled "Formal Term Details - [ego]". It contains the following elements:

- Formal Term:** A text box containing "ego".
- Type:** A dropdown menu set to "object".
- Part of:** An empty text box.
- Parts:** A list box containing "fita", "flower", and "fruit".
- Save:** A button.
- Definition:** A text box containing "A robust rhizomal understorey herb found in forests and abandoned cocoa farms. The arils of which are the".
- Synonym(s):** A list box containing "1. Thaumatococcus daniellii", "2. abwonon", and "3. abrohabam".
- up/down:** Two small buttons.
- add/delete:** Two buttons.
- Show use in statements/hierarchies:** Two buttons at the bottom.
- Thumbnail:** A small image of a plant on the right side.

Figure 2: The formal term dialogue box

This provides you with a brief description including information on what type of formal term it is and a thumbnail photograph (if one is available). Double click on the thumbnail to enlarge the picture.

3.2.7 Understanding Parts

Parts:

It is sometimes useful to identify component parts of an object. For example a tree may have braches, leaves and bark, which are also objects in their own right. It is useful, therefore, to refer to be able to refer to these as components of the tree. In the dialogue box that is now open you

can see that there are many parts of ego by scrolling down the list. Some of the parts of **ego** are **fita, flower, fruit, leaf, leaf_joint, rhizome, root, seed , seedling, sepal, shoot and stem.**

Now click on '**leaf**' in the **Parts** box.

Part of:

You will now see that the dialogue box has changed and the object that is the formal term is '**leaf**'. As you pressed '**leaf**' from the '**ego**' dialogue box you will see that the thumbnail picture is of an '**ego leaf**'. You will also see that leaf is not only a '**Part of** ego but **afunpan, branch, cocoa and seedling.**

If you now click on '**ego**' in the Part of box you will return to the **ego** formal term dialogue box.

The **Definition** is fairly self explanatory and provides further information about **ego**.

Synonyms The dialogue box lists the synonyms attached to a specific formal term. During knowledge base development in Ghana, the standard practice was to write the formal terms in *Twi*, the first synonym being the scientific name and the second and third place synonyms used for English and other local languages.

Still using the **ego** formal term dialogue box, now press **Show use in Hierarchies**. You will see that ego appears in the object hierarchy '**weed**'. Press **OK** to close this dialogue box.

Press **Show use in statements**. There are 440 statements about ego in the knowledge base.

Close all dialogue boxes

Once again from the main menu select **KB→ Formal Terms...** using the same method as above select the object **okusie**. Highlighting details informs you that **okusie** is a rat! Pressing the **Show use in statements** displays a new dialogue box with three statements containing the term **okusie**. Under '**Diagram Selection Type**' at the bottom of the dialogue box press **All Statements**.

3.2.8 Introduction to Diagrams

The diagram that you see shows all the statements about okusie that can be represented diagrammatically. The diagram has only got three nodes (boxes). To see a diagram that is more complex, click on **Diagrams→ Show Kb Diagrams...** and select one of the diagrams that have been produced by the knowledge base developer.

Please select the diagram labeled **ego fruit location**.

Diagrams are a way of representing the connections between statements. Only causal and link statements can be represented diagrammatically. One statement is represented by two **nodes** (a rectangular or oval box) connected by an arrow. The different colours and shapes of the nodes indicate different types of node – action, process, object and attribute nodes. The arrows represent the linkages between the nodes. It is possible to view diagrams in either English.

Press the **Label Mode** button once. This will now show a pair of arrows, adjacent to a number, next to each statement. The numbers, 1 or 2, represent whether the statement is reversible.

An arrow pointed upwards signifies an increase in the value where as a downward pointing arrow would signify a decrease in the value associated with the attribute in the node.

An * indicates a different value, such as low, high, yes, no, '<3_months', or a range especially useful if representing a period of time for instance the rain season is between January to March can be represented using this function.

If the Label mode is pressed again this gives you statements written on the diagram in full. You can make the statements more legible by dragging the nodes across the screen to separate them out. Alternatively you can drag the statements themselves around the screen.

If the diagram is too large for the screen you can scroll through the diagram using the scroll bars, or alternatively you can **Zoom out** (up to four times to see the diagram if it is really large)

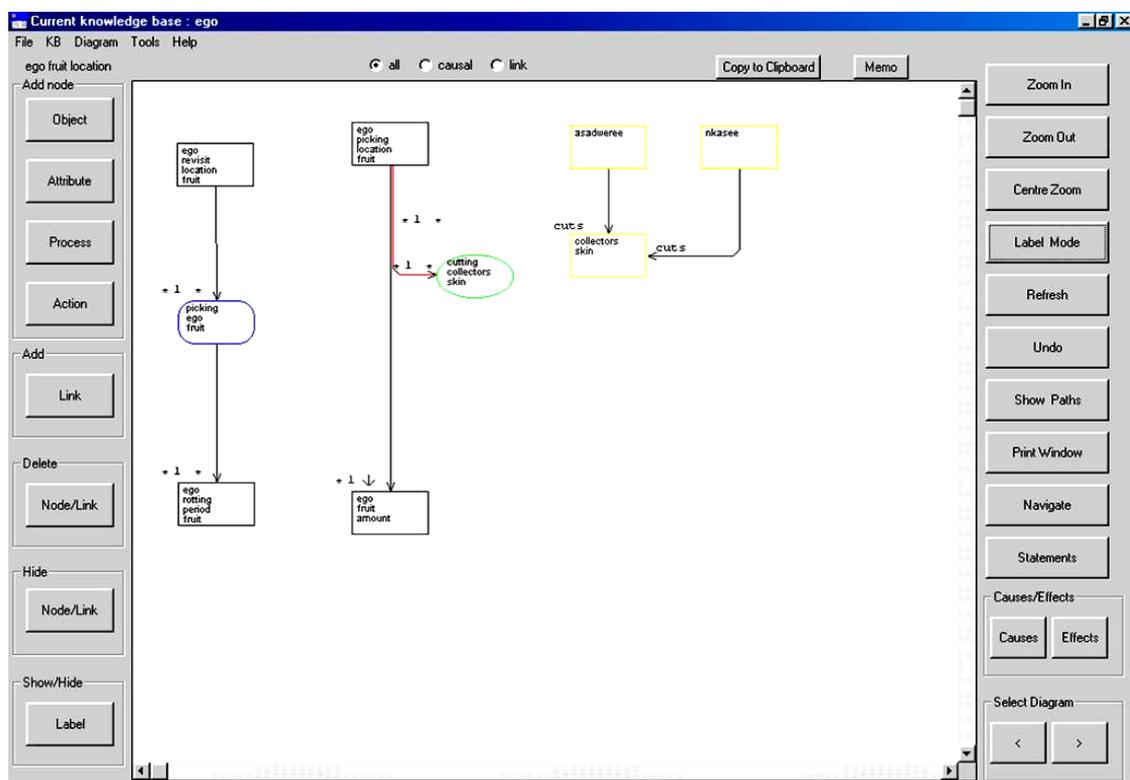


Figure 3: The diagram interface of AKT5

There are two methods for finding extra information about the statements containing the word Aswaderee:

- 1) Click on the **Statements** button on the right to get a list of all the statements represented on the diagram. Then select the statement containing 'Aswaderee' and click on **Details**. At the top of the dialogue box you will see the natural language statement and at the bottom the formal language. The source of the statement is given at the top.

2) Double click on the node 'Aswaderee' and a list of all the formal statements pertaining to 'Aswaderee' will appear. Highlighting and clicking on 'Details' will provide information about that statement in a 'Statements dialogue box'.

Statements are typed into the knowledge base as **formal language statements** using a formal grammar (like a code) specific to AKT. These are then translated by the AKT program into stylised natural language equivalents. This use of computer generated translation explains why some statements in the knowledge base do not sound like natural English.

If you require further clarification about a certain formal term click on **Formal terms**, on the right hand side of the 'Statements dialogue box', select the formal term from the list and click on **Details**. In the new dialogue box a definition, synonym and picture will be shown if they are available.

Close all the dialogue boxes and return to the diagram.

When working with complex diagrams it is helpful to remember to switch the labels off. You can do this by clicking the **Label mode** button once more.

The **Navigate** button gives you the immediate causes and effects of each node.

Click on **Navigate** on the right hand side of the screen and then click on the node, 'picking ego fruit'. The node will be highlighted in green and some additional nodes will appear connected to 'picking ego fruit'. Carefully drag sideways all new nodes to reveal any further nodes underneath (by pressing the left-hand mouse button over the node and dragging the node away). The red lines indicate that there is more than one line or arrow on top of one another.

You can continue to explore the knowledge base using this method, building the diagram by selecting **Navigate** each time and clicking on one of the new nodes. You can try this by clicking the navigate button and selecting 'ego stem death'.

Alternatively if you are only interested in the factors that are an effect of a node, or a cause for a node then click on either 'Causes' or 'Effects' in the 'Causes / Effects' box towards the bottom right of the diagram interface. You will get an upward arrow if you have selected 'Causes' and a diagonal arrow if 'Effects' has been selected. By placing the arrow over the node of interest and clicking the immediate causes or effects are displayed.

When you have finished, go to the main menu (top left-hand corner) and select **Diagram→Hide Diagrams**.

3.2.9 Boolean Search

Go to the main menu
Select **KB→Boolean Search**.

Formal terms and sources will now appear in the **Display Kb terms of type** dialogue box.

Scroll through the terms listed and Select **'haan'**.

Now press **Select**, and **'haan'** will appear in the Boolean search string at the bottom of the dialogue box. (If you want to know what **'haan'** is and which object hierarchies it is a member of please follow the instructions given in 3.2.6)

Now press the **AND** button.

From the list select **'asase_mremre'** (an object) and press **Select** once more. (If you want to check the synonym for **'asase_mremre'** select **Details**.)

Take care to ensure that you have not accidentally selected a formal term twice in succession as the Boolean search string will not operate. If you do this, highlight the second entry and press delete on your keyboard or backspace to remove it.

Press the **Search** button. Only one statement will appear. This is the only statement in the knowledge base which include both **'haan'** and **'asase_mremre'**.

In the Search Results dialogue box press **Close**. In the Boolean Search dialogue box press **Clear**. Now do the same thing again, selecting **'haan'** and **'asase_mremre'**, only this time using **OR** instead of **AND**. Press **Search**.

Now you have 27 statements. This is because you have selected all the statements that include either **'haan'** or **'asase_mremre'**.

In the Search Results press **Close**.

How many statements are there for **asase_mremre** alone?

In the Boolean Search string box keep **asase_mremre** in the Boolean Search string but this time select **'subobject'** in the search options box so that it is highlighted as well as **'object'**.

Press **Search** once more.

You now have 17 statements because, besides the statements using **asase_mremre** alone, you also have all the statements about its subobjects, **afonwea** and **asase_tuntum**.

In the Boolean Search string box keep **asase_mremre** in the Boolean Search string but this time select **'superobject'** in the search options box so that it is highlighted as well as **'object'**.

You now have 108 statements because, besides the statements using **asase_mremre** alone, you also have all the statements related to its **superobject**, **soil**.

*Question: How many statements are there if you select **asase_mremre** and select **'object'**, **'subobject'** and **'superobject'**?*

3.2.11 Closing a Knowledge Base

Close the knowledge base by selecting **KB→Close KB...** and close AKT by going to the main menu **File→Exit from AKT**

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