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Knowledge Model for Cassava Production

[1]Emmanuel Ukpe and [2]S.M.F.D. Syed Mustapha
[1]School of Information and Communication Technology, Asia e University, Jalan Sultan Sulaiman, Kuala Lumpur, Malaysia
[2]College of Computers and Information Technology, Taif University Taif, Saudi Arabia

Abstract: Agricultural economic development and survival depend on the ability of the people to learn about their environment. Understanding an environment is influenced by learning which focuses on the capacity to sense dissonance in the interaction between the people, the environment and to devise appropriate response for alleviation. Proper response brings about intellectual assets which provides the foundation to learn, understand and respond to areas of necessity. This research considers agricultural knowledge as an elusive commodity because it is held subconsciously in our tacit state of mind. The notion of knowledge offers numerous definitions and interpretations of which offer valuable perspectives and insights. Of particular interest for this article is crop model, specifically cassava crop. Cassava production, especially which is meant for the regulated market requires an expert that involves specific laid down procedures. The fact that Cassava can be converted to numerous end products such as flour, cake, starch, chemical, fuel to name a few, means that Cassava production and processing which could satisfy best practice standards would be a tough task, especially for a small-scale farmer. This study tends to describe the process involved in Cassava production and processing in the idea of not only building a knowledge model that will assist the farmer to comprehend easily such process but also to guide the development of an ontology development tool that can capture agricultural processes. The emphasis of this paper is on knowledge modeling.

Key words: Knowledge management, cassava model, KAPE, software, tool

INTRODUCTION

This study focuses on a conceptual consideration of cognitive devices and model which could be used for transforming knowledge from a tacit to an unambiguous state of understanding. Of particular interest is knowledge of Cassava processing, from using Cassava as a source of food energy to industrial use of Cassava. Cassava is considered as cash spinner in the agricultural industry and many farmers engage in its production across the tropical region of the world. The demand for the product is also very high as it is used as flour in making confectionaries apart from the fact that it is also an excellent source of carbohydrate.

Research, however, has shown that the process involved in Cassava production and processing to meet a specified standard is cumbersome and most of the farmers especially in the rural areas do not have the technical skill needed to meet up with best practice standards. Researchers have shown that the development of ontology on entire Cassava production would be invaluable to the farmers and economic growth. This paper intends to create a knowledge model that describes such process which would aid other scholars in the development of ontology for other crops.

We discussed contemporary modeling methodology adapting to Cassava production and processing to create a model that will effectively describe the processes and stages therein. So many knowledge models have been formed to develop software for various knowledge models across the curriculum, but none is focused on Cassava specifics as the study intend to examine.

MATERIALS AND METHODS

The design and construction of software application that satisfies a specific form of usage or objective can be difficult; especially when it is without a frame of reference. The purpose of knowledge modeling is to guide and make things easier for developers to design and deploy applications that satisfy complex scenarios. This further allows standard and reasonable procedures to be applied in creating a system, especially for Cassava Processing and other crops.

Corresponding Author: Emmanuel Ukpe, School of Information and Communication Technology, Asia e University, Jalan Sultan Sulaiman, Kuala Lumpur, Malaysia

To develop a system that will in the end support farmers and provide best practices of how to process Cassava; system developers' first need to understand how the process works and the best way to acquire this understanding is the application of a knowledge modeling methodology. Modeling serves as a guiding tool and also as means to incorporate all the complex steps and functions needed to be understood by farmers in processing Cassava (Girard and Hubert, 1999).

Classification of knowledge modeling methoda: Of particular interest is knowledge of Cassava processing, from using Cassava as a source of food energy to industrial use of Cassava. We conducted this study from a perspective of lifecycle trajectory of a knowledge asset which classifies knowledge model methods into three categories: automatic, semi-automatic and manual.

Automatic methods simply indicate that the roles of both the farm expert and knowledge engineer on entire cassava processing are minimized. The method focuses on rules of known cases to construct a knowledge base.

Semiautomatic methods come in two categories: one is a category expected to support the expert's opinion, it permits the experts to construct knowledge base without contribution from knowledge engineers and the second type is meant for those who seek assistance from knowledge engineers to build a knowledge base in an efficient manner.

Manual methods are organized around an interview either structured, semi-structured or unstructured interview including face-to-face interview analysis. With the manual method, the knowledge engineer provokes knowledge from noted experts or other sources and uses this information to construct the knowledge base. Manual methods are considered expensive, sometimes inaccurate and can be time-consuming. Thus, there is an inclination by knowledge base designers to shift toward an automatic method, particularly, if money and time are critical.

Sources of knowledge: Knowledge can be accumulated from various sources, such as observed behavior, movies, books, computer databases, flow diagrams, researched, pictures, maps, practical experiments, news, sensors, history/stories and Radio Frequency Identification (RFID) to name a few. There are two types of knowledge Sources: most popular is the undocumented and documented knowledge. The undocumented is common because it resides in the mind of the people.

A human can identify and collect knowledge using any of our many senses, namely eyes, nose, ear, feel and taste. Knowledge can also be identified, collect and stored by machines using scanners, sensors, cameras, keyboard, pattern matches and other intelligent agents. These information source diversity and categories of knowledge contribute to the difficulty of knowledge acquisition. This difficulty is one of the reasons why it is hard to acquire knowledge and the motivation for this research.

Knowledge acquisition from observation: Bandura (1981) argues that human will continuously learn desirable or undesirable behavior by observation. Observational learning advises that a person's environment, behavior and cognition, will integrate and eventually determine how the person functions.

Observation is the dynamic attainment of information from the main source. Among human, we observe by using our senses. While in scientific observation, we involve the use of recording devices to gather data and related information. Scientific observations can be quantitative in which numerical assessment is added to the observed occurrence. Using a qualitative approach connotes the presence or the absence of property.

Observational learning occurs by witnessing the actions of others. Observation can be a method of social learning that comes in various forms, based on several practices. In human, particularly learning agricultural skills, this type of learning does not require reinforcement. Instead, it requires a social model, such as learning from a sibling, parent, farming teacher, parent or a friend.

Through this observational learning, a farmer's entire cassava processing behaviors can spread within a culture through a process known as diffusion chain. This chain occurs for example when a person first learns a farming behavior by observing a farmer and that person serves as a model through whom other individuals will learn the farming process behavior

Stages of observational learning: According to Bandura's Social Learning Theory, it suggests that human learns from one another, through observation, modeling and imitation. Also known as the bridge between behaviorist learning and cognitive learning theories for the reason that it encompasses attention, motivation and memory.

Bandura (1989) states that the social cognitive learning theory has four stages of observational learning, namely attention, retention, initiation and motivation:

Attention: Observers can only learn by paying attention to ongoing activities around them and the process is influenced and characterized the model and observers expectation.

Retention: The observer or learner should recognize the observed behavior and remember what was observed at some point in time. Retention skill of the learner depends on the ability to structure the information in a way facilitate recall.

Initiation: The observers or learner must be intellectually and physically capable of reproducing the activity witnessed. In most cases, reproducing the model's performance might require skills the student/observer has not acquired.

Motivation: Depending on the crowd or learners, most trainers recognize the need for motivation and provide pep talks, to motivate the audience. Unless motivated, some people will not reproduce learned behavior due to lack of motivation. Motivation comes from within the person and or can be external reinforcement such as promises of a reward.

Knowledge engineering process: Wagner and colleagues presented the following five key activities for knowledge engineering process:

Knowledge acquisition: This activity involves acquiring knowledge from the experts, computer files, books, sensors and or documents. The acquired knowledge may be problem specific or problem-solving procedures which can be meta-knowledge (knowledge about knowledge) or a general knowledge (knowledge about specific task or business).

Research by Byrd argued that acquisition of knowledge today is the source of a bottleneck in expert System development. Wagner also support Byrd's position and posit that many applied and theoretical research is ongoing in this area, Wagner research analyzed more than 90 expert system applications and their knowledge acquisition techniques.

Knowledge representation: The acquired knowledge is mapped, mining of data, represented accordingly, encoded and structured in a way that it is freely accessible for use in the knowledge base.

Knowledge validation: Involves verifying and authenticating the acquired knowledge using some test cases for quality is acceptance. The domain expert will need to verify the test result for the accuracy of the expert System.

Inference: The activity of inference includes software design which allows the computer to make inferences on specific problem based on the stored knowledge.

Explanation and justification: The last step consists of the development and programming of clarification capability to answer questions of why and how certain information is needed and derived by the computer.

Types of knowledge: Entirely intelligent machines may not have been produced by the advances of Artificial Intelligence but one of the key achievements is the advancement of a variety of methods in which knowledge could be represented. The simplicity of problem solving is almost, entirely determined by the way the problem is intellectualized and represented. Thus, the comprehensive understanding of diverse knowledge representations becomes a significant aspect of problem-solving skill.

The use of a good diagram can facilitate learners understanding, especially when we attempt to communicate a complex process such as entire cassava processing to someone a non-farer or expert in the field of Cassava farming. Knowledge specialists and engineers apply several methods in representing knowledge in an attempt to acquire knowledge from the farm (Storey and Kahn, 2010). This approach is referred to as the application of knowledge models. In the last several decades, many attempts by knowledge researchers have been made to categorize knowledge and diverse professions have concentrated on diverse aspects of knowledge. This attempt to classify knowledge has resulted in various categories based on philosophy.

Most people mistake and limit knowledge acquisition and management to capturing only best practices, in contrast to this thought; this is precisely what knowledge acquisition and management is not. Within the agricultural domain, knowledge acquisition and management is simply getting the right knowledge, from the right place, from the experts, using the right tool and at the right time. Agricultural information and knowledge is usually found in a variety of places, mostly on the farm, research extensions, research papers, databases, crop manuals and specifically a crop expert. Most often this knowledge resides in people's heads. However, the right place and time are on the field at a point of action and when you are observing or doing the task.

Botha *et al.* (2008) argued that explicit and tacit knowledge should be perceived as a spectrum instead of final points. Thus, in a practical sense, all knowledge is a combination of tacit and explicit components rather than one or the other. On the contrary, it is essential to explain these ideological opposites for a better understanding of knowledge acquisition and management. Research by Gamble and Blackwell (2001) used a measure which consists of signified-embodied-embedded knowledge, in which the first two equal the explicit-tacit. The scholars further distinct and discuss embedded knowledge to enable one to distinguish between knowledge embodied in individuals and embedded in processes, routines and organizational cultures. For the purpose of this research and within the agriculture business and knowledge management, three types of knowledge will be defined, namely explicit, tacit and embedded knowledge.

Explicit Knowledge: According to Brown and Duguid (1991) explicit knowledge is formalized, categorized and often codified as know-what information. Explicit knowledge can be verbalized in formal languages, easy to identify, record, store and transmitted to individuals when necessary. Wellman (2009), posit that knowledge management systems most easily handle explicit knowledge and it is most effective at enabling information storage, retrieval, editing of documents and texts.

Challenges faced by this knowledge type, from a managerial point of views, are ensuring access what is needed, storage facility and information retrieval editing and discarded after use. A high number of researchers Brown and Duguid (1991) and Bukowitz and Williams (1999) regard explicit knowledge as less important because it is one-dimensional in nature and does not have the capability to add rich knowledge based know-how which could have provided a long-lasting viable advantage.

Although, the solution to knowledge challenges, is gradually been addressed with application of technology, in knowledge management. Today, explicit knowledge can be found in databases, notes, documents and memos as knowledge management software (Botha *et al*., 2008).

Tacit knowledge: Tacit knowledge is defined by Polanyi in 1966 as experience-based knowledge, because it is personal in nature, hard to articulate, non-codified content and not easy to store. Research by Brown and Duguid (1991) referred to tacit knowledge as know-how knowledge which is also instinctive and hard to define experience based knowledge. Tacit is a personal understanding deep-rooted in individuals which is influenced by their experiences and mostly involves elusive elements like personal values, expertise, mental models, cultural beliefs, attitudes, capabilities and perhaps religion perspective (Botha *et al*., 2008). Nonaka and Teece (2001) posit that tacit knowledge is difficult to transfer because it is rooted deeply in individual's action, involvement and commitment.

For the record, tacit knowledge is considered the most valuable source of knowledge which is most likely and in many cases central to innovations. Knowledge management system, find it difficult to handle tacit source of knowledge since information technology system relies mostly on codification. For example, a cassava farmer will troubleshoot and understand why a particular type of Cassava yield smaller and tiny tubers in a given season, based on his experience and intuition. This knowledge would be difficult for him to codify into documentation for a beginner to follow. Apparently, it would be almost awkward for this farmer to transfer his intuitive knowledge gathered from years of farming experience and practice. Mostly all farmers rely on this type of and experience.

Embedded knowledge: Embedded knowledge, like tacit knowledge, is embodied in people. It is sheltered in rules, codes of conduct, manuals, routines, processes, artifacts, products, culture or structures (Gamble and Blackwell, 2001). Knowledge is embedded both informally as use in organizational routines or formally, such as the ones executed in management initiative to formalize a valuable optimistic routine. It relates to the connotations amongst formal procedures, roles, emergent and technology routines in a complex system or a complex process. The efforts to coordinate and manage embedded knowledge differ considerably; for example cultural beliefs and agricultural routines can be both demanding to comprehend and inflexible to change. However, a formalized routine may be easier to deploy and the management of these routines can embed results of learned lessons into processes, procedures and products.

Research by Hardman Agribusiness (2016) argued that the role of Information technology be limited in this context and could have a disruptive effect on beliefs and processes. We beg to differ; our position is that, despite the fact that embedded knowledge can exist in explicit basis, the knowledge aforementioned is not explicit. Thus, application of information technology tools can be used to map agricultural knowledge areas, as in the cases of cassava farming. These technological tools can be used to support mechanism for processes or to capture entire processes or for product reverse engineering in an attempt to capture unknown or concealed embedded knowledge. However, we agree to some extent, that uses and wrong implementation of technological tools can have disruptive influences if not supervised. While successful implementation of IT and management of embedded knowledge, would deliver significant competitive benefit.

Finally, it is important to point out that most distinction in types of knowledge management is between tacit and explicit knowledge. The extent technological tools can aid in knowledge transfer and enhancement of tacit knowledge is relatively a complex discussion, for this reason, enhancement of tacit knowledge, a topic that could fill textbooks and probably extends outside the domain of knowledge management is beyond the scope of this paper which is focused on models. However, we find embedded dimension to be more of value which explains why experience (combination of all knowledge type) is highly regarded in all areas.

Other knowledge types

Declarative and procedural knowledge: Declaratively refers to actual knowledge and information that is known, otherwise refers to as knowledge of facts. While Procedural relates to knowing how to execute an assured activity, otherwise refers to as knowledge of how to execute things (Lee and Choi, 2003). According to the researcher, John Anderson of Carnegie-Mellon University, every skill that we learn starts out as declarative information and procedural knowledge is learned through inferences from available knowledge within us.

Generic and Domain Specific Knowledge: Another way to classify knowledge is to determine the extent such knowledge is generic which can be used to solve any problem (knowledge applicable to many situations).

Tricot and Sweller argued that generic skills be developed spontaneously for evolutionary genetic motives and are difficult to teach. While Domain specific can be memorized information which can lead to task execution in a specific area/s (applies to one or a few situations).

Tricot and Sweller also argued that these skills require learning of specific rules for solving a problem and found domain specific teachable. The acquirement of domain-specific skills, such as agricultural process, either secondary or genetically knowledge, is regarded as deeply reliant on prior acquisition of first knowledge

Types of knowledge creation, acquisition and modeling

Knowledge creation and acquisition: Knowledge acquisition is type knowledge; everyone can try to obtain from external sources. External knowledge resources are vital for human knowledge development, growth and it is essential to take a holistic view of this knowledge value chain (Gamble and Blackwell, 2001). The need for survival, innovation and competitive advantage gives us the capacity to craft new insights. Knowledge creation takes practice can acquire many form, knowledge, transfer or learned. Nonaka's SECI model define, knowledge creation as a continuous transfer, conversion and combination of diverse types of knowledge, as domain users interact, practice and learn.

Janani and Devi (2013) differentiate knowledge and knowing when the scholars suggested that creation of knowledge is the artifact that interplays between knowing and knowledge. The authors argued that act of knowing and the possession of knowledge be through action, filed practice and interaction. This act of knowing is, in essence, the source of new insights, for these interchange to be productive, it is vital to place a high priority in unstructured work settings, especially in domains where innovation and creativity are important.

Knowledge creation, acquisition and sharing go together. Knowledge is usually created through observation, practice, interaction; collaboration, learning and training; where various types of knowledge are shared and converted. Beyond this, knowledge creation and acquisition is also supported by pertinent information, data or models which can increase understanding and serve as building blocks for new knowledge creation.

Knowledge modeling: Artificial intelligence perhaps has not created a complete intelligent machine; on the other hand, one of its major accomplishments is the improvement in ways we can represent knowledge using models. Since agricultural knowledge is inextricably linked to bountiful farming strategy, an overview of a model available to farming will be helpful to understanding the full potential role of knowledge acquisition. Research shows that a significant feature of knowledge acquisition is the aid of knowledge modeling as a way of acquiring, validating, structuring and storing knowledge for future reuse.

Models are symbolic and or anatomical illustrations of knowledge to represent fragments of knowledge and their relationships. Knowledge model structures include:

- Structured text and instruction list such as hypertext designed for (PLC) Program Logic Controller
- Character-based symbolic languages, such as logic, ASCII and Unicode, Japanese, Chinese and other character-based
- Tabular representations differ in variety, notation, flexibility, structure and representation such as matrices
- Diagrammatic representations, use of visualized diagrams and imagery such as ladders and or networks

Why use knowledge models: The production and adaptation of a knowledge model is a critical feature of knowledge acquisition. Knowledge model assists in clarifying the language used and helps to transmit information for authentication and alteration where needed. Thus, applying knowledge models would be of a significant advantage in the course of:

- Knowledge elicitation methods: (from domain expert)
- validation: (examination, comparison and testing the accuracy with the expert)
- Cross-validation: (analysis, comparison and testing the accuracy with another expert)
- Knowledge publication: offers insight and validation into the distinctive competencies of the subject matter
- Maintenance and updating of the knowledge system or publication

The best types of knowledge models comprise of fundamental components called knowledge objects.

Knowledge objects: Knowledge process has been in the thoughts of Philosophers for many years. This endeavor brought about the identification and classification of various types of knowledge. Knowledge experts adopted these topologies for examination and design of knowledge models. Additionally, logic studies stimulated other essential intelligence types, such as concepts, values, attributes, relationships and rules.The following lower knowledge objects were examined:

Concepts: Concepts are nouns and components of a domain, some of these elements are physical objects, people, ideas and organizations. These items are defined by their relationships to other elements in the domain hierarchy, by its values and attributes.

Values: Values are adjectives and the precise potentials of a concept such as the actual age, height or weight. Values are connected with a particular characteristic which can be numerical such as 7 year, 1.5 m and 220 lb or categorized as young, tall and dark.

Attributes: Attributes are the large properties, qualities or topographies which belong to a class of concepts, such as age, weight, ability and cost. Attributes and values define the characteristics of knowledge objects.

Relationships: Relationships are passive verbs and represent the method knowledge objects such as tasks and concepts are related. Relationships are passive verbs and frequently symbolized as arrows on diagrams.

Rules: Rules are statements of the form "IF... THEN..." Some examples are: If the room temperature is cold THEN close the window or start the fireplace IF the engine compression rate is low THEN increase flow of oil.

Processes (tasks, activities): Processes are activities and tasks which sets of actions implemented to fulfill established objectives or a goal such as:

- House construction
- The design of the model
- Plan of processes

Processes are defined with the aid of other knowledge objects, namely; inputs, resources, outputs and decision points.

Instances: Instances only provide support to clarify an object class. For example, "Shirt" is a case of the concept "fashion or clothes". Instances only have inherited attributes and that of their class. Instances could supersede any of it is the default values.

Basic types of knowledge models: Knowledge engineer applies many ways to represent knowledge when acquiring it from domain knowledge experts (Shadbolt, 2001). These methods are referred to as models, knowledge models that are the three primary types of knowledge models are:

Ladders: are categorized (tree-like) diagrams. Laddering methods encompass the construction, review and refining of hierarchical knowledge, in the form of ladders. The essential types of ladders are concept, composition, decision and attribute ladder. Ladder tool in PCPACK can be used to construct and edit ladder.

Network diagrams: show nodes that are connected by arrows. The design usually depends on types of issues and of the network diagram. Nodes may be used to signify concepts, attributes, values or tasks, arrows between nodes and any relationship types. Network diagrams examples; include concept & process maps and state transition networks. Diagram Tool in PCPACK can be used to construct and edit Network diagrams.

Tables and grids: Tables and grids are used to make tabular illustrations; it comes in three standard flavors, form, frames, matrices/grid and timelines. Matrix tool in PCPACK can be used to construct Matrices (Shadbolt, 2001).

Support for agriculture model: Climate change adaptation, youth migration and pressure on agricultural land have made a food insecurity most important issue of this decade in Africa. These forces have brought about the need to find an alternative lasting solution. One of the resolutions agreed by all is crop modeling for the future of agroecosystems development.

The ease to solve a given problem is virtually and determined by the way a problem is intellectualized and represented. The same goes for communicating a knowledge task that is difficult in nature. An appropriate analogy or a brilliant diagram can make a difference when describing a complicated idea to a non-agricultural expert. Most agricultural models are dynamic usually represents time course of events over a period from pre-harvest to a few days, or growing season to post harvest for many years (Heaidari *et al*., 2011).

Functional mechanistic and empirical models: Functional model is a structured representation of actions, activities, processes and operations within the modeled domain area. It applies a primary closed functional form to mimic processes that are complicated. Functional models are mathematically easier than empirical and mechanistic models which often produces results that are not very accurate.

Empirical models are grounded on direct observation, extensive data records and measurement Empirical models, for example, aim mainly to describe the reactions and feedbacks of a system; this model gives us the underlying processes motivating patterns. Using either mathematical or statistical calculations and unconstrained by any scientific principles or any scientific content and based on the objectives, the Empirical model may be the best kind to construct.

While Mechanistic model accepts the fact that a complex system could be understood by inspecting the functioning of its parts and how these parts are combined. Mechanistic models are grounded in the consideration system's components behavior (Dalkir, 2005). Typically, most Mechanistic models have a physical aspect; it is tangible; the system components are realistic, visible and reliable. Other Mechanistic models are based on elements that are classified discrete and cannot be substantially observed, such as those founded on psychology testing. One advantage of a Mechanistic model is that it provides learner opportunity to see, touch and feel while the object learning. For example, one can observe changes in Cassava yield due to the irrigation system and or water supply during raining season over many years and construct an empirical model that enable us to predict the quantity of cassava yield when rain occur on a regular basis, without knowledge of how the sun temperature affects the soil. One can construct a mechanistic, mathematical model that uses the laws of nature to predict rainfall which provides farmers knowledge of cultivating and planting period.

Cassava processing model

Agriculture model for Cassava crop: A model is a narrative of a proposed system which aid the observer or prospective learner understanding how it works and or predict its positive or undesirable behavior. Models are naturally conceptual, present as a conceived idea, residing in our heads, as mathematical formulas or in a computer program. Different modeling tools have been developed and used to support decision making and planning in the agricultural sector. An essential component of this machine is Cassava crop modeling. Conversely, any model could be a physical object, such as a Cassava tuber model used to test on Cassava bug pesticide performance for a hectare of Cassava farm.

In the case of Cassava modeling, in the absent of an Ontology tool that is capable of capturing an entire crop processing (Ukpe and Mustapha, 2016), especially that of Cassava. We choose the functional model because it has the ambition to improve the condition by quantifying some of the uncertainty in Cassava processing, by stating how operations are performed and other areas of need. Functional modeling relates to existing or mental entities which produce a model that reveals only goal-oriented characteristics of the modeled crop/object.

There are several different steps involved in processing Cassava depending on the end product desired; these finished goods include starch, flour, snack food and ethanol to name a few. The truth is that some of these different steps involved in Cassava processing can be complex based on types of consumer demand. For instance, according to Nape and Bua (2016) in Uganda, research shows that boiled cassava is the preferred form of cassava end product for consumption. While there are other products such as cassava flour, chips or local alcohol, brewed and distilled from fermented cassava, all of which comes with different processing steps, but the Ugandans prefer the boiled cassava because it is less complex to prepare.

Various and complex steps of many Cassava end-products prompted the need to consider building a knowledge model which encompasses cassava peeling, splitting, crushing, water expressing, fermentation, slaving, drying and cooking. Although, packaging may not be part of the processing steps; it is worthwhile to include this step to educate farmers on how proper packaging can impact on the sale of their finished product.

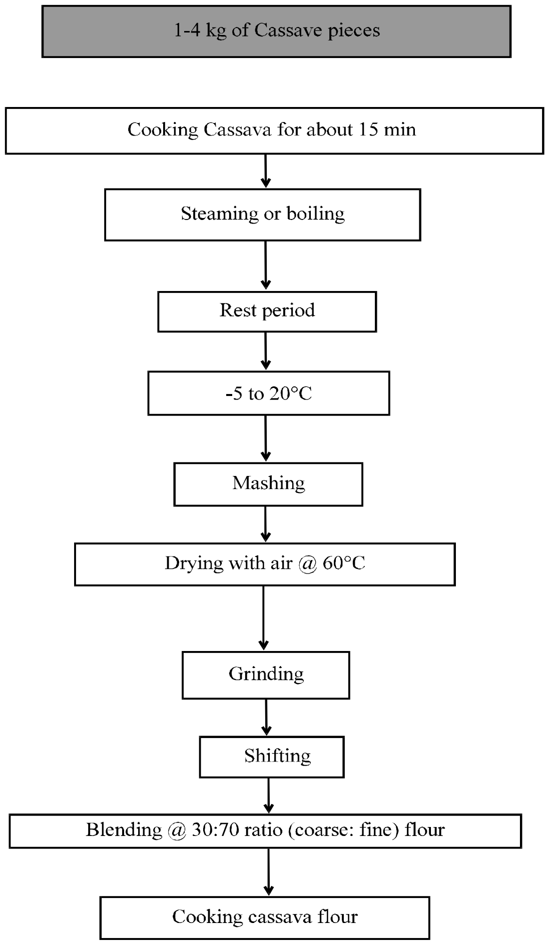

Fig. 1: Flow diagram of pilot plant processing of cooked Cassava

Steps of model construction: The very first step is to identify the components of the farm system. Significant items to identify are soil types, mineral content, organic and depth of soil; rain information relating to trends and annual average; sunlight information such as growing season, light duration, temperature average and trends; crop information such as seed types, effect on soil, hardiness to drought and floods; fertilizer details such as organic, inorganic, application methods and cost; pesticide types application methods; and harvest window to name a few. The above information should be related in the model to aspects of calorie and nutritional requirement, food security, storage costs, distribution, transportation costs, population size and government regulation if any. At this point, all the variables identified would be part of a new diagram and or concept map connecting altogether.

However, most crop models, including functional model have limitations such as crop-specific heat stress problem, deficiencies in process descriptions and impacts around flowering plants during raining season and or dry season. That is why this research would have preferred an ontology tool that is capable of capturing entire crop processes, due to these deficiencies.

Limitations of crop model: The implication of the above is that a knowledge model has to take the perspective of the end product for the processing itself. Knowledge model will make the design of the final software module easier and user-friendly, to enable users who use the knowledge base understand, learn and follow the processing steps. On the contrary mixing steps in a model that result in two different products such as starch or snack food may not be handy. For the purpose of this paper, the cooked Cassava flour as a final product is used in describing a model for Cassava processing steps. The successful implantation of this model as shown in Fig. 1 can be duplicated for other crops. Adapted from Sandoval *et al*. (2008) Effect of processing conditions on the texture of reconstituted cassava dough

RESULT AND DISCUSSION

Software development model: According to Cuena and Molina (2000), the use of knowledge-based schemes has been restricted to an expanse of particular applications where distinct methodologies and tools are used based on the model, agreeing to diverse conventions of knowledge illustration. The fact that certain requirements have to be made to arrive at a specific software design objective to satisfy end-users; the need to adopt suitable development model cannot be overemphasized. The emphasis in this regard is to tailor the Cassava processing steps discussed above to enable the construction of a model that will be suitable for Cassava as a branch of knowledge (Cuena and Molina, 2000). To construct a model, it is imperative to first of all identify system objectives that developers can use in building ontology tool efficient enough to capture all the steps and/or modify same. It is also important to determine essential requirements as a model to use in building the system.

Symbolic objective: Any system that is built to satisfy knowledge acquisition should be designed to meet derived objectives of the end user who uses the acquired knowledge to satisfy defined goals. According to research result by Molina users of knowledge base services are increasingly concerned in profound functions integrated into the systems. In view therefore, the objectives listed below can serve as a model to guide the development of any knowledge management model on Cassava processing:

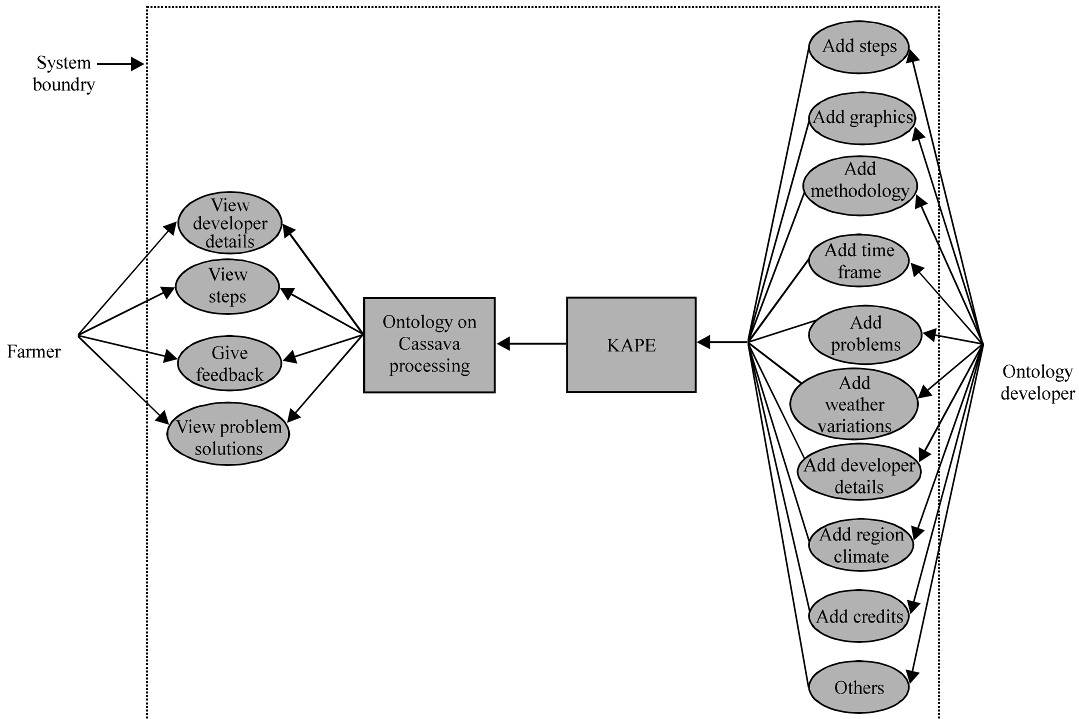

Fig. 2: Use case model Cassava production processing ontology development

- Cassava processing takes different steps considering the diverse end product that 0is derived from it. The system objective should satisfy the end user requirements regarding modeling the right steps which will produce the correct finished goods
- Build a system that can accommodate different models for a different end-user and/or end-product of Cassava
- The system should be able to create knowledge ontology that will help farmers regardless of their level of knowledge, background or language
- The final medium for passing the knowledge to the farmer should be flexible in satisfying their level of literacy and technical know-how

System requirement: The goal of developing any software that will enhance human knowledge is to ensure that learning takes place in a simplified manner. This goal is achieved by formulating relevant concepts that will translate into some form of format that will guide programming and design process, otherwise considered as system requirements. Different CASE tools have been proposed guiding the development and maintenance process of an application from the conceptual specifications to computable models. Increase thoughtfulness is required in the research area for requirements engineering, aiming for conceptual modeling via specifications of the underlying human understanding of applications' (Cuena and Molina, 2000). In view, therefore, some of the functional requirements that can be considered for any ontology development tool such as KAPE for developing Cassava Production processing; are as follows:

- The system should capture all inputs essential for entire Cassava processing stepsb. Capture the type of methodology used
- Capture time frame required completing the process
- Capture different types of problems that may be encountered within the various processing steps
- Capture variations regarding weather or temperature and how to handle same
- The system should be able to capture graphics and display or include same in the final ontology
- Identify and Capture, who developed the ontology, when and where
- Capture the region or climate that is best suitable for the type of process used
- The system should be able to capture relevant credits if required especially for graphics
- The system should allow editing of already developed processes

Model architecture

Use case: Figure 2 is a use case model for development an ontology tool for Cassava production processing. The use case diagram for Cassava production processing development is shown in Fig. 2. Cassava processes are complex systems that require a substantial design effort. A model or an Ontology tool that captures all processes can help assure that the system correctly satisfies its specifications and users.

The actors in the above use case are ontology application developer and the farmer who is considered as the cassava expert. The objective of the designer use case is to captures some of the characteristics of the farmer and all steps the farmer implemented for cassava processing. The ontology developer represents the engineering expert who is developing the software from modeled knowledge. The farmer or cassava domain expert is characterized as the individuals with knowledge of the domain specifics for the system.

CONCLUSION

Agricultural systems are fundamentally reformed ecosystems. The management of these ecosystems can be a tough task without some intervention. These ecosystems, to some extent, are influenced by human and mostly by the weather and other natural disasters. Therefore, we have to manage our land assets and resources through application of various agricultural crop specific systems models. Models such as Deterministic, Dynamic, Function, Static, Statistical, Mechanistic, Stochastic and Simulations are presently used for assessment and prediction of crop growth and yield. Ontologies are progressively becoming a significant mechanism for integration of disparate information systems. Also, ontologies are relevant for domain specific issues like cassava processing.

In this study, we present importance of knowledge engineering as relate to acquisition, representation, reasoning and processes, cassava model, potential uses of ontologies, patterns in knowledge bases. We posit that there are significant advantages for using models and ontologies for processing and knowledge which is either difficult to achieve or almost impossible without domain ontologies. Although, Cassava production processes and steps vary according to the end product, the model provided in this paper reflects steps that will yield cooked cassava floor. However, the same pattern can be used for various cassava and other crops finished products to generate an ontology that will be suitable for that purpose. This study concludes that the current crop knowledge models need significant improvement to be worthwhile. Preferably, the construction of an ontology tool that is capable of capturing entire crop processes would be an excellent addition to agriculture and specific crop modeling.

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