Development and assessment of a knowledge-based decision support tool for sustainable land management of sloping lands

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Abstract

Information is amongst the most important supporting components for productive, profitable and sustainable agriculture. In this respect, it should be useful, technical and practical with a focus on increased production and of a user friendly nature that would encourage farmers to use it. To be more effective, there should be closer collaboration among information sources or information providers to help the farmers making a sound decision. With this concept in mind, the International Board for Soil Research and Management (IBSRAM) and the Food & Fertilizer Technology Center (FFTC) initiated a joint project to develop a database containing information related to sustainable land management. The first phase of this project focused on the conduct of a survey on “Information flow in the national extension system and information needs of farmers” in the Philippines, Vietnam and Samoa from January – June 1999 (a report on this survey can be found in the FFTC Extension Bulletin 482).

Since August 2000, IBSRAM, in collaboration with the Center for Agroclimate Research (CSAR) in Indonesia, the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) in the Philippines, and the Land Development Department (LDD) in Thailand have been collaborating in the provision of contents to the structure of a database. The overall goal of the project is to provide users (extension workers and farmers) with meaningful and practical information on sloping lands conservation and management for sustainable agriculture. A prototype database on sloping lands conservation and management was designed in English in December 2000 and CSAR and LDD translated it into Indonesian and Thai languages, while PCARRD was asked to review and modify the database in English version for more clear and useful information. Assessments of the database were undertaken in Indonesia and the Philippines during January – February 2001 and in Thailand in March 2001 to validate its technical and non-technical aspects including the ability of the database to complement and support extension activities. The aim of this activity was to review and upgrade the materials in the database so that they would be more meaningful and useful to the target users. After the merger of the IBSRAM programs and activities with the International Water Management Institute (IWMI) in April 2001, IWMI has supported this database project. The prototype database in English was reviewed and upgraded at IWMI and the database content in Thai was revised for the second assessment in Thailand in September 2001. After assessment, the database was revised again and placed in the public domain through the IWMI website (www.agribase.org) in October 2001.

It was found from assessments undertaken in the three partner countries (Indonesia, Philippines and Thailand) that not only the extension workers would benefit from the information provided in the database, but also researchers, trainers, academicians, and students. The database is currently revised and updated to provide more farm level information on soil and water conservation practices for sustainable agriculture in sloping areas. In addition, the contents will not only be presented as necessary, but also as needed to be adequate for making sound decision by the farmers who are the end user. The IWMI’s Asialand network on management of sloping lands for sustainable agriculture
project-phase 5 is operating this activity as a part of its attempt to promote widespread adoption of sustainable land management practices by farmers in 7 participating countries. The database will be accessible in 8 languages (Chinese, English, Filipino, Indonesian, Laos, Malaysian, Thai and Vietnamese) to complement and support extension work. An assessment of the impact of information transfer and utilization will be conducted and reported before the end of project in 2004.

Introduction
Soil erosion has been identified as the major problem affecting sustainable agriculture in sloping land areas. Without soil and water conservation measures, serious soil erosion can occur, resulting in land degradation, severely reducing productivity, increased runoff, and seriously impacting on off-site sedimentation of reservoirs or other storage structures. To overcome these problems, improved soil and water conservation and management practices should be introduced to farmers for widespread adoption as an integral part of their farming systems. The information technology which is instrumental in disseminating sustainable land management of sloping lands should be provided to complement and support the extension work. This computer-based tool will be valuable to extension workers in having useful, practical and methodological information to discuss with the farmers for their effective decision-making in solving soil and water conservation problems. Characteristics of good information are relevance, timeliness, accuracy, cost-effectiveness, reliability, usability, exhaustiveness, and aggregation level. Information has a great impact on decision making, and hence its value is closely tied to the decisions that result from its use (Babu, Singh and Sachdeva, 1997).

The database on sustainable land management of sloping lands was initiated by IBSRAM in collaboration with partner organizations in 3 countries, i.e. CSAR in Indonesia, PCARRD in the Philippines and LDD in Thailand since August 2000. The project goal was to provide users (extension workers, development workers and farmers/land users) with meaningful and practical information on sloping lands conservation and management for sustainable agriculture. It was expected that the database in English and other 3 national languages (Filipino, Indonesian and Thai) would be meaningful, useful and practical to the users, especially the extension workers who ordinarily provided alternative courses of action for farmer’s decisions to solve soil erosion problems. The database could be downloaded and printed out for use as extension and training materials. Other information users, e.g. researchers, development officers, educators, trainers, students and interested persons would also benefit from this database.

Materials and Methods

Development of the database
There were 2 major phases in developing the database:

Phase 1: Designing the prototype database
This phase (August 2000 – January 2001) focused on the provision of contents to the structure of the prototype database on sustainable land management of sloping lands through the following steps:
1) Collection of technical information on sustainable land management, with a focus on soil and water conservation practices for sloping land agriculture from various sources. The information was reviewed, modified and digested for easy understanding by target users.
2) Surveying questions frequently asked by extension workers and farmers/land users and provide answers to them.
3) Entering modified materials and frequently asked questions (FAQs) into a prototype database in English version.
4) The prototype database was translated into Filipino for the glossary and FAQs, while the database records and database index were still maintained in English. The entire database was translated into Indonesian and Thai by partner organizations and IBSRAM pooled them for reading on-line through the www.agribase.org with a search engine to be ready for the assessment. The prototype database in the form of a CD-Rom was also produced to facilitate assessment in Indonesia as the on-line website was not accessible in some areas where the assessments were conducted.
Phase 2: Upgrading the database
This phase (February 2001 – October 2001) focused on reviewing and upgrading the database based on results and recommendations made in the assessment phase (Phase 1) to make the database more meaningful, useful and practical to the users. The revised database in the national languages and English were pooled by IWMI and were made widely available through IWMI website (www.agribase.org).

Assessments of the database

1) The assessments of the database were undertaken in Indonesia and the Philippines during January – February 2001 and in Thailand in March 2001 to validate the materials in the database in terms of topics covered, the quality of information presented, their effectiveness in communicating technical information to the users, feedback mechanism, and their ability to complement and support extension work. The respondents were extension workers, technical staff, information technology workers, and farmers, where ever possible. The database in the national languages was used by respective country to facilitate understanding by the respondents. In the Philippines, PCARRD used the database containing the information in English and some parts, i.e. the glossary and FAQs were in Filipino.

2) After each assessment, the materials in the database (in the national language) were reviewed and amended based upon the assessment results and recommendations.

3) The assessment reports were sent by partner organizations to IWMI in March 2001 for further action.

4) IWMI repeated the assessment in Thailand in September 2001 with assistance from the LDD Regional Office 6 and the Department of Agricultural Extension (DOAE) to revalidate the revised database contents and format. The results and recommendations were used in reviewing and upgrading the database.

Results and Discussion

Development of the database

Examples of the various pages in different languages are presented in Appendix 1 at the end of this paper. Readers are referred to these for clarification during the reading of the following sections.

The prototype database on sustainable land conservation and management practices was developed in collaboration with partner organizations. It comprised of 4 major components: (i) data flow diagram (DFD) that covered 85 topics on sloping land conservation and management practices, (ii) database search function, (iii) glossary of sloping land conservation and management systems, and (iv) Frequently Asked Questions (FAQs) and answers. After the revision of the materials upon the assessment results and recommendations from the respondents (extension workers, technical staff and farmers), the materials in English, Filipino, Indonesian and Thai were pooled and widely available through IWMI website (www.agribase.org) for reading, or they can be downloaded and printed out for use as extension and training materials. A computerized record of the number of visits to website is also kept.

One important development is the DFD accessibility; it was improved and renamed to database index. Due to the limitations of computer screens and printed material sizes, DFD is particularly difficult to fit into the aforementioned formats. In contrast a database index is designed in a form that items are kept into a compressed form and can be expanded or shrunk easily using Windows Explorer. As a consequence of this change to a database index, the database could be directly accessed in 3 ways: (i) users could manually search through a database index that grouped records by subheadings according to management type, (ii) search under a single keyword for a particular conservation practice and the search engine would gather all the techniques listed under that heading, and (iii) scroll through the entire list of records at the click of a button.
Assessments of the database

Prior to the latest version of the database, partner organizations conducted assessments in their respective country to get feedback from the users for reviewing and upgrading the database. A guide questionnaire was used. It contained the following parameters as a basis for validation: (i) scope and format of the database, (ii) quality of information presented, (iii) usefulness of the database, (iv) accessibility and easy of operation, (v) problems that might be encountered in using the database, and (vi) other suggestions to improve the database. The results and recommendations from the assessments were brought for the revision of the prototype database before pooling all languages for wide accessibility by the users.

In Indonesia, the off-line website was used for validation in February 2001. The first one-day validation workshop was done with 38 respondents (24 extension workers and 14 technical staff) in Bangko, Merangin District, Jambi Province to validate the materials in the database. After orientation to familiarize the respondents with the database development background and the overall structure and contents, the respondents were divided into 10 groups to validate the database in Indonesian language. Aside from validating database searching function, glossary and FAQs, each respondent selected 12 topics for validation by following a guide questionnaire mentioned above. The assessment results and recommendations were used for revising the database and the second one-day workshop was undertaken with a different group of respondents. A total of 36 respondents (7 extension workers and 29 farmers) at Kubang Ujo, Pamenang District joined the revalidation workshop. Since 81% of the respondents were farmers, therefore an average of 7 topics per person could be validated. Questionnaire, observation, dialogue and discussion were used as the instruments for collecting data from the respondents. After the workshop, the database was revised again and sent to IWMI (CSAR, 2001).

In the Philippines, the first one-day validation workshop (23 February 2001) was done with 21 respondents (12 extension workers and 9 researchers and information technology workers). The respondents were grouped into four, with 5 members in each group. Twenty two topics/records were randomly selected and assigned to each group. Out of the 22, each group subjectively selected one more record/topic for validation. The basis for the member’s choice of a topic was (i) his/her interest on the subject matter and (ii) his/her knowledge of the subject matter. Since, not all respondents were subject matter specialist, majority chose a topic on the basis of interest, not on their expertise. In evaluating the contents of the database, respondents assumed themselves to be users of information. Aside from validating one topic per member, each group selected one more topic for group validation. The total number of topics validated was 23 and they were evaluated based on a guide questionnaire. Each group was assigned a computer with Internet connection to view the website. The instruments used for collecting data from the respondents were questionnaire, observation, group presentation and discussion. After the revision of the database upon the assessment results and recommendations, the second one-day workshop was undertaken with a different group of respondents. A total of 19 respondents (8 extension workers, 5 researchers, 2 training officers, 3 information management officers and 1 planner) attended and the revalidation process was the same as the first assessment. After review and modification of the database, the revised database and report were sent to IWMI (ARMRD, PCARRD, 2001).

In Thailand, IWMI conducted the assessments in March and September 2001 with assistance from the LDD Regional Office 6 and the Department of Agricultural Extension (DOAE). A computer was provided for each respondent to access the database at the Internet Cafe in Chiang Mai. The first one-day validation workshop was done with 11 respondents (5 extension workers, 2 researchers and 4 information technology workers). After orientation period, the respondents validated the database by using a guide questionnaire. Each of them was asked to select the topics of his/her interest at least 6 topics for validation. The results and recommendations from this event and from the reports from CSAR and PCARRD were brought for reviewing and upgrading the database. The materials in the database both in English and Thai were adjusted, modified and refined, while the DFD was changed.
and renamed as the “Database index”. It contained a list of soil and water conservation practices available in the database, arranged in a hierarchical manner by which a list of broad headings was firstly shown and then under each broad heading was a listing of sub-categories. The colors were also changed to be more attractive and more comfortable to read. This took about 5 months and the second one-day validation workshop was done with 19 respondents (17 extension workers and 2 information service worker) to assess the revised database. The instruments used for collecting data from the respondents were questionnaires, observation and discussion. The results were eventually taken for reviewing and upgrading the database.

The opinions of the respondents toward the prototype database

1. Scope and format of the database
It was found from the assessments in the 3 partner countries that the respondents considered the database as a documentation of technologies, tools and techniques on soil conservation, soil erosion management, and sloping land management for sustainable agriculture. The majority of the respondents (63%, 70% and 71% in Indonesia, Philippines and Thailand, respectively) who assessed the database indicated that the topics in the database were sufficient to answer the users’ need, especially the extension workers, and 55% of them mentioned that the information was presented in a user-friendly format. However, respondents considered that the database was not necessarily presented in a user-friendly format and suggested that procedures should be presented in a step-by-step format, there should be more visual aids or illustrations with proper input and label, and the use of simple words (avoid jargon). Other topics that could be included or provided in more details in the database were soil fertility improvement techniques, potential plants for sloping land agricultural production (cut flowers, vegetables, fruit trees, fast growing trees, sericulture, apiculture, agro-silvo-pastoral system, silvipasture and others), integrated farming systems, integrated pest management, water management systems, indigenous knowledge and practices on sloping land conservation and management, and sub-topics on main topics e.g., green manure, mulching, cover crops.

2. Quality of information presented
With respect to the quality of information provided in each of the data fields under each topic in the database (see example in Figure 9), there was a diverse range of opinions from the respondents in the three partner countries. In this respect, respondents indicated that the most clear data fields were keywords and sources; moderately clear data fields were descriptions, advantages, disadvantages, and limitations; and the least clear data fields were procedures, areas where applicable, requirements and recommendations. In addition, it was found that 69% of the topics assessed were technically precise. Therefore, all data fields were revised and adjusted and these weak data fields were improved for more clear presentation and understanding. However, based upon the revalidation of the database undertaken by IWMI in Thailand with extension workers, it was still found that while other data fields were more clearly presented, the ‘procedures’ data field still needed to be improve (32% of the respondents confirmed this situation).

In respect to the glossary that contained over 250 terms, the respondents determined that most terms were presented clearly and only a 9% had inaccurate descriptions. Some terms were incompletely defined and unclear, and the description should be consistent with the database search. The respondents also suggested that additional terms should be added with clear explanations.

The FAQs part of the support system was given most favorable comments by the respondents in partner countries due to its simple presentation. Though there had been only a few questions posed at the time of assessment as the site was still under development, it allowed users to see each others questions and answers. This means it might not be necessary to submit a question to get an appropriate answer. By selecting a question similar to his/her own and then viewing the answer, a user might also find the information he/she needs.
3. Usefulness of the database
The majority of the group respondents who are extension workers indicated that the database was informative and useful for extension work and also for their profession (90%, 86% and 91% in Indonesia, Philippines and Thailand, respectively). They also mentioned that other users would benefit from the information provided in the database as well, especially researchers, trainers, academicians, students and interested persons. In general, 79% of extension workers who attended the assessment in partner countries gave feedback that the database materials were applicable, while 57% of the farmers who attended the assessment in Indonesia agreed. They commented that the benefits of the database to farmers were limited unless simplified. It is evident that the presentation might be too technical for farmers to understand and the farmers still need more detailed explanation. In addition, farmers do not normally use computer and the Internet, and they are invariably not computer literate. Hence, the database should be emphasized as a tool for extension workers to update them on new developments as well as useful and practical information to discuss with farmers so that sound decisions can be made. Farmers will benefit from the database by having technology options and more alternatives in improving their farm practices for productive agriculture.

4. Accessibility and ease of operation
The majority (74%) respondents found the database easy to maneuver. Fifty eight percent indicated that the database would be available to users, once introduced in their work places. However, their concern became the issue of availability of computers and Internet facilities. Normally, extension workers do not have a computer and many of them need skills in their operation. This is supported by the evidence that 100%, 62% and 48% of the respondents who joined the assessments in Indonesia, Philippines and Thailand, respectively had never used the Internet. In addition, more than 80% of the respondents who were extension workers had never used the Internet, and for the ones who had experience in using it, they relied on some other persons to help them due to a lack of computer and Internet literacy.

5. Problems that might be encountered in using the database
The problems that might be encountered in using the database, as cited by the respondents, can be categorized into 3 aspects: manpower support, technical support, and financial support. Most of the respondents (96%) indicated that training is necessary to equip extension workers in operating computers, using the database and in mechanisms of delivering the information to farmers. Similarly, technical problems with respect to hardware and software facilities and interconnectivity might be a problem in some areas where Internet facilities are lacking. Moreover, there might be differences in the interpretation of information, if the content is not qualified and clarified. Funding is important because of the maintenance of accessibility to the Internet. Other aspects such as uncontrolled electricity or power failures were also deemed to limit the use of this technology.

6. Other suggestions to improve the database
The following are suggestions from the respondents for the improvement of the database to be more effective, attractive and productive:

- Improve the database design in terms of format and layout by adding more graphics and illustrations, accuracy and consistency of the contents, translation of contents into layman’s terms, and more color combination.
- Include in the database structure, LINKS to related websites or a directory of related websites.
- Include cost and benefit analysis of a particular technology or practice in the database. Farmers are more interested in monetary benefits that could be gained from adopting the technology.
- For effective feedback mechanism (FAQs), the webmaster team should be organized to address promptly any inquiries. Immediate answers should be provided to inquiries.
• Mailing address should be added aside from e-mail address for those who do not have e-mail address to send their inquiries by mail for answers.
• Putting the database in a CD-ROM format, so that others without Internet connection can still have access to the database.

Conclusion
The database on sustainable land management of sloping lands was developed by IBSRAM and then IWMI with assistance from the partner organizations in Indonesia, Philippines and Thailand. It was found from the assessments in partner countries that not only extension workers would benefit from the information provided in the database, but also researchers, trainers, academicians, and students. Farmers would also benefit from the database by having useful and practical information and more alternative courses of action for solving soil erosion problem and improving their farming practices for productive sloping land agriculture. After the assessment of the database in these countries in terms of topics covered, the quality of information presented, their effectiveness in communicating technical information to users, feedback mechanism, and their complement and support to the extension work, the database materials were revised and updated for more technical preciseness, usefulness and practicality. It has been widely accessed through www.agribase.org from November 2001 and as a consequence become an activity of the IWMI’s Asialand network on management of sloping lands for sustainable agriculture project-phase 5. The database is currently revised and updated to provide more farm level information about soil and water conservation practices for sustainable agriculture in sloping areas. In addition, the contents will not only be presented as necessary, but also as needed to be adequate for making sound decision by the farmers who are the end user. The database is being developed into 8 languages (Chinese, English, Filipino, Indonesian, Laos, Malaysian, Thai and Vietnamese) to complement and support the extension work in 7 network participating countries (China, Indonesia, Lao PDR, Malaysia, Philippines, Thailand and Vietnam). An assessment of the impact of information transfer and utilization will be conducted to get feedback from extension workers and farmers and reported before the end of project in 2004.

It is important to stress that this computer-based tool is a knowledge-based decision support tool that will complement extension work by providing meaningful, practical and methodological information on sloping lands conservation and management. The tool will be valuable to extension agents in disseminating information and technology to the farmers for their effective decision-making in solving soil and water conservation problems. Though it has been developed to be responsive to the farmers’ requirements and changing situation, communication between extension agents and farmers is needed to clarify and supplement the information for more productive decision-making by farmers.

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References
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Appendix 1

Figure 1. www.agribase.org language selection page
Figure 2. Home page of English version

Figure 3. Database Index page
Figure 4. A part of Database Index item list
Figure 5. Database search page

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Basic SALT steps</td>
</tr>
<tr>
<td>Agroforestry</td>
</tr>
<tr>
<td>Alley Cropping (Hedgerows)</td>
</tr>
<tr>
<td>Bench Brush Layers</td>
</tr>
<tr>
<td>Bench Terraces</td>
</tr>
<tr>
<td>Biological Control (pest management)</td>
</tr>
<tr>
<td>Broad Based Terraces</td>
</tr>
<tr>
<td>Brush Covers</td>
</tr>
<tr>
<td>Building an A-Frame</td>
</tr>
<tr>
<td>Check Dams: Regular</td>
</tr>
<tr>
<td>Check Dams: Temporary</td>
</tr>
<tr>
<td>Chemical Control (pest management)</td>
</tr>
<tr>
<td>Compost</td>
</tr>
<tr>
<td>Contour Banks</td>
</tr>
<tr>
<td>Contour Cultivation</td>
</tr>
<tr>
<td>Contour Ditch</td>
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<tr>
<td>Contour Hedgerows (Alley Cropping)</td>
</tr>
<tr>
<td>Contour Planting</td>
</tr>
<tr>
<td>Cover crop</td>
</tr>
<tr>
<td>Cultural Control (pest management)</td>
</tr>
<tr>
<td>De-acidification</td>
</tr>
<tr>
<td>Declining Ditches (Hillside Ditches)</td>
</tr>
<tr>
<td>Diversion Ditch</td>
</tr>
<tr>
<td>Donga</td>
</tr>
<tr>
<td>Drainage Canal/Ditch</td>
</tr>
<tr>
<td>Drop Structures</td>
</tr>
</tbody>
</table>

Figure 6. A part of the database record/topic list
Figure 7. A part of glossaries from Glossary page
Figure 8. A part of Frequently asked questions and answers from FAQs page

![Part of Frequently asked questions and answers from FAQs page](image1)

Figure 9. Example of a record in English

![Example of a record in English](image2)

Figure 10. Example of a record in Indonesian

![Example of a record in Indonesian](image3)
Figure 11. Example of a record in Thai