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A Farmer-guided Soil Classification System for the Philippines

A case study for Barangays Triala and Santa Rosa, Nueva Ecija, Central Luzon

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BSWM

Bureau of Soils and Water Management

ISRIC

International Soil Reference and Information Centre

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ABSTRACT

The Centre for Research and Information Exchange in Ecologically Sound Agriculture (ILEIA) and the International Soil Reference and Information Centre (ISRIC) have enunciated a project on farmer-based soil classification (ethnopedology) in the Philippines, in close collaboration with the Bureau of Soils and Water Management (BSWM), Manila. Two pilot areas, comprising the administrative units (barangays) of Rajal Centro (1600 ha) and Triala (450 ha), in the broad alluvial plain of Nueva Ecija in Central Luzon were used to initiate the process for developing a farmer-based soil and land use classification, and to compare and integrate the results of this work with the results of a classical (*sensu* science-based) soil survey by BSWM staff.

The project provided the soil and natural resource scientists with a unique experience in working directly with the local communities with particular focus on comparing and integrating classical methodologies of soil survey with local knowledge of soils and their agricultural potential. Farmers clearly related micro-topographic variations within their plots, as related to differences in drainage, soil texture and flooding, to the agricultural potential of the soils. The entire exercise brought forth a methodology which integrates elements of indigenous knowledge with those of the formal scientific survey, the results of which may later be up-scaled to soils of similar agro-ecological zones at the national level. On the whole, this participatory project lay the foundation for the exchange of indigenous knowledge and practices of safe farming through mapping of soil and farm resources.

In view of the uniformity of the study areas, in terms of their biophysical, cultural and socio-economic conditions, it is recommended to expand and test the system for farmer-based soil classification to other, more heterogeneous and agro-ecologically representative regions in the Philippines.

From a land use perspective, the study showed the need for in-depth agro-ecological and economic studies at farm level as well as at a higher level of aggregation, such as the district. Water availability for irrigation during the dry season at Barangay Triala forms an important constraint. During the dry season, the growing of less-water demanding crops than irrigated rice should be stimulated. More efficient water-distribution techniques need to be developed. Human-induced changes in soil properties should be monitored at (farmer's) experimental plots to address the observed decline in production capacity of these intensively cultivated soils, induced by excessive use of acidifying fertilizers. Farmers appeared particularly interested in collaborative, on-farm experiments aimed at assessing the agronomic and economic viability of substituting part of the currently used inorganic fertilizers with organic fertilizers.

1 INTRODUCTION

The Information Centre for Low External Input and Sustainable Agriculture (ILEIA) and the International Soil Reference and Information Centre (ISRIC) have signed a Cooperation Agreement (No. 18) to carry out a number of investigations in pilot areas located in:

- Ghana: a semi-arid savanna zone in the north of the country, near Langbensi and Wiaga;
- Peru: high mountain valleys in the Andes in Cajamarca and Huancajo;
- Philippines: subhumid low lying floodplains in the broad alluvial plain of central Luzon.

The main issues to be addressed in this collaborative project are:

(1) Correlation of traditional farmers-knowledge of soil and land suitability with internationally accepted systems of soil and land suitability classification, in order to identify main constraints and to propose possible solutions.
(2) Assess the geographic representativeness of the pilot sites for the agro-ecological zone and district in which they occur.
(3) Presentation of project results to farmers and NGO's in participatory meetings.
(4) Establish linkages for international collaboration on developing a sustainable basis for agro-technology transfer, in a participatory framework.

This Country Project Report covers the work carried out in the Philippines. It has been distilled from the base document prepared by the subcontracted agency, the Soils Research and Development Centre, Bureau of Soils and Water Management (SRDC-BSWM), Manila [1] and two field-trip reports [4, 6].

Chapter 2 describes the climate, soils and cropping systems in the study areas. The methodology developed for the farmer-based classification system and used for the classical classification exercise are presented in Chapter 3. Results of the soil mapping exercises by the farmers and scientists are discussed in Chapter 4, in which the results of the two approaches to soil characterization and appraisal are also compared and integrated. Results of the study are discussed in Chapter 5, while conclusions and recommendations for further work on the subject are made in Chapter 6. A glossary of farmer's terms may be found at the end of this report.

2 THE PROJECT SITES

2.1 Site selection

Contrary to what has been the case for Ghana and Peru, the location of the pilot areas in the Philippines was selected by ILEIA staff and local NGO's during short field missions, without consultation with the Soil Survey Organization (BSWM). The pilot sites are located in the broad alluvial plain of Central Luzon, in Barangay (Brgy.) Rajal

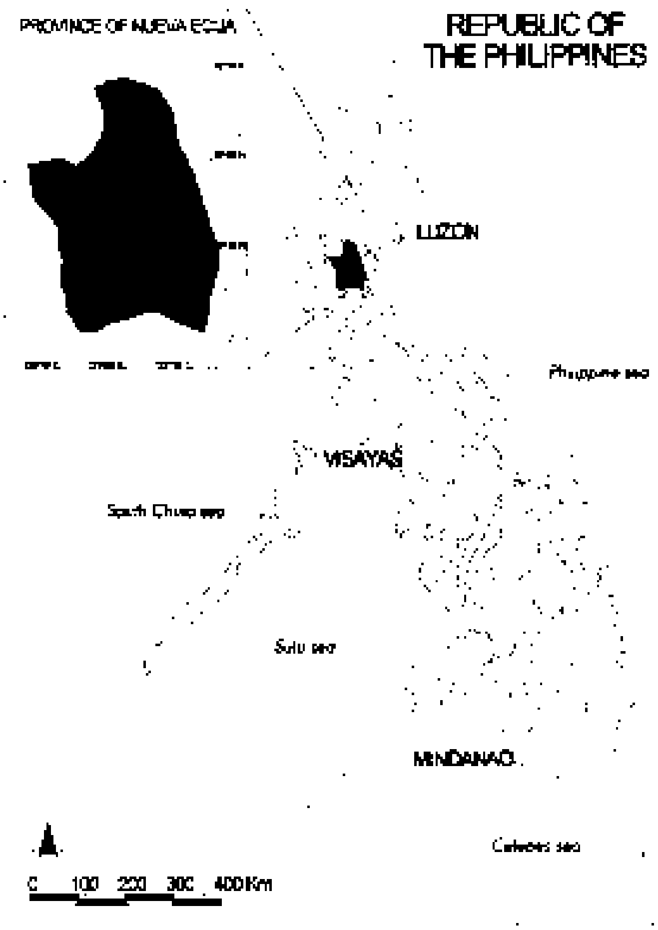


Figure 1 Project location map

Centro (1600 ha), Sta. Rosa, and Brgy. Triala, Guimba (450 ha). These Barangays occur in Nueva Ecija Province (Figure 1), one of the most intensively cropped lowland rice areas in the Philippines. Nueva Ecija occupies the eastern rim of the broad central Luzon plain, a meandering floodplain of the Talavera and Pampanga Rivers bounded by mountains on the east, west and north [5]. Elevation declines gradually from about 80 m in the northeastern part to 30 m in the southeastern part, but the entire region is almost flat with small terraces along the rivers and creeks.

2.2 Climate

Seasonal rainfall distribution in this typhoon- and drought-prone tropical region is mainly influenced by the southwest monsoon, which normally occurs from June to October. Mean annual rainfall in the area is 1441 mm. Mean 10-day rainfall between December to May ranges from 1 mm in January to 28 mm in May, the month in which the wet season starts. Mean 10 day rainfall is highest in August (128 mm) and lowest in November (18 mm), which corresponds with the end of the wet season. Mean cumulative rainfall during the dry season (December to May) is only 112 mm, while it is 1323 mm during the wet season (June to October). Thus about 90% of the total annual rainfall is received during a six month period; during the remainder of the year few crops can be grown without irrigation. Irrigation water is provided by the Upper Pampanga River Irrigation System, or locally by pumps. Mean annual air temperature in the area is 27 °C [5].

2.3 Physiography and soils

Both pilot areas are located in a gently undulating floodplain dominated by deep, fine textured and slightly acid soils (vertisols). Technically, these swelling-and-shrinking clay soils classify as members of the very fine, montmorillonitic, isohyperthermic family of Ustic Endoaquerts [for further details see reference 1]. They have grey to dark grey, very sticky and very plastic (moist) and extremely hard (dry) surface soils, about 20-30 cm thick. The mottled subsoil has a prismatic structure, with intersecting slickensides, and is a grey to greyish brown, very fine clay that is very sticky and plastic when wet. Periodic water saturation associated with rice cultivation results in intensive redoximorphic features. During the dry season, these soils crack deeply and widely (> 1 cm) to a depth of 100 to 150 cm. The cracks remain open for more than 90 cumulative days during the year, unless the soils are irrigated.

2.4 Land use and cropping systems

The success rating of cropping patterns in rice and rice-based cropping systems greatly depends on: (a) highly dynamic and less predictable factors, including occurrence of typhoons, droughts, pests and diseases; and (b) less dynamic, and mappable, soil properties [3]. As a result, the project area in Rajal Centro, traditionally, is cultivated to paddy rice, but some of the more elevated and somewhat better drained lands are under vegetables and fruit trees for home consumption. Small farms (1-3 ha) and field sizes (0.1-0.5 ha) dominate in the study region, and between-farm differences in soil and crop management practices, particularly fertilizer application and use of weedicides/pesticides or Integrated Pest Management (IPM), are large [5]. Fertilizer rates used by different farmers in a neighbouring area in Nueva Ecija are in the range 40-300 kg N ha^{-1}, 4-44 kg P ha^{-1} and 0-81 kg K ha^{-1} [5]. Generally two rice crops are grown in Rajal Centro, the first from June to September and the second, with supplemental irrigation, from December to April. Rice yields measured from 63 farmer's fields during the 1994 dry season, in the above mentioned neighbouring area in Nueva Ecija, varied from 2.6 to 7.7 t ha^{-1} [5]. During the dry season, soil consistence is very hard and moisture reserves without irrigation are inadequate to produce crops. Due to their slow permeability when wet, the soils are well suited to ponding, fish culture and duck raising.

In Triala rice is also grown extensively but in some areas with fine textured clay soils, within access of irrigation schemes, a variety of vegetables is grown and harvested all year round. Some of the farmers have been contracted to grow cucumbers by private enterprises, at an agreed price.

3 METHODOLOGY

3.1 General approach and strategy

3.1.1 Process documentation

In total 51 farmers participated in the project, with 30 farmers coming from Rajal Centro and 21 from Triala. The BSWM made full use of video and photography to record important aspects and phases of both the informal and formal interactions between farmers and scientists [1]. These materials clearly illustrate the process by which farmers were motivated to illustrate and apply their methods of identifying and selecting soil attributes in making farm decisions, as described in this report.

3.1.2 Multi-disciplinary approach and harmonization of efforts

Considering that soil attribute mapping requires the recognition of the interaction in space and time with the historical use of the soil, a multi-disciplinary team composed of a pedologist, land use expert and an agronomist was formed by BSWM to interact with the farmers and farmer communities (e.g. KADAMA and PRRM) as well as with the ILEIA Country Coordinator.

The technical team was supported by specialist of BSWM's Training and Information Department in order to establish proper communication and a timely rapport with the farming communities and NGO's operating in the pilot areas. The BSWM technical and social science teams ensured that all training efforts was complementary with the efforts of NGO's involved in other ILEIA activities in the respective pilot areas. This mainly related to the timing of training programs and the design and content of the various training activities, thus precluding conflicts in interest and possible confusion among the farmers. BSWM staff thus attended the initial training sessions organized by the International Rice Research Institute (IRRI), the results of which were used as a basis for designing the follow-up BSWM training program on soil survey and classification.

3.1.3 Participatory formulation of soil mapping criteria

The BSWM team strongly focused on the deliberations by the farmers during a series of so-called consultation/training "think-shops". During these sessions, the indigenous knowledge of the farmers of the soil conditions and cropping systems were identified and recorded. The series of "think-shops" served to encourage farmers in spelling-out their criteria for defining or classifying soils and for comparing their farms (in terms of productivity and income) with those of their neighbours and friends. This then lead to the convergence of the various sources of information and a general agreement of the farmers on how the soils are to be described.

3.1.4 Walk-through mapping

As an integral part of the mapping process, the local communities were divided into "thinking" groups of close friends and neighbours. Each group was directed to traverse a section of the barangay in order to record differences in soils, crops and other recognisable features of the farms that can be used in differentiating between soils and in deciding on: (a) what crops are to be grown; (b) where these crops should be grown; and (c) when each crop is to be grown.

Following each transect, results were discussed by and with the farmers involved. The farmers then volunteered to make transect interpretations of their own plots. The results of this strategy have been discussed in detail elsewhere [1].

3.2 Classical soil mapping and classification

3.2.1 Compilation and evaluation of base materials

All available information, including reports and maps, for the project area were collected, compiled and evaluated for their usefulness in formulating the soil classification mapping and training programs. The available maps included:

(1) Parcellary maps, at scale 1:4,000, obtained from the National Irrigation Administration. These maps show the location of the individual plots as well as the names of the respective owners. Since the time of compilation of these maps, however, the ownership of a number of plots has changed.

(2) A 1:50,000 scale Soil Taxonomic map prepared by BSWM on which soil units are defined at the subgroup level. Thus the soils of individual map units have similar drainage conditions, texture and (natural) soil fertility.

(3) Topographic maps, at scale 1:50,000, prepared by the National Mapping and Information Centre; these are the most detailed topographic base maps available for the country.

3.2.2 Scoping sessions and design of training sessions

The BSWM team joined and observed the training sessions for farmers conducted by the KADAMA in Barangay Triala and by the PRRM in Barangay Rajal Centro. This resulted in community sketches of the soil and farm resources. These materials were then used in guiding the technical staff of BSWM in designing their field work and in locating the transects, as well as in designing the process for the training program on "farmer-based soil classification".

3.2.3 Initiation of design for soil classification

Soil fertility determination

The portable Soil Test Kit (STK) was introduced by BSWM staff to gauge the farmers capacity to detect soil fertility (changes) as a factor of declining crop yields over years of continuous rice cultivation. Soil profiles were observed at random and samples for soil fertility assessment collected. The N, P and K values obtained with STK were recorded for use as reference during the subsequent training sessions.

Soil fertility management

Traditionally, most rice straw is burnt in the area while it could be used to improve the organic matter and nutrient status of the soil. A one day hands-on training and demonstration on the use of a decomposing agent (*Trichoderma*) for rice straw and other organic farm wastes was organised. During this day, the farmers devised a number of simple experiments under guidance of BSWM staff. The immediate and long-term objectives in providing this training were to create technology tools for managing organic matter residues by composting to reduce the dependence on chemical fertilizers, notably urea. Further sessions focused on the application of compost to irrigated rice fields. The process of composting and subsequent incorporation of this compost into the soil, however, are termed labour-intensive by the farmers. In addition, it may prove difficult to produce enough compost from the available rice crop residues. Thus, there may not be enough compost for wide-scale application [6].

3.3 Community-based soil mapping

3.3.1 Soil classification in convergence workshop

This convergence workshop was introduced to test the farmer's ability to use the basic human senses — sight, hearing, smell and touch — in identifying soil attributes useful for the classification of soils and for making farm decisions. The role of speech and the brain (thought) for the consolidation and analysis of information were also discussed by the farmers, but they jointly agreed to use solely the above mentioned senses. The exercise brought about the whole process of soil attribute mapping by the farmers, and resulted in the initial sketch map. It showed that the farmers in Triala and Rajal Centro recognized and made use of a number of soil and landscape attributes that can be seen, touched by feet and hands, and can be smelt. The selected attributes were perceived by the farmers to have been the major factors in determining the productivity of their farms.

3.3.2 Community-based transect-mapping

Transect mapping, or "walk-through", is a system of mapping in which the resulting soil resources information is presented in a cross-matrix or as "transects" with illustrations of objects that are visible on the soil surface. In this exercise, farmers from adjoining plots were grouped together and asked to walk-through the village to identify, record and discuss the land use practices in the area.

3.3.3 Community-based spatial-mapping

Spatial mapping refers to the mapping of soil resources where the outputs are presented in polygons that represent areas occupied by a given set of mappable properties (i.e. uniform soils conditions).

4 RESULTS

4.1 Classical soil mapping

Technically speaking, both study areas are rather homogeneous and similar in terms of their soil conditions. In large floodplains, only few distinct landscape features serve as the basis for delineating units in a classical soil survey. Micro-variations in land elevation (< 1m) and surface texture occur as un-mappable micro-variations in the landscape. Thus they were described as normal inclusions of the defined range of properties of the soil taxonomic unit. The observed micro-variations did not technically warrant the redefinition of the soil classification by BSWM staff, nor the subdivision of the soil mapping units on the classical soil map. BSWM staff, however, paid due attention to the importance of this micro-variation in the decision-making process of the farmers.

Findings of the classical survey include:

(1) Analyses with the Soil Test Kit (STK) indicated that the soils in the two project areas are low in N and P content, and that K levels are generally adequate.
(2) STK results somewhat confirmed that there has been a decline in the availability of native N and P, which may be attributed to the current imbalance in N and P-fertilizer utilization in the area.
(3) Most vertisols are chemically degraded as shown by low contents of organic matter (OM). Under prolonged cultivation the surface soils tend to become acidic while the subsoils originally were not. This situation is a reflection of the

high use of Urea (which acidifies upon hydrolysis) and of the poor management of organic farm residues in the area.

(4) The ratio of N:P utilization in the pilot areas is quite wide, ranging from 6:1 to 5:1 N over P, which is considered a primary reason for the decline in rice yields during the last decade. At present, farmers need to apply more fertilizers than before to obtain similar yields of 6 to 7.5 t ha^{-1} (120-150 cavans per hectare). The large N:P ratio causes high withdrawals of P from the soil. Further, part of the applied P is either fixed to the soil particles or lost from the soil system.

(5) Farmers use the broad term of "acidification" to refer to a complex range of factors — including soil compaction and the increased need for (in)organic fertilizers to sustain yields at current levels — indicative for a decline in crop production [6].

(6) An important source of concern in the pilot areas is the lowering of the water-table through the excessive use of water-pumps, as reported by farmers during a community meeting.

4.2 Community-based soil mapping

4.2.1 Sketch maps

The farmers produced sketch maps of individual soil attributes (their decision variables) that were not drawn to scale. The main findings of the farmers, based on the natural senses, are summarized below:

Sight:

(1) As a general rule the farmers prefer dark coloured soils, which reflect higher contents of organic matter, on which rice yields tend to be highest.

(2) A dark colour is often associated with vertisols high in clay. These soils are very stiff and hard when dry and very sticky when whet, which largely limits their use to irrigated rice production.

(3) Light coloured surfaces are often associated with exposed subsoils, low in organic matter content or of silty clay texture (exposed by deep ploughing).

(4) Elevated positions in the landscape, called "pantok", are easily recognized by farmers and traditionally used to establish houses and to grow vegetables and some fruit trees, to raise farm animals (carabao) and livestock (mainly poultry and some pigs). "Bana" or depressions, being flood-prone, are generally used for wetland rice. Similarly, low lying plain areas ("Patag") with poor drainage are generally under rice.

Smell:

During hot days the farmers were able to smell gaseous emissions, emanating by ebullition, resulting from excessive application of urea and the anaerobic decomposition of rice straw. The term "lupang maasim" was used by the farmers to express the emergence of acid soils induced by excessive application of Urea. In one instance, the smell of the smoke and sound emanating from the irrigation pump was seen as an indicator for the increasing depth of the groundwater table. The smell of maturing rice is an indicator for the fact that the farming operation was successful, from a biophysical point of view.

Hearing:
Sound is an important indicator of biodiversity (e.g. birds, bees and other insects) in these rural areas, and it is most diverse in clean environments (e.g. where Integrated Pest Management practices have been introduced). In areas where large quantities of herbicides and pesticides are used, few of these "natural" sounds are heard.

Fluctuations in the sound of water flowing though irrigation canals were considered a useful indicator of changes in topography, especially at night.

Touch:
Touch was mainly used by the farmers to differentiate between clayey and "sandy" soils. In this rather uniform area, soil texture (besides water supply) is a major attribute that affects land use. "Lagitikin" or clayey soils are devoted to irrigated rice. "Galas", corresponding with sandy clay or silty clay soils, generally are also used for rice except in the more elevated positions where vegetables are grown in farm backyards. The term "pilla" is used for exposed silty subsoils composed of adobe materials; these are generally chemically poor soils that require high applications of fertilizers when cultivated.

Some farmers also used their feet to detect changes in soil attributes; in clayey areas wider dykes are built whereby farmers can walk easily over these dykes.

4.2.2 Transect maps

Figure 2 illustrates how farmers in Rajal Centro associated their crops with topography, drainage and other characteristics of the soils. Generally homeplots with vegetables and fruit trees are located on the elevated positions of the terrain ("taas ng lupa"), which have the best drainage. Vegetables are preferred on the better drained soils ("uri ng lupa"), while clayey soils are devoted to rice. The main crops grown ("halaman") in the area thus are rice, with some fruit trees, root crops and vegetables where drainage conditions increase. Generally, the water source ("pingagkukunan ng tubig") during the dry months is by canal irrigation or via pumps. The main sources of animal feed ("pagkain ng hayop") are rice straw ("dayami"), vegetable refuse, and golden snails for the ducks. "Uri ng hayop" refers to significant biodiversity in the area. This can be associated with problems ("problema") when the incidence of pest and diseases is high. Other important problems are of an economic nature, such as access to markets, need for middlemen to transport the produce, and payment for irrigation water. When the biophysical conditions are favourable, there are opportunities ("oportunitad") for augmenting food production and farm income and thus for generating off-farm income.

MAGSASAKA : CONCTANTINO GARGANTA

PANANIM : *PALAY*

ANYO : *PANTOK - PANTOK*

KLASE/URI NG LUPA : *LAGKIT MESTISONG LAGKIT MESTISONG LAGKATIN*

KAASIMAN : *MAASIM*

PAGHAWAK NG TUBIG : *MATAGAL MADALI MATAGAL MATUYUAN*

PAGBAHA : *HINDI BINABAHA*

MGA NILALAGAY : *12 bags ABONONG KOMERSYAL (UREA, 16- 20 - 0, 14 - 14 - 14)*

PAGMAMAY-ARI :

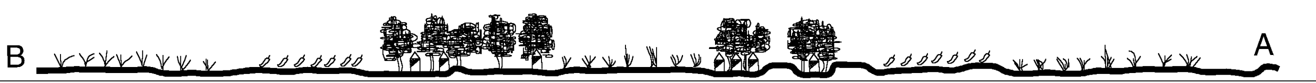
SUKAT NG SAKA : *3.0 ha*

Figure 2 Farmer-based soil and land use classification for Brgy Rajal Centro, Sta Rosa, Nueva Ecija

Farmers in Barangay Triala (Figure 3) reported similar relationships between soil conditions and land use as were described for Rajal Centro.

Brgy. Triala, Guimba, Nueva Ecija

Soil Texture							
Surface	Clayey	Silty Clay Loam		Clayey		Silty Clay Loam	Silty Clay Loam
Subsoil	Clayey	Clay		Clayey		Clay	Clay
Soil drainage	Somewhat poorly drained	Moderately well drained		Somewhat poorly drained		Moderately well drained	Somewhat poorly drained
Flooding	None	None	None	None	None	None	None
Topography (elevated)	Broad plain	Broad plain	Elevated	Broad plain	Elevated	Broad plain	Broad plain
Land Use	PRNI	Vegetable Road	Residential	Paddy rice irrigated	Residential	Vegetables	Paddy rice non-irrigated
Soil Acidity	Slightly acid			Slightly acid		Slightly acid	Slightly acid



Farmers:
a) Constantino Garganta
b) Mario Imperio

Farmer:
Agrifino Santiago

Farmer:
Teodulo Libunas

Soil Taxonomy Classification

Quingna clay loam
VkuE - Vertisols, very fine clayey, Ustic Epiaquerts
Afo 0-3% slopes, no apparent flooding

Figure 3 Farmer-based soil and land use classification for Brgy Triala, Guimba, Nueva Ecija

4.2.3 Spatial mapping

The spatial mapping exercise showed that the farmers and their families, who have used these lands for generations, clearly understand the importance of moisture-related variables for the productivity of their crops and in selecting suitable cropping systems. They clearly recognized that these variables are part of the micro clino/topo-sequence that controls seasonal moisture conditions and the depth and duration of flooding. Elevated areas with the better draining soils thus are devoted traditionally to crops susceptible to waterlogging, for example squash, onions and cucumber. Similarly, flood prone and water-logged lowland areas are under irrigated rice. Crop diversification on the better drained patches, and rice cultivation are important features of the current farming system.

4.3 Comparison and integration of farmer-guided and classical approaches

4.3.1 Framework and principles for up-scaling

The study showed that over the years farmers have created their own sets of decision variables for mapping soils. These allow for an informal convergence of farming decisions that lead to the optimal use of the soils and to minimal conflict in the use of farm resources in the project area.

The farmer's concept of soil classification is primarily based on inter-generational transfer of experience and changing perceptions of the degree, importance and ways to use the land. Decisions are made in such a way that they conform with the changing level of satisfaction and needs from the use of the farm.

Up-scaling of the farmer-based map information requires the convergence of criteria for soil use classification that are accepted and well understood by both the farmer and scientific communities.

Figure 4 shows the initial attempt to integrate the local knowledge systems into the National Soil Classification System. The soil classification system adopted by the farmers is both visual and mental, and is based on a thematic expression of soil attributes that directly influence farming decisions, viz. crop selection, farm inputs, suitable locations for houses and other facilities. The decision variables include three basic soil properties: soil texture, drainage and risk and depth of flooding. These variables are directly related to soil moisture management and thus to the possibility for crop diversification. Indeed, these very same factors were important determinants for placement of soils into Taxonomic units and for land suitability classification by the scientific team.

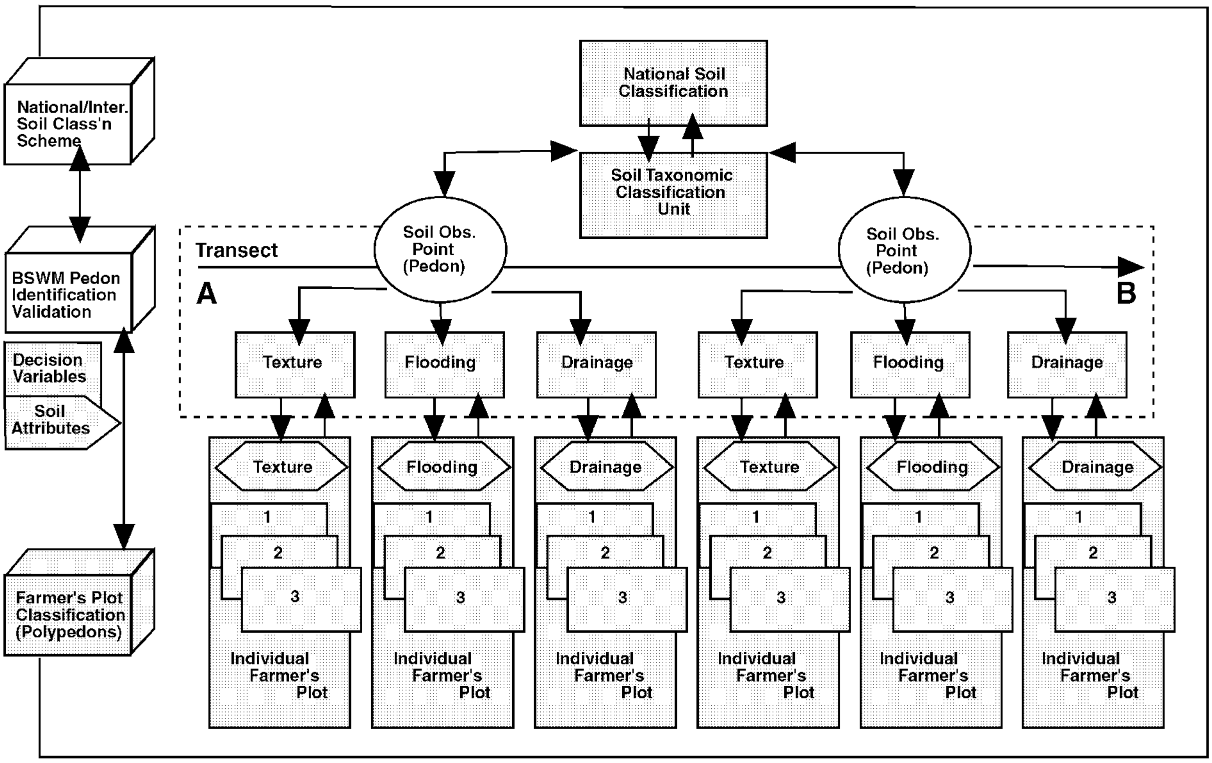


Figure 4 Framework for upscaling of farmer-based soil classification schemes

The entire exercise opened-up rare opportunities for soil scientists and agronomists in making use of a farmer-guided soil classification system which is easily understood by the farmers because it ensures the convergence of classical parameters with the decision variables of the farmers. The study showed that three basic steps are required to upscale the farmer-based Soil Classification System to the pilot area:

(1) Determination of the farmers decision variables and rules (soil attribute mapping).
(2) Use of the poly-pedon concept of soil classification and mapping, where each polypedon represents a group of natural soil bodies that occur in orderly "homogenous soil clusters" in the landscape. In the case of the farmers these were represented by their plots, the micro-variability of which was assessed during the study.
(3) Use of transect studies to compare and integrate the results of the farmer's sketches with those of the formal soil survey transects.

4.3.2 Requirements for up-scaling of farmer-guided soil classification systems

As indicated earlier the classification and mapping scheme of farmers is mentally conducted and then translated to sketch maps or transects maps. These are not drawn to scale, a mapping requirement that is vital in creation of a generalized or up-scaled map. In order to correct for this limitation, there is a need to have parcellary maps at a scale of about 1:5000.

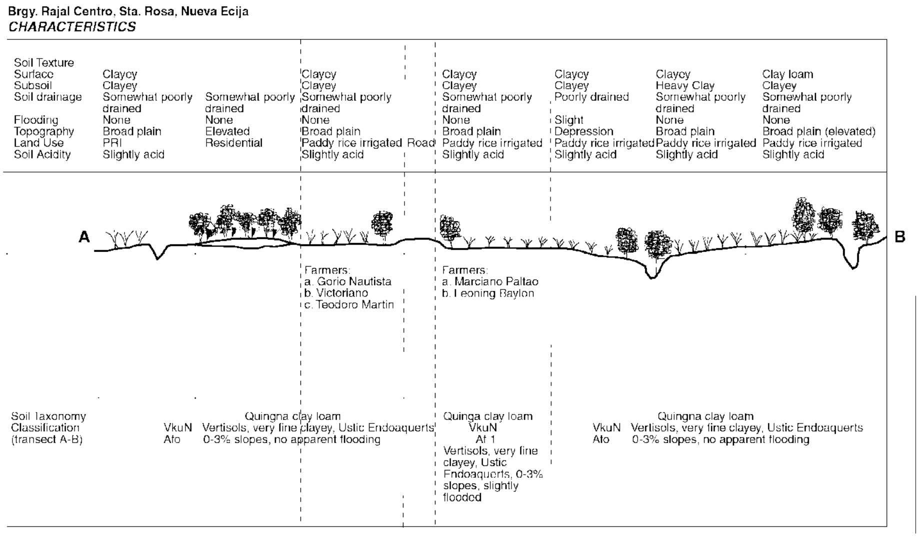


Figure 5 Example of a farmer's sketch map

Main procedures for up-scaling of community-based, soil classification systems are:

(1) Classification of soils, by individual plots, by the farmers whereby micro-variations in topography and soils are recorded. Figure 5 is an example of such a sketch map. A short glossary of the farmer's terminology may be found at the end of this report, while a more comprehensive glossary is presented in BSWM's main report [1].

(2) Identification of key soil attributes used by farmers in classifying their soils, in the present case these are flooding, drainage and soil texture. These soil attributes are then used a variables for congruence or divergence between the information collected by the farmers and the technical team of BSWM.

(3) Transect sampling of landscape, during which soil attributes identified by farmers and BSWM in the respective plots are compared. BSWM conducted two transect studies in each pilot area and recorded soil conditions for all the traversed farmers plots and further compared these with the original Soil Taxonomic map.

(4) Correlation of soil attributes defined by the BSWM team with the farmers maps and Soil Taxonomic units of BSWM.

(5) Spatial translation or up-scaling of results of farmer and classical transect studies. The typifying pedon in both project sites is a poorly drained, clayey vertisol prone to flooding. The overall range is soil characteristics is rather narrow in this section of the broad alluvial plain; small inclusions of somewhat dissimilar soils could not be mapped at the considered scale.

(6) As the initial step in comparing and matching the farmer-based and soil taxonomic classification schemes, the soil attributes recorded during the transect studies were translated into maps covering the entire barangay (Figure 6 and 7; for location of transects see [1]). This was done by plotting the individual soil attributes, recorded by the farmers in their respective plots, on the 1:4000 parcellary maps. Farm plots (polypedons) with similar soil attributes were then connected by lines to demarcate soil bodies on the map that are uniform in terms of their main differentiating characteristics. Based on this exercise three single attribute maps were generated, i.e. for soil texture, soil drainage, and flooding hazard map (Figures 8 and 9). Two categories of soil texture were recognized, viz. heavy ("Lagkitin") and medium ("galas") clay soils; when classified for their agricultural uses and management properties these textural groups are similar. In general, flooding is considered a minor problem in both pilot areas. Flooding risk is mainly associated with depressions and some areas along canals.

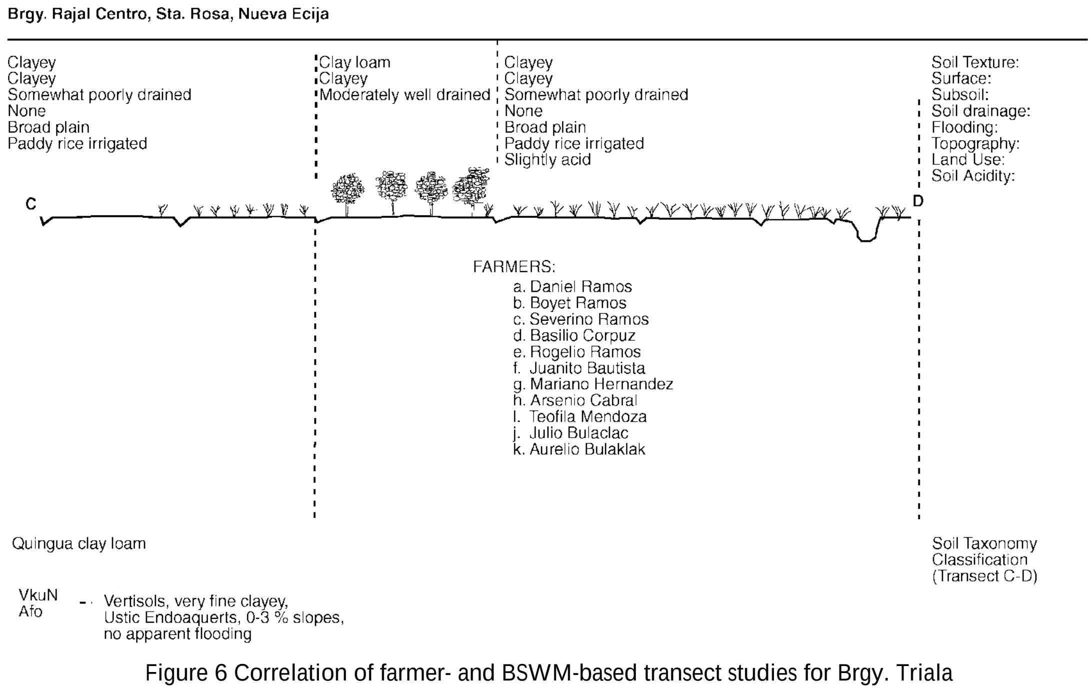


Figure 6 Correlation of farmer- and BSWM-based transect studies for Brgy. Triala

5 DISCUSSION

The project has brought forth a methodology that integrates unique and complementing key elements of indigenous knowledge with the formal (scientific) soil classification system, which may later be up-scaled to the national level, and eventually to global agro-ecological zones. On the whole, the project created a strong environment that lay the basic foundations for the exchange of indigenous knowledge and practices on safe farming through mapping of soil and farm resources. In turn, this will facilitate the transfer of resource-based technologies as the resulting soil maps are readily understood by the local extension workers and farmers.

An important limitation during the current study has been that both pilot sites, as originally selected by ILEIA, were located in a relatively homogenous landscape, both in terms of its climatic conditions, topography, soils and land use. As such these pilot areas did not show significant variability, which essentially limited the current exercise to detecting primary decision variables that are used by farmers in classifying their soils and in deciding on the location and extent of crop-diversification projects. The study has shown that farmers recognized micro-topographic variations within their plots as an important decision variable, and that this criterion largely served as the basis for planting crops other that wetland rice. Minute differences in elevation (no more than 1 m) are associated with minor changes in soil texture, structure and wetness, and these slight differences have motivated some of the farmers to test alternative land use, such as growing of vegetables in backyards. In some cases, changes in land use are associated with the development of irrigation facilities, the availability of which is critical for crop diversification during the dry period. Although soil type in this area may have had some effect on rice yield, differences in soil and crop management factors between farmers within the same soil unit may well be the main yield determining factor [see also 5]. Important non-soil related production constraints include the limited accessibility to markets (e.g. transport facilities), high production costs (e.g. fuel, herbicides, labour) and limited access of the small farmer to acceptable credit facilities.

6 CONCLUSIONS

1. The farmers in Triala and Santa Rosa have evolved a number of knowledge-based rules about the intrinsic properties of their soils that determine the suitability of these soils for a particular use, with due consideration for food-security and ecological conservation.

2. There are distinct sets of decision variables that created the convergence of actions by the farmers to optimize the productivity of the farm as well as to maximize the use of land resources in a given agro-climatic region.

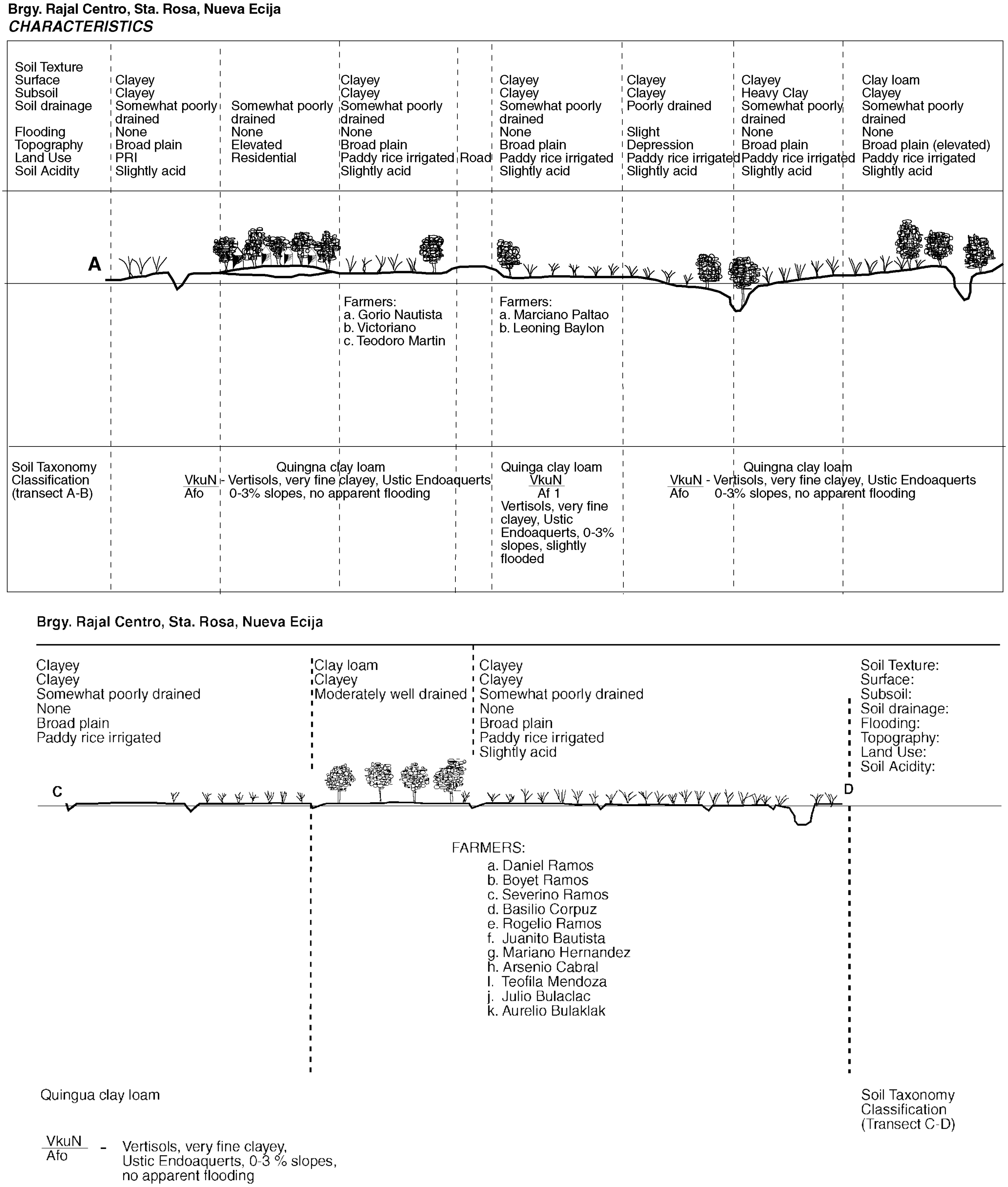


Figure 7 Correlation of farmer- and BSWM-based studies for Brgy. Rajal Centro

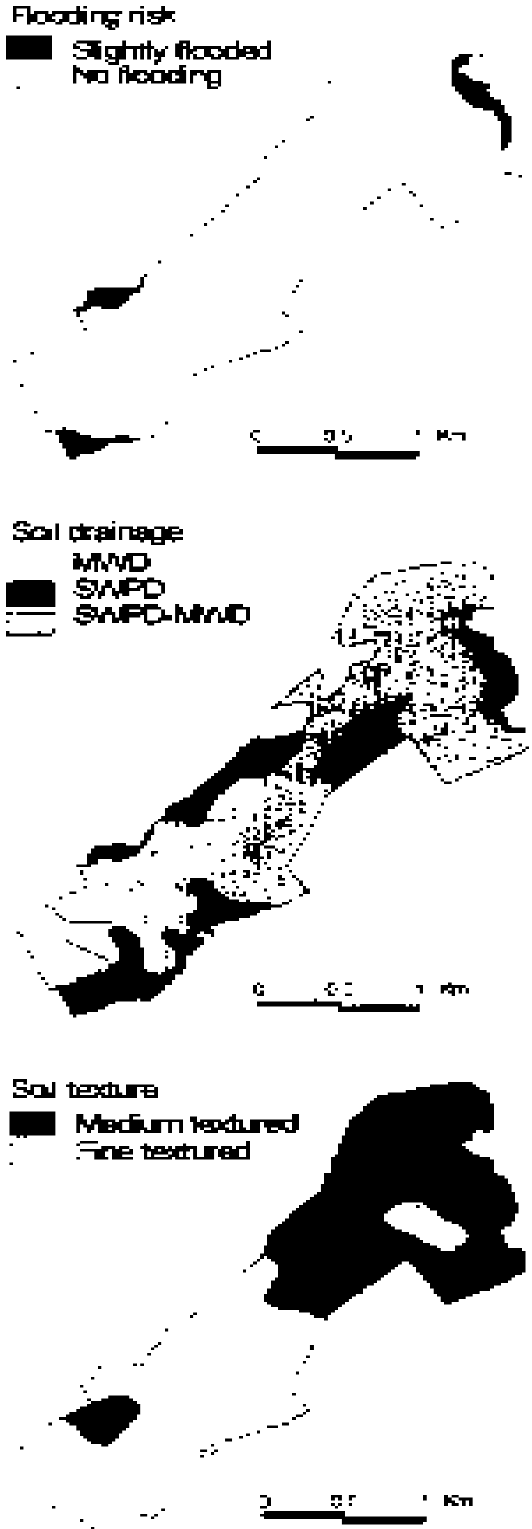


Figure 8 Farmers maps of flooding risk, soil drainage and soil texture for Brgy Triala

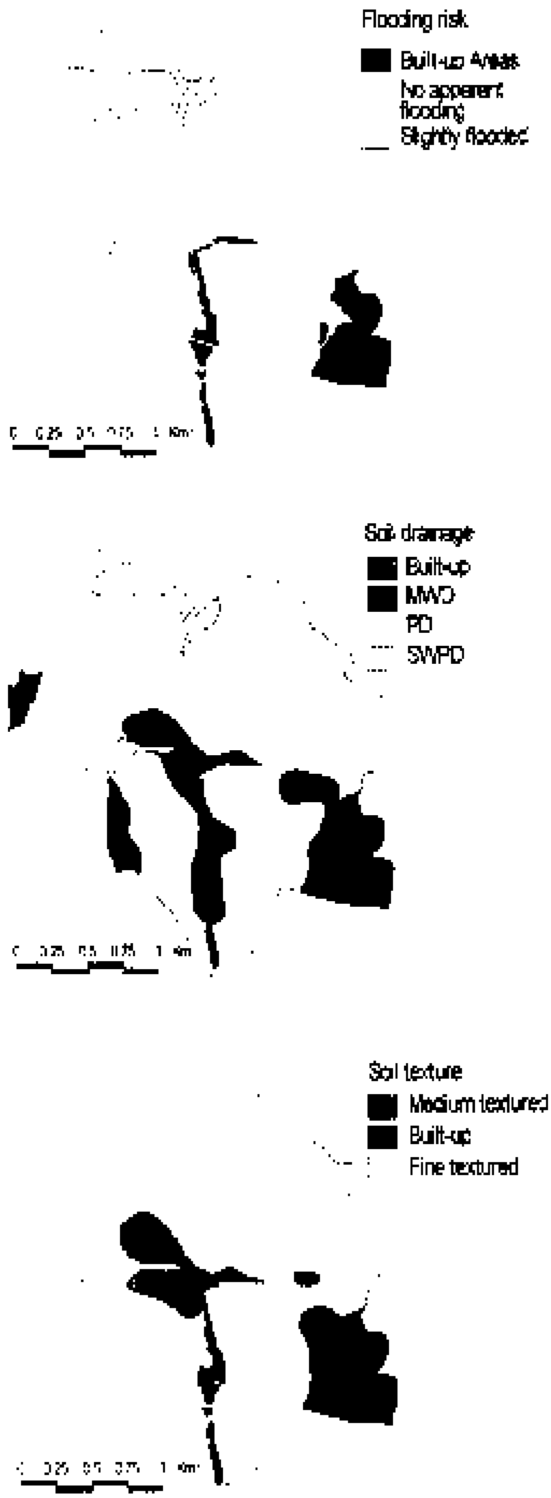


Figure 9 Farmers maps of flooding risk, soil drainage and soil texture for Brgy Rajal Centro

3. The main decision variables used by the farmers, i.e. soil texture, drainage and flooding, are within the scope and application of pedological classification schemes.

4. Farmers, through years of experience and experimentation, have created a reservoir of local knowledge that is useful in developing classifications schemes that are simple, creative, socially acceptable, and extremely useful for extension work and the formulation of socially relevant and sustainable production technologies.

5. The concept of pedon (transect sampling point) and polypedon (farmers plot) used for mapping soils applies to the up-scaling of farmer-guided soil classification systems in both pilot areas.

6. The project should be expanded to a wider range of soils, ecological conditions and cultural groupings to cover the variation in social, economic and cultural factors on farmer-based perception of soil classification and use in the Philippines.

7. From a land use perspective, the concluding farmer meetings showed the need for in-depth agro-ecological and economic studies at farm level as well as at a higher level of aggregation, such as the district. Water availability for irrigation of a second crop in Brgy. Triala remains an important constraint. The growing of crops, that require less water than irrigated rice, should be stimulated during the dry season and possibilities for more efficient water-distribution techniques should be explored further [6]. Changes in soil properties should be monitored at (farmer's) experimental plots to address the observed decline in production capacity of these intensively cultivated soils, possibly caused by a prolonged and un-balanced application of mainly N-fertilizers. Finally, the farmers appear to be interested in on-farm experiments to identify the agronomic and economic viability of substituting part of the inorganic fertilizers applied with organic fertilizers.

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GLOSSARY

A	
abonong komersiyal	commercial fertilizer
abuhin	greyish
anyo	form; slope
ani	harvest
aso	dog
atbp.	etc.
B	
baboy	pig
babuyan/ baboyan	piggery
bagyo	storm; typhoon
baha	flooding
bahayan	residential area
bana/ kabanaan	wide tract of low-lying land
banas	rice paddies
barangay	smallest administrative unit in the Philippines
basura	garbage/ waste materials
bato	stone
bawang	garlic
benta	sell
2 beses na pagtatanim	twice a year of planting
bibe/ itik	duck; duckling
binahaba pag may bagyo/ nababaha/ nababaha kunk malakas ang ulan	flooded during heavy rain
buhangin/ buhanginin	sand/ sandy
buwisan	leasehold
C	
C.L.T.	Certificate of land transfer
D	
daang pambarangay	road leading to the barangay
daang pambukid	road leading to the farm/ field
dagdag kita	additional income
di gaano/ hindi gaano	not so much
di gaanong mmasim/ hindi masyadong maasim	not so acidic
E	
ektarya	hectare
G	
galas	sandy
gastos sa labor	labor cost
golden kuhol	golden snail
gulay	vegetable
gulayan	vegetation
graba	gravel
H	
halaga ng produkto	price of commodities
halaman	plant
hindi binabaha/ di bahain	not flooded
hindi kaasiman	not so acidic
hindi pa maasim	not yet acidic
hinuhulugan sa LandBank	amortized in Land Bank
hindi tiyak	unsure

I	
ibon	bird
insekto	insect
isda	fish
itim	black
K	
kaasiman	acidity
kababaan	low lying land
kaki	khaki/ brown in colour
kahuyan	logging area
kalabang insekto	harmful insects/pests
kalabasa	squash/pumpkin
kalabaw	carabao
kalagayan ng pinagkukunan	update/availability of resources
kalamansi	calamansi, a small citrus fruit
kalamidad	calamity, such as a typhoon
kamatis	tomato
kambing	goat
kamoteng baging	sweet potato
kalupain/ kalupaan	track of land
karaniwan/ pang-karaniwan	common
kataasan	elevation
kuhol	snail
kulang sa tubig	lack of irrigation
kulang sa sanitasyon	lack of sanitary measures
kulay abo	grey
L	
labas ng pera	expenses; expenditures
lagkit/ lagkitan/ lagkitin	clay; clayey
lalim	deep
lamok	mosquito
lubak	rough road
M	
maasim	acidic
mababa	low-lying
madali	easy
madaling lumubog	easily flooded
madaling makaipn ng tubig/ madaling makaipon	easy to store water
mahirap makaipon	difficult to store water
madaling matuyo/ madaling mawala and tubaig/ madailing matuyuan	easily drained
magsasaka	farmer
mahina	weak
malabo/ labo	silty/silt
malagkit	sticky
manok	chicken
mataas	high
mataas ang input	high input
mataba	fertile
matagal	long
matagal matuyo/ matagal ang tubig/ matagal matuyuan	high water holding capacity; flood-prone areas
matibay	durable
may pagkaasim/ may kaasiman	slightly acidic
medyo	somewhat
medyo itim	somewhat black in colour
medyo maasim	somewhat acidic

medyo mataas	somewhat elevated
medyo pantok	somewhat sloping
medyo tuyuin	somewhat drained
melon	cantaloupe
mestiso/ mestisuhin	loam
mestisong galas	sandy loam
mestisong lagkit/ mestisong lagkitin minsan	clayey loam
minsan	sometimes
mga nilalagay	inputs
N	
nakakahawak ng tubig	could hold water
nakakapigil ng tubig	could retain water
nakikisaka	tenant
natutuyo sa tag-araw	dry during summer
O	
oportunidad	opportunity
P	
pag-aalaga	oversee
pagbaha	flooding
pagbebenta	selling
paggawa	labour
paghawak ng tubig	water retention
pagkain ng hayop	animal feeds
pagma-mayari	ownership
pagpigil se erosion	erosion control
pagtatanim	planting season
pakwan	water melon
palaka	frog
palay	rice
palayan	rice field
panandalian	temporary
pananim	type of crop
pangkabuhayan	livelihood programs/projects
pantok/ pantukin/ pantokin	sloping
pason ng pera	income
patag	flat
patubig	irrigation
pestisidyo	pesticides
pilapil	paddy dikes
pinagkukunan ng tubig	source of irrigation
pitak	paddy field
posa/ bomba	water pump
potensyal/ potensiyal	potential
presyo	price; amount; cost
problema	problem; hindrance
punong-kahoy	tree
purok	area
S	
sarili/ sariling bukid/ sariling ari	ownership
sibuyas	onion
sili	pepper
sitaw	string beans
sprey	spray
sukat ng lupa	land area
suso	snail

T	
tabon	landfill
tag-araw	dry season
tag-ulan	rainy season
talong	eggplant
trabaho sa brgy	job opportunity for the barangay
transect/ transek ng kikas kayamanan	transect of natural resources
tubig	water
tuyuin	dries easily
U	
ulan	rain
uod	worm
uri ng hayop	raising of animals
uri ng lupa	type of soil
W	
wala	none
walang baha	no flooding