Land Resource Information System Of Cagayan Valley A Guide for A Sustainable Agricultural Production System

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Abstract: A soil resource database of the major agricultural soils of Cagayan Valley was developed and complemented by a printed guidebook “Soils in Cagayan Valley: Guidebook to Sustainable Soil Resource Management”. The database contained an inventory of all the established soil series in the four provinces of Cagayan Valley, Region 2—Cagayan, Isabela, Nueva Vizcaya and Quirino. Morphological, physical and chemical properties of the established soil series of the four provinces under study were collated and properly validated in the field using standard procedures of profile description, soil sampling and laboratory testing. After correlation and validation of the primary and secondary data, assessment of crop suitability was conducted, and finally, management recommendations for each soil series were formulated. The location of the soil at the barangay level were identified using the Geographic Information System (GIS). The soil resources database includes the soil physical and chemical characteristics, constraints to crop production, suitability for major crops of the region, and soil management recommendations intended for agricultural practitioners to grasp vital information on the different soils in the region. It will guide technicians and farmers to undertake decisions on what crop to grow in a specific soil series based on crop suitability rating, harnessing the innate characteristics and nutrient contents of the soils, as it provides standardized systems in nutrient management stipulating the quantified fertilizer inputs for specific soil series—an information needed at the field for optimal and sustainable soil resource management. As designed, a user friendly system would facilitate the location of the soil in any of the four provinces as well as show the municipalities under specific province. A list of barangays can be seen as well and the selection for specific barangay can therefore be obtained easily. Once the barangay is selected, the dominant soil series in that area with the corresponding information on their characteristics, crop suitability, limitations up to soil management recommendation will be seen on the screen. The guidebook will complement the information system, especially for localities lacking tools to access the system. The information contained in the soil resource information system can therefore serve as decision-support information system towards sustainable agricultural production.

Index Terms: crop suitability, Geographic Information System (GIS), land evaluation, soil database, soil survey and classification

1. Rationale/Significance of the Study

Agriculture is the principal industry in the Philippines and it remains as the main livelihood of millions of Filipinos. Its advancement and sustainability depends much on the proper conservation of soil resources of the country. However, so much activity remains to be done to improve the agriculture industry and to increase the earning capacity of the farmers. Every year there is an anticipated shortage of the staple food crops in the country because of continuous decline in the quality of our prime agricultural areas. The soils in most of our arable areas have been seriously depleted of nutrients primarily due to the practice of nutrient mining by majority of our poor Filipino farmers. Such practice therefore requires immediate and continuous replenishment of the depleted nutrients in order to revive as well as sustain soil productivity. More and more of the marginal lands located in the rolling and hilly lands have been brought to tillage in order to augment declining productivity of the remaining prime agricultural areas in the country.

The opening of marginal areas by mostly marginal farmers, farmers without the capacity to provide adequate inputs as well as lacking sufficient land management skill and field experience would inevitably result into occurrence of serious soil erosion and may even end into irreversible land degradation. With the advent of new technologies, it is believed that the present area devoted to food crops can be made to produce much more than the need of the population of the country today. One way of raising productivity of existing agricultural areas would be the utilization of land according to its best use. This can be achieved through proper understanding of the production capacity of soils. The nature and properties of soils as they occur in the field including the recognition of their respective constraints to crop production can be addressed under the scope of soil survey and classification activities. Soil surveying and classification is the science of studying characteristics and distribution of soils in the field. It has been designed to help farmers identify and characterize the soils in the farm. Further, through soil surveying, the behavior of different soils when grown to different crops is determined including the inherent limitation of the soils to different uses. The result of evaluation of the morphological, physical, chemical characteristics and inherent limitations of the soils various uses can guide in the establishment of proper use and management of soils. It can likewise help in selecting the most suitable crops to grow relative to the kind of soil. Unfortunately, the use of soil survey and soil classification is seldom realized primarily because of the problem of presentation of the report which is highly technical and sometimes too complicated to ordinary farmers, not to mention the problem of availability, accessibility and the recency of information. This project is an attempt to translate and simplify the soil resource information

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generated from the soil survey and classification activity and to make it accessible to the farmers, agricultural technicians and researchers. Access to the said information can be made possible through the use of internet technology. The development of information system covers a comprehensive database related to description, characteristics, crop suitability, limitations and behavior of the major agricultural soils in Cagayan Valley. It can be accessed by farmers, technicians, researchers and other end-users and can be used for proper soil identification and characterization. Through a users friendly system, they can acquire the information about the soils in their locality, they can easily exchange information related to farm problem identification, and can cooperate in finding solution to the problem as well, especially in matters related to the selection of appropriate crop and recommended agricultural production system. With the soil series identified up to barangay level, the information system can likewise serve as vehicles of transfer for site specific technologies. Further, allocation and optimization of land use especially in the selection of crop/cropping pattern/production system can be done more systematically.

**Objectives**

To develop a soil information system that contains a comprehensive soil database related to description, characteristics, crop suitability, limitations, recommended management strategies, and behavior of major agricultural soils in Cagayan Valley. Specifically, it aimed to:

a. To validate and update existing data on the morphological, physical and chemical characteristics of the major soil series in Cagayan Valley;

b. To collate available information related to the agro-ecological distribution and behavior of major soil series when used for crop production

c. To develop tailor-made printed and automated guide to soil identification and characterization up to barangay level; and

d. To offer guides for fertilizer requirements, fertilizer material equivalents and lime requirement for the major soils of the valley when grown to the 11 major crops of the region.

**2. Methodology**

The information system contains inventory of all the soil resources of the four provinces — Cagayan, Isabela, Nueva Vizcaya and Quirino. The project essentially involved six general activities: (1) collection, collation and interpretation of available secondary data; (2) correlation and validation of the soil morphological description; (3) determination of physical and chemical properties of the soils; (4) taxonomic classification of individual soils at series level; (5) webpage design, development of soil resource information system and formulation of the guidebook; and, (6) pre-evaluation, training and dissemination of information about the webpage and the guidebook.

**Assessment of data requirements and study site**

The project relied on available records about the characteristics, behavior and distribution of major soils series in Cagayan Valley. It primarily depended on published Provincial Soil Survey Report prepared by the Bureau of Soils and Water Management (BSWM), including other relevant data and information. Established soil series were categorized according to their importance to crop production and geographic distribution.

**Systematization and interpretation of the soil survey reports**

Following the analysis of available information related to the characteristics and distribution of major soil series, the researchers located on a controlled maps the reported places where the individual soil series in the region were mapped. Further, a genetic key that relates unique individual features and landscape distribution was prepared to simplify the identification of major soil series in the field.

**Digging of pits, soil characterization and collection of samples**

Next to collection and analysis of secondary data was the field validation of target soil series. Geographic positioning system (GPS) was used to obtain the geographic reference sites of the major soil series of the region. Soil pits which measured one-meter wide and one-meter long were dug at a depth of about 1.5 meters to fully expose the soil profile which were described according to the guidelines of the USDA. During field validation, the morphological characteristics of the known soil series were examined, described and pictures taken from a newly opened pit. In addition, soil samples per identified soil horizon/layer were taken for laboratory analysis.

**Sample collection, preparation and laboratory analysis**

Soil samples were collected from each horizon of the soil profile, air-dried crushed, thoroughly mixed and passed through a 2.0 mm sieve for physical and chemical analysis. The current and potential suitability ratings of the major soil series were determined by matching the soil qualities with the crop requirements. The suitability assessment adopted the three classes within the order S for suitable and two classes within the order U for unsuitable as provided in the FAO framework.

**Database Encoding, Webpage Design and Development**

Further processing of both secondary and primary data collected during field validation was conducted preparatory to the development of the soil information system (webpage) and the guidebook. The step required the continuation of correlation between the secondary data and primary data. Secondary data on morphological description and soil properties were matched with the primary data to confirm the validity of the information. Finally, all data and information of soil series were organized into a soil information system that include description of the major soil series, soil quality, suitability ratings and limitations, recommended management practices and fertilizer guides.

**Pre-test of the soil information system of the region**

In the validation of the soil resource information system, the researchers invited the municipal agriculturists, technicians, extension workers and other interested private groups including farmers from the area to give comments, suggestions and recommendations regarding the content, color and texture, font style and format of the developed
Crop Suitability and Limitations
Based on the physical and chemical properties of the different soil series in Cagayan Valley, the ratings for the limitations and suitability for the 11 major crops of the valley was determined based on slope (f), drainage and flooding (w), soil depth, texture (s), pH and percentage organic matter (f). The FAO land evaluation system was used in determining the crop suitability which was interpreted based on limitations of the different soil series to crop production. The system adopted the use of three classes within Order S and two classes within Order U. This information guides technicians and farmers as well, to undertake decisions on what to grow on a specific soil series based on the standard crop suitability; harnessing the innate characteristics, and nutrients of the soils.

Suitability Maps and Area Distribution
In response to the food security program of the government, arable lands were delineated and suitability maps were generated based on the result of land evaluation undertaken. Under this category are the suitability maps and distribution of the suitable areas for the eleven major crops of the region that include: lowland and upland rice, corn, banana, mango, pineapple, sugarcane, coconut, tobacco, peanut and cassava. The maps will guide the user on the specific location of soils considered highly and moderately suitable for a particular crop.

Fertilizer Guides
This section utilized standardized systems in nutrient management stipulating the quantified fertilizer inputs for a specific soil series – information needed at the field for optimal and sustainable soil resource management. With the scenario in the field having farmers implement fixed amount of fertilizer in their fields without informed decisions as to the characteristics and nutrient supplementation needs of their lands, the gap to answer is the provision of information system stating the required input supplementations to cut agricultural cost by utilizing the inherent potentials of the various soil series.

Soil Series Determined at Barangay Levels of the Four Provinces
The location (provincial, municipal, and barangay level) of the soil was identified using the Geographic Information System (GIS). The user can select from the four provinces – Cagayan, Isabela, Vizcaya and Quirino. The various municipalities within a province will be provided with the respective list of the barangays. The user can then select the barangay he/she wishes to identify associated soil series and their characteristics. Once the barangay is selected, the soil series with a representative soil profile will be shown on the screen along with corresponding information on its physic-chemical characteristics, suitable crops, suitability ratings and limitations, and soil management recommendations.

The Guidebook
The guidebook “Soils in Cagayan Valley: Guidebook to Sustainable Soil Resource Management” provides a holistic approach towards achieving sustainable soil resource management – a decision-support system for agricultural practitioners to discern effectively in terms of managing and
harnessing the bounties offered by one of the most indispensable agricultural commodity – the soil. The book is intended for agricultural practitioners to grasp vital information as to the characteristics, properties, crop suitability, limitations and recommended management strategies of the different soils in region 2. The book guides technicians and farmers as well to undertake decisions on what crop to grow in a specific soil series based on standard crop suitability rating, harnessing the innate characteristics and nutrient contents of the soils, and finally, it provides standardized systems in nutrient management stipulating the quantified fertilizer inputs for specific soil – an information needed at the field for optimal and sustainable soil resource management.

Information derived in the Soil Information System
The bottom line of knowing the soil series in a specific area and its properties is to determine soil management required to attain higher agricultural productivity and assure sustainability. Information on soil characteristics give us idea on the soil features that limits crop production, consequently determining what are the appropriate management practices needed to conquer such limitations. Moreover, information on soil qualities and soil requirements of crops, and suitability analysis of the major crops commonly grown in the valley was done and indicated in the information system. Accordingly, fertilizer and lime recommendation were derived on specified crops for each of the 30 major soil series. Crop suitability analysis provides information on soil properties that limits the production of specified crop(s). For instance, growing corn in Bantog clay loam would have problems on wetness or flooding indicated by the subscript, w. Further, it shows what crops that would give the highest benefit in terms of productivity and profitability from a given soil series, indicated by S1 as the most suitable down to S3 as marginally suitable. The symbol U implies that the crop is either currently not suitable, (U1) where the effect of limitation is so severe as to greatly reduce the yield or to require costly inputs, or permanently not suitable (U2) where the limitations cannot be corrected permanently.

4. Summary
The main component of the project was the development of soil resource information system in printed and automated forms for Cagayan Valley. The developed information system reinforced by the guidebook was designed for use by the municipal agriculturists, technicians, extension workers, farmers, researchers and other interested parties. It includes information about general characteristics of the different soil series found within the region together with their classification. The proper identification of soil series up to barangay level is important for it can improve communicating farm related problems between the technicians and farmers. Ultimately, the project – soil information system of Cagayan Valley - aims to provide a holistic approach towards achieving sustainable soil resource management – a decision-support system for agricultural practitioners to discern effectively in terms of managing and harnessing the bounties offered by one of the most indispensable agricultural commodity- the soil.

REFERENCES

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APPENDICES
Overview of the Information System (IS)

HOME – About the IS

Soils of Cagayan Valley

Agriculture is the principal industry in the Philippines and it remains as the main livelihood of millions of Filipinos. Its advancement depends much on the proper conservation of soil resources of the country. However, much remains to be done to improve the agriculture industry and to increase the earning capacity of the farmers. Every year there is a shortage of the staple food crops. The soils have been seriously depleted of nutrients and there is the need for replenishment. More and more of the marginal lands and the rolling and hilly lands have been brought to cultivation so much so that they are not properly utilized and manage resulting in serious soil erosion and low productivity. On the other hand, it is believed that the present area devoted to food crops can be made to produce much more than the need of the population of the country today if the soils are properly utilized according to best use that they can be put to. All these problems come under the scope of soil survey and classification.

Soil surveying and classification is the science of studying characteristics and distribution of soils in the field, and has been done in order to identify and determine the soils in that area. Further, it can recognize the behavior of different soil types in order to produce crops accordingly.
Suitability Ratings and Limitations of the Different Land Units

Crop Suitability
Suitability Maps and Area Distribution

Lime and Fertilizer Guides of the Soils in Cagayan Valley
Specific Locations of each Soil Series
(Provincial, Municipal, Barangay)

Soil Series at Barangay Level