CLASSIFICATION OF LAND FOR ITS USE CAPABILITY AND CONSERVATION REQUIREMENTS

by

F.R. Moormann*

The intensification of agriculture on land used for shifting cultivation requires in most cases a thorough knowledge of the edaphic and other attributes of such land. Modern techniques such as mechanization, higher-yielding varieties and the use of fertilizers can transform the extensive form of land use under shifting cultivation to a more intensive one with a considerably higher agricultural output per unit area. Introduction of such techniques can, however, lead to failure if soil conditions are not suitable or if other environmental factors are adverse. Many examples of failure to use shifting cultivation land for a high input, temperate zone type of agriculture can be cited from various countries in the lowland tropics. Determination of correct intensified land use thus requires a study in depth of the land and and evaluation of factors which are limiting in view of such intensification.

The technique which makes it possible to determine the most suitable use for any area of land is Land Classification. A great number of systems of Land Classification are in use, varying in approach mainly according to the purpose for which the land is classified. Land may be classified according to its present land use, to its suitability for a specific crop under the existing forms of management, to its capability for producing crops or combinations of crops under optimum management, or to its suitability for non-agricultural types of land use.

Land capability classification

The purpose of land capability classification systems is to study and record all relevant data, which will lead to a decision as to the combination of agricultural use and conservation measures which permit the most intensive and appropriate agricultural use of the land without undue danger of soil deterioration.

The best known of these systems is the United States Department of Agriculture system (Klingebiel & Montgomery, 1961), which has been adapted and modified for use in a number of countries, including, those in which shifting cultivation is widely practised. The USDA system is an interpretative system, using the soil survey map as a basis and grouping the individual soil map units into groups that have similar management requirements. The capability grouping is designed to help land users to use and interpret soil maps and to make possible broad generalization, based on soil potentialities and on limitations in use and management. The system is primarily concerned with the risk of erosion and to a lesser extent with other management hazards such as wetness, shallowness and salinity or alkalinity of soils. In the highest category, eight classes are distinguished, i.e.

Class I. Soils that have few limitations that restrict their use. Erosion hazards on these soils are low; they are deep, productive and easily worked. For optimum production, these soils need ordinary management practices to maintain productivity, both as regards to maintaining soil fertility and favourable physical soil properties.

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices. Limitation of soils in Class II include singly or in combination the effect of gentle slopes, moderate susceptibility to erosion, less than ideal soil depth, somewhat unfavourable soil structure, slight to moderate correctable salinity, occasional damaging overflow, wetness correctable by drainage, slight climatic limitation. Soils in this class require more than ordinary management practices for obtaining optimum production and for maintaining productivity.

* Soil Scientist, International Institute of Tropical Agriculture, (IITA) Ibadan.

Class III. Soils that have severe limitations that reduce the choice of plants or require special conservation practices.

The limitation of soils in this class are those of Class II, but in higher degree; including as additional possible limitations, shallow depth, low moisture holding capacity and low fertility which is not easily corrected. Class III soils require considerable management inputs but even so, choice of crops or cropping systems remains limited because of inherent limiting factors.

Class IV. Soils having very severe limitations that restrict the choice of plants, require very careful management or both.

Restrictions, both in terms of choice of plants and of management and conservation practices, are greater than in Class III to such an extent that production often is marginal as regards the inputs required. Limiting factors are of the same nature as in the previous classes, but are more severe and more difficult to overcome, while several of the limitations, such as steep slopes, are a permanent feature of the land.

In the USDA system, the soils of classes V to VIII are generally not suited to cultivation, although certain of them may be made fit for agricultural use by costly reclamation measures.

Class V. Soils that have few or no erosion hazards but have other limitations, impracticable to remove, that restrict their use to pasture, range, woodland or wild life food and cover. Many of these soils are subject to inundation, are ponded or are stony or rocky, though level or nearly level.

Class VI. Soils having severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wild life food and cover. This class is a continuation of Class IV with very severe limitations that cannot be corrected. They may serve for some kinds of crops, such as tree crops, provided unusually intensive management is practised.

Class VII. Soils with very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland or wild life. The limitations, are such that these soils are not suited for any of the common crops.

Class VIII. Soils and land forms that preclude their use for commercial plant production.

In the second level of generalization of the USDA system, the sub classes the kind of limitation is specified. Four kinds of limitation are recognized at this level, i.e. risk of erosion, wetness, drainage or overflow, rooting zone limitations and climatic limitation. The third level, that of the capability unit, provides more specific and detailed information for application to specific fields on a farm. In tropical countries where the framework of the USDA system has been introduced, adaptations and changes have been made. Examples of such adaptions for Rhodesia and the Philippines were discussed by Hudson (1971); for the monsoon area of Thailand reference may be made to Gallop et al. (1967). One of the main reasons that the USDA system cannot be used without substantial revision for local conditions is the premise that the system assumes a moderately high level of management, one that is practical and within the ability of a majority of the agricultural land users in the United States. It is, therefore, of particular use for areas where the mechanized, moderate to high input types of agriculture are practised. It caters to a much lesser degree to the areas, under discussion in this seminar, where the level of management under shifting cultivation is particularly low. The use of the system in such areas most often has to be based on interpretation of soil characteristics only, without the benefit of relevant agronomic data or of the knowledge of the dynamics of soils under intensified management. Whereas shifting cultivation is frequently adapted to the ecological and socio-economic conditions of the land, intensified cropping especially of annual food crops, is not. While environmental parameters, leading to classifying land in classes V to VIII are commonly easy to discern by field studies alone, this is not so for classes I to IV where such parameters have to be tested for their effect on agricultural productivity in order to be of value in the determination of the correct land capability class of a given piece of land.

Land evaluation for agricultural land use planning

A new standard framework for land evaluation by means of land suitability classification is presently being developed under the aspices of FAO (FAO, 1972), based on experiences in developing countries and to a large extent on the work of Beck and Bennema (1972). As in other systems, the land suitability component of land evaluation is based on the survey of the physical attributes of the land (soils, climate, vegetation, topography, hydrology, etc.), and consequently requires interpretation of these attributes. The proposed land suitability classification represents the first stage in the evaluation process for rural purposes; a further step is the economic suitability classification which integrates relevant social and economic factors with the technical suitability classification. At the present stage, the system mainly concentrates on the technical suitability classification of land.

The system recognizes the fact that land suitability depends to a large extent on the purposes which the land is required to serve. Hence, the notion of land utilization type is introduced. Land, according to this notion, can only be evaluated within the context of a given utilization type as defined by its produce, capital intensity, labour intensity, farm power, technical knowledge, farm size and land tenure. Of these factors, produce is certainly the most important when evaluating the potential of land under shifting cultivation for increased and sustained agricultural production. Land utilization types can be defined in broad terms, based on differences in agricultural use (e.g. rainfed arable farming, tree crop farming, horticulture, etc.) but also in more narrow refined terms of crop rotations, single crops or even single varieties. This approach implies that evaluating land under shifting cultivation for its suitability for intensified agriculture will require consideration of a number of alternative land utilization types.

The suitability classification proposed recognizes the fact that intensified land use requires inputs, whether recurrent or minor inputs such as tillage, fertilizers which are applied by the land users themselves, or major capital inputs such as the introduction of irrigation, land shaping or terracing or, as in the case of shifting cultivation in forest areas, land clearing. A range of suitability classifications is proposed, referring to actual land utilization on to potential land utilization requiring major capital inputs.

The same structure of interpretative groupings proposed would be used in all of the interpretative classifications, each grouping retaining its basic meaning of suitability in relative terms within the context of the different classifications and in relation to each land utilization type. Four categories of generalization would be recognized, i.e. land suitability order, land suitability class, land suitability subclass and land suitability unit. Three orders are proposed:

Order 1. Suitable

Order 2. Conditionally suitable

Order 3. Unsuitable

In the classes, degrees of suitability would be indicated in order of increasing limitations. For Order 3, a two class subdivision is proposed, i.e. Class 3.1 presently unsuitable for practical or economic reasons, but with the possibility that it may become suitable in future, and Class 3.2 unsuitable, when no such possibility would exist.

The subclasses are divisions within the classes, according to the nature of limitations, whereas units would be recognized according to minor differences in production characteristics and/or management requirements.

In order to arrive at a satisfactory diagnosis of the suitability of land for a specific purpose, the FAO system introduces the notion of land qualities. Land qualities are groupings of attributes of the soil and environment which determine, alone or in combination, the suitability of a given piece of land for a specific type of land utilization. The land quality ''Resistance to erosion'', for instance, could be seen as an integration of single land attributes such as erodibility of the soil, degree and length of the slope, erosivity of the climate. Major land qualities in relation with agricultural use are grouped according to the kind of requirement they serve. They are related with requirements of plant growth, animal growth, natural product extraction or with management practices in plant production, animal production, or extraction. Determination of land qualities, sufficiently precise to be used as diagnostic characteristics in the land suitability classification process, is possible if reliable agro-ecological data are available. This is mostly not the case in wide areas of shifting cultivation, particularly in the lowland humid forested areas of the tropics.

Parametric methods of soil and land evaluation

The parametric method consists of evaluating separately the different properties of soils and their environment and of combining these factors according to a mathematical model taking into consideration the relationships and interaction between the single properties. The outcome is an index of performance which is used to rank soils in order of (agricultural) value. A summary of the major parametric methods was given by Riquier(1972). As quoted by Riquier, a multiplication method for soils of the humid tropics has been worked out by Sys & Frankart (1971, unpubl.). The criteria considered as factors are: profile development, parent material, depth of the soil, colour, drainage, pH, base saturation and development of the Al horizon. In this method, improvement measures are taken into account but without computing their influence on productivity. Moreover, no climatic factor is used in the formula which is established for use in the warm and very humid tropics where recurring droughts would not be limiting for productivity. Parametric methods have a number of advantages, the major one being that the indices chosen and the arithmetic procedure used can be standardized, thus eliminating a certain element of subjectivity common to other methods. Nevertheless, the choice of the indices is, of necessity, often subjective in as much as it is difficult, if not impossible, to evaluate the action of certain factors used in the equation on plant growth and crop productivity. Hence, parametric methods usually are empirical and of application for specific crops in limited agro-ecological areas only. In the meanwhile, the ideas which they embrace are likely to form a usefully objective basis for determining the place of individual land units within a standardized framework of land suitability classification.

Conclusions

Different methods of land capability and/or suitability classifications have been in use in many countries, including those where, at present, shifting cultivation is an important form of land utilization. In areas where shifting cultivation predominates, the type of land suitability classification should preferably be one which takes into account the desirability of developing a more intensive type of land utilization. Potential land suitability classification is thus clearly indicated for such areas.

Determination of land use alternatives to shifting cultivation requires a thorough knowledge of crop performance in the areas under study. In most countries, considerable amounts of agricultural data are available from experimental farms and stations, from field experiments and demonstrations with fertilizers and new varieties, and from records of commercial farmers. In certain cases, notably where tree crops and certain annual commercial crops are concerned, enough is known of crop perfomance in function of environmental factors to enable the land classifier to make pertinent predictions of the suitability of land for such a specific land utilization type. This, however, is generally not the case for various food crops. The principal shortcoming of the available agricultural research data is, in general, the lack of a solid quantitative description of the physical environment in which experiments are carried out. Climatic data of the sites are often not available or, if they are, very frequently only mean values are given. Soil data, if mentioned at all, are commonly insufficiently precise and are unrelated to the general soil conditions of the area which the experimentation is required to serve. Quite often, results of experimental work are not very accessible. Even more alarming is the fact that negative results of experiments are most frequently not published, even though such adverse results are of great importance for the land classifier because they may inform him on the nature and severity of factors limiting production. With all their shortcomings, however, the results of agronomic experimentation are of eminent importance for the land classifier. Such data should be integrated and, where possible and feasible, made more meaningful by adding the lacking data on soils, on climate and on other physical environment parameters. Quite frequently this would entail a detailed study of the physical environment of selected experimental sites.

A further step would be the establishment of experimental fields or farms on selected soils or soil associations representative for larger land areas. Agronomic experimentation on such bench mark sites should be directed towards the determination of the soil potential under improved management while studying, at the same time, physical production limiting factors and the ways and means to overcome such limitations.

REFERENCES

Beck, K.J. and J. Bennema, 1972. Land evaluation for agricultural land use planning; an ecological methodology, Landbouw Hogeschool, Wageningen, mimeogr., 60 p.

FAO, 1972 Background document, Expert consultation on land evaluation for rural purposes, FAO Document AGL/LERP 72/1 (restricted), 110 p.

Gallop D.L., S. Kashemsanta and A. Pimpand, 1967. Soil Survey Handbook for North east Thailand, part II - Land capability classification. Soil Survey Report No. 60. Bangkok, 18 p.

Hudson, N., 1971, Soil conservation. B.T. Batsford Ltd., London, 320 p.

Klingebiel A.A. and P.H. Montgomery, 1961. Land-capability classification. Agriculture Handbook No. 210, S.C.S. US. Department of Agriculture. Washington D.C., 21 p.

Riquier, J., 1972. A summary of parametric methods of soil and land evaluation, in: FAO Document AGL/LERP 72/1 (restricted) pp. 81-87.