CHAPTER TWO: LAND EVALUATION

2.1 Introduction

Decisions on land use have always been part of the evolution of human society. In the past, land use changes often come about by gradual evolution, as the result of many separate decisions taken by individuals based on past experience (Mather, 1986). On the other hand, in the over populated and complex world of today, they are resulted from the process of land use planning. This practice of planning takes place in both the developed and developing countries. It can be said that, the essence of planning is to put environmental resources to new kind of productive use. The FAO Framework for Land Evaluation (FAO, 1976) stated that, the function of land use planning is to guide decisions on land use so that natural resources are put to the most beneficial use for present, whilst at the same time conserving those resources for the future use.

Land resources are gifts of nature, and they are described in strictly scientific terms; they give no indication on how they should be used. Land qualities, are used as a means for showing the direct link between the land as an ecological complex and the biological and technological activities of land use. Land qualities may, therefore, be used as diagnostic criteria for land suitability, but they do not themselves indicate suitability. Land qualities are very important in indicating how a land, with given natural (resource) characteristics could be used for a given land utilization type. They do not, however, indicate if one land utilization type would be better on a particular kind of land than another. They can also indicate improvement needs, but they do not show suitable improvements to execute for future land utilization type. Therefore, a systematic land evaluation is necessary for the purpose of judging 'land suitability' both for land use and for land improvement (Vink, 1975,). But what is land evaluation?

2.2 What is Land Evaluation?

Vink (1975), citing Brinkman and Smith (1973), defines land evaluation as "the process of collating and interpreting basic inventories of soil, vegetation, climate and other aspects of land in order to identify and make a first comparison of promising

land use alternatives in simple socio-economic terms". Dent and Young (1981) said that land evaluation is the process of estimating the potential of land for alternative kinds of use. These include productive uses, such as arable farming, livestock production and forestry, together with uses that provide services or other benefits, such as water catchment areas, recreation, tourism and wild life conservation. As FAO (1976) stated it, sometimes land evaluation may be concerned with present use of the land but most frequently it deals with change and its effects in the future i.e. with change in the use of land and in some cases change in the land it self.

Almost every activity of man uses land and, as the population number increased and activities multiplied, land has become a scarce resource. Decisions to change the use of land could have advantages and disadvantaged, (e.g. economic or environmental). Decision making about land use could also result in political unrest, often raising strong emotions and mostly determined by the social and economic situation of the people (McRae and Burnham, 1981). It is obvious that crop production, grazing by livestock, forestry and recreation call for different qualities of land, but their requirements are not the same (i.e. one require more than the other). As Young (1998) suggested, the general essence of land evaluation is to compare kinds of land use with types of land. It answers questions of two kinds:

1. Here is an area of land; what is the best use to which it can be put?
2. If one want to expand the existing uses, where are the best areas on which to do it?

Questions of the first kind arise when the planning objective is to improve the living standard of a region as a whole, by any kind of development which is found to be most appropriate. It can also be used at national level planning to identify priority areas for different kinds of development. Questions of the second kind apply where the objectives are to find areas for development of specified kinds of land use, such as small scale coffee cultivation, irrigation projects or poultry farms. In these circumstances, the need is to find which areas of land will support such uses, and those that can not support it.

According to Dent and Young (1981) land evaluation demands information from three sources: land, land use and economics. Data on land can be collected through

natural resource surveys, including soil surveys. Information on the ecological and technical requirements of different kinds of land use is obtained from agronomy, forestry and other relevant disciplines. Depending on the objectives of the evaluation, economic data are required. For physical evaluation, the economic data needed are only concerned broad features of the economic and social context, e.g. general wage levels, the extent of mechanization, size of land holdings etc. But for economic evaluation, the data on specific costs and prices are needed (McRae and Burnham, 1981).

Evaluation procedures compare relevant kinds of land use and their requirements with land mapping units and their qualities (Dent, 1986). Davidson (1980) suggested that, in the process of evaluation, assessment of physical characteristics is not enough, but the exercise should be extended to the point where economic feasibility, social consequences and environmental impacts of the proposed use should also be analysed. In addition McRae and Burnham (1981) noted that land varies greatly in topography, climate, geology, soil and vegetation cover, so a clear knowledge of the opportunities and limitations presented by these relatively permanent factors of the environment is vital. Land evaluation concerned with these opportunities and limitations and tries to translate the information collected about land into a form usable by land users.

2.3 Definitions of important concepts

The following definitions of important concepts are adopted from FAO (1976) where it is taken from other source the reference is stated on the corresponding definition.

Land: is an area of the earth's surface: the characteristics of which embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area, including those of the atmosphere, the soil, and underlying geology, the hydrology, the plant and animal populations, and the results of past and present human activity, to the extent that these attributes exert a significant influence on the present and future uses of land by man.

Soil: is a natural body consisting of layers or horizons of mineral and/or organic constituents of variable thickness, which differ from the parent material in their morphological, physical, chemical, and mineralogical properties and their biological characteristics (Davidson, 1980).

Land mapping unit: is a mapped area of land with specified characteristics. They are defined and mapped by natural resource survey, and form a basis for evaluation.

Major kind of land use: is one of the few major sub-divisions of rural land use, such as rainfed agriculture, irrigated agriculture, extensive grazing, forestry and recreation.

Land utilization type: is any use of the land defined in greater detail than a major kind of land use. It, for example, refers to a specific crop under a specific management system. Factors that should be considered during formulation of land utilization are presented in appendix 7.

Multiple land use: land use consists of more than one kind of uses simultaneously undertaken on the same land, e.g. livestock grazing within a tree-crop plantation.

Compound land use: land use consists of more than one kind of use undertaken on areas of land which are treated in the evaluation as a single unit, e.g. mixed arable-livestock farming.

Land quality: is a complex attribute of land which act in a manner clearly distinct from the actions of most other land qualities in its effluence on the suitability of land for a specific kind of land use.

Land characteristics: are those properties of land that can be measured or assessed without excessive effort e.g. topographical, meteorological and ecological information.

Land suitability: refers to the potential of a land for a defined use or practice, e.g. suitability for carrot growing.

Land capability: refers to the range of uses of a land e.g. for agriculture, forestry, recreational development etc.

Current suitability: refers to the suitability for a defined use of land in its present condition, without major improvements.

Potential suitability: refers to the suitability, for a defined use, of land units in their condition at some future date, after specified major improvements have been completed where necessary.

Minor land improvement: Improvements that have small effect, or less permanent, or do not require large capital investment.

Major land improvement: is one which involves a substantial and reasonably permanent improvement in the qualities of land, and which requires a large capital expenditure.

Prime farmland: is the land best suited for producing food, feed, forage, fibre and oil seed crops, and also available for these uses (the land could be crop land, pasture land, forest land or other land, but not urban built-up land or water).

Unique farmland: is land other than prime farmland that is used for the production of specific high-value food and fibre crops. It has the special combination of soil quality, location, growing season and moisture supply needed to produce sustained high quality and/or high yield of a specific crop when treated and managed according to modern farming methods e.g. citrus, olives and vegetables.

2.4 Functions of land

Land and people are the two most basic resources. But human beings are ever inclined to stress the importance of human resources, so it is important to acknowledge the

essential roles land resources play in supporting our existence and our day-to-day activities (Barlowe, 1986). Lichfield and Drobkin (1980) noted the role of land resources by stating that it is common place for all which makes it unique, in the sense of being significantly different from all other aspects of economic, social and political life and it is a platform for all human activities. According to Young (1998) land comprises all elements of the physical environment to the extent that these influence potential for land use. Thus land not only refers to soil but also includes the relevant features of geology, landforms, climate and hydrology, the plant cover, fauna, including insects and micro fauna associated with diseases.

On the other hand Davidson (1992) indicated that physical results of past human activities, such as vegetation clearance and reclamation from the sea, are included within the concept of land. Unfavourable consequences from past use, such as eroded soils and degraded vegetation, must also be included. Economic and social features, however, whilst taken into account in evaluation procedures, are not part of land.

The first use of land which comes to mind is as a means of production for agricultural and forestry, together with urban settlement. But according to Young (1998) and FAO (1999), there are a number of functions which land can offer to human society, putting the production first, these functions are as follows:

I. Production based on plant growth: production of food, animal fodder, fibres, timber and fuel-wood, by means of agriculture, forestry and fresh water fisheries.
II. Regulating of the storage and flow of surface water and groundwater.
III. Conservation of bio-diversity and habitats: ecosystems, plant and animal species and genetic resources.
IV. Storage and ongoing supply of non-renewable resources: fuels, minerals and non-biotic raw materials.
V. Functions related to human activities: housing, industry, transport and recreation.
VI. Waste disposal: receiving, filtering and transforming the waste products of settlement.

VII. The heritage function: preserving natural sites of interest and beauty and evidence of cultural history

Some of these functions seem to be mutually exclusive, but even in apparently single-purpose uses, there is a degree of multiple function e.g. cereal crop production contribute to atmospheric and hydrological regulation, urban areas include appreciable areas of trees, grass and crop and animal production.

2.5 Principles of land evaluation

The objective of land evaluation is to judge the value of an area for defined purposes. For evaluation to be based on some common line it is necessary to develop a certain kind of guideline. To help this the FAO Framework (1976) established six main principles that should be followed during evaluation for a specific use. These are:

1. *Land suitability is assessed and classified in relation to a particular land use*. This principle recognises that land uses vary in their requirements so that a field highly suitable for one crop may be unsuitable for another.
2. *Evaluation requires a comparison of the input needed and output obtained on different types of land.* This could be done by comparing the costs of production with the economic returns of different types of land.
3. *A multidisciplinary approach is required.* Contributions from such specialists as crop ecologists, agronomist, pedologists, climatologists, economists and sociologists are vital in order to make a comprehensive and sound assessment of land suitability for a specified use.
4. *The evaluation is made with careful reference to the physical, economic and social context of the area under consideration.* It is fairly obvious that any land use proposal has to be realistic for an area. It is important to take into account such factors as cost of available labour and skills of the labour force and the environmental impact of any change and acceptability by the community.
5. *Suitability refers to use on a sustained basis*. The proposed use of land must not result in its degradation through processes such as wind erosion, water erosion or salinization.

6. *Evaluation involves comparison of more than a single kind of use*: The comparison could be between different land uses or between individual crops. Sometimes it includes comparing the existing practice with the proposed new land use. Evaluation is only effective if benefits and inputs from any given kind of use can be compared with a least one, and usually several different alternatives. This is because, if only one kind of use is considered, there is a problem that, whilst the land may be suitable for that use, some other and more important use may be ignored.

2.6 Purposes of land evaluation

According to Dent and Young (1981), the major purpose of land evaluation is to predict the consequences of change. For instances if a farmer is already growing maize or barley, he can simply assess the production from records of his own costs, yields and returns without formal evaluation procedures. Land evaluation becomes necessary where the change is contemplated. These may include change in kind of use, such as bringing into production land formerly under natural vegetation or establishing a recreational park; or it may be the introduction of new technology, such as supplementary sprinkler irrigation, the introduction of mechanized farming in areas of manual and animal labour. Prediction is needed of the suitability of the land for different forms of production, the inputs and management practices needed, the production or other benefits, and the consequences of such changes upon the environment. These include adverse consequences, such as the warning that certain land should not be cultivated owing to a severe hazard of soil erosion. McRae and Burnham (1981) cited the example of the United States where all soil survey reports present yield predictions for the crops commonly grown in each map unit.

2.7 Types of land evaluation

The results of land evaluation may be presented in terms of qualitative, quantitative physical, or economic.

2.7.1 Qualitative land evaluation

This is one way in which the result of land evaluation is expressed and according to Singer, Tanj and Snyder (1978), it results in the ranking of the land areas for specific use. The suitability of land for alternative purposes is expressed in qualitative terms only, such as highly suitable (S1), moderately suitable (S2) or marginally suitable (S3) or not suitable (N) for a specific use. Economic considerations are necessarily present as a background to differentiate the boundary. There are, however, no calculations based on specific costs and prices, although the boundary between land assessed as suitable and not suitable for a given purpose is set what is roughly estimated to be that between profit and loss.

Qualitative evaluation is used mainly in surveys at a reconnaissance scale, or as a preliminary to more detailed investigations and these help to indicate the general potential of the land for a specific use (Rossiter, 1994).

2.7.2 A quantitative physical evaluation

This is used to provide quantitative estimates of the production or other benefits to be expected, e.g. crop yield, beef or poultry production, rates of timber growth etc. To achieve this it is necessary to specify the inputs also in quantitative forms, e.g. tonnes of fertilizer, man-days of labour, pesticide treatments. Some approximate calculations of costs and prices are often made, in order to decide appropriate levels of inputs on which to base the estimates. Quantitative physical evaluation is most frequently carried out as the basis for economic evaluation. The shortcoming with this type of evaluation is that it does not normally supply a basis for comparison between different forms of production (Dent and Young, 1981).

2.7.3 Economic evaluation

This is purely economic which deals with profit and loss, for each specified enterprise on each kind of land. Specific money values are applied to data from quantitative physical evaluation, thereby obtaining the cost of inputs and value of production. It should be stressed, however, that an economic evaluation is by no means exclusively

confined to considerations of profit and loss. Other consequences, e.g. environmental and social, are also set out among the results, to be combined with the economic data as a basis for taking decision (McRae and Burnham, 1981). Figure 2.1 can be used to explain the process of economic land evaluation in a very simple way.

Input/output prices have a direct effect over economic evaluation. E.g. the increase in costs of input (e.g. fertilizer) can make an area to be currently not suitable (N1). On the other hand the price increase of some inputs (e.g. coffee) can transfer currently not suitable (N1) land to marginally suitable (S3) land. This is because the boundary between S3/N1 is purely economic (Rossiter, 1994). Therefore, economic evaluation needs to be updated with the current input and output costs.

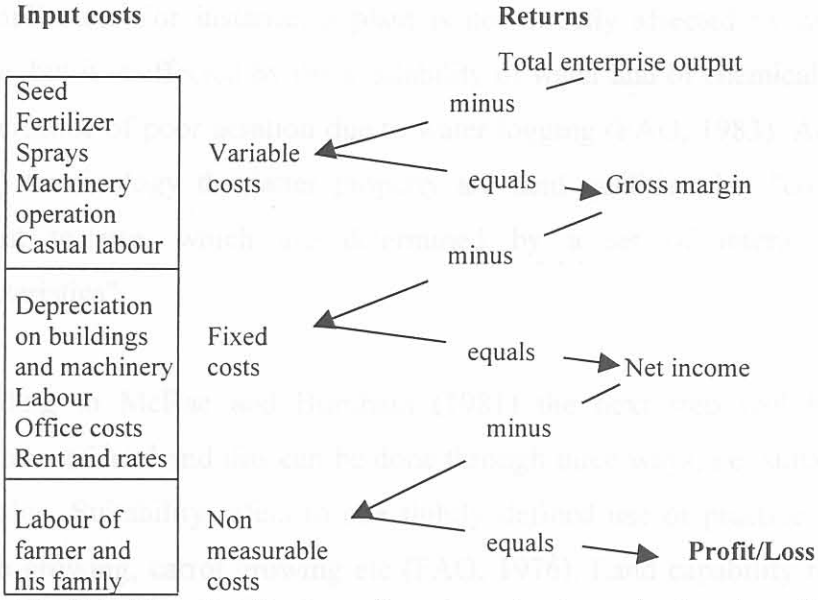

Fig 2.1: The distribution of costs and returns in farming (from McRae and Burnham, 1981)

2.8 Methods and strategy of land evaluation

2.8.1 Methods of land evaluation

Land may be evaluated **directly**, by trials i.e. by growing the crop and measuring the results. Strictly speaking, this type of evaluation is applicable only to the specific trial sites and for that particular use. Direct evaluation is of limited value unless the evaluator has the resources to collect a large amount of data. Most of the time existing data are always biased and tend to be inadequate and they are open to challenge. Thus

most land evaluation systems are **indirect**, they assume that certain soil and site properties influence the success of a particular land use in a reasonably predictable manner, and that the quality of land can be deduced from observations of those properties (McRae and Burnham, 1981).

Indirect land evaluation has six steps, representing successive interpretative stages (Figure 2.2) (McRae and Burnham, 1981). The first interpretative stage must ascertain which land properties are likely to be relevant and can be measured or assessed without excessive effort, and then to measure or assess them, such properties are called land characteristics. Data concerning these are collected from soil surveys, including topographical, meteorological and ecological information.
The effect of these land characteristics on systems of land use is seldom direct and uncomplicated. For instance, a plant is not directly affected by rainfall or by soil texture, but it is affected by the availability of water and of chemical nutrients and by the incidence of poor aeration due to water logging (FAO, 1983). According to FAO (1976) terminology the latter property are land qualities, i.e. "complex attributes, relevant to use, which are determined by a set of interacting single land characteristics".

According to McRae and Burnham (1981) the next step will be to assess the usefulness of land and this can be done through three ways, i.e. suitability, capability and value. Suitability refers to one tightly defined use or practice, e.g. suitable for banana growing, carrot growing etc (FAO, 1976). Land capability refers to range of uses, e.g. for agricultural, forestry or recreational development (Davidson, 1981). The concept value involves a monetary or similar basis. The final step and the end product of indirect land evaluation is a decision on optimal land use, whether private "shall I plant an banana in this field?" or public "On which site shall we build this new factory"?

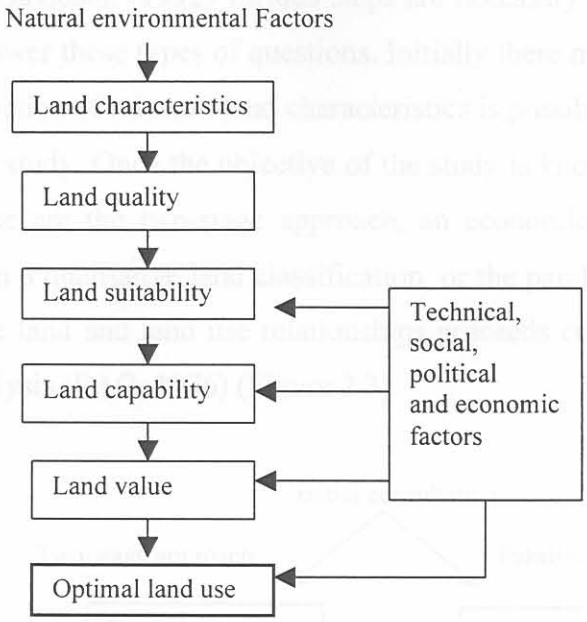

Fig 2.2 The stages in indirect land evaluation (from McRae and Burnham, 1981)

2.8.2 Approaches to land evaluation

FAO framework (1976) proposes that any land evaluation project should be able to answer questions of the following type:

1. How is the land presently managed, and what will happen if present practices do not change?
2. What improvements in management practices, within the present use, are possible?
3. What other uses of land are physically possible and economically and socially acceptable?
4. Which of these uses offer possibilities of sustained production or other benefits?
5. What negative effects i.e. physical, economic or social are associated with each use?
6. What kinds of inputs are necessary to bring about the desired production and reduce the adverse effects?
7. What are the benefits of each forms of land use?

According to Davidson (1992) various steps are necessary in order for an evaluation exercise to answer these types of questions. Initially there must be a clear objective of the study. Selection of relevant land characteristics is possible only with in the context of a particular study. Once the objective of the study is known, two approaches could be used. These are the two-stage approach, an economic and social analysis may follow on from a qualitative land classification, or the parallel approach, in which the analysis of the land and land use relationships proceeds concurrently with economic and social analysis (FAO, 1976) (Figure 2.3).

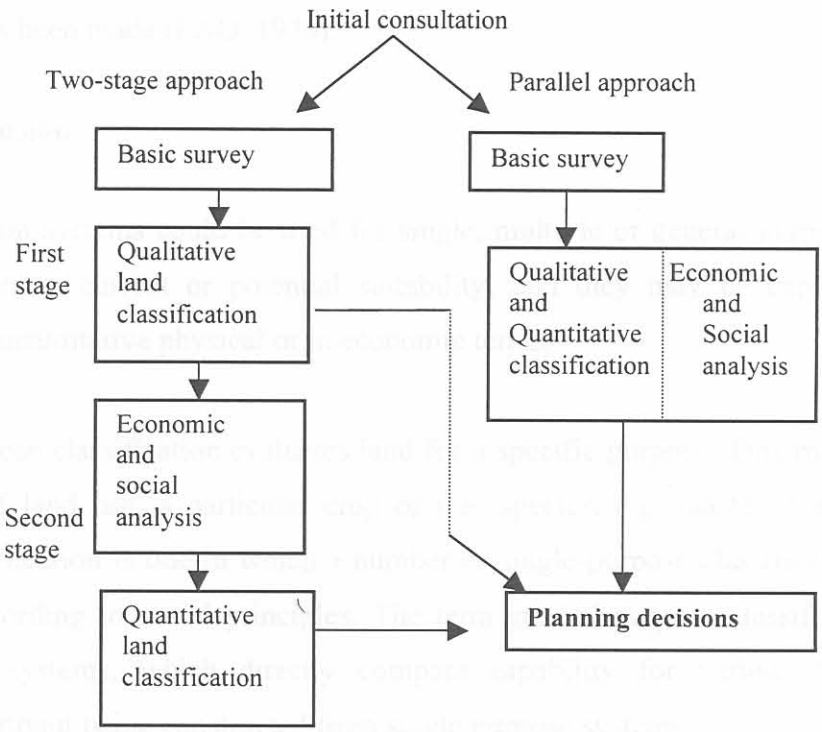

Fig 2.3 Two-stage and parallel approaches to land evaluation (from FAO, 1976)

2.8.3 Levels of intensity

Three levels of intensity are distinguished i.e. reconnaissance, semi-detailed and detailed. These are usually reflected in the scales of resulting maps (Young, 1976).

Reconnaissance surveys deals with broad inventory of resources and development possibilities at regional and national level (Dent and Young, 1981). Evaluation is

qualitative with very general economic analysis. The result from this type of survey leads to selection of development areas and priorities at national scale.

Surveys at the semi-detailed, or intermediate, level are concerned with more specific aims such as feasibility studies of development projects (FAO, 1976). Land evaluation is mostly quantitative. This level provides information for decision on the selection of projects, or whether a particular development project or other change is to go ahead. On the other hand detailed level covers surveys for actual planning and design, or farm planning and advice, usually carried out after the decision to implement has been made (FAO, 1976).

2.9 Conclusion

Land evaluation systems could be used for single, multiple or general purpose; they may also refer to current or potential suitability; and they may be expressed in qualitative or quantitative physical or in economic terms.

A single-purpose classification evaluates land for a specific purpose. This might be a major kind of land use, a particular crop or tree species, e.g. maize. A multiple-purpose classification is one in which a number of single-purpose classifications are combined according to stated principles. The term general-purpose classification is reserved for systems, which directly compare capability for various land use alternatives without being constructed from single purpose systems.

Current land suitability is the potential of land in its present condition, with recurrent inputs (e.g. fertilizer) and minor land improvements (e.g. stone clearance) but without major improvements. Potential land suitability is the potential of the land at some future date that is after major improvements have been carried out.

Major land improvements are those which need a substantial non recurrent input of capital, which can rarely be financed or executed by an individual farmer, and which would cause a significant and reasonably permanent change to the land characteristics, e.g. drainage, reclamation, and irrigation. On the other hand, minor

land improvements can be financed by the individual farmer from his own resource or short-term loans and cause no substantial permanent change e.g. bush clearance or simple soil conservation works.

Qualitative land evaluation systems give the suitability of land in general physical terms. It specifies the inputs and the production from the forms of land use under consideration; economic conditions are taken into account but as a general background only. Economic evaluation systems assess land suitability in terms of costs of inputs and value of production. In the next chapter attempt will be made to distinguish between suitability and capability classifications. The most important factors that need to be considered during the process of land evaluation will also be discussed.