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DEPARTMENT OF AGRICULTURAL ENGINEERING

24AG402 SOIL AND WATER CONSERVATION ENGINEERING

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2.41 Land Use and Capability Classification

The land in any place is used for several purposes such as crop and livestock production, forestry, housing, recreation, residential areas, markets, roads, railways etc. The most desired way of using a particular land is possible when one can understand the type of the soil in the land capability classification which gives complete information regarding various parameters based on which classification is done.

2.42 Soil Use and Land Capability Classification

Land capability classification is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deterioration over a long period of time. Land capability classification is subdivided into capability class and capability subclass. Important factors on which the classification is based are:

1. The soils are well managed and cropped under a mechanized system.
2. Land requiring improvements including clearing that can be possible by the farmer with his own means is classed according to its limitations or likely hazards due to its use after the improvements are made. Land requiring improvements beyond the means of the farmer himself is classed according to its present condition.
3. Other factors like distances to markets, kind of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators and hazard of crop damage by natural calamities like storms are not considered.

The classification does not include capability of soils for trees, tree fruits, small fruits, ornamental plants, recreation or wildlife. The classes are based on intensity, rather than kind of their limitations for agriculture. Each class includes many kinds of soil and many of the soils in any class require different management and treatment.

2.43 Land Capability Classes and their Characteristics

In this classification the mineral soils are grouped into seven classes on the basis of soil survey information. Soils classes as 1, 2, 3 and 4 are considered capable of sustained use for cultivated field crops, those in classes 5 and 6 only for perennial forage crops and those in class 7 for neither.

Class 1 - Soils in this class have no significant limitations in use for crops. The soils are deep, well to imperfectly drained, hold moisture well, and in the virgin state were well supplied with plant nutrients. They can be managed and cropped without difficulty. Under good management practices, they are moderately high to high in productivity for a wide range of field crops.

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The soils are deep and hold moisture well. The limitations being moderate, the soils can be managed and cropped with a little difficulty. Under good management practices, they are moderately high to high in productivity for a fairly wide range of crops.

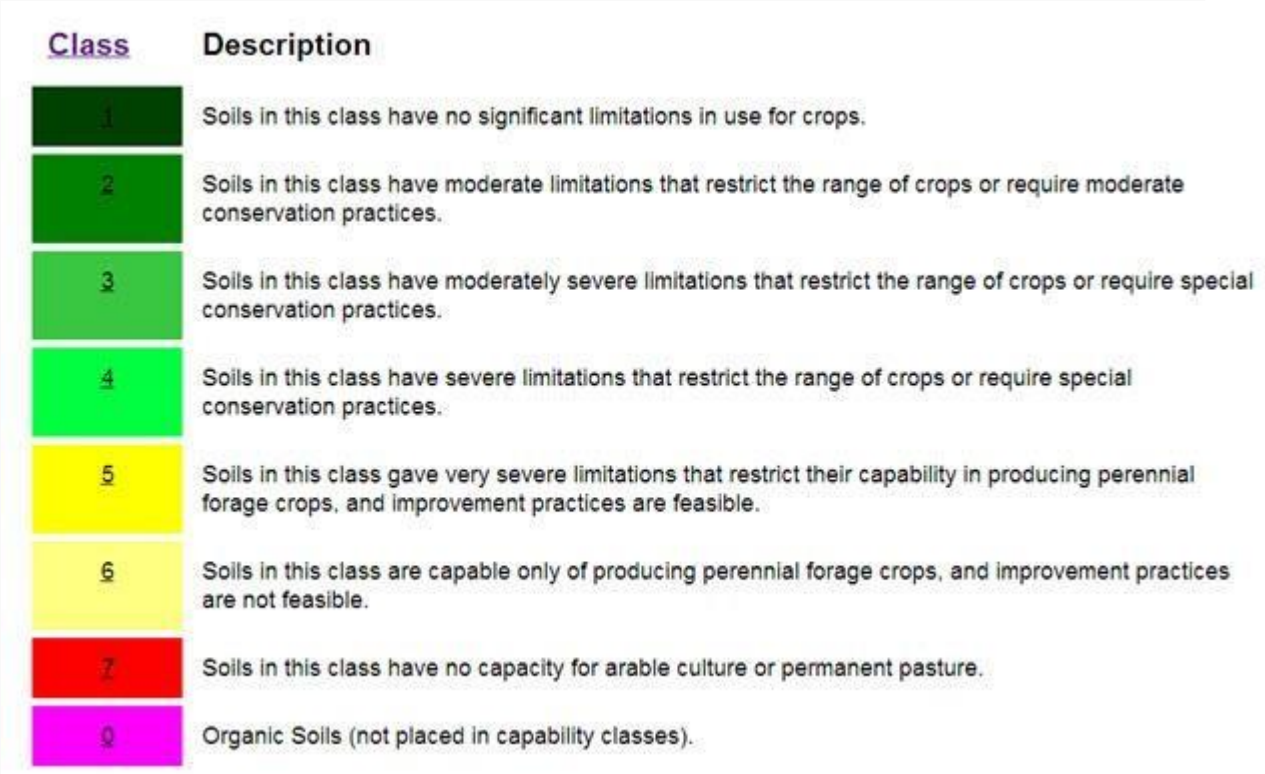

Fig. 25.1. Land Capability Classes. (Source: Dhillon, 2004)

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. The limitations are more severe than for class 2 soils. They affect one or more of the following practices: timing and ease of tillage, planting and harvesting, choice of crops, and methods of conservation. Under good management they are fair to moderately high in productivity for a fair range of crops.

Class 4 - Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both. The limitations seriously affect one or more of the following practices: timing and ease of tillage, planting and harvesting, choice of crops and

methods of conservation. The soils are low to fair in productivity for a fair range of crops but may have high productivity for a specially adapted crop.

Class 5 - Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops and improvement practices are feasible. The limitations are so severe that soils are not capable of use for sustained production of annual field crops. The soils are capable of producing native or tame species of perennial forage plants and may be improved by the use of farm machinery. The improvement practices may include clearing of bush, cultivation, seeding, fertilizing and water control.

Class 6 - Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. The soils provide some sustained grazing for farm animals, but the limitations are so severe that improvement by use of farm machinery is impractical. In this class, terrain may be unsuitable for use of farm machinery or the soils may not respond to improvement or the grazing season may be very short.

Class 7 - Soils in this class have no capability for arable culture or permanent pasture. This class also includes rock land, other non-soil areas, and bodies of water too small to be shown on the maps.

Class 0 - Organic soils (not placed in capability classes).

2.44 Land Capability Sub-Classes

Subclass Descriptions: Capability sub-class is the second category in the land capability classification system. It represents the soils physical, chemical or atmospheric limitation due to which the land use is further restricted. These land capability sub-classes can be described as below.

'**c**' Adverse Climate - This subclass denotes a significant adverse climate for crop production as 'median' climate which is defined as one with sufficiently high growing-season temperatures to bring crops to maturity.

'**d**' Undesirable Soil Structure and/or Low Permeability - This subclass indicates soils that are difficult to till or soils where water is absorbed very slowly or where the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

'**e**' Erosion - This subclass includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

'**f**' Low Fertility - This subclass includes soils having low fertility that is either correctable with careful management with the use of fertilizers and soil amendments or is difficult to correct by any practical means. The limitations may be due to lack of plant nutrients, high acidity or alkalinity, low cation exchange capacity, high levels of carbonates or presence of toxic compounds.

'**i**' Inundation by Streams or Lakes - This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

'**m**' Moisture Limitations - This subclass consists of soils where crops are affected by drought owing to inherent soil characteristics. These soils usually have low water-holding capacity.

'**n**' Salinity - Soils of this subclass possess excessive soluble salts which adversely affect crop growth or restrict the range of crops that may be grown.

'**p**' Stoniness - These soils are sufficiently stoney to hinder tillage, planting and harvesting operations.

'**r**' Consolidated Bedrock - This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 90 cm from the surface is not considered as a limitation except on irrigated lands where a greater depth of soil is desirable.

'**s**' Two interpretations were accorded to subclass s. In the case of maps generally prepared before 1969, subclass s was used in place of subclasses d, f, m or n. If two or more of subclasses d, f, m or n are applicable to the same area, then again subclass s may be used. On most of the maps prepared after 1969, the applicable subclass d, f, m or n appear if an area is classified with a single subclass. For areas classified with two or more of the d, f, m or n subclasses, subclass s will appear denoting a combination of subclasses.

'**t**' Topography - This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions affect the cost of farming and the uniformity of growth and maturity of crops as well as creates erosion hazard.

'**w**' Excess Water - This subclass includes soils where excess water other than brought about by inundation is a limitation to agricultural use. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

'**x**' - This subclass is comprised of soils having a limitation resulting from the cumulative effect of two or more of the adverse characteristics.

2.45 Identification of Classes in Field

Soil and climatic limitations in relation to the use, management, and productivity of soils are the basis for differentiating capability classes. Classes are based both on the degree and number of limitations affecting the kind of use, risks of soil damage if mismanaged, needs for soil management and risks of crop failure. It comes from research findings, field trials and experiences of farmers and other agricultural workers. Among the more common kinds of information obtained are soil and water losses, kinds and number of plants that can be grown, weather conditions as they affect the plants and the effect of different levels of management practices on plant response. This information along with the laboratory data on soil profiles is analyzed. Careful analysis of this information proves useful not only in determining the capability of these individual types of soil but also in assessing the suitable use and management of the related soils. Where information on response of soils to management is lacking, the estimates of yields and the grouping of soils into capability units, sub-classes, and classes are based on an evaluation of combinations of the followings:

1. Ability of the soil for plant response due to management practices and use of nutrients as evident by the availability of organic-matter content, ease of maintaining a supply of plant nutrients, percentage base saturation, cation-exchange capacity, clay mineral type, parent material type, available water holding capacity, response to added plant nutrients, or other soil characteristics.

2. Texture and structure of the soil to the depth that influences the environment of roots and the movement of air and water.
3. Susceptibility to erosion as influenced by the kind of soil (and slope) and the effect of erosion on land use and management.
4. Continuous or periodic water logging in the soil caused by slow permeability of the underlying material, a high water table or flooding.
5. Depth of soil material to layers inhibiting root penetration.
6. Salts toxic to plant growth.
7. Physical obstacles such as rocks, deep gullies, etc.
8. Climate (temperature and effective moisture).

Although the soils of any area may differ from one another in only a few dozen characteristics, none can be taken for granted. Extreme deficiencies or excesses of trace elements, for example, can be vital. Any unfavorable fixed or recurring soil or landscape features may limit the safe and productive use of the soil. One unfavorable feature in the soil may so limit its use that extensive treatment would be required. Several minor unfavorable features collectively may become a major problem and thus limit the use of the soil. The combined effect of these in relation to the use, management, and productivity of soils is the criterion for different capability units. Some of the criteria used to differentiate between the capability classes are discussed in the following sections. The criteria and ranges in characteristics suggested assume that the effects of other soil characteristics and qualities are favorable and are not limiting factors in placing the soils in the specific capability classes.

2.46 Arid and Semiarid, Stony, Wet, Saline-Sodic and Overflow Soils

The capability-class designations are assigned to soils subject to flooding, poorly or imperfectly drained soils, stony soils, dry soils needing supplemental water and soils having excess soluble salts or exchangeable sodium on the basis of continuing limitations and hazards after removal of excess water, stones, salts and exchangeable sodium.

The soils are classified into the following kinds on the basis of their existing continuing limitations and hazards:

1. Dry soils (arid and semiarid areas) now irrigated
2. Soils from which stones have been removed
3. Wet soils that have been drained
4. Soils from which excess quantities of soluble salts or exchangeable sodium have been removed
5. Soils that have been protected from overflow.

The soils are classified into the following kinds on the basis of their continuing limitations and hazards as if the correctable limitations had been removed or reduced:

1. Dry soils not irrigated now but for which irrigation is feasible and water is available
2. Stony soils for which stone removal is feasible
3. Wet soils not drained now but for which drainage is feasible,
4. Soils that contain excess quantities of soluble salts or exchangeable sodium feasible to remove

The soils are classified into the following kinds on the basis of their existing continuing limitations and hazards if the limitations cannot be feasibly corrected or removed:

1. Dry soils,
2. Stony soils,
3. Soils with excess quantities of saline and sodic salts,
4. Wet soils,
5. Soils subject to overflow

2.47 Climatic Limitations

Climatic limitations (temperature and moisture) affect capability. Extremely low temperatures and short growing seasons are limitations. Limited natural moisture supply affects the capability in sub humid, semiarid and arid climates. As the classification in any locality is derived in part from the observed performance of crop plants, the effects of the interaction of climate with soil characteristics must be considered. The capability of comparable soils decreases as effective rainfall decreases. In an arid climate, the moisture from rainfall is not enough to support crops. Arid land can be classed as suited to cultivation (class I, II, III or IV) only if the moisture limitation is removed by irrigation. Wherever the moisture limitation is removed, the soil is classified according to the effects of other permanent features and hazards that limit its use and permanence, without losing sight of the practical requirements of irrigation farming.

2.48 Wetness Limitations

Excess water in the soil presents a hazard or limits to its use. Such water may be a result of poor soil drainage, high water table, overflow (includes stream overflow, ponding, and runoff water from higher areas), and seepage. Wet soils are classified according to their continuing soil limitations and hazards after drainage. In determining the capability of wet areas, emphasis is laid on the practices considered practical now or in the foreseeable future.

2.49 Toxic Salts

Presence of soluble salts or exchangeable sodium in amounts toxic to most of the plants can be a serious limiting factor in land use. Where toxic salts are the limiting factor, the following ranges are the general guides until more specific criteria are available:

1. Class II -- Crops slightly affected.

2. Class III -- Crops moderately affected.

3. Classes IV-VI -- Crops seriously affected on cultivated land. Usually only salt-tolerant plants will grow on non-cultivated land. In irrigated areas, even after leaching, severe salinity or large amounts of sodium remains or is likely to recur.

4. Class VII -- Satisfactory growth of useful vegetation is impossible, except possibly for some of the most salt-tolerant forms.

Slope and Hazard of Erosion

The steepness of slope, length of slope and shape of slope (convex or concave) all directly influence the soil and water losses from a field. Wherever available, research data on annual soil loss under given levels of management are used on sloping soils to differentiate between the capability classes.

Soil Depth

Effective depth includes the total depth of the soil profile favorable for root development. In some soils, this includes the C horizon; in a few case only the A horizon is included. Where the depth is the limiting factor, the following ranges are commonly used:

1. Class I, 36 inches (91.44 cm) or more

2. Class II, 20-36 inches (50.8 - 91.44 cm)

3. Class III, 10-20 inches (25.4 - 50.8 cm)

4. Class IV, less than 10 inches (25.4 cm)

These ranges in soil depth between classes vary from one section of the country to another depending on the climate. In arid and semiarid areas, irrigated soils in class I are 60 inches or more in depth.

Previous Erosion

On some kinds of soils, previous erosion reduces crop yields and the choice of crops materially; on others the effect is not great. The effect of past erosion limits the use of soils (1) where subsoil characteristics are unfavorable or (2) where soil material favorable for plant growth is shallow to bedrock or material similar to bedrock. Therefore, in some soils, the degree of erosion influences the capability grouping.

Available Moisture-Holding Capacity

Water-holding capacity is an important quality of soil. Soils that have limited moisture-holding capacity are likely to have limitations in variety of crops that can be grown. They also present fertility and other management problems. The ranges in water-holding capacity for the soils in the capability classes vary to a limited degree with the amount and distribution of effective precipitation during the growing season. Within a capability class, the range in available moisture-holding capacity varies from one climatic region to another.