

# **RAINFED AGRICULTURE CROP SUITABILITY FOR TANZANIA**



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## 1: Background

Crops Suitability commonly referred to as Land Evaluation is a term used to **define** an approach for rating relative quality of land resources based upon specific measurable features such as pH, rainfall, altitude and temperature etc and matching the rated land quality with crop requirements. The formulation of this assignment came about from The National Leaders' Organized Consultative Seminar which asked for provision of suitability maps at national and district levels, to serve as planning tools for District Leaders.

Suitability assessment for Tanzania was based on Agroecological zones mostly considering several land qualities which mostly influences crop adaptation and sound growth. The land qualities were soil pH, drainage, temperature, rainfall and altitude above sea level and length of dependable growing period (DGP). This report provides detailed instructions on how to utilize the suitability at National and district levels by indicating the agroecological zone, its characteristics and the crops which are suitable to be grown.

## 2. Approach to Crop Suitability

Crop suitability was carried out in three major activities. One of the activity involved grey literature covering different books on tropical crops. This covered crops' requirements in term of soil pH, air temperature, and amount of rainfall during the growing period. It also covered appropriate altitude above sea level for each crop, drainage requirements and the length of growing crop during the growing period.

Second activity was extracting 'agroecological zones' data and organized it in the GIS database and scrutiny of all available land qualities in various AEZ in the country. The sources of data were Agroecological zones and Soils and Physiography by De Pauw (1983 and 1984). The GIS database (ArcView) structure composed of several columns the mandatory ones for the systems like identification number or code and attributes codes which covered Agroecological zone code, Physiography description, altitude in metres above sea level, minimum temperature, maximum temperature (in centigrade Celsius) total rainfall per year (mm) moistures storage capacity and dependable growing period. Other land qualities covered were rainfall pattern (mono-modal and bimodal), and lastly soil pH. The last column in the database composed of crops that accept the existing land qualities.

## 3. Description of some land qualities

The *land qualities* used to match *crop requirements* to arrive to suitability is briefly discussed below.

### 3.1 Soil pH

Is a measure of acidity (hydrogen ion concentration). The pH values range from 0 to 14: 0 is most acidic, 7 is neutral, and 14 is most basic (lowest hydrogen ion concentration).

Soil pH values in Tanzania range from 4 to 10. Both extremes pose some limitations to crop production.

### **3.1.1 Effect of pH on nutrient availability**

Extremes of soil pH release substances from soils in amounts that can be toxic to plants. Acid soils may dissolve toxic amounts of metals (such as aluminum and manganese). Alkaline soils may accumulate salts and sodium carbonates in toxic concentrations that can alter soil structure, thereby making it difficult for roots to grow. Stunted root systems have trouble taking up adequate water and nutrients. Toxic metals in acid soils, subsoil nutrient depletion, and subsoil clay pans also stunt root growth.

Slightly acidic soils (pH of 6.5) are considered most favorable for overall nutrient uptake. Such soils are also optimal for nitrogen-fixing legumes and nitrogen-fixing soil bacteria. Some plants are adapted to acidic or basic soils due to natural selection of species in these conditions. Potatoes grow well in soils with pH <5.5 while cotton, garden pea, and many grasses grow well in alkaline soil (>7.5).

Soil pH also affects the soil in other ways. For example, soil microbe activity; particularly nitrogen-fixing bacteria may be reduced in acid soil.

Soil acidity is managed by adding lime (carbonates of calcium and magnesium).

### ***3.2 Drainage***

This refers to the rapidity and extent that water is removed from a soil by surface runoff, underground flow through the soil, and evaporative loss. Drainage also refers to soil drainage status the frequency and duration with which soil is waterlogged. If drainage is very rapid, the soil is excessively drained. If drainage is very slow, the soil suffers from excessive water-logging and is very poorly drained.

Soil drainage extremes present the same types of problems for crops that extremes of soil pH do. Excessively drained soils do not provide most crops with adequate water and nutrients, and the structure of the soil limits root growth. Water and nutrient availability are also limited in poorly drained soils because oxygen deficiency limits the ability of roots to take up adequate water and nutrients. With water-logging, decaying sets in. decaying occurs when partially decomposed organic matter accumulates, clogging soil pores and blocking root growth and the drainage of water through soil. Decaying or putrefaction produces toxic substances: reduced nitrogen, sulfur, metals, and organic fermentation products. Furthermore, it produces methane; a gas that attacks the atmosphere's self-cleansing system.

In Tanzania drainage problems are principally limited to few valley bottoms and during rainy seasons which does pose threat in most areas. Ditching and subsurface tiling typically improve drainage. With improved drainage, excessive organic matter is destroyed due to decomposition by oxidation rather than putrefaction.

### *3.3 Temperature*

Temperature affects the amount of water a crop requires, and the rate of physical and chemical reactions that determine a crop's rate of growth and development.

Water evaporates (transpires) through leaf openings (stomates) that permit carbon dioxide to enter and oxygen to exit the plant. As much as 99% of the water "used" by a plant simply travels through the plant, entering the roots and exiting through the stomates. Increasing air temperature, accompanied by reduced air humidity, generally increases evapotranspiration. By definition, evapotranspiration is the water lost by evaporation from the soil surface, and transpiration of water from a plant's leaves. When there is insufficient water in the soil to meet the evapotranspiration demand, the plant wilts. Plants conserve water by closing stomates when humidity is low. The threshold at which stomates close varies among crops. When stomates close, transpiration is reduced as well as the entry rate of carbon dioxide, which results in a reduction of the rate of photosynthesis.

Generally, physical processes (e.g., diffusion rates) and chemical reactions that control life and growth increase with temperature. The rate of chemical reactions and the enzyme activities that catalyze chemical reactions function most efficiently at crop-specific optimum temperatures. The basic plant processes of respiration and photosynthesis are examples of temperature affecting chemical reactions (respiration) and physical reactions (photosynthesis).

Respiration is the process of "burning" sugar to release stored chemical energy that powers the cellular activities required to maintain the health of a plant, and to increase the size of the plant. Respiration tends to increase directly with temperature.

Photosynthesis, on the other hand, accumulates energy using sunlight to transform carbon dioxide and water into sugar and oxygen; it is not as directly related to temperature. The rate of photosynthesis in maize, for example, plateaus at about 86°F (30°C). Although warmer conditions increase the diffusion rate of water out of and carbon dioxide into the leaves, the physical process of trapping light, a process that is not sensitive to temperature changes, limits photosynthesis rates. Generally, solar radiation intensity is more limiting than the diffusion rate in well-watered plants. However, high air temperatures and low air humidity also may limit photosynthesis by slowing the rate of carbon dioxide diffusion into the leaves of water-stressed plants with closed stomates.

High air temperatures and low air humidity may limit photosynthesis by triggering stomates to close, reducing the diffusion of carbon dioxide into the leaves of water-stressed plants.

Raw materials and resulting products of photosynthesis are the same for all plants. However, differences exist in the pathways that produce the photosynthetic products. Plants use one of several pathways to link and store carbon dioxide in photosynthesis. Briefly, "C3 plants" use the most common and the least efficient method. The C3 plants

generally originate from temperate regions and photosynthesis is optimized at temperatures from 59-86°F (15-30°C). Certain grasses (corn, sorghum and sugarcane) and other crops (cotton) use the more efficient “C4” pathway of accumulating carbon dioxide. The C4 plants generally originate from tropical regions, and photosynthesis is optimal at temperatures from 68-95°F (20-35°C). “CAM” plants, such as pineapple, save water by collecting carbon dioxide during cool nights and storing it until daylight when chloroplasts use sunlight to complete photosynthesis.

Growth depends on the combined and coordinated chemical reactions of photosynthesis and respiration and many other biochemical reactions, each with its own optimum temperature. The combination of these different optimum temperatures for the many biochemical reactions results in crops having unique optimum temperatures for growth. Optimum temperatures indicate the upper and lower temperature limits at which a crop grows best. Absolute temperatures mark the temperatures at which growth ceases until temperatures return to more favorable conditions, or the plant will die if the temperatures remain outside the absolute temperature range for a long enough period. Upper and lower optimum and absolute temperatures are called cardinal temperatures and vary from crop to crop. For example, wheat, a C3 plant, will flourish in low temperatures that suspend or retard growth in corn, a C4 plant.

### *3.4 Rainfall*

Rainfall refers to the liquid form (rain) that provides the water needed for crops to grow. Realizing that 85% or more of a plant may be water, it is easy to understand the importance of rainfall in crop growth and development. Drought the condition when precipitation fails to meet crop needs and floods excessive precipitation can be disastrous.

An area’s precipitation often is reported as an annual average. This statistic, although helpful, is incomplete when comparing an area’s precipitation to crop water needs. If 800 mm of rain falls during a period when the crop is not growing, without any additional rainfall, the annual average precipitation would be 800 mm. Although technically meeting the annual rainfall requirement for many common crops, this 800 mm of rain likely would not meet the crop’s water demand.

A crop’s water requirement changes during its life cycle. For most crops, water requirements are modest during early growth. Soil water content during germination and early growth is critical. Once the seed coat ruptures and the radicle (root) and plumule (shoot) emerge, the plant cannot return to seed dormancy. If the germinating seed does not receive ample water, it will die. Too much water will displace air containing needed oxygen in the soil, and the plant will suffocate. Water needs increase with increased growth and leaf area. For the many crops harvested as fruits or seeds, meeting water needs during reproduction and grain fill is critical.

Causal organisms associated with plant diseases also have specific environmental needs, some of which are related to precipitation. High humidity, flooding, and drought may

promote the development of specific infectious agents and the spread of their associated diseases.

The map at the right shows the average annual precipitation in Tanzania. The general pattern is increasing annual rainfall from 400 millimeters or mm in Central part of the country to 2500 mm in highlands.

Altitude refers to the height of things above a reference level, especially above sea level or above the earth's surface. Altitude influence some crops flowering and hence fruting and or quality. For example cashew, coconut, cow pea and cacao are low altitude crops. Some crops grow at low altitude because they need high temperatures, and some are just sensitive to high altitude such that when grown in high altitude does not produce fruits. Crops like pyrethrum, tea grown in high altitude and their quality are altitude determined. There diversity of altitude in Tanzania ranging from below sea level in Lake Tanganyika to the top of Mount Kilimanjaro which lies above 5,895 metres above seas level.

Within this diversity, various crops grow well from sea level to the foot slopes of high Mountains and hills.

#### 4. RAINFED AGRICULTURE - CROP SUITABILITY MATRIX IN TANZANIA

COAST PLAINS								
AEZ CODE	SUB ZONE -AREA (Sq-Km)	pH (H <sub>2</sub> O)	Temperature (°c)	Soils and Topography	Altitude (m)	Rainfall mm/Year	Length of Growing Period and Soil Moisture Properties	Suitable Crops
CI	8,783	5-7	29-31 19-23	Nearly level to rolling plains of slope range 0-10%, developed on Quaternary, Neogene, Jurassic and Cretaceous sediments. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure, and very low natural fertility; and moderately well to imperfectly drained, shallow to deep usually calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and moderate natural fertility.	< 200	1000-1200	2 dependable growing periods (DGP) per year. Variation of DGP length as function of soil moisture storage capacity and crop rooting habits. Duration is 3-4 months. Main DGP is March-April, while the secondary DGP is October – November. The zone has deep sandy soils with low AWC (30-80 mm/m) and moderate soil depth (1-2m). Poor to moderate moisture storing capacity (Smax 50-150mm)	Cashew, coconut, mangoes, cassava, simsim and passion fruit. Finger millet sorghum, cow pea, pigeon pea, sweet potato, citrus, cow pea, sisal, jatropha. Early maturing maize varieties grown in soils with high moisture storing capacity. Suitable for tropical grasses
C2	27,900	5-7	29-31 19-23	Nearly level to gently rolling plains and plateaux, slopes ranging from 0-10%, developed on Quaternary, Neogene, Jurassic and Cretaceous sediment. Soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in subsoil and poor structure and with very low natural fertility; and moderately well to imperfectly drained, shallow to deep usually calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and moderate natural fertility.	< 500	800-1000	One DGP per year with duration of 3-4½ months, with variation of 3-4 weeks depending soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Soils have moderate to high AWC (80-150 mm/m) and favourable moisture storing characteristics (Smax 150-350 mm).	Cashew, coconut, mangoes, cassava, simsim, sorghum, cow pea, pigeon pea, sweet potato, passion fruit, finger millet, sisal, jatropha. Early maturing maize varieties grown in soils with high moisture storing capacity. Suitable for tropical grasses
C3	6,310	5-7	29-31 19-23	Strongly dissected uplands and rolling to steep hills, slope range of 10-45%, developed on Jurassic, sandstones, shales, limestones, Paleogene limestone and marls and Neogene sandy clays. Soils are mainly well drained, moderately deep to deep, reddish and yellowish sandy clay loams and sandy clays, often with more sandy topsoils, with weak structure and low natural fertility; and complex of rock outcrops, surface ironstone, very stony and very shallow soils; and important proportion of moderately well to imperfectly drained, shallow to deep, usually calcareous, black,	<500	800-1000	One DGP per year with duration of 3-4½ months, with variation of 3-4 weeks depending soil moisture storage capacity and crop rooting habits. Unreliable onset dates  Soils in the zone are characterised to be of low to moderate AWC (80-100 mm/m) and poor to moderate moisture storing properties (Smax 50-150 mm) according to rainfall acceptance.	Cassava, mango, cashew and coconut sorghum, cow pea, sweet potato, passion fruit cow pea, pigeon pea, sisal, jatropha  Different types of tropical grasses

				dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and moderately high natural fertility.				
C4	4,450	5.5-7	29-31 19-23	Flat, low altitude riverine floodplains (84%) and deltas (16%) with spatially and temporally varying flooding regimes and sedimentation patterns; mainly covered by young alluvial soils with variable drainage and flooding conditions. Dominant soils are well to moderately well drained, deep, brownish fine sands to sandy clay loams with high textural variability over short distances and highly stratified with more sandy or more clayey layers; and imperfectly to poorly drained, deep, (dark) grey, or grey brown clays, sandy clays or clay loams often mottled and usually with more sandy horizons within the profile and moderate toposoil structure, with high natural fertility; and imperfectly to poorly drained, deep, coarse almost pure bleached sands often with finer texture overly usually with poor natural fertility	<200	1200-14000	Growing period mainly determined by flooding regime.  The zone moisture characteristics is influenced by flood regimes, drainage variability,	Rice, sugar cane and maize, finger millet, Sorghum, cow pea, pigeon pea, sweet potato, cotton, mango, passion fruit, cow pea , pigeon pea, sisal. Mainly after flooding and by irrigation.  Setaria grass, Rhodes grass, Andropogon spp., other pasture grasses and legumes.
C5	8,569	5-7	29-31 19-23	Flat to gently undulating plains, slope range 0-3% developed on old alluvial terrace no longer flooded. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in subsoil, weak structure and very low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with weak structure and very low natural fertility; and imperfectly to poorly drained due to flat topography and ponding above ironstone pans in subsoil (0-7 to 1.5 m deep) which prevent deep percolation and are able to maintain perched water tables stable enough rice cultivation.	< 200	1000-1200	One dependable growing period per year with duration of 3-4½months. Mainly covered by deep, medium to heavy textured soils with moderate to high AWC (80-150 mm/m) and favourable moisture storing properties (Smax 150-350 mm). Topographical favours runoff additions and promote flood risk.	Maize, rice, cashew, sugar cane, sorghum, cow pea, pigeon pea, sweet potato, cotton, mango, passion fruit, cow pea, pigeon pea, sisal.  Setaria grass, Rhodes grass, Andropogon spp., other pasture grasses and legumes.
C6	1,227	5-7	29-31 19-23	Nearly level to undulating and rolling plains developed on Neogene and Quaternary limestone, sandstones, marls, sands, clays. Soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in subsoil, weak structure and very low natural	<100	1600-2000	Long growing periods (5-10 months) depending on crop rooting habits and soil moisture storage characteristics. Onset dates are reliable. The physiographic units has low AWC (30-80 mm/m) and poor to moderate moisture storing capacity (Smax 50-150mm) but dry conditions are	Cassava, sugar cane, citrus, cloves, coconut, rubber, oil palm, simsim, soya bean, castor, passion fruit, sweet potato, ground nut, pine apple, mango, cow pea, pigeon pea, sorghum, sisal, maize,  Many types of tropical grasses and legumes.

				fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands but with more clayey or stratified subsoils (sandy loams to sandy clays) with weak structure, somewhat higher organic matter content and very low natural fertility; and windblown sands patterned into dunes stabilized by vegetation.			minimized by long rainy season.	
C7	2,132	5-7	29-31 19-23	Nearly level to undulating and rolling plains developed on Neogene's and Quaternary limestone, sandstones, marls, sands, clays. Soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in subsoil, weak structure and very low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands but with more clayey or stratified subsoils (sandy loams to sandy clays) with weak structure, somewhat higher organic matter content and very low natural fertility; and windblown sands patterned into dunes stabilized by vegetation.	< 100	1400-1600	Two dependable growing periods (DGP), duration of 4-5 months for the main growing period with reliable onset dates and 1½ to 2½ for the secondary growing period with unreliable onset dates. Soil moisture properties same as C6.	Cassava, sugar cane, citrus, cloves, coconut, Sisal, rubber, oil palm, simsim, soya bean, castor, passion fruit, sweet potato, Ground nut, pine apple, mango, cow pea, pigeon pea, sorghum.  Many types of tropical grasses and legumes

### EASTERN PLATEAUX AND MOUNTAIN BLOCKS

EI	34,934	5-7	27-30 15-18	Mainly well drained, gently undulating to rolling plains and plateaux with altitude variability, developed on gneissic rocks, includes some poorly drained, flat and wide topographical depressions developed on young alluvium. Dominant soils are well drained, moderately deep to deep, dark reddish brown, yellowish red or red sandy clay loams and sandy clays with weak or moderate structure and low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with poor structure with very low natural fertility.	500 - 1200	400-500	One DGP per year with duration of less than 2 month, varying by less than 1 week in response to soil moisture storage properties and crop rooting habits. Onset dates are very unreliable. Soils are medium to heavy textured with moderate AWC (70-120mm/m) and poor moisture acceptance to due to surface sealing (Smax 40-60mm)	Pastures (grasses and legumes) strictly considering land carrying capacity  Carrying capacity 2 Livestock Unit per sq. km.
E2	39,134	5-7	27-30 15-18	Mainly well drained, gently undulating to rolling plains and plateaux, altitude 500-1200 m developed on gneissic rocks. There are poorly drained flat wide topographical depressions developed on young alluvium. Sloppy areas are strongly dissected, often rocky and severely eroded. Dominant soils	500-1200	<500 in some areas 800-1000	One DGP per year with duration of 2 - 2½ months varying by less than 2 weeks in response to soil moisture storage capacity crop rooting habits. Unreliable onset dates. Soils are medium to heavy textured with moderate to high AWC (AWC 80-150 mm/m) but with poor moisture acceptance	Sorghum, hyacinth bean (Lablab purpurens) Pastures (grasses and some legumes), sisal

				are well drained, moderately deep to deep, dark reddish brown, yellowish red or red sandy clay loams and sandy clays with weak or moderate structure and low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with poor structure with very low natural fertility (Pare, Usambara and Lower Kilimnajarō)			properties due to tendency for surface sealing (S <sub>max</sub> 40-60 mm).	
<b>E3</b>	30,332	4-7	29-31 19-23	Mainly well drained, flat to rolling plains, low altitude developed on intermediate metamorphic rocks. Major soils are well drained, moderately deep to deep, reddish and yellowish sandy clay loams and sandy clays, often with more sandy topsoil, with weak structure and low natural fertility; and somewhat excessively to moderately well drained, moderately deep to deep, reddish, brown or grey loamy sands, sandy loams and sandy clay loams with weak structure and low natural fertility; and well drained, moderately deep to deep, yellowish or reddish sandy clays with weak structure, very low to low natural fertility.	200-750	800-1000	Mainly one DGP 3 - 4½ months varying by 1-4 weeks depending on soil moisture storing properties and crop rooting habits. Onset dates are unreliable. Soil texture varies from medium to heavy textured alluvial with moderate to high AWC (80-150 mm/m) and favourable moisture storing properties (S <sub>max</sub> 200-350mm). Natural soil fertility shows marked differences between sites, and soil acidity may be common	Maize, sorghum, rice, cassava sweet potatoes, sugar cane, cow pea, pigeon pea, hyacinth bean, citrus, mangoes, passion fruit, pine apple, cashew, coconut, ground nuts, soya bean, sunflower, tobacco, cotton, sisal, jatropha.  Grasses and legumes for animals
<b>E4</b>	8,463	4-7	29-31 19-23	Physiographic units range from well drained, level to rolling plains at low altitude (200-500m) to strongly dissected uplands and low hills transitional to mountains at altitude 500 – 1000 m; mainly developed on intermediate metamorphic rocks. Major soils are well drained, moderately deep to deep, yellowish or reddish sandy clays to clays with moderate to very low natural fertility.	200-1000	800-1000	One DGP per year which is 4½ to 6 month long, varying by 6 weeks depending soil moisture characteristics and crop rooting habits. Onsets are not reliable. In less dissected and less steep parts covered by well drained, deep clays, AWC is moderate (70-120 mm/m) and favourable moisture storing properties (S <sub>max</sub> 200-400 mm). There are areas with soil toxicities which hinder root development and hence reduce ability of crop to extract stored soil moisture to (S <sub>max</sub> 50-80 mm).	Maize, sorghum, wheat, cassava, sweet potato, cow pea, pigeon pea, lablab, castor, ground nut, simsim, soya bean, sunflower, tobacco, Cotton, finger millet, sisal, jatropha.  Tropical grasses and legumes for livestock
<b>E5</b>	15,291	5-7	29-31 19-23	Well drained, level to rolling plains at low altitude (200-500 m) developed on acid intermediate metamorphic rocks. Major soils are well drained, moderately deep to deep, reddish and yellowish sandy loams and sandy clays, often with more sandy topsoils. Other soils well drained, moderately deep to deep dark red to red, friable clays with moderate to strong structure and evidence of clay illuviation, with low natural fertility.	200-500	800-1000	One DGP per year, with duration of 5-6 months, varying by 3-5 weeks depending on soil moisture storing properties and crop rooting habits. Onset dates are reliable. Soils are well drained, moderately deep, medium to heavy textured soils with moderate AWC (70-120mm/m) and poor moisture acceptance to due to surface sealing (S <sub>max</sub> 40-60mm). S <sub>max</sub> in areas without surface capping and or chemical barrier ranges from 150 – 300 mm.	Cashew, coconut, mangoes, cassava, citrus, simsim, passion fruit, maize, rice, sorghum, cow pea, pigeon pea, sweet potato, finger millet, ground nut, tobacco, cotton, sisal, jatropha  Various tropical grasses and legumes for animal fodder

E6	934	4-7	29-31 19-23	Well drained, undulating to rolling plains at low altitude (150-500 m) developed on intermediate metamorphic rocks. Major soils are well drained, moderately deep to deep, yellowish or reddish sandy clays to clays with moderate to low natural fertility, and some units low pH values with possibilities for aluminium toxicity.	150-500	1000-1200	Two DGP per year, with duration of 4-4½ months for the main growing period which has reliable onset dates and 2½ - 3 months for the short growing season, with unreliable onset dates, both varying by 2-3 weeks depending on soil moisture storage capacity and crop rooting habits. There is possibility of double cropping in many years. Soils are well drained, moderately deep, medium to heavy textured soils with moderate AWC (70-120mm/m) and poor moisture acceptance due to surface sealing (Smax 40-60mm). Smax in areas without surface capping and or chemical barrier ranges from 150 – 300 mm.	Sorghum, cassava, sisal, cashew, coconut, citrus, early maturing maize, cow pea, pigeon pea, green gram, ground nuts, soya bean,  Various tropical grasses and legumes for animal fodder.
E7	40,961	5-6½	27-30 15-18	Mainly well drained, flat to rolling plains, locally hilly at medium altitude (750-1300 m). 30% is strongly dissected uplands and low hills transitional to the medium altitude plateau. Major soils are well drained, moderately deep to deep dark red to red to friable clays with moderate to strong structure and evidence of clay illuviation. Natural soil fertility is low to moderate, with common problem of soil acidity.	800-1500	800-1000	One medium to long DGP with reliable onsets per year with duration of 5-7 months in most of the zone, varying by 1½-2 months depending on soil moisture storing capacity and crop rooting habits. Moderate moisture storing properties (good rainfall acceptance, lateral seepage water addition) poor to moderate water storing properties depending on the presence of chemical barriers (AWC 80-120 mm/m, Smax 30-70 with chemical barriers, Smax 100-300 without chemical barriers)	Maize, peas, beans, sorghum, rice, wheat, cassava, irish potato, sweet potato, finger millet, pigeon pea, hyacinth bean, banana, citrus, mangoes, passion fruit, pine apple, macadamia, castor, simsim, sunflower,  Various grasses and legumes for fodder
E8	1,777	5½ >8½	27-31 15-23	Flat (flood plains) alluvial plains with poorly drained, clayey soils, severely affected by salinity. Major soils are alkaline and saline with different colours, textures, structures, consistence and drainage but with fertility status and moisture storing properties adversely affected by presence of exchangeable sodium and or soluble salts at high levels enough to interfere with growth of most crops (ESP >15, pH>8½, EC>4), an important proportion of dark cracking clays of topographical depressions with moderate to high natural fertility.	1200	500-600	One DGP per year with onset date mostly determined by flooding regime. Soils are moderately well to imperfectly well drained, shallow to deep usually calcareous, with moisture storing properties with effective rooting depth restricted by impervious subsoil, AWC 150, Smax 75 – 150, often high ESP.	Rice, sugar cane, maize (by irrigation).
E9	7,701	≥ 7	29-31 19-23	Flat alluvial plains with homogenous sedimentation pattern. Major soils are imperfectly to poorly drained, deep, dark grey or grey brown, often mottled clays (clay 40-70%), more compact and contain fewer sandy strata. Natural fertility status is low to moderate.	400 - 500	800-1000	One DGP per year with duration of 4½ - 6½ months, varying by 2 months depending on soil moisture storing capacity and crop rooting habits. Onset dates are unreliable, and the growing period is influenced by rainfall ponding and runoff collection. Moisture storing properties less favourable due to poor internal drainage (AWC 150,	Rice, cotton, maize, sorghum, cow pea, pigeon pea, sisal Various tropical grasses and legumes for fodder.

							Smax 150-225).	
EI0	6,253	5½-7½	29-31 19-23	Flat alluvial plains with complex sedimentation pattern, subject to regular flood from braiding rivers. The physiographic units are mainly covered by young alluvial, well to moderately well drained, deep, brownish fine sands to sandy clay loams with high textural variability over short distances and highly stratified with more sandy than more clayey layers, with high natural fertility. About 30% of the soils covering the unit are imperfectly to poorly drained, deep, dark grey or grey brown clays, sandy clays or clay loams often mottled, with high natural fertility.	400-600	1400-1600	On non-flooding land, one DGP per year with duration of 5½ - 8 months, varying by 2½ months according to soil moisture storage capacity and crop rooting habits. Moisture storing properties ranges from moderate to high (more stable water table, AWC 80-150 mm/m, Smax 150-300 m). Onset dates are not reliable.	Rice, cashew, coconut, mangoes, cassava, simsim and passion fruit. maize, , sorghum, pigeon pea, sweet potato, cow pea, finger millet, ground nut, tobacco,cotton, sisal, jatropa, sunflower, castor  Various tropical grasses and legumes for fodder
EII	3,357	5-7	27-31 15-23	Complex depressions composed of dissected ridges, fault scarps and alluvial plains; low to medium altitude. Mainly covered by well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth. Natural fertility is low to very low.	500-1000	1000-1200	One DGP per year with duration of 5 – 6 months, varying by 1 month depending on soil moisture storage capacity and crop rooting habits. Onset dates are reliable. Moisture storing properties ranges from low to moderate (AWC 50-80 mm/m, Smax 50-150 m). The soils have goof rainfall acceptance.	Maize, cassava, rice, ground nut, sugar cane, cotton, sisal, cacao, sunflower, castor, pine apple, cashew, macadamia, mangoes, passion fruit, banana, citrus, hyacinth bean, pigeon pea, cow pea, common bean, sweet potatoes, finger millet, wheat.  Various tropical grasses and legumes for fodder
EI2	2,752	4½-7	22-25 10-15	Dissected, rolling to hilly mountains plateaux, slope range 10 – 40%, in parts affected by severe water erosion. Mainly covered by well drained, deep yellowish or reddish sandy clays with moderate to strong structure, with moderate natural fertility; and well drained, moderately deep to deep, yellowish or reddish sandy clays to clays with weak structure with very low to low natural fertility.	1000-2000	2000-3500	One DGP per year duration of 5-6½ months, varying by 1½ months according to soil moisture storage capacity and crop rooting habits. Onset dates are unreliable. The soils have moderate AWC 70-120 mm/m and favourable moisture storing properties (Smax 200-400mm). Chemical barriers to root development may occur in some soils.	Coffee, tea, maize, beans, vegetables, sorghum, finger millet, wheat, Various tropical grasses and legumes for fodder
EI3	640	4½-7	22-25 10-15	Dissected, rolling to hilly mountain slopes and plateau, slope range 10-40%, slightly affected by soil erosion. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure and moderate natural fertility; and well drained, deep yellowish or reddish sandy clays to clays with weak structure and with low to very low natural fertility.	800-2000	>1200	One DGP per year but often transition from into next growing period without intermediate dry period. Duration 9-12 months, varying depending on soil moisture storage capacity and crop rooting habits, orographic factors and topography (runoff). Onset dates difficult to establish because of overlapping growing period. AWC (80-120 mm/m) moderate and moisture storage capacity is favourable (Smax 200-400 mm)	Tea, coffee, mango, maize, sorghum, rice, banana, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, macadamia, castor, simsim, sunflower, vegetables,  Various tropical grasses and legumes for fodder.
EI4	2,976	4½-7	22-25 10-15	Mainly 67% of the physiographic units are very strongly dissected mountain block with steep to very steep slopes (15-60%), narrow valleys; altitude 1000 – 2000 m; includes	500-2000	1000-1200	One DGP per year but often transition from into next growing period without intermediate dry period. Duration 5½ - 7 months, varying depending on soil moisture	Tea, coffee, mango, maize, sorghum, rice, banana, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple,

				33% of strongly dissected foothills at low altitude (500-1000 m). Zone, particularly foothills, strongly affected by soil creep, gully erosion and landslides. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure and moderate natural fertility; and well drained, deep yellowish or reddish sandy clays to clays with weak structure and with low to very low natural fertility			storage capacity and crop rooting habits. Onset dates difficult to establish because of overlapping growing period. AWC (80-120 mm/m) moderate and moisture storage capacity is favourable (Smax 200-400 mm)	macadamia, castor, simsim, sunflower, Vegetables, fruit trees. Various tropical grasses and legumes for fodder.
<b>EI5</b>	1,920	4½-7	22-30 10-18	Dissected, rolling to hilly mountain slopes and plateau slope range 10-40%, in parts affected by severe water erosion and landslides. Mainly covered by well drained, deep yellowish or reddish sandy clays with moderate to strong structure, with moderate natural fertility; and well drained, moderately deep to deep, yellowish or reddish sandy clays to clays with weak structure with very low to low natural fertility.	800-1700	1000-1200	One DGP per year duration of 5-6½ months, varying by 1½ months according to soil moisture storage capacity and crop rooting habits. Onset dates are unreliable. The soils have moderate AWC 70-120 mm/m and favourable moisture storing properties (Smax 200-400mm). Chemical barriers to root development may occur in some soils.	Coffee, tea, maize, beans, vegetables, sorghum, finger millet, wheat, Various tropical grasses and legumes for fodder

<b>HIGH PLAINS AND PLATEAUX</b>								
<b>HI</b>	13,137	5-7	22-25 10-15	Mainly flat and undulating to rolling plains and plateaux at high altitude, developed on granites and gneisses. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure, with moderate natural fertility; and well drained, moderately deep to deep, reddish and yellowish sandy loams and sandy clays, often with more sandy topsoils, with weak structure and low natural fertility.	1500-2000	600-1600	One DGP per year with duration of 5-6 months depending on soil moisture storage capacity and crop rooting habits. The zone has reliable onset dates, moderate AWC (120 mm/m) and favourable moisture storing properties (Smax 300-400 m).	Tea, coffee, mango, maize, sorghum, banana, wheat, cassava, irish potato, sweet-potato, pyrethrum, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, macadamia, castor, simsim, sunflower, tomato, carrot, eggplant, fruit trees. Various tropical grasses and legumes for fodder.
<b>H2</b>	6,989	5-7	22-25 10-15	Undulating to rolling plains at the high altitude developed on granites. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure, with moderate natural fertility; and well drained, moderately deep to deep, reddish and yellowish sandy loams and sandy clays, often with more sandy topsoils, with weak structure and low natural fertility.	1500-2100	1400-1600	One DGP per year with duration of 6-9 months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates, moderate AWC (120 mm/m) and favourable moisture storing properties (Smax 300-400 m).	Tea, coffee, mango, maize, sorghum, banana, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, pyrethrum, macadamia, castor, simsim, sunflower, tomato, carrot, eggplant, fruit trees. Various tropical grasses and legumes for fodder
<b>H3</b>	13,137	4½-7	22-25	Mainly strongly dissected hills and	1500-2300	1000-1400	One DGP per year with duration of 6-9	Tea, coffee, mango, maize, sorghum, banana,

			10-15	mountains at high altitude strongly susceptible to erosion and landslides. Major soils are well drained, moderately deep to deep, reddish and yellowish sandy loams and sandy clays, often with more sandy topsoils, with weak structure and low natural fertility.			months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates, moderate AWC (120 mm/m) and favourable moisture storing properties (Smax 300-400 m).	wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, pyrethrum, macadamia, castor, simsim, sunflower, tomato, carrot, eggplant, fruit trees.  Various tropical grasses and legumes for fodder
<b>H4</b>	658	5½-7½	29-31 19-23	Flat to very gently undulating lacustrine plain at low altitude. Major soils are imperfectly to poorly drained, deep, dark grey or grey brown clays, sandy clays or clay loams often mottled; high natural fertility; and well to moderately well drained, deep, brownish fine sands to sandy clay loams with high textural variability over short distances and highly stratified with more sandy or more clayey layers. High natural fertility.	500	1600-2400	One DGP per year, often merging into next without intermediate dry period. Duration DGP 8-10 months, varying depending soil moisture storage capacity and crop rooting habits. Onset dates difficult to determine because of overlap of growing periods. AWC is moderate to high (80-150 mm/m) with moderate to high soil moisture storing properties (Smax 150 – 300 mm)	Banana, cashew, oil palm, rubber, cacao, sisal, maize, rice, cassava, sweet potato, hyacinth bean, coconut, tobacco
<b>H5</b>	9,300	5-7	22-25 10-15	Volcanic landforms ranging from undulating to rolling, medium to high altitude plains and plateaux; to strongly dissected hills, mountains, plateaux and plains at medium altitude. Major soils are well drained, deep, dark grey brown loamy sands, sandy loams and loams rich in allophanic clays with weak structure, low bulk density and with high natural fertility; and well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure with moderate natural fertility.	1200-2400	1000-2000	One DGP per year, increasing in duration from 6-9 months to 9-12 months, depending on altitude and soil moisture storage capacity. Onset dates difficult to determine because of overlap of growing periods. Soil moisture characteristics vary between physiographic units ranging from moderate to high AWC (100-200 mm/m) with favourable moisture storing properties (Smax 300-400).	Tea, coffee, mango, maize, sorghum, banana, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, pyrethrum, macadamia, castor, simsim, sunflower, tomato, carrot, eggplant, fruit trees.  Various tropical grasses and legumes for fodder
<b>H6</b>	790	5-7	16-19 5-10	Undulating to hilly plateau at very high altitude, developed on volcanic ash and pumices, covering basement complex and volcanic rocks. Major soils are well drained, deep, dark grey brown loamy sands, sandy loams and loams rich in allophanic clays with weak structure, low bulk density and with high natural fertility; and well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure with moderate natural fertility	2300-2700	1000-1200	One DGP per year, often merging into next without intermediate dry period. Duration DGP 8-10 months, varying depending soil moisture storage capacity and crop rooting habits. Onset dates difficult to determine because of overlap of growing periods. Mainly covered by volcanic ash soils with high AWC (100-200 mm/m) and very favourable moisture storing properties.	Tea, maize, Irish potato, common bean, pyrethrum, macadamia, sunflower  Various tropical grasses and legumes for fodder
<b>H7</b>	18,438	4½-7	22-25 10-15	Mainly mountainous topography at high altitude, either with extensive, undulating to hilly plateau crests or strongly dissected with limited plateau crests. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong	1500-2300	800-1000	One DGP per year with duration of 5-7 months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils have moderate AWC (120 mm/m) and favourable moisture storing properties (Smax 300-400).	Maize, sorghum, irish potato, finger millet, common bean, pigeon pea, hyacinth bean, banana, passion fruit, castor, simsim, sunflower, sisal,

				structure with moderate natural fertility and complex of rock outcrops, surface ironstone, very stony soils and very shallow soils.				
<b>VOLCANOES AND RIFT DEPRESSIONS</b>								
<b>NI</b>	6,114	4½-7	22-25 10-15	Mainly rolling to hilly, dissected plateaux at high altitude developed on volcanic ash, lavas and on gneisses. Mainly covered by heterogeneous soil types with important proportions of fertile, well drained, deep yellowish or reddish sandy clays to clay with moderate to strong structure developed on volcanic ash and lavas, and strongly weathered, heavy – textured soils of low to medium fertility.	1500-2500	500-700	One DGP per year with duration of 3-5 months depending on soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Moderate to high AWC (70-150 mm/m) and favourable moisture storing properties (Smax 200-400).	Maize, millet, common beans, sorghum, wheat, irish potato, sweet potato, hyacinth bean, castor, sunflower, sisal,  Various pasture grasses and legumes
<b>N2</b>	1,060	6½-7	16-19 5-10	Rolling to hilly, high altitude with calderas and volcanic cones. Major soils are well drained, deep, dark brown non-calcareous loams, silty loams and clay loams with moderate structure, high natural fertility with proportion of shallow soils which are complex of rock outcrops, surface ironstone, very stony soils and very shallow soils; and shallow, stony, black sandy loams to sandy clay loams developed on lavas and lahars.	2000-2500	800-1000	One DGP per year with duration of 3-5 months depending on soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Moderate to high AWC (70-150 mm/m) and favourable moisture storing properties (Smax 200-400).	Low temperatures and shorter DGP does not favour economic production of cereals.  Irish potatoes, apples, plums, peaches, grapes, apricots, pyrethrum, wattle.  Temperate grasses.
<b>N3</b>	3,686	>8½	27-30 15-18	Flat lacustrine plains at medium altitude, with extensive salt and soda flats, often inundated. Major soils are of varying colour, texture, structure, consistence and drainage but with fertility status and moisture storing properties adversely affected by presence of exchangeable sodium and/or soluble salts at levels that are high enough to interfere with growth of most crops (ESP>15, pH>8.5, EC>4. Also, moderately well to imperfectly drained, shallow to deep usually calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and moderate to high natural fertility. Often high ESP in subsoil.	900 -1100	400-500	Very short to short growing periods, adversely influenced by dominance of salts in soil. The zone is mainly covered by salt affected soils with important proportion of dark cracking clays of topographical depressions with moderate moisture storing properties.	Salt negatively affects many crops. Rice could possible be grown in few areas.
<b>N4</b>	3,159		16-30 5-10	Volcanic mountains with gentle to steep ash and lava slopes stretching from medium (900-1600 m) to high altitude (2000-3500 m). Major soils are well drained, deep, reddish friable or firm clay loams and clays with strong structure with high natural fertility and accumulation of partly decayed	900-3500	500-1400	One DGP per year with duration increasing from 3-5 months to 6-11 months with altitude, soil moisture storage capacity and crop rooting habits. Onset dates are unreliable. The zone mainly covered by volcanic ash soils with low to moderate AWC (50-100 mm/m) and moderate	Tea, coffee, mango, maize, sorghum, banana, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, pineapple, pyrethrum, macadamia, castor, simsim, sunflower, tomato, carrot, eggplant, apples, plums, peaches, grapes, apricots.

				plant material in permanent swamps or alpine meadows.			moisture storing properties (Smax 100-200).	Various tropical grasses and legumes for fodder
N5	4,544	6½-8½	27-30 15-18	Mainly flat to rolling plains at medium altitude, developed on volcanic ash and sediments. Major soils are well drained, shallow to deep, dark brown or dark grey calcareous sandy loams with weak structure with moderate natural fertility; and well drained, deep, dark grey or brown loamy sands, sandy loams and loams rich in allophanic clays with weak structure, low bulk density and high natural fertility.	1300-1700	600-1200	One DGP per year with duration decreasing toward south from 4-6 months to 2-2½ months. Unreliable onset dates. The zone mainly covered by volcanic ash soils with low to very high AWC (50-200mm/m) and moderate to very favourable (high) moisture storing properties (Smax 100 – 600mm).	maize, sorghum, wheat, cassava, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, tobacco, castor, simsim, sunflower.  Various tropical grasses and legumes for fodder
N6	6,127	6½-8½	27-30 15-18	Mainly flat to rolling plains at medium altitude, developed on volcanic ash or lava or lahars. Soils are heterogeneous with important proportions of shallow soils, well drained, dark (sandy) loams on volcanic ash and pumice and dark cracking clays of topographical depressions.	1300-1700	400-500	One DGP per year with duration of less than 2 - 2½ months depending on soil moisture storage capacity and crop rooting habits and exposure to rain shadow effect of Mt Kilimanjaro and Mt Meru. Onset dates unreliable, with low to moderate AWC (50-100 mm/m) and moderate soil moisture storing properties (Smax 100-200 mm).	Not suitable for agriculture (too short growing period).  Grasses for livestock observing strictly carrying capacity.
N7	10,926	6½-8½	22-30 10-18	Level to rolling plains medium to high altitude, developed on slightly weathered volcanic ash. Major soils are well drained, shallow to deep, dark brown or dark grey calcareous sandy loams with weak structure with moderate natural fertility; and well drained, deep, dark grey or brown loamy sands, sandy loams and loams rich in allophanic clays with weak structure, low bulk density and high natural fertility	1300-1800	500-800	One DGP per year with duration of 2 - 3½ months depending on soil moisture storage capacity and crop rooting habits and exposure to rain shadow of Ngorongoro highlands. Onset dates unreliable. Soils developed from volcanic ash with characterized by moderate AWC (50-100 mm/m) and moderate moisture storing properties (Smax 100-200).	Not suitable for agriculture (too short growing period).  Grasses for livestock observing strictly carrying capacity.
N8	9,610	6½-7	22-30 10-18	Level to undulating or rolling plains at medium to high altitude developed on volcanic ash and sediments, often with steep hills. Major soils are well drained, deep, dark brown non-calcareous loams, silty loams and clay loams with moderate structure with high natural fertility; and moderately well to imperfectly drained, shallow to deep mostly calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure with high natural fertility.	1300-2300	800-1000	One DGP per year with duration of 3-3½ months, varying depending on soil moisture storage capacity and crop rooting habits. Onset dates are unreliable. Volcanic ash soils, mostly well drained clays with moderate to high AWC (70-150 mm/m) and favourable moisture storing properties (Smax 200-400 mm).	Wheat, millet, maize, sorghum, cassava, sweet potato, bean, pigeon pea, hyacinth bean, simsim, sunflower.  Grasses and legumes
N9	2,675	7-8½	22-30 10-18	Undulating plains at medium to high altitude, developed on sodic volcanic ash. Major soils are well drained, deep, reddish friable or firm clay loams and clays with strong structure and high natural fertility;	1100-1800	600-800	One DGP per year with duration of 3-3½ months, varying depending on soil moisture storage capacity and crop rooting habits. Onset dates are unreliable. Soils are heavy textured with high sodicity	Require crops that can tolerate sodicity.

				and moderately well to imperfectly drained, mostly calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure with high natural fertility.			and poor moisture storing properties (Smax 30-50).	
<b>NIO</b>	724	5-6½	22-25 15-18	Undulating to rolling plateaux and plains of medium to high altitude, developed on lavas and granites. Major soils are well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure, with very low to low natural fertility; and well drained, moderately deep or deep yellowish or reddish sandy clays to clays with weak structure and moderate natural fertility; well drained, moderately deep to deep, red or brown, often gravely, sandy loams and sandy clay loams with weak structure and low natural fertility.	1500-1800	1400-1600	One DGP per year with duration of 6½ - 9½ months depending on soil moisture storing properties and crop rooting habits. Onset dates difficult to determined due to overlap of growing periods. Covered by soil with moderate to high AWC (70-150 mm/m) and favourable moisture storing capacity (Smax 200-400 mm).	Tea, coffee, maize, Irish potatoes, sweet potatoes, finger millet, vegetables, common beans, sorghum, rice, wheat, cassava, hyacinth bean, banana, passion fruit, macadamia, tobacco, rubber, pyrethrum,  Grasses and legumes for livestock

### CENTRAL PLATEAUX (PLAINS)

<b>PI</b>	7,995	5-7	27-30 15-18	Mainly gently undulating plains with some rocky hill-footslope association at medium altitude, developed on granites. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility; and well drained, moderately deep to deep, red or brown, often gravely, sandy loams and sandy clay loams with weak structure and low natural fertility; and immature soils which are complexes of rock outcrops, surface ironstone, very stony, and very shallow (< 25 cm); and good proportion of well drained, very shallow to moderately deep, black or dark grey sandy loams to sandy clay loams with strong topsoil structure and high natural fertility.	1100 - 1300	600-700	One DGP per year with duration of 2-2½ months depending soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Soils are generally moderately deep sandy or loamy with low to moderate AWC (30-100 mm/m) and poor moisture storing properties mostly for sandy and loamy soils susceptible to surface capping (Smax 50-150mm); and favourable for other loamy soils (Smax 150-300 mm).	Sorghum, millet, Other crops can be grown using water harvesting technologies.  Grasses and legumes (but low carrying capacity).
<b>P2</b>	50,093	5-7	27-30 15-18	Mainly gently undulating plains, for the most part well drained, at medium altitude, developed on granites and gneisses. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility;	1100-1300	550-600	One DGP per year with duration of 3-3½ months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils are generally moderately deep sandy or loamy with low to moderate AWC (30-100 mm/m) and poor moisture storing	Drought tolerant crop: sorghum, millet, ground nut, sunflower, sweet potato,

				and well drained, moderately deep to deep, red or brown, often gravelly, sandy loams and sandy clay loams with weak structure and low natural fertility; and immature soils which are complexes of rock outcrops, surface ironstone, very stony, and very shallow (< 25 cm); and moderately well to imperfectly drained, shallow to deep frequently calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and high natural fertility.			properties mostly for sandy and loamy soils susceptible to surface capping (S <sub>max</sub> 50-150mm); and favourable for other loamy soils (S <sub>max</sub> 150-300 mm). In some units with salt affected soils effective soil depth is restricted by impervious subsoil, often high ESP.	
<b>P3</b>	42,662	5-7	27-30 15-18	Mainly gently undulating plains, for the most part well drained, at medium altitude, developed on granites and gneisses. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility; and well drained, moderately deep to deep, red or brown, often gravelly, sandy loams and sandy clay loams with weak structure and low natural fertility; and immature soils which are complexes of rock outcrops, surface ironstone, very stony, and very shallow (< 25 cm); and moderately well to imperfectly drained, shallow to deep frequently calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and high natural fertility.	1100-1300	600-1000	One DGP per year with duration of 4-5 months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils are generally moderately deep sandy or loamy with low to moderate AWC (30-100 mm/m) and poor moisture storing properties mostly for sandy and loamy soils susceptible to surface capping (S <sub>max</sub> 50-150mm); and favourable for other loamy soils (S <sub>max</sub> 150-300 mm). In some units with salt affected soils effective soil depth is restricted by impervious subsoil, often high ESP.	Sorghum, millet, simsim, cotton, ground nut, sweet potato, sisal, cassava, early maturing maize, beans.
<b>P4</b>	27,545	5-7	27-30 15-18	Mainly flat to gently undulating plains with scattered hill-footslope associations at medium altitude, developed on granites, banded ironstones and young alluvium. Soils exhibit heterogeneous pattern with important proportions of well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility; and well drained, moderately deep to deep, red or brown, often gravelly, sandy loams and sandy clay loams with weak structure and low natural fertility; and immature soils which are complexes of rock outcrops, surface ironstone, very stony, and very shallow; and moderately well to imperfectly drained,	1200-1300	800-1000	One DGP per year with duration of 3½-5 months depending on soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Soils are moderately deep to deep with low to moderate AWC (50-100 mm/m) that may present 'chemical barriers' (e.g. salts) to root development in which case moisture reserve that can be used by crops is very low (S <sub>max</sub> 30-50 mm). Where no chemical barriers exist, the moisture storing properties are moderate (S <sub>max</sub> 100-200 mm).	Sorghum, millet, simsim, cotton, ground nut, sweet potato, sisal, cassava, early maturing maize, beans.

				shallow to deep frequently calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and high natural fertility.				
<b>P5</b>	67,855	5-7	27-30 15-18	See P3	1100-1300	800-1000	One DGP per year with duration of 5-6 months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils are generally moderately deep sandy or loamy with low to moderate AWC (30-100 mm/m) and poor moisture storing properties mostly for sandy and loamy soils susceptible to surface capping (S <sub>max</sub> 50-150mm); and favourable for other loamy soils (S <sub>max</sub> 150-300 mm). In some units with salt affected soils effective soil depth is restricted by impervious subsoil, often high ESP.	mango, maize, sorghum, banana, wheat, rice, irish potato, sweet-potato, finger millet, common bean, pigeon pea, hyacinth bean, passion fruit, cotton, sisal, castor, simsim, sunflower, cassava.  Various tropical grasses and legumes for fodder

<b>P6</b>	30,079	5-7	27-30 15-18	Mainly undulating plains and plateaux developed on sandstones, shales and quartzites medium altitude. Major soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility; and well drained, deep, reddish or brown sandy loams and sandy clay loams and sandy clays often with more sandy topsoil, weak structure and low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with poor structure and very low natural fertility.	800-1800	850-1700	One DGP per year with duration of 6-8½ months depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils are heterogeneous with low to moderate AWC (50-100 mm/m) and poor to moderate moisture storing properties (S <sub>max</sub> 30-150 mm).	Tea, coffee, maize, Irish potatoes, sweet potatoes, pigeon pea, citrus, mango, simsim, sunflower, finger millet, vegetables, common beans, sorghum, rice, wheat, cassava, hyacinth bean, banana, passion fruit, macadamia, tobacco, black wattle, pyrethrum,  Grasses and legumes for livestock
<b>P7</b>	6,253	7-8½	27-30 15-18	Flat to very gently undulating plains developed in old lake sediments. Major soils are well to moderately well drained, shallow to moderately deep, grey or brown, friable calcareous clay loams and clays, with moderate to strong structure and high natural fertility; and imperfectly drained, shallow, dark grey or brown sands to sandy clays with hardpan within 50 cm from the surface, often calcareous and sodic in the subsoil (ESP 10-15) with moderate natural fertility.	1000-1100	600-800	One DGP per year with duration of 3-3½ months depending on soil moisture storage capacity and crop rooting habits. Unreliable onset dates. Soils are shallow to moderately deep (0.5 – 1.5 m) friable clays with high AWC (150). Favourable moisture storing properties (S <sub>max</sub> 200-250).	Millet, sorghum, ground nuts, early maturing maize (katumani etc).

<b>P8</b>	38,496	6½-7	27-30 15-18	Flat to gently undulating plains developed partly on granites, partly on old colluvium; medium altitude. Major soils are imperfectly drained, shallow, dark grey or brown sands to sandy clays with hardpan within 50 cm from the surface, often calcareous and sodic in the subsoil (ESP 10-15) with moderate natural fertility; and moderately well to imperfectly drained, shallow to deeper, usually calcareous, black, dark grey or brown cracking clays often overlying paler subsoil with ephemeral structure and with high natural fertility; and well drained, moderately deep to deep, red or brown often gravely, sandy loams and sandy clay loams, with weak structure and low natural fertility.	1000-1200	600-1200	One DGP per year with duration of 3-3½ months depending on soil moisture storage capacity and crop rooting habits. Onset dates unreliable. The zone mainly covered by hardpan soils with poor moisture storing properties AWC (30-100), with important proportions of dark cracking clays of topographical depressions with moderate moisture storing properties AWC 150 mm/m; Smax 75-150 mm; and sandy and medium textured with moderate to high moisture storing properties (AWC 50 – 100 mm/m; Smax 50-300 mm).	Millet, sorghum, ground nuts, early maturing maize (katumani etc), rice in imperfectly drained depressions.
<b>P9</b>	6,180	4-6	27-30 15-18	Mainly gently undulating to plains formed on 'continental deposits' overlying granites. Major soils are somewhat excessively to moderately well drained, moderately deep to deep, reddish, brown or grey loamy sands, sandy loams and sandy clay loams with poor structure with very low natural fertility; and well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility; and well drained, moderately deep to deep, red or brown, often gravely, sandy loams and sandy clay loams with weak structure and low natural fertility.	1100-1400	500-600	One DGP per year with duration of 3-3½ months depending on moisture storage capacity and crop rooting habits. Reliable onset dates. Heterogeneous soils with dominance of light and medium textured soils with poor to moderate moisture storing properties (AWC 50-100 mm/m; Smax 50-200 mm) without chemical barriers.	Millet, grapes, sorghum, ground nuts, early maturing maize (katumani etc), rice in imperfectly drained depressions
<b>P10</b>	10,114	4-6	27-30 15-18	Gently undulating plains formed on 'continental deposits' overlying granite. Major soils are somewhat excessively to moderately well drained, moderately deep to deep, reddish, brown or grey loamy sands, sandy loams and sandy clay loams with poor structure with very low natural fertility; and well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with poor structure and very low natural fertility	1100-1400	600-800	One DGP per year with duration of 3-3½ months, depending on soil moisture storage capacity and crop rooting habits. Reliable onset dates. Soils are mainly moderately deep with low to moderate AWC (50-100 mm/m) that may present chemical barriers to root development in which case moisture reserve that can be used by crop is very low (Smax 30-50 mm). Where on chemical barriers exist, the moisture storing properties are moderate (Smax 100-200 mm).	Millet, grapes, sorghum, ground nuts, early maturing maize (katumani etc), rice
<b>P11</b>	4,146	6½-7	27-30 15-18	Flat plains at medium altitude developed mainly on alluvium. Major soils are imperfectly drained, shallow, dark grey or brown sands to sandy clays with hardpan within 50 cm from the surface, often calcareous and sodic in the subsoil (ESP 10-	900	400-600	For upland areas comparable to those of zone P10 above. However most of the zone DGP is influenced by flooding, water-logging, runoff losses or additions and presence of salinity.	Millet, sorghum, ground nuts, early maturing maize (katumani etc), rice <b>The zone is mostly affected salinity</b>

				15) with moderate natural fertility; and soils of varying colour, texture, structure, consistence and drainage but with fertility status and moisture storing properties adversely affected by presence of exchangeable sodium and/or soluble salts at levels that are high enough to interfere with growth of most crops (ESP>15, pH>8.5, EC>4				
PI2	4,568	5½ - 9	27-30 15-18	Flat seasonally inundated, lowland plains developed on young alluvium. Major soils are moderately well to imperfectly drained, shallow to deep often calcareous, black, dark grey or brown cracking clays mostly overlying paler subsoil with ephemeral structure and high natural fertility; and imperfectly drained, shallow, dark grey or brown sands to sandy clays with hardpan within 50 cm from the surface, often calcareous and sodic in subsoil (ESP 10-15), with moderate natural fertility.	900-1200	600-700	DGP varies with Physiography. For upland areas one DGP per year with duration of 3-3½ months depending soil moisture storing capacity and crop rooting habits. For most of the zone growing period in determined by duration of depth of flooding. Soil moisture storage is poor to moderate AWC 30-150 mm/m, Smax 75-150 mm.	Rice,
PI3	17,216	5 - 8½	27-30 15-18	Flat, seasonally inundated lowland plains with important proportion of permanent or semi-permanent swamps. Major soils are moderately well to imperfectly drained, shallow to deep often calcareous, black, dark grey or brown cracking clays mostly overlying paler subsoil with ephemeral structure and high natural fertility; and imperfectly to poorly drained, deep, non-calcareous, grey or brown sandy loams to sandy clays with strongly mottled and compact subsoil but with more sandy, more friable and darker topsoil. Moderate natural fertility; sodic subsoil possible.	900-1200	800-1000	DGP varies with Physiography. For upland areas, one DGP per year with duration of 5-6 months depending on soil moisture storage capacity and crop rooting habits. However, in most of the zone, growing period condition determined by duration and depth of flooding.	Rice and crops that withstand water-logging.
<b>RUKWA - RUAHA RIFT ZONE - ALLUVIAL FLATS</b>								
RI	17,461	>8½	27-30 15-18	Mainly flat plains covered by riverine or lacustrine alluvium, strongly affected by salinity or sodicity and by variable flooding conditions, medium altitude, mostly below 1000 m. Mainly covered by salt affected soils which are soils of varying colour, texture, structure, consistence and drainage but with fertility and moisture storing characteristics adversely affected by presence of exchangeable sodium and/or soluble salts at levels that are high enough to interfere with	900 - 1200	850-1300	One DGP per year with duration of 5-6 months around Lake Rukwa and 6-9 months in the Northwest (Karema depression). Growing period in the zone varies with rain-shadow effects in the lee of hill ranges or escarpments and variable flooding conditions. Reliable onset dates. Major soils covering the zone are characterized with moderate to high AWC (80-150 mm/m) and moderate to high moisture storing properties (Smax 150-350	Sorghum, pigeon pea, hyacinth bean, banana, citrus, passion fruit, simsim,

			growth of most crops (ESP>15, pH>8.5, EC>4); and well drained, moderately deep to deep, reddish and yellowish sandy clay loams and sandy clays, often with more sandy topsoil, weak structure and low natural fertility; and well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, with weak structure and very low natural fertility; and moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with weak structure and very low natural fertility.			mm). In 35% of the zone the ability of crops to extract moisture is negatively affected by strong salinity or alkalinity.	
R2	4,619	27-30 15-18	Flat to very gently undulating plains covered by lacustrine alluvium or by alluvial fans, levees, piedmonts and tributaries floodplains, medium altitude mostly below 1000 m. Major soils are imperfectly to poorly drained, deep, dark grey or grey brown, often mottled clays. They have usually higher clay content than the young alluvial clays (clay % 40-70), are more compact and contain fewer sand strata, contain sodicity and soluble salts in subsoil, and usually lower natural fertility; and salt affected soils with varying colour, texture, structure, consistence and drainage but with fertility and moisture storing characteristics adversely affected by presence of exchangeable sodium and/or soluble salts at levels that are high enough to interfere with growth of most crops (ESP>15, pH>8.5, EC>4);	800 - 1200	800-1200	One DGP per year with duration of 4-5 months depending on soil moisture storing capacity and crop rooting habits. Actual growing period is strongly influenced by flooding regime and salinity and highly variable in the zone. Reliable onset dates. Soils covering the zone exhibits moderate to high AWC (80-150 mm/m) and moderate to high moisture storing properties (Smax 150-350 mm). Ability of crops to extract moisture is negatively affected by strong salinity or alkalinity	<b>Adequate for irrigation development</b> Cotton, rice, sorghum, pigeon pea, hyacinth bean, banana, citrus, passion fruit, simsim,

R3	2,688	>8½	27-30 15-18	Complex terrain, formed partly by flat to very gently undulating plains of lacustrine origin and partly by undulating plains of very old surface, at medium altitude. Covered by heterogeneous soils, ranging from sodic salt affected soils with varying colour, texture, structure, consistence and drainage but with fertility and moisture storing characteristics adversely affected by presence of exchangeable sodium and/or soluble salts at levels that are high enough to interfere with growth of most crops (ESP>15, pH>8.5, EC>4); well drained, moderate deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams depth with weak structure and very low natural fertility; and hardpan soils, and seasonally waterlogged soils with moderate fertility.	900-1400	600-1000	One DGP per year with duration of 3-3½ months depending on soil moisture storing capacity and crop rooting habits. Reliable onset dates. Heterogeneous soils with low to moderate moisture storing properties and seasonally waterlogged soils.	Millet, grapes, sorghum, ground nuts, early maturing maize (katumani etc), rice in imperfectly drained depressions, sweet potato, cow pea, cotton, simsim,
R4	1,514	5½-7	27-30 15-18	Flat plains covered by riverine alluvium and regularly flooded, with complex sedimentation pattern; medium altitude. Dominant soils are well to moderately drained, deep, brownish fine sands to sandy clay loams with high textural variability over short distances and high stratified with more sandy or clayey layers. High natural fertility; and imperfectly to poorly drained, deep, dark grey or grey brown clays, sandy clays or clay loams often mottled and usually with more sandy horizons within the profile and moderate topsoil structure and high natural fertility.	800-1000	1200-1400	One DGP per year with duration of 3-3½ months depending on soil moisture storing capacity and crop rooting habits. Reliable onset dates. In most of the zone growing period mainly determined by flooding regime which shows considerable spatial and temporal variability.  The zone is mainly covered by heavy textured soils with moderate to high AWC (80-150 mm/m) and moderate moisture storing properties (Smax 150-350 mm).	<b>Adequate for irrigation development</b> Millet, grapes, sorghum, ground nuts, early maturing maize (katumani etc), , sweet potato, cow pea, cotton, simsim, rice in imperfectly drained depressions
<b>INLAND SEDIMENTARY SEDIMENTS</b>								
SI	11,136	5-7	29-31 19-23	Mainly gently undulating to rolling plateaux developed on Karroo sandstones and Neogene sandy sediments; low altitude. Major soils are well drained, moderately deep to deep, red, yellowish or red or orange sands and loamy sands with sands with sandy loams in depth, with weak structure and very low natural fertility; and important proportion of moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with weak structure and very low natural fertility.	200-500	800-1000	One DGP per year with duration of 3-4½ months, varying by 3-4 weeks depending on soil moisture storing capacity and crop rooting habits. Unreliable onset dates. The zone is covered by well drained loamy sands with low fertility and poor to moderate moisture storing properties.	Sorghum, tobacco, maize, cassava, sweet potato, finger millet, cow pea, pigeon pea, lablab, mango, passion fruit, cashew, castor, simsim, sunflower, cotton, ground nut, sisal,
S2	51,5992	5-7	27-31 15-23	Mainly gently undulating to rolling plateaux developed on Karroo sediments. Some parts	200-1000	1000-1200	One DGP per year with duration of 5-7 months, varying by 1-2 months depending	Cashew, coconut, mangoes, cassava, maize, sorghum, rice, simsim and passion fruit. finger

				of the zone strongly dissected terrain. Dominant soils are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, weak structure and very low natural fertility; and proportion of moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with weak structure and very low natural fertility			on soil moisture storing capacity and crop rooting habits. Reliable onset dates. The zone is mainly covered by moderately deep sandy and loamy soils with low to moderate AWC (50-80 mm/m) and poor to moderate moisture storing properties.	millet, cow pea, pigeon pea, sweet potato, citrus, sisal, jatropha, castor, ground nut, soya bean, sunflower, tobacco, cotton,  Suitable for various types of grasses and legumes
<b>UFIPA PLATEAU</b>								
U	16,654	5-7	22-25 10-15	Complex of flat to gently undulating plains developed on various parent rocks (gneiss, schist, sandstones, acid volcanics, and granites) but mostly well drained and located at high altitude. Major soils are well drained, moderately deep to deep, reddish and yellowish sandy clay loams and sandy clays, often with more sandy topsoil, weak structure and low natural fertility; and well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, weak structure and very low natural fertility; and important proportions of moderately well to imperfectly drained, deep, brown, pale yellow, light grey or white mottled sands and loamy sands with poor structure and very low natural fertility.	800-1800	800-1200	One DGP per year with duration of 5-6½ months depending on soil moisture storage capacity and crop rooting habits. In the northwest corner of the zone growing period may be 6-8½ months. Reliable onset dates. The zone is mainly covered by (moderately) deep sandy and loamy soils with low to moderate AWC (30-100 mm/m) and poor to moderate moisture storing properties (Smax 50-300 mm).	Maize, banana, sorghum, finger millet, wheat, rice, cassava, finger, potatoes (sweet, Irish), ground nut, beans, tobacco, simsim, cow pea, pigeon pea, lablab, citrus, mango, passion fruit, castor, soya bean, sunflower, coffee robusta, cotton, sisal  Various grasses for livestock keeping
<b>WESTERN HIGHLANDS</b>								
WI	8,688	4-7	22-25 10-15	Mainly strongly dissected hills formed by parallel ridges of sandstone and quartzites and deep, broad or narrow valleys developed on phyllites, often with permanent samps at high altitude. Major soils are well drained, moderately deep or deep, yellowish or reddish sandy clays to clays with weak structure and very low to low natural fertility; and complex of undifferentiated very shallow soils (< 25 cm deep) with rock outcrops.	1300-1800	1000-1500	One DGP per year often merged into the next, with duration of 7-9 months depending on soils moisture storage capacity and crop rooting habits. Unreliable onset dates. Major soils are well drained, clayey soils with moderate AWC (70-120 mm/m) and with favourable moisture storing properties (Smax 200-400 mm). Existence of chemical barriers may hamper utilisation of soil moisture reserves (Smax 50-80 mm).	Banana, coffee, cassava, sweet potatoes, maize, beans, simsim, sorghum, rice, wheat, Irish potatoes, finger millet, pigeon pea, hyacinth bean, passion fruit, macadamia, castor, jatropha, sunflower, tobacco, sisal, pyrethrum,
W2	13,427	4-7	22-25 10-15	Dissected hilly plateaux developed on basalt, argillaceous sandstones and shales, with flat or gently undulating tablelands bounded by steep scarps and valleys often strongly affected by erosion, at high altitude. Mainly	1500-1700	1000-1500	One DGP per year with duration of 6½ - 8 months depending on moisture storage capacity and crop rooting habits. Reliable onset dates. Major soils are well drained, clayey soils	Banana, coffee, cassava, sweet potatoes, maize, beans, simsim, sorghum, rice, wheat, Irish potatoes, finger millet, pigeon pea, hyacinth bean, passion fruit, macadamia, castor, jatropha, sunflower, tobacco, sisal, pyrethrum,

				covered by equal proportions of heavy – textured soils with high organic matter contents which are well drained, moderately deep or deep, yellowish or reddish sandy clays to clays with weak structure and very low to low natural fertility; and well drained, deep yellowish or reddish sandy clays to clays with moderate to strong structure and moderate natural fertility.			with moderate AWC (70-120 mm/m) and with favourable moisture storing properties (Smax 200-400 mm). Existence of chemical barriers may hamper utilisation of soil moisture reserves (Smax 50-80 mm).	
<b>W3</b>	6,690	5-7	27-30 15-18	Mainly undulating to rolling plains and plateaux with resistant quartzite ridges often broken by steep escarpments, high altitude, developed on sandstones, often more dissected and hilly with parallel ridges and intervening narrow valleys. Major soils are mainly equal proportions of sandy soils and heavy-textured soils with strong acidity which are well drained, moderately deep to deep, red, yellowish red or orange sands and loamy sands with sandy loams in depth, and weak structure and very low natural fertility; and, well drained, deep, reddish or brown sandy loams and sand clay loams with weak structure and very low natural fertility; and accumulation of partly decayed plant materials in permanent swamps or alpine meadows.	1200-1600	800-1000	One DGP per year with duration of 4-5 months depending on soil moisture storing capacity and crop rooting habits. Unreliable onset dates. The zone is mainly covered by sandy and loamy soils with low to moderate AWC (50-100 mm/m) and with moderate moisture stroing properties (Smax 100-200 mm). Chemical barriers may prevent roots to utilize moisture reserves (Smax 50-80 mm).	Maize, banana, sorghum, finger millet, wheat, rice, cassava, finger, potatoes (sweet, Irish), ground nut, beans, tobacco, simsim, cow pea, pigeon pea, lablab, citrus, mango, passion fruit, castor, soya bean, sunflower, coffee robusta, cotton, sisal
<b>W4</b>	10,622	4-7	27-30 15-18	Undulating to rolling upland plains developed on phyllite with protruding ridges of quartzite capped ironstone. Include a large flat to undulating central valley developed on alluvium and colluvium derived phyllites. Contains also flat riverine plain regularly flooded. Major soils are well drained, moderately deep or deep, yellowish or reddish sandy clays to clays with weak structure and very low to low natural fertility; and complex of undifferentiated very shallow soils (< 25 cm deep) with rock outcrops; and well drained, young and fertile alluvial soils, sandy and loamy soils.	1400-1500	1000- >1500	One DGP per year often merged into next, with duration of 9-12 months depending on soil moisture storing capacity and crop rooting habits. Onset dates difficult to establish because of overlap of growing period. The zone is mainly covered by sandy and loamy soils with low to moderate AWC (50-100 mm/m) and with moderate moisture storing properties (Smax 100-200 mm). Chemical barriers may prevent roots to utilize moisture reserves (Smax 50-80 mm).	Banana, coffee, cassava, sweet potatoes, maize, beans, simsim, sorghum, rice, wheat, Irish potatoes, finger millet, pigeon pea, hyacinth bean, passion fruit, macadamia, castor, jatropha, sunflower, tobacco, sisal, pyrethrum,

## Annex 1 Different crop requirements

Crop	Soil pH (Water)	Rainfall (mm/year)	Temperature (°C)	Drainage	Altitude (masl)	Soil depth
Maize ( <i>Zea mays</i> )	5-7	> 400 mm	18-30	Well drained	0-3800	Deep well aerated
Sorghum ( <i>Sorghum bicolor</i> Moench)	5.5-8.5	500-1500	28±3 °C	Poorly to well drained	Up to 2000	Wide range of soils
Rice ( <i>Oryza sativa</i> )	6-7	800-1000	12-35 varies with stage of growth	Well to poorly drained	free	Heavy clayey soils
Wheat ( <i>Triticum</i> spp)	6-7 never below pH 5	450 – 600 well distributed	< 38	Well drained	-	Deep well drained heavy soil
Cassava ( <i>Manihot esculenta</i> Grantz)	Tolerate acid soils 5	500-1500	25-29	Well drained sandy clay	Up to 1500	Deep friable sandy clay. Has high K requirements, Soils rich of N limit roots formation
Irish potato ( <i>Solanum tuberosum</i> L)	5.5-6	Moderate to high rainfall	16-29	Well drained	1800-2300	Deep light moist well drained soils
Sweet potato ( <i>Ipomoea batatas</i> (L) Lam	Tolerate Al-rich and P-poor soils pH 4	400-800	15-28	Well drained fairly permeable loam	Up to 2000	Light soils depleted of N and P
Finger millet ( <i>Eleusine coracana</i> (L) Gaertn	5-7	300-500	-	Well drained sandy to Sandy loam	0-2500 Common 1000 to 1800	
Sugar cane ( <i>Saccharum officinarum</i> L	4 - 9	1500 - 1800	26 - 33	Well drained		Heavy clay or sandy soils
Common bean ( <i>Phaseolus vulgaris</i>	6 – 7.5	400 - 1200	12 - 32	Well drained	800 - 2800	-
Cow pea ( <i>Vigna unguiculata</i> (L) Walpers	6-7	600 - 1500	15 - 36	Well or adequately drained	Low altitude as a rule not grown above 1000	Wide range of soils
Pigeon pea ( <i>Cajanus cajan</i> (L) Millspaugh	5 – 8.5	500 - 1000	18 - 29	Well drained	20 - 1500	Wide range of soils (poor to fertile)
Hyacinth bean ( <i>Lablab purpurens</i> (L) Sweet	Best in slightly acid to neutral BUT Tolerate poor acid soils pH 4.4) and toxic	200 - 2500	18 - 30	Well drained	0 - 2000	Deep sandy loam

	soils					
Banana <i>Musa L</i>	4 - 8	1300 - 3600	19 - 33	Well drained	1200 - 1800	Deep well drained loam
	5 - 8	1200	-4 to 52 optimal 20 - 30	Well drained	< 1000	Sandy to heavy clays
Citrus ( <i>collective name for the genus Citrus L</i> )						
Mango <i>Mangifera indica L</i>	5.5 – 7.5	> 700	2 - 40	Well drained	1200 upwards	Deep, fairly light to medium soils
Passion fruit <i>Passiflora edulis Sinus</i>	Acid to alkaline	900 - 1500	12 - 33	Well drained	1500 - 2000	Diver soil types
Pine apples <i>Ananas comosus (L) Merr</i>	4.5 – 5.5	1200 - 1500	24 - 27	Well drained	Low and mid-altitude	Light sandy clay or clayey sand
Cashew nut <i>Anacardium occidintale L</i>	4.5 – 6.5	800 - 2000	22 - 27	Well drained	Varies with Latitude	Sandy loam soils water table between 3 and 10 metres.
Macadamia <i>Macadamia spp</i>	6.5 – 7.0	1200 - 1600	18 - 21	Well drained	800 - 1900	Deep soils
Castor <i>Ricinus cummunis L</i>	6 - 7	600 - 1200	20 - 30	Well drained	Wide altitude	Deep soils
Coconut <i>Cocos nucifera L</i>	5 - 8	1500	26 - 27	Well drained	300 - 400	Diverse soils
Ground nut <i>Arachis hypogaea L</i>	6.2 – 7.5	500 - 600	20 - 35	Well drained	varies	Light sandy to sandy loam
Oil palm <i>Elaeis guineensis Jacq</i>	4 - 5	1700	24 - 26	Well drained	Maximum elevation 700	Deep permeable soils
Sesame <i>Sesamum indicum L</i>	5.5 – 8.0	400 - 500	25 - 27	Well drained	0 - 1500	Fertile soils
Soya bean <i>Glycine max (L) Merrill</i>	5 – 5.2	250 – 850 Well distributed	22 - 30	Well drained but tolerate temporary water-logging	-	Deep loamy sand to clay loams
Sunflower <i>Helianthus annuus L</i>	6 – 7.5 Sensitive to low pH/ acidity	300 -450	18 - 27	Deep well drained	0 - 2500	Deep light sandy soils. Sensitive to acidity but tolerate salinity
Cacao <i>Theobroma cacao L</i>	6 -7 Sensitive to Zinc and Boron deficiencies	1500	24 - 28	Well drained	< 500	Fertile (humus rich soils)
Coffee	5 - 6	1,100 - 1500	18 - 22	Well drained	1200 - 1500	Deep Permeable

Coffea arabica						good structured
Coffea robusta	5 - 6	1000 - 1500	22 - 27	Well drained	700 – 800	Same as above
Tea Camellia sinensis (L) O. Kuutze	4 – 5 Optimal 5.5 Does not grow at pH over 6	1300 - 1400	12 - 30	Well drained soils not eroded	1500 - 1800	-
Tobacco Nicotiana tabacum L	5 – 5.6	400 – 2000 Depending type	> 20	Well drained	Diverse altitude requirements by type	Fertile soils
Cotton Gossypium hirsutum L	6 - 7	400 - 700	25 - 30	Well drained	Does not grow in mountains but it grows in high altitude plateaux	Deep permeable fertile soils Tolerate little salinity
Sisal Agave sisalana Perrine	6 -9	600 - 1250	18 - 33	Well drained	0 - 1800	Fertile soils with K and high base status
Rubber Hevea brasiliensis (H.B.K.) Muell. Arg	4.5 - 5.5	1800 – 2500 Ideal for rubber growing	25	Well drained	Varies	Deep well drained Well structured
Pyrethrum Chrysanthemum cinerariae folium Trev . Bocc	5.5 - 7	1000 - 2500	< 15	Well drained	1800 – 2000 best at 200 for yields and pyrethrin	Light permeable of usually of volcanic origin