

Appendix A

Topsoil properties and their description

PROPERTY DESCRIPTION

- Aggeric (a3)** Topsoils that consist of accumulated surface materials as a result of land shaping or land levelling.
- Allophanic (x)** Topsoils that have Al(o) + 1/2 Fe(o) of 2% or more in the fine earth fraction, Si(o) of 0.6% or more; pH (NaF) is >9.4, a BD of 0.9 Mg m⁻³ or less and a P retention capacity of >85%, that have a Al(p)/Al(o) ratio of <0.5; pH of 5.0 or more; and KCl-extractable Al of <2 cmol(+) kg⁻¹, that have dark brown colours (value 3, chroma 3.5, moist); an OC content of 5% or more with stable organo-mineral complexes; dominated by allophane that have a fine very friable crumb or granular structure with fluffy microstructures, non or slightly plastic; and a high biological activity.
- Altaric (a5)** Topsoils that consist of a mixture of former surface and subsurface soil materials, as such recognizable as separate chunks, as a result of deep disturbance of the topsoil by human activity (e.g. through deep ploughing, subsoiling, etc.).
- Arctic (t1)** Topsoils that contain ice for the greater part of the year, or that have a mean annual soil temperature at 10 cm depth of 0° C or less.
- Areolic (m7)** Topsoils that have, on average, <3% OM, and in which biological activity is restricted to a well-defined rainy season, resulting in a surface layer enriched in humus of no more than 10 cm thick. They are dry for more than 3 consecutive months during each year and frequently have hard-setting properties as well.
- Arid (t2)** Topsoils that are dry for most of the year, that have an OC content of 0.6% or less, or 0.2% or less, if the texture is coarser than sandy loam, that have weakly developed structures, usually platy at the surface with vesicular pores, and granular, crumb or subangular blocky below, that have a consistence that is soft when dry, and that have 5% or more K at the exchange complex.
- Brunic (m3)** Topsoils with well-mixed, completely or almost completely mineralized OM, that have an OC content of 0.6% or more, that have brownish or blackish colours with hues of 5YR to 2.5Y, that have a BS of 35% or more and a pH of 5.0-6.5, and that have weakly or moderately developed structures.
- Calcic (b)** Topsoils that have, on average, 15% or more CaCO₃ equivalent, or 15% or more (by weight) distinct CaCO₃ concentrations.
- Chemically Degraded (d6)** Topsoils that under cultivation have obtained such adverse chemical properties (acidity, reduced levels of available nutrients such as N, P, S, K, and the presence of toxic Al, i.e. an Al saturation of >25 %, presence of a high amount of soluble salts, as expressed by an EC of >6 dS m⁻¹ at 25° C), that a yield decline of >30% is observed, compared to original yield levels, or that nutrient deficiencies are observed in the plants.

- Chernic (m0)** Topsoils that are 30 cm thick, that have well-mixed, completely mineralized OM and an OC content of at least 3% throughout; that have blackish colours with moist values of 2 or less in the first 15 cm and moist chromas of <3.5, that are nearly or completely base saturated (>80%), with a pH ranging from 6.5-8.0, and that have dominantly granular or crumb structures in the upper part grading towards subangular blocky in the lower part.
- Compacted (p2)** Topsoils that have a BD in the upper 10 cm of 1.7 Mg m^{-3} or more.
- Crusting (r1)** Topsoils with >25 % silt and (sealing) < 35 % sand, that have a CEC of 24 cmol(+) kg^{-1} clay, and an OM/clay ratio of <0.07, with or without an ESP of 15% or more, or 50% or more exchangeable Mg (sodic properties in the Revised Legend of the Soil Map of the World).
- Cumulic (a2)** Topsoils that show an accumulation of fine sediments resulting from long-continued irrigation.
- Depositional Crust (r3)** Topsoils where soil particles, suspended in water, are deposited on the soil surface as the water infiltrates or evaporates. Externally derived materials are always involved in the construction of depositional crusts.
- Drained (a7)** Organic topsoils that are artificially drained and that show evidence of physical ripening, indicated by subsidence and the development of shrinkage cracks.
- Duric (v3)** Topsoils that are very or extremely hard when dry, that have 30% or more clay throughout, and that have coarse subangular blocky or prismatic structures, or are massive.
- Fibric (I)** Organic topsoils that have 75% or more recognizable plant fragments.
- Folic (F)** Organic topsoils that consist entirely of litter accumulation.
- Gypsic (y)** Topsoils that have in some layer 5% or more gypsum.
- Halic (I)** Topsoils that have within 15 cm from the surface an EC in the saturation extract of $>15 \text{ dS m}^{-1}$ at 25°C at some time of the year, or $>4 \text{ dS m}^{-1}$, if the pH exceeds 8.5.
- Hard-setting (v4)** Topsoils that are hard to extremely hard when dry, and that have coarse subangular blocky structures, or are massive. These topsoils may have a thin surface layer of <10 cm thickness which is enriched in OM and that do not show the hard-setting characteristics.
- Hemic (H)** Organic topsoils that have between 15 and 75% recognizable plant materials.
- High Al Saturation (a)** Topsoils with >60 percent Al-saturation of the effective CEC within 50cm of the soil surface, or >67 percent acidity saturation of CEC by sum of cations at pH 7 within 50cm of the soil surface, or >86 percent acidity saturation of CEC by sum of cations at pH 8.2 within 50 cm of the soil surface, or pH < 5.0 in 1:1 H_2O within 50cm, except in organic soils where pH must be less than 4.7.
- High Iron Oxides and Hydroxides (i)** Topsoils where in the presence of iron oxides and hydroxides precipitation of P occurs which is gradually converted into crystalline iron phosphate. Percentage free Fe_2O_3 divided by percentage clay > 0.25 and more than 35 percent clay, or hues of 7.5YR or redder and granular structure. This modifier is only used in clay soils and it applies only to the first 20cm of the topsoil or whichever is shallower.

- Humic (m6)** Topsoils that receive a large amount of organic debris, and in which high biological activity prevents the downward movement of the organic substances through a rapid turnover of the OM at or near the surface, resulting in a humus-rich surface layer of no more than 10 cm thick. That layer has, on average, 3% or more OC and a C/N ratio of 12 or more, and is never dry for more than 3 months during most years.
- Hydric (w)** Topsoils that consist either of organic materials that have a BD of 0.1 Mg m^{-3} or less, or mineral materials that have an n-value of >0.7 .
- Jarositic (c2)** Topsoils that have common distinct yellow jarosite mottles.
- Low K Reserves (k)** Topsoils with less than 10 percent weatherable minerals in silt and sand fraction within 50cm of the soil surface, or exchangeable K $< 0.20 \text{ meq/100g}$, or K less than two percent of sum of bases (if bases $< 10 \text{ meq/100g}$).
- Low Nutrient Reserves (e)** Topsoils with CEC less than 4 meq/100g soil by sum of bases plus extractable Al (CEC_{eff}), or CEC $< 7 \text{ meq/100g}$ soil by sum of cations at pH 7, or CEC $< 10 \text{ meq/100g}$ soil by sum of cations plus Al plus H at pH 8.2.
- Mazic (v2)** Topsoils that are very or extremely hard when dry, that have 30% or more clay throughout, that have cracks when dry that are at least 3 cm wide at the surface, and that have very coarse prismatic structures, or are massive.
- Melanic (m2)** Topsoils that have throughout their thickness, (Mullic) well-mixed, completely mineralized OM and an OC content of at least 0.6% (lower mollic limit), that have blackish colours with moist values and chromas of <3.5 , that have a BS of 80% or more with a pH (H_2O) of 6.0 or more, and that have mainly subangular blocky structures.
- Moderately Eroded (d3)** Topsoils which show clear evidence of removal of all or substantial part of surface horizons by sheet erosion to a depth of 10 to 30cm, or by a rill network (less than 30cm), or by terracette erosion with still well-vegetated parts inbetween the steps, or by landslips with subsurface exposition to limited depth.
- Modic (m8)** Topsoils that have poorly mixed, incompletely mineralized OM and an OC content of $>0.6 \%$, that have blackish, brownish or greyish colours in the hue range of 5YR to 2.5Y, that have a BS of $<35 \%$, in extreme cases even $<10 \%$, and a pH of <5.0 , and that are usually structureless or only weakly structured.
- Natric (n)** Topsoils that have an ESP of 15 or more, or that have 50 % or more exchangeable Na plus Mg.
- Opalic (o)** Topsoils with Al(o) + $1/2 \text{ Fe(o)}$ of 2% or more, Si(o) $<0.6 \%$, Al(p)/Al(o) of more than 0.5, KCl-extractable Al of $>2 \text{ cmol(+) kg}^{-1}$, and pH of < 5.0 .
- Organic (O)** Topsoils that are 30 cm thick, and that have 18 % or more OC, if there is 60% or more clay, or have $>12 \%$ OC in the absence of clay.
- Para-modic (m9)** Topsoils that are similar to modic surface layers, but that have a BS of $<50\%$, and a pH of 5.5-6.0, and have Mull-like Moder OM characteristics.
- Para-sombric (m5)** Topsoils that are similar to sombric surface layers, but that are less thick and/or may have less OC.

- Physically Degraded (d7)** Topsoils that have obtained under cultivation such degraded adverse physical properties (low porosity, high bulk density (compaction), strong platy structures or being massive, occurrence of crusts, reduced infiltration), that a yield decline of > 30 percent is observed compared to original yield levels.
- Plaggen (a1)** Topsoils that are produced by centuries-long manuring with earthy admixtures that have >250 mg kg⁻¹ soil extractable P₂O₅ in 1% citric acid.
- Puddled (a4)** Topsoils that are saturated with water for at least part of the year and that are subject to puddling in most years. They show signs of reduction-oxidation processes such as rusty root channels, dominantly pale reduction colours, Fe-Mn concretions, mottling due to segregation of iron, or a combination of these, they are loosely structured when submerged, but becoming massive or showing platy structures when dry.
- Redoxic (o)** Topsoils that are periodically saturated with groundwater, that have high chroma mottles on pedfaces, that have evidence of biological activity such as mixing of OM with the mineral soil particles, or animal burrows and excreta, and that have, in wet conditions, a wide ranging soil reaction from strongly acid to alkaline (pH (H₂O) 5.0-8.5).
- Reductive (u)** Topsoils that are permanently saturated with groundwater, that have neutral, blueish or greenish colours, that are usually poorly structured with little or no mixing of OM and the mineral soil particles, that have, in wet conditions, a neutral or only slightly acid reaction, that may show mottling around roots ("rusty root channels"), and that may or may not have a histic surface layer.
- Rendzic (m1)** Topsoils that have, throughout their thickness, well-mixed, completely mineralized OM and an OC content of at least 1% throughout, that contain calcareous coarse fragments and overly calcareous materials with a CaCO₃ equivalent of >40%, that have blackish colours with moist values and chromas <3.5, that are saturated with Ca or Ca plus Mg as dominant ion(s) with a pH of 7.0-8.5, and that have granular, crumb or (very) fine subangular blocky structures.
- Salsic (s)** Topsoils that have within 15 cm from the surface an EC of the saturation extract of >4 dS m⁻¹ at 25° C at some time of the year.
- Sapric (A)** Organic topsoils with <15 % recognizable plant materials.
- Self-mulching (v1)** Topsoils that are very or extremely hard when dry, that have 30% or more clay throughout, and that have, when dry, both cracks 3 cm wide at the surface extending down to at least 30 cm depth and a fine or medium sized granular structure at the surface with or without fills of surface materials inside the cracks.
- Severely Eroded (d4)** Topsoils which show clear removal of soil by sheet erosion of all surface horizons exposing subsurface, or by gully erosion (defined as channels of more than 30cm) which may cut into subsurface horizons and/or underlying parent material, or by terracette erosion with clearly reduced vegetated parts inbetween the steps, or by landslips/slumps which expose subsurface to a considerable depth. Removal of soil to a depth of more than 30cm.
- Slightly Eroded (d2)** Topsoils which show some evidence of damage to surface horizon by sheet erosion but no direct visible evidence, or development of individual rills. Removal of soil to a depth of 10cm.
- Soil Acidity (h)** Topsoil with 10-60 percent Al-saturation of the effective CEC within 50cm of the soil surface, or pH in 1:1 H₂O between pH 5.0-6.0.

- Sombric (m4)** Topsoils that are 30 cm thick, that have well-mixed, completely or almost completely mineralized OM and an OC content of 3% and more, that have blackish colours with a moist chroma of < 2 in the first 15 cm and not exceeding 3.5 below, and moist values < 3.5 , that have a BS of $< 35\%$ and a pH (H_2O) of < 5.0 , the exchange complex being dominated by H^+ , and they have only weakly developed structures.
- Sulfic (c1)** Topsoils with 0.75% or more S (dry weight), mostly in the form of sulphides, and $<$ three times as much $CaCO_3$ equivalent as S.
- Surface Seal (r2)** Topsoils where the orientation and packing of dispersed soil particles which have disintegrated from the soil aggregates due to the impact of rain drops. They are formed at the very surface of the soil, rendering it relatively impermeable to water.
- Termitic (f2)** Topsoils with 10% or more of the volume consisting of termite chambers and channels, while the surface is covered by 10% or more termitaria.
- Thixotropic (p1)** Topsoils with a smeary consistence and in which the soil material under pressure suddenly changes to fluid.
- Truncated (d1)** Topsoils that consist of former subsoil layers, which have been exposed by removal of the original surface layer(s) either through accelerated erosion or through land shaping.
- Urbic (a6)** Topsoils that are formed by accumulations from mines, town refuse, fills from urban developments, etc.
- Vermic (f1)** Topsoils with 50% or more of the volume consisting of worm holes, worm casts, or filled animal burrows.
- Vitric (t)** Topsoils with $> 60\%$ glass and associated weatherable minerals in the fine earth fraction, that have $Al(o) + 1/2 Fe(o)$ between 0.4 and 2%, that have an OM content of 1-5%, a BD between 0.9 and 1.2 Mg m^{-3} and a P retention capacity of $< 85\%$.
- Wind-eroded (d5)** Topsoils that have lost $< 5 \text{ cm}$ from their surface by wind action.