Official Handbook

3rd International Soil Judging Contest

August 8-11, 2018
Seropédica, RJ, Brazil

International Union of Soil Sciences

Sociedade Brasileira de Ciência do Solo

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Official Handbook of the 3rd International Soil Judging Contest

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This handbook was compiled by the 3rd International Soil Judging Contest organization team, based in the handbooks of the 1st and 2nd International Soil Judging Contests, carried out in South Korea and Hungary, and considering the necessary adaptations for the Brazilian event.

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GENERAL INFORMATION

As part of the celebrations of the International Decade of Soils and the 21st World Congress of Soil Science, the 3rd International Soil Judging Contest has been organized for August 8-11, 2018 in Seropédica, RJ, Brazil. The occasion is a great opportunity for students, researchers and people interested in soils from around the world to interact and experience some of the landscapes and tropical soils of Brazil.

The scope of the International Soil Judging Contest (ISJC) is for participants to use their knowledge and practical skills to describe, understand and interpret soil characteristics in the field. Participants (in the form of teams and individuals) will describe a series of contest profiles and landscapes using basic field tools, selected standards and guidelines. The winners will be selected on their ability to correctly describe and classify each soil profile and landscape, and interpret their capacity to perform under different uses and management practices.

Based on those activities, the aims of this event are: to encourage the wider adoption of the discipline of soil judging around the world, to give motivated students an opportunity to assess soil in a different part of the world, to give students an opportunity to develop networks in the soil science community, and to demonstrate the career opportunities that soil science offers.

The 3rd ISJC will consist of three days of practice on soil and landscape description, classification and interpretation, followed by a contest day. During the practice days, expert soil scientists will give short information sessions on different aspects of the soil, geology and geomorphology of the region. Each team will have an accompanying academic coach, who will assist participants in the field during the training days, but not during the contest day. The contest day will consist of description, classification and interpretation of two soil profiles and landscapes performed by team and two soil profiles and landscapes performed individually.

Training (3 days)

An international team of soil experts will give an overview of the site, profile description guidelines and soil classification standards. Local soil experts will introduce the landscape and soil conditions of Rio de Janeiro, Brazil, with a focus on the area of the contest. Short classroom sessions will be followed by practical training of field procedures and techniques. Standard samples will be provided for training of texture type, clay and sand percentage estimation. The soils in question will cover a diverse geographical area with a range of topographic, parent material and soil moisture regime conditions. The soils most commonly found in the Seropédica region are Leptosols, Gleysols, Ferralsols, Planosols, Acrisols, Histosols and Cambisols according to the World Reference Base of Soil Resources (WRB) and Entisols, Inceptisols, Alfisols, Ultisols, Oxisols and Histosols according to Soil Taxonomy (ST).

The Contest (1 day)

Participants (teams or individuals) will describe and classify the contest profiles and landscapes, based on the available field tools and selected standards and guidelines. Interpretation of the capacity of the soil to perform under different land uses and management practices will be also scored. The four contest soil profiles will be of the same type of the soil profiles used for training.

Equipment and reference materials

The following equipment will be available with the pit monitor, but in a limited number, so we encourage each team to bring their own.

- Soil knife
- Hand lens
- Water bottle
- Container for soil samples
- Clinometer
- Munsell® Soil Color Chart
- 2 mm sieve

The teams are requested to bring their own Munsell® Soil Color Chart books, as only very limited number can be supplied by the organizers. The soil knife provided will be very small and simple, so we suggest the competitor to bring their own.

All the participants are encouraged to bring their own sunscreen, insect repellent, raincoat, boots, cap and any other important personal material, cause none of them will be provided by the organizing team.

The list of the supplied materials will be available for the participants before the event.

Besides this printed handbook, the following reference materials will be permitted during the contest (but not provided by the organizing team):

- World Reference Base for Soil Resources (IUSS Working Group WRB, 2015)
- Keys to Soil Taxonomy Twelfth Edition (Soil Survey Staff, 2014)
- The official USDA published Illustrated Keys to Soil Taxonomy
- Guidelines for Soil Description (FAO, 2006)
- Field Book for Describing and Sampling Soils (Schoeneberger et al., 2012)

Conduct of the Training

On the 1st day there will be classroom presentations on the soils of Brazil as well as an introduction to important interpretations of soils in the region. After lunch there will be a field training. The 2nd training day will take place focusing on the soils of Seropédica region, in a field trip during the whole day. On the 3rd day there will be a field training focusing on the contest soils. Four profiles will be investigated (two in the morning and two in the afternoon).

A typical section will be selected in each pit and clearly designated as the control section by the contest officials. The control section will be used for measurement of horizon depths and boundaries; it will constitute the officially scored profile and must remain undisturbed and unblocked. All measurements should be made within the designated area. A measuring tape will be placed in the control section at all pits and will be maintained by pit monitors. Several horizons will be described within 150 cm or bedrock depth. A nail will be placed at the bottom of the third horizon from the top of the profile. A card at each site will give the profile depth to be considered, the number of horizons to be identified and described, and chemical or physical data that may be required for classification.

Every participant will get 1 scoresheet per pit (all the scoresheets will be provided by the organizing team – a sample of the scoresheet may be found at the end of this handbook). The scoresheets are to be filled considering the laboratory information and the instructions of this handbook. Teams will be randomly assigned a team color and name at registration. Individual competitors will be assigned a team name and a letter that will be used to identify their scoresheet and the training rotation schedule. The team coaches will receive a schedule of the training, the full laboratory dataset and the already filled practice pit scoresheets that can be used for guidance.

Conduct of the Individual Contest

Sixty minutes will be allowed for evaluating each soil and site for individual judging.

The competitors will be randomly divided into two groups. At the first site, Group 1 will follow this schedule:

1. 10 minutes in the pit,
2. 10 minutes out,
3. 10 minutes in,
4. 10 minutes out, and
5. 20 minutes free-for-all.

Group 2 will follow the opposite in-and-out schedule. At the second site, the groups will switch the in-and-out schedule, with Group 2 in the pit first. Competitors may obtain a sample from the surface horizon while out of the pit, as long as they do not enter the pit or disturb those already in the pit. These procedures may be altered prior to the contest to meet unanticipated difficulties at the site.

General rules of the individual contest:

- Competitors must use official abbreviations (codes) found in this handbook;
- Competitors are not allowed to speak to each other;
- Competitors are not allowed to use mobile phones, tablets, PDA-s or any communication device but may have them on hand in case of health emergency;
- Competitors may have health-related items with them during the contest (such as inhalers or allergy medicine);
- Competitors are allowed to use the equipment provided on site, and the allowed standards.
- Each student will describe two soil pits. The final result will be the average of the two individual-judged pits. No scores are dropped.

Conduct of the Team Contest

Sixty minutes will be allowed for teams to evaluate each of the two team-judged sites. The time will be divided into 10-minute segments similar to the individual contest. Teams that start in at the first pit will start out at the next pit. All competitors on each team may participate in the team contest. The starting time(s) of the team contest will be announced at the coaches' meeting.

General rules of the team contest are the same as the individual contest, with these exceptions:

- Team members are allowed to speak to other team members (only within the team), as long as their conversation is not loud enough to be heard by other teams;
- A maximum of four and a minimum of three students may compete per team in the team judging contest.
- Each team will describe two soil pits. The final result will be the average of the two team-judged pits. No scores are dropped.
- For the overall score only the best three scores at each individually-judged pit will be considered to the team final score. Both team-judged pit scores will count. The final score will consist of the top six individual scores plus the two team scores.

I. SITE CHARACTERISTICS

Land Use

Task on the scoresheet: Determine the land use class according to Table 1.

Table 1. Land use classification (FAO, 2006)

Code	Class
A	Crop agriculture (*annual and perennial field cropping)*
M	Mixed farming (*agroforestry and agropastoralism)*
H	Animal husbandry
F	Forestry
P	Nature protection
S	Settlement, industry (*excavation or disposal sites, recreational use, industrial use, residential use)*
Y	Military area
O	Other land uses
U	Not used and not managed

Slope Position

Task on the scoresheet: Determine the slope position according to Figure 1 and Figure 2. Use the class codes indicated in Table 2. Slope stakes are placed on the same landscape position as the pit.

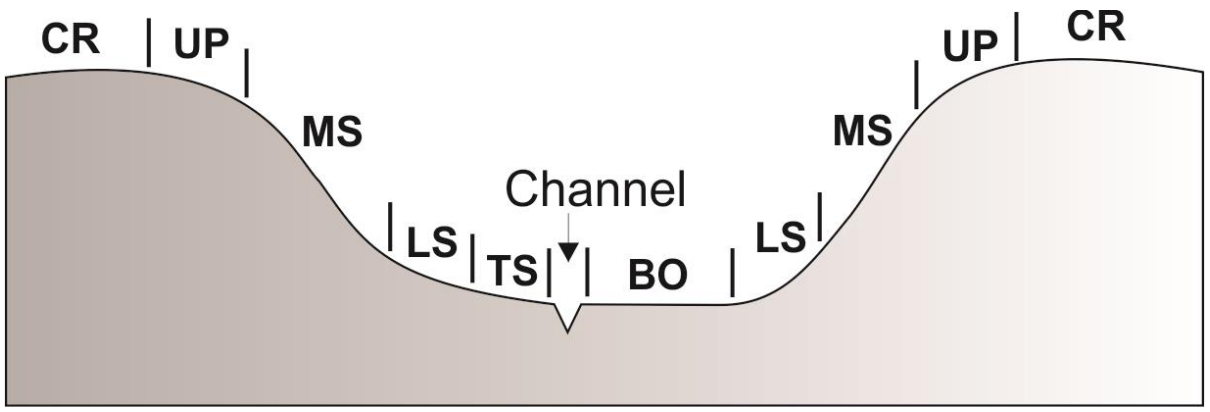

Figure 1. Slope positions in undulating and mountainous terrain (adapted from FAO, 2006)

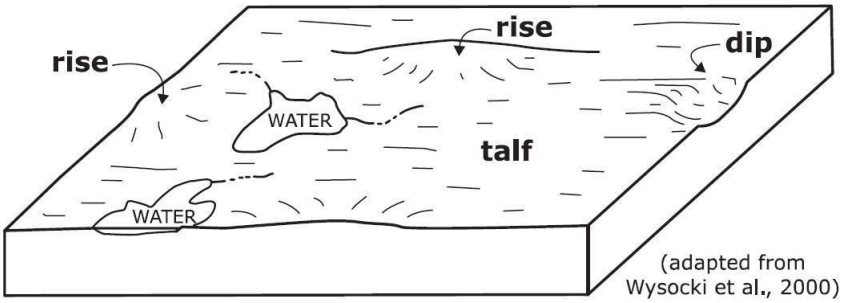

Figure 2. Slope positions in flat/almost flat terrain

Table 2. Slope positions and codes in undulating/mountainous terrain and flat/almost flat terrain

Position in undulating/mountainous terrain		**Position in flat/almost flat terrain**	
Code	Landform	Code	Landform
CR	Crest (summit)	**HI**	Higher part (rise)
UP	Upper slope (shoulder)	**IN**	Intermediate (talf)
MS	Middle slope (backslope)	**LO**	Lower part (dip)
LS	Lower slope (footslope)		
TS	Toeslope		
BO	Bottom (flat terrace or floodplain)		

Slope %

Task on the scoresheet: Determine the slope gradient as a percentage according to the Table 3.

Table 3. Slope gradient class codes (adapted from FAO, 2006)

Code	Class	Slope gradient (%)
01	Level	0 - <2
02	Gently sloping	2 - <5
03	Sloping	5 - <10
04	Strongly Sloping	10 - <15
05	Moderately steep	15 - <30
06	Steep	30 - <60
07	Very steep	≥60

Parent Material

Task on the scoresheet: Determine the parent material according to Table 4.

Table 4. Types of possible parent materials to be indicated (adapted from FAO, 2006)

Code	Lithology
I	Consolidated Igneous
M	Consolidated Metamorphic
S	Consolidated sedimentary
UR	Unconsolidated (uncemented weathered bedrock or saprolite) material
UF	Unconsolidated sedimentary (Fluvial)
UL	Unconsolidated sedimentary (Lacustrine)
UC	Unconsolidated sedimentary (Colluvial)
UE	Unconsolidated sedimentary (Aeolian)

Erosion

Task on the scoresheet: Determine the dominant erosion category using Table 5 and degree of erosion using the Table 6. An off-limits area will be marked for evaluating erosion. If the classification of erosion is "N" the degree of the erosion must be ∅.

Table 5. Classification of erosion, by category (FAO, 2006)

Code	Class
N	No evidence of erosion
WS	Water erosion (Sheet erosion)
WR	Water erosion (Rill erosion)
WG	Water erosion (Gully erosion)
WT	Water erosion (Tunnel erosion)
WA	Water and wind erosion or deposition (Water and wind erosion)
M	Mass movement (landslides and similar phenomena)
AD	Wind (aeolian) deposition (Wind deposition)

Table 6. Classification of erosion, by degree (FAO, 2006)

Code	Class	Description
∅	-	Not applicable
S	Slight	Some evidence of damage to surface horizons.
M	Moderate	Clear evidence of removal of surface horizons.
V	Severe	Surface horizons completely removed and subsurface horizons exposed.
E	Extreme	Substantial removal of deeper subsurface horizons.

Coarse Surface Fragments

Task on the scoresheet: Estimate the abundance of coarse fragments (> 2 mm) over the surface by volume according to the Table 7. You suppose to use the charts available on figure 5, page 18, to estimate the % of coarse fragments.

Table 7. Abundance of coarse fragments by volume (adapted from FAO, 2006)

Code	Class	%
N	None	0
F	Few	>0-5
C	Common	>5-15
M	Many	>15-40
A	Abundant	>40-80
D	Dominant	> 80

II. SOIL DESCRIPTION

Horizon Designations

Task on the scoresheet: Indicate the horizon designation including a numeric prefix (Prefix), a capitalized alphabetic master designation (Master), a lower case alphabetic subordinate designation (Sub) and if applicable, a numerical subdivision (No.).

Horizon – Master – Letter (Master horizons and layers) Horizon designations to be used are indicated in Table 8.

Table 8. The master horizons (FAO, 2006)

Code	Description
Mineral horizons	
A	Surface or near-surface mineral horizon with some organic accumulation, usually a darker colour than underlying horizons and/or smaller clay content than underlying horizons.
E	A near-surface mineral horizon characterized by a loss of clay, iron, aluminum, or some combination of these; usually lighter in color (higher value and/or lower chroma) than the overlying A and underlying B.
B	A mineral horizon characterized by one or more of the following: a concentration of clay, iron, aluminum, organic material or several of these; a structure and/or consistence unlike the horizons above and below; stronger colours (higher chroma and/or redder hue) than the horizons above and below.
C	Consolidated or unconsolidated material, usually partly chemically weathered, otherwise little affected by pedogenic processes. Includes weakly-moderately cemented bedrock.
R	Hard, strongly cemented bedrock that cannot be cut with a spade.
Organic horizons	
O	Horizons dominated by organic materials that have accumulated on the surface of either mineral or organic soils. O horizons are not saturated with water for prolonged periods.
H	These horizons dominated by organic material formed from accumulations of undecomposed or partially decomposed organic material. All H horizons are saturated with water for prolonged periods, or were once saturated but are now drained artificially.

Transitional Horizons

There are two kinds of transitional horizons: those with properties of two horizons *superimposed*; and those with the two properties *separate.*

For horizons dominated by properties of one master horizon but having subordinate properties of another, two capital letter symbols are used, such as AB, EB, BE and BC. The

master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon.

Horizons in which distinct parts have recognizable properties of two kinds of master horizons are indicated as above, but the two capital letters are separated by a slash (/), such as A/C, B/E, B/C, etc.

Horizon – Master – Prefix (Discontinuities)

In mineral soils, Arabic numerals are used as prefixes to indicate that a soil has not formed entirely in one kind of material, which is referred to as a lithologic discontinuity. Wherever needed, the numerals precede the master or transitional horizon designation. A discontinuity is recognized by a significant change in particle-size distribution or mineral suite that typically indicates the horizons formed in different parent materials (Table 4). Stratification common to soils formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (is strongly contrasting), even if genetic horizons have formed in the contrasting layers.

When a discontinuity is identified, prefix numbering starts in the material underlying the surficial deposit and is designated by adding a prefix of '2' to all horizons and layers that formed in the material underlying the discontinuity (note the '1' is implied and not actually added to the surface deposit). If a surficial deposit of differing parent material is found, the material must extend below the A horizon in order to be identified as a separate deposit. There is no minimum number of horizons and layers needed in materials that underlie the surficial deposit to be marked as a separate deposit. If another discontinuity is found below material with prefix '2', the horizons and layers formed in the third material are designated by the prefix '3'. For example, Ap, E, Bt1, 2Bt2, 2Bt3, 3BC. The number suffixes designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity. A discontinuity prefix is not used to distinguish material of buried (b) horizons that formed in material similar to that of the overlying deposit (no discontinuity). For example, A, Bw, C, Ab, Bwb1, Bwb2, C.

If there is no discontinuity present, place a dash (–) in the prefix box for each horizon.

Horizon – Suffix (Subordinate characteristics within master horizons and layers)

Designations of subordinate distinctions and features within the master horizons and layers are based on profile characteristics observable in the field and are applied during the description of the soil at the site. Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features. Subordinate characteristics that may be used are found in Table 9. Subordinates can be used with any master or transitional horizon if needed. For example: Ap, BA, Bt1, Bt2, BCt, C.

Table 9. The suffixes to be used (FAO, 2006)

Suffix	Description	Used for
b	Buried genetic horizon	mineral horizons
c	Concretions or nodules	mineral horizons
g	Stagnic conditions/strong gley	mineral horizons
l	Capillary fringe mottling (gleying)	no restriction
p	Ploughing or other human disturbance	surficial horizon
r	Strong reduction	no restriction
t	Illuvial accumulation of clay	mineral horizons
v	Plinthite	mineral horizons
w	Development of colour or structure	B horizons
x	Fragipan characteristics	no restritions

Horizon – Number (No) (Vertical subdivisions)

Horizons or layers designated by a single combination of letter symbols can be subdivided using Arabic numerals, which follow all the letters.

These conventions apply whatever the purpose of subdivision. A horizon identified by a single letter symbol may be subdivided on the basis of evident morphological features, such as structure, colour or texture. These subdivisions are numbered consecutively.

Horizon Boundary

Task on the scoresheet: Determine the *depth (cm)* from the mineral soil surface to lower boundary of each horizon except the last horizon. Determine the *distinctness* of the horizon boundaries and the *topography* of the horizon boundary according to the Table 10 and Figure 3. No boundary is described for the lowest horizon.

Table 10. Classification of horizon boundaries by distinctness and topography (FAO, 2006)

Distinctness			Topography		
Code	Class	cm	Code	Class	Description
A	Abrupt	0-2	S	Smooth	Nearly plane surface
C	Clear	>2-5	W	Wavy	Pockets less deep than wide
G	Gradual	>5-15	I	Irregular	Pockets more deep than wide
D	Diffuse	>15	B	Broken	Discontinuous

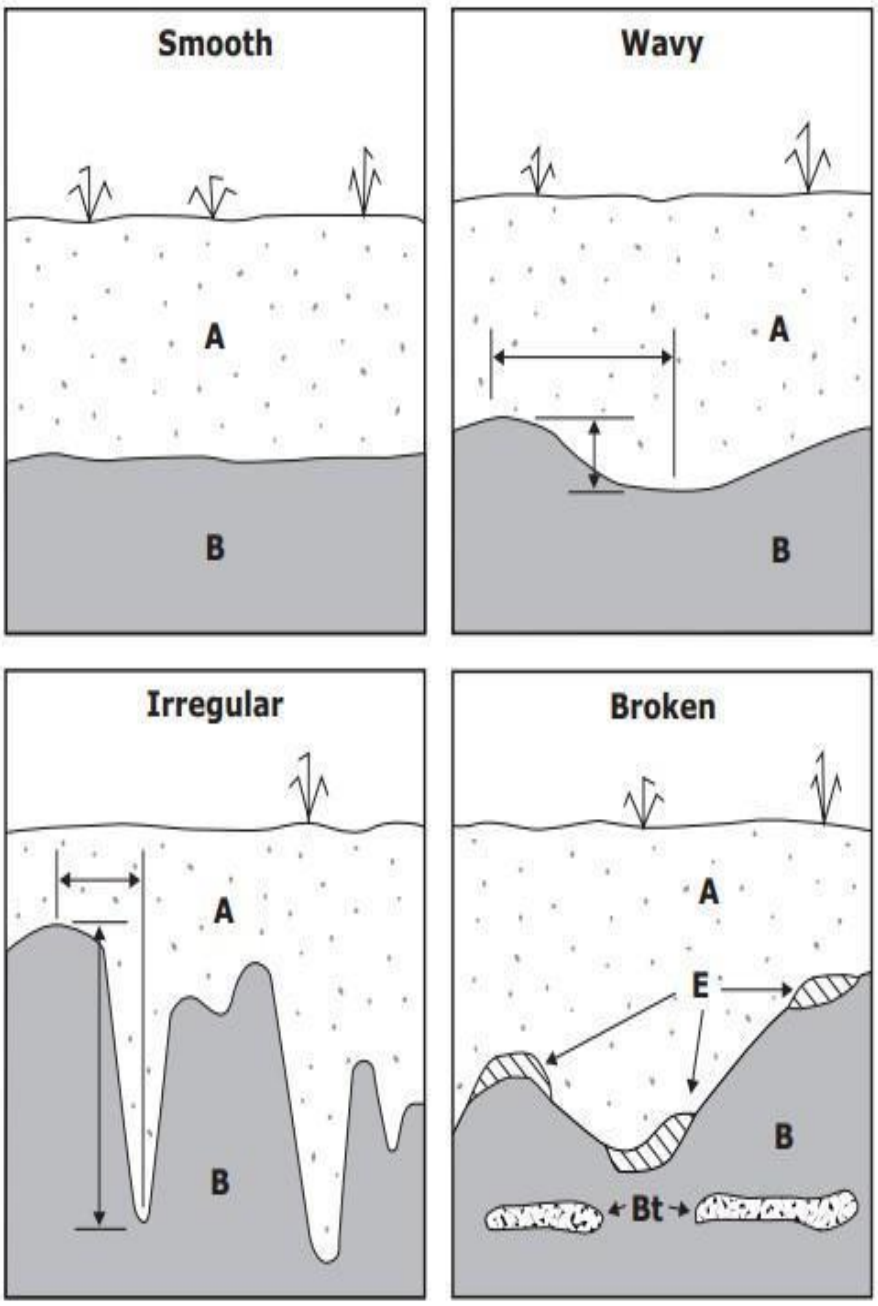

Figure 3. The categories of horizon topography (Schoeneberger et al., 2011)

Soil color

Task on the scoresheet: Use the Munsell® naming system to determine the moist color of each horizon described. Colors must be designated by Hue, Value and Chroma.

For routine descriptions, soil colours should be determined out of direct sunlight and by matching a broken ped with the colour chip of the Munsell® soil color charts. For special purposes, such as for soil classification, additional colours from crushed or rubbed material may be required.

Texture

Task on the scoresheet: Estimate the clay, silt, and sand content for each horizon. Determine the textural class using the USDA Textural Classification chart (Figure 4) and use the coding indicated in Table 11.

Table 11. The coding of texture classes (FAO, 2006)

Code	Class	General category
S	Sand	Sand
LS	Loamy sand	
SL	Sandy loam	Loam
SCL	Sandy clay loam	
SiL	Silt loam	
SiCL	Silty clay loam	
CL	Clay loam	
L	Loam	
Si	Silt	Silt
SC	Sandy clay	Clay
SiC	Silty clay	
C	Clay	

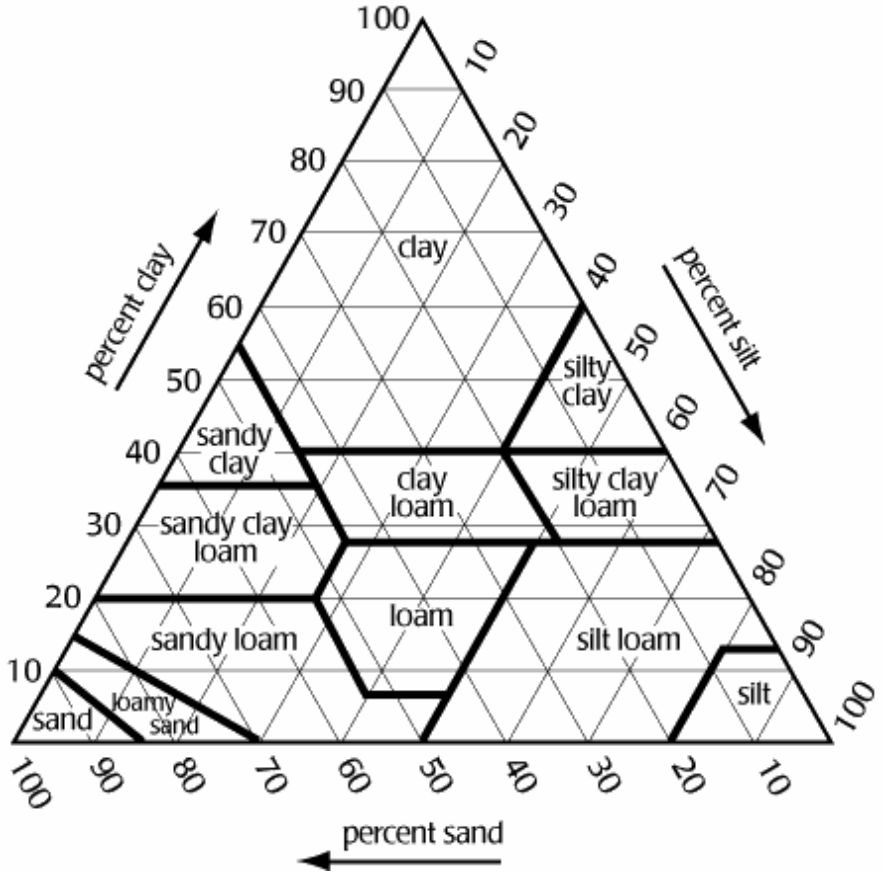

Figure 4. Relation of constituents of fine earth by size, defining textural classes (FAO, 2006)

In addition to the textural class, a field estimate of the percentage of clay and sand are given. This estimate is useful for indicating increases or decreases in clay and/or sand content within textural classes, and for comparing field estimates with analytical results.

Rock Fragments and Artefacts (R.F./AF)

Task on the scoresheet: Estimate the abundance of rock fragments or artefacts into the profile horizons (> 2 mm) by volume according to the Table 12. Use the figure 5 to estimate the % of the fragments.

Table 12. Abundance of internal fragments by volume (adapted from FAO, 2006)

Code	Abundance	%
N	None	0
F	Few	>0-5
C	Common	>5-15
M	Many	>15-40
A	Abundant	>40-80
D	Dominant	> 80
S	Stone line	Any content, but concentrated at a distinct depth within a horizon

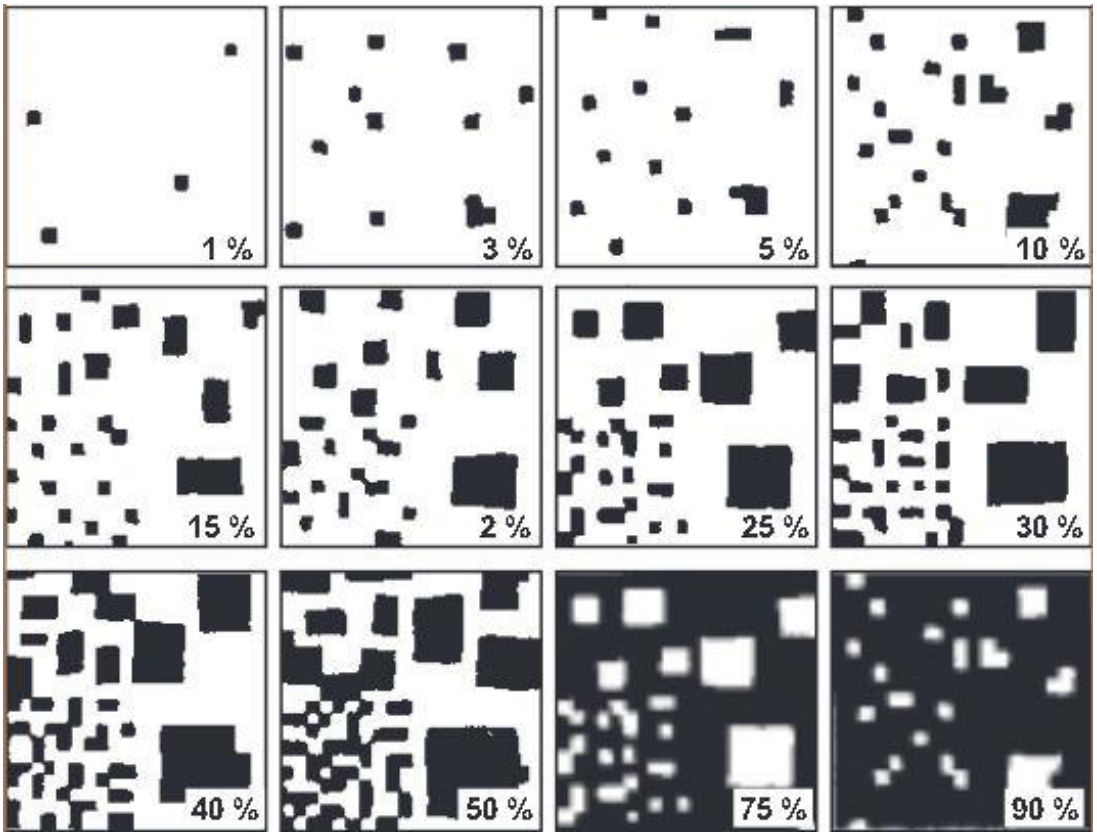

Figure 5. Charts for estimating proportions of coarse fragments (FAO, 2006)

Structure

Task on the scoresheet: Record the dominant structure type for each horizon using Figure 6 and Table 13. Record the dominant structure grade for each horizon using the codes indicated in Table 14. If the structure type is SGR or MA the structure grade must be ∅.

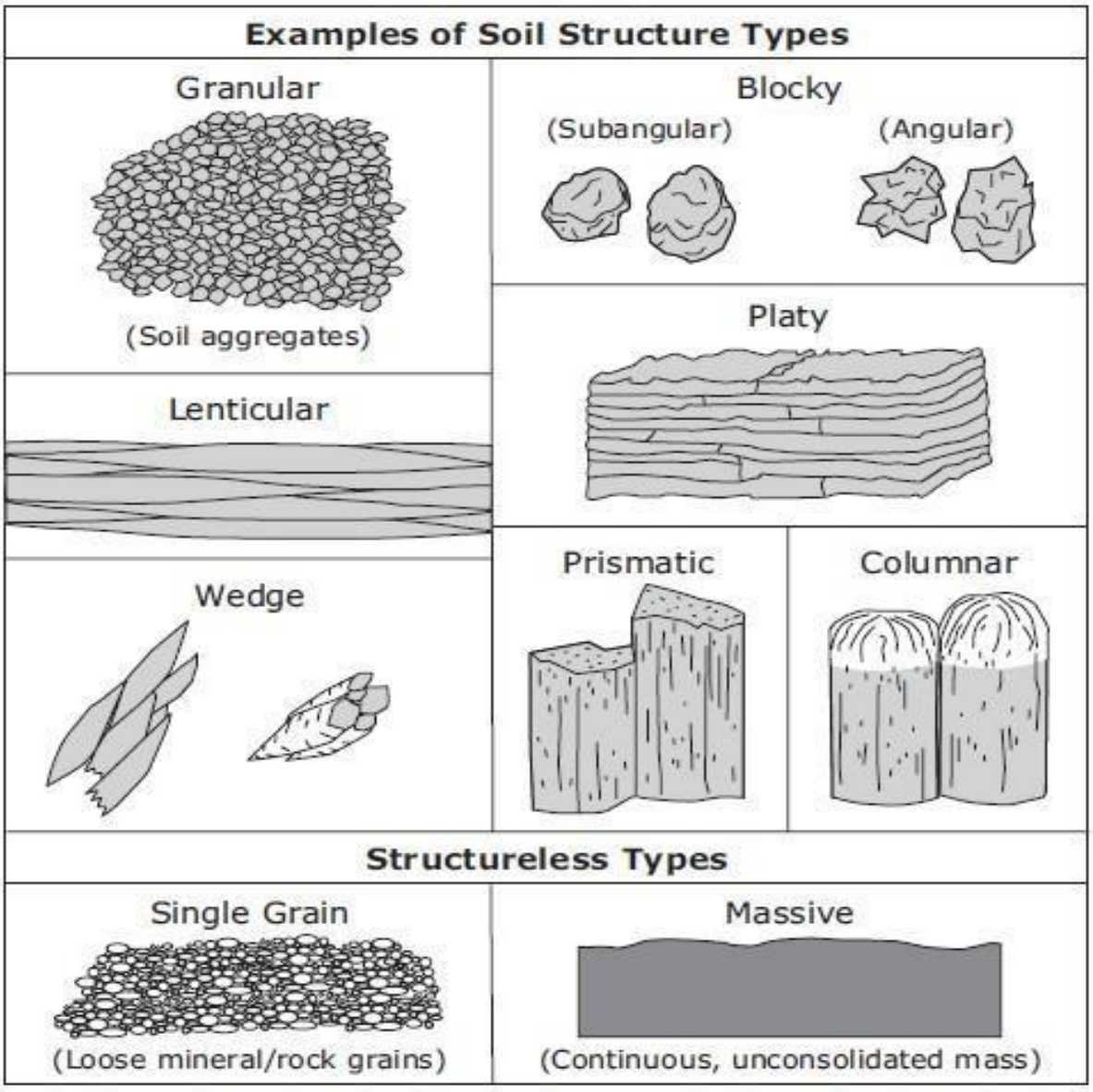

Figure 6. Examples of soil structure types (Schoeneberger et al., 2011)

Table 13. Classification of soil structure (Schoeneberger et al., 2011)

Code	Type	Description
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)		
GR	Granular	Small polyhedrals with curved or very irregular faces.
AB	Angular blocky	Polyhedrals with faces that intersect at sharp angles (planes).
SB	Subangular blocky	Polyhedrals with subrounded and planar faces lacking sharp angles.
PL	Platy	Flat and platelike units.
WG	Wedge	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials.
PR	Prismatic	Vertically elongated units; flat tops.
CO	Columnar	Vertically elongated units with rounded tops that commonly are "bleached."
STRUCTURELESS		
SG	Single grain	No structural units; entirely noncoherent; e.g. loose sand.
MA	Massive	No structural units; material is a coherent mass (not necessarily cemented).
ARTIFICIAL EARTHY FRAGMENTS OR CLODS (nonpedogenic structure)		
CD	Cloddy	Irregular blocks created by artificial disturbance; e.g., tillage or compaction.

Table 14. Classification of structure grade of pedal soil materials (FAO, 2006)

Code	Class	Description
WE	Weak	Aggregates are barely observable in place and there is only a weak arrangement of natural surfaces of weakness. When gently disturbed, the soil material breaks into a mixture of few entire aggregates, many broken aggregates, and much material without aggregate faces.
MO	Moderate	Aggregates are observable in place and there is a distinct arrangement of natural surfaces of weakness. When disturbed, the soil material breaks into a mixture of many entire aggregates, some broken aggregates, and little material without aggregates faces.
ST	Strong	Aggregates are clearly observable in place and there is a prominent arrangement of natural surfaces of weakness. When disturbed, the soil material separates mainly into entire aggregates.

Redoximorphic Features

Task on the scoresheet: Indicate the type of redox concentrations or depletions (Table 15).

Redoximorphic (RMF) features are soil morphological features caused by alternating reduction/oxidation processes. The reduction/oxidation of iron (Fe) and, to a lesser extent, manganese (Mn), minerals result in most RMF features. Iron is a major pigment that influences soil color. The loss, accrual, and valence/mineral state of Fe are major determinants of color patterns within or across soil horizons. Fe or Mn reduction occurs when free oxygen is limited or excluded from a soil volume or horizon by water saturation for extended time. Reduced iron (Fe^{2+}) is comparatively much more soluble and mobile than oxidized iron (Fe^{3+}), and moves with water flow and by diffusion gradients. When soil is reduced, Fe and Mn in local zones can be removed, leaving *uncoated mineral grains (depletions)* of lighter color. Reduced Fe is oxidized and precipitates when water drains from soil (re-entry of free oxygen), or where oxygen is present in, or along, soil pores, including root channels, or along roots. The re-oxidized Fe or Mn may form crystals, soft masses, or *hard concretions or nodules (concentrations)*. Oxidized Fe will generally have a redder or yellower color than adjacent soil particles, while Mn often will have a darker color than adjacent soil particles.

Redox concentrations are defined as zones of Fe-Mn accumulation from:

Nodules and concentrations – concentrations have internal rings and nodules do not.

Masses – are non-cemented concentrations within ped interiors.

Pore linings – may be either coatings on pore surfaces or impregnations from the matrix adjacent to pores.

Redox depletions are defined as zones with chromas less than 2. They may be identified as:

Iron depletions – zones that contain lesser amounts of Fe and Mn oxides but have clay content similar to that of the adjacent matrix.

Clay depletions – zones that contain lesser amounts of Fe, Mn, and clay compared to the adjacent matrix.

Concentrations and depletions are present compared to the described, dominant soil matrix color in the hue, value, and chroma columns. If the dominant soil color is described as a depleted matrix (with a value of 2 or less) ***and*** concentrations are present, depletions should not be indicated in the (Conc/Dep) column and a 'g' should be used as the Master horizon suffix (e.g. Btg) instead.

Table 15. Types of redoximorphic features to be indicated on the scoresheet

Class	Types
∅	Redoximorphic features absent
CONC	Nodules and Concentrations, Masses, or Pore linings
DEP	Iron depletions with value ≥ 4 and chroma ≤ 2, or Clay depletions
CONC/DEP	Concentrations and depletions with value ≥ 4 and chroma ≤ 2

Coatings

Task on the scoresheet: Determine the nature of the coatings using Table 16.

Table 16. Classification of coatings (FAO, 2006)

Code	Nature
C	Clay
H	Humus
CC	Calcium Carbonate
S	Salt coatings

III. SOIL PROFILE CHARACTERISTICS

For each of the four characteristics to be assessed, competitors are to place an 'X' in one box only.

Hydraulic conductivity

Task on the scoresheet: Determine the hydraulic conductivity of the *surface* and the *most limiting* horizon.

Critical for agronomic soil functions and partitioning of rainfall, we will estimate the saturated hydraulic conductivity of the surface horizon (*Surface*) and the most limiting horizon (*Restrictive layer*) within the depth specified on the scoresheet. If a lithic or paralithic contact occurs at or above the specified depth, it should be considered in evaluating conductivity.

Three general hydraulic conductivity classes are used:

High (H) – includes *sand* and *loamy sand* texture classes. *Sandy loam*, *sandy clay loam*, *silt loam* and *loam* texture grades that are especially 'loose' because of very high organic matter content (>5% organic carbon) also fall into this category. Horizons containing >60% of coarse fragments with insufficient fines to fill voids between fragments are also considered to have high hydraulic conductivity.

Moderate (M) – this includes those materials excluded from 'low' and 'high' classes.

Low (L) – low hydraulic conductivity is indicated with any of the following:

- *Clays*, *silty clays* or *sandy clays* having structure grade of MO or WE; or structureless and massive.
- *Silty clay loam*s and *clay loams* that have a structure grade of WE; or structureless and massive.
- Bedrock layers (Saprolite or Rock) where the horizon directly above contains redoximorphic depletions or a depleted matrix due to prolonged wetness (value ≥4 with Chroma ≤2).

Effective Soil Depth and Type of Restrictive Layer

Task on the scoresheet: Determine the effective soil depth category.

Soil depth classes are defined as the depth from the soil surface to the upper boundary of a root restricting layer. Restrictive layers include:

- bedrock (lithic or paralithic materials);
- SiC, C or SC texture grades that are structureless and massive;
- B horizon with SiC, C or SC texture grades and a textural gradient B/A > 2;
- Excessive presence of gravel (above 30% by volume);

- Excessive presence of plinthite/iron concretions (above 30% by volume).

If the lower depth of judging is less than 150 cm, and there is no restricting layer within or at the judging depth, the horizon encountered at the bottom of the judged profile may be assumed to continue to at least 150 cm and 'very deep' should be selected.

Available Water-Holding Capacity (AWC)

Task on the scoresheet: Determine the available water-holding capacity of the soil.

Critical to agronomic interpretations for crop growth, the available water-holding capacity is approximately the water held between field capacity and permanent wilting point. The approximate amount of moisture stored in the soil is calculated for the top 150 cm of the soil profile or to a root-limiting layer if on is shallower than 150 cm. This soil thickness may or may not be the same as that designated for the purposes of profile descriptions. The total water is calculated by summing the amount of water held in each horizon or portion of horizon, if the horizon extends beyond 150 cm. If a horizon or layer is unfavourable for roots (as defined under effective soil depth), this and all horizons below should be excluded in calculating the available moisture. For available water calculations, the properties of the lowest horizon designated for description can be assumed to extend to 150 cm, if no restrictive layer is present. If a restrictive layer is present between the lowest described horizon and the 150 cm depth, the depth to the restrictive layer should be considered for available water estimations. Four retention classes listed in the Table 17 will be used:

Table 17. Water retention classes

Code	Class	Description
VL	Very low	≤7.5 cm
L	Low	7.6 to ≤15.0 cm
MO	Moderate	15.1 to ≤22.5 cm
H	High	>22.5 cm

The relationship between available water retained per centimeter of soil and the textures is given in the Table 18. Coarse fragments are considered to have negligible (assume zero) moisture retention, and estimates must be adjusted to reflect the coarse fragment content. If a soil contains coarse fragments, the volume occupied by the rock fragments must be estimated and the available water holding capacity corrected accordingly.

For example, if a silt loam A horizon is 25 cm thick and contains rock fragments which occupy 10% of its volume, the available water-holding capacity of the horizon would be **25 cm × 0.20 cm/cm × [(100-10)/100] = 4.50 cm** of water. Calculate the available water for each horizon to the nearest hundredth, sum all horizons, then round the grand total to the nearest tenth. For example, 14.92 would round to 14.9 in the low class; 15.15 would round to 15.2 in the moderate class.

Texture is an important factor influencing available water holding capacity, and the following estimated relationships are used:

Table 18. Water retention capacity classes

Available Water Capacity (cm water per cm soil)	Texture classes
0.05	sand, loamy sand
0.10	sandy loam
0.15	sandy clay loam, sandy clay, clay, silty clay, loam, clay loam
0.20	silt loam, silt, silty clay loam

Soil Wetness Class

Task on the scoresheet: Determine the soil wetness class

Critical for understanding the effects of critical soil function of flooding, partitioning of water, drainage, habitat, water purification, and construction, soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Landscape position, slope gradient, infiltration rate, surface runoff, and permeability, are significant factors influencing the soil wetness class. Redoximorphic features, including concentrations, depletions and depleted matrix, are the common indicators of prolonged soil saturation and reduction (wet state), and are used to assess soil wetness class. The following determines the depth of the 'wet state':

(1) The top of an A horizon with:

a. Matrix chroma ≤2, and

b. Redoximorphic depletions with value ≥4 and chroma ≤2; or redoximorphic concentrations as soft masses or pore linings, and

c. Redoximorphic depletions with value ≥4 and chroma ≤2; or a depleted matrix with value ≥4 and chroma ≤2 due to prolonged saturation and reduction in the horizon directly below the A horizon, or

(2) The shallowest observed depth of value ≥4 with chroma ≤2 redoximorphic depletions or depleted matrix due to prolonged saturation and reduction.

The wetness classes utilized in this contest are those which define a 'depth to the wet state' (Table 19).

Table 19. Wetness classes

Class	Description
1	Not wet at 150 cm depth or above.
2	Wet in some part between 101 and 150 cm.
3	Wet in some part between 51 and 100 cm.
4	Wet in some part between 26 and 50 cm.
5	Wet at 25 cm or shallower.

Notes:

If no evidence of wetness exists within the specified depth for judging and that depth is less than 150 cm, then assume Class 1: not wet at 150 cm or above.

Do not evaluate the soil for wetness below the depth to be described.

IV. INTERPRETATIONS

For most rapid analysis of limitations:

1. Start in the right column of the tables.
2. Read down the column, checking the criteria.
3. If one factor is met in the right-hand column, place a mark in the Class 3 box on the scoresheet.
4. If no factors are met in the right-hand columns, check the middle column. If one factor is met in the middle column, place a mark in the Class 2 box on the scoresheet.
5. If none are met in either the right-hand or middle column, place a mark in the Class 1 box on the scoresheet.

Vegetable Production

Task on the scoresheet: Use the following table to assess the suitability of the soil and site for vegetable production, with the most limiting factor of any of the six soil attributes to allocate a soil to a suitability class. Use a 'X' to select on suitability class.

Factors	Suitability		
	Class 1 Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Texture class in thickest horizon with upper boundary ≤ 20 cm	S, LS, SL, L	SiL, Si, CL, SiCL, SCL	SC, SiC, C
2. Slope (%)	<2	2–15	>15
3. pH in the upper 20 cm of soil	5.5-7.0	5.0-5.5	<5.0 and >7.0
4. Hydraulic conductivity of most limiting layer in profile	High	Moderate	Low
5. Depth to root restriction or abrupt textural change (cm)	>50	20–50	<20
6. Erosion degree	None (Θ) or (S) slight	Moderate (M);	Severe (V) or Extreme (E)

Silvopastoral Production

Task on the scoresheet: Assess the suitability of silvopastoral production by assessing a range of soil and land features with the most limiting factor of any of the six soil attributes used to allocate a soil to a suitability class.

Factor	Suitability		
	Class 1 Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Effective soil depth (cm)	> 100	100-50	<50
2. Erosion degree	None (Θ)	Slight degree (S)	All other erosion type and degree
3. Slope (%)	<5	5 – <20	20 or more
4. Available Water- Holding capacity(AWC) class	High	Low or Moderate	Very low
5. Wetness Class	Class 1 or 2	Class 3	Class 4 or 5
6. Rock Fragment (%) in the upper 20 cm	<15	15-35	>35

Local Roads and Streets for Community Planning

Task on the scoresheet: Assess the suitability of building local roads and streets by assessing a range of soil and land features with the most limiting factor of any of the six soil attributes used to allocate a soil to a suitability class.

Limitations			
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Flooding	None	Not a choice	Flooding occurs
2. Slope (%)	<5	5 – <20	20 or more
3. Rock Fragment (%) in the upper 20 cm	>50	<50	Not a choice
4. Shrink swell potential anywhere in the upper 100 cm when soil is dry	No slickensides present	Not a choice	Slickensides present
5. Wetness Class	Class 1, 2, or 3	Class 4	Class 5
6. Effective soil depth (cm)	>50	<50	Not a choice

V. DIAGNOSTICS AND SOIL CLASSIFICATION

The team and individual competitors can choose between the Soil Taxonomy (Twelfth Edition, 2014) and the World Reference Base for Soil Resources (2015). For each contest profile, the maximum possible points obtainable from the Soil Classification part will be the same for both the Soil Taxonomy and WRB parts. Chemical data necessary for the classification will be provided at each pit on a pit card.

World Reference Base for Soil Resources (2015)

Diagnostic horizons/properties/materials

Task on the scoresheet: Use a cross (X) to select as many diagnostic horizons/properties/materials that apply to the profile within the specified judging depth. For detailed information on the horizons/properties/materials see the WRB 2015. Credit for each correct answer. Only excess answers are incorrect. For example, if two choices are needed and the student puts three, the excess one is incorrect automatically.

Reference soil group

Task on the scoresheet: Use a cross (X) to select one Reference Soil Group (RSG) only. Use the key to the RSG of the WRB.

Principal qualifiers

Task on the scoresheet: Use a cross (X) to select only the first two principal qualifiers that applies to the profile within the specified judging depth. For detailed information on the principal qualifiers see the WRB 2015.

Soil Taxonomy (2014)

Epipedon

Task on the scoresheet: Use a cross (X) to select one epipedon that applies to the profile. For detailed information on the epipedon definitions see the Keys to Soil Taxonomy, 12th Edition.

Subsurface horizons

Task on the scoresheet: Use a cross (X) to select as many of the subsurface horizons to the profile within the specified judging depth. For detailed information on the subsurface horizon definitions see the Keys to Soil Taxonomy, 12th Edition.

Diagnostic characteristics

Task on the scoresheet: Use a cross (X) to select as many of the diagnostic characteristics to the profile within the specified judging depth. For detailed information on the diagnostic characteristic definitions see the Keys to Soil Taxonomy, 12th Edition

Order

Task on the scoresheet: Use a cross (X) to select only one soil order. See the Key to Soil Orders in the keys to Soil Taxonomy, 12th Edition.

Suborder

Task on the scoresheet**:** Use a cross (X) to select only one soil suborder.

Great group

Task on the scoresheet**:** Use a cross (X) to select only one soil great group.

REFERENCES

FAO (2006): Guidelines for Soil Description. Food and Agriculture Organization of the United Nations, Rome. www.fao.org/3/a-a0541e.pdf

IUSS Working Group (2015): World Reference Base for Soil Resources. World Soil Resources Report 106. Food and Agriculture Organization of the United Nations, Rome. www.fao.org/soils-portal/soil-survey/soil-classification/world-reference-base/en/

Official Handbook of the Inaugural International Soil Judging Contest, June 5 -7, 2014, Jeju, Korea

Official Handbook of the International Year of Soils (IYS) 2015 Field Course and Soil Judging Contest, September 1-5, 2015, Gödöllő, Hungary. http://soiljudging-iys2015.com/wp-content/uploads/2015/08/IYSSJ_handbook_FINAL.pdf

Schoeneberger, P. J., Wysocky D. A., Benham, E. C., Soil Survey Staff (2012): Field Book for describing and sampling soils, Version 3.0., National Resources Conservation Service, National Soil Survey Center, Lincoln, NE.
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054184

Soil Survey Staff (2014): Keys to Soil Taxonomy. United States Department of Agriculture National Resources Conservation Service. Twelfth Edition.
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/taxonomy/?cid=nrcs142p2_053580

SCORING INFORMATION

<table>
<tr><td colspan="2">SITE CHARACTERISTICS /EROSION/SURFACE CHARACTERISTICS</td></tr>
<tr><td>Land use type
Slope position
Slope %
Parent material
Erosion category
Erosion degree
Crack width
Crack depth
Crack distance
Salt characteristics (cover %)
Salt characteristics (thickness)</td><td>Only one answer for each is correct. If the correct answer is given, 1 point will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td colspan="2">SOIL DESCRIPTION</td></tr>
<tr><td>Master prefix</td><td>If the correct answer is given, 1 point will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td>Master horizon letter</td><td>If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td>Suffix</td><td>Multiple suffixes might be correct. The maximum number of indicated suffixes is three. If all of the required suffixes are indicated 3 points will be awarded. The following examples illustrate the case when incorrect answer is given or suffix/suffixes is/are missing.
<table>
<tr><th>Correct answer</th><th>Competitor answer</th><th>Calculation</th><th>Net Point(s)</th></tr>
<tr><td>Bk</td><td>Bk</td><td>+3-0</td><td>3</td></tr>
<tr><td>Bk</td><td>Bl</td><td>+3-3</td><td>0</td></tr>
<tr><td>Bhs</td><td>Bs</td><td>+3-1</td><td>2</td></tr>
<tr><td>Btnh</td><td>Bt</td><td>+3-2</td><td>1</td></tr>
<tr><td>Btnh</td><td>Btsg</td><td>+3-2</td><td>1</td></tr>
</table></td></tr>
<tr><td>No.</td><td>If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Boundary lower depth</td><td>The threshold of correct lower depth readings will depend on the distinctness of the boundary. Abrupt/Clear: ± 5 cm, Gradual/Diffuse: ± 10 cm. If the answer is correct 2 points will be awarded. If the answer is incorrect 0 point will be awarded.</td></tr>
<tr><td>Boundary distinctness</td><td>If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Boundary topography</td><td>If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
</table>

Soil Color HUE	If the correct answer is given 1 point will be awarded. If incorrect answer is given 0 points will be awarded.
Soil color value	If the correct answer is given 2 points will be awarded. If the answer is lower or higher than the correct one by 1 value category 1 points will be awarded. If the answer is lower or higher than the correct one by 2 value category 0 point will be awarded.
Soil color chroma	If the correct answer is given 2 points will be awarded. If the answer is lower or higher than the correct one by 1 chroma category 1 points will be awarded. If the answer is lower or higher than the correct one by 2 chroma category 0 point will be awarded.
Texture clay %	A range of correct answers from the lab data ± 5% are accepted for full credit. Outside of this range gets 0 points.
Texture sand %	A range of correct answers from the lab data ± 5% are accepted for full credit. Outside of this range gets 0 points.
Texture class	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
Rock fragments and artefacts	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
Structure grade	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
Structure type	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
Redox features	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
Coatings nature	If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.
SOIL PROFILE CHARACTERISTICS/INTERPRETATIONS	
Hydraulic conductivity/ Effective soil depth/ Type of the restrictive layer/ AWHC/Soil Wetness class/ Potato production/ Irrigated Corn Production/ Local Roads for comm. planning	If the correct answer is given, 3 points will be awarded. If incorrect answer is given 0 points will be awarded.
DIAGNOSTICS AND SOIL CLASSIFICATION - WRB	
Horizons	Multiple answers might be correct. If correct horizons are marked 10 points will be awarded for each one. If incorrect horizons are marked -10 points will be awarded. The overall score cannot be lower than 0.
Properties	Multiple answers might be correct. If correct properties are marked 5 points will be awarded for each one. If incorrect

	properties are marked -5 points will be awarded. The overall score cannot be lower than 0.
Material	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
RSG	Only one answer is correct. If the correct RSG is marked 15 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Principal qualifiers	Multiple answers might be correct. If correct qualifiers are marked 5 points will be awarded for each one. If incorrect prefix qualifiers are marked -5 points will be awarded. The overall score cannot be lower than 0.
DIAGNOSTICS AND SOIL CLASSIFICATION - SOIL TAXONOMY	
Epipedon	Only one answer is correct. If the correct RSG is marked 10 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Subsurface horizon	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
Diagnostic characteristics	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
Order	Only one answer is correct. If the correct RSG is marked 10 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Suborder	Only one answer is correct. If the correct RSG is marked 5 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Great Group	Only one answer is correct. If the correct RSG is marked 5 points will be awarded. If incorrect RSG is marked 0 points will be awarded.