GROW OBSERVATORY

| Term | Definition |
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| A Horizon | Topsoil layer, composed of a mix of organic and mineral components and usually full of soil life. A good topsoil is ideal for growing plants. |
| Absolute volumetric water content | The quantity of water in soil measured by volume. |
| Actual Evapotranspiration (AET) | A measure of how much water moves from the earth to the atmosphere and is determined by how much water is available, linked to precipitation. |
| Aggregate | Groups of soil particles that bind to each other more strongly than to adjacent particles. The space between the aggregates provide pore space for retention and exchange of air and water. |
| Agroecology | An ecosystem-focused approach to agriculture that applies ecological concepts and principles to food production. It aims to minimise negative environmental impacts and improve the function, diversity and resilience of the whole ecosystem. |
| Agroforestry | An umbrella term for all growing practices using trees as the main component (except traditional forests), including food forests and forest gardens, where different fruit trees are combined with other edible plants and shrubs to more traditional orchard-like plantations. |
| Ammonification | The process when soil bacteria or fungi convert nitrogen locked away in organic material to back into ammonium. |
| Ammonium (NH4) | A form of nitrogen chemically combined with hydrogen which is common in oxygen-poor or low pH soils but is more toxic than nitrate to most crop plants. |
| Anthroposphere | The anthroposphere is the part of the environment made or modified by humans for use in human activities and human habitats. |
| Arenosols | Sandy-textured soils that lack any significant soil profile development. They exhibit only a partially formed surface horizon (uppermost layer) that is low in humus, and they are bereft of subsurface clay accumulation. Given their excessive permeability and low nutrient content, agricultural use of these soils requires careful management. |
| Aspect | The direction a slope faces - north, east, south-west and so on. |
| Atmosphere | A layer - or a set of layers - of gases surrounding a planet. |

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| Available water | The amount of water available to a plant that is stored in the soil at field capacity minus the water that will remain in the soil at a permanent wilting point. |
| B horizon | A layer of soil that is commonly referred to as the subsoil; mainly a mineral soil but much more broken up by chemical and physical weathering than the rocks below. |
| Backscatter | The amount of the outgoing radar signal from the scientific instrument on the satellite that the target (i.e.. Earth's surface) redirects directly back towards the radar antenna on the satellite. |
| Bar (column) chart | A useful way to represent relative counts of data. The height of each bar will clearly show which categories have more or less of the variable. |
| Bias | In a scientific experiment, this is a prejudice, preference or error that can mean the findings do not well reflect the 'true' result. Bias can occur in several ways e.g. when selecting or excluding individuals or areas to measure; when deciding how to analyse the findings; or when deciding what to report. A good experimental design should reduce potential bias. |
| Biodiversity | The variety of life and can be measured in many ways including genetic diversity, species diversity, and ecosystem diversity. |
| Biome | A large naturally occurring community of flora and fauna occupying a major habitat, e.g. forest or tundra. |
| Bioregion | A relatively large land area (region) defined by characteristics of the natural environment - rather than the human environment. |
| Biosphere | The layer of the planet where life exists, also known as the ecosphere. |
| Biota | All living things (animals, plants, fungi and microbes) in an area at a particular time. |
| Broadcast sowing or broadcast | A method of planting whereby seeds are scattered across an area. It is quicker than planting in rows, but can give uneven spacing. |
| C horizon | One of the layers of soil that refer to the parent rock - somewhat broken up but still very rocky. |

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| Calcisols | Soils developed from rocks rich in calcium carbonate (e.g. limestone, chalk); these soils occur in regions with distinct dry seasons, as well as in dry areas where carbonate-rich groundwater comes near the surface. |
| Calcium (Ca) | A metallic element found in soil. High concentrations of calcium are related to soil with a high pH. |
| Cambisols | Often called brown soils, are most common in the oceanic zone of Europe (covering 12%), and because of their favourable aggregate structure and high content of weatherable minerals, they usually can be exploited for agriculture subject to the limitations of terrain and climate. |
| Canopy cover | How much of the land is covered by various land cover, i.e. how much of an area of land is covered with trees, grass, vegetable plants, or mulch. |
| Capacitance | The ability of a system to store an electric charge. |
| Capillary force | The ability of a liquid to flow in narrow spaces without the assistance of, or in opposition to external forces (e.g. gravity). |
| Carbon (C) | A non-metallic element but importantly it forms the basis for organic materials. |
| Carbon dioxide (CO2) | A gas that occurs naturally in the atmosphere but it is also a greenhouse gas. |
| Chernozems | Soil with a thick black surface layer rich in organic matter. |
| Chlorosis | Yellowing of plant leaves caused by a lack of chlorophyll as a result of certain nutrient deficiencies. |
| Citizen science | Public participation in formal scientific research, most commonly, citizen scientists are involved in collecting and categorising data but they may also be involved in method development and data analysis. |
| Citizen sensing | Citizen participation in environmental monitoring and action which is bottom-up, participatory and empowering to the community. It can result in shared decision making and even making change in the world. |

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| Clay | The smallest size fraction in soil. Clay has already undergone chemical weathering, changing its physical and chemical composition and so is known as secondary material. Clays are less than 0.002 mm in size. |
| Column chart | See bar chart |
| Community Level Indicators (CLIs) | Measurements that provide information about past and current trends and assist planners and community leaders in making decisions that affect future outcomes. |
| Compaction | The process by which applying pressure to the soil surface compresses it, reducing the space amongst the particles that make up the soil. Compaction impairs soil functions by impeding root penetration and limiting water and gas exchange. |
| Companion planting | A type of polyculture which requires the growing of plants in proximity. It focuses on creating specific benefits between plants, including pest control, synergies in root space and nutrient use. |
| Conductivity | A measure of a material's ability to conduct an electric current. |
| Control | In a scientific experiment this is a plot or sample that is kept constant and unchanging so it can be used to compare against the results. |
| Crop density | How close together or far apart individual plants are spaced. It might be expressed as the number of plants per area e.g. 5 per square metre |
| Crop Rotation | Growing two or more crops in the same piece of land sequentially and in cycles, usually over more than one growing season. |
| Cryosols | Ice-affected soil common in the arctic tundra. Plant roots are unable to penetrate the permafrost, and as a result, there is very little biological activity. Cryosols are rich in organic matter as the climate only permits the very slow break-down of materials. |
| Cryosphere | The portion of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (which includes permafrost). |
| Data quality | A measure of data accuracy and fitness for use - having high quality data is key to a successful investigation. The main stages at which we can influence the objectivity of the research process are during data collection – the actual measurements and observations we make – and in data recording – writing down our measurements in a notebook or recording sheet and/or typing them into a computer. |

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| Decomposition | The process of rotting or decay that organic matter undergoes. Decomposition breaks down the complex organic material into simpler substances or basic elements. Bacteria and fungi play an important role in decomposition. |
| Deforestation | The removal of forest. |
| Dielectric | A material that can be polarized when applied an electric field. Charges do not flow through the material (as they do in conductors), but only shift from their average equilibrium causing polarization. |
| Dielectric constant (relative permittivity) | The ratio of the permittivity of a dielectric material to the permittivity of a vacuum. |
| Digital Elevation Model (DEM) | A three dimensional computer generated representation of a the Earth's surface, generated from elevation data. |
| Double cropping | Growing two crops in the same piece of land sequentially, usually over one growing season. |
| E Horizon | "E", being short for eluviated, is most commonly used to label a horizon that has been significantly leached of clay, iron, and aluminium oxides, which leaves a concentration of resistant minerals, such as quartz, in sand and silt sizes. These are present only in older, well-developed soils, and generally occur between the A and B horizons. |
| Earth Observation (EO) | The gathering of information about planet Earth's physical, chemical and biological systems. It is used to monitor and assess the status of, and changes in, the natural and the built environments. |
| Eco-agricultural intensification | Methods that improve agricultural production by actively increasing the intensity of ecological processes, such as pollination, nutrient cycling and natural pest control. |
| Ecology | The study of organisms in their natural location. It considers the interactions between organisms and with the environment at scales from individuals to ecosystems and biomes. |
| Ecosystem | A dynamically interactive biological community of organisms and their physical environment, often with a complex network of relationships and interconnections. |

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| Electric resistance | A measure of how a material reduces the electric current flow through it. If we make an analogy to water flow in pipes, the resistance is bigger when the pipe is thinner, thus the water flow decreases more significantly compared to larger pipes. |
| Epiphytes | Plants that grow harmlessly on other plants and do not root into the soil, such as bromeliads and some orchids. |
| Erosion | Soil erosion by water or wind is a natural process where soil particles become detached from the land and are blown away by wind or washed away by water. However, it can be made worse by extreme weather events, poor land management or both. Loss of soil through erosion can seriously damage soil quality. |
| Evaporation | The amount of liquid water lost from the land or ocean surface to the atmosphere (as vapour). |
| Evapotranspiration | The combined movement of liquid water through direct evaporation from the land and through plants into gaseous form in the atmosphere. |
| FAO | Food and Agriculture Organisation of the United Nations |
| Field capacity | The amount of soil moisture or water content held in the soil after excess water has drained away; the large soil pores are filled with both air and water while the smaller pores are still full of water. This usually takes place 2–3 days after rain or irrigation in pervious soils of uniform structure and texture. |
| Fungi | Single-celled or multicellular organisms that produce spores to reproduce. They live by decomposing and absorbing the organic material in which they grow and include mushrooms, molds, mildews, smuts, rusts, and yeasts. |
| Gravimetric measurements | A method for precisely determining the water content of a soil sample. In particular, the soil sample mass is measured before and after drying; the water mass is the difference between the weights of the wet and dry samples. Then, the soil moisture is calculated as ratio of the water mass to the dry weight of the soil sample. |
| Gridded product | The GROW Observatory's gridded product is the output of a data grid, maps of soil moisture in different time series and other soil properties estimated from sensor and citizen science data. These data layers can be used by data grids that pull together data and resources from connected services or databases so that users based in different locations can access and interpret large amounts of geographically distributed data for research purposes. |

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| Ground truth | When information collected on specific locations by direct observations and measurements rather than by inference from remote satellite data. Ground truth allows image data from satellites to be related to real features and variables on the ground. |
| Haber-Bosch process | An artificial nitrogen fixation process used to produce fertilisers. |
| Hectare (ha) | A unit of land area measurement 100 metres long by 100 metres wide (a total of 10 000 square metres). One hectare is 2.47 acres. |
| Histosols (or peat soils) | Soils consisting primarily of organic materials, common where water accumulates (in bogs) and the breakdown of vegetation occurs slowly under anaerobic conditions. |
| Hydrosphere | The combined mass of water found on, under, and above the surface of a planet. |
| Hypothesis | In an experiment, a hypothesis is our expectation of what will happen. We can either prove our hypothesis (what we expect does happen) or disprove it (what we expect does not happen). Either finding is a valid and important outcome. |
| Internet of Things | The Internet of Things extends the internet beyond standard devices like desktop PCs, laptops and smartphones. This is achieved by embedding ‘smart’ technology into traditionally ‘dumb’ objects, creating a cloud-based network of objects around us. For example, the ability to turn on lights or the heating with your phone. |
| Interpolation algorithms | Methods of estimating the value of unknown measures from between known measurements. |
| Irrigation | The addition of water to promote plant growth. It is commonly used for crop growth in many regions of the world when there is insufficient or irregular rainfall. |
| Leptosols | Very shallow soils with minimal development, formed typically on hard rock or highly calcareous materials. They also include deeper soils on gravelly or stony parent materials lacking fine earth. Leptosols cover approximately 1.7 billion hectares of the Earth's surface. |
| Limestone | A rock formed from the skeletal fragments of aquatic organisms such as corals. It is mostly made up of different forms of calcium carbonate. |
| Litter | Materials from plants in the early stage of decomposition, litter is still easily recognisable as plant material such as dead leaves on the ground. |

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| Macronutrient | Nine elements essential for plant growth and needed in relatively large amounts: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulphur (S), magnesium (Mg), carbon (C), oxygen (O) and hydrogen (H). |
| Magnesium (Mg) | A metallic element and plant macronutrient. |
| Makerspace | A workspace where people with common interests such as fabrication, technology, science or art, can meet to work on projects, create, learn and collaborate. A makerspace may also be referred to as a fablab or hackerspace, depending on the focus of work conducted there. |
| Microclimate | Changes in light, temperature, moisture, and exposure across a small distance; these changes influence how well (or bad) plants grow e.g. difference from an open area to under the shade of a tree or shrub. |
| Micronutrient | Also called trace elements, these eight elements are essential for plant growth but needed in smaller amounts than macronutrients: iron (Fe), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo) and nickel (Ni). |
| Monoculture | Growing one crop is a given area, with no other crops grown in that area at the same time. |
| Mycorrhizal fungi | Fungi which form mutualistic relationships with plant roots where both partners benefit. |
| Nitrate (NO3) | A form of oxidised (chemically combined with oxygen) nitrogen that plants can use readily. It does not bind to soil easily so it can move through soil in water. |
| Nitrification | The process where soil bacteria convert ammonium into nitrate (NO3) and nitrite (NO2) which are less toxic forms of nitrogen than ammonium. |
| Nitrogen (N) | A very abundant non-metallic element. It is an important constituent of the atmosphere but is also an important plant nutrient. It can also become a pollutant. |
| Normalised Difference Vegetation Index (NDVI) | A graphical indicator used to analyze remote sensing measurements, often from a satellite, and to assess whether the observed location contains live green vegetation or not. |

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| O horizons | Soil layers with a high percentage of organic matter, typically within a woodland area. There are three distinct organic layers: one with leaves, pine needles and twigs (Oi); underlain by a partially decomposed layer (Oe); and a very dark layer of well-decomposed humus (Oa). |
| Objective | Not influenced by personal feelings, interpretations, or prejudice. The opposite of subjective. |
| Open source | Computer programs with source code available to the public for use and modification. |
| Organic matter | Comes from organisms that once lived in and on the soil. When they die they decompose and are incorporated into the soil. |
| Organism | An individual form of life. This covers all forms of life including animals, plants, fungi and microbes. |
| Overstory | The highest layer of vegetation in a forest, usually forming the canopy. |
| Parent material | The rock material underlying the soil. This material is weathered to form the mineral particles in the soil. |
| Participatory governance | A form of government which strives to involve all members of a population to make meaningful contributions to decision making. |
| Permaculture | An ecological design approach to living within nature's limits. Derived from "permanent agriculture" it has widened to also reflect "permanent culture" and the importance of the social aspects in successful design. The three core ethics are "earth care," "people care" and "fair shares." Permaculture designs are now applied to many areas beyond food production. |
| Permafrost | A soil layer beneath the surface that stays frozen year round. |
| Permanent wilting point (PWP) or wilting point (WP) | The minimum level of soil moisture a plant requires to prevent wilting. |

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| Permittivity | In electromagnetism, permittivity is the measure of a material's ability to resist an electric field. A charge will yield more electric flux in a medium with low permittivity than in a medium with high permittivity |
| Phosphorus (P) | A very abundant non-metallic element which is also an important plant nutrient. It can also become a pollutant. |
| Photosynthesis | The process by which plants use the energy from light to convert water and carbon dioxide into stored energy (in the form of sugars and starches. |
| Podzols | The typical soil of coniferous, and boreal forests. Formed where organic compounds are washed down into the lower layers of the soil, these cover 14% of Europe and are the dominant soil of northern latitudes. |
| Podzoluvisols | An intermediate type of soil between cambisols and podzols that can be found in cooler European areas between boreal and temperate zones. |
| Pollution | Soil pollution occurs when substances such as acids, nutrients or metals, are added to soil, resulting in increases in their concentrations above safe levels. |
| Polyculture | Growing two or more crops close to each other at the same time. |
| Pore space and pores | Gaps between soil particles which can be filled with air or water. Pores vary in size from micropores (5-30 microns), mesopores (30-75 microns) to macropores (more than 75 microns) and can be created by physical or biological processes in the soil. |
| Potassium (K) | A metallic element which can be found in the soil. |
| Potential amount of evapotranspiration (PET) | The amount of water that could be evaporated or transpired if unlimited water was available. PET is determined by solar radiation (heat) and wind speed. |
| Qualitative | Non-numerical data e.g. the quality of a crop yield. |
| Quantitative | Data collected in numerical form e.g. the weight of crop yield. |
| R horizon | A solid bedrock layer of large rocks at the bottom of the soil that cannot be moved by hand. |
| Raw data | Data that has not yet been processed for use; in the form it was collected. |

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| Regenerative agriculture or growing practices | An approach to growing food that aims to regenerate topsoil, enhance biodiversity and improve ecosystem integrity. |
| Remote sensing | Remote sensing is the science of obtaining information about objects or areas from a distance (which can vary from few meters up to hundreds of kilometers). |
| Replication or replicate | In an experiment, replication means having several identical repetitions of each set of conditions (the treatments and the control). Each of these repeats is called a replicate. Having replication helps us to see how much findings differ from plot to plot in the same treatment and get a more accurate result. |
| Revisit time | In Remote sensing, the revisit time is the time elapsed between observations of the same point on Earth by a satellite. |
| Rhizomes | Determinate rhizomes are relatively short horizontal underground stems that form a clump of vertical stems around the spot where they are planted. Indeterminate rhizomes are much longer and may branch off at several points. This type of long-branch rhizome is a trait often found on very invasive plant species. |
| Salinization | The build-up of salts in the soil. Salts can reach concentrations where they are toxic to plants. Salinity is often associated with prolonged wetness and lack of surface cover and therefore increases the vulnerability of soils to erosion. |
| Sample or data sample | In experimental terms, a sample is a set of data that is taken from, and used to represent, a greater set or “population” of data. A sample is usually taken where it is unrealistic to measure the whole larger data set. The sample is used to make an informed guess (inference) about characteristics of the whole population. For example, the average height of women in your country is calculated from a representative sample of women - not by measuring all women. |
| Sand | Soil particles that range in size from 0.02 to 2 mm. Sand is often composed of quartz grains that are resistant to weathering. They are largely unaltered chemically, compared to the parent material. |
| Saturated | When something is holding as much water as it possibly can. In soil, this means that all of the available pore spaces are filled with water. You can tell if soil is saturated by putting pressure on it and seeing if water pools on the surface around the point where pressure is applied. |

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| Savanna | A biome found under hot, seasonally dry climatic conditions. It is characterised by an open tree canopy (i.e., scattered trees) above a continuous tall grass understory (the vegetation layer between the forest canopy and the ground). |
| Scatter plot | Are useful when you have two or more sets of numerical data. They give a visual clue of how data relate to each other, and can be used to look for patterns or trends in the data. |
| Sentinel 1 | The first part of the Copernicus Programme of satellites conducted by the European Space Agency. |
| Silt | Soil particles that range from 0.02 to 0.002 mm in size. Silts are largely unaltered compared to parent material. Both sand and silt are considered primary materials of soil. |
| Soil aggregates | Groups of soil particles that bind to each other more strongly than to adjacent particles. The space between the aggregates provides pore space for retention and exchange of air and water. |
| Soil horizon | Layers in the soil that run roughly parallel to the soil surface. The horizons vary with depth and the influence of different soil forming factors. |
| Soil moisture | Refers to the amount of water in the soil and it is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. The field capacity, permanent wilting point (PWP) and available water content are called the soil moisture characteristics. |
| Soil moisture content | The amount of water in the soil (usually described as a percentage). |
| Soil moisture tension | How hard the plant root has to work to extract water from the soil (usually described as KiloPascals (kPa) which are units of pressure measurements). |
| Soil profile | A vertical section of the soil that depicts all of its horizons |
| Soil security | Refers to protecting our soils to ensure they are there for the future to perform all of their natural functions that sustain life. |
| Soil structure | Refers to the way individual particles of sand, silt, and clay are assembled. When single particles are assembled they appear as larger particles called soil aggregates (see: soil aggregates). It is often described at the degree of aggradation (grade), average size of individual aggregates (class), and form or shape of individual aggregates (type). |

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| Soil texture | The relative amounts of three mineral particle sizes: sand (the largest), silt and clay (the smallest). |
| Spatial resolution | In remote sensing, spatial resolution is defined as the size of the smallest feature that can be detected by a sensor. |
| Standard deviation (SD) | A measure used to quantify the amount of variability of a dataset. A low standard deviation indicates that the values tend to be close to the average of the dataset, while a high standard deviation indicates that the data points are spread out over a wider range of values. |
| Statistics | A branch of mathematics dealing with the collection, organisation, analysis, interpretation, and presentation of data. It is a key tool that can help complex data easier to find patterns or differences in. |
| Stomata | Tiny pores which plants use for gas exchange and which water vapour exits via transpiration. |
| Subjective | The opposite of objective - thoughts on an object that belong to an individual, and may be different to other individuals. |
| Sulphur (S) | A non-metallic element and plant macronutrient found in the soil. |
| Surface sealing | The act of covering the soil surface with impervious materials that prevent soil from being able to absorb water. This mainly occurs as a result of urban development like new residential, retail or industrial developments, as well as new transport links. |
| Sustainable Development Goals (SDGs) | 17 goals set by the United Nations to address global challenges, including poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. |
| Temporal | Relating to time. |
| Timeseries | A time series is a sequence of values taken at successive (equally) spaced points in time. |
| Topography | The physical arrangement of the natural features of an area of land, especially the shape of its surface |
| Transpiration | The movement of water through plants to the atmosphere. |
| Treatment | In an experiment the treatment is the change in conditions that we make. For example, adding compost (to assess if it increases crop yield). Treatments are usually compared to a control. |

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| Understory | The shrubs and plants growing beneath the main canopy of a forest. |
| Variable | A characteristic or measurement that can vary e.g. from low to high, from light to heavy. We know in advance of starting research what the measurement is of, but not what the value will be. |
| Vector | In remote sensing, a vector is the platform bringing the sensor. The most common types of vectors are spaceborne (satellites), airborne (airplanes, balloons, etc.), and unmanned aerial vehicles (drones, etc.). |
| Visualisation | The use of graphs, plots and other graphics to communicate data in accessible, understandable and usable way. |
| Weathering | General process by which rocks are broken down at the Earth's surface into such things as sediments, clays, soils and substances that are dissolved in water. Weathering can be physical, chemical or biological. |
| Wilting | The loss of rigidity of non-woody parts of plants as a result of diminished water in the plant cells. |
| Yield | The amount of crop harvested. |

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