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Shaping Lives...
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Soil Health & Quality

Dr. Arunabha Pal



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Outlines

- Introduction
- Soil quality
- Soil Health vs Soil Quality
- Why assess soil quality??
- Assessment of soil quality
- Soil quality parameters
- Soil quality index
- Soil quality assessing tools
- Case Study
- Available Facilities
- Alternative agriculture
- Conclusion
- References



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Introduction

WHAT IS SOIL??

- Soil also known as Soul Of Infinite Life.

Because of 5 basic functions-

Sustaining plant and animal life

Regulating water

Filtering potential pollutants

Cycling nutrients

Supporting structures

- Healthy soil is essential for the production of crops used to feed humans and livestock. In addition to providing a stable base to support plant roots, soil stores water and nutrients required for plant growth.
- Unfortunately, industrial & Modern agricultural practices continue to damage it and depleting its quality.
- To restore and management of soil fertility and reduce soil pollution assessment of soil quality through establishment of various quality parameters is one of the most essential process.



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Soil Quality

The integration of growth-enhancing factors that makes a soil productive has often been referred to as "soil quality" or *How well soil does what we want it to do.*

- **As per **USDA(1994)** Soil quality can be defined as-**
The capacity of a specific kind of soil to function, within its natural or managed ecosystem boundaries, to sustain animal and plant productivity, maintain or enhance air and water quality and support human health and habitats.

Soil Quality mainly encompasses two distinct but related parts-

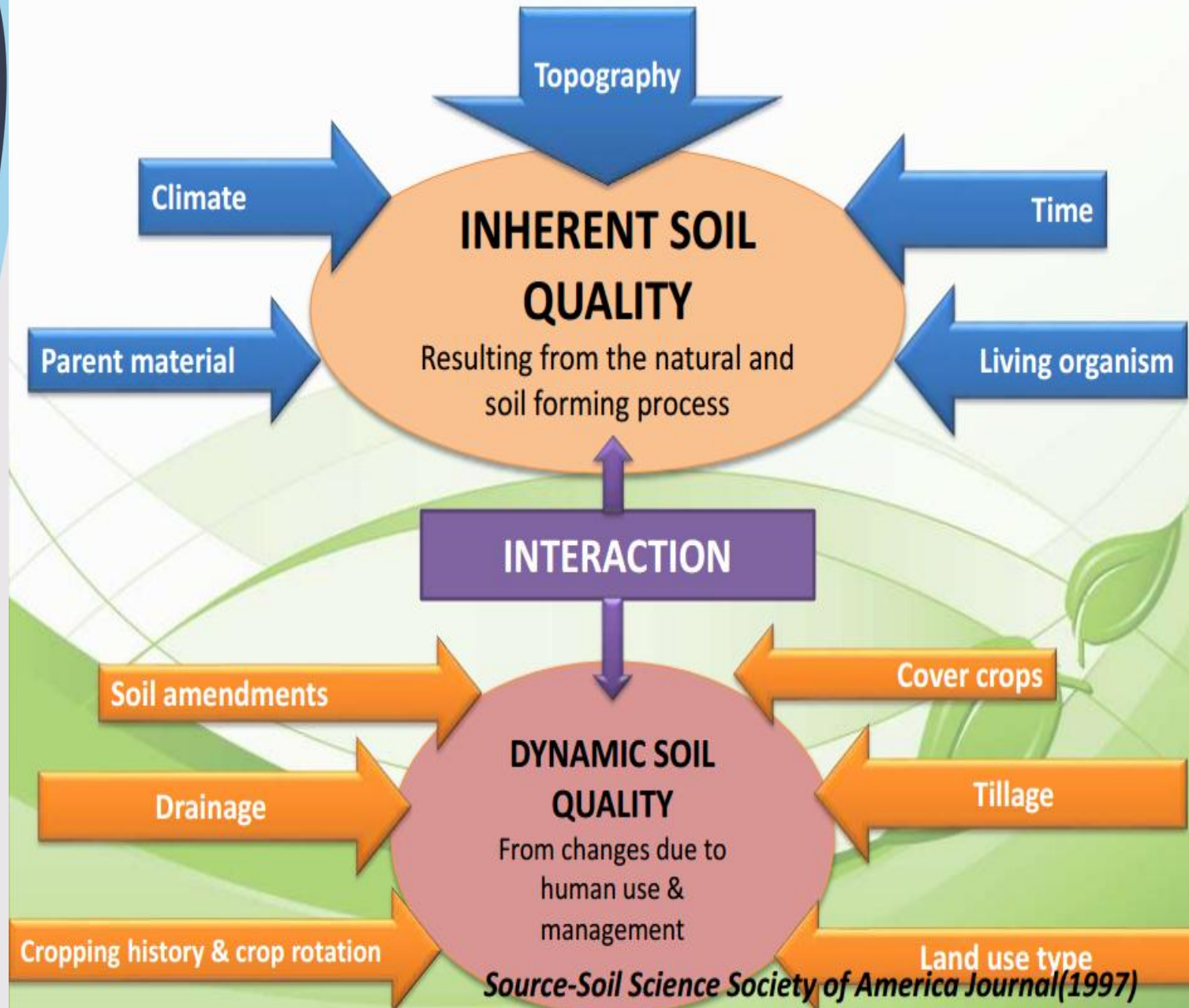
1. **Innate Qualities (Soil Formation & Characteristics)**
2. **Dynamic Qualities (Soil Erosion & Management)**

Factors effecting soil quality



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Soil Quality and Soil Health

Soil Quality- (Soil Condition to predict its productivity)

Capacity of a soil to function within its ecosystem boundary to sustain biological productivity, maintain environmental quality and promote plant and animal health

-Doran & Parkin, 1994

Soil scientists prefer “soil quality”, which describes quantifiable physical, chemical and biological characteristics.

Soil Health- (Soil condition to predict how soil function)

Defined as the continued capacity of soil to function as a vital living system, by recognizing that it contains biological elements that are key to ecosystem function within land-use boundaries.

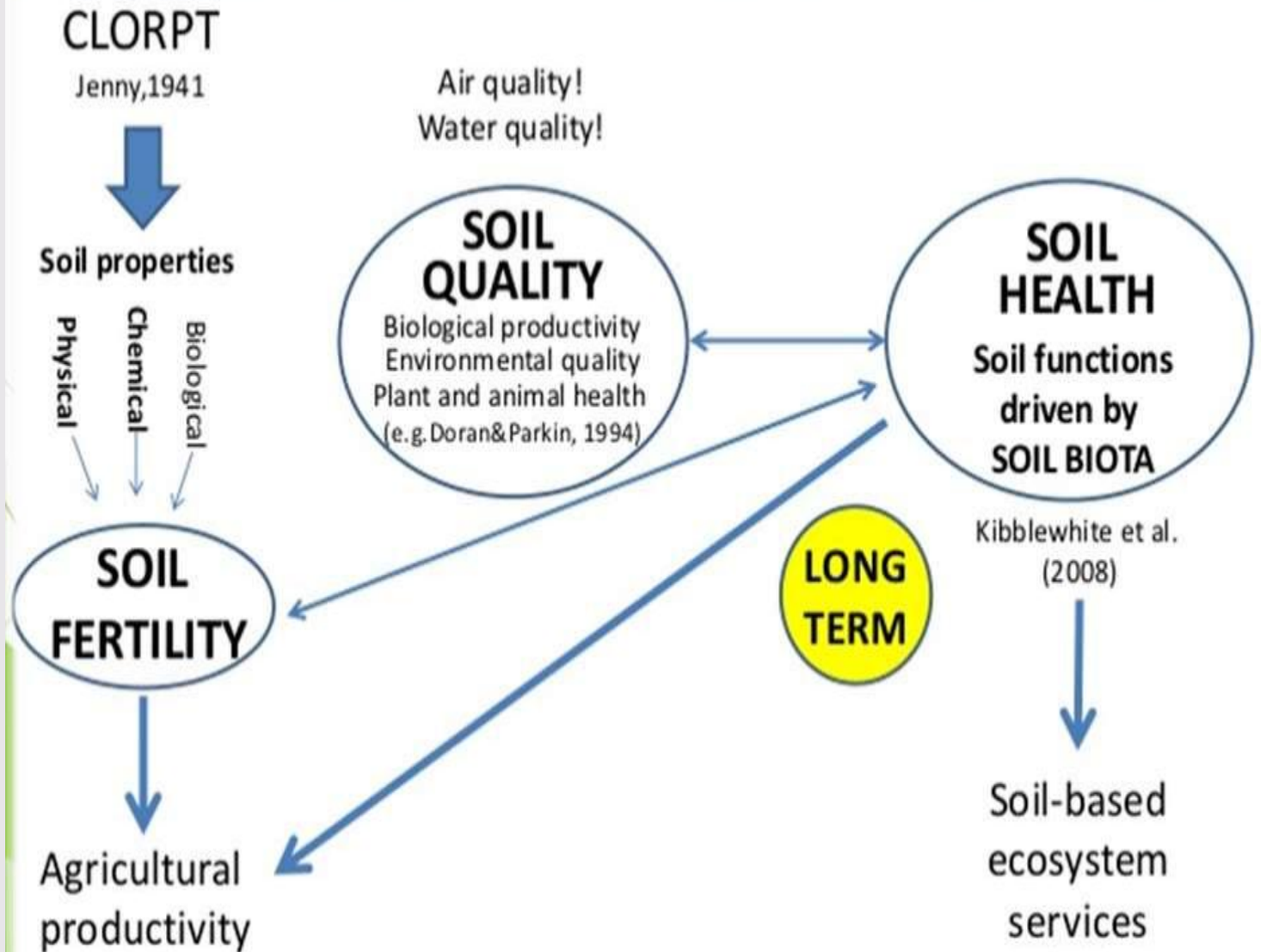
-Doran and Zeiss, 2000; Karlen et al., 2001



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SOIL FERTILITY-SOIL QUALITY-SOIL HEALTH



Source- Soil Quality and Soil Health, NRCS, USDA, USA



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Why Assess Soil Quality???

Soil quality is evaluated to learn about the effects of management practices on soil function. Reasons for evaluating soil quality fall into these categories:-

- Awareness and education
- Evaluation of practice effects and trouble-shooting
- Evaluation of alternative practices
- Assessment as an adaptive management tool



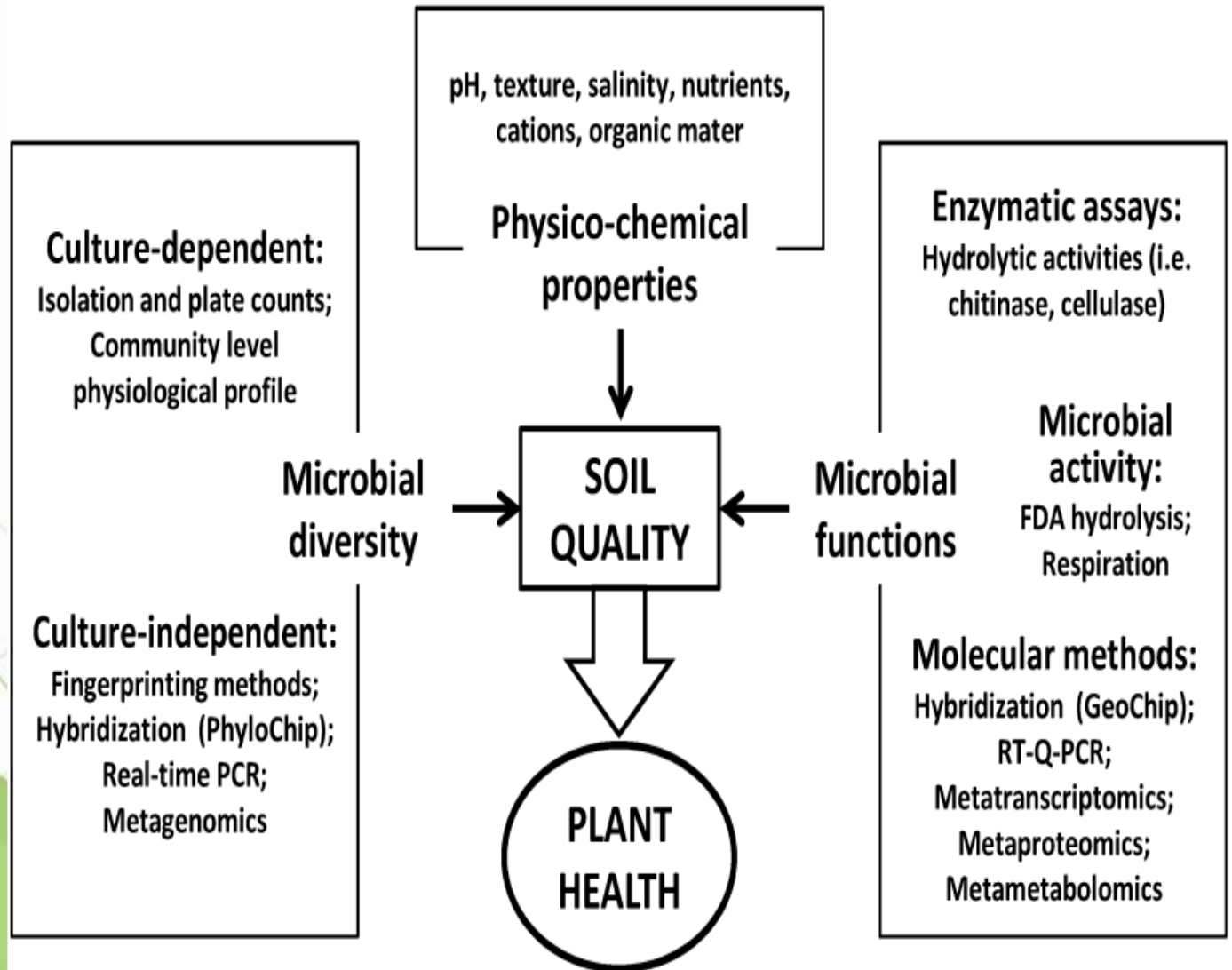
Hierarchical relationship of soil quality to agricultural sustainability

Source- SSSAJ, Andrews, 1998



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Source- Antonio de Vicente, Diversity(2012), Instituto de Hortofruticultura Subtropical y Mediterránea "La Mayora", Malaga, Spain



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ASSESSMENT OF SOIL QUALITY

It cannot be determined by measuring only crop yield, water quality, or any other single outcome it is an assessment of how it performs all of its functions now and how those functions are being preserved for future use.

**Soil quality cannot be measured directly,
so we evaluate *indicators***



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- **Indicators** are measurable properties of soil or plants that provide clues about how well the soil can function.
- Indicators can be physical, chemical, and biological characteristics.

Useful indicators Means:

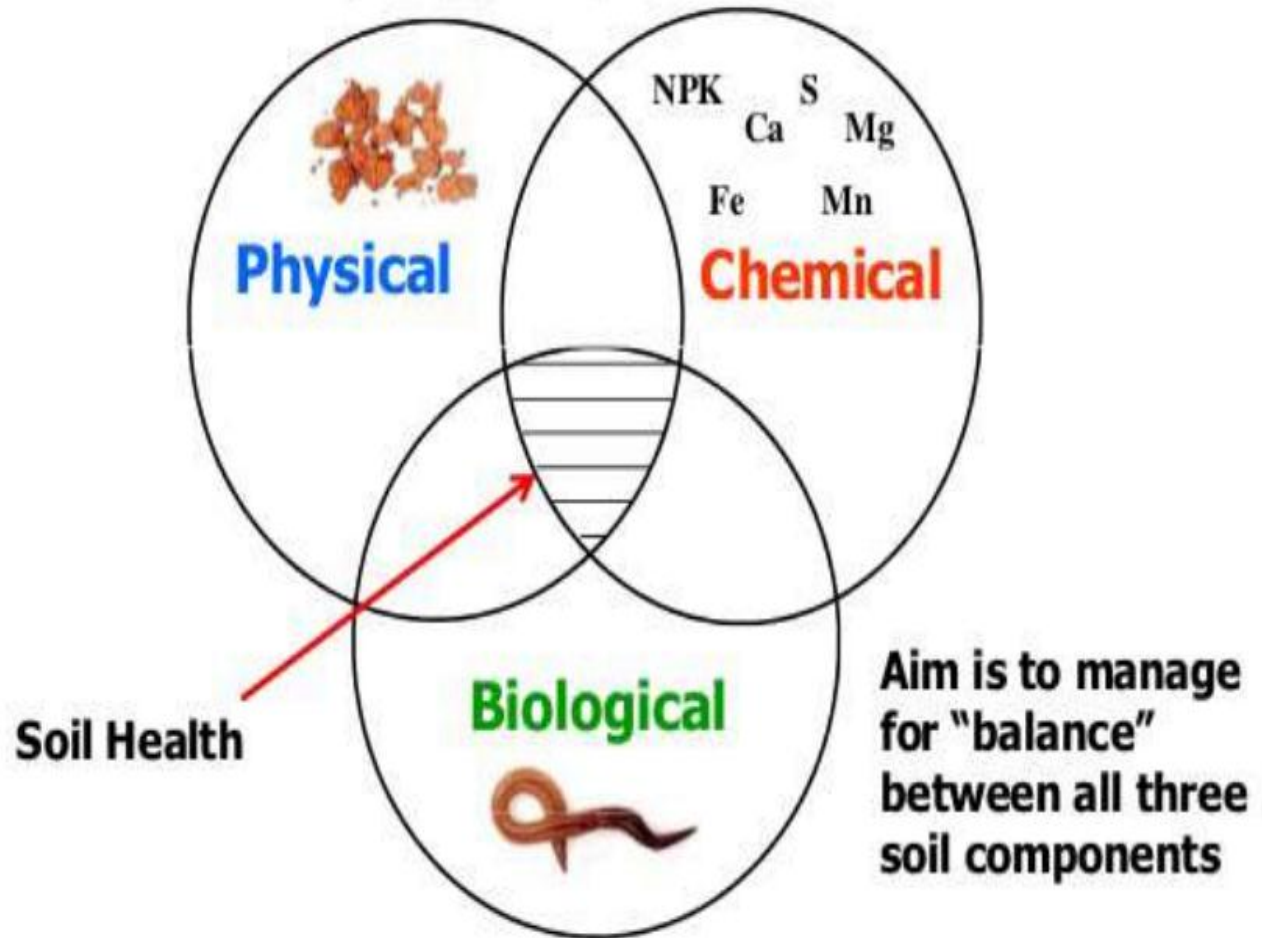
- Should be easy to measure.
- Measure changes in soil functions
- Re accessible to many users and applicable in field conditions.
- Are sensitive to variations in climate and management.



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Soil quality is the capacity of a soil to function (in a farm or ecosystem) and thereby sustain productivity, maintain environmental quality, and promote plant and animal health



Source- Ranchworx, Pasture Aerators, North America(1998)



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Soil Quality Parameters

Pedological or Soil factors that influencing its Quality can be divided into 3 broad categories as-

Physical Factors-

- Soil depth & Water Holding Capacity
- Physical environment- Structure, Aeration, Drainage, Texture, Density
- Soil Erosion- Water and Wind Erosion

Chemical Factors-

- Nutrient Availability- Capacity & Intensity Factor
- Soil Reaction- Acidic, Saline, Sodic Soil
- Presence of toxic elements
- Ion Exchange Phenomena(CEC & AEC)

Biological Factors-

- Microorganisms present and their interaction among themselves
- Earth worms activities
- Soil Enzyme Activity
- Organic Matter content



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Soil Physical Indicators Selected for Assessing the Soil Quality

Physical Indicators	Units	Relationship with Soil Quality	Sensitivity Index
Soil Depth	cm	Productivity Potential and Surface Stability	Medium
Soil Texture	% (Sand, Silt, Clay)	Water Retention, Nutrient Retention, Infiltration etc...	High
Bulk Density	Mg/m ³	WHC, NHC, Aeration, Organic Carbon, Root Penetration etc...	Medium
Available Water Content	%	Plant Water Relation	Medium
Aggregate Stability (Top 30cm)	%	Potential Soil Erosion, Infiltration, Water Retention.	High

Source- Zueng-Sang Chen(1999), Department of Agricultural Chemistry,
National Taiwan University, Taipei



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Soil Chemical Indicators Selected for Assessing the Soil

Quality

Chemical Indicators	Units	Relationship with Soil Quality	Sensitivity Index
pH	-	Biological Activity and Soil Reaction	High to Very High+
EC	dS/m	Chemical Activity, Plant Nutrition	Moderate to high+
Organic C	ppm	Soil Stability, Erosion Control, Aggregation	High
Available N	ppm	Essential Nutrient of Plant	Moderate to High
Available P	ppm	Essential Nutrient of Plant	Moderate to High
Available K	ppm	Essential Nutrient of Plant	Moderate
Available Cd	ppm	Toxic Level for Plant Growth and Soil Quality	Moderate to high+
Available Pb	ppm	Toxic Level for Plant Growth and Soil Quality	Moderate to high+
Available Cu	ppm	Toxic Level for Plant Growth and Soil Quality	Moderate to high+
Available Zn	ppm	Essential Nutrient of Plant, Toxic in Excess	Moderate to High+

+ refer to variability with crops type

Source- Zueng-Sang Chen(1999), Department of Agricultural Chemistry, National Taiwan University, Taipei



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Soil Biological Indicators Selected for Assessing the Soil Quality

Biological Indicators	Units	Relationship with Soil Quality	Sensitivity Index
Mineralizable N	Kg N/ha/30cm top layer	Organic Matter, Plant Nutrition, Microbial activities, CO ₂ Production	High
Biomass C	Kg C/ha/30cm top layer	Microbial potential activity, C pool, Organic matter	High
Biomass N	Kg N/ha/30cm top layer	Microbial potential activity, N pool, Organic matter	Moderate
Biomass P	Kg P/ha/30cm top layer	Microbial potential activity, P pool, Organic matter	Moderate
Soil Respiration	Kg C/ha/day	Microbial activity, Microbial biomass, C-loss & Gain	Moderate
Earth worms	Nos/ m ³	Relative biomass, Plant essential enzymes & chemicals	Less
Crop Yield	Kg/ha	Plant available nutrient content, productivity & soil quality	High

Source- Zueng-Sang Chen(1999), Department of Agricultural Chemistry, National Taiwan University, Taipei



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Soil Quality Index

Such a relationship could take following form

$$\text{Soil Quality Index} = f(SP, P, E, H, ER, BD, FQ, MI)$$

Here,

SP	Soil Property
P	Potential Productivity
E	Environmental Factor
H	Health of human and animals
ER	Erodibility
BD	Biological Diversity
FQ	Food Quality
MI	Management Inputs

Source- J.F. Parr et. al., ARS, USDA, 1998



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Methods of Assessment

Farmers
Methods

Soil Color

Soil Smell

Statistical
Methods

Measure of
Dispersions

Soil Management
Assessment
Framework

Conventional
Method

Soil Index

Scoring



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Farmers Method

- Farmer who work daily with soils usually note that some of their fields perform better than others .
- They tend to judge the quality or condition of their soils by such observable factors as the performance of the crop plants, the colours associated with accumulation of organic matter, the ease of tillage ,the presence of standing water after rain storms.

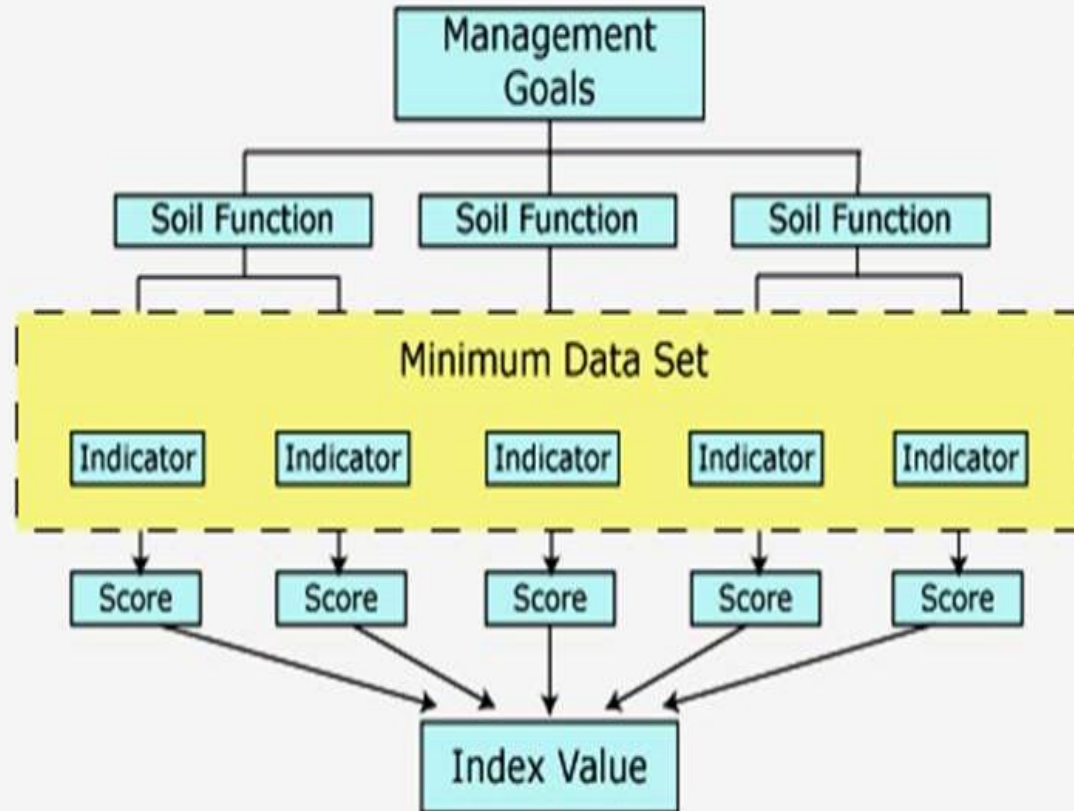




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Scoring Method

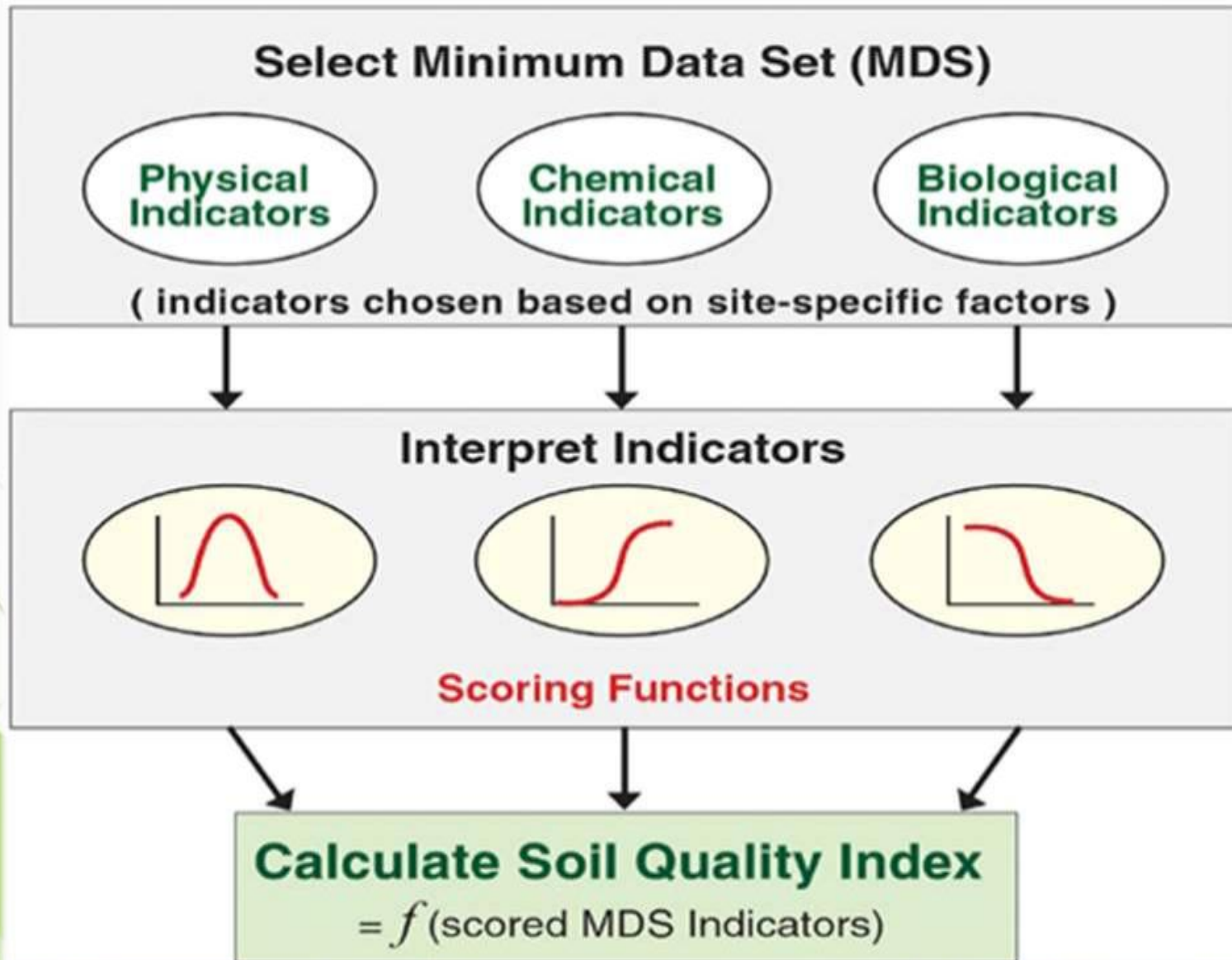


Source- Andrews, S.S., D.L. Karlen, and J.P. Mitchell. 2001. A comparison of soil quality indexing methods for vegetable production systems in Northern California. *Agriculture, Ecosystems and Environment* 1760: 1-21.



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Source- Andrews, S.S., D.L. Karlen, and J.P. Mitchell. 2001. A comparison of soil quality indexing methods for vegetable production systems in Northern California. Agriculture, Ecosystems and Environment 1760: 1-21.



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TABLE 28.5. Proposed minimum data set (MDS) of physical, chemical, and biological indicators for assessing soil quality

Indicator	Rationale for assessment
Biological	
Microbial biomass C and N	Describes microbial catalytic potential and repository for carbon and nitrogen Provides an early warning of management effects on organic matter.
Potentially mineralizable N	Describes soil productivity and nitrogen supplying potential. Provides an estimate of biomass.
Soil respiration	Defines a level of microbial activity Provides an estimate of biomass activity.
Chemical	
Soil organic matter (OM)	As a proxy for soil fertility and nutrient availability.
pH	Biological and chemical activity thresholds.
Electrical conductivity	Plant and microbial activity thresholds.
Extractable N, P, and K	Describes plant-available nutrients and potential for N loss. Indicates productivity and environmental quality.
Physical	
Soil texture	Indicates how well water and chemicals are retained and transported. Provides an estimate of soil erosion and variability.
Soil depth and rooting	Indicates productivity potential. Evens out landscape and geographic variability.
Infiltration and soil bulk density (ρ_b)	Describes the potential for leaching, productivity, and erosion. ρ_b is used to correct soil analyses to volumetric basis.
Water holding capacity	Describes water retention, transport, and erosion. Available water is used to calculate soil bulk density and organic matter.

Source- Zueng-Sang Chen(1999), Department of Agricultural Chemistry,
National Taiwan University, Taipei



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Case Study

Soil Quality Changes and Quality Status: A Case Study of the Subtropical China Region Ultisol

A. C. Odunze, Wu Jinshui, Liu Shoulon, Zhu Hanhua, Ge Tida, Wang Yi and Luo Qiao

Key Laboratory of Agro-ecological Processes in Subtropical Region, Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha 410125, China.

Present affiliation: Department of Soil Science/IAR, Faculty of Agriculture, Ahmadu Bello University, P. M. B 1044, Zaria Nigeria

Aim:

To provide a soil quality assessment frame work and threshold limits for assessing soil quality in Ultisol of subtropical China region.

**British Journal of Environment and Climate Change,
ISSN: 2231-4784, Vol.: 2, Issue.: 1 (January-March, 2015)**



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Study Design:

Selected minimum data set for soil quality assessment and threshold limits for the study were total carbon, nitrogen, soil pH and phosphorus, biomass carbon, nitrogen and phosphorus, maize grain and fresh potato tuber yields.

Soil data (2000-2010), maize grain and fresh potato yield data (2000-2009) from a long term experiment under the Institute of subtropical Agriculture, China were analyzed using the SAS statistical package and means were graphically compared to determine threshold limits for selected data set and fitted into a soil quality model.

Place and Duration of Study:

The key Laboratory for Agro-ecological Processes in Subtropical Regions, Chinese Academy of Sciences; Institute of Subtropical Agriculture, Changsha, Hunan China long-term experimental site in Taoyuan county

Conducted from the year 2000 to 2010.



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Methodology:

Soils samples at the experimental fields were obtained from depths 0-20 cm using an auger at each replicate in triplicates and homogenized to obtain a composite sub sample, air-dried, sieved through 2.0 mm to obtain samples for analysis in the Laboratory.

Parameters analyzed for were organic carbon concentration, measured by the combustion method using an automated C/N analyzer (Vario MAX CN, Elemental Co., Germany) while total nitrogen was by the Kjeldahl method of ISSCAS (1978).

Microbial carbon, nitrogen and phosphorus levels were determined using the chloroform-fumigation-extraction method (Jenkinson and Powlson, 1976; Vance et al., 1987; Brookes et al., 1982) and adopting the conversion factors 0.45 (Wu et al., 1990), 0.45 (Brookes et al., 1985), and 0.29 (Wu et al., 2000) respectively for the C, N and P.



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Extractable N and Olson P were taken from values obtained from the non fumigated soil samples.

Data obtained were statistically analyzed using the SAS package for ANOVA and significant means were separated using the Duncan's New Multiple Range Test (DNMRT).

Treatment means were also matched graphically to delineate critical threshold limits between classes for each parameter. Soil quality was assessed by using the Parr et al. (1992) equation;

$$\mathbf{SQ = f(SP, P, E, H, ER, BD, FQ, MI);}$$

Where SQ= soil quality, SP= soil properties, P = potential productivity, E=environmental factor, H= health (human/animal), ER= erodibility, BD= biodiversity, FQ= food quality and MI= management input.

A score scale of 1 to 5 was used in the assessment of parameters in the model; where 1 is best and 5 is the worst condition. However, E, H, ER, FQ and MI were each scored 1.0 because the long-term experiment has an environmental component, health factor, biodiversity, food quality and management input components that are being optimally managed. Therefore $SQ = f(SP, P)$ was used to assess quality of the Ultisol at the uplands and slope land locations.



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Treatments in Experiment

In the uplands the following trials were compared:

- i) Fallow/nil fertilizer application (Fnf)
- ii) Maize-Rape/Nil fertilizer application (M-R/nf)
- iii) Maize-Rape/NPK fertilizer application (M-R/NPK)
- iv) Maize-Rape/NK+ residue (M-R/NK+R)
- v) Sweet Potato-Rape/Straw+NP (P-R/S+NP)

and in the slope land, the following trials were compared:

- i) Fallow-Nil fertilizer (Fnf)
- ii) Sweet potato-Rape/Nil fertilizer (Sp-R/nf)
- iii) Sweet potato-Rape/NPK (Sp-R/NPK)
- iv) Sweet potato-Rape/NP+straw (Sp-R/NP+S)
- v) Pea nut-Broad bean/NP+straw (Pn-Bb/NP+S)
- vi) Maize-Barley/NK+ maize residue (M-B/NK+R)

Plot size for each treatment was 3m by 7m i.e., 21mt sq while straw rate was 12.7 t/ha.yr, marsh residue was 10.0 t/ha.yr and fertilizer rates were 224 Kg N ha⁻¹.yr⁻¹, 52 Kg P ha⁻¹.yr⁻¹ and 174 Kg K ha⁻¹.yr⁻¹.

The treatments were replicated three times and maintained for the period 2000-2006/2010.

However, maize yield was monitored on M-R/nf, M-R/NPK and MR/NK+R treatments from 2000-2009 at the uplands.

Potato yield was assessed on Sp-R/nf, Sp-R/NPK and Sp-R/NP+S on the slope lands.



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Result Tables

Potato-Rape Slope land Microbial C, N and P with treatments during 2000-2008

Treatments	Biom. C mgkg ⁻¹	Biom. N	Biom. P
F/Inf	86.982d	14.924d	4.984b
Sp-R/Inf.	107.285c	16.359dc	4.989b
Sp-R/NPK	125.131b	18.336c	6.453a
Sp-R/NPK+S	132.66a	23.956a	7.351a
En-Bb/NPK+S	129.810ba	21.756b	7.387a
MSE	15.4542	4.59047	2.1252
CV%	13.2971	24.0543	33.9687

Means in column with the same letters are not significantly ($P \geq 0.05$) different according to DNMRT

Summary of criteria for soil quality monitoring and evaluation in subtropical China region Ultisol

Nutrients/Grain Yield	Soils in the Upland			Soils in Slope Land		
	High	Medium	Low	High	Medium	Low
Total carbon (gkg ⁻¹)	≥ 8.8	8.0- 8.7	< 8.0	≥ 6.8	5.8 -6.8	< 5.80
Total Nitrogen (gkg ⁻¹)	≥ 0.97	0.97– 0.87	< .87	≥ 0.85	0.8-8.5	< 0.8
Total Phosphorus (mgkg ⁻¹)	≥ 0.49	0.45–0.49	< 0.45	≥ 0.39	0.37– 0.39	<0.37
Biomass carbon (mgkg ⁻¹)	≥ 175	130 - 174	< 130	≥ 125	100 -125	<100
Biomass nitrogen (mgkg ⁻¹)	≥ 33.0	28 -33.0	< 28.	≥ 24.0	18 -24	<18.0
Biomass Phosphorus (mgkg ⁻¹)	≥ 7.5	4.0 – 7.5	< 4.0	≥ 5.8	3.8 -5.8	< 3.80
Soil pH	≥ 5.7	5.55 – 5.7	< 5.55	≥ 5.07	5.01 – 5.07	< 5.01
Maize grain yield (tha ⁻¹)	≥ 7.50	4.50– 7.50	< 4.50			
Potato Fresh weight (tha ⁻¹)				≥ 4.0	3.0 -4.0	< 3.0



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Results Analysis:

At the uplands, the practice of maize-rape/marsh residue+NK (8.54gkg^{-1} C, 1.0gkg^{-1} N and 5.67mgkg^{-1} P) treatments could be rotated with Maize-rape/nil fertilizer (7.51gkg^{-1} C, 0.87gkg^{-1} N and 0.39mgkg^{-1} P) to encourage improved soil quality by allowing for more years with soil carbon sequestration, nitrogen and phosphorus credit than years of depletion and discourage soil degradation.

At the slope lands, treatments that combined application of organic and inorganic fertilizer materials [Sweet potato-rape/NP+straw (7.18gkg^{-1} C, 0.88gkg^{-1} N and 0.38mgkg^{-1} P) and Peanut-broadbean/NP+straw (6.81gkg^{-1} C, 0.86gkg^{-1} N and 0.38mgkg^{-1} P)] improved soil quality significantly over time by sequestering significantly higher total carbon, nitrogen and phosphorus better than sole inorganic fertilizer [Sweet potato-rape/NPK (6.52gkg^{-1} C, 0.81gkg^{-1} N and 0.38mgkg^{-1} P)].

Conclusion:

Ultisol at the upland positions had better quality (SQ1) than those at the slope (SQ2) positions. Threshold limits for nutrients, pH and yield of maize and Fresh Potato tubers in the subtropical China region Ultisol was developed.



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Facilities Available

Willamette Valley Soil Quality Card

Date: _____ Crop: _____
 Field location: _____ Year of planting: _____

☐ Good for planting
 ☐ Too dry for planting
 ☐ Too wet for planting

Indicator	Preferred										Observations	Rating the indicator		
	1	2	3	4	5	6	7	8	9	10		1	5	10
1. Does the soil have good structure and tilth?											Cloddy, powdery, massive, or flaky	Some visible crumb structure	Friable, crumbly	
2. Is the soil free of compacted layers?											Wire flag bends readily; obvious hardpan; turned roots	Some restrictions to penetrating wire flag and root growth	Easy penetration of wire flag beyond tillage layer	
3. Is the soil worked easily?											Many passes and horsepower needed	Medium amount of power and passes needed	Tills easily; requires little power to pull tillage implements	
4. Is the soil full of living organisms?											Little or no observable soil life	Some (moving) soil critters	Soil is full of a variety of soil organisms	
5. Are earthworms abundant in the soil?											No earthworms	Few earthworms, earthworm holes, or casts	Many earthworms, earthworm holes, and casts	
6. Is plant residue present and decomposing?											No residue or not decomposing for long periods	Some plant residue slowly decomposing	Residue in all stages of decomposition; earthy, sweet smell	
7. Do crops/weeds appear healthy and vigorous?											Stunted growth, discoloring, uneven stand	Some uneven, stunted growth; slight discoloration	Healthy, vigorously and uniformly growing plants	
8. Do plant roots grow well?											Poor root growth and structure; brown or mushy roots	Some fine roots; mostly healthy	Vigorous, healthy root system with desirable root color	
9. Does water infiltrate quickly?											Water on surface for long periods after light rain	Water drains slowly; some ponding	No ponding after heavy rain or irrigation	
10. Is water available for plant growth?											Droughty soil, requires frequent irrigation	Moderate degree of water availability	The right amount of water available at the right time	
Other														

How to use the card

- 

Enter date, location, crop, year of planting (if perennial crop), and soil moisture level in the field. Select 1-5 representative spots in the field.
- 

Use a shovel or a wire flag to probe the soil. Rate each indicator on a scale from 1 to 10. Refer to the rating guide to determine the score for each indicator.
- 

Record your observations. Review and evaluate your scoring.
- 

On the back page, write down current management practices. Record ideas for changes in management that you will implement as a result of your assessment.

Source- Extension & Experiment Station Communications, Kerr Administration,
 Oregon state University, Corvallis, USA



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Home

Fact Sheets

Calculators ▾

Videos

Fact Sheets

Western Australia

South

les

Queensland

Victoria

Grape and Wine

Biological Indicators

- Making Sense of
- Soil Biological Fe
- How Much Carbo
- Total Organic Car
- Organic Carbon S
- Carbon Storage -
- Carbon Storage -
- Soil Organic Cart
- Labile Carbon
- Microbial Biomass
- Interpreting Micro
- Tillage, Microbial
- Soil Nitrogen Sup
- Biological Inputs -

BIOLOGICAL

Green Manure Calculator

Wheat Yield Potential Calculator

Retaining Stubble Calculator

Organic Matter Biomass Calculator

Biochar Calculator

Bio Product Calculator

CHEMICAL

Lime Comparison Calculator

Lime Benefit Calculator

PHYSICAL

Controlled Traffic Calculator

Gravel and Bulk Density

Deep Cultivation for Non-Wetting Soils

GENERAL

Gross Margin Calculator

T Test

General



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SOIL HEALTH CARD RESULTS SHEET



Date: _____ Location / management: _____ (draw a sketch map overleaf)

Soil Type: _____ Productivity: _____ Days since 20mm Rain: _____ Soil Moisture: dry / moist / water logged

RESULT ▶ TEST ▼	POOR			FAIR			GOOD			TEST SCORES (1 - 9)					
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	Av.
1. GROUND COVER	Less than 50% ground cover (ground plants or mulch)			50% to 75% ground cover (ground plants or mulch)			More than 75% ground cover (ground plants or mulch)								
2. PENETROMETER	Wire probe will not penetrate.			Wire probe penetrates with difficulty to less than 20 cm.			Wire probe easily penetrates to 20 cm.								
3. INFILTRATION	More than 7 minutes			3 to 7 minutes			Less than 3 minutes								
4. DIVERSITY OF MACROLIFE	Fewer than two types of soil animals.			Two to five types of soil animals.			More than five types of soil animals.								
5. ROOT DEVELOPMENT	Few fine roots only found near the surface.			Some fine roots mostly near the surface.			Many fine roots throughout.								
6. SOIL STRUCTURE	Mostly in clods or with a surface crust, few crumbs.			Some clods but also many 10 mm crumbs.			Friable, readily breaks into 10 mm crumbs.								
7. AGGREGATE STABILITY 10 cm depth → 20 cm depth →	Aggregate broke apart in less than one minute.			Aggregate remained intact after one minute.			Aggregate remained intact after swirling.								
8. EARTHWORMS	0 - 3			4 - 6			more than 6								
9. SOIL pH 5 cm depth → 20 cm depth →	pH 5 or lower			pH 5.5			pH 6 to pH 7								
10. LEAF COLOUR	Stunted plants, leaf discolouration.			Some variation in growth and colour.			Appropriate leaf colour and uniform plant growth.								

NB Numbers resulting from the different tests are not intended to be combined to give an overall value of soil health.



Source- NRCS USDA Portal



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Indian Scenario



Ministry of Agriculture & Farmers
Welfare, Government of India

SOIL HEALTH CARD MULTIPLE BENEFITS



Issue of 14 crore
'Soil Health Cards'
for all the Holdings
once in a cycle of
2 years.

All 2.53 crore samples
collected, 2.42 Crore
Sample tested
across the country
in cycle-1,
2015-17.

Information to
the farmers on
optimal doses of
fertilizer application to
Crops.

8.94 Crore
'Soil Health cards'
distributed till
12th June, 2017.
Balance distribution soon

Nation-wide program
to improve soil health.

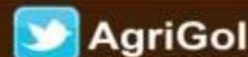
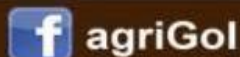
**SOIL HEALTH
CARD**



Informed choices to
the farmers on soil
health for increasing
productivity.

Swasth Dhara, Khet Haraa

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Empowering Communities...

कृषि एवं सार्वजनिक विभाग
कृषि एवं किसान कल्याण विभाग
भारत सरकार



किसान कल्याण एवं कृषि विस्तार विभाग
सूचना एवं प्रसारण



समय पर, करे हम

सॉयल हेल्थ कार्ड संख्या: _____

किसान का नाम: _____

पता: _____

सॉयल हेल्थ कार्ड		प्रयोगशाला का नाम	सॉयल परीक्षण परिणाम			
किसान का विवरण		क्रमांक	पैरामीटर	परिणाम	इकाई	आंकड़न
नाम						
पता						
ग्राम						
उप-जिला/तहसील						
जिला		1	पी एच (pH)			
पिन कोड		2	ई सी (EC)			
आधार सड़चा		3	जैविक कार्बन (OC)			
नाबाइल सड़चा		4	उपलब्ध नाइट्रोजन (N)			
सॉयल नमूना विवरण		5	उपलब्ध फास्फोरस (P)			
सॉयल नमूना सड़चा		6	उपलब्ध पोटेशियम (K)			
नमूना एकत्र करने की तिथि		7	उपलब्ध सल्फर (S)			
सर्वे सड़चा		8	उपलब्ध जिंक (Zn)			
खसरा सं. / Dag No.		9	उपलब्ध बोरॉन (B)			
खेत का क्षेत्रफल		10	उपलब्ध आयरन (Fe)			
भू-स्थिति (GPS)	अक्षांश: _____ देशांतर: _____	11	उपलब्ध मंगनीज (Mn)			
सिंचित भूमि / वर्षा सिंचित भूमि		12	उपलब्ध कॉपर (Cu)			

द्वैतविक एवं सूक्ष्म पोषक तत्वों संबंधी सिफारिशें

क्रमांक	पैरामीटर	सॉयल अनुप्रयोग संबंधी सिफारिशें
1	सल्फर (S)	
2	जिंक (Zn)	
3	बोरॉन (B)	
4	आयरन (Fe)	
5	मंगनीज (Mn)	
6	कॉपर (Cu)	

General Recommendations

1	जैविक खाद	
2	जैव उर्वरक	
3	घुना/जिप्सम	

International
Year of Soils



Healthy Soils
for

संदर्भ उपज के लिए उर्वरक सिफारिशें (जैविक खाद के साथ)

क्रमांक	फसल व किस्म	संदर्भ उपज	एन.पी.के. के लिए उर्वरक संयोजन-1	एन.पी.के. के लिए उर्वरक संयोजन-2
1	धान			
2				
3				
4				
5				

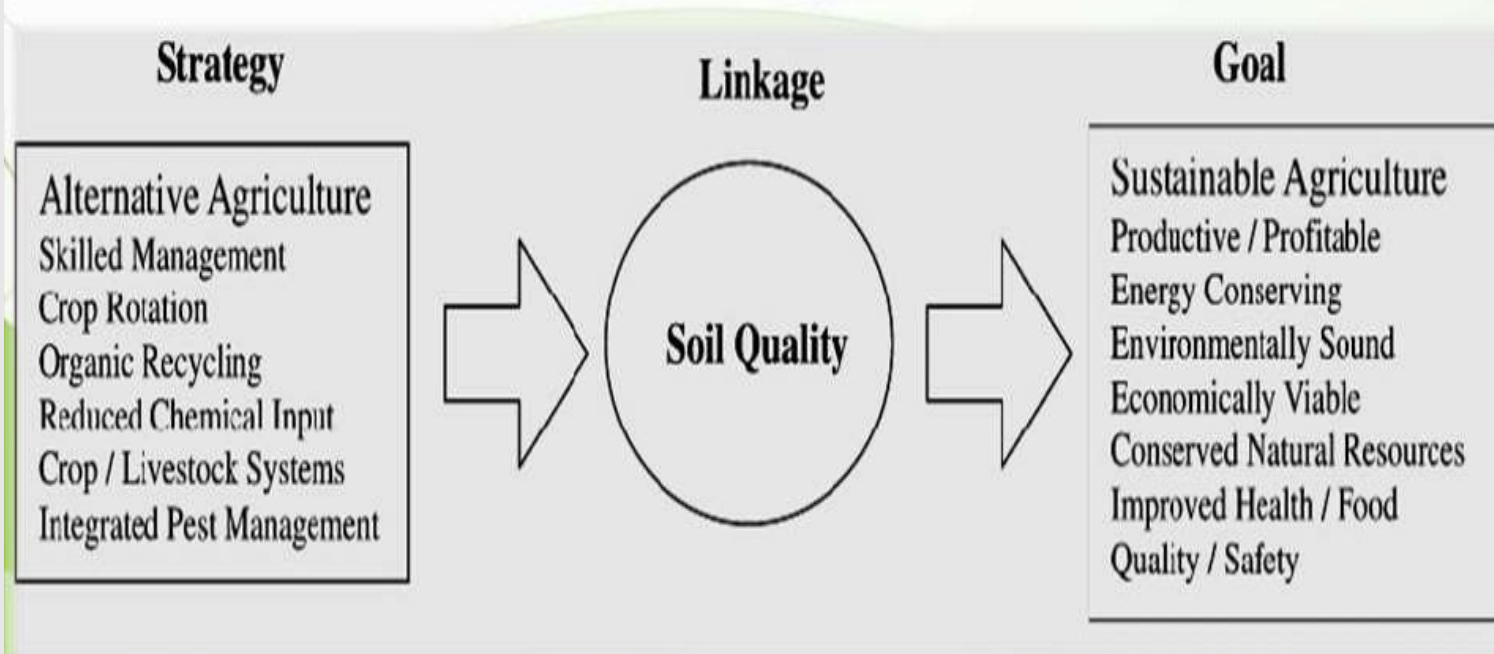


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Alternative Agriculture: The Strategy

These are some of the Strategy that should be followed in modern day intensive and chemical based farming system in order to attained the long term production sustainability maintaining soil health or Soil Quality and this is Known as **Alternative Agriculture-**



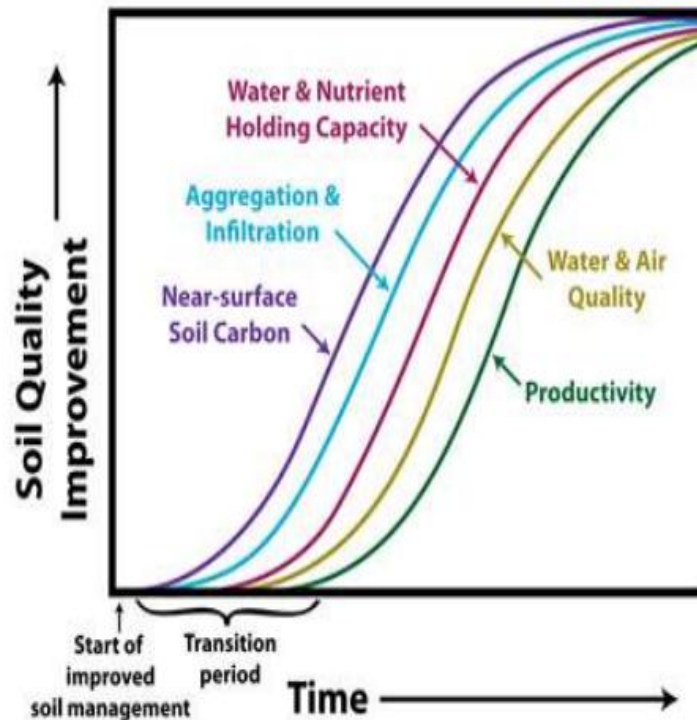
**Source- Soil-Microbial Systems Laboratory, Agricultural Research Service,
U.S. Department of Agriculture, Beltsville, Maryland, U.S.A.**



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Effect of Improved Soil Management



This Graph shows how soil quality parameters like Carbon Content, Soil aggregation, Infiltration rate, WHC, Nutrient reserve improved with time in a soil with adoption of improved soil management practices that followed in alternative agriculture. It also result in increased crop productivity that can lead to longevity or sustainability of crop production.



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Conclusion

- **Research is needed to quantify the indicators or attributes of soil quality into indexes that can accurately and reliably characterize the relative state of soil quality as affected by management practices and environmental stresses.**
- **The best indicator of soil quality probably will differ according to agro ecological zones, agro climatic factors, and farming systems. It is likely that soil quality indicators would be quite different for paddy rice compared with crops grown in well drained soils.**
- **A high priority for future research is to identify and quantify reliable and meaningful biological/ecological indicators of soil quality, including total species diversity and genetic diversity of beneficial soil microorganisms.**
- **We need to know how these indicators are affected by management practices, and how they relate to the productivity, stability and sustainability of farming systems.**
- **At last there should be some program to aware our uneducated and resource poor farmer about importance of soil health and agricultural sustainability.**