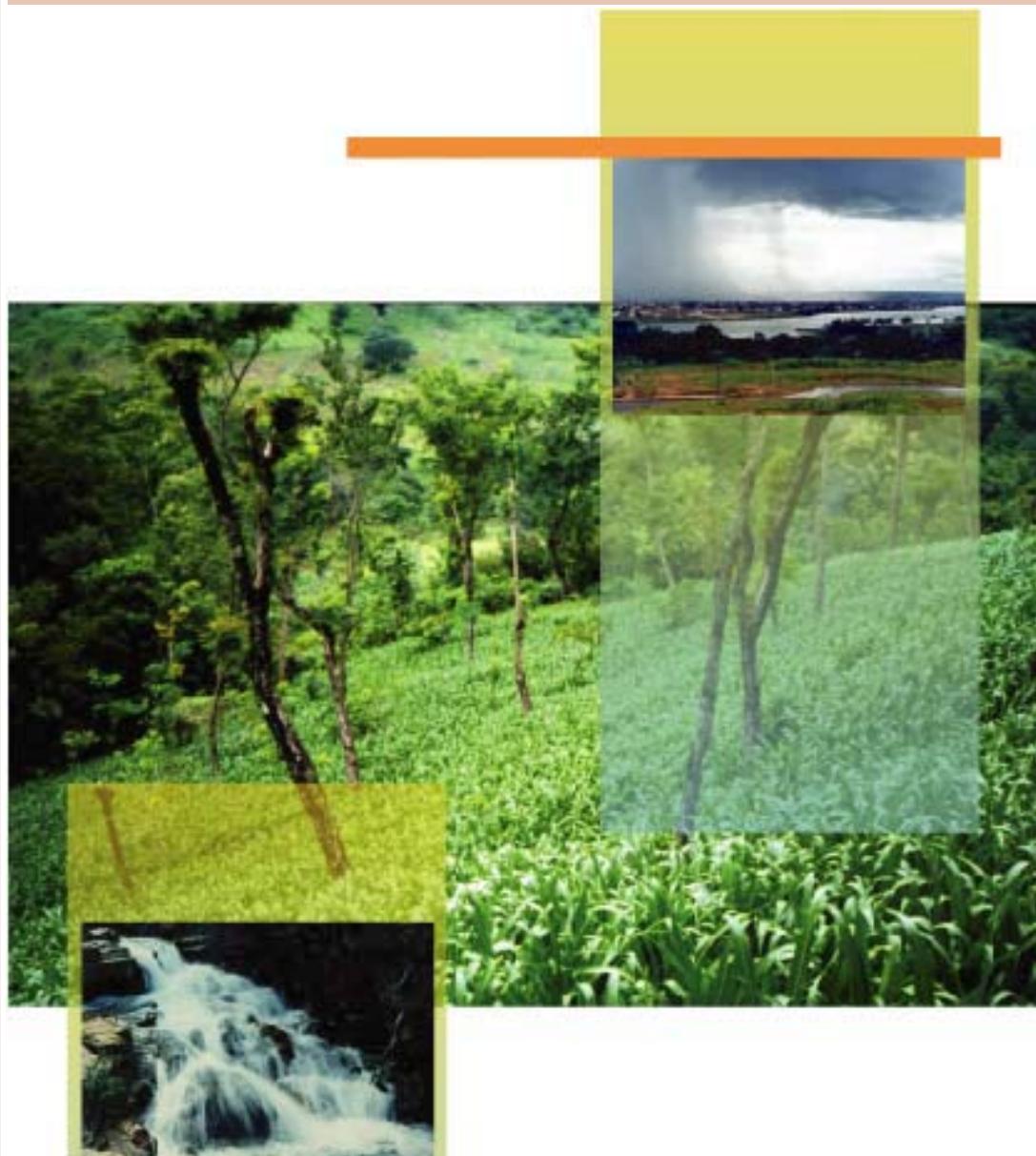


Optimizing soil moisture for plant production

The significance of soil porosity



Preface

As the human population grows, notably in the tropics and subtropics (where many rural people live in poverty), the difficulties of increasing food production also increase. In these areas, average crop yields are in gradual decline. In spite of improved plant breeding, the rates of rise in potential yield are slowing down. Problems caused by erosion and lowland flooding are more frequent, providing evidence of ecological instability in upland areas. Water tables are falling as a result not only from drought, but also from overuse. People without formal land rights cultivate ever-larger areas of steep slopes and other marginal land.

As good land for the lateral expansion of agriculture becomes scarcer, there will be increasing need to intensify land use without causing a decline in productive potential.

There are experiences in a growing number of countries indicating that an agricultural revolution based on principles of better soil management can have a significant positive impact on the sustainability and productivity of agriculture.

Soil moisture is often neglected, but improved soil moisture management is crucial for sustainable improvement of food production and water supply. A wider perception of soil productivity and the reasons for soil erosion and runoff will contribute to achieving higher, profitable and sustainable plant production and to improve the regularity of streamflow.

Reduction of a soil's capacity to accept, retain, release and transmit water reduces biomass productivity, whether of crops, pasture species, shrubs or trees. Soil porosity is closely linked with yields, with the economics of farming and with the sustainability of farm families' livelihoods. Farmers are aware that land cleared from previously undisturbed vegetation provides "free fertility" from which the first crops benefit. But they also know that after a few seasons, productivity declines and that part of this decline is associated with the degradation of soil physical conditions. It is less commonly recognized that this soil damage and the loss of organic matter results in increased surface runoff and reduced soil moisture status.

People are aware of problems of water shortage and soil loss, but despite continued efforts, effective means of overcoming them have not become widespread. However, there are examples in parts of Brazil, Niger and Kenya where better understanding and care of the land are avoiding or reducing water shortages. This is being achieved by increasing rainwater infiltration into the soil, where it is retained for plant use or moved below the root zone to the groundwater.

Where surface runoff is a problem, it can indicate that the soil has become unreceptive, less porous and that much of the rainfall is ineffective in supporting plant growth and regular streamflow. The challenge is to enable the entry of as much rainfall into the soil as possible by promoting conditions that simulate an absorptive forest floor. Such conditions will stabilize the landscape, limit erosion and maximize the usefulness of rainfall. It is important to stress that while inadequate soil water supply is a major cause of low crop productivity, the nutritional aspects of crop productivity are also important. Consequently, an integrated approach to solving low crop productivity should always aim at an adequate supply of both soil water and nutrients.

Scientific endeavour will continue to increase our knowledge of the components of these problems and offer partial solutions. However, unravelling details of problems will not automatically result in workable means of solving them. This is because there is too little understanding of some key ecological and ever-changing linkages. For example, it is the complex set of interactions among weather, plants, soils, water and landscape that results in the crop yields each season. Conventional approaches to crop production offer limited scope for future progress. There is a need to think laterally, to see if there are other ways of looking at old assumptions to identify new ways forward.

This book, intended for extension staff and other technicians, as well as farmer leaders, aims to provide a solid basis for sound, sustainable soil moisture management.

This document has been made more user-friendly by presenting a guide for field workers with activities, exercises and discussion topics in non-technical language, and by interspersing the text with illustrations and diagrams. The complete materials of this guide are included on the CD-ROM that accompanies this document. The emphasis in this CD-ROM is on the use of careful field observations of soil and plant indicators to identify soil water problems.

Contents

1. INTRODUCTION	1
A way forward	6
The hydrological cycle	9
2. HYDROLOGY, SOIL ARCHITECTURE AND WATER MOVEMENT	9
Catchments and watersheds	11
Soil architecture and the importance of pore spaces in soils	17
Soil water movement	19
Infiltration of rainwater into soil	20
Percolation of rainwater through soil	21
Loss of water vapour from soils	21
Water movements into and through a plant	21
Water stress – nutrient interactions	22
Causes of restricted rooting	23
Indicators of restricted rooting	25
3. RAINWATER, LAND PRODUCTIVITY AND DROUGHT	27
Rainwater for improving yields	27
Deteriorating water supply	28
Indicators of deteriorating water supply	29
Soil productivity and soil erosion	29
Soil productivity	29
Soil erosion	33
Plant-damaging drought	36
Making droughts worse	37
Shortening the duration of drought	37
Changing the perspective on saving soils	39
Care about roots, soil organisms and water	40
4. MINIMIZING WATER STRESS AND IMPROVING WATER RESOURCES	43
Improving restricted rainfall infiltration	43
Improving the infiltration capacity of the soil surface	43
Using surface residue covers to increase infiltration and reduce runoff	44
Mechanisms by which surface residue covers enhance rainwater infiltration	46
Advantages of surface residue covers	46
Constraints to using surface residue covers	47
The amount of residues needed	47
Conditions favouring the adoption of surface residue covers	47
Fallowing under cover crops or natural vegetation	47
Temporary closure of grazing lands and subsequent protection	48
Importance of forest protection for water infiltration	48
Increasing the period for infiltration by detaining runoff with physical structures	49

Contour field operations	50
Constraints of surface irregularities formed by contour field operations	51
Conditions favouring the adoption of contour field operations	51
Narrowly spaced contour planting ridges and tied ridges	51
Advantages of narrowly spaced contour ridges and tied ridges	52
Constraints of narrowly spaced contour ridges and tied ridges	53
Conditions favouring the adoption of narrowly spaced contour ridges and tied ridges	53
Impermeable and permeable contour barriers at discrete intervals downslope	53
Conditions favourable for adoption of impermeable cross-slope barriers for water conservation	55
Permeable cross-slope barriers	55
Bench-type terraces	55
Deep tillage to increase subsoil porosity and permeability	56
Reducing water losses from evaporation and excessive transpiration	56
Minimizing evaporation from the soil surface	57
Reducing excessive transpiration	57
Weed control	57
Windbreaks	58
Conditions favouring the adoption of windbreaks	59
Shade	59
Reducing rainwater drainage beyond the rooting zone	60
Soils without restricted rooting	60
Increasing available water capacity of soil	60
Dry planting	60
Improving plant nutrition for early root development	61
Introducing deep-rooting crops	61
Improving soils with restricted rooting	61
Conditions favouring the adoption of biological methods	63
Mechanical solutions to physical root restriction	63
Mechanical disruption of shallow root-restricting layers	63
Mechanical disruption of moderately deep root-restricting layers	64
Mechanical disruption of very deep root-restricting layers in the subsoil	66
Conditions favouring the adoption of mechanical methods	69
Chemical solutions to restricted root growth	69
Maximizing usefulness of low and erratic rainfall	69
Match land use to soil characteristics	69
Use of drought-resistant and drought-escaping crops and varieties	70
Increase crop water use efficiency	71
Selecting water-efficient crops	71
Adjusting plant population to expected rainfall	72
Applying fertilizers	72
Weed control	73
Seed priming	73
Early planting	73
Accumulate moisture from one season to the next	74
Water harvesting	74
Zai pits or Tassa	76
Half moons (demi-lunes)	78

Contour stone lines	78
Contour earth ridges and bunds	79
Retention ditches	79
Retention pits	80
Retention basins	80
Farm ponds	80
Floodwater harvesting and water spreading	80
Collaborative stakeholder participation	80
Need for a facilitator	81
Need to tackle root causes	81
Participatory identification and prioritization of soil water problems	81
Participatory identification of the root causes	81
Participatory identification of possible solutions for testing	82
Participatory selection of possible solutions for testing	82
Participatory testing and evaluation of possible solutions	84
 5. CONSERVATION AGRICULTURE	85
Improving soil conditions	85
Residue-based zero tillage in Brazil and Paraguay	85
History	87
Implementing conservation agriculture	88
Effects of conservation agriculture	91
Effects on crop yields	91
Effects on soil moisture	91
Effects on some other soil health indicators	93
Effects on erosion and runoff	94
Effects on catchment hydrology	95
Effects of zero tillage systems on farm economics	95
Observations about residue-based zero tillage systems in Latin America	97
Constraints of conservation agriculture and some approaches to overcome them	98
 REFERENCES	101

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List of figures

1. Human-induced soil degradation	3
2. Simplified diagram of the hydrological cycle	9
3. The sequence of destinations of rainwater	10
4. Catchment vs. watershed as distinct but interrelated features of the landscape	11
5. A nested hierarchy of interrelated constructed and natural catchments	12
6. Typical available water capacities of different textured soils	15
7. Runoff and percolation: two routes for rainwater	15
8. Sideways development of tap-root of a wild okra weed growing in a maize field; the change in growth habit of the root is caused by a compacted hoe pan at the base of the ridges formed by hoeing to the same depth (and the passage of feet during the rains) over many years	24
9. Examples of rooting pattern and growth habit when roots are physically impeded or prevented from penetrating a root-restricting soil layer	26
10. Soil structure and its impact on soil processes and agricultural sustainability	31
11. Where the soil is not crusted and is protected by litter from the force of raindrops more water enters the soil than where the surface is bare	31
12. Yield after erosion is related to the quality of soil remaining, not to quantity and quality of soil removed	34
13. Within-season droughts with annual rainfall totals of 1 275 mm (1915), 776 mm (1965) and 340 mm (1972) in Hyderabad, India	38
14. Root systems of two young tea plants of the same clone (MT12) without and with irrigation, after 9 months in the field	39
15. Fate of rainwater for three soil management practices	53
16. Fanya Juu terrace at construction and after several years	55
17. Example of a paraplow	65
18. a) Shows the depth of shank penetration for in-row subsoiling in relation to the root-restricting horizon, b) shows a cross-sectional view of the effect on crop root development	66
19. Example of concentrated runoff harvesting by diverting ephemeral flows into retention ditches or basins	75
20. Permeable rock dams with contour stone bunds for floodwater harvesting and water spreading	75
21. Example of possible solutions to the problem of high runoff	82
22. Example of a problem-cause tree for high runoff	82
23. The growth of residue-based zero tillage in Brazil 1972 –1999	88
24. Soil moisture available to plants at different depths during the vegetative phase of wheat growth, under three methods of soil preparation	92
25. Frank' Anna farm's production graphs 1978-2000 in Paraná, Brazil	93

List of tables

1. Arable land and permanent crops area (1 000 ha) per 1 000 capita by region	1
2. Decline in average yields of unfertilized maize in kg/ha – local/traditional varieties, Malawi	2
3. Decline in response of local maize to fertilizers in Malawi	2
4. Three-year running means of five major crops' yields (kg/ha), Lesotho	2
5. Differences in available water capacities between two East African soils	15
6. Functions and sizes of soil pores	18
7. Dimensions of roots of three grasses in sample of 0.688 litre taken to a depth of 15 cm	30
8. Annual rainfall totals at Indore, India	36
9. Length of growing period for different soil available water capacities in bimodal rainfall areas of semiarid India	69
10. Effect of P fertilizer and soil depth on rainwater use efficiency and sorghum grain yield in Botswana	73
11. Effects of improved zaï on sorghum yields over 2 years	77
12. Yields, net value of production and returns to labour from existing tassa/(zaï) and demi-lunes, Niger	78
13. Checklist of possible solutions to soil water problems that will need validating and adapting with farmers	83
14. Yields of wheat and soybean, averaged across rotations, under three different soil preparation methods in Londrina, Brazil	91
15. Changes in mean diameter and stability of soil aggregates after 7 years of rotation under residue-based zero tillage (ZT) and conventional tillage (CT) in Paraná, Brazil	93
16. Buildup of soil organic matter under ZT compared with conventional cultivation	94
17. Influence of different methods of soil preparation on population of earthworms in Paraná, Brazil	94
18. Number of maize roots to depth of 1 m after 15 years of zero tillage (ZT) and conventional tillage (CT) in Paraná, Brazil	94
19. Losses of soil and water under conventional tillage (CT) and residue-based zero tillage (ZT)	94
20. Comparative short- and long-term economic results on typical 135 ha farms with tractor power, from conventional tillage (CT) and residue-based zero tillage (ZT) in San Pedro and Itapúa regions, Paraguay	96
21. Summary of farming system results on small farms with cotton, soybeans, tobacco, maize	96

Acronyms

ABLH	Association for Better Land Husbandry
ABRACOS	Anglo-Brazilian Amazonian Climate Observation Study
AWC	Available Water Capacity
CA	Conservation Agriculture
FAO	Food and Agriculture Organization of the United Nations
FC	Field Capacity
FEBRAPDP	Federação Brasileira do Plantio Direto na Palha
IAPAR	Paraná State's agricultural research station, Brazil
Instituto CEPA/SC	Santa Catarina State's Institute for Planning and Agricultural Economics, Brazil
MAI	Moisture Availability Index
NGO	Non-Governmental Organization
PWP	Permanent Wilting Point
SUREHMA	Paraná State's agency for water resources and the Environment, Brazil
SWC	Soil and Water Conservation
TRIEA	Tea Research Institute of East Africa
WSC	Water and Soil Conservation
ZT	Zero Tillage

Glossary of soil moisture terms

Field Capacity (FC) – refers to the relatively constant soil water content reached after 48 hours drainage of water from a saturated soil. Drainage occurs through the transmission pores (greater than about 0.05 mm diameter; but note that field capacity can correspond to pores ranging from 0.03 to 0.1 mm diameter). The FC concept only applies to well-structured soils where drainage of excess water is relatively rapid; if drainage occurs in poorly structured soils, it will often continue for several weeks, and so poorly structured soils seldom possess a clearly defined FC. FC is best determined in the field by saturating the soil and measuring its water content after 48 hours of drainage have elapsed. Soil at field capacity feels very moist to the hands.

Permanent Wilting Point (PWP) – refers to the water content of a soil that has been exhausted of its available water by a crop, such that only non-available water remains. The crop then becomes permanently wilted and cannot be revived when placed in a water-saturated atmosphere. At this point the soil feels nearly dry or only very slightly moist.

Available Water Capacity (AWC) is the water available for plant growth held between Field Capacity and Permanent Wilting Point.

Saturation – refers to a soil's water content when practically all pore spaces are filled with water. This is a temporary state for well-drained soils, as the excess water quickly drains out of the larger pores under the influence of gravity, to be replaced by air.

List of background documents (available on CD-ROM)

1. Preliminary activities: community maps and transect walks
2. Activities: exploring soil hydrology, biology, porosity, etc.
3. Discussion topics for farmers' groups
4. Assessing project success: the significance of farm families' comments
5. Reinterpreting reports
6. An example of how to begin the steps of improvement
7. Soil moisture use under different land uses and vegetation
8. "The soil maker of Chile"
9. List of publications about cover crops
10. Demonstrating the importance of soil porosity

System requirements to use the CD-ROM:

- IBM compatible with Microsoft® Windows 95 / 98 / 2000 / Me / NT / XP
- 64 MB of RAM
- 50 MB of available hard-disk space
- Internet browser such as Netscape® Navigator or Microsoft® Internet Explorer
- Adobe Acrobat® Reader 5.0 (included on CD-ROM); to be installed in case of problems with previous versions of Adobe Acrobat® Reader