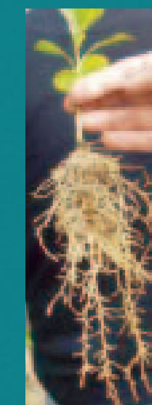
CONSERVATION
of natural resources
for sustainable
AGRICULTURE

Soil compaction

An unnecessary form of land degradation

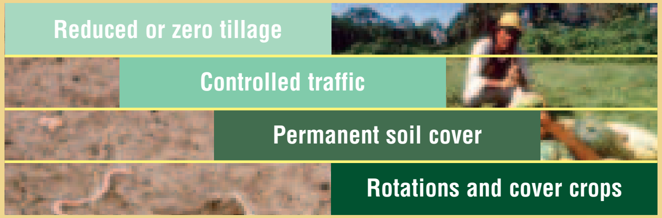
T.F. SHAXSON

DES McGARRY



C.N. ROISTACHER

Prevention of soil compaction is best achieved through the implementation of the four key principles and practices of conservation agriculture:



DES McGARRY

M.SISTINI/FAO/18131

Reduced or zero tillage

Minimum or zero tillage not only protects soil architecture through minimal soil disturbance, but also permits the population growth of soil biota. These soil organisms undertake biological ripping that improves soil structure, preventing compaction and facilitating root penetration.

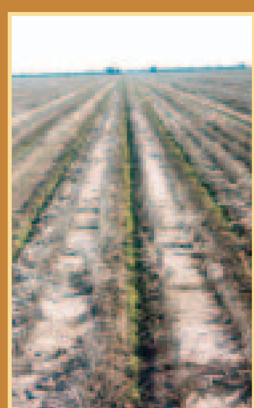
DES McGARRY

Controlled traffic

The in-field traffic of human feet, animal hooves and the tyres of tractors, seeders and harvesters is restricted to established tracks. The result is that the area between the tracks is totally free of compaction, where combined with zero or reduced till. Soil porosity and water infiltration are maximized, soil biological activity prospers, organic matter is not lost and becomes bound and integrated more closely with the soil.

The efficiency of in-field operations is increased with controlled traffic because there is a greatly reduced overlap of traffic, seeding and harvesting, with consequent reductions in labour and costs.

In addition, the use of flotation tyres on the heavier farm equipment can help spread the load and so reduce the risk of soil compaction.



DES McGARRY

Permanent soil cover and rotations and cover crops

These two principles of conservation agriculture reduce compaction levels by:

- enhancing biological activity;
- increasing organic matter levels: this maximizes the aggregation of soil particles and consequently increases soil stability. Organic matter content is essential for optimized soil architecture.

In addition, rotation crops provide a variety of root types and patterns in the soil that break up compacted layers and create a network of root channels.

The power of the system comes from the **SYNERGY** of the above four principles of conservation agriculture. However, the system is not prescriptive and there is no one recipe to suit all conditions.
It is important that individuals find a system that works for them on their land using available equipment and expertise.

T.F. SHAXSON

S. VANEPH

T.F. SHAXSON

Conservation agriculture optimizes soil structure for reduced-cost, sustainable cropping systems that maximize the use of rainfall and irrrigation water for improved and more guaranteed productivity. The overall outcome is the more productive soil system that obtains the best from even a 'poor' soil because of the enhanced soil water store and deep rooting system in an uncompacted, biologically diverse and organic-matter-rich soil.

FOR MORE INFORMATION:

Development and design: Antonio Castellanos

Land and Plant Nutrition Management Service
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla - 00100 Rome, Italy
http://www.fao.org/landandwater

Dipartimento di Scienze degli Alimenti
Universitá degli Studi di Teramo
Via Spagna, 1 - 64023 Mosciano S. Angelo (Teramo), Italy
http://www.unite.it

This is a joint publication of FAO and the University of Teramo. The concept for this leaflet originated from José Benites (FAO) and Michele Pisante (University of Teramo).
Acknowledgements: this material has been elaborated by Des McGarry, Queensland Government, Australia.

TC/I/Y4819E/1/8.03/100

1 SOIL STRUCTURE: SUPPORTING THE FARMER

Soil structure degradation – often called soil compaction – is regarded, with soil erosion, as the costliest and the most serious environmental problem caused by conventional agriculture. The immediate consequences of soil compaction are:

- decreased water and fertilizer efficiencies
- increased soil erosion

This type of land degradation causes major negative impacts at many levels from subsistence farmers to large-scale farms. It increases the risk of crop failure under reduced water supply and it increases farming costs (higher input requirements and investments to alleviate the problem).

2 INADEQUATE KNOWLEDGE AND SOIL MANAGEMENT PRACTICES: COMPACTING THE SOIL

Soil consists of more than the solid parts. The network of pore spaces is particularly important. The number, size and connectivity of pores are related directly to the chemical and biological processes that are found in natural ecosystems. In agro-ecosystems, an adequate network of pore spaces supports and enhances yields because of:

Increased water infiltration and crop water availability

Reduced runoff

Improved environment for root development

Facilitated seed germination

Soil porosity is affected considerably by soil management practices. Appropriate soil management reduces excessive and inappropriate physical inputs (in-field traffic and tillage) and protects the biological activity that improves soil structure, porosity and quality for crop production.

Soil compaction is a human-induced problem. It can be prevented through better soil practices that do not disrupt the natural soil architecture.

3 IDENTIFYING SOIL COMPACTION

J. PRETTY

It is important to identify whether soil compaction is reducing crop productivity. If this is the case, then direct, practicable management systems should be devised to repair and prevent it.

DES McGARRY

Compaction is a subsurface phenomenon that requires soil excavation in order to view and describe it. Crop performance is not an efficient indicator because compaction effects are minimal under adequate rainfall patterns.

DES McGARRY

The two most common visible forms of soil compaction are:

- Massiveness: soil aggregates are compressed into large and dense blocks that equate to reduced air space and increased soil strength.
- Platiness: the soil forms plate-like structures, horizontal to the soil surface. These structures are a strong barrier to plant root proliferation and water movement into subsoils.

Soil water content and compaction risk

Soil water content during traffic and cultivation determines the severity and extent of soil compaction. Soil water acts as a lubricant, permitting soil aggregates and individual particles to move in response to pressure from the transit of animals, vehicles and tillage equipment. This leads to the loss of air spaces and the closer packing of soil particles. Thus, compaction risk is greater in moist soils.

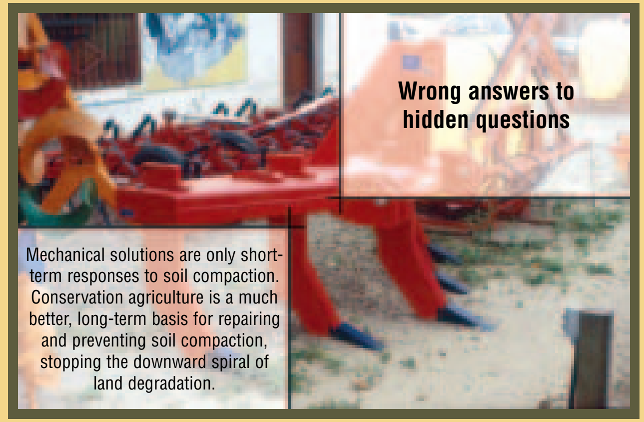

DES McGARRY

The consequent decline in yields from soil compaction is explained by a combination of:

- reduced water infiltration and water availability;
- increased runoff;
- restricted root growth (reduced soil depth);
- poor seed germination;
- poor soil aeration;
- greatly reduced fertilizer efficiencies: either plant roots cannot reach the fertilizer or the applied nutrients remain locked-up in the compacted soil because of reduced soil water dynamics.

4 CONSERVATION AGRICULTURE: REPAIRING AND PROTECTING THE SOIL RESOURCE

Once compaction is recognized and the cause (or causes) of its formation resolved, farming systems can be designed to repair and then ensure future prevention of the problem.



Mechanical solutions are only short-term responses to soil compaction. Conservation agriculture is a much better, long-term basis for repairing and preventing soil compaction, stopping the downward spiral of land degradation.

R.G. BARBER

A compacted soil can be repaired using a workable combination of break and rotation crops that provide:

- natural crop-induced wetting and drying cycles to crack the soil;
- root penetration to break up massive and platy soil structure;
- increased organic matter to enrich and strengthen the soil.

This is called 'biological ripping', achieved through the break and rotation crops that grow through and break up the compacted soil, increase organic matter levels, improve water penetration and facilitate the return of earthworms – the best 'soil cultivators'.