Towards Alleviation of Poverty in the Tropics

Technical Workshop, FAO, Rome: 22-24 JULY 2008

Investing in Sustainable Crop Intensification:

The Case for Improving Soil Health

Technical Background Note 2[1]

"Despite the artistic pretensions, sophistication and many accomplishments of mankind, we owe our existence to a six-inch layer of topsoil and the fact that it rains".

Pinned on Don Meyer's office wall /? Confucius

1. Pressures and Problems

With growing human populations and ever-more limited areas of land suitable for lateral expansion of agriculture, higher production of vegetation per unit area is essential for future security of food and other agricultural products.

At the same time, water supplies are becoming less reliable. Plant growth, streamflow and groundwater availability are being adversely affected, situations which climate changes are likely to worsen.

In the majority of rainfed areas of the tropics and subtropics, the agricultural productivities of soils, of water, of nutrients, and hence of the rural livelihoods that depend on them, are not being sustained. For those already poor, their livelihoods are becoming increasingly insecure.

There is evidence - from both temperate and tropical regions – that, after clearing of undisturbed vegetation, whether in the recent or distant past, organic matter in the soil declines at first rapidly and then, over many decades, more slowly to very low levels if insufficient regular additions of organic (carbon-based) materials are not regularly returned. Associated with this are depletions of nutrient reserves and of soils' capacities to store soil moisture, resulting in decline in underlying production potentials.

This has been known for long by soil specialists but was never mainstreamed into development initiatives. Thus, techniques adopted for reducing rates of productivity loss or countering rising costs of maintaining average yields, avoiding soil erosion and minimising flooding, have in many cases proved to be insufficiently effective. Production can thus prove unsustainable under 'conventional' practices plus commonly-recommended 'add-ons' such as some of the techniques aimed at soil and water conservation.

Merely proposing 'strengthening' conventional approaches, with or without improved plant genetic resources, is unlikely to remedy such a situation on lasting basis.

2. Principles of Soil Health for Sustainable Intensification and Productivity

From many physical landscapes, we expect the three-dimensional catchments which are clothed in soil to yield sufficient crops and other vegetation of various types and, simultaneously, volumes of clean water from streams and boreholes regularly on a repeated annual basis.

[1] Complementing '*Background*' in the TAA *et al*. Workshop Record, Newcastle University, 30-31 March 2007.

Plants, rivers and groundwater depend on water penetrating into soil which is porous from the surface downwards. Insufficiency of water for plants hinders the interacting functioning of the other components of soil productivity: biological, physical, and chemical.

The rate of entry of water into and through soil is governed by soil's porosity, which in turn is governed by the volume and inter-connectedness of pores able to transmit water. The volume and availability of water which plants can use is determined by the proportion of soil pores which can retain water against the force of gravity and yet can release that water in response to 'suction' exerted through roots as dictated by the plants' physiology and atmospheric demand.

Insufficiency of water and/or of various nutrients required by plants for growth processes diminish the derived productivity of the soil in which they are growing, inhibiting full interactions in the plant-soil system. Inadequacy of plant nutrients hinders plant growth and development; severe water-stress stops the whole system.

Soil porosity is damaged or destroyed by compaction, pulverisation, and/or collapse due to degradation and loss of organic matter. Net loss of organic matter is caused by tillage of the soil, which results in accelerated oxidation of the carbon in the materials to carbon dioxide gas and its loss to the atmosphere.

Following such damages, appropriate soil porosity is regained and maintained chiefly through biotic transformation of the non-living fraction of organic matter by its living fraction - soil-inhabiting fauna and flora - from micro-organisms such as bacteria to macro-organisms such as worms, termites and plants themselves. Their metabolic activity contributes glue-like substances, fungal hyphae etc. to the formation of irregular aggregates of soil particle, within and between which are the all-important pore-spaces in which water, oxygen and carbon dioxide flow and roots grow. These substances also contribute markedly to the soil's capacity to capture and retain nutrient ions on organic complexes, and provide a slow-release mechanism for their liberation back into the moisture in the soil. For this activity and its effects to be maintained, a sufficient supply of new organic matter needs always to be available as a source of energy and nutrients to the soil organisms – not just to the plants alone.

If the conditions are kept favourable for biotic activity in the soil, this dynamic process of formation and re-formation of the porous soil architecture will continue from year to year, maintaining the capacities of landscapes thus treated to continue yielding vegetation and water on a recurrent basis, contributing to sustainability of such production processes.

Here lies the significance of maintaining 'soil health'. For the purposes of deciding how best to manage the land to maintain its productivity, it is more appropriate to think of the soil primarily as a living biological entity interpenetrating the non-living components, and forming from the top downwards, rather than as a geological entity forming from the bottom upwards with living things in it at the top.

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Definition of 'Soil Health'[2]

> Soil health is the capacity of soil to function as a living system, with ecosystem and land use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health. It emphasises a unique property of biological systems, since inert components cannot be sick or healthy.
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> Healthy soils maintain a diverse community of soil organisms that help to control plant disease, insect and weed pests, form beneficial symbiotic associations with plant roots (e.g. nitrogen-fixing bacteria and mycorrhizal fungi); recycle essential plant nutrients; improve soil structure (e.g. aggregate stability) with positive repercussions for soil water and nutrient holding capacity, and ultimately improve crop production.

[2] Derived by combining Doran and Zeiss; Wolfe; Trutmann, quoted together on http://ppathw3.cals.cornell.edu/mba_project/moist/TropSCORE.html

Examples of management practices for maximising soil health would include maintaining vegetative cover on the land year-round to increase organic matter input and minimize soil erosion, more reliance on biological as opposed to chemical approaches to maintain crop productivity (e.g. rotations with legume and disease-suppressive cover crops), and avoiding physical (mechanical) interventions which might compact, alter or destroy the biologically created porous structural arrangements of soil components.

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3. Putting Principles of Sustainable Intensification into Practice with Conservation Agriculture ('CA') Systems

A growing number of farmers – on large and small farms in a rising number of countries – have successfully been developing crop-production systems which satisfy three important conditions favourable to biotic activity in the soil: (a) permanent cover of the soil with organic matter provided by a mulch of retained residues from the previous crop or fallow and by living cover-crops; (b) minimal soil disturbance by tillage, and preferably no tillage once the soil has been brought to good condition; (c) rotation of crops, (to include N-fixing legumes) which contribute to maintaining biodiversity above and in the soil and avoid build-up of pest-populations within the spectrum of soil inhabitants.

The generic name commonly used for such systems is 'Conservation Agriculture', in which the rate of accumulation of organic matter consistently exceeds the rate of its loss, and as such clearly distinguishes it from 'conventional' tillage agriculture ('TA').

Benefits which attract people at farm level include[3]:

- Labour, time and farm power are saved through reduced cultivation and weeding requirements.
- Lower variable costs because both operations and external inputs are reduced.
- Mechanical equipment has a longer life-span, lower repair costs, and consumes less fuel than with tillage agriculture.
- Less movement of machinery and equipment necessary in the field; less drudgery of repetitive work.
- More stable yields, particularly in dry years because more nutrients and moisture are available to the crops.
- Labour savings provide opportunities for diversification of enterprises and into other activities.
- Yields are increased even as inputs decrease, including lesser inputs of energy, lower demand for pesticides and lower demand for fertiliser although accompanied by greater unit efficiency of those which are applied[4].
- Increased profits, in some cases from the beginning; in all cases after a few years, as efficiency of the production system increases.
- Most or all rainfall is harnessed as effective rainfall, with no runoff and no soil erosion leading to longer and reliable moisture regime for crop growth, and improved drought proofing.
- Increase in biological nitrogen fixation, soil organic matter and carbon sequestration, cation exchange capacity, soil moisture-holding capacity, soil biota and general agro-biodiversity.

When increasing areas of land become covered by effective CA, these benefits extend onwards to the local community and beyond as ecosystem services, and to the three-dimensional catchments in which the farms are located:

[3] After Pieri, Evers, Landers, O'Connell, Terry: '*No-Till Farming for Sustainable Rural Development*'. WB Agriculture & Rural Development. Working paper; and authors' own observations.

[4] In situations where farmers are at 'starting points' with regards to fertilizer use, the productivity of applied nutrients with CA increases dramatically, thus creating more incentives for smallholder farmers to increase their very low use of fertiliser, especially P which is limiting in many soils.

- More constant water-flow in rivers/streams, improved recharge of the water-table/groundwater, with re-emergence of water in formerly dried-up wells and water sources.
- Cleaner water because pollution, erosion and sedimentation of water bodies are reduced.
- Less flooding because infiltration increases; less damage from droughts and storms.
- Improved sustainability of production systems and enhanced food security.
- Increased environmental awareness and better stewardship of natural resources.
- Lower costs of municipal and urban water-treatment.
- Reduced maintenance costs of rural roads.
- Increased social interactions between members of the local community
- Improved livelihoods and rural life.

The rate and nature of such improvements due to CA are in positive contrast with what appears to be being achieved with conventional tillage agriculture ('TA').

4. The Challenge: Mainstreaming Conservation Agriculture for Sustainable Intensification

In some countries such systems which improve soil health and increase efficiency of factor-use in agriculture are now widespread across both varied types of country and varied types and sizes of farms. They have become established despite initial resistances -- intellectual, administrative, and financial -- which have gradually been overcome by persistence which built up sufficiently striking examples of success to reach the point of ultimate convincement of the doubters. Ultimately 'a fair wind'- of increasing facilitation and assistance to those who then wanted to start - also developed.

However, to move from conventional tillage agriculture to effective CA requires much alteration in conventional thinking and attitudes about how agriculture should be undertaken not only on the part of the farmers but also of policy-makers, scientific experts and advisory staff. Retaining crop residues as mulch, using unfamiliar crops in rotation, changes in needed equipment etc., all may pose great operational and financial uncertainties to a farmer, some of whom may nevertheless decide to start out without important e.g. advisory support or appropriate legislation to facilitate the transition. Others may be less bold and watch how their innovative neighbours fare before 'making the jump' Nevertheless systems of CA have been 'catching-on' surprisingly rapidly, much of it through farmer-to-farmer contact.

However, in the light of the problems increasingly posed by the combination of climate change and population increase to restoring, increasing and sustaining the productivity of land for vegetation and water, such systems deserve more than just tacit acknowledgement and approval.

The potential of CA to reverse decline in soil conditions and make production more secure is so significant a factor that farmers in any situation deserve to be encouraged and supported in practical ways to start and complete the transition to CA, to the benefit of themselves, their local and national communities, and to the on-coming generations.[5]

5. The Rome Technical Workshop

For this to be achieved, appropriate support capacity needs to be brought together, and integrated into multi-faceted and co-ordinated initiatives among policy-makers, financial institutions, the private sector, administrators, research institutions, advisory and knowledge exchange bodies, and

[5] See e.g. the Millennium Ecosystems Assessment '*Living beyond our means*' at http://www.millenniumassessment.org/documents/document.429.aspx.pdf; '*Global Environment Outlook – GEO 4* at http://www.unep.org/geo/geo4/report/GEO-4_Report_full_en.pdf; also World Development Report 2008: Agriculture for Development at http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2008/0,,contentMDK:21410054~menuPK:3149676~pagePK:64167689~piPK:64167673~theSitePK:2795143,00.html

others, in response to the key requirements of, and in closest collaboration with, the members of 'the front line' – the farmers.

The purposes of the Rome Workshop are:

- To describe the principles of Conservation Agriculture and demonstrate its benefits for farmers and societies to widen attention of potentially-supportive decision-makers in the broad fields of policy-making, science & technology, field practice, and financing;
- To discuss, suggest and agree the chief forms of interlinking decisions and action which would provide positive encouragement of, and support to, farmers to make and sustain their transition to beneficial CA systems as most appropriate to their different agro-ecological and socio-economic situations;
- To pave the way for comparable forums to develop and function at continental, national and local levels;
- To favour the development of an inter-connected Community of Practice around the subjects pertaining to and the benefits deriving from Conservation Agriculture.

6. Outline Workshop Agenda

The proposed programme (see annex) comprises a 3-day meeting (22-24 July 2008) in the form of a stakeholder technical Workshop. The first day will be spent examining the field evidence or 'proof of concept' from the developing regions – Latin America, Africa and Asia -- of successful soil management practices for both crop intensification and sustainability, and the relevant features they have in common which are favourable for scaling. Cases (including crop-livestock systems) from each region will be presented covering different agro-ecologic and socio-economic settings, each illustrating the basic principles and practices leading to soil health improvement and agricultural intensification based on conservation-effective practices. The outcome of this examination will be the identification of principles, opportunities and issues from four viewpoints – policy, science & technology, field practice and financing & donor support.

The subsequent two days will be spent on identifying opportunities for investment of various kinds of resources by different stakeholders under the four broad sectors of policy, science & technology, field practice and financing & donor support. The outcome of the Workshop will be a Declaration with Action Plan and a statement on the next steps.

The planning group considered the issue of the most appropriate venue for this international workshop. Given the broad range of stakeholders which will benefit from the subject matter and its potential related impacts on the global challenges posed by climate change, degradation of land and water resources, loss of soil carbon, erosion of biodiversity, and increase in chemical loading, it was considered particularly desirable to hold the consultation under the auspices of FAO, Rome.

7. Workshop Participants

About 80 public, private and civil society stakeholders across the four primary interest groups in policy, science and technology, field practice and financing & donor support, and who have influence, commitment and capacity to make a difference, will be invited as illustrated by the following incomplete list (a number of stakeholders fit into more than one of the four primary interest groups).

Policy stakeholders: e.g., Government representatives (from countries having already relevant policies in place and others that are interested), as well as NEPAD, CAADP Pillars I and IV, FAO, EU, WB and regional banks, IFAD, GFAR, CGIAR and others.

Science & Technology stakeholders: e.g., National Research Systems and Universities, GFAR, FARA, FORAGRO, APAARI, AARINENA and other regional and subregional research organizations and networks, CGIAR Centres, CIRAD, IRD, EMBRAPA, ICAR, CIIFAD, Eco-Agriculture Partners, IIED, NRI, Rothamsted International, WOCAT, FAO, IAEA and others.

Field Practice stakeholders: e.g., Private sector and Farmers' representatives (extensionists, farmer group leaders, trainers etc.) from small and large farming background with experience in using CA practices; commercial input supply sector and output processing and marketing sector (dealers, importers, manufacturers), NGOs in production and marketing (including "green label" certification) such as Oxfam and WWF, and organizations including in-countries' own in-service training institutions involved in providing technical assistance and training for capacity building of farmers and service providers such as World Vision, AKDN, FAO, ACT, WFP.

Financing & donor support stakeholders: e.g., Donors and funders of all kinds including: Bill & Melinda Gates Foundation, AGRA, Rockefeller Foundation, Kilimo Trust, EU, WB and regional banks, IFAD, Representatives from donor countries (UK, Sweden, Norway, The Netherlands, Germany, USA, France, Japan etc.), Development NGOs as conduit for finance (German Agro Action, Total Development International Foundation, Oxfam, World Vision, WWF etc), and others.

8. Organizational Arrangements

The 'organizing group' has included representatives from TAA, FAO, FARA, KARI, ACT, UNEP, ICRAF, TSBF-CIAT, ILRI, CIMMYT, CIRAD, GFAR, Eco-Agriculture Partners and CIIFAD.

The meeting venue will be provided by FAO which will also participate in a technical capacity. FAO and FARA will assist with travel arrangements and FAO will provide local administrative support and assistance.

FAO and CIRAD will arrange for field evidence of successful implementation of CA practices from African countries and other regions to be synthesised for the Workshop. Other institutions such as GFAR, CGIAR Centres and regional and national networks will also provide field evidence of successful implementation of CA from a number of countries in Africa, Asia and Latin America.

TAA, FAO, FARA, UNEP, ICRAF, TSBF, CIMMYT, CIRAD, GFAR and CIIFAD will provide technical guidance on the Workshop process, on the participants, session convenors, speakers and rapporteurs, on the preparation of Workshop material, and will oversee the preparation of the Workshop report.

TAA and FAO will handle all formal communication with participants and liaise with agencies providing financial and technical support.

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Annex

Investing in Sustainable Crop Intensification:

The Case for Improving Soil Health

Proposed Workshop Outline Programme
22-24 July 2008, Philippines Room, FAO, Rome

Day 1: 22 July 2008 (Tuesday)

08:30-09:00 Registration of public, private and civil society stakeholders and indication of personal background /primary interest /specialisation (among four topics: policy, science & technology, field practice, financing & donor support)

09:00-09:45 Session I: Opening Session
- i. Welcome
- ii. Background to the Workshop; objective of the Workshop, process & agenda, outcome

09:45-10:30 Session II: Global overview presentation on Soil Health and Sustainable Intensification through Conservation Agriculture Systems: Setting the Scene

10:30-11:00 Coffee Break

11:00-12:30 A range of cases (two to four per region, 20 min presentation, 10 min discussion each case) of evidence of successful adoption and spread of Conservation Agriculture and Sustainable Intensification in different regions

Session III: Conservation Agriculture cases from Latin America (e.g., Argentina, Brazil, Paraguay)

12:30-14:00 Lunch break

14:00-15:30 Session IV: Conservation Agriculture cases from Asia (e.g., China, Kazakhstan, North Korea)

15:30-16:00 Tea break

16:00-17:30 Session V: Conservation Agriculture cases from Africa (e.g., Madagascar, Tanzania, Tunisia, Swaziland)

Notes:
- a. Convenors plus Rapporteurs from sessions II to V: sum up, make first proposals for issues
- b. Working Groups the next day: to note specific issues for their Working Group; plenary may identify more issues for each session
- c. Slides, PowerPoints, video and audio recordings of farmers' testimonies and/or time sequences of changes of farms, fields, landscapes could be brought along and shown in the evenings of Days 1 and 2, and during session XIV on Day 3.

Day 2: 23 July 2008 (Wednesday)

09:00-09:30 Session VI: Explanation of the objectives and arrangements of the parallel prime-topic Working Group sessions

09:30-10:30 Session VII: Four Parallel Working Group discussions (four primary topics: policy, science & technology, field practice, financing)

a. Working Group Convenors & Rapporteurs: Convenor background according to topic of the Group, plus two to three Rapporteurs per Working Group
b. Participants: public, private and civil society stakeholders generalised/mixed across four primary interests (policy, science & technology, field practice, financing)
c. For each prime topic, the Working Group to identify:
    i. Principles, issues (including cross-cutting) & gaps
    ii. Opportunities for investment
        - providers of opportunities
        - investors in the opportunities
    iii. Cross-sector 'knowledge brokering'
    iv Contribution to an Action Plan Declaration

10:30-11:00 Coffee break

11:00-12:30 Session VIII: Parallel Working Group sessions continue (including preparing draft reports)

12:30-14:00 Lunch break

14:00-15:30 Session IX: Presentation of reports of Working Groups 1 and 2
    i. Principles, issues (including cross-cutting) & gaps
    ii. Catalogue of opportunities
    iii. Cross-sector 'knowledge brokering'
    iv. Expressions of interest/commitments to an Action Plan
    v. Facilitated discussion

15:30-16:00 Tea break

16:00-17:30 Session X: Presentation of reports of Working Groups 3 and 4 (i.– v. as in Session IX)

Notes: Action Plan Declaration drafting team to draft Action Plan Declaration in light of Working Groups' presentations (to work after hours)

Day 3: 24 July 2008 (Thursday)

09:00-09:30 Session XI: Explanation of the objectives and arrangements of the Working Group sessions

09:30-11:00 Session XII: Parallel Working Group discussions on draft Action Plan Declaration, each specifically focussed on a prime topic (policy, science & technology, field practice, financing):
a. Working Group Convenors & Rapporteurs: different from Session VII
b. Participants in each group: by common interest/specialisation in the specific topic (policy, science & technology, field practice, financing),
c. For each Working Group to review: how can each of the primary sectors, as represented by that particular topic-group,) contribute to the Action Plan Declaration?

11:00-11:30 Coffee break

11:30-13:00 Session XIII: Working Group presentations (20 min each Group) on the revisions to the draft Action Plan Declaration

13:00-14:00 Lunch

14:00-15:30	Session XIV: Consolidation & finalization of Action Plan Declaration by the drafting committee. For the others, more slides and video recordings etc. of farmers' testimonies and/or time sequences of changes of farms, fields, landscapes.
15:30-16:00	*Tea break*
16:00-17:00	Session XV: Adoption of Action Plan Declaration, and next steps
17:00-17:30	Closing session

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For latest information on the Workshop, check the website: www.fao.org/ag/ca/