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NO-TILLAGE FARMING FOR SUSTAINABLE LAND MANAGEMENT: LESSONS FROM THE 2000 BRAZIL STUDY TOUR

by

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NO-TILLAGE FARMING FOR SUSTAINABLE LAND MANAGEMENT: LESSONS FROM THE 2000 BRAZIL STUDY TOUR

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ABBREVIATIONS

BLH	**Better Land Husbandry**
FEBRAPDP	**Brazilian Federation for Direct Planting into Crop Residue**
NT	**No-Tillage**
PRO-SLM	**Producer-Led Rural Organizations for Sustainable Land Management**
PTD	**Participatory Technology Development**
SFI	**Soil Fertility Initiative**
WB	**World Bank**

A. INTRODUCTION

1. In November 2000, the World Bank (WB) and the Brazilian Federation for Direct Planting into Crop Residue (FEBRAPDP) organized the third Study Tour on "Producer-Led Rural Organizations for Sustainable Land Management" (PRO-SLM), with particular emphasis on no-tillage systems (NT).[1] The Study Tour followed a 10-day itinerary of over 1,000 km through Southern Brazil, covering Paraná and Santa Catarina States, two states which received WB support through land and micro-watershed management projects.[2]

2. The schedule included field visits to large and small farms which were at various stages in the NT adoption process, as well as technical lectures and visits to research stations and demonstration plots. The emphasis of the tour programme was on farming methods, and the development and adaptation approach for small farmers. Throughout the trip, participants were accompanied by Brazilian researchers and extension workers who had played a significant part in the development and adaptation of NT in Brazil.[3]

3. This Paper presents the salient features of NT development in Southern Brazil and discusses the lessons learned with special reference to the scope for adapting and developing such production systems to Africa, in line with the Better Land Husbandry approach advocated through the Soil Fertility Initiative (SFI) in several African countries.[4]

[1] Participants included representatives from Ghana, Côte d'Ivoire, Mali, Zambia, Tanzania, Mozambique and South Africa, Mexico, the World Bank , GTZ, FAO and Brazil.

[2] Paraná Rural Poverty Alleviation and Natural Resources Management Project (1996-2002); Land Management I (Paraná) Project (1989-1996); Land Management II (Santa Catarina) Project (1991-1999).

[3] The WB also produced a short video presenting NT farming in Brazil: "Farming the Future: The Brazilian Sustainable Land Management Experience" - June 2000.

[4] The SFI was launched in 1996 by a consortium of international stakeholders under the leadership of the WB and FAO. The Initiative was born out of a growing concern over the widening food gap in most of the countries in Sub-Saharan Africa. While the underlying causes are complex, one of the main reasons for the slow rate in the increase of food production is due to the low productivity of the soils throughout much of the continent. The SFI is not a free-standing programme but an instrument through which to strengthen collaborative action between international organizations and governments to give greater impetus to activities which are focusing on issues related to soil fertility in Africa. Some 25 countries are participating in one way or another in the Initiative.

B. GUIDING TECHNICAL PRINCIPLES

4. In the context of this Paper, the term No-Tillage (NT) is used to describe the farming system studied in Brazil. NT has been an integral part of the (micro)watershed management approach developed in the Southern Brazilian states of Paraná and Santa Catarina. NT was developed in response to continuously declining land productivity under "conventional" systems based on soil tillage. The underlying land management principles that led to the development of NT systems were to protect the soil surface from sealing by rainfall, to achieve and maintain an open internal soil structure, and to develop the means for safe disposal of any surface runoff that would nevertheless still occur. Consequently, the NT technical strategy was based on three essential farm practices, namely: (i) not tilling the soil; (ii) maintaining soil cover at all times; and (iii) using suitable crop rotations. All three practices must be followed if improved results are to be obtained in a sustainable fashion.

5. The NT systems imply direct seeding into crop residues. Soil cover is maintained using crop residues, life or desiccated cover crops and crop growth throughout the growing cycle (see Plates 1-6, pp. 12-13). As in conventional agricultural systems, liming may be necessary to correct soil acidity. NT does not necessarily imply organic farming, although a number of farmers in Brazil have adopted organic practices coupled with NT. In standard NT systems, inorganic fertilisers are generally used to complement organic amendments and herbicides are applied to control weeds, especially during the transition phase from conventional to NT practices. Examples of NT farming systems for different farm types in Southern Brazil are presented in Annex 1 for illustration.

6. *Integration of crop and livestock under no-tillage*. In mixed farming systems where NT is practised, crop and livestock compete for the biomass produced by cover crops and residues. Grazing can still take place on crop land but it needs to be carefully managed in order to guarantee sufficient soil cover at all times and to prevent soil compaction.

7. The critical challenge for the adoption of NT is the 3-5 year transition phase from conventional farming practices. Critical issues are soil decompaction in degraded areas, weed management, the adjustment or development of implements and the adoption of suitable cropping systems (cover crops and crop rotations) as well as increased yield variability in the early years of adoption.

C. THE BRAZILIAN EXPERIENCE

8. The driving force behind the development and adoption of NT in Brazil was the precarious situation of farmers in the southern states. Land degradation, associated mainly with water runoff and soil erosion, was acute and highly visible, while incomes from farming activities were low and subject to large risks. Some farmers realised that radical changes in their farming systems were required to reverse the trend of degradation and restore and secure their livelihoods.

9. *From large to small.* The first adopters of no-till practices in Brazil were large farmers. The first commercial farmer started NT on less than 500 ha in 1972 and, over the 1980s, a few innovative farmers started to develop NT systems in collaboration with research and extension specialists. Challenges in the early adoption phase included the lack of adequate equipment, knowledge, suitable cover crops and weed control techniques, including herbicides. As of the 1999/2000 growing season, NT systems have been adopted on over 13 million ha in Brazil. The Brazilian NT experience covers latitudes from 3^{o}N to 33^{o}S. Initially, NT adoption spread most rapidly in the Southern Brazilian States, which enjoy high rainfall (bi-modal, with around 1,800 to 2,000 mm) and cool climate (altitude around 1,000 m a.s.l.). Over the last five years, however, the highest growth rate (about 10% per year) has been observed in the Cerrados, a tropical warm region with a rainfall distribution ranging from 1,000 to 1,800 mm/yr. In the Cerrados, over 4 million ha are now cultivated using NT systems.

10. Only in the last five years has NT been widely adopted by small farms.[1] Since then, specific techniques and implements have been developed to suit the requirements of small farmers, including manual planters and animal drawn implements (e.g. knife-roller, planter and sprayer). Upfront investments in equipment, use of herbicides, cover crop selection and management, as well as possible yield reductions during the transition phase are significant challenges for poor small farmers, exacerbated by the lack of suitable credit opportunities.

11. *Development support strategy.* The success of NT in Brazil cannot be attributed to technical parameters alone. In conjunction with technical innovation, an effective participatory approach to research and extension was adopted which has tied farmers into the process of development of a system suited to their specific requirements. Institutional support has been demand-driven and has concentrated on training and education to equip participating farmers with the skills to adapt and refine NT on their own farms. The cornerstones of the development support strategy have been:

- *close collaboration between researchers, extensionists and farmers* for the development, adoption and improvement of NT systems;
- *on-farm trials and participatory technology development* (PTD);
- *strengthening of farmers' organizations*. Creation of local "Friends of the Land Clubs" where farmers exchange information and experiences, improve their access to extension and other advisory services as well as input and output marketing;
- *close cooperation with existing and new cooperatives* concentrating primarily on marketing and training for diversification into livestock and processing;

[1] In the South of Brazil, small farmers are classified as having less than 50 ha, but in Santa Catarina more than 90% of the 100,000 small farmers participating in the WB micro-catchment project and applying NT had less than 10 ha.

- *the national NT farmers' organization FEBRAPDP* has played a significant role in advocating and supporting the promotion of NT on large and small farms, especially through farmer-to-farmer exchanges;
- *farm management support.* No-tillage systems are complex to manage and require efficient farm management. An integral part of the support to small farmers has been training in record keeping and a holistic comprehension of farming systems' dynamics which considers, manages and aims to optimise all linkages between the different components, such as the use of biomass produced on farm for fodder and soil cover;
- *private-public partnerships.* Agro-input companies have been supporting demonstration projects in large and small farms through the provision of inputs and extension services;
- *targeted subsidies.* Subsidies have played a significant part in supporting small farmer adoption of no-till practices. In Paraná much of the hand held or animal drawn equipment was acquired with financial support from the State in the context of development programmes (mainly WB). Highly subsidised or even free equipment is still made available to groups of farmers. Apart from economic constraints to adoption, the rationale for public subsidies has been the generation of off-site benefits from no-till adoption (see below). In some instances private companies, for example the tobacco industry, have provided equipment for small farmers;
- *integration of crop and livestock.* Special attention has been paid to the complex interaction between crop and livestock in NT systems, including the integration of poultry, hog and fish farming. A particular challenge is the development of rotational grazing patterns on cover crops which do not jeopardise the sustainability of NT systems;
- *incorporation of environmental considerations.* NT has also been developed with a view to addressing the degradation of watersheds and in some instances monitoring systems have been installed to capture downstream impacts of improved farming practices. NT was complemented by other environmental activities in the context of (micro)watershed management approaches including awareness raising amongst farmers, but also specific measures such as the installation of central facilities for the disposal of pesticide containers, household sanitation, protection of springs and recovery of gallery forests.

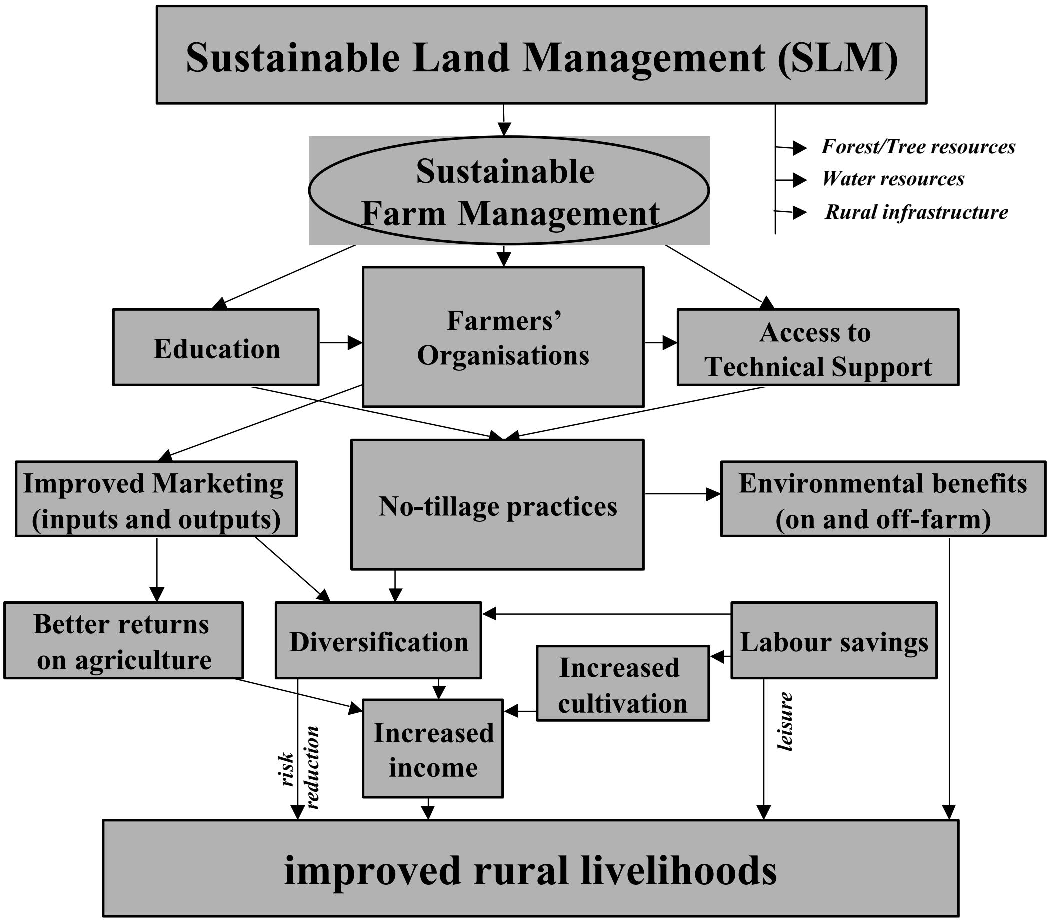
12. Farmers reported positive *on-farm impacts of NT* which have increased their standard of living (see Figure 1). NT has had profound effects on both inputs and outputs of agricultural production. These include:

- *labour savings* in soil preparation (trips across the field have been reduced by 40-60%) and increased flexibility of farming operations, especially at planting time;
- *better soil structure and an increase in nutrients stored* which has resulted in a reduction in yield variation and risk and reduced spending on fertiliser. In many instances, improved yields have been observed. Large farmers reported large variations in yields in the early years of adoption;
- *reduced erosion and run-off* and increased infiltration rates in the medium and long run. Following the transition from conventional to NT, a reduction in soil loss by

88% in Paraná (sub-tropic) and 81% Minas Gerais (tropic) and water loss reductions of 66% and 42% respectively were observed (Derpsch et. al, 1997);

- *increased incomes* – farmers who have adopted NT have been better off than farmers relying on conventional techniques. In some areas (i.e. Santa Catarina), incomes actually decreased despite NT adoption. This was due to falling commodity prices, but income losses suffered on NT farms were lower than those on conventional farms;
- *opportunities for diversification.* Labour savings have opened up the possibility for diversification into livestock[1], different/higher value crops and vertical expansion into agro-processing (dairy products, sausages, fruit and vegetable processing, etc.);
- *improved quality of life.* Labour savings also increased the time available to spend with the family or on other leisure opportunities.

Figure 1. Impact of sustainable land management on rural livelihoods



[1] In many cases crop production is used as livestock feed, hence resulting in "on-farm" added value for crop which would not fetch an attractive price on the grain market.

13. Cost increases were reported for weed control. In the first two to three years of adoption, additional herbicide costs even outweighed the benefits of labour savings in some farms. After the transition phase, herbicide costs were lower than in conventional systems. Other problems in NT adoption have been soil compaction and weed infestation caused by unsuitable combinations of crop rotations (particularly mono-cropping), cover crops and grazing systems.

14. In addition to positive impacts on farm, a number *off farm benefits* from NT have been reported. Most of the impacts observed in Paraná and Santa Catarina States are attributable to integrated watershed management strategies, of which NT adoption is the key "conservation" element[1]. Environmental benefits include downstream effects as well as global impacts. The key impacts are:

– *lower flood-peaks, reduced water run-off and induced soil erosion,* attributable primarily to the increase in soil cover thereby increasing water infiltration and decreasing gully formation, better recharge rate of aquifers, and reduced *sedimentation/siltation* of downstream infrastructure and waterways. The Itaipu Dam company, for example, has recognised this impact and is providing financial support for NT systems' research and development; *road maintenance* costs in Paraná State have been reduced by an estimated 50% as a result of NT practices and erosion control measures on rural roads;

– *reduction in water treatment costs.* In Santa Catarina the reduction in treatment costs owing to a decreased concentration of faecal coliform bacteria was estimated to be 50%;

– *reduced herbicide and pesticide applications after the transition phase and increased recycling of animal waste on mixed farms* reduce negative health impacts and downstream pollution. The enhancement of soil microbiology through NT also results in increased decomposition of these substances in the soil;

– *enhanced biodiversity* both at the microflora and fauna levels. At one of the sites visited in Paraná a bird's nest was easily observable in the crop residue on the NT field;

– *reduced carbon emission.* In mechanised farms in Paraná NT led to fuel savings of up to 66%;

– *increased carbon sequestration.* In a controlled experiment in Rio Grande do Sul, a Mucuna/maize rotation plot was observed to sequester 15.5 Mg CO_2 ha^{-1} over 8 years compared to net emissions of 4.32 Mg CO_2 ha^{-1} from the traditional fallow/maize plot.

15. *Sustainability* of the NT system is a serious challenge despite the positive evaluation by farmers and technical staff. The key constraints for sustainability are:

– *imperfect adoption.* Many adopters do not fully adhere to the three essential practices of NT – not tilling the soil, soil cover and rotations. At first, results might be encouraging even in imperfect systems, but incomplete adoption is not

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1 Integrated watershed management strategies aim to ensure the sustainability of the ecological, economic and social exchanges taking place among upstream and downstream areas of a given territory through the participatory establishment of a conducive legal framework, socio-economic practices and technical measures (adopted from *Developing Participatory and Integrated Watershed Management,* P. Warren, FAO 1998).

sustainable and creates problems such as soil compaction or increased weed infestation in the medium and long run. In many instances NT is a slow learning process. Some farmers have reverted to ploughing in response to soil compaction problems, reportedly caused by inadequate "NT" practices, especially poor crop residue management or inadequate crop rotation;

– *intensive support structure.* The promotion of NT in Brazil has built on intensive technical assistance to all participating farmers. Results have been very encouraging where innovative and resourceful farmers met enthusiastic and highly committed research and extension teams. Following closure of the WB supported micro-watershed management project in Santa Catarina, concerns have been raised about sustainability of the system since a large number of extensionists paid for by the project are now no longer available to assist farmers with NT development and adaptation;

– *subsidies.* WB projects in Santa Catarina and Paraná have supported NT adoption in the transition period through a variety of subsidies including reduced price or free NT equipment and per ha payments. These public financial incentives cannot be sustained beyond project closure. There is some concern that subsidies have distorted the estimation of private benefits from NT which could lead to a backlash as farmers are suddenly confronted with full market prices. It would be economically justified to compensate farmers for environmental and other benefits which NT adoption generates outside their farms, but in that case a regular transfer system from beneficiaries to farmers should be developed. Subsidies for pre-defined, specific technologies should be avoided in order not to stifle innovation.

16. The key *lessons learned* from the Brazilian experience are the following:

– NT starting point is considered to be a drastic change in mindset, or "brain decompaction", to prepare farmers to shift from traditional practices to the adoption of NT systems;

– NT involves significant changes in agricultural practices. Farmers were willing to take the risk of shifting to NT, because degradation was threatening their livelihoods. NT was seen as a "last option" to avoid migration to urban centres;

– NT development by small farmers has not been driven by spontaneous adoption, but is a result of intense collaborative efforts by researchers, extensionists, the private sector and participating farmers;

– NT is not just a technical solution. The success in Brazil is attributable to NT as a component of an integrated development approach including education and training, marketing, social mobilisation and diversification;

– NT is not merely a technical package. NT success stories are created by farmer driven adaptation of the system to their specific circumstances and requirements in their respective farm environments;

– integration of appropriate cover crop(s) in the NT system and their management are the most critical challenges of the transition phase;

– good farm management skills (technical, organizational and financial) are crucial for successful NT farming;

- farmers can derive considerable direct benefits from NT adoption, but additional benefits accrue downstream or at the global level;
- a development process starting with adoption on large farms and then moving and adapting the systems to small farms is possible and might reduce riskiness of adoption in the development phase of NT;
- private-public collaboration can enhance adoption and increase resources available to support large and small farmers;
- where a NT strategy is introduced as part of a project (as in Paraná and Santa Catarina) sustainability beyond the project period must be seriously considered at the preparation and implementation stages. Post project strategies must be formulated for the provision of advisory services and extension as well as the phasing out of subsidies. The necessity for subsidies should be scrutinised in the process of project formulation in order to avoid distortions in farmers' perception and to ensure that public resources are only used where they are necessary and warranted. Transfer mechanisms for environmental service provision could substitute across-the-board subsidies and carry less or even negative distortionary effects.

D. THE POTENTIAL FOR DEVELOPING NO-TILLAGE SYSTEMS IN AFRICA

17. Soil degradation is a significant threat to rural livelihoods and food security in Africa. As discussed in several SFI country strategies, radical measures are called for to reverse the situation. The rationale for developing NT systems and the guiding principles and practices of NT are also valid in Africa. The NT concept is fully in line with, and already included in, the "Better Land Husbandry" approach adopted by several countries in Eastern and Southern Africa[1] (see Attachment). A particularly attractive aspect of NT in the African context, especially in countries with ample land resources, is its potential for labour savings. HIV/AIDS is rapidly diminishing the able bodied work force in many African countries leading to labour shortages in rural areas. Production systems which reduce the time and intensity of labour inputs required, especially at the planting stage, could help to mitigate the devastating impact of the pandemic.

18. Several constraints to NT adoption in Sub-Saharan Africa have been identified. The predominant constraints are related to the *socio-economic* context. These include:

- *small farm sizes* make farmers more risk averse and less willing to experiment. Putting a part of the plot aside for new technology developments may represent a significant risk in terms of short- to medium-term household food security;
- *tenure* problems, such as the absence of private tenure or the lack of tenure security, may decrease incentives for such long term investments;
- *full crop rotations,* such as switching 100% of the land in cereals to legumes, (e.g. maize/beans, soybean/maize), may be difficult to achieve, mainly because of the lack of market opportunities for grain legumes, in turn related to food habits, poverty, lack of agro-processing industry and export outlets;
- *grazing systems* relying on communal use and traditional grazing patterns are a threat to soil cover throughout the year. Individual farmers cannot restrict grazing even on their own land without challenging the traditional rights of others in the community;
- *low education* and literacy standards of farmers means they are less likely to participate in pro-active on-farm development in a partnership approach with researchers and extensionists, and to become on-farm researchers in their own right;
- *women* increasingly account for the main agricultural labour force and are taking on even ploughing and other activities, which were traditionally men's tasks. Since they already perform other time-consuming tasks such as weeding with the hand hoe – in addition to other household tasks and wood and water collection - they would be the greatest beneficiaries of NT. However, despite their increased role they often do not have full decision-making powers. The decision-making men might not value women's labour savings adequately and might place greater weight on potential risk factors associated with a transition to NT;
- *farmers' organizations*, which could be building blocks for a NT development strategy, are not very common or are poorly organized;

[1] Such as Malawi, Tanzania, Zambia, Uganda and Eritrea.

- the *lack of effective input/output marketing systems and infrastructure* are seen as major constraints to NT development in Africa. Timely supply of inputs and equipment (and maintenance) and the sale of value added production present significant challenges.

19. *Physical challenges* for NT adoption in Africa area also manifold:

- the drought-prone mono–modal rainfall patterns, which characterise large parts of Africa are a particular challenge for ensuring soil coverage throughout the year (due to fast decomposition of crop residues and limited choice of cover crops);
- highly degraded soils might require a longer transition phase (including initial soil restoration) before NT systems can be well established. For example, compaction layers would need to be broken up either mechanically or by suitable cover crops (leguminous crops/agro-forestry species with strong root systems that can break the layer);
- in addition to uncontrolled grazing (see above), the traditional use of fire and the threat of termites may jeopardise the principle of maintaining soil cover at all times.

20. The abundance and seriousness of socio-economic and physical challenges which need to be overcome in order to implement successful NT schemes emphasise the need for the careful adaptation of the NT approach to the African environment. NT systems should not be seen as a set of "quick fix/no-problem" packages that could be spread throughout Africa. Rather, the guiding principles of NT should be introduced (as one element of sustainable land management/better land husbandry practices) and adapted to the prevailing farming circumstances. Therefore, the development of NT systems should be aimed at complementing, rather than replacing other promising land husbandry options. For example, in many areas of Sub-Saharan Africa, agroforestry can significantly contribute to: (i) enhancing farm productivity (i.e. production of animal feed and live fencing which contribute to livestock integration, wind breaks, biomass production and nutrient recycling, etc.); and (ii) meeting essential households needs, directly or through income generation (i.e. food and fuel). In Africa, agroforestry should be integrated into NT farming systems.[1]

21. The development of NT systems in Africa will require that farmers, together with research and extension staff, are committed to solving problems as they arise. The Brazilian experience can be helpful as a guiding example for the approach to be followed in developing suitable systems in the African context.

[1] Whether indigenous agro-forestry species, such as *Faidherbia albida,* or exotic species; see for example ICRAF achievements in Western Kenya.

E. CONCLUSIONS AND WAY FORWARD

22. In a brainstorming session held on the last day of the study tour, participants from various countries outlined their action plans. Proposals generally included a review of ongoing activities, awareness raising measures, revisions of policy to create an environment which is conducive to the introduction and dissemination of NT practices, capacity building, education and field research and development (see Annex 2).

23. The study tour has convinced participants that NT systems can be potentially beneficial, and should receive greater attention in future investments geared towards agricultural and rural development. First and foremost it will be important to raise awareness of the potential of NT in various contexts and increase understanding of the NT systems as well as the adaptation and adoption processes. The Brazilian experience has demonstrated that NT is no quick-fix solution. Rural development stakeholders should ensure that NT systems be gradually incorporated into the policy framework, development strategies[1] and investment priorities, and therefore into project and programme formulation in a continuous learning process, assessing experiences in different regions and contexts as NT adoption expands. A number of specific recommendations can be made:

- it will be important to keep potential future NT development in mind even when preparing “standard” agricultural investment projects and programmes, and refrain from investing in programmes which are diametrically opposed to the NT philosophy and techniques. In technical and policy advice, recommending extensive investments in tilling implements and particularly disc-ploughs and disc-harrows should be discouraged;
- countries should consider the potential for NT systems and formulate development and adaptation strategies, placing strong emphasis on farmer-driven approaches; in this respect, FAO is in the process of preparing a framework for piloting NT systems (based on the draft document on “Promoting Conservation Agriculture/NT in Sub-Saharan Africa”) and the World Bank is preparing a document on best practices for integrating NT/SLM into projects and programmes;
- in the context of HIV/AIDS projects which should make considerable new resources available for development work, NT should be incorporated as a measure to combat the impact of HIV/AIDS in rural areas.

[1] Such as Rural Development Strategy (RDS) and Poverty Reduction Strategy Paper/Credit (PRSP/C).

Plate 1. Direct sowing of bean through a cover crop (black oat) desiccated with a knife roller

Plate 2. Tractor-drawn knife rollers

Plate 3. Single-row direct planter

Plate 4. Direct sowing of maize on a cover crop desiccated with herbicide

Plate 5. Direct sowing of soybean on maize crop residues

Plate 6. Direct sowing of soybean on maize crop residue and a desiccated cover crop

ANNEX 1: Examples of Smallholder No-Tillage Production Systems in Paraná State[1]

Small farmers (maize and beans)

(a) Main characteristics: use of animal traction, family labour, low use of inputs, subsistence and market-oriented.
(b) Cropping system: planting of black oat *(Avena strigosa)* and green peas *(Pisum sativum)* in mid-May (120 days from planting to milking stage/full flowering). Biomass management with animal-drawn knife-roller in mid-august and planting of maize in early September, with animal-drawn no-tillage planter. Harvesting of maize in April, management of crop residues with knife-roller and sowing of rye (*Secale cereale)* in May, cover crop management and planting of common beans in mid-September.
(c) During the transition period: runoff control with the use of contour bunds built with animal-drawn mouldboard plough and planting of elephant grass (dwarf variety) on the contour bunds. During summer, this material can be cut twice to be given to livestock (e.g. horses and dairy cattle for home consumption). In February, the last sprouting can be used to prepare a silage mixture (60% elephant grass + 40% maize).

Small farmers (tobacco)

(a) Main characteristics: use of animal traction, family labour (in this system, labour is a strong constraint due to tobacco cultivation and processing), marketed-oriented.
(b) Cropping system: sowing of black oat in April/May (120 days from planting to milking stage). Biomass management with animal-drawn knife-roller in mid-August, furrow opening with animal traction and manual transplanting of tobacco in September. Manual harvesting of tobacco and planting of beans in January. Manual harvesting of beans in April, sowing of Black oat and vetch (*Vicia sativa*) and biomass management in mid-August. Planting of maize with animal-drawn no-tillage planter.
(c) During the transition period: runoff control with the use of contour bunds built with animal-drawn mouldboard plough and planting of *Phalaris hibrida* on the contour bunds.

Small farmers (handicrafts and beans)

(a) Main characteristics: Use of animal traction, family labour, low labour availability, low use of inputs, subsistence and market-oriented.
(b) Cropping system: planting of vetch (*Vicia villosa)* in April-May; planting of sorghum for brush making; harvesting of sorghum and planting of black oat. Management of black oat with animal-drawn knife-roller and planting of beans in mid-September. Harvesting of beans by late December/January.
(c) During the transition period: runoff control with the use of contour bunds built with animal-drawn mouldboard plough and planting of Phalaris hibrida on the contour bunds.

Small farmers (dairy cattle and soybeans)

(a) Main characteristics: Use of mechanical power (owned or hired), family labour, medium use of inputs, marketed-oriented.
(b) Cropping system: sowing of black oat or azevém (cycle of 150 days from planting to milky stage). Depending on soil and climate conditions, 2-3 controlled grazing beginning 40 days after planting, the biomass is used as pasture on a rotational basis. The last sprouting is left to produce soil cover for no-tillage. Biomass management with knife-roller only or knife-roller & herbicide. depending on the amount of oat residues left and weed infestation. Planting of soybeans in November, harvesting in February-March. Planting of black oat and vetch *(Vicia villosa)* and controlled grazing. Biomass management in November and planting of maize for silage. A dwarf variety of pigeon peas can be sown between maize rows 40 days after planting in order to replace part of nutrient extraction of maize harvesting, promote soil de-compaction and provide N to the system.

[1] Adapted from: Ribeiro, M.F.S; Gomes E.P. and Miranda G.M; From Conventional to No-Tillage Systems: The Transition to Conservation Agriculture for Small Farms in the Southern Brazilian State of Paraná; World Bank Study Tour to Brazil, November 2000.

ANNEX 2: Outline of Country-Specific Study Tour Follow-up [1/]

Salient/Common Features of country follow-up proposals

The follow-up actions presented by the participating countries generally included the following:

1. start with a review of on-going activities, with further action building on/complementing what has already been done;

2. immediate action to include awareness raising (through existing or ad hoc networking, including a national workshop;

3. lobbying/awareness raising to include policy makers so as to ensure that the prevailing policy environment and rural development strategies and investment priorities are conducive to PRO-SLM adaptation and adoption (or if already conducive, are actually implemented);

4. capacity building/education and specific training activities to be launched for stakeholders, including producers, research and extension services, private sector, etc.

5. initial field level research and development activities will:

   ⇒ be integrated within other related activities;
   ⇒ cover different agro-ecological zones;
   ⇒ be farmer-driven and require strengthening of farmer groups/organizations;
   ⇒ adopt a participatory process, and involve all stakeholders;
   ⇒ focus on critical SLM aspects, such as crop rotation, cover crops and tools/implements;
   ⇒ take advantage of on-going/planned projects for financial support, in particular WB projects;
   ⇒ require technical backstopping, both at national and international levels, particularly from Brazil.

[1/] Brainstorming Session held at Foz do Igassu on 15 November 2000-11-20.

ANNEX 3: List of Key Documentation Received During the Study Tour

Books and Proceedings:

FEBRAPDP (2000) Guia para plantio direto (Direct drilling guide). July, 2000. 110p.

FEBRAPDP (1999) Resumos. 7º Encontro Nacional de Plantio Direto na Palha (Proceedings of the 7th National Workshop on Direct Drilling through Crop Residues. 166p.

IAPAR (1999) Uso e manjo dos solos de baixa aptitão agrícola (Use and management of soils with low agricultural potential). Circular Técnica Nº 108. Instituto Agronõmico do Paraná. August 1999. 268p.

EPAGRI (1998) V Reunião Centro-Sul de Adubação Verde e Rotação de Culturas (Proceedings of the 5th Centre-South Workshop on Green Manure and Crop Rotations) Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina S.A. Chapecó, SC., 1998. 160p.

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ANNEX 4: The Role of Farmers' Organizations in the NT Adoption Process

Farmers' organizations have played a significant role in driving the NT development and adoption process in Brazil. The activities of farmers' organizations in Brazil – the Friends of the Land Clubs – at the various stages of the NT adoption process are outlined in the following table:

Adoption Phase	Mature Phase	Advanced Phase
– basic instruction – farmer-to-farmer exchanges – short courses – lectures, farm visits/field tours – planter clinics for adoption	– specialist seminars – field days – ad hoc on-farm research/ data collection – links with universities – planter clinics for trouble-shooting – professionalisation of rural workers	– rural leadership courses – cost accounting – on-farm research partnerships (new crops, varieties, fertiliser trials) – advanced management groups – field tours

Critical success factors to ensure effective development and functioning of farmers' organizations for NT development include the following:

1. ***strong leadership*** – usually from one farmer
2. ***support capacity*** – farmer cooperatives or foundations, extension service, municipal authorities, commercial companies (with reservations)
3. ***development of second and third phase activities***
4. ***representation in water resources and municipal development committees***

Adapted from J. Landers, presentation in Paraná, November 2000.

ATTACHMENT

The Better Land Husbandry: an Outline[1]

1. Experience from land management projects has shown that present problems with low farm productivity cannot be solved solely through isolated solutions, such as increased use of inorganic fertilisers, improved seed, irrigation and/or mechanisation. What is needed is an integrated approach, which addresses soil fertility problems as an integral part of improved land management. Improvements can be achieved through the positive synergies resulting from the combined adoption of improved crop/plant, soil and rainwater management practices that offer both production and environmental benefits. This is the essence of what is referred to as the Better Land Husbandry (BLH) approach, which underpins the proposed Soil Fertility Initiative (SFI) strategy and actions. Land husbandry is a broader concept than soil and water conservation. It addresses the household livelihood system in regard to the management of land resources, inputs and outputs with the aim of improving the productivity and sustainability of the production system. The BLH approach also brings synergies between the sustainable land productivity and the environmental agendas (see Box 1).

2. The concept of husbandry, signifying understanding, management and improvement, is widely understood when applied to crops and animals. It is equally applicable to land. Thus, land husbandry can be defined as:

"*the care and management of the land for productive purposes; only through sound land husbandry can the land's productive potential be sustained and enhanced*".

3. The following are intrinsic components to BLH:

- ***Promotion of an integrated and synergistic resource management approach*** embracing locally appropriate combinations of the following technical options:

  ⇒ <u>build-up of soil organic matter and related biological activity</u> to optimum sustainable levels (for improved moisture and nutrient supply and soil structure) through the use of compost, farmyard manure, green manures, surface mulch, enriched fallows, agroforestry, cover crops and/or better crop residue management;

  ⇒ <u>integrated plant nutrition management</u> with locally appropriate, and cost effective, combinations of organic/inorganic and on/off-farm sources of plant nutrients (e.g. organic manures, crop residues, rhizobial N-fixation, transfer of nutrients released by weathering in the deeper soil layers to the surface via tree roots and leaf litter, rock phosphate, lime and chemical fertiliser);

  ⇒ <u>better crop management</u>, improved seeds of appropriate varieties, improved crop establishment at the beginning of the rains (to increase protective ground cover, thereby reducing water loss and soil erosion), weed management and integrated pest management;

[1] Adapted from various Soil Fertility Initiative Concept Papers for Eastern/Southern Africa (FAO Investment Centre, 2001).

⇒ better rainwater management to increase infiltration and reduce runoff so as to improve soil moisture conditions within the rooting zone, thereby lessening the risk of moisture stress during dry spells, while reducing erosion;

⇒ improvement of soil rooting depth and permeability through breaking of cultivation-induced compacted soil layers (hoe/plough pan) through no-tillage and conservation tillage practices, including, where required, by means of tractor-drawn subsoilers, ox-drawn chisel ploughs, and hand-hoe planting pits/double dug beds; and/or interplanting of deep rooted perennial crops/trees & shrubs); and

⇒ reclamation, where appropriate (i.e. if technically feasible and cost effective), of arable land that has been severely degraded by such processes as gullying, loss of topsoil from sheet erosion, soil compaction, acidification and/or salinisation.

- ***Adoption of people-centred learning approaches*** through which farmers are enabled to learn about, and investigate for themselves, the costs and benefits of alternative land husbandry practices.

- ***Community-based participatory approaches*** to planning and technology development that build on rural people's inherent skills and capability to formulate and implement their own development plans, and to develop and disseminate their own improved land husbandry technologies.

- ***Better land husbandry for business*** through the promotion of field level interventions that offer farmers tangible economic, social and environmental benefits.

4. The BLH approach is based on the premise that with **improved plant[1] management** (higher yields, good vegetative cover), **improved soil management** (better organic matter management, IPNM, improved soil structure, good rooting conditions) and **improved rainwater management** (reduced runoff, increased infiltration, replenishment and maintenance of soil moisture, prevention of waterlogging), it is possible to reduce erosion, improve fertility, increase food security and enhance people's livelihoods. Moreover, by maintaining vital ecosystem functions, notably the hydrological, nitrogen and carbon cycles, it also generates wider environmental benefits. Three principles are fundamental to this approach:

⇒ rural people, whether educated or not, have the knowledge and ability to analyse, plan, implement, monitor and evaluate their own research and development activities;

⇒ rural people respond to market opportunities when they judge that their livelihoods would improve as a consequence; and

⇒ it is possible to minimise and reverse soil degradation through management practices which yield production benefits and are conservation-effective.

5. By integrating improved soil, water, crop and animal management practices, farmers are likely to obtain synergistic benefits in terms of agricultural production and sustainability. The

[1] Annual and perennial crops, grasses and other herbaceous pasture species, trees and shrubs.

final result should be greater than would be expected from adding the results of each single improvement separately. For example, enhanced soil biological properties (through good organic matter management) will have a positive impact on the soil chemical status (nutrients, pH), physical properties (better structure and porosity), and moisture availability (improved rainwater infiltration, permeability and retention). Likewise, the adoption of conservation tillage practices that minimise disturbance, will enhance root development through the prevention of subsoil compaction and the maintenance of good soil structure. Thus, BLH seeks to increase crop yields (food and fodder) through improving the ability of the soil to sustain good plant growth by ensuring that there is no hindrance to root growth and that the roots have optimal access to nutrients and moisture within the soil. BLH also seeks to maintain and enhance soil fertility through more efficient use of available moisture and nutrients.

6. It is critical that farmers, technicians and policy makers are awakened to the fact that fertilisers are complementary to other suitable land husbandry practices in maintaining and enhancing soil productivity. To leave farmers reliant solely on purchased inputs as the key to addressing productivity decline, risks jeopardising the challenge of engaging farmers in the wider range of practices which are essential for restoring and sustaining land productivity. IPNM is a key component of the BLH approach: as production increases, it may be necessary for farmers to supplement the nutrients available from on-farm sources (farmyard manure, compost, crop residues, and biological N fixation) with off-farm collection of organic materials and purchased fertiliser, in order to replace the nutrients and biomass lost in the harvested products.

Box 1: Synergies between the Land Management and the Environmental Agendas

The SFI aims to reverse the extensive decline of soil fertility and improve land productivity through, *inter alia*, promoting the adoption of better land husbandry practices, including the integrated management of soil, water and biological (plant and animal) resources.

Sustainable land management practices contribute simultaneously to enhancing agricultural production and providing national and global environmental benefits. Such benefits include preventing and mitigating land degradation, reducing carbon emissions or enhancing its sequestration (storage), sustaining agricultural biodiversity and maintaining other vital ecosystem functions. These are the main areas of focus of the following international conventions:

- UN Convention to Combat Desertification and Drought (http://www.unccd.int);
- UN Framework Convention on Climate Change (http://www.unfccc.int);
- UN Convention on Biological Diversity (www.biodiv.org); as well as being key issues in
- Chapter 10 of Agenda 21 (Rio Summit) on Integrated Planning and Management of Land Resources.

The success of SFI will depend on developing sustainable agricultural systems, that provide economically viable, environmentally friendly, and socially and culturally acceptable alternatives to current practices which are degrading natural resources and threatening the sustainability of agricultural systems. The main ecological regulatory functions of land ecosystems include:

- climatic moderation: release of greenhouse gases; carbon sequestration; solar energy and hydrological cycle;
- organic matter breakdown, humus formation and nutrient recycling;
- nutrient mobilisation, retention and slow release to plants, and breakdown of pollutants;
- provision of habitats for living organisms: pollinators, beneficial predators and diverse soil fauna, flora and microbes that decompose and recycle nutrients, mix the soil and influence its structure, texture and rooting depth (from earthworms and termites to rhizobial bacteria and mycorrhiza).

The development of sustainable agricultural systems will also improve the:

- conservation of soil and water resources: maintaining land cover and landscapes, and watershed functions (e.g. capture and recharge of surface, soil and ground water sources, regulation of stream flow and mitigating soil erosion); and
- resilience of plant, fish and animal populations (e.g. to pests and diseases) and reduced invasion by harmful or less useful species (e.g. weeds such as parasitic Striga; less palatable forage species);
- resilience of land and water systems to sudden alterations (e.g. drought, intensive rains and floods).

There is a strong argument for focusing the attention of stakeholders, from policy makers to resource users, to finding "best practices" that contribute to agricultural production and socio-economic benefits, such as food and livelihood security, and environmental benefits. In this regard, conservation agriculture, integrated production systems (crop/livestock systems, aquaculture and agroforestry) and complex home gardens are examples of best practices. Besides improving land and/or labour productivity, they provide opportunities for:

- maintaining a good vegetative cover and rooting structure for plant and animal growth;
- maintaining or enhancing soil fertility, soil moisture availability and soil biological activity;
- conserving and ensuring the sustainable use of agricultural biodiversity (harvested and non-harvested); and
- sequestering carbon and reducing greenhouse gas emissions.

Not all agricultural systems will provide the full range of benefits. The aim should be, where possible, to maximise synergies and generate multiple benefits for diverse actors/stakeholders at farmer, community, national and global levels, while maintaining resources for future generations.