ORGANIZATIONAL AND POLICY CONSIDERATIONS IN ZERO TILIAGE

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There are many lessons from the widespread adoption of Zero Tillage (ZT) in Brazil. It is a story of farmer persistence and empowerment, community resource management and farmer/private sector/government partnerships which have engendered a new philosophy for truly sustainable agricultural systems at high production levels.

This chapter summarises the functional aspects of this important opportunity, which the example of the ZT system of conservation agriculture, as developed in Brazil, now offers other countries. Internationalisation of this experience began from 1994 onwards with study tours, international participation in ZT events and other interchanges with Brazil, involving over 40 countries.

The Brazilian ZT technology has arisen as a farmer-promoted response to their own and society's desires to achieve economic development and poverty alleviation, combined with sustainable, and increasingly communal, management of the nation's natural resources. It

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is certainly the best current alternative to achieve these goals in the humid and sub-humid tropics, but requires more development in the semi-arid and arid tropics, where grazing rights and irregular rainfall, termites and bush-fires are major obstacles to maintaining soil cover. In spite of such constraints, which are seen more as challenges, the basic principles of ZT pertain world-wide.

ZT has led to the professionalisation of the farmer as a manager and to higher skills development and remuneration for rural manpower, with considerable positive impact on the intensity of cropping, yield levels, net farm incomes and on the quality of rural life. The wide-ranging impacts of ZT and associated natural resource management strategies, such as development planning and administration by hydrographic units, extend far beyond the farm boundaries in a totally new dimension of agriculture's (largely unperceived) interaction with society. This integrates the farmer's activities into the very fabric of society, resulting in: food security, cheaper agricultural products, conservation of the natural resources involved on behalf of the whole of society.and other benefits, as shown in Figure 1. The determination of Brazilian farmers to make ZT work is expressed by the words of Franke Dijkstra, president of the Batavo Cooperative in Carambei–PR (99% in ZT, the exception being potatoes) to the members of the World Bank/FEBRAPDP Study Tour, in November 1998, "in ZT, we have many problems, BUT we have many more solutions".

A process of "technological integration" has evolved based on responses to the farmers' demands. This has engendered the concept of ZT as a system and, by extrapolation, involves a number of interacting stakeholders. These comprise : individual farmers and technicians, manufacturers of machinery and farm inputs and their distributors, R&D and extension organizations, farmer foundations and NGO's such as Clubes Amigos da Terra and their associations and federations, agricultural co-operatives, state and municipal governments and the federal government ministries of Agriculture &

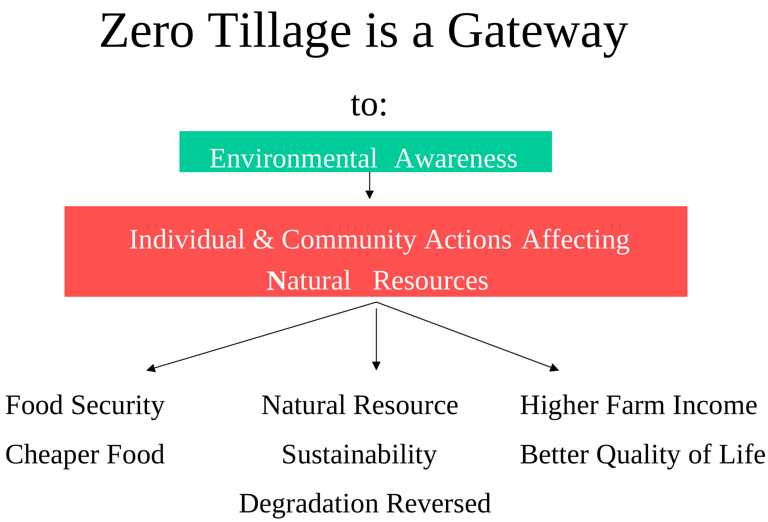

Figure 1. ZT as the Gateway to Sustainability

Supply and of the Environment. These stakeholders generate continuing improvements and an amplification of the impacts of the series of improved practices which are generated and disseminated through technical events, result demonstrations, publications, farmer-to-farmer contact and technical advice, conquering new adepts and inspiring innovations in new frontiers and new crops. The national ZT meetings in Goiânia (1996), Brasilia (1998) and Foz do Iguaçú (2000) followed this philosophy of integrating the efforts of all the stakeholders with the edition of the "Carta de Brasília", in 1998, enunciating the needs and desires of the practitioners of ZT. These efforts have resulted in a national awakening to this new responsible and sustainable technology.

In figure 2 the complex institutional system surrounding the farmer is shown, with an inner ring of organizations controlled directly by farmers and, outside this, a number of different private sector, state and federal government entities, all of which are involved in partnerships fostering the development of ZT.

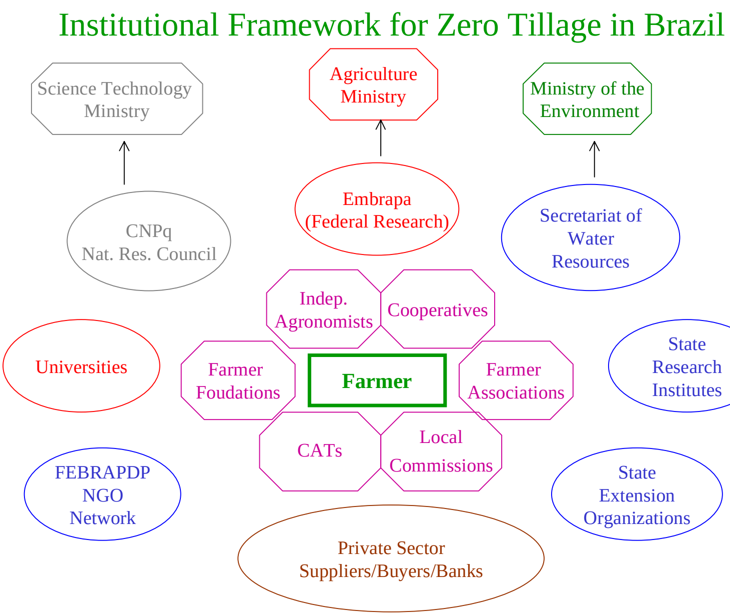

Figure 2. The Institutional Framework for ZT in Brazil.

The degree with which the Brazilian experience can be replicated in other countries, beyond purely technical considerations, will depend on the partnerships, which can be forged amongst the different stakeholders in the system. The empowerment of farmers' organisations to clearly focus the efforts of this "technological integration" process will also be crucial to success and motivation of the farmers themselves. Given favourable institutional support, the successful implantation of ZT, anywhere, will rest squarely on the efficiency of the new technology in bringing benefits to farmers.

Why was the Recent Expansion of ZT so Rapid in Brazil?

Starting in the seventies, the early phases of ZT in Brazil, in fact, showed very slow expansion (see figure 1, Chapter 1). This was principally because of technical difficulties with weed control and planter and drill design. IAPAR (1981) showed variable costs of ZT in Paraná State, where much of the early development occurred, as 8% and 10% above those of CT for maize and soybeans respectively. Thus, in the early years of ZT, a premium in higher variable costs had to be paid in order to adopt this system, with the principal motive of controlling erosion. By the late 1980's, in the South of Brazil and early 1990's in the tropical region, the variable costs of ZT were competitive with those of Conventional Tillage (CT). The slow initial development of ZT in the sub-tropics of Brazil was later mirrored in the tropical Cerrado region, lagging by a decade. But by about 1992/3, the principal problem for tropical ZT, biomass generation, was being solved through second cropping in most regions (see Chapter 7).

Today there are considerable cost and yield advantages with ZT. For small farmers, the advantages lie more in the reduction of labour demands and increase in the return per man-day. Depending on the level of mechanization, labour savings can vary from 16-18% (Ribeiro et al 1999) to 53-59% (da Silva (1997), while Ribeiro et al. (1999) showed an increase of 47% in the earnings per man-day under ZT as compared to CT, with minimum strip tillage in an intermediary position.

Estimates by the Secretariat of Agriculture and Supply of Paraná state (2000) for mechanized grain farms show returns on total costs of rainfed soybeans (including capital in land and machinery) of 25% for ZT and below 1% for the conventionally-tilled situation and 16% versus minus 5% respectively for maize, due also to yield advantages in ZT for both crops. In Mato Grosso do Sul State (tropics), Melo Filho (2000) calculated reductions of production costs of 6.9 and 10.3% for soybeans and maize under ZT, when compared to CT. A similar trend was demonstrated in the more tropical Goiás state (Abreu and Ferreira, 1998), while Landers et al. (1994) demonstrated internal rates of return of 15 to 27% for ZT but only 5% for CT, on a mechanised grain farm in the same state. In the basic case (IRR 15%), the considerable economy in machinery investment and replacement costs was more important than small differences in variable costs and yields. Other economies estimated by farmers elevated the IRR to 27%, the most important being profit from a second crop on 50% of the area. **Brazil's vertiginous growth in ZT adoption was based on these cost advantages, earlier planting and dramatic reductions in erosion, all immediate benefits.**

INSTITUTIONAL ASPECTS

A variety of institutional arrangements have been used in transferring the ZT technology to adopting farmers. One basic principle is that small farmers need government assistance in order to organise associations, clubs and/or small watershed commissions and to reduce the risk and costs of change, as exemplified by the successful World Bank land management projects in the **three** southern states of Brazil. For the larger (mechanised) farmers the formula is ad hoc, with private institutions, **such as Clubes Amigos da Terra, FEBRAPDP and APDC** predominating and where, locally, the most appropriate combination of entities and leadership emerges, through practical considerations. Examples of the actors in technology transfer are listed below, according to their respective spheres of influence :

NATIONAL LEVEL

- Private sector agribusiness product marketing and technical support countrywide;
- Embrapa (Brazilian National Agricultural Research Enterprise), through publications, participation in technical events and training courses;
- NGO national network: FEBRAPDP and its 60-affiliate entities (farmers' organizations, agribusiness, government and universities);
- National press and TV programmes and specialized publications.

State or regional level

- State government extension and research services (e.g. The Agronomy Institutes of Paraná and São Paulo states, IAPAR and IAC);
- State ZT associations and the ZT Association for the Cerrado region (APDC);
- Partnerships between private sector and state or federal governments for extension and on-farm research;
- State/ Regional agricultural press and TV programmes, specialized publications;
- State federations of farmers' unions.

Multi-municipal level

- Farmer-owned foundations doing adaptive research and extension;
- Farmer-owned foundations of seed producers;
- Farmers' and farm workers'unions;
- Technical departments of farmer co-operatives;
- Universities and technical colleges;
- River Basin Commissions (incipient);
- Press, TV and publications of farmer organisations.

Municipal level

- Individual farmers;
- Clubes Amigos da Terra;
- Private agronomists acting individually (as employees or consultants);
- Local farmers' associations, cooperatives, unions, etc.;

- Municipal agro-ecological development commissions;
- Microcatchment commissions;
- Local press and TV.

The activities of farmer-led NGO's have been important in the development and dissemination of ZT technology in Brazil and other countries of both American continents, which are today united in the Confederación de las Américas de Asociaciones para la Agricultura Sostenible (CAAPAS). Also, the RELACO Network (Rede Latinoamericana de Agricultura Conservacionista), promoted by FAO, which held its 5th biennial meeting in 1999 interacts positively with this confederation and country ZT organizations.

In terms of mechanisms for the spread of ZT, the promotion of farmer-to-farmer contact, through field days, seminars, talks by farmers and on-farm demonstration/research units has been by far the most cost-effective mechanism for the adoption of ZT. This has been promoted through partnerships involving farmer associations, Clubes Amigos da Terra, other farmer organizations, private and public sector participation in events and the watershed planning approach used by the extension services, the latter mostly in the southern states of Brazil, The perception of direct benefits over and above the cost of change is the chief motivation for adoption of ZT. This must be preceded by increased technical capacity of lead farmers and extension workers. On the other hand, decision-makers need to be motivated by the gains to society (see the list of direct and indirect benefits generated by ZT in Chapter 7).

The technology transfer from southern Brazil speeded up the process of local adaptation of ZT technology in the tropics. Pioneer farmers and their organisations, interacting with private and public sectors, played a leading role in developing and disseminating this technology in Brazil. It is important to note that the technological advances generated for the large/medium farmers had a spin-off effect for small farmers. Adaptation of the basic principles of cover crops, planters, weed control and crop rotations to animal traction and manual systems needed much less on-farm research than starting from scratch. There has also been a synergism through ZT NGO's, with larger mechanized farmers assisting small farmers to adopt ZT, in an expression of social conscience..

ZT in Rural Development Projects

ZT requires a holistic treatment of the agricultural system. It is very easy to lose sight of the fact that the benefits of ZT are so great for both farmer and society that the expansion of this new sustainable farming system, after validation at farm level, should be the central action of a rural development project involving food and fibre crops, improved pastures and even the establishment of permanent tree crops. Protection of the environment and poverty alleviation will come as automatic consequences of ZT adoption and specific actions to achieve these objectives should be complementary to the whole ZT development process, should enter at a later stage and not compete for scarce (especially human) resources within a project. Improved farm incomes are necessary before environmental actions become acceptable to farmers, or, as one Brazilian aptly put it: **"a farmer in the red can't look after the green".**

Traditionally, nearly all government agricultural research and extension services have been top-down, with single crop interventions. This was taken to an extreme in the "Training and Visit" system. This methodology can work well if there is a relatively simple new technology involved, with a high benefit: cost ratio (i.e. a large margin for error) and a wide technical knowledge gap between extensionist and farmer. This is now not the case for many farmers in Brazil. Also, the farming system approach required in ZT has led to a bottom-up movement, in which farmers, who are acutely good technical observers and systems analysts in their own manner, decide the priorities for research and technical support services. Farmer empowerment in setting priorities for research and extension is an essential factor, which ensures a sharp focus on quick economic results. Obviously, not all research can have a bottom-up focus, but about 50% would be a good starting point anywhere. Farmer empowerment comes in several ways, but the entry point should be increased farm profits, because this gives the farmer both an incentive and the flexibility to promote change (Box 1).

Box 1. Routes to Farmer Empowerment with ZT

a) Automatic:

- Increased net income;
- Reduced labour and management demands;

b) Requiring Organization and Leadership:

- Municipal, micro-catchment and basin commissions;
- CATs and farmer associations;
- NGO networks (state, national, international);
- Menu approach to extension;
- Technical/management training;
- Effective farmer control over major research and extension priorities.

Capital investment is usually required to assist resource-poor farmers to adopt ZT and other conservation agriculture practices. This can take the form of initial purchases of cover crop seeds and specialised planting or spraying equipment, concrete manure pits, communal waterproof waste dumps for used pesticide containers, piped water supplies for agricultural sprayers and feeder road re-location. However, even though all the stakeholders in a micro-catchment be involved in development decisions, poverty alleviation incentives can be directed to specific target groups or other incentives to the whole community, e.g. where watershed management actions are envisaged. In the latter case, the larger farmers make a faster impact and can be motivated to involve private sector support.

In Box 2 is presented a résumé of points which need to be taken into account when considering how Brazil's ZT conservation farming systems could be adapted to similar soil/climate regions in other countries of the world.

Box 2. Premises for Sustainable Conservation Agriculture with Zero Tillage.

- ZT as the ENGINE of DEVELOPMENT;
- On-farm adaptive research comes first;
- Promulgation of benefits to motivate farmers and policy-makers;
- Planning/execution in watershed/micro-catchment units;
- Involvement of all sizes of landholders;
- All soil constraints to be removed BEFORE adopting ZT;
- A legal basis is required for implementation of majority decisions in watersheds;
- Farmer empowerment gives clear focus to extension, research, watershed management;
- Inter-agency and interdisciplinary collaboration are required;
- Training is necessary for both technicians and farmers;
- Financial or other incentives enhance adoption and do not constitute subsidies, provided they are smaller than the benefits which accrue to society from project actions;
- Compatibility mechanisms are required. between rural and urban water users.

In the new agro-ecological situation represented by ZT adoption, adaptive on-farm research comes first. This is especially relevant to small risk-averse poor farmers (Darolt & Wall, 1999). Financial incentives may not be needed for medium and large farmers if ZT is immediately profitable (as in Brazil). The resistance to change can be overcome by making both farmers and policy-makers aware of the wide range of benefits of ZT and by removing the financial risk for innovating farmers. Other inducements may be required to encourage research or extension workers to collaborate with these innovative farmers, on their farms and on their terms. These professionals and university/college teaching staff perceive no financial rewards for "adopting" ZT – they must be motivated by increased job satisfaction.

An important policy consideration is that the intensification of rural land management, which ZT permits and promotes, can be an important factor in slowing de-forestation. The significant increases in yields obtained under ZT produce more food per unit area; this means less expansion of the agricultural frontier in developing countries with a growing population. This is especially true for ZT of soybeans, maize, Phaseolus beans and upland rice into degraded pastures, a technology recently developed in Brazil. Incentives to this activity (Box 3) could absorb all expansion in grain production and the cattle herd for the foreseeable future. This practice has been shown to increase stocking rates by a factor of over 3 and farm incomes by 85% (Broch 1998), while also increasing crop yields, lowering the costs of crop protection and consequently making conservation agriculture with the ZT system more profitable for the farmer in the long term. Financial incentives with this objective mplicitly involve society putting a value on the native vegetation so preserved. Specific actions may also be needed to encourage cattle owners (who have neither crop husbandry skills nor the necessary machinery) to rent their degraded pastures to arable farmers in return for pasture re-establishment and low rent. However, to overcome the economic attractiveness of clearing new land, a specific grant incentive may be required to compenstae for the initial costs of crop production in degraded pastures (removing cattle trails, erosion damage and/or stumps and roots which impede mechanised cropping).

Box 3. Incentives which can be used to encourage adoption of Zero Tillage:

- Support for technical events, training of farmers/technicians and technical publications;
- Cheap investment credit lines or grants for specialised machinery purchase, incremental inputs and environmental actions;
- Donation of startup cover crop seeds accompanied by training in seed production practices;
- On-farm technology development and demonstration grants;
- Land use capability revision to include ZT management;
- Crop x Pasture rotation intensification grants;
- One-off , annual or phased Carbon Sink or reduced emission grants;
- Labelling of Conservation Agriculture or ZT farm products as sustainable.

ZT has even more wide-ranging impacts. The protective soil cover in ZT permits revision of slope and texture criteria in determining erosion susceptibility, permitting cultivation of some lands considered unsuitable for CT. Compensation for a reduction in CO_2 emissions, due to the significant on-farm carbon sequestration shown in earlier chapters, is under discussion internationally, but could be implemented at national level to encourage conservation agriculture with ZT. Finally, for society as a whole, food security considerations are important. ZT reduces drought risks, practically eliminates crop loss through erosion, increases productivity and reduces input levels (especially fuel) per unit of food produced, thus increasing food availability and reducing its cost

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