Potential role of CA in strengthening small-scale farming systems in the Brazilian Cerrados, and how to do it [1]

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Abstract

Throughout Brazil, landless families are being resettled under the government's National Land Reform Program. The corresponding resettlements, the so-called '*assentamentos*', constitute for Brazil a new type of small-scale agriculture, the successful development of which promises to be long and challenging. The new settlers encounter a range of technical difficulties related to their limited, heterogeneous knowledge and experience about agricultural production, and to their restricted access to financial resources and institutional support.

This paper looks at some of the key characteristics of the farming systems of three *assentamento*s in the district of Unaí in the Cerrados region, and assesses whether and how conservation agriculture could constitute a viable basis for improving existing crop management practices and for increasing their sustainability and overall contribution to improved household livelihoods. The key problems identified were in order of importance: 1) restricted access to tillage equipment for seedbed preparation; 2) late planting 3) poor weed control; and 4)·low soil fertility and restricted access to fertilizers. An approach to participatory development of CA cropping systems is outlined, as well as the first steps taken to test potentially useful CA technologies and to identify and formalize CA focus groups. A major strategy is to articulate research activities conducted with individual farmers to design and adapt CA systems to their specific conditions, and activities conducted with farmers' organizations at the community and regional (participatory evaluation, activity planning, organization of market relationships for inputs and outputs, etc...).

Key-words: Small-scale farming, conservation agriculture, focus groups, agronomic diagnosis, farmers' practices, livelihoods, participatory approaches, scaling up.

Introduction

In Brazil, conservation agriculture (CA) systems based on the use of no-tillage and cover crops is widely used as more than 18 millions hectares are reported to be planted under such systems (Derpsh and Benites, 2003). Adoption has mainly been concentrated in very large scale, intensive farms of sub-tropical Southern Brazil, even though small holders of the same regions have also adopted CA to a significant degree. Obviously, adoption rates and modalities vary among regions and conditions (see for example Landers, 2001, Ekboir, 2003, Ribeiro et al., 2005). In the conditions of the Brazilian Cerrados, small scale farmers belonging to the agrarian reform sector (called "assentados") are facing many specific constraints to stabilize their agricultural production systems and, beyond that, to improve their overall economic and social situation, something which has recently become a priority for the Brazilian government following the presidential elections of 2003. Presently basically none of the assentados practice CA in the Cerrados, even though CA may contribute significantly to addressing some of the constraints these farmers face or the objectives they pursue

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In this context, this paper will identify and discuss some of the main issues to address as well as the methodological consequences for promoting new CA cropping systems for assentados in the region of Unaí, in the North-west of the State of Minas Gerais. In particular, we illustrate how CA can contribute to addressing some of the main concerns of the farmers, based on preliminary results obtained within the context of the Unaí project. We also discuss how this relatively new participatory, multiple stakeholder Research and Development project is planning to tackle the corresponding agenda.

The Brazilian Cerrados and the Agrarian reform Sector

The Cerrados region covers 200 millions hectares in the mid altitude (1000 m) savannahs of central Brazil. It is mainly constituted of large plateaux called "Chapadas". The climate is tropical humid with an good mean rainfall (from 1300 to more than 2000 mm) concentrated on eight months between September to April, and high temperatures (25 °C in average) during the whole year. Since the seventies, agriculture started to colonize the "chapadas". After initial liming, the corresponding deep, well structured oxisols are very favourable to intensive, mechanized grains production. On the other hand, the margins of the chapadas and the uneven, sloppy zones between chapadas (Valverde da Silva et al., 2004), are made up of chemically poor soils, with few exceptions. Under hot and wet conditions, organic matter stocks which make up most of the fertility of these soils can rapidly disappear under strong erosion processes and/or weak biomass returns to the soil.

As in the whole of Brazil, small scale agriculture represents a vast majority of the farms but covers only a small portion of the total cropped area (Table 1). Unsurprisingly, while large-scale farmers (exploiting typically thousands of has) producing grains or cattle farm the 'chapadas', small-scale farmers (exploiting a few tens of has) have only access to the neighboring poor soils, when they have access to land at all through an on-going yet slower-than-desirable land reform process.

Table 1. Importance of small scale agriculture across Brazil

Region	Number of farms	Small Farms (%)	Total area under small farms (%)
Nordeste	2 055 157	88	43
Centro-oeste (Cerrados)	162 062	67	13
Norte	380 895	85	37
Sudeste	633 620	75	30
Sul	907 635	90	48
Total Brazil	4 139 369	85,2	30,5

Source: INCRA/FAO, 2000

This is one reason why small farmers from the agrarian reform sector (referred to in Brazil as the "assentamentos") are facing significant economic difficulties. Other reasons include the fact that farmers have a very weak access to capital, cash, credit and information. They have furthermore few commercial activities and opportunities, obliging them to work off-farm to supplement their meagre on-farm income. Additionally, technical options allowing farmers to manage adequately their natural resources base are generally undeveloped or even unknown and technical assistance to farmers is thoroughly lacking. Finally local markets for inputs and outputs are poorly accessible and less favourable to small farmers in this region, especially compared to what the situation is in Southern Brazil.

The Unaí project

The project "Adaptation and use of participatory approaches for enhancing the sustainable development of the "assentamentos" from agrarian reform", better known as the Unaí project, was launched in 2002. Its main objective is to develop participatory approaches capable of supporting the local development of small scale farming communities. The Unaí region was chosen because

of its high concentration of communities from the agrarian reform, 24 in total. Out of these, three contrasting ones were chosen for initial activities, according to the length of time since settlement, from recently installed (2 years) to stabilized ones (12 years).

Lead partners in the Unaí project include Embrapa (national agronomic research), the University of Brasilia, a local training center for agricultural technicians, CIRAD (Center of International cooperation in Agronomic Research for Development, France), as well as the farmers councils of the 3 communities. In addition, regional farmers' unions, cooperatives, local authorities, and private sector are participating increasingly to scale up the activities, depending on the specific objectives pursued by the project.

The Unaí project formalized 4 principal objectives:

1. Develop local references on farming systems through the monitoring of a network of representative reference farms, in order to analyse their organization and develop technical alternatives adapted to their needs.
2. Strengthen farmers' capacity for collective action
3. Improve market relationships and diversify agricultural production
4. Achieve a more sustainable management of the natural resources at the farm level.

Development and adaptation of CA systems is an integral part of this last objective while also entertaining close interactions with the first three. Additionally the Unaí project includes a strong education and training component directed at farmers, both for household heads and for the sons (male or female) of "assentados", who are being trained as agricultural technicians and change agents during a 3-year program based on an alternate scheme (2 weeks at school and 6 weeks on the farm).

Farming Systems of the "assentados" in Unaí

Diversity of farming systems in the "assentamentos" is mainly related to the time elapsed since the establishment of the farms. Indeed, farmers develop gradually their farm after they have received their land grant, making use of specially designed official loans. A fraction of the loan is generally used to buy some cattle and/or to install some pasture. Usually the first few years, farmers slash part of the existing forest vegetation (called Cerrados) to produce food crops (rice, beans). In subsequent years, they increment gradually the area under pasture. In this initial period, farmers' livelihood is derived from selling their own labour off-farm, generally by working part-time on large-scale farms or in the city, and by making and selling coal from slashed trees.

Early on, dairy production plays an important role in the economic strategies of farmers. Milk production based on a mixture of grazing and complementary feeding is indeed the easiest way to obtain regular and satisfactory cash incomes. Furthermore, milk marketing is well organised in the region. As soon as the communities get connected to the electric network, which allows them to invest in refrigerated milk tanks, a truck collects the community milk production every other day.

A farmer surveys conducted in 2002 (Valadares Xavier, 2003) and completed in 2004 (Goudet 2005) identified five different types of producers in the Unaí "assentamentos" (Table 2).

Type I represents farmers not well installed, either because they just got settled or because they faced many difficulties in their installation (acute lack of capital, failures with agricultural or grazing activities). They didn't buy any cattle or they already sold them.

Type II includes farmers who already possess some cattle, but the number or the quality of the cows don't allow them to produce enough milk for sale. Sometimes these farmers are located in recently settled communities without electricity or without enough organizational basis to jointly sell their production.

Type III is very similar to type II, except that these farmers transform their milk production into cheeses which are sold on the local markets, thus not having to depend on collective organization or electricity.

Type IV and V are actively engaged in a process of milk production intensification. Compared to type IV, type V does this by increasing significantly the number and quality of the cattle.

Table 2. Main characteristics of the different types of Farming systems in the "assentamentos" of the Unaí region

Type	General Description	Animal production	Destination of the products
I	Subsistence agriculture without cattle	Small animals (pigs, chickens…); **No cows**	Self consumption + small-scale marketing
II	Subsistence agriculture with cattle	Small animals (pigs, chickens…), **1 - 10 cows**	Self consumption + small-scale marketing
III	Cheese producers	Small animals (pigs, chickens…), **2 - 11 cows**	Self consumption + small-scale marketing + cheese sale
IV	Milk producers (non exclusive)	Small animals (pigs, chickens…), **1 - 10 cows**	Self consumption + small-scale marketing + milk sale (1 -30 l/day)
V	Milk producers (specialized)	Small animals (pigs, chickens…), **4 - 35 cows**	Self consumption + small-scale marketing + milk sale (12-115 l/day)

Source: Adapted from Valadares, 2003 & Goudet, 2005

Overall, the proportion of land that has been cleared increases from Type I (36% of total land) to type V (79%), and conversely, the area used for annual crops decreases from type I to type V (from 27% to 6%). This indicates that cultivated area is quite stable for all groups and additional cleared land is dedicated to pastures as cattle and dairy activities increase. Maize production is nevertheless important in all cases in order to produce grain and forage for the five-month long dry season.

Regardless of the farm type, no clear differences were detected with respect to the key characteristics of the cropping systems. In particular, maize production and its main limiting factors are very similar across all farmers. Sustainability of this production is essential and that's why it is concentrated, when possible, on the few, more fertile fields .

Maize crop management practices & farmers' perceptions

Land preparation for maize generally involves one to three tillage operations with tractor and disks tools (Goudet, 2005). It relies on contract services provided by tractor owners from neighbouring large-scale farms, since local tractors are very few. This situation yields three main negative consequences: (1) frequent delays in planting dates relative to optimum ones; (2) a lower-than-desirable quality of soil preparation (hired services do not give farmers a choice in terms of implement, date, speed and depth of ploughing); and (3) low quality and heterogeneity of planting.

While mechanized planting exist, maize is usually planted manually with a jab- planter: the famed "matraca". Because of the relative drudgery of the corresponding work and of the poor conditions of the soil after land preparation, quality of planting is often low. This translates into poor plant germination and low plant stands (< 3 plants/m²).

Maize is usually fertilized at planting. Rates vary hugely between 0 to 400 kg ha^{-1} of a 5N-25P-15K fertilizer. Manual top-dressing of urea is common with rates varying between 0 to 100 kg N ha^{-1}. Many farmers also apply occasionally lime to their fields but the resulting effect on acidity correction is not uniform, as it depends on soil type, amount and quality of lime applied. How well acidity is neutralized in turns affects the global productivity and overall fertilizer efficiency that farmers gain from applying fertilizer.

Weed control is mainly done manually using a local tool called "enxada" or with an animal-drawn cultivator. The combination and number of controls varies however among farmers (Table 3). Interestingly, very few farmers use herbicides mainly because of their lack of knowledge about which herbicides to use and how, and their perception that herbicides may be bad for their health or the environment. Cost and access to these inputs does not per se seem to be major issues.

There is no weed control at all during the second half of the maize cycle, and hence many weed species are able to reproduce freely, thus enriching the seed bank. Many of these seeds germinate at the beginning of the next rainy station. The repetition of this type of management every cycle explains why after a few years, farmers face severe difficulties in controlling weeds efficiently. This generates negative consequences in terms of competition between the crop and the weeds and, hence, production costs and productivity. Overall farmers consider weeds control as a major constraining factor, both because of its difficulty and its high labour requirements (which oblige busy dairy farmers to hire external labour for weeding).

Table 3. Key Modalities of weed control in maize by the "assentados" in the Unaí region

MODALITY	FIRST CONTROL	*DATES*	SECOND CONTROL	*DATES*
Single control, manual	Manual ("enxada")	*11/20 - 12/31*		
Single control, animal traction	AT cultivation followed by manual control	*11/15 - 12/15*		
Double control (Alternative a)	AT cultivation followed by manual control	*11/15 – 12/15*	AT Cultivation	*15-20 d. after the first control*
Double control (Alternative b)	AT cultivation followed by manual control	*01/11 – 15/12*	AT cultivation followed by manual control	*15-20 d. after the first control*

(AT: Animal traction) Source: Adapted from Goudet, 2005

In contrast to weed control, farmers do not worry much about land degradation, which remains a rather blurred concept / issue for most of them. While they identify readily symptoms of erosion processes in their fields, the impact this erosion might be having on soil fertility and crop productivity is far from obvious to them, perhaps because of its cumulative nature (i.e it happens gradually and may take several years before something really bad happens). Also, as many farmers are still in the process of clearing patches of forest from the land they received through the agrarian reform, they may not yet consider that they have reached a level where land degradation is critical. At this stage, their main concern is often constituted by direct and material limiting factors such as access to electricity, credit and technical assistance, dependence on external tractors, and weed control (see above). Consequently, soil conservation does not appear to be an adequate entry points into CA for farmers in the Unaí region.

Introducing CA: Entry points and approach

Entry points

Taking into account the difficulties faced by the "assentados", the limited economic flexibility they have, their high sensitivity to risk and their resulting cautious attitude towards technical change, the Unai project decided not to promote CA technical packages as is common elsewhere, but rather to develop in a participatory fashion relevant technical solutions based on CA principles with the potential to solve some of the main technical limiting factors farmers face. Three key entry points were identified during collective meetings at the community level, which strengthened the results of prior diagnostic activities. They include (in order of decreasing importance from the farmers' viewpoint):

- Reducing dependency on hired tractors

Farmers are keenly interested in this issue because of its multiple implications (cf analysis made above). In all the situations where soil structural conditions are not too unfavorable or liming is not necessary, no-tillage appears to be a good option.

- Improving the quality and facility of planting

Farmers are interested in novel planting methods which are quicker and more efficient than manual planting. In order to avoid creating a new dependency on hire services, this new option has to rely on animal-drawn seeders. Luckily, good, cheap NT drills are readily available in Brazil (Ribeiro, 2001)

- Improving weed and fertility management

Farmers are interested to work on integrated weed and fertility management options. For weeds, special attention needs to be paid to the beginning of the maize to reduce weed impact by planting earlier, reducing maize inter-rows, and/or using chemical herbicides. Given the residual moisture available, cover-crops species may also be introduced relatively easily towards the end of the maize cycle to compete with spontaneous weeds and to reduce weeds seeds production.

For fertility management, higher returns of biomass to the system should contribute to maintaining soil organic matter stocks. Also the introduction of legume cover crops could contribute to improving N balance into the system as well as a quality source of forage.

For both weeds and fertility management, a transition period will be necessary. The idea is to reduce over time the use of external inputs and to shift gradually to more agro-ecological farming.

- Forage production & quality

All farmers with livestock identified the lack of forage in quantity and quality during the dry season as a limiting factor for intensifying their milk production. While maize fields are generally grazed during the dry season, they offer poor forage potential as crop residue and weeds are totally dry and poor in nutrients. The introduction of adequate cover crops could contribute to increasing forage quality of these fields.

- Labor saving issues

Some dairy farmers are quite interested in saving labor in their agricultural activities in order to invest it in the intensification of their milk production. They are sensitive to cost/benefit comparisons between herbicides use versus mechanical control or between manual planting versus animal traction. These same farmers are the ones who wish they could spend less time looking around for a tractor. Hence they are very interested in CA cropping systems, hoping these latter can contribute to both reduce their work load and produce better quality forage through cover crops (as long as this extra activity does not by itself requires much labor).

Initial experiments with CA technologies

During the 2004-2005 cycle, simple exploratory experiments were conducted with a handful volunteer farmers to at the same time (1) demonstrate to them the potential of specific CA technologies (unknown to them until that day) in addressing their needs (cf. entry points above) and (2) initiate, albeit in a rather informal manner, a participatory development and adaptation innovation process.

Specific topics of each experiment were negotiated with each farmer and tested without any repetition into the farmer's field. The following items were tested:

- Efficiency of animal-drawn NT drills and back sprayers
- Chemical weed control
- Test of a few cover crops species planted into the maize at flowering (millet, Crotalaria sp, Cajanus cajan, Canavalia sp., Mucuna sp.
- Test of diverse techniques for planting the cover crop species (throwing, "matraca", small mechanical planters)

Preliminary qualitative results show the efficiency of the different pieces of equipment tested. The quality of maize planting was always satisfactory and time of planting could be reduced from 4 to 1 man-day ha^{-1}. Farmers were also satisfied with the use of back sprayers, as herbicides applications were very quick and efficient, allowing good, cost-efficient weed control in all experiments. Some cover crop species such as millet didn't withstand competition with maize for radiation. Species with slow initial growth (Cajanus, Canavalia) would have benefited from being planted earlier than maize flowering time, while the contrary was true for other species such as Crotalaria or millet. Also, it appears that cover crops species actually need to be planted into the

soil under maize crop, rather than being simply broadcasted. Tests of this later labor-saving technique made with small seeded species showed poor germination of the corresponding cover crops. Planting cover crop with a jab-planter worked well but required at least 3 man-days ha^{-1} and significant efforts, compared to one man day ha^{-1} if using a horse-driven NT drill

Launching of CA focus groups

Individual experiments proved useful in motivating participating farmers and were furthermore closely scrutinized by neighboring farmers, some of whom want now to start CA as well. However, some activities need also to be organized and conducted at the collective level in this process of participatory innovation development to be able to go further.

A step in this direction has already been taken when informal CA focus groups of 10 15 volunteer members were created from scratch in each community. Researchers are working with these new focus groups on how to improve their organization, with the objective that they will soon become stronger partners for researchers and for example have the capacity to work together on the following issues (and others which may pop up in the future):

1) Selection of the most promising options to tackle mains problems identified in the initial diagnosis;
2) Negotiation and implementation of experimental designs (controlled trials and demonstrative fields);
3) Participatory evaluation and adaptation of the new CA cropping systems;
4) Farmers' training on equipment calibration & management, cover crops use, input efficiency and integrated weed management, as well as on CA principles and on Participatory innovation processes.
5) Collective negotiations with institutions (Embrapa, Regional farmers' Union, Emater, etc.) for provision of technical support and access to external inputs.

Furthermore, focus groups will need to identify the best ways of providing to interested farmers satisfactory access to NT drills and to spraying equipment, reliable and cost-efficient access to external inputs whenever necessary (lime, fertilizers, herbicides), and finally ensuring local production and management of cover crops seeds. How the different local focus groups will articulate themselves with the existing community organizations and among themselves remains to be seen. Already some encouraging early signs include the fact that some members of the CA focus groups are also members of the community boards. Furthermore, one of the focus groups has already negotiated access to inputs by reaching a deal with the community board, which in turn got the benefits linked to its status as full member of the District Cooperative.

The Unaí project is refining a participatory approach based on three level of partnership between farmers and research:

- Farm level: technical and economical monitoring of a network of representative farms, demonstration units, agronomic on-farm experimentation and development of cropping systems, etc.
- Community or settlement level: strategic participatory planning and implementation of collective activities (such as CA or milk tank focus groups) and exploration of community issues (collective infrastructures, milk prices negotiation, cassava market alternatives, etc.)
- Municipal / regional level: methodological support to a regional farmer's union, to help it organize a future regional technical assistance team.

A key issue at this stage is how to develop this approach in such a way that it might work satisfactorily on a larger scale, without requiring unbearable amounts of human resources. Another delicate issue is finding an adequate link between the individual farm level and the diverse collective levels. This will require taking into account the heterogeneity in terms of functioning, leadership and results which can be observed between and among diverse collective structures: focus groups, women groups, community associations, religious groups, etc.

Whatever the case, a successful articulation between activities at these three levels (individual / plot level, community and regional) is required for the eventual success of the Unaí project, and represents one of its biggest challenges.

Conclusions and perspectives

This study illustrates the fact that cropping systems based on sound CA principles can contribute to solve some of the main problems small scale farmers from agrarian reform communities face in the Cerrados region. They may help to suppress poorly executed soil tillage operations, improve quality and timing of crop planting, improve and make weed control easier, produce more and better forage for the dry season, saves labor spent on cropping for more desirable activities and, over time contributing to improving soil fertility management with less erosion and more organic returns to the system.

Adoption by small holders of such rather complex innovations on a significant scale require involved projects and institutions to implement approaches which are as fully participatory as possible. This include designing technical options based in CA principles jointly with farmers since the very beginning in order to answer more closely their main constraints and/or objectives. It also includes strengthening farmers' capacity to organize themselves, this for at least two key reasons. First, because it is perhaps the only or best way for farmers to gain adequate access to CA inputs, including training and technical assistance. But beyond this functional reason, collective organization also opens the door to achieving non-technical innovations such as better negotiating capacities between communities and milk cooperatives, or improved marketing of farm products, not to mention the achievement of broader political goals.

Altogether, it is by pursuing and achieving simultaneously these various types of innovations that farmers may stand a better chance of improving their livelihoods in a sustainable manner. This is clearly the path chosen by the Unaí project, with no certainties yet on how things will unfold, except that challenges will be numerous.

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