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Conservation Agriculture in Southern Africa Results and Experiences of a New Technology

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Resumé
Une forte proportion des terres cultivées d'Afrique Australe est affectée par l'érosion et la perte de fertilité des sols, en raison de systèmes d'utilisation du sol et de gestion des ressources naturelles non durables. L'adoption de l'Agriculture de Conservation (CA) est forte sur les continents américains et australien mais demeure faible en Afrique, principalement en raison du manque de savoir technique de la part des agriculteurs. CA réduit les perturbations du sol, protège le sol par une couverture et permet l'alternance des cultures et l'utilisation d'engrais verts. Les résultats préliminaires en milieu paysan d'expériences menées au Zimbabwe, en collaboration avec le CIMMYT, démontrent que CA peut augmenter le rendement en grains par 36% et la biomasse produite par 91% comparée au contrôle.

Introduction

Extensive parts of rural areas in Southern Africa are affected by soil erosion and fertility decline due to unsustainable cropping systems and inappropriate management of the natural resource base. Mainly the excessive use of the traditional mouldboard plough increases soil erosion and run-off, depletes soil organic matter on arable land, and leads to an overall decline in maize yields and consequent famines. There is an urgent need for cropping systems that increase agriculture production in a sustainable way.

Conservation Agriculture (CA) is such sustainable system. It is based on three main principles: a.) minimum soil inversion, b.) crop residue retention and c.) crop rotation and, where possible, green manure cover crops (IIRR and ACT, 2005). CA improves the soil’s physical, chemical and biological fertility. It increases the soil organic matter content, minimises soil erosion, improves infiltration, conserves soil water status during seasonal droughts, reduces labour and draft power requirements, augment the resilience against crop failures and therefore contributes to food security in the region (FAO, 2002).

Although CA can be practiced on a wide range of soils, it has its limitations in waterlogged conditions and on very sandy soils. Furthermore, CA has higher management requirements. Traditionally, tillage was carried out to reduce weed pressure. If this is omitted, weed control becomes of paramount importance especially in the first years of transition. Soil tillage aerates the soil, which leads to higher organic matter decomposition and nutrient release. Although this is beneficial in the short term for the farmers and their immediate yields, it leads to nutrient mining especially in cases of low inherent soil fertility. Therefore, if soils remain undisturbed and covered with residues they need higher fertilization rates at the beginning due to the lack of nutrient release and higher nitrogen lock-up by microorganisms.

CA has been practiced for many years in other parts of the world with high adoption rates of direct seeding, one major component of CA. Direct seeding for instance is practiced on about 90 mio ha in the Americas and Australia (Derpsch, 2005). However, uptake amongst smallholder farmers in Southern Africa was low due to the lack of knowledge about the technology by local farmers and extensionists and due to socioeconomic constraints and traditions which counteract the widespread uptake of CA in this region.

CIMMYT started a new project in 2004, funded by the German government, to facilitate adoption of CA in maize-based systems in Southern and Eastern Africa. This project is a

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research for development project, based in Zambia, Zimbabwe, Malawi and Tanzania, which includes activities to increase knowledge and overcome limitations of adoption of CA by smallholder farmers. Components of this new project are: Community awareness activities; Farmer training in CA techniques; Demonstration plots on farmer fields; Organization of groups of interested farmers focusing on the demonstration plots; Farmer experimentation; Farmer-to-farmer exchange, both within the community and outside the community; Researcher and extension agent training in CA principles and practices; Participatory evaluation and modification of equipment for seeding and spraying in animal traction and manual systems; Local manufacturing of adapted equipment; On-farm and on-station research trials to develop solutions to problems observed in demonstration plots; Farmer experiments; Long-term trials on-station conditions to monitor the effects of CA practices on crop productivity and soil physical, chemical and biological characteristics. This paper aims to summarize some preliminary results and experiences from on-farm and on-station research sites in Zimbabwe.

Materials and Methods

On-station research on different CA interventions was carried out at Henderson Research Station (S 17° 34.362’, E 30° 59.234’), Mashonaland Central Province, 30 km north of Harare and on-farm at Zimuto Communal Area (S 19° 50.182’, E 30° 52.335’), Mashvingo Province, 270 km South of Harare. At Henderson Station soils are characterized by a sandy soil texture derived from granitic bedrock. Predominant soils types are Arenosols and Acrisols. Zimuto soils are sandveld soils developed from granitic sands and are mainly characterized as Arenosols. Henderson Research station is located in natural region II with average rainfalls of about 780 mm a^{-1}. Zimuto is located in natural region IV and has an average rainfall of 620 mm a^{-1}. Data from the 2004/2005 season presented here was affected by a seasonal drought which reduced overall yields in Zimbabwe.

Trials on station at Henderson Research Station consisted of five treatments laid out in a completely randomized block with four replications. The treatments consisted of: 1.) Traditional farmers practice, normal mouldboard plowing with animal draft power, maize; 2.) Subsoiling with a Palabana subsoiler, animal draft power, manual seeding, crop residues as mulch, maize; 3.) Direct seeding with an animal drawn direct seeder, fertilizer and seeding simultaneously applied, residue retention, maize; 4.) Planting basins, hand hoes, residues, maize; 5.) Ripping with a Magoye ripper, manual seeding, residues, maize with green manure cover crops intercropped as a relay crop six weeks after maize planting.

On-farm treatments in Zimuto were replicated by farmers and consisted of: 1.) Traditional farmers practices, normal mouldboard plowing with animal draft power, maize; 2.) Subsoiling with a Palabana subsoiler, animal draft power, manual seeding, crop residues as mulch, maize; 3.) Direct seeding with an animal drawn direct seeding tool, residues, maize.

On-station treatments at Henderson station were fertilized at a rate of 163 kg ha^{-1} Compound D (7-14-7) at planting and with 150 kg ha^{-1} Ammonium Nitrate when plants were 25-30 cm high. Chemical weed control on the CA treatments 2-5 was done with Roundup. Further weeding was carried out manually using hoes. The maize hybrid SC 627 was used as the main crop.

Zimuto trials on-farm were fertilized at a lower rate of 100 kg ha Compound D and 50 kg of AN to reflect local farmers conditions. Weeding was done manually using hoes. The open pollinated variety ZM513 was used in Zimuto.

Results

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Conservation agriculture is a long-term investment. Results presented here should be put in this context and viewed more as preliminary short term trends than long-term results.
At Henderson Research Station, the Basin treatment (T4) performed best in terms of dry grain yield (2.8 t ha^{-1}) and dry biomass (2.2 t ha^{-1}) closely followed by the Subsoiling treatment (T2). The Direct seeding treatment (T3) had higher fresh cob and biomass yields but slightly lower dry grain yields than the control (Figure 1). Although the conventional farmers' practice developed very promising at the beginning of the season, it did not continue to grow well especially when a mid season drought hampered plant growth. This is reflected by the harvest yield results. The Magoye ripper treatment with *Mucuna pruriens* intercropping, did not perform better than the control.

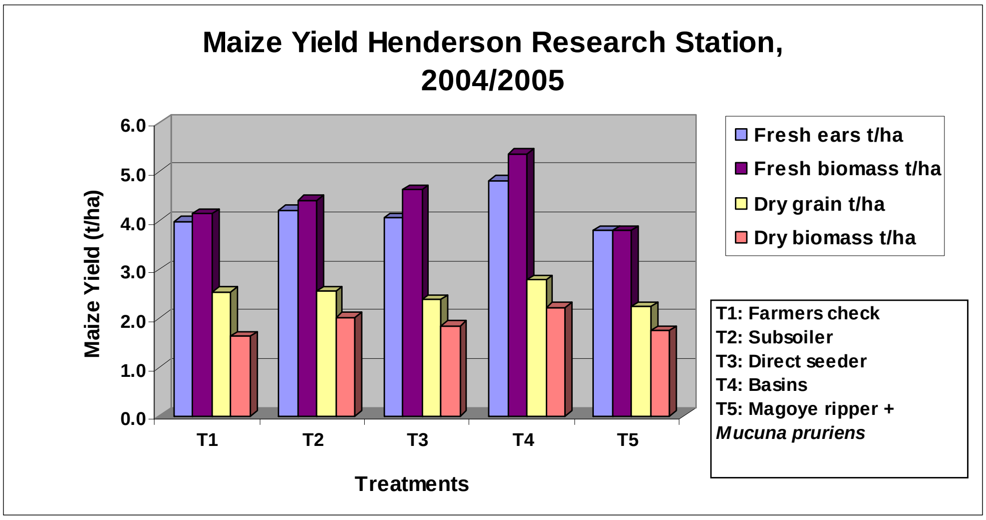

Figure 1: Overall yield results from Henderson Research Station in season 2004/ 2005. The trial consists of one conventional farmers' check (T1) and four CA treatments (T2-T5).

Farmer-managed fields showed generally highest yields in the CA interventions. Dry grain yield for example was 36% and dry biomass amount was 91% higher on CA fields than the control (see Figure 2). Highest, although not yet significant, grain yields were found in the Subsoiling treatment (0.45 t ha^{-1}). The highest amount of dry biomass was found in the direct seeding treatment (0.39 t ha^{-1}).

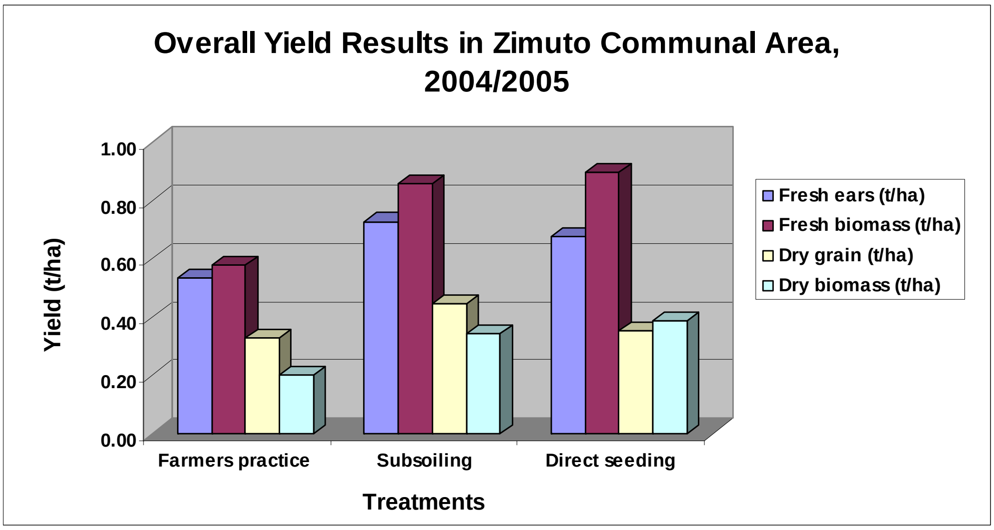

Figure 2: Yield results from Zimuto Communal Area, Mashvingo Province, Zimbabwe.

Discussion and Conclusion

It was very obvious that most CA interventions on-station showed yield increases of up to 11% in dry grain and 38% dry biomass over control. Only the Magoye ripper treatment performed worse. This was mainly due to competition between the main and the cover crop especially during the drought-prone season. On farmer-managed fields grain yields were 36% and biomass amount was 91% higher on CA fields compared to the control.

Given these preliminary results, CA has proved to be a very promising technology for Southern Africa. As CA is a system that constantly builds up its benefits, it is too early to draw further conclusions.

Additional results from participatory on-farm work not elaborated here, showed hat CA is a complex technology for farmers. Linear extension approaches for CA did not work if researchers carried out the basic, strategic or applied research, passed that over to extension people who tried to enable farmer to adopt the technology. Experiences from the season 2004/2005 showed that innovation networks including communities, farmers, researchers, extensionists, policy makers, machinery manufacturers, input suppliers etc. are key players and if they work closely together they can facilitate adoption.

Benefits of CA were acknowledged by farmers mainly as labour and draft power savings which allow early planting, a key to success for maize production in the region. Often the main gain of changing into a CA system was seen in the reduction of draft power which is tremendously reduced by a direct seeding technology. Southern Africa is highly affected by labour shortage due to HIV/AIDS and a variety of animal diseases such as the corridor as well as foot and mouth disease. A reduction in labour and draft power requirement therefore is of major benefit for the farmers.

Thus more research is needed to fully analyze the overall benefits of such a system for rural Southern Africa to turn down the vicious circle of soil degradation, overuse and fertility decline.

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