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CONSERVATION AGRICULTURE: SOUTH AFRICA'S NEW GREEN REVOLUTION?

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SUMMARY

- Conservation Agriculture (CA) has the potential to greatly improve the sustainability of South African crop production.
- Targeted and effective policy support is necessary to sustain the momentum behind CA, and to ensure that consistent techniques are properly applied, maximizing benefits and reducing the risk of poor outcomes.

BACKGROUND

As farmers move from conventional to conservation farming, agricultural production becomes more resilient to climate variability, and therefore to at least some aspects of anticipated climate change (FAO, 2011a). The components comprising Conservation Agriculture (CA) (a trifecta of no-till or minimum-till farming, permanent soil cover and crop rotations) have existed for nearly a century, but uptake has generally been slow and uneven (FAO, 2011a; Knowler and Bradshaw, 2007). Though adoption of no-till farming has been widespread in South America, rates in sub-Saharan Africa (including South Africa) remain particularly low (McCarthy et al., 2012), necessitating government support through targeted and integrated policy-making.

DRIVERS

The adoption of CA has generally been driven by necessity (Huggins and Reganold, 2008). First arising in the aftermath of the 1930s "dust bowl" in the United States, no-till and minimum-till farming evolved as a way to curb soil erosion (Hobbs et al., 2008). Though farm-level decision-making is difficult to

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disentangle, major drivers of no-till uptake include soil degradation, erosion and water scarcity, exacerbated by rising input costs, globalized markets and lower profit margins (Hardy et al., 2011; Knowler and Bradshaw, 2007).

In South Africa, an accelerated shift towards conservation farming began largely as a result of market deregulation that accompanied the end of apartheid. The withdrawal of protective price controls sparked a dramatic change in South African agriculture. Vast swaths of marginal agricultural land were abandoned as it became economically detrimental to continue its cultivation (Hardy et al., 2011). To offset diminished revenues, farmers were quickly forced to become more efficient, driving a technological shift as well as rapid consolidation within the industry. Crop switching occurred on a wide scale, as farmers were forced to adopt more climatically suitable, while also switching some cropland to pasture for livestock (Hardy et al., 2011).

COMPONENTS

A concept developed and promoted largely by the Food and Agriculture Organization of the United Nations (FAO), CA comprises three major practices: no-till farming, permanent soil cover, and crop rotations (FAO, 2011b).

1. No-till farming: To the greatest extent possible, the soil should not be disturbed (e.g., through plowing). This allows for the soil ecosystem and structure to return to a more natural state.
2. Permanent soil cover: To the greatest extent possible, the soil surface should not be left bare – most easily achieved by leaving crop stubble and residues on the field after harvest. This reduces the soil's exposure to environmental degradation and increases soil moisture retention.
3. Crop rotation: Crops should be grown in rotation, rather than in a monoculture. Crop rotation systems increase the diversity of production; intensive, nutrient-depleting crops are interspersed with more soil-friendly crops in short or long-term cycles. This may necessitate planting beneficial cover crops, rather than simply fallowing (resting) land. For example, farmers will no longer plant

wheat following a wheat harvest, but may instead rotate wheat with canola, grasses or nitrogen-fixing legumes.

BENEFITS

CA, when practiced in a comprehensive way, improves crop yields over time and reduces the required quantity of most inputs (FAO, 2011b). As the soil recovers from decades of tillage, and cover crops and residues add organic matter and nutrients, soil fertility, soil moisture, the system's resilience to environmental pressures improves dramatically (Hobbs et al., 2008).

CA increases soil organic matter content, soil moisture retention, while sharply reducing run-off (and therefore chemical pollution of nearby waterways), erosion by wind and water, and soil surface temperatures (helping to protect soil biota from extreme heat). As the health of soil fauna improves, soil organisms naturally till the soil, drawing nutrients from the surface down into the root zone, reducing soil compaction (thereby facilitating root penetration and water infiltration) and breaking down organic matter to make nutrients readily available for crops (Hobbs et al., 2008).

CA also reduces input costs by cutting fuel consumption in mechanized systems (planting is done using single-pass machinery), seed costs (due to direct planting) and fertilizer inputs, though herbicide use may increase (Knowler and Bradshaw, 2007). Crop rotations also allow for the inclusion of crops that contribute to increased soil fertility (e.g., nitrogen-fixing legumes). Pesticide use may also decrease – crop rotation systems under no-till are particularly resistant to pests and disease, since those that are crop specific have no host in the intervening years, and because robust soil biota increase the soil's resistance to pathogens (Hobbs et al., 2008).

The practice specifically decreases the farm system's sensitivity to weather variability and extremes (e.g., improving both water-logging and drought performance over time) (Holland, 2004; Thierfelder and Wall, 2010). For example, improved soil moisture retention makes for more reliable planting conditions, while single-pass techniques allow for planting to be completed within a much shorter timeframe. Planting under the CA approach therefore requires less rainfall and a smaller window of good weather, improving the farmer's ability to optimally time planting relative to the growing season (Hobbs, 2007).

In non-mechanized systems, CA may reduce labour inputs, though this finding has been variable across different studies (FAO, 2010; Giller et al., 2009). At the very least, CA requires less animal traction and may allow for labour inputs to be spread over a larger timeframe, since permanent soil cover reduces erosion between preparation and planting, allowing for earlier preparation.

Aggregate or off-farm benefits include increased food security, improved water quality through reductions in the agricultural pollution and sedimentation of water bodies, more regular and predictable river flows, increased soil biodiversity, lower greenhouse gas emissions from diesel use and soil processes, increased carbon sequestration in soil organic matter and higher soil albedo (reducing surface temperatures) (Holland, 2004; Knowler and Bradshaw, 2007).

COSTS AND CHALLENGES

No-till equipment is costly, making capital input an important limiting factor in the adoption of CA in mechanized systems. Farmers need to invest in single-pass planters, and despite the fact that no-till systems require fewer tractors because of reduced traffic, no-till planters may require more powerful tractors (Knowler and Bradshaw, 2007).

There may be an early reduction in yields and profit until natural soil fertility improves, leading to financial losses. This may necessitate the application of higher volumes of mineral fertilizer due to immobility of nutrients in the crop residue for the first few years (Giller et al., 2009).

CA may also increase the incidence of weed infestation, requiring more herbicide or more labour for weeding (Giller et al., 2009). Where conventional tillage or residue burning may have previously provided regular non-chemical weed control, farmers may increase their use of chemical herbicides under CA (Jat et al., 2012).

In mixed crop-livestock systems, there may be competition for crop residues between soil cover and animal feed – or fuel, where residues are used as an energy source. Farmers may be unwilling or unable to buy feed externally, and may therefore allow their animals to feed on residues (Giller et al., 2009). This can result in reduced soil cover late in the dry season, affecting soil moisture retention, temperature and erosion.

Animals may also compact the soil surface if they are left to roam freely, requiring loosening of the soil prior to planting (Hobbs et al., 2008).

There is anecdotal evidence that CA's improved water retention may lead to water-logging of the soil under some conditions, though over time water infiltration should improve, reducing this risk. Additionally, if some measure of soil erosion continues to occur, drainage gullies may get deeper over time, since they are not fixed each season through plowing. In some circumstances, these factors may necessitate drainage infrastructure improvements under CA (Jat et al., 2012).

The benefits of CA only fully accrue through years of rigorous application of the underlying principles. Some farmers may not apply the techniques consistently and may therefore risk jeopardizing the accrued benefit. For example, if a farmer is not consistent in minimizing tillage, soil fertility may be reduced through rapid mineralization of soil nutrients after plowing (Jat et al., 2012). This is of greater risk where farmers lack information and training, or where extension officers are poorly trained, themselves. Poor training can result in the incomplete application of CA techniques and may lead to lower yields than in conventional agriculture (Hobbs et al., 2008; Knowlder and Bradshaw, 2007).

CLIMATE SMART AGRICULTURE

The concept of Climate Smart Agriculture (CSA) builds on CA in many ways, and emerged in preparations for the climate negotiations at Durban, South Africa, in December 2011 (Beddington et al., 2012). CSA was promoted as a way to accrue multiple concurrent benefits by encouraging farmers to switch to production methods that both mitigate climate change and increase agricultural resilience to climate variability. With a primary focus on increasing soil carbon sequestration, farmers might thereby be able to sell carbon credits in foreign carbon markets (McCarthy et al., 2011).

Unfortunately, the costs and uncertainty in measuring soil carbon sequestration would likely make it financially unfeasible for small-scale farmers to participate in foreign carbon markets. Widespread implementation of CSA might therefore drive further consolidation in the agricultural sector by creating another revenue source that benefits from economies of scale (McCarthy et al., 2011). CSA may still provide incentives and additional policy tools to promote the adoption of CA practices, but at present, the cost of carbon accounting and the volatility of carbon markets largely preclude the use of CSA to promote CA adoption in South Africa.

POLICY IMPLICATIONS

The factors driving adoption of conservation farming techniques in South Africa are dynamic, and the agricultural sector continues to evolve as a result. The geography of production will continue to shift – in sectors with substantial infrastructure, high capital costs and long lead times (e.g., wine grapes), the effect has been delayed, and the impact has not yet fully been revealed. These shifts can be expected to continue as the climate changes.

CA is generally of net benefit, both at the farm scale and regionally (Knowler and Bradshaw, 2008). Policy-makers should increase support for farmers who would like to switch from conventional agriculture, but are limited by access to financing for new equipment or by lack of knowledge and training. For non-mechanized agriculture, further research and development must drive technological improvement to make CA more feasible for small-scale farmers. Crop rotation systems must be optimized for local climatic and soil conditions.

As with all agricultural policy in southern Africa, extension services for information and training are crucial. Current levels of extension and resources for training are insufficient (FAO, 2011b), especially as South Africa undertakes land reform, increasing the number of inexperienced farmers. Provincial agricultural departments should also focus on developing specific and localized crop rotation systems, since their development is particularly resource-intensive and their benefits widespread.

CA may also concurrently benefit from and help to imbue a sense of stewardship, as farmers become more explicitly aware of the role of ecosystem services in the success of their operations (Kassam et al., 2009). With facilitative policies, government may harness this emerging awareness to draw farmers into related conservation programs, and help farmers to prepare for climate change. Provincial agricultural policies need to be better integrated with land reform and climate change policies, to ensure the success of each program and encourage approaches that will result in comprehensive benefits.

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ABOUT THE AFRICA PORTAL

The Africa Portal is an online knowledge resource for policy-related issues on Africa. An undertaking by the Centre for International Governance Innovation (CIGI) and the South African Institute of International Affairs (SAIIA), the Africa Portal offers open access to a suite of features including an online library collection; a resource for opinion and analysis; and an experts directory — all aimed to equip users with research and information on Africa's current policy issues.

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