

## Importance of Herbicides for Conservation Agriculture in Sub-Saharan Africa Leonard P. Gianessi

### INTRODUCTION

Over the last decades there has been a general trend of soil productivity decline on cropland in Sub-Saharan Africa (SSA). As a result, average cereal yields on smallholder farms in SSA have stagnated since the 1960s.<sup>16</sup> Land degradation, including a decline in plant available moisture, reduced soil fertility, and soil compaction, has been identified as the factor behind this stagnating productivity. Approximately 65% of agricultural lands in SSA are subject to degradation.<sup>19</sup> Soil erosion is a severe problem in crop areas of SSA. Erosion removes the topsoil, reduces the soils ability to hold moisture and nutrients and results in the removal of essential nutrients. A steady decline in soil fertility results from soil erosion. The primary cause of resource loss and land degradation on the crop lands of SSA is tillage with the hand hoe and the moldboard plow.<sup>1,19</sup>

### TILLAGE

Tillage on small farms is typically manual using a hand hoe or a single-furrow, animal-drawn moldboard plow. Farmers in SSA value the plow foremost for weed control.<sup>16</sup> If soil tillage is omitted, weed pressure greatly increases. Tillage as a means of weed control is achieved by killing growing weeds by burying them. Pre-plant tillage with hand hoes require about 8-10 days of labor per hectare.<sup>5</sup> Following planting, cereal growers typically hand weed their crop field 1-2 times during the growing season.

The continuous intensive soil preparation by hoe or plow leaves the soil exposed to rain, wind and sun. Soil organisms are destroyed by exposure to solar radiation and rapid drying of the soil. Soil inversion enhances the decomposition of organic matter in the soil through oxidation and leads to soil compaction, and increased water evaporation. Although in the short term, soil pores temporarily increase through tillage, they collapse



Tillage

once the soil settles leading to soil crusting and surface sealing which impedes rainfall infiltration.<sup>6</sup> Reduced infiltration of rainwater into soil reduces water availability to plants, increases surface runoff and reduces groundwater recharge. Frequent tillage causes the development of a hardpan at the bottom of the ploughed or hoe cultivated layer which impedes water infiltration and root penetration. Increased runoff results in surface erosion and gullies. With tillage, soil losses of up to 50t/ha/year through sheet erosion and water losses of 30% of seasonal rainfall have been estimated for Zimbabwe.<sup>7</sup>



Tillage

## CONSERVATION AGRICULTURE (CA)

For the past 25 years, several hundred million dollars have been spent by many international and national organizations promoting conservation agriculture (CA) to smallholder farmers in SSA. The three principles of CA are: minimum or no soil disturbance, permanent organic soil cover, and crop rotation. CA trials have generated yield improvements of 20-120% in smallholder agriculture .<sup>4, 12</sup>

Conservation agriculture does not disturb the soil by turning it over. Minimum soil disturbance leads to greater available soil moisture and a higher potential for groundwater recharge through increased water infiltration rates and reduced evaporation from the soil surface. Minimal soil disturbance means less soil erosion (-58%), improved soil structure, and more biological activity.<sup>15,14</sup> However, not tilling the soil results in greater weed pressure. Controlling weeds then requires increased hand weeding or the use of herbicides.

In SSA, farming is limited by labor, not land. Strategies that increase requirements for hiring labor are unlikely to be adopted.<sup>16</sup>



Hand-Weeding

## CA WITHOUT HERBICIDES

Higher weed pressure with minimal tillage increases peak labor demand for weeding where no herbicides are used.<sup>11</sup> Without herbicides, labor demand was more than double under reduced tillage than in the tillage plots.<sup>21</sup> Before planting, weeds are slashed to ground level with machetes, pulled by hand or scraped off the surface with hoes. CA increases labor requirements during the cropping season for weeding when implemented without herbicides. Without herbicides, conservation agriculture requires up to six weeding operations using hand hoes each cropping season.<sup>10</sup>

Although some farmers carry out more than three post-planting hand-hoe weeding operations in a reduced tillage system, the majority are unable to do so on time owing to labor constraints.<sup>10</sup> A survey of farmers in Zimbabwe showed that without herbicides farmers had to weed their reduced tillage plots significantly more frequently compared to the conventional tilled plots (41.5 man days vs 24.8) yet the reduced tillage plots still had more weeds (17% more weed ground cover).<sup>10</sup> Although proponents of CA argue that weed management inputs decline after the first years, research has shown that CA systems require early and frequent hoe weeding even after four years.<sup>12</sup>

Reduced tillage systems relying purely on manual techniques for weed control are not an attractive option for smallholders.

## CA WITH HERBICIDES

Herbicide application at planting time makes weeding easier in CA systems. With use of non-selective herbicides, all weeds can be removed in a single operation. If weed control is achieved with herbicides, the labor requirement is reduced. Use of pre- and post-plant herbicides in no till in Ghana required only 15% of the time required for seedbed preparation and weed control with a hand hoe.<sup>1</sup>

Research in Zimbabwe shows that it is economical to use herbicides under CA because farmers save at least US\$388/ha worth of time to be used on other off— or on—farm activities.<sup>13</sup>

When minimum tillage with herbicides has been compared to minimum tillage with hand weeding, grain yield was higher in 60% of cases with herbicides than when hand weeding was used.<sup>18</sup> On-farm trials in Tanzania demonstrated that a pre-plant glyphosate spray increased the yield of no-till maize by 13% and cost reduction increased net income by 24% in comparison to manual weeding.<sup>1</sup>

In Zambia experiments, water infiltration in the herbicide treatments exceeded the conventionally ploughed control treatments by as much as 494%.<sup>6</sup>

The availability of glyphosate has been the driving force behind increased adoption of no-till among small-scale farmers in Ghana.<sup>2</sup>

Nearly three-quarters of the Conservation Agriculture projects in Malawi promote the use of herbicides.<sup>11</sup> In a six-year study in 12 communities in Malawi, maize yields in herbicide-treated conservation plots out-yielded conventional control plots by 22-24%.<sup>8</sup>

In SSA, the principal factor limiting the area of cropped fields is weeding. Where herbicides have been adopted in reduced tillage, farmers have increased their crop area by over 140% from 1.1 to 2.7 hectares.<sup>20</sup>



No Till: Herbicides (L), No Herbicides (R)

## CONCLUSIONS

Despite more than two decades of research, adoption of conservation agriculture by smallholders in SSA has been extremely low. For example, the proportion of the total cropland area under conservation tillage in Zambia, Kenya and Zimbabwe is lower than 1%.<sup>9,17</sup> Weed pressure and high labor demands are important factors that reduce the benefits and limit adoption of conservation agriculture by smallholder farmers in SSA. The use of herbicides will facilitate the success of conservation agriculture in SSA. Farmers will need to be trained in their use and application. The availability and affordability of herbicides is the key for the widespread adoption of conservation agriculture technology by small-scale farmers throughout sub-Saharan Africa.<sup>5</sup>

It is recognized inside the CA community that weeds are the “Achilles Heel” of CA in Africa.<sup>17</sup> If farmers have ready access to reasonably priced herbicides, then weeds need not be a constraint to the use of CA systems.<sup>3</sup>

### Herbicides and Conservation Agriculture

“In order for CA to be practiced on a large area by smallholder farmers, there is need for research on the economical feasibility of using herbicides for early season weed control.”<sup>12</sup>

“The use of herbicides in conservation agriculture systems can be recommended in most farming circumstances; it controls weed species that are difficult to manage, reduces the weeding time for farmers, and is seen as a viable option even for smallholder farmers in Zimbabwe.”<sup>13</sup>

“We conclude that CA does not overcome constraints on low-external-input systems and will deliver the productivity gains that are required to achieve food security and poverty targets only if farmers have access to fertilizers and herbicides.”<sup>4</sup>

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