

WHAT'S IN IT FOR FARMERS?

Farm Level Advantages of Conservation Agriculture (CA) in Kenya



Key messages



Conservation agriculture (CA) involving minimum tillage offers reasonable yield and financial propositions to farmers.



The cost reduction advantages are the drivers of observed better financial returns in the very short run, consistent with research from around the globe.



CA practices are still relatively novel to many farmers.



To achieve long-term adoption, CA-based practices need to be successfully demonstrated to farmers. They also need to be able to experiment with these practices in small steps.



Therefore, innovative and intensive extension approaches appear crucial for adoption of conservation agriculture.

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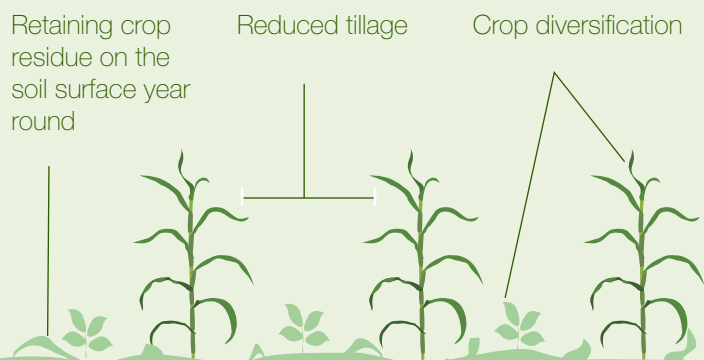
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First principles

Conservation agriculture (CA) consists of three principles: reduced tillage, retaining crop residue on the soil surface year round, and crop diversification (either intercropping or rotational systems). This practice is important to sustainably increase crop productivity through improving soil organic matter, conserving moisture, weed control, pests and diseases management, and enhancing farmers' resilience to drought and climate change and variability.

A four year (2010–2014) experiment was established on farmers' field sites in eastern region (Embu, Meru and Tharaka-Nithi counties) and western region (Siaya and Bungoma counties) of Kenya. The experiments included conventional tillage (CVT) or farmers' average practices, and two CA-based practices involving no or zero tillage (ZT) and a system of tillage involving construction of furrows and ridges (FR) rather than full tillage (although furrows and ridges were not established in the western Kenya sites). Beans in eastern and *Desmodium* in western regions were incorporated as intercrop in maize cropping systems (Table 1). The experiments were carried out both in the short rain (SR) and long rain (LR) seasons. The financial analysis of the various treatments was carried out based on average village grain and crop residue prices and daily labour wage rates. For inputs (fertilizer and herbicides) the prevailing market prices were used.

Principles of Conservation agriculture (CA):



CA increases crop productivity through:



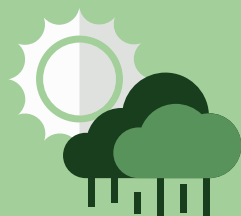
Improving soil organic matter



Pests and diseases management



Weed control



Enhancing farmers' resilience to drought and climate change



Conserving moisture



Photo credit: Alfred Mwachem/KALRO

Table 1: Tillage practices and cropping systems in eastern and western Kenya sites

Tillage method	Cropping pattern
Conventional tillage (CVT): At least two ploughing and two weeding events conducted per season using conventional tools.	In Embu only Maize – bean intercrop
CA_Zero tillage: A CA system where land is not tilled. Control of weeds done using appropriate herbicides. Crop residues retained on the soil surface after every harvest.	In Embu only Maize – bean intercrop
CA_Furrows/ridges: A CA system where furrows/ridges are made at trial establishment and maintained afterwards with minimal soil disturbance. Control of weeds done using appropriate herbicides. Crop residues retained on the soil surface after every harvest.	In Embu only Maize – bean intercrop
CA_Zero tillage + desmodium: No land tillage. Green leafed desmodium was intercropped with maize. Weed control was done using appropriate herbicides as needed. Crop residues retained on the soil surface after every harvest.	In Kakamega only Maize desmodium intercrop

Varieties and non-labor inputs

A newly released maize variety (KH500-39E) was the test crop in eastern, while a pre-released variety (KM-1101) was used in western region. A newly released bean variety (Embean-14) was grown as an intercrop with maize in eastern Kenya. A green leafed desmodium species at the rate of 1.0 kg/ha was intercropped with maize in western Kenya. Every season, maize and bean were applied with basal inorganic fertilizer at the rate of 60 and 20 kg N/ha, respectively.

A non-selective glyphosate- based post-emergence herbicide (Weedall) was applied at the rate of 3.0 litres/ha to kill annual and perennial weed species before crop sowing. Application of the glyphosate was immediately followed by application of a pre-emergence herbicide (Dual Gold) on moist soil surface at a rate of 3.0 litres/ha to manage emerging weeds at their juvenile stage. Care was taken to apply the Dual Gold immediately after the crop sowing and before the emergence of both the crop and the weeds. The two herbicide products were sold at US\$9/litre and US\$14/litre for Weedall and Dual Gold, respectively .

All the dollar prices and amounts are based on an exchange rate of 1 US\$=Kshs (Kenya shillings) 85 as at the end of 2014.



Photo credit: Alfred Micheni/KALRO

Cobs of KM-1101 maize variety



Photo credit: Alfred Micheni/KALRO

Pods of Embean-14 bean variety

MAIZE TEST CROP

(KH500-39E)
in eastern region

(KM-1101)
in western region



BEAN INTERCROP

(Embean-14)
in eastern region

desmodium
in western region



FERTILIZER

60 kg N/ha
applied to Maize

20 kg N/ha
applied to Beans



HERBICIDE

Post-Emergence

Glyphosate- based post-emergence herbicide (Weedall)



Pre-Emergence


Dual Gold



Labour use

Participatory studies with members of local innovation platforms indicated that over 80 percent of the labor in conventional tillage farming was used for land preparation and weed control. On average, US\$118/ha per season was spent on ploughing while half of that amount (US\$59) was used for harrowing the same piece of land. At least two hand weeding events were conducted on the conventional treatment. Weeding cost US\$178 and US\$89 for

the first and second weeding events, respectively. Among the three CA-based treatments (furrow and ridges, zero tillage and zero tillage + desmodium), the furrows and ridges required at least US\$89 for initial construction of furrows and ridge structures. The land is therefore not dug every season as it is the case with conventional tillage practices, as a result, labor burden is greatly reduced. The labour cost is further reduced through use of herbicides to control weeds.



80%

of the labor in conventional tillage farming was used for land preparation and weed control

US **\$118**

/ha/season was spent on ploughing

US **\$59**

was used for harrowing

US **\$178**


For the first weeding events

US **\$89**

Second weeding events

US **\$89**

For initial construction of furrows and ridge structures



Yield performance

Maize grain yield averaged at 3.8 t/ha obtained using maize-bean intercropping system under both the conventional tillage and CA-based treatments. The average maize biomass and grains yields under conventional tillage and the CA-based zero tillage or furrow and ridges were similar. Overall, as seen in Figure 1, the yield enhancing effects were modest, confirming the long standing recognition that CA-based practices have their greatest advantage when it comes to cost reduction and long term ecosystem improvements (which are not possible to capture in a four-year experiment).

The lowest average maize yield was from CA-based zero tillage with desmodium. The yields increase was attributed to improved field management (e.g. appropriate plant density, fertilization and adherence to early sowing). The maize-bean configuration was therefore modified to enhance production of both crops. In this case, maize rows were maintained at 125 cm instead of 75 cm apart. On the other hand, the inter-row spacing was maintained at 30 cm with two plants per station instead of the earlier 50 cm with the same number of plants per station.

Figure 1: Average maize (left) and bean (right) biomass and grain yields

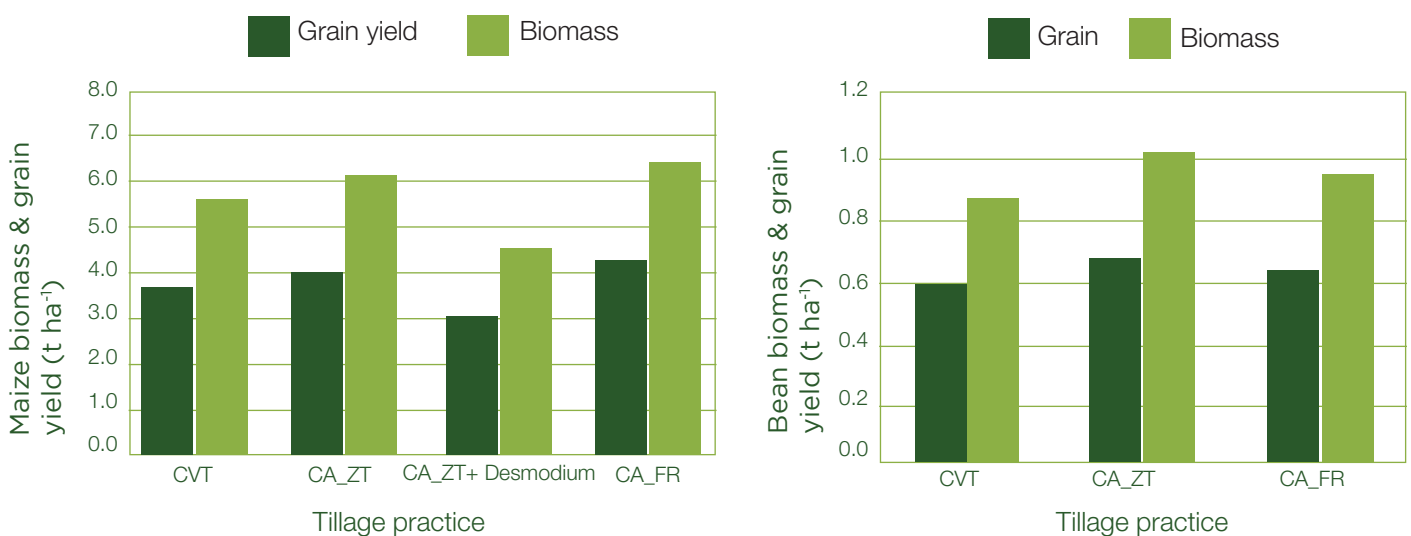


Photo credit: Alfred Muehni/KALRO

Modified maize-bean intercropping configuration

The yields increases that were observed attributed to improved field management (e.g. appropriate plant density, fertilization and adherence to early sowing)

Financial performance

The CA-based treatments, zero tillage and furrows and ridges provided the farmers with the largest cost reductions and higher returns to resources compared to the conventional tillage practice under maize-bean intercrop (refer to Table 2). The highest net crop income was achieved under the furrows and ridges (US\$1,505) followed by zero tillage (US\$1135), and then the conventional tillage (US\$934). The zero

tillage +Desmodium system had a financial return of US\$717. The return from the CA_ZT+Desmodium could have been improved further if the value of Desimodium as feed for livestock was considered. The return to labour was 1.22 for zero tillage and 2.56 for furrows and ridges. The CA_ZT + Desmodium had a return to labor of 1.27 while the conventional tillage had 1.00, the lowest average return to labour.

NET INCOME



LABOUR COSTS



RETURN TO LABOUR



Table 2: Revenues (US\$/ha), returns to labour and variable costs from 2010-2014

Costs and revenues	Conventional tillage	Zero tillage	Zero tillage + Desmodium	Furrows / ridges
Gross income (A)	1890.3	2092.7	1298.4	2116.9
Labour costs (B)	933.5	933.5	565.0	587.4
All Variable costs (including labour) (C)	956.3	958.6	581.2	613.0
Net crop income (D=A-C)	934.0	1134.3	717.2	1504.0
Return to labour (D/B)	1.00	1.22	1.27	2.56
Return to variable costs (D/C)	0.98	1.18	1.23	2.45

Conclusion

The results presented in this brief are similar to data from around the world, which has consistently shown that CA-based practices have as their immediate benefits, the reduction in the costs of labor for tillage and weeding. While in the long run the yield enhancing benefits are likely to accrue due to improved natural resource base, in the short run these cost reductions offer the best immediate financial benefit and incentives for farmers to adopt these new practices.

Considering that CA practices are still relatively novel for many farmers, these benefits of CA-based farming systems need to be strongly demonstrated to farmers. Strong and ongoing efforts to use diverse extension and farmer educational approaches are needed if these immediate and long-term benefits are to become apparent to farmers.

Further readings

A. N. Micheni, F. Kanampiu, O. Kitonyo, D. M. Mburu, E.N. Mugai, D. Makumbi and M. Kassie (2016). On-farm experimentation on conservation agriculture in maize-legume based cropping systems in Kenya: water use efficiency and economic impacts. *Experimental Agriculture*, 52, pp 51-68. doi:10.1017/s0014479714000556.

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ETHIOPIA



KENYA



MALAWI



MOZAMBIQUE



TANZANIA



AUSTRALIA

