



Photo credit: Thierfelder/CIMMYT

# Animal traction-based maize–legume conservation agriculture

The main benefits of animal traction are more efficient planting and reduction in farm labor, which complement conservation agriculture advantages of increased soil fertility, climate resilience, and crop productivity.

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## Description of the technology

Conservation agriculture (CA) is a crop management practice based on three main principles: minimum soil movement (no soil inversion by tillage); surface cover with crop residues and/or living plants; and crop rotations to reduce pests and diseases. The principal idea of using animal traction CA is to reduce drudgery and plant crops on time. Two mechanical options are commonly used when implementing animal traction in CA across southern Africa:

1. animal traction rippers, which make riplines according to the defined crop row spacing (main photo above)
2. animal traction direct seeders that rip and apply seed and fertilizer at the same time (main photo page 2).

## Conditions that favor uptake

**Agro-ecological conditions:** Animal traction CA systems are applicable under a wide range of environmental conditions – from very sandy to clay soils, and rainfall levels between 450 mm and 1600 mm. Culturally, there are areas where livestock raising is the predominant livelihood and in those areas animal traction CA is common. Currently, animal traction CA is widespread in Zambia and Zimbabwe due to their greater abundance of cattle, whereas in Malawi and Mozambique manual CA is dominant. Animal traction CA allows for timely establishment of seeding lines, which can

## Key messages

**Animal traction ripline** or direct seeding **save labor**. Farmers require **only four hours**



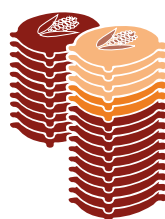
TO SEED 1 HA  
against **three days**



under conventional tillage using a moldboard plow.

**Ripline seeding** in a conservation agriculture maize–soybean rotation led to **HIGHER NET BENEFITS**. For each US dollar invested, **a return of US\$ 17.8** was received, whereas the return was **only US\$ 6.5** in conventional tillage.

## Yield increases OF RIPLINE SEEDING



over conventional tillage ranged on average between **20% and 35% (662–1139 kg/ha)** with **UP TO 60%** in some years over a period of seven years in Eastern Zambia.





Animal traction direct seeding into surface mulch using a pair of oxen and a Fitarelli direct planter at Monze, Zambia.  
 Photo credit: C. Thierfelder/CIMMYT.

be an added advantage at the onset of the cropping season when soil moisture is still limiting. Timely planting usually leads to improved crop yields.

**Livestock:** Animal traction CA is often practiced where farmers have abundant land, where livestock keeping is common, and where livestock is not threatened by the tsetse fly. Often the use of animal traction CA is directly linked to the lack of availability of farm labor or traction power. In some areas where it is practiced, ripping or direct seeding has advantages as animals are often too weak to pull a plow at the onset of the season – after 7–8 months of dry winter season, there will be limited fodder available to maintain animal strength. The reduced draft requirements needed for ripping and direct seeding therefore favor their uptake.

**Land holding size and soil conditions:** Land holding size plays a critical role if farmers adopt animal traction CA, as only a limited land area can be cultivated manually with family farm labor. Larger areas require mechanical solutions such as the proposed animal traction CA.

## Alignment with household resource endowments

As ripper attachments are cheap, their purchase and use are the most affordable way to change from conventional tillage-based agriculture to CA. An existing moldboard plow beam can be easily modified to attach a ripper for making riplines and subsequent seeding. On the other hand, direct seeders are more labor efficient and more attractive to farmers as they do several operations (ripping, seeding, fertilizing, and covering).

A ripper attachment to modify a moldboard plow costs around US\$ 25, whereas a direct seeder imported from Brazil costs approximately US\$ 1000 (most animal traction direct seeders currently available in the region are produced in and imported

Gertrude Banda, a farmer in Kawalala Camp, Eastern Zambia, is content: her flourishing soybean crop was seeded using an animal traction ripper.  
 Photo credit: C. Thierfelder/CIMMYT.

from Brazil). Prices for both implements can be spread over several years. Community or cooperative ownership of direct seeders has been tried in Zimbabwe to reduce the cost per individual farmer. However, it has been more successful where the equipment is owned by an individual, who takes better care of it. Service provider models are considered most successful where individuals provide seeding services to other community members for a service fee.

## Necessary ingredients for implementation

A range of prerequisites have been identified for successful animal traction CA.

**Availability of equipment:** The availability of suitable machinery for ripline or direct seeding has always been a challenge in southern Africa. However, since the early 2000s, a range of ripper attachments and types (e.g., Magoye ripper, Gibson ripper, and Palabana sub-soiler) have been available as cheap replacements to be mounted on existing moldboard plow beams. If a plow beam is not available, one has to be acquired. Animal traction direct seeders have become more common, mostly in Zambia, where agro-dealers increasingly import and stock them.

**Trained pair of oxen:** Farmers who want to practice animal traction CA systems need a pair of trained oxen. Oxen traditionally used for pulling moldboard plows tend to be irritated initially by the rippers or direct seeders. However, after some time, they get used to the new implements and can rip much more area in a given time than they can plow with a moldboard plow. A trained oxen pair can rip approximately 1.5 ha per day depending on soil type and soil moisture, compared with only a third of a hectare in a conventional tillage system using a moldboard plow.

**Training and calibration:** For farmers used to plowing their land, the transition to ripline seeding is easy and can be learned within a few hours. Calibrating seed and fertilizer amount per hectare on a direct seeder requires more knowledge and training. However, farmers are quick to learn if they understand the principles of plant population and fertilizer rate.

## Adaptation possibilities

Ripper attachments are adaptations from full plowing systems to minimum or no-tillage. Ripline and direct seeding have been successfully practiced for all main cereals (maize, sorghum, and millet) and legumes (soybean, cowpea, common bean, groundnut, etc.) in southern Africa. In Zambia, seeding of cotton and sunflower with a ripper is also standard.

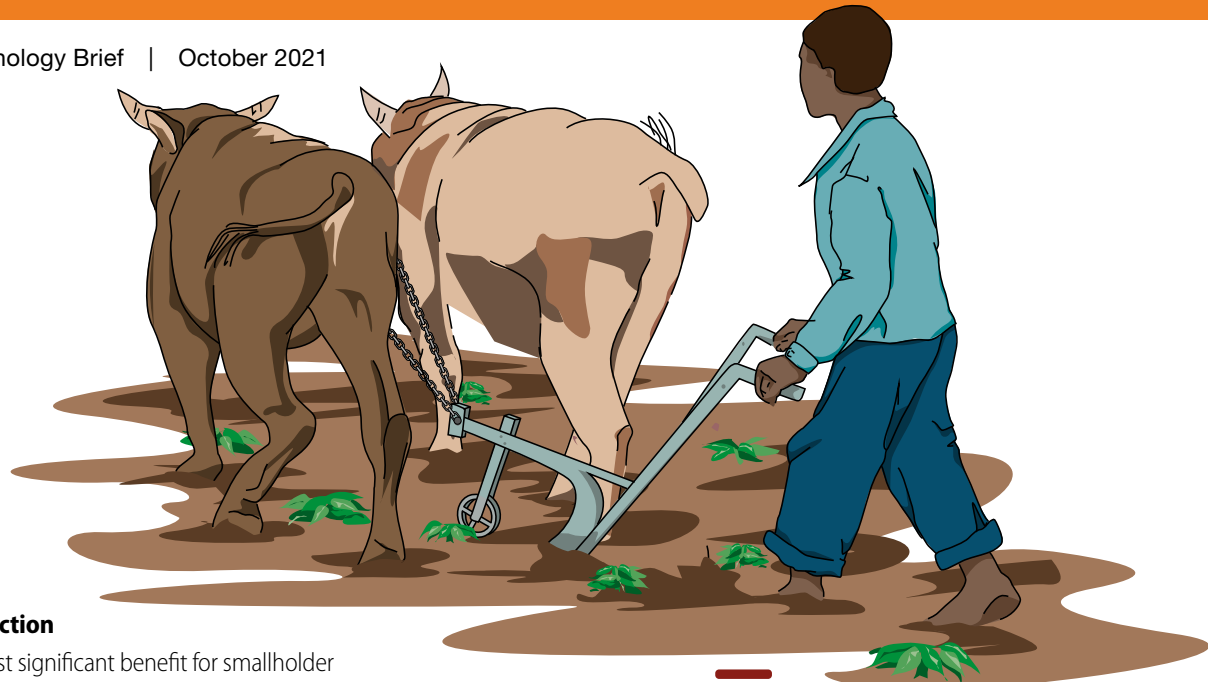


## Where was the technology validated?

Long-term research on animal traction CA started in 2004 in Zambia and Zimbabwe. Since 2011, it has been validated by Africa RISING in the Eastern Province of Zambia in Chipata, Lundazi, and Sinda districts.







## Potential benefits to users



### Labor reduction

**at planting** is the most significant benefit for smallholder farmers using animal traction CA. Farmers can plant up to 1.5 ha per day with a ripper or direct seeder, whereas they need at least three days for 1 ha in a conventional tillage system using a moldboard plow. The walking time that farmers or their family members must spend following a plow is also reduced – to one-third of that required for conventional tillage.



**Timely planting** can be achieved in ripline or direct-seeded systems as farmers can seed immediately after the first effective rains and do not have to wait for the land to be plowed first to start planting. This can be a huge benefit, especially if rains are erratic at the onset of the cropping season. Farmers tend to lose 3–5% of their potential crop yield per day delay in planting.



**Reduced soil disturbance at planting:** As in manual CA using a dibble stick, the soil is much less disturbed when using a ripper or direct seeder compared with plowing. This is why the system is commonly referred to as 'no-tillage'. With animal traction CA, the soil outside the riplines can develop stable aggregates, allowing rainwater to enter the soil. This leads to increased biological activity (earthworms proliferate) and a more stable and firm soil over time.



**Moisture conservation during planting** in response to reduced soil disturbance and better water infiltration means that ripline or direct-seeded systems have a greater chance to overcome in-season dry spells, giving them an advantage over tillage practices.

## Things to worry about



**Soil moisture status:** Generally, it is vital to plant when the soil is neither too wet nor too dry. Ripline or direct seeding is easiest when the soil moisture is at or slightly below field capacity. After heavy rainfall, it is advisable to wait until the soil moisture has drained for some hours to avoid smearing or clogging the implements. If surface crop residues are present, an animal traction direct seeder requires that they have dried, otherwise the cutting disk (coulters) will not cut through the mulch.



**Plant spacing:** Different crops can be planted with rippers and direct seeders but require different row spacings optimal to their growth habit. Different yokes need to be used to achieve the right spacing. Farmers commented that a cultivator yoke, which is wider than the traditional plowing yoke, made handling easier. In-row spacing needs to be calibrated carefully before seeding to achieve optimal plant population. Appropriate or optimal crop spacings are 90 cm between rows and 25 cm within rows for maize, and 45 cm x 5 cm for soybean.



**Weed control:** Increasing the planting area under no-tillage requires new strategies to control weeds, as manual hoe weeding may become too laborious if farmers expand their land area under animal traction CA. Farmers should plan a rotation of cereals with a competitive legume (e.g., soybean, groundnut, or green manure) that suppresses weeds, or apply a suitable herbicide to their crops to control weeds. After 3–5 years of animal traction CA, the numbers of weeds drop significantly as no new weed seed is plowed into the soil.



The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative. Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation, and impact assessment.

Africa RISING website: <https://africa-rising.net>



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