

Weed Management in Conservation Tillage Systems

Authors: Kurt G. Steiner, GTZ & Steve Twomlow, ICRISAT, 2003

Weed management is an important aspect in crop production. Weeds reduce crop yields and can lead to total crop failures if not controlled. Manual weed control is labour intensive and therefore limits the production area. Weeding one hectare takes at least 48 person days. In many rural African communities it has become increasingly difficult to hire labour for weeding and other farming activities, due to a swindling labour force as consequence of out-migration of the male population and the impact of HIV/AIDS. As a result farm operations are often delayed and labour costs have increased. The situation calls for labour saving farming practices, in other words an increase in labour productivity.

Effects of ploughing

One reason for tillage is to control the weeds, i.e. to produce a "clean" seedbed. Ploughing and harrowing kills growing weeds mainly by burying them. This gives the planted crop an advantage in emerging before most weeds come out.



Ploughing with oxen in Tanzania (Source: K. Steiner)

Traditional means of weed control:

- ploughing, harrowing
- stubble grazing
- burning of crop residues including weeds before ploughing.
- hand weeding

Other recommended cultural means of weed control:

- crop rotation
- high planting densities
- fertilisation

Effects of conservation tillage

With conservation tillage (CT) (no- or minimum tillage) the weed control by ploughing is eliminated. Therefore, when adopting CT, a farmer must have a carefully planned weed control strategy, especially in the early years when weed levels will be high, as they are no longer controlled by primary tillage.

Control of weeds under CT systems: Options for smallholder farmers

A number of weed control methods are available, the choice of which depends on the ecological and socio-economic circumstances of specific farm household.

- Green manures / cover crops and crop residues
- Crop rotations
- Planting density
- In-row slashing of weeds
- Superficial weeding (hoeing, ridging) by hand, draught animals or tractors
- Pulling out, and/or slashing even at crop maturity and post-harvest to prevent seed production
- Herbicide application
- Increased rates of nitrogen



A weed control strategy with the greatest potential for success is the one that fully integrates the many management options available. It is important to have a long-range strategy to help predict and avoid potential weed problems in the future. The following are some weed control options and considerations possible for CT farmers.

Mechanical weed control

Weeding

As the field was not ploughed, weeding has to start early, using a hoe or an animal drawn weeder or ridger. In view of minimising soil disturbance a shallow weeding is recommended. Special equipment for draught animals weeding has been developed for this purpose.



Ripping with draught animal power saves time and facilitates rainwater infiltration while preventing negative effects (soil erosion, plough sole) linked to ploughing (Source: W. Mariki)

Timeliness of weeding is crucial in reducing competition with crops and preventing seed production. Evidence from Zimbabwe and South Africa suggest that two weedings carried out 2 and 6 weeks after crop emergence is the ideal. For use of a cultivator crops have to be planted in line in intervals according to the width of the cultivator.

Slashing

This is normally done as a pre-planting operation. Just before making the basins (planting pits) or planting furrows (in animal power systems), any plants growing in the field are slashed. In-row slashing, a practice known to farmers in some African regions

e.g. Somalia, is the preferred practice for CT, as it does not disturb the soil. Weeds should be slashed even after crop harvest and during the dry season to prevent seed formation.

Biological and cultural means of weed control

The weed pressure and hence costs of weed control can be effectively and cost efficiently reduced by cultural and biological means.

Crop rotation

A sound crop rotation prevents the build up of noxious weed populations. Due to expressed market preferences for crops like maize or sorghum, this is hardly practiced.

Seeding Rates

Crop density is an important component of the crop's ability to compete with weeds.

Intercropping

Intercropping preferentially spreading types of crops, legumes, pumpkins or sweet potatoes, contributes to a faster and denser ground cover and suppresses weed growth.



Intercropping with spreading types like pumpkins or creeping cowpeas suppresses weed growth at least during the growing season (Source: K: Steiner)

Green manures or Cover crops

Growing green manures or cover crops planted in the minor season or as a relay crop efficiently suppresses weed growth (see ACT Information Series No. 3). This is a cost- and labour efficient practice, and therefore



Field with cover crops at planting time and adjacent field covered with weeds (Tanzania) (Source: K. Steiner)

green manures are sometime called the “herbicides” of small farmers. Especially perennial grasses (*Imperata cylindrica*, *Cynodon dactylon*) and other problem weeds (e.g. *Striga* spp. or *Chromolaena odorata*) can be suppressed by one or two seasons of cover crops.

Some cover crop species have allelopathic effects, which make them even more efficient in weed control (e.g. black oats frequently used in Brazil).



A solid ground cover of crop residues and cover crops prevents weed growth and seed production after harvest during the dry season (Source: K. Steiner)

Chemical weed control

While chemical weed control is a common practice in commercial agriculture, it is hardly applied in smallholder farming due to several limiting factors, especially access to herbicides and sprayers, costs, availability of clean water in the field, and knowledge/expertise of appropriate and safe handling of herbicides. However, appropriate training and access to herbicides provided, chemical weed control is a real option for smallholder farmers. Increasing labour shortage and costs of labour makes chemical weed control an attractive alternative for small farmers in many regions. With chemical companies starting to offer smaller packages (1-5 l containers) and the invention of cheap and easy to handle equipment like the ZAMWIPE herbicide application becomes a realistic option.

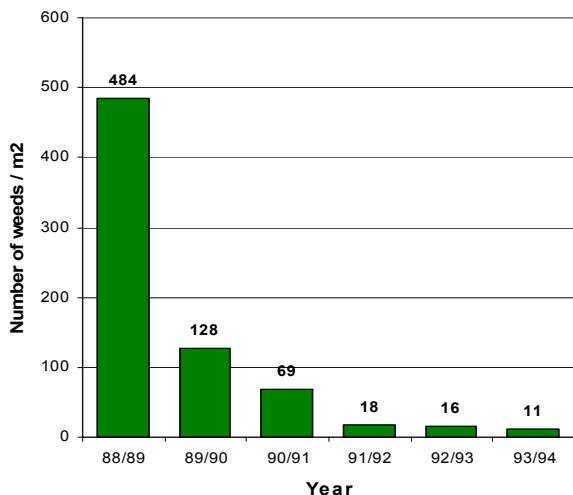
Ecological aspects of herbicide use in CT

The use of herbicides is generally criticised because of the danger of negative environmental impacts. However, herbicides have an ecological advantage as ploughing is no longer necessary, and consequently soil erosion reduced and soil life enhanced. And the most commonly used glyphosates are environmentally friendly. They are systemic, i.e. absorbed by the living (green) plants, only. Contrary to other herbicides glyphosates are fixed and deactivated by soil particles when touching the soil, and thus are not leached into the ground water. They are no persistent, i.e. have no residual effect. Chemical weed control is of great help in the transition phase from conventional to CT, when the weed pressure is high. Experience from Brazil and Ghana Paraguay shows that small farmers drastically reduce frequency and application rates, as soon as they have learned to manage the new systems ad as the weed pressure declines.



The "Weed Wipe", a really simple tool that permits late application of Roundup in a maize crop (Source: ZAMWIPE)

Decline in weeds under no-tillage as a result of reduced seed formation (Skora Neto et. al., 1994)



Soil fauna under no-tillage as compared with minimum and conservation tillage (Derpsch et al., 1986)

	Conventional tillage	Minimum tillage	No-tillage
Earthworms /m ² March 1979	5.8	7.5	13.0
Earthworms /m ² Nov. 1981	3.2	5.2	27.6
Anthropods /300 cm ³			
Soyabean /wheat	7.0	-	33.0
Soya bean /cover crop	23.0	-	192.0

The challenge: To overcome the first years of changing from conventional to no-tillage

Economical aspects of weed control in CT systems

The economic advantage of chemical weed control is a reduction of labour requirements; especially the breaking of labour peaks, and in most cases also a reduction of production costs. A comparison of costs of manual and chemical weed control depends on the weed pressure and the types of weeds, on the costs of labour, the costs of the herbicides, the frequency of necessary weeding and herbicides applications. A rough calculation, based on a medium weed pressure is given in the table below. To be more precise the yield losses induced by late weeding, which is the usual case with manual weeding, need to be included into the calculation.

Farmers' strategies to reduce the costs of chemical weed control

As herbicides are expensive and especially in most African countries not easily accessible for small farmers, farmers try to reduce the number of applications and the quantity of herbicides by

- cultural practises (intercropping, green manures, etc. See above)
- spot application of herbicides to kill noxious weeds
- post emergence application of *Roundup* with the "Weed Wipe" (risk aversion strategy, herbicide applied only, when the (maize) crop is well developed)

The "Weed Wipe" is a simple tool, like a broom, that works just by gravity. A plastic container filled with a premixed herbicide solution is fixed on the top of the handle. The herbicide is applied by touching the weeds with the foam-coated "brush". Unlike sprayers there is no danger of drift affecting the crop. For further information contact zamwipe@zamnet.zm

Comparison of time requirements and costs of weed control in conventional fields and with direct planting through cover crops – Arusha Region/Tanzania (Mariki, 2003)

Labour requirements: manual	Costs/ha	Labour requirements: chemical	Costs TSh/ha
1 st weeding: 16 man-days	8.000	Renting of sprayer	1.000
2 nd weeding: 16 man-days	8.000	Round-up application: 1 man-day	5.200
		Collecting water: 0,5 man-days	500
3 rd weeding: 12 man-days	6.000	Rouging weeds: 6 man-days	3.000
		Rouging weeds: 6 man-days	3.000
Total: 44 man-days	22.000	13,5 man-days	12.700
500 TSh per man-day			



Dolichos relay cropped under maize. Suppresses weed growth in the maize crop and leaves a nearly weed free field for the subsequent season. (Source: K. Steiner)

Important questions when introducing CT and herbicides

- Economic viability:
The crucial question is that of the economic viability. This comprises first of all the comparison of costs, i.e. manual vs. chemical weeding.
 - cost of herbicides
 - availability on markets
 - availability of and access to sprayers
 - access to clean water
 - expertise in handling sprayers and herbicides (e.g. farm hires services, trained persons within farmers groups)

- Ecological sustainability:
Major questions address the long term effects of a given herbicide:
 - impact on soil biota
 - pollution of water bodies (ground and surface waters)
 - persistence in the soil
 - resistance of certain weeds (selection of problem weeds)

Conclusions

Conservation tillage does not necessarily mean use of herbicides. Biological means, such as a ground cover of crop residues and cover crops and a crop rotation, are efficient and preferred means of weed control. Farmers have also to learn that not all weeds are noxious, and that weeding should be selective. Herbicides help to overcome weed pressure especially in the transition period from conventional to conservation tillage. Environmentally friendly herbicides are available. Chemical weed control in combination with cover crops and a crop rotation can be an answer to increasing labour shortage in African smallholdings, provoked by male out-migration and HIV/AIDS. Conservation tillage, when properly applied and if necessary with use of herbicides, levels off labour peaks and relieves especially women and children from drudgery.



Contacts

ACT – African Conservation Tillage Network
Martin Bwalya c/o IES - University of Zimbabwe
P.O.Box MP 167
Harare/Zimbabwe
Tel: +263-4-334395 / 302603
Fax: +263-4-332853
e-mail: actsecre@ies.uz.ac.zw
www.ies.ac.zw/act-network or www.fao.org/act-network

Literature

CROVETTO, C. 1996: Stubble over the soil. American Society of Agronomy, Madison, USA

DERPSCH, R., SIDIRAS, N. AND ROTH, C.H. 1986: Results of studies made from 1977 to 1984 to control soil erosion with cover crops and no-tillage techniques in Parana, Brazil. Soil and Tillage Research 8:253-263.

FINDLAY, J.B.R., COLLINS, S.C., BOA-AMPONSEM, K., MABUZA, S. AND MIHESO, V. 2002: Conservation tillage programmes for smallholder farmers in Africa. Paper presented at the "Conservation Agriculture for Small Scale Farmers in Developing Countries" Symposium, American Society of Agronomy, Indianapolis, USA, 10 – 14 November 2002.

JANSEN, A-E. 1999: Impacto ambiental del uso herbicidas en siembra directa. GTZ/MAG/DIA/DEAG, San Lorenzo, Paraguay, 1999 TFSC/SAR, Arusha. p.59-62

KLIEVER, I., CASACCIA, J., VALLEJOS, F. AND DERPSCH, J. 2000: Costs and herbicide reduction in the no-tillage system by using green manure cover crops in Paraguay. Proceedings 15th ISTRO Conference, Fort Worth, Texas, USA, July 2-7-, 2000

MARIKI, W.: Personal communication

MODESTUS, W.K. 2001: Conservation tillage and annual maize production based on herbicide use for small scale farmers in Arameru District, Tanzania. Proceedings of the National Workshop Conservation Farming for Sustainable Agriculture in Tanzania. 23-25 July, 2001 Arusha.

SKORA NETO, F. AND DAROLT, M.R. 1996: Controle integrado de ervas no sistema de plantio direto em pequenas propriedades. Congresso Brasileiro de Plantio Direto para uma Agricultura Sustentavel. 18-22 March, 1996. Ponta Grossa, Brazil.