African Conservation Tillage Network
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Conservation Tillage – Gateway to Food Security and Sustainable Rural Development

The Economics of Conservation Tillage

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Background

Conservation tillage (CT) aims at making better use of agricultural resources through the integrated management of available soil, water and biological resources, combined with limited external inputs. It contributes to environmental conservation and to sustainable agricultural production by reducing soil disturbance and protecting the soil with a permanent or semi-permanent organic cover. Adoption of CT at farm level is associated with lower labour and farm-power inputs, more stable yields and improved soil quality. Crop production profitability under CT tends to increase over time in relation to conventional agriculture. Despite these apparent advantages, CT has spread relatively slow with the exception of Latin America. Transformation from conventional agriculture to CT seems to require considerable farmer management skills and involves investments in new equipment. It may also require some social capital to enhance its dissemination.

An Economic Rationale for Promoting Conservation Tillage

Benefits of CT do not only occur on farm level, but are even more pronounced at national and global levels. Off-site benefits are primarily cleaner water due to reduced sediment pollution of surface water and reduced CO_2 emissions. While many incremental costs associated with adopting CT accrue at farm level, relatively few of the benefits do so. There is a distinct divergence between the social desirability of CT and its potential on-farm attraction. The benefits at national and global level strongly argue for policy support.

Experiences with conservation tillage in Brazil and Africa

The rapid spread of conservation tillage in Brazil (information leaflet No.1) and the neighbouring countries was mainly caused by the fact that this production system reduces the production costs significantly. Farmers were trapped between rising input prices, declining output prices and diminishing yields due to heavy soil erosion. Having no control of prices, the only way to survive meant a profound change of the production system. The challenge was not only to reduce production costs but also to prevent further yield declines due to soil degradation. Conservation tillage, in this case direct planting through mulch, made the unthinkable possible. The costs could be considerably reduced while yields increased over the years through the build up of soil fertility.
Even though African farmers face a similar scenario, dissemination of conservation tillage practices is rather slow. Reasons are, amongst others, an underdeveloped rural infrastructure and the dominance of very small farms, using manual labour and being reluctant towards any changes of farming systems because of risk avoidance.

Factors influencing the Choice and Benefit of Conservation Tillage

The choice of the appropriate tillage method and its profitability is influenced by a range of factors:

- Climatic zone: semi-arid or humid (length of growing period, one or two seasons, biomass production, soil cover)
- Farming systems: only crop production or mixed farming (in this case alternative use of crop residues)
- Power source, cost and availability: manual, draft animal, tractor
- Farm size: small holding, large commercial
- Management capability of the farmer (assumption: CT requires better management skills)

Expected benefits of Conservation Tillage at farm level

- ***Reduction of production costs:***

Conventional agriculture is labour and energy intensive. CT on the other hand saves energy (fuel, manual labour) and time for land preparation and weeding. Ploughing or hoeing is replaced by ripping, pot-holing or is completely abandoned in the case of no-tillage.
The general assumption is, that CT reduces the production costs and increases the yields and/or reduces the risk of crop failure due to drought. The later is of special importance in semi-arid areas with a high drought risk.

Cost comparison of land preparation in conventional tillage and no-tillage systems in motorised farming/Zimbabwe

	Units used per ha		Costs Z$/ha	
	Con-ventional	No-till	Con-ventional	No-till
Fuel l/ha				
Plough	36,0	0	396	0
Disk harrow	6,0	0	66	0
Poller	2,0	0	22	0
Plant protection	1,4	1,4	15	15
Subtotal	45,4	1,4	499	15
Weed control				
Pre- emergent l/ha	4,0	4,0	380	380
Manual work d/ha	1,0	6,0	17	104
Post- emergent[1] l/ha	14,0	14,0	1177	1177
Subtotal			1574	1661
Total			**2073**	**1676**

WINKFIELD: 1997

- ***Timely planting:***

As important as the savings of labour and costs is the fact, that CT allows for timely planting. While in conventional agriculture farmers start ploughing or plough a second time only after the onset of the rains, CT allows for planting directly after the first rains. This is of economic importance, as every day of delay reduces the potential yield by 1-2% depending on the climatic zone. Delays in planting of 30 days are not unusual in small holder farming, and thus yield losses are quite significant.

Time requirement to prepare and plant maize on a 1000 m² demonstration plot - Ghana

Practice	Traditional	No Till
Hand hoeing -seed bed preparation	8-10 d	-
- in crop weeding	4 d	1 d
Pre-plant herbicide	-	30 min
Planting maize	1 d	1 d
Fertiliser application	40 min	40 min
Post plant pre-emerge herbicide	-	30 min
Total time	14 d, 40 min	2 d, 1h, 40min

FINDLEY *et al*. 1998

- ***Increased flexibility:***

CT, especially no-tillage, reduces waiting time for field operations after rains because of a better soil structure and increased water infiltration. This again is a precondition for timely planting.

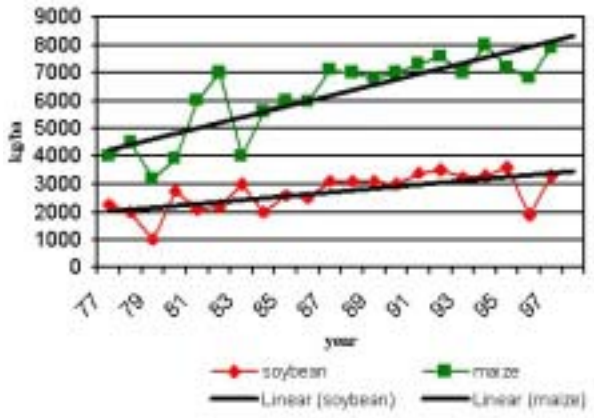
- ***Conservation tillage increases yields over time:***

CT steadily improves soil fertility and water use efficiency. This together with timely planting leads to increasing yields. Long-term data from Brazil show that maize and soybean yields nearly double within twenty years, while the input in form of fertilizer and pesticide could be cut by 30% in the case of maize and 50%in the case of soybeans.

CT reduces drudgery; especially for women and children (Photo: Jürgen Hagmann).

[1] Post-emergent combination of Dual, Atrazin, Gramoxon and Bladex

Development of yield under no-tillage in Parana, Brazil (Farm of Frank Dijkstra, Pioneer in no-tillage)



- ***Conservation tillage increases net returns:***

CT is a win-win option. Production costs are reduced, while yields increase over time. The risk of crop failure due to drought is reduced.

Man-days, maximum number of cultivated ha and yields associated with tillage systems in Ghana

Tillage system	Working days for 1 ha maize[2]	Max. n° of ha under good cultivation (ha)	Yields associated with soil preparation (t/ha)
Handhoe	100-120	1-2	1-2
Animal traction + hand weeding	50-60	4-6	3-4
Animal traction + hand weeding	25-30	8-12	4-5
No-tillage + herbicide	15-20	Up to 20	5-6

SOZA et.al. 1998

Comparison of conventional and CT production costs in smallholdings at two locations in Paraguay

Crop cost item (US$ 1998)	Conven-tional	CT	Ratio
Edeliria			
Farm area (ha)	15,6	15,6	-
Labour (pers. days)	287	240	1,20
Net farm income (US$/year)	2570	4272	0,60
Return to labour (US$/day)	8,95	8,95	0,50
San Pedro			
Farm area (ha)	6,8	6,8	-
Labour (person/d)	164	163	1,01
Net farm income (US$/year)	1010	2229	0,45
Return to labour (US$/day)	6,16	13,67	0,45

SORRENSEN *et al*., 1998

Social Benefits of Conservation Tillage

Significant social benefits accrue from the adoption of CT practices.

- ***Reduced off-site costs of soil erosion:***

Reduced soil erosion results in reduced sediment charge into lakes and dams. The lifespan of hydro-electric power stations, for example, can be prolonged significantly if CT is practiced in the entire watershed area. This benefit should be shared with the farmers.

Broad practice of CT can reduce the costs of water purification considerably and municipal or private operators of water purification plants should share the benefit with the farmers in the entire watershed area.

- ***Reduced CO_2 emissions***:

This global benefit is significant but difficult to measure and prove on a larger scale. It is therefore not recognised by global funding mechanisms (e.g. GEF).

[2] Total man-days required to produce 1 ha of maize considering all operations, from soil preparation to crop harvest

Cost Implied by Change of Tillage Systems

The change from conventional tillage to CT implies additional costs which are not immediately balanced by the reduction of some inputs or increased yields. This may constitute a serious constraint for resource-poor farmers. Apart from additional costs for inputs, costs might accrue for learning how to apply the new practice to a specific situation.

Additional costs of inputs in the transition phase (year 1 - 3)

- Purchase of new implements (e.g. ripper, direct planter)
- Seeds of green manure/cover crops
- Increased fertilizer rates when crop residues are left in the field, till a new equilibrium is obtained (less crucial when leguminous cover crops are produced)
- Liming to adjust soil acidity
- Subsoiling to remove hardpans caused by years of ploughing or hoeing
- Herbicides for the control of noxious weeds or
- Increased labour input for weeding

Reduction of inputs after transition phase

- Herbicides: with good management (ground cover) only one application of a pre-emergence herbicide per season
- Fertilizers: rates can be reduced due to improved soil fertility status (organic manures, soil life)

Why do farmers not adopt more widely the apparently income raising techniques?

Especially African smallholder farmers are reluctant to change their production systems because of a range of reasons.

Principal reasons of non-adoption are:

- Lack of information on CT
- No farms around practicing CT could serve as demonstration/example
- Extensionists know very little or nothing about the system
- Costs implied by changing the tillage systems
- Lack of access to inputs and credits (for purchase of CT implements)
- Risk avoidance (fear of failure or wrong application of new technique in the absence of guidance phase)
- No direct returns from green manures/cover crops
- Opportunity costs of crop residues

Purely economic considerations are overlaid by social and institutional aspect, such as uncontrolled bush fires, free grazing on crop residues.

Enhancing the Dissemination of Conservation Tillage Practices

Experiences in Brazil show that technical advice by extension workers and incentives or subsidies for the purchase of CT equipment are preconditions for a broad adoption by small farmers. The latter is pertinent for the majority of African smallholder farmers, who do not dispose of enough cash to purchase even relatively cheap implements like the jab planter (*matraca*) or animal drawn rippers or planter.

Contacts

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