# Farming with Animal Power: With or Without the Plow

By Klaus Strüber, February 2011

Cultivator prototype from 2008 for cultivation with workhorses, but no traditional plow. Project "Humussphäre"

*In developed countries 52% of food is cultivated with the help of animals (FAO 1996). Animals are vital to this agricultural process as the main source of power behind cultivation techniques, with or without the use of a plow. The plow is an agricultural machine used to turn the earth, as opposed to other machines, such as a standing cultivator, that do not turn the ground. Both techniques have their own unique features and effects. In this article both techniques for using animal labor force will be explained and valued. Subsequently, the solution approaches from a current long-term project in Germany will be explained.*

Horse-pulled Plows

A plow horizontally and vertically cuts the earth in its wake. Plow blades can be turned up to 180°. In the face of the limited power of work animals and their demand, tractors are normally used for shallow cultivation to a depth of 20 cm.

The biggest advantages of plows:

- The "black" plowed field becomes valuable for sowing grains and vegetables.
- Through the rotation of the plow's blades, the ground becomes crumbled.
- Weeds are effectively chopped and buried.

Plows have had these advantages, particularly since the 19th century, due to new preparation designs. However, the employment of such also has disadvantages:

- Plowed earth is not protected from, and instead exposed to, wind and water erosion.
- Ground-dwelling organisms (bacteria, fungi, and also animals) are destroyed and their habitats damaged. The result: ground degeneration.

"Ground cultivation with plows loosens surface soil. Its loosening of soil creates good cultivation areas, but this effect is not long-term, because loosened soil is highly sensitive to

compaction. The tilled earth has weaker soil structure and its frequent cultivation leads to a larger strain (and degeneration) of the worked areas (Sommer 1990)." This pedagogical realization leads to, what is already acknowledged from the implementation of large tractor on farms, the degeneration of farmland; for example Krüger (1947), *"Mangelsdorff ascertained in 1928 that 54% of German farmland suffer from ground compaction and negative plow related effects."*

Non-plow Cultivation with Animal Labor

When the ground is worked with devices that cut the earth through the use of blades, but do not to turn the ground in the process, then this is called non-plow cultivation.
The history of non-plow cultivation with work animals goes all the way back to the beginnings of agricultural cultivation, and is today still the only form of farm cultivation in many regions of the Earth.
The biggest advantages of non-plow cultivations methods:

- Cutting (cultivating) the earth in this manner better preserves the habitats of many ground-dwelling organism (and creatures).
- The danger of erosion due is minimized, because the surface layer and roots (which help hinder erosion) remained less damaged.
- Ground worked through non-plow methods can, after many years, regain a higher level of optimal soil conditions and exhibit more fertile properties, through previously mentioned effects from this method.

Despite the positive experiences with non-plow cultivation and its advantages, particularly in connection with ecological friendly practices, it does not come without problems:

- The negative impact of weeds can increase, since the weeds cease to be buried cultivation. The lieu of herbicides, the conventional method used by organic farming methods, the regularities of nature remain unchanged: nature permits open land, in other words, nature takes over all open spaces. In line with this regularity of nature, a farm can use, for instance, a grain nurse-crop from the mustard family and leguminous plants for ground cover; this makes use of the space and will also prevent the growth of weeds. This method requires, however, a reformed knowledge from the farmhands/managers for plant selection and for the proper seeding season.
- The needs of sowing techniques are different, because no loosened seedbed present. Therefore, only normal drill-raking methods can be used. The alternative of this is the recess-drill machine, a drill put behind plow teeth or a sower (which slices the earth)**.** This method is suitable if the depth of the drill can be precisely adjusted, and is suitable for hard ground.

To summarize, from an ecologically friendly point of view, non-plow methods are interesting. Agricultural industries can become reputable for such practices, since the extraction of (farm) products still rebuilds the earth, instead of degrading it (Montgomery 2010). Ground conditions are successful, primarily, through the make-up of humus in the soil, the breeding of plant roots, and the support of earth dwelling organisms and their environment. The degeneration of earth is mainly caused through erosion. The factors with non-plow methods often bring about better soil quality, compared to cultivation with plows.
In places, such as South America, there are even new developments for these modern devices (Fitarelli 2011).

The performance of plowing methods with animal force is dependent on many factors. The type and weight of the animal, the condition of the ground—density and moisture as well as the type of soil—have a significant influence on the success of such practices.
Plowing one hector of land, with poor ground conditions and the availability of only 1-2 animals and a plowshare, can for instance, required up to 24 work hours (Strüber 2010). With

greater animal use (up to 12 animals) 3-4 tractor-like blades can replace a tractor in only about 12 hours of work time, even though the normal speed is always stays at the pace of the horse, about 3-5 km/h.

Overall the development of non-plow devices is displayed through 3 important factors:

1. A good soil quality is achievable: ability to absorb water, ground cover, and aeration are guarantied for better harvests, particularly in organic cultivation and the new by-products of climate change—extreme dry and moist ground phases.
2. The challenge against crude oil dependency in agriculture through the use of horses, and other farm animals, which is not possible with tractor use (Strüber 2010).
3. The optimal parts on this device means it can potentially meet a higher performance of cultivation compared with plowing methods. Non-plow methods are more successful and use less work stages than the traditional plow, which is especially important considering the slow pace of the work animals that pull these devices (only 3-6 km/h).

## Project Results from Plow-less Cultivation

Since 2007 the German project "Humussphäre" has explored to what extent cultivation with only horses powered prototypes, instead of plows, can be implemented (Strüber 2010).

### Operational Data

The test-area has clayey soil, about 600-800 mm of rain a year, and an average temperature of about 9 ° C. Wheat, rye, spelt, and oats are cultivated.

### The Prototype

A developed prototype has been tested through the employment of such non-plow tractors (system "EcoDyn"). For this reason, it also a question having the right cultivator; one which can evenly work the land with three teeth, 4 cm apart and which work to a depth of 90 cm.

### Experience of the Cultivation

Since 2009 different agricultural cultures (clover, wheat, and peas) were planted, on a test area of 0.4 ha, with the device. Until 2010 this device will require the use of 3-4 carthorses, which is surprising for the required (and shallow) depth of cultivation. In 2010 new technical modifications were made to this device and those results will be first available end of 2011.

The harvest yields are still below average and there is a frequent need for weeding; crouch grass, in particular, is a problematic by product. However, this is a known side effect, to the trial supervisor (the German agriculturalist F.Wenz), of non-plow tillage with tractors. In coming years, there should be a growth in harvest yield and a decline in the 'weed problem', once the land becomes used to this new cultivation technique; this prediction is based on the experiences of F. Wenz.

The performance of this device is considerably higher compared to plowed trials with animal labor on test farms. Due to the fact that in the future, it will be possible to fit these devices with units for seeding as well as de-weeding. But, even without these improvements, work with non-plow devices proves to be faster, since they are flatter and are not pulled over the land as often.

Since 2008 an improvement in ground quality is recognizable; Dr. U. Hampl, a soil scientist, evaluates the ground yearly. This improvement will, most likely, continue to be a development in subsequent years.

Discussion and Outlook

Non-plow cultivation through the use of work animals is also still an important method in agricultural industries. Although modern devices attain some level of new advances, nevertheless, the further test results of non-plow cultivation will be described in the following. The following points are important:

- The device will evenly work on flat, hard earth. Many traditional horse-drawn devices (i.e. the skimmer plow) fail at this, do not cut into the ground, or have uneven results, thus, applicable devices need a certain weight. Climate change has also created problems in some areas due to corresponding dry-phases.
- The device needs to be pulled by animals evenly at a specific pace of max. 6 km/h. No fast rotating tools (i.e. a rotary harrow) can be put into use.
- The heaviness of this device requires, above all things, a power source. The prototype previously described requires 3-4 carthorses, which is an unpopular option for many farms with either few or only small animals available. Naturally this need can be reduced, particularly where the productivity of the space is decreasing. Equipment that is successful and requires the use of only one larger animal or numerous smaller animals is being further developed.
- In total, the tilth, the amount of humus in the soil, and the soil type will determine the positive effect of the non-plow device. The device will more easily work ground that has a high level of moisture than dry, heavily seasoned land. Using this non-plow tillage method can developed the land back into a more positive structure. Primarily, the demand for this device is high during this transitions phase and its use will taper off once a good quality of moist soil is achieved.

The exertion of animals argues primarily against the dependency on crude oil, which is a good aptitude for smaller farms and less ground degeneration compared to tractors. Non-plow cultivation stands to show for the positive development of the ground, and the expectation that modern non-plow methods will exhibit the potential for better soil conditions in the future compared with plowed land.

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