



TECHNICAL NOTE 20. THE MOLDBOARD PLOW

20.0 BACKGROUND

As a soil-working tool, the moldboard plow in modern times has been censored with extreme prejudice. In the provocative 1943 classic *Plowman's Folly*, Ohio author Edward Faulkner questioned the time-honored practice of land plowing to grow crops. He argued that moldboard plowing harmed both the soil and plants and was an unnatural and moot practice. Field trials conducted in the USA and abroad since then have shown that on well-drained land, conventional plowing isn't needed for large-seeded crops like corn, cotton, and soybean. In fact, land damage caused by moldboard plowing is due mainly to improper adjustment of the plow, untimely plowing, and over-use of the plow. With the advent of no-tillage and conservation tillage planting equipment, there's scant reason for farmers going back to the days of the turning plow. The moldboard plow is, however, still useful in a few situations on the farm, such as turning sod and bringing fallow land into production. In this Technical Note we discuss the soil-working aspects of the moldboard plow, its principal parts, and operation.

20.1 THE PLOW AS SOIL-WORKING TOOL

Moldboard plows are designed to bury plant residue as well as loosen the soil. By adjustment, they can flip a furrow slice 180 degrees such that the soil surface is inverted (**Figure 1**). Moldboard plows are an attractive alternative for small farms because there are many good used plows available,



Figure 1. Sod inversion with the moldboard plow. Moldboard plowing is a form of primary tillage used to completely bury sod, crop residue, etc. before planting. Often it is followed by shallow disking. Photo: K. Fager

and the cost is low (\$75-\$300, depending on size). Skillful moldboard plowing is a fast-disappearing art; it's very easy to damage the land without careful adjustment and operation of the plow.

The plow bottom is the business end of a moldboard plow. The principal parts are the share, shin, moldboard, landside, frog, and brackets (**Figure 2a, b**). The tip of the share is pointed downward, causing the plow to run into the ground. This is called 'suction'; it literally sucks the plow into the ground. The share cuts the furrow bottom, while the shin cuts the furrow wall. The landside runs along the furrow wall thereby stabilizing the plow horizontally as it moves forward. The frog is an irregularly shaped piece of iron that holds the share, shin, and landside together. The frog is attached to the standard, which in turn is attached to the beam; one or more braces complete the assembly. The plowshare must be kept sharp otherwise the plow will not suck. Shares may be re-sharpened, or simply replaced. The share is attached to the frog via countersunk bolts for easy replacement. There are many moldboard designs; the most common is the general purpose bottom shown in **Figure 2a, b**, which is a cross between the sod and stubble bottom (**Figure 2c, d**). The general-purpose bottom is good for average soil conditions.

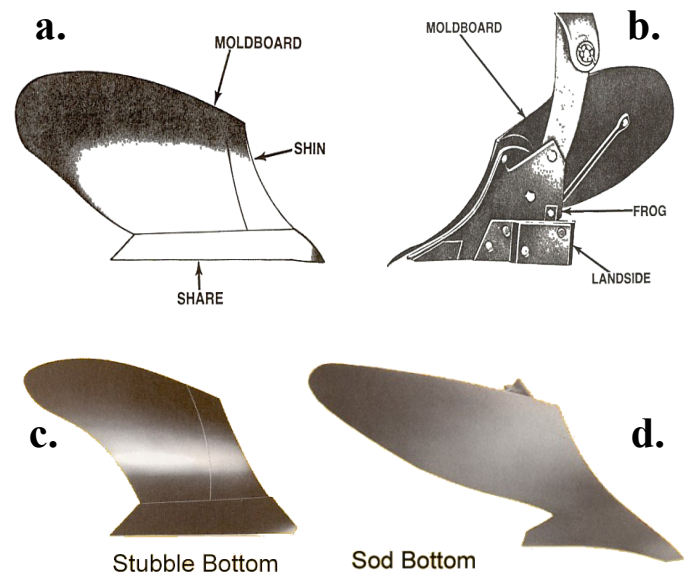


Figure 2. The general purpose moldboard plow with principle furrow (**a**) and landside (**b**) parts labeled. Variants of the general-purpose plow include the stubble (**c**) and sod or 'scotch' (**d**) bottom. The stubble bottom has a sharply turned moldboard and shorter bottom used under difficult scouring conditions such as stubble land. The long, curved moldboard and narrow share point of the sod bottom is used to plow heavy clay soil under sod; the furrow slice is set on edge to catch rain and snow. Images: John Deere Service Publ. (1976).

Moldboard plows may be equipped with a rolling landside, tail wheel, jointer, and rolling coulter (**Figure 3**). A rolling landside or 'tail wheel' trails behind the plow and may be adjusted to increase or decrease landside pressure on the furrow wall. Under sod or heavy residue, the rolling coulter cuts trash to make a smooth furrow face. The jointer is

shaped like a little moldboard; its job is to deflect trash, manure, etc. from the edge of the furrow slice into the bottom for good coverage.

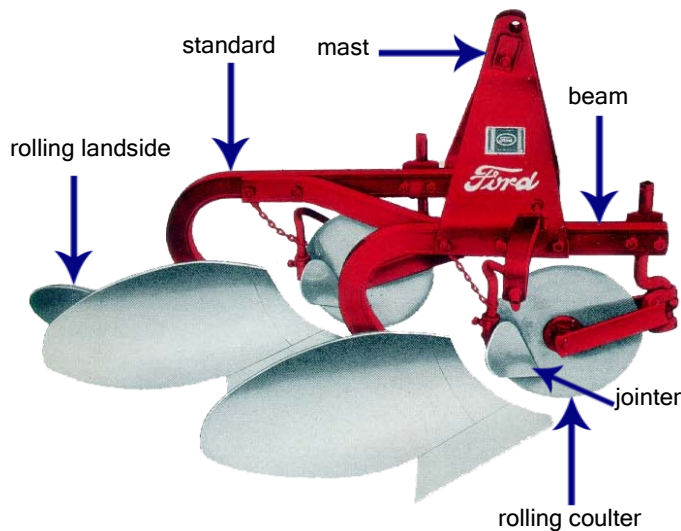


Figure 3. The plow bottom is attached to an iron standard that connects to the beam. The mast is the point of attachment for the top link on a three point hitch. Better plows come with extras like rolling landside, coulter, and jointer. *Image: adapted from Ford Motor Co. advertising.*

Moldboard plows come in many different sizes. The correct way to size a plow is to measure the distance from the heel of the landside to the wing of the share (**Figure 4**). A 16-inch moldboard plow, properly mounted, cuts a 16-inch furrow. Three 16-inch bottoms mounted on the same frame cut a land furrow 48 inches wide. It's also important to match the horsepower of your tractor to the draft, or drag, of the plow as it's pulled through the soil. Equipment dealers can help you figure this out (see Technical Note 21 for information about equipment sizing for different soil conditions).

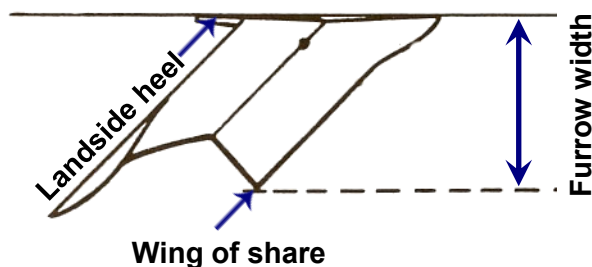


Figure 4. Sizing a moldboard plow. *Image: adapted from Finner and Straub (1985).*

The soil-working actions of the moldboard plow are slice, lift, fracture, and invert. The moldboard concave is the most important part of the plow because upon it the furrow slice is broken and pulverized by shearing stress. Referring to **Figure 5**, a nail driven through the furrow slice at position 1 shows no shearing. As the furrow slice is lifted, shearing is evident at position 2. Bending of the furrow slice along the

moldboard concave at position 3 causes blocks of soil to be sheared at regular intervals; at this point, the blocks of soil rub and slip against each other, causing pulverization of the furrow slice. Soil shearing and fracturing on the concave in **Figure 5** can be observed in the furrow slice shown in **Figure 6**.

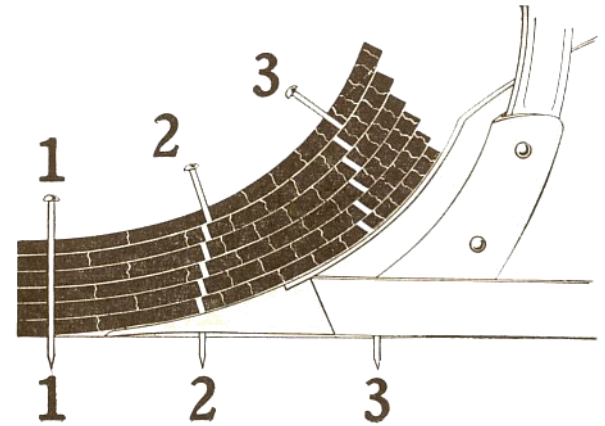


Figure 5. Soil shearing on the moldboard concave. *Image: John Deere, Moline, IL.*



Figure 6. The shape of the moldboard concave promotes shearing and fracturing of the furrow slice. *Photo: K. Fager*

There is a relationship between depth and width of plowing and the angle of furrow slices (**Figure 7**). In general, furrow slices should not be turned over flat (I) but rest at a 30-40 degree angle with the furrow bottom (II and III). This allows for good coverage and distribution of residue in the soil, and allows for downward and upward transfer of moisture. Furrow angle is also influenced by speed of plowing, moldboard curvature, and levelness of the plow. Deep plowing should be avoided as this may bring clayey subsoil to the surface. If deep plowing is indicated to break up hardpans, it's better to use non-inversion tillage such as a chisel plowing or under-row subsoiling.

The moldboard plow is designed to throw soil to the right only (except flip, or two-way plows). To begin, plow across the field and then back in the same furrow to make a *back furrow*. At the edges of the field, two open furrows result.

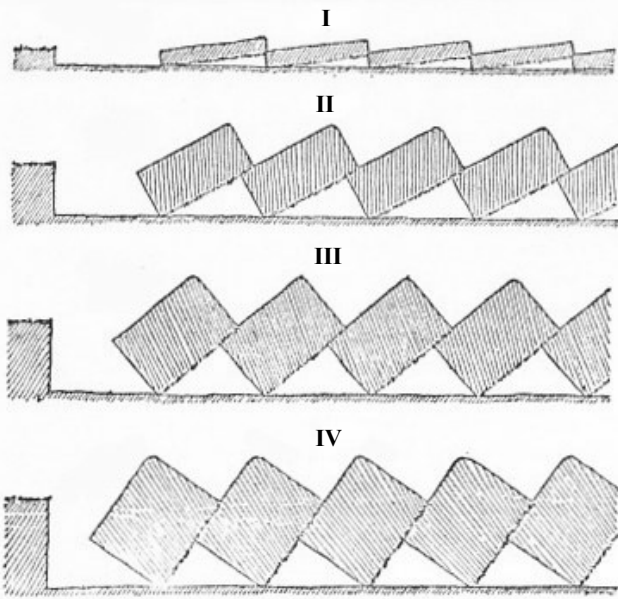


Figure 7. Relationship between depth and width of plowing and furrow angle. Image: *Encyclopedia of Practical Farming*.

When the next 'land', or block is plowed, there are now two open furrows at the edges, which are called *dead furrows* (Figure 8). Next year, you'll need to reverse the pattern so that back furrows become dead furrows, and vice-versa. Or simply go back and shallow-plow soil into the dead furrow. On very small plots, you may simply start on one side and plow to the other. Remember, on sloping land always plow *along* the contour, not up and down.

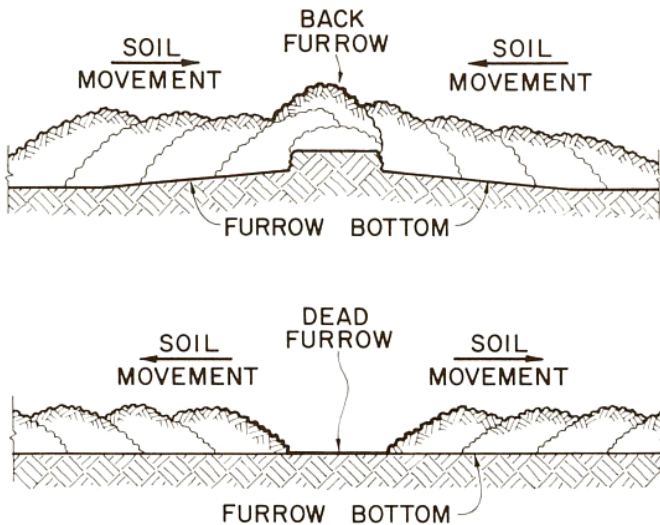


Figure 8. Soil movement and its relation to back- and dead-furrow formation. Image: *Finner and Straub (1985)*.

20.2 PLOW ADJUSTMENTS

Proper adjustment of the moldboard plow is essential for good results. The points differ depending on whether the plow is mounted directly to the tractor's three point hitch or is a drawn implement. Here we consider the main adjustments of the mounted plow. See Buckingham et al. (1976) for more complete information for all types of plows.

The plow bottoms must be leveled fore and aft, and from side to side. These adjustments are usually made at the tractor's top and lift links, part of the three-point hitch assembly (Note: A thorough understanding of the tractor's three point hitch mechanism is essential for safe, proper mounting and operation of farm equipment. Never attempt to mount or operate farm equipment without training). Depth of the plow furrow is changed by adjusting the suction of the plow bottom by tipping the individual bottoms fore-and-aft (Figure 9). Tipping the bottoms forward increases suction; tipping the bottoms aft decreases suction. The correct suction is obtained when the plow bottom runs approximately level with the bottom of the furrow.

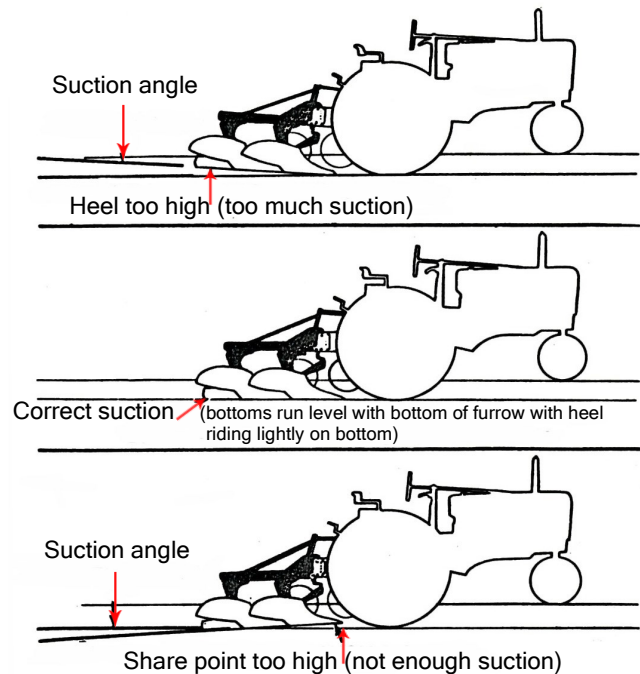


Figure 9. Adjusting depth of the plow furrow. Image: *adapted from D. Hunt, Iowa State Univ. Press (1983)*.

In addition, the landside and heel must be adjusted about $\frac{1}{2}$ -inch above the furrow bottom, with $\frac{1}{2}$ -to $\frac{3}{4}$ -inch gap between the heel and furrow wall, respectively. This reduces plow draft and wear on the landside. These clearances are usually obtained by adjusting the tail wheel or rolling landside as shown in Figure 10a, b. The tail wheel or rolling landside wheel should point slightly away from the furrow wall to relieve some of the pressure on the landside.

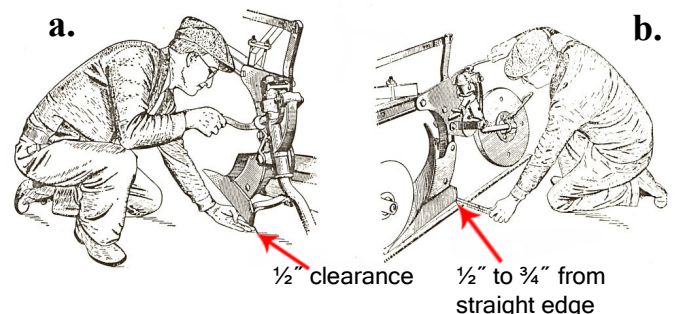


Figure 10. Heel (a) and landside (b) adjustment on the moldboard plow. Image: *adapted from D. Hunt, Iowa State Univ. Press (1983)*.

The plow's rolling coulters, if so equipped, must also be adjusted properly. Coulters should be adjusted, individually and beginning with the rear coulters, to run about 3-4 inches deep, just enough to cut sod roots and trash. Under average conditions, center the coulters to run about 2-4 inches ahead of the share point (**Figure 11**) and about 1/2- to 5/8-inch to the left of the share point (**Figure 12**). Coulters brackets allow both vertical and horizontal adjustment.



Figure 11 (left).
Adjusted fore-and-aft
coulters position. Photo: John Deere Service Publ. (1976).

Figure 12 (below).
Adjusted horizontal coulters
position. Photo: John Deere
Service Publ. (1976).



Figure 13. Side-by-side comparison of soil-working action of the moldboard plow and disk harrow. Despite three passes over this ground, the disk harrow only partially incorporates sod residue, a soil-working job it's designed to do. Photo: K. Fager

20.3 PLOWING VS. DISKING

Choosing the right tillage tool requires that we understand the nature of the soil-working job that is contemplated; what *end result* is desired; and, the underlying *purpose* of the tillage. As noted earlier, the soil-working actions of the moldboard plow are slice, lift, fracture, and invert. In so doing, it:

- Buries trash and crop residue completely
- Aerates the soil
- Controls some weed, insect, and disease pests
- Incorporates lime and fertilizer in the soil
- Provides a clean seedbed for better germination of small-seeded crops

If the purpose of soil-working includes any of the above, the moldboard plow will fit the bill. Disk harrows have limited penetration ability and will not produce satisfying results on sod or cover-cropped land, or land that has been under a long fallow (**Figure 13**).

Before plowing, it's a good idea to scout the land for weeds. Neither moldboard plowing nor disking is capable of controlling deep-rooted perennial weeds such as Bermuda grass, nut sedge, dock, briars, and horse nettle. If the land is infested with perennial weeds, they must be eradicated before plowing. A systemic herbicide such as glyphosate or equivalent is most useful in this situation. After plowing, think about integrating cover crops and limited (vertical) or no-tillage planting into your soil management plan. Remember: *good land stewardship over the long haul makes every good farmer.*

FURTHER READING

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