EC96-780 Equipment Wheel Spacing for Ridge-Till and No-Till Row Crops

Robert D. Grisso
University of Nebraska-Lincoln

Paul J. Jasa
University of Nebraska-Lincoln, pjasa1@unl.edu

Alice J. Jones
University of Nebraska-Lincoln, ajones2@unl.edu

Todd A. Peterson
University of Nebraska-Lincoln

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Equipment Wheel Spacing for RIDGE-TILL and NO-TILL Row Crops

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by Robert D. Grisso, Extension Engineer, Ag. Machinery
Paul J. Jasa, Extension Engineer, Conservation Tillage
Alice J. Jones, Extension Soil Erosion Control/Conservation Tillage
Todd A. Peterson, Former Extension Cropping Systems Specialist

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This Extension Circular discusses how to plan and control equipment traffic to reduce potential soil compaction and maintain ridge integrity in ridge-till and no-till row crop production systems.

- Controlled Traffic
- Wheel Spacings for Crop Production
- Wheel Spacing for Harvesting
- Combine Wheel Spacing Requirements
- Combine Wheel Spacing Options
- Tire Width Compatibility
- Other Combine Compatability Issues
- Other Harvest Practices
- Other Wheel Spacing Considerations
- Planting Ahead
- Summary

Use of ridge-till and no-till systems has increased dramatically since the early 1980’s when ridge-planting equipment and conservation tillage cultivators became readily available. The ridge-till system involves the establishment and annual re-forming of permanent, single-row ridges into which crops are planted year after year. To obtain maximum productivity with the ridge-plant system (and many believe with no-till systems), all wheel traffic should be confined to interrows.

Wheel traffic on ridges can alter the ridge profile and condition of crop residue. Ridge deformation or excessive tire sinkage can affect subsequent planter performance, crop emergence and the overall productivity of both ridge-till and no-till systems. Thus, the row (ridge or root zone) area should not be compacted by the tires from field equipment. For these reasons, it is important to consider equipment wheel spacing.

Controlled Traffic

Controlled traffic is defined as the field situation where the wheel spacing of all vehicles are arranged such that all wheels run between the crop rows (interrows/furrows/row middles) and the wheel tracks are in the same interrow positions year after year. The maximum advantage of controlled traffic occurs when the operating widths of all equipment are matched (or the same) and wheels are arranged to minimize the number of traffic lanes created.

From controlled traffic research, the first pass of a vehicle on tilled soil can cause 70 to 80 percent of the wheel compaction. If trafficked lanes are followed by additional traffic with lighter or similar loads, little additional compaction occurs. Because once a traffic lane has been driven on, subsequent passes with similar loads have little effect on the amount of soil compaction.

Controlled traffic lanes improve traction, soil load bearing, and timeliness of planting and harvesting operations while minimizing potential yield reduction from compaction. Compaction is managed, not eliminated, and the area subjected to compaction is minimized. The concept is to separate traffic zones from root zones. Controlled traffic keeps compaction where it is less detrimental to root development and uptake of nutrients and water. Fertilizer placement and furrow irrigation practices can be modified as these traffic zones are established and the traffic lanes are known.

Wheel tracks become compacted even when relatively light machinery is used. Without controlled traffic, random traffic could cover 75-90% of the field after only a few years. Review the NebGuide entitled, *Management Strategies to Minimize and Reduce Soil Compaction*, G89-896-A for additional details.

Wheel Spacings for Crop Production

Tractors used for planting, cultivating, spraying, fertilizer spreading and anhydrous ammonia application have long had adjustable wheel spacings to allow producers matching the wheel spacing to the planted row spacing. Since the adoption of 30-inch rows, many tractors and combines have also had the capability of being equipped with straddle duals.

Similarly, pull-type fertilizer and pesticide application equipment is available to match crop row spacing. Many units have adjustable wheel spacing. However, similar adjustments are limited for chemical application equipment such as: floaters or high-flotation spreaders and sprayers used by custom fertilizer and pesticide applicators. How does a big-wheeled applicator used for preplant applications keep from compacting the ridges? One possible solution is to apply certain materials, such as lime, with this equipment when the soil (ridge) is frozen during the winter. However, this practice is not very practical for most pesticide applications, or surface applied nitrogen.

Wheel spacing options are available for tractors and associated planting, cultivating, spreading, and spraying equipment that allow farmers to practice controlled traffic with ridge-planted and no-till crop production systems. Farmers may have to check at several equipment dealerships for this equipment, since wheel spacing options vary by brands and models. Ask about wheel spacing specifications -- are they available? Some may have to consider a "do-it-yourself" approach for certain practices if a custom operator has equipment with tire width and wheel spacings not compatible with existing ridge-till or no-till row spacings.

Wheel Spacings for Harvesting

The self-propelled combine is probably the hardest piece of equipment for which to develop plans for controlling traffic patterns. This is one reason farmers and manufacturers have paid little attention to matching tire-size and wheel-spacing on combines with controlled traffic strategies. But several options are available.

Typically, harvest equipment is the heaviest axle loads operated in the field. Combine tires are often as wide or wider than the row spacing, unless row-straddling split duals are used. Efforts to manage harvest traffic in traffic lanes will protect the root zone for future crops.

In the past, most wheel spacing and tire-size recommendations for combines have been more concerned with load carrying capacity, operating width, adequate flotation for wet-harvest conditions and other factors. The lack of concern of wheel traffic has changed as ridge-till and no-till have become more widespread and as the detrimental effects of equipment traffic compaction on soil conditions and crop productivity is shown.

Combine wheel traffic on ridges, particularly during a wet harvest, can alter the ridge profile and affect planter performance. Even with good-harvest conditions (ridges dry and firm with little or no ridge deformation), compaction from combine traffic can significantly affect yields in subsequent years. In ridge planting studies with continuous corn, yield in traffic rows compacted during a wet harvest season was reduced about 10 to 20 bu/A.

Combine Wheel Spacing Requirements

To keep combine tires from compacting the rows (or ridges), specific wheel spacings are required. *Figure 1* illustrates the wheel spacing recommendations for row-crop combines. *Table I* shows the percentage area trafficked by equipment for wheel spacing of a tractor and combine as related to row spacing. Four- and six-row crop headers have wheel spacing recommendations for single tires. Combines with larger headers (eight- and 12-row) may be equipped with straddle duals to adequately support the weight. These recommendations for wheel spacing could be reduced one full row width as shown in *Figure 1*, with odd-row headers such as a five row header straddling three rows

(*Figure 6b*).

The wheel spacing for rear steer tires should be the same as for single tires on the main drive axle (*Figure 1*); twice the planted row width when harvesting with even-row headers; or three times the row width when harvesting with an odd-row header. A variation of ± 2 to 4 inches from these target wheel spacings is usually acceptable for ridged crops, since steering wheels are usually much narrower than drive tires.

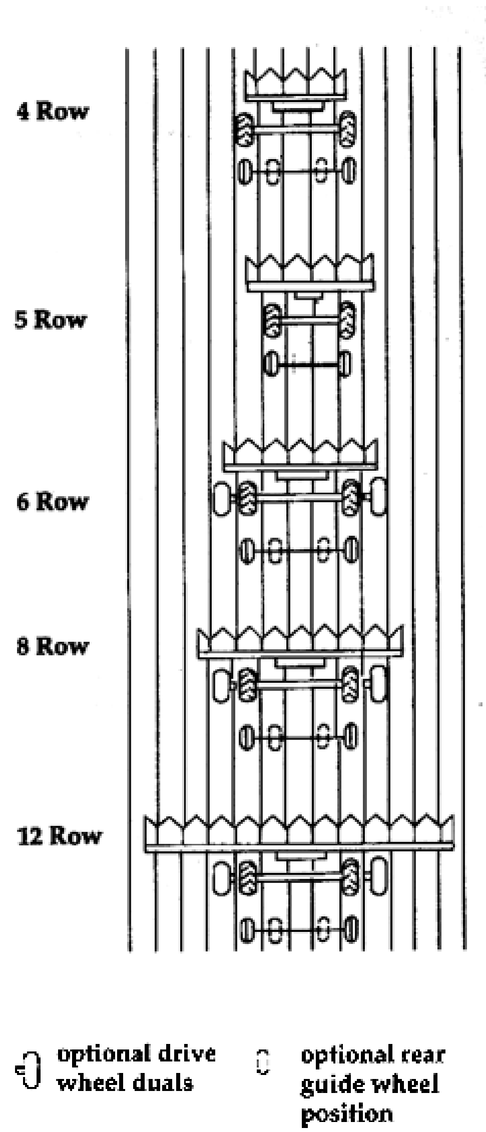

Figure 1. Combine row crop header size and wheel spacing combinations. The outer edge of the drive wheels on the 4- and 6- row (using straddle duals) may extend past the header and could run very close to the next unharvested row. May require tire shielding and superior driving skills.

Table 1. Combine and tractor drive wheel spacing recommendations for centerd combine headers of various row spacings and the number of lanes trafficked. Percent of the field trafficked assumes each tire path is 20" wide.

# or Rows[1]	*Wheel Spacing[2] (inches)*		*# of Lanes Trafficked*	*% Trafficked*
	Tractor	*Combine*		
30" row spacings				
6	60	120	4	44

6	60	120 (on guess row)	2	22
6	120	120	2	22
6	60 & 120[3]	120	4	44
8	120	120 (4-row)[4]	4	33
8	120	120 (8-row)	2	17
8	60 & 120	120 (8-row)	4	33
8	60 & 120	120 & 180 (8-row)	6	50
12	60	120 (6-row)	4	22
16	60	120 (8-row)	6	25
16	60 & 120	120 & 180 (8-row)	8	33
24	60 & 120	120 & 180 (12-row)	12	33
36" row spacings				
6	72	144	4	37
8	72	72[5] (4-row)	6	41
8	72	144	4	28
12	72	144 (6-row)	6	18
12	72 & 144	144 (6-row)	6	18
38" row spacings				
4	76	76 (4-row)	4	53
6	76	152[5]	4	35
8	76	76 (4-row)	6	40
8	76	152[5]	4	26
10	76	114 (5-row)	4	21

[1]Represents all equipment size except combines.

[2]Wheel spacing dimensions are tire center-to-center distance. Assumes that front and rear wheel spacing are the same.

[3]Wider dimension represents the tracks from dual tires.

[4]The number rows of the combine header if different from # of rows.

[5]No current combines offer this wheel spacing.

Combine Wheel Spacing Options

A survey of combine manufacturers showed most offer some flexibility in wheel spacing settings. Very narrow wheel spacing, however, is not readily available on a combine and very wide wheel spacing may require truss rods to reinforce the axle housing.

Rear Steer Wheels

With non-adjustable rear axles, some manufacturers offer reversing wheels (dish "in" or "out") for two wheel-spacing settings. Most manufacturers though, do offer adjustable rear axles (*Figure 2*) with three to seven alternative wheel spacing settings. Some farmers have made modifications on rear axles to set the desired wheel spacing, rather than invest in manufacturer-offered options.

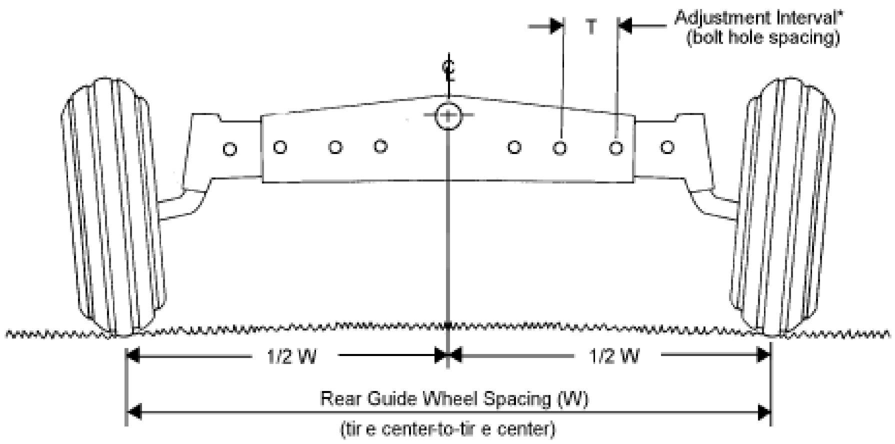

Figure 2. Adjustable rear steer axle for self-propelled combines. Some fixed axles allow wheels to dish "in" or "out" for two possible wheel spacings.

Main Drive Wheels

The majority of manufacturers also offer some means of adjusting or setting alternative drive wheel spacings. Several options for this are illustrated in *Figure 3*. These include mounting wheels on one side or the other (dish "in" or "out"), wheel or hub spacers between final drive and the wheel and axle spacers or extensions that reposition final drives. Wheel spacer thickness varies from 2 to 6 inches; axle extensions varies from 6 to 16.5 inches.

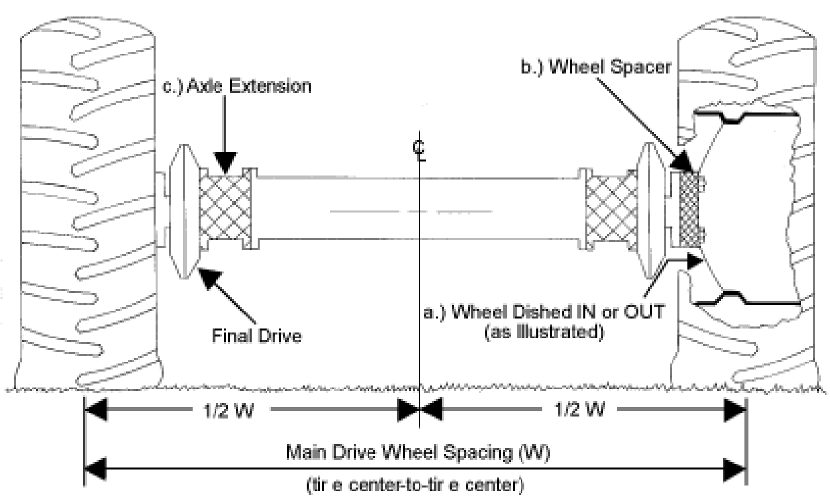

Figure 3. Wheel spacing adjustment for combine drive axle. Also available are: a) wheel dish "in" and "out", b) wheel or hub spacers, c) axle extensions for the final drives.

One manufacturer offers wheel spacers of different thicknesses which are used on each side of the combine (to shift tires to the correct wheel spacing). In some cases, different tires widths provide different wheel spacings. Some manufacturers reported wheel spacing was the same regardless of tire widths used.

Straddle Duals

Some manufacturers will allow dual tires on the main drive axle of combines. Some narrow-spaced arrangements are not "ideal" for duals in ridge-planted crops, because there is not adequate room between the duals to straddle the ridge. As a result, many farmers choose to ignore warranty considerations and use homemade arrangements or equipment available from shortline manufacturers. To be compatible with ridge-planted crops, several combines have been introduced with a straddle duals package (with planetary final drives) with added strength to handle increased forces. The manufacturer's literature claims increased stability, smoother ride, longer tire life, elimination of stubble damage and greater flotation. For example, by substituting four 18.4-38 tires for two 30.5-32 tires, the flotation can be increased by 24% with more ground contact area.

Tire Width Compatibility

Most combine manufacturers can provide rear steer-tire widths acceptable for ridge-planting. Main drive wheel widths (for single tires) are a different story -- some are acceptable for ridge-planting while others are not. Some manufacturers offer compatible tire widths for certain row widths on certain models, but not on all models.

Tire width compatibility is further compounded by the tire size versus row spacing (tire width versus ridge spacing/ridge profile) as shown in *Figure 4*. A wheel spacing slightly wider than the ideal given in *Table I* may be perfectly acceptable when 18.4 or 20.8 tires are used with 30 inch rows (ridges), but unacceptable when wider tires such as 23.1 or 24.5 tires are used. In 30 inch rows (even with 18.4 tires or 20.8 tires), the wheel spacing should exactly center tires between ridges in order to minimize trafficking on the ridge side. Review the NebFact NF96-300, *Selecting and Sizing Combine Drive Tires* to evaluate tire alternatives.

Other Combine Compatibility Issues

When the tire widths on the main drive axle are increased to prevent ridge compaction or when duals are used, the ladder to the operator's station may have to be moved. Some manufacturers have made provisions for this; other combines may need modification.

The single-tire diagrams for the 4-row combines (*Figure*

1) and the wide-spaced dual arrangements for the 6-row combine show the outer edges of the tires extending beyond the outer edge of the corn header. Depending on the specific combination of row width, wheel spacing and tire size, the tire may be very close to the adjacent unharvested crop row, especially in 30 inch or narrower rows. This may not be a problem with a skilled operator or when the crop is standing upright, but lodged or leaning crops may present serious problems. For these conditions, tire shielding and excellent driving skills are necessary.

Some farmers select header combinations for a given combine that allow them to harvest more bean rows than corn rows. For example, 6-row, 30 inch row, corn header and a 18-ft platform header (to harvest seven bean rows), may be perfectly acceptable when not ridge planting or no-till planting and when interrow compaction from combine tires is not a concern. However, for controlled traffic, one wheel space setting will not satisfy both conditions.

The farmer who needs both a platform and row crop header has a number of options:

1. Obtain a combine with quickly and easily changed wheel spacings.
2. Choose a combine with the proper wheel spacings for one header, then simply accept compaction when harvesting the other crop.
3. Harvest an even number of bean rows -- six with the current header and accept lower field capacity or harvest eight-rows with a larger header (20 ft) and accept reduced operating speeds.

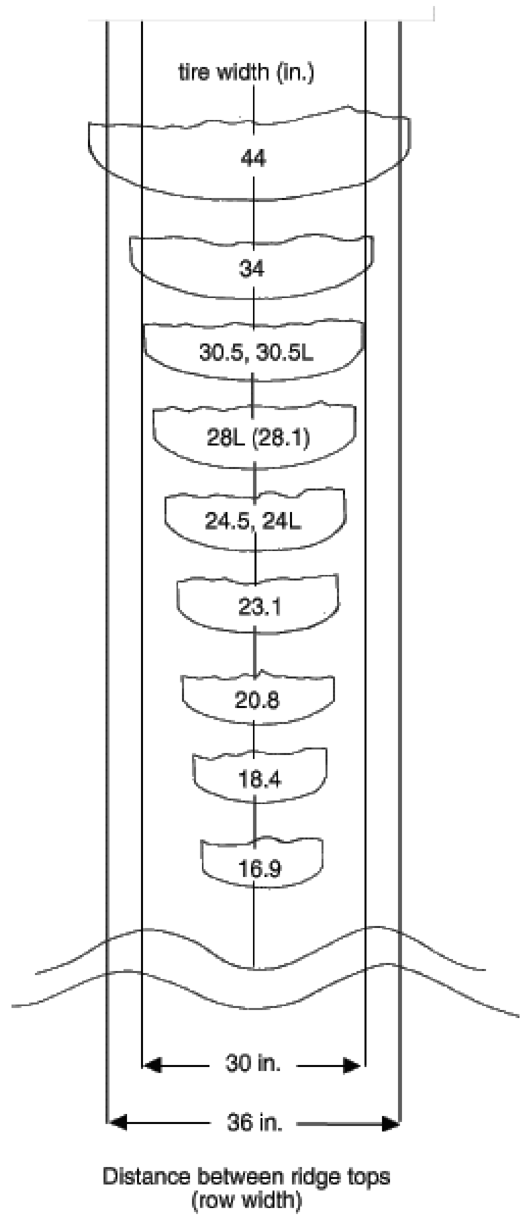

Figure 4. Combine tire size within ridge profiles. Minimize ridge deformation with proper tire sizing and spacing.

Other Harvest Practices

In addition to the combine, the wheel spacing on equipment used for on-the-go unloading (grain) practices must be considered when adopting ridge-planting or wish to reduce interrow compaction in no-till crops. Most farm trucks with rear duals will not be acceptable for on-the-go unloading from the combine. Trucks can cause increased compaction because they often have much higher tire pressures than most field equipment. Unloading vehicles (grain buggies, grain carts) should have compatible wheel spacings with the combine. Then run it in the same tracks as the previous pass of the combine. This may require an extension of the combine unloading auger. Some larger unload vehicles with wide, high flotation tires may not be acceptable, regardless of wheel spacing. Keeping the unload vehicles out of the field is the better alternative.

Many ridge-till farmers do not ridge plant the headlands (turn strips at the ends of the field) to eliminate equipment bounce when turning. Some also plant unridged turn strips midway through long fields for use by on-the-go unload vehicles.

Other Wheel Spacing Considerations

In addition to eliminating wheel traffic compaction on crop rows (ridges), traffic patterns should be examined for all field operations. For instance, the combination of equipment used to plant, cultivate, apply fertilizers and pesticides and harvest may result in certain interrows receiving little or no soil compacting forces from drive wheels or implement tires, while other interrows may be compacted four or more times during the growing and harvest seasons.

For example, consider the set of equipment and practices for a six-, eight- and 10-row ridge-till equipment system shown in *Figures 5a*, *6a* and *6b*. About one-third of the interrows in the examples received equipment traffic, while about 10 percent of the interrows were compacted by five equipment passes (six-row system) or six equipment passes (8- and 10-row systems) sometime during the year. Most crop rows (ridges) experience wheel traffic on one side of the ridge or the other. In some cases, about half the ridges receive wheel traffic on both sides.

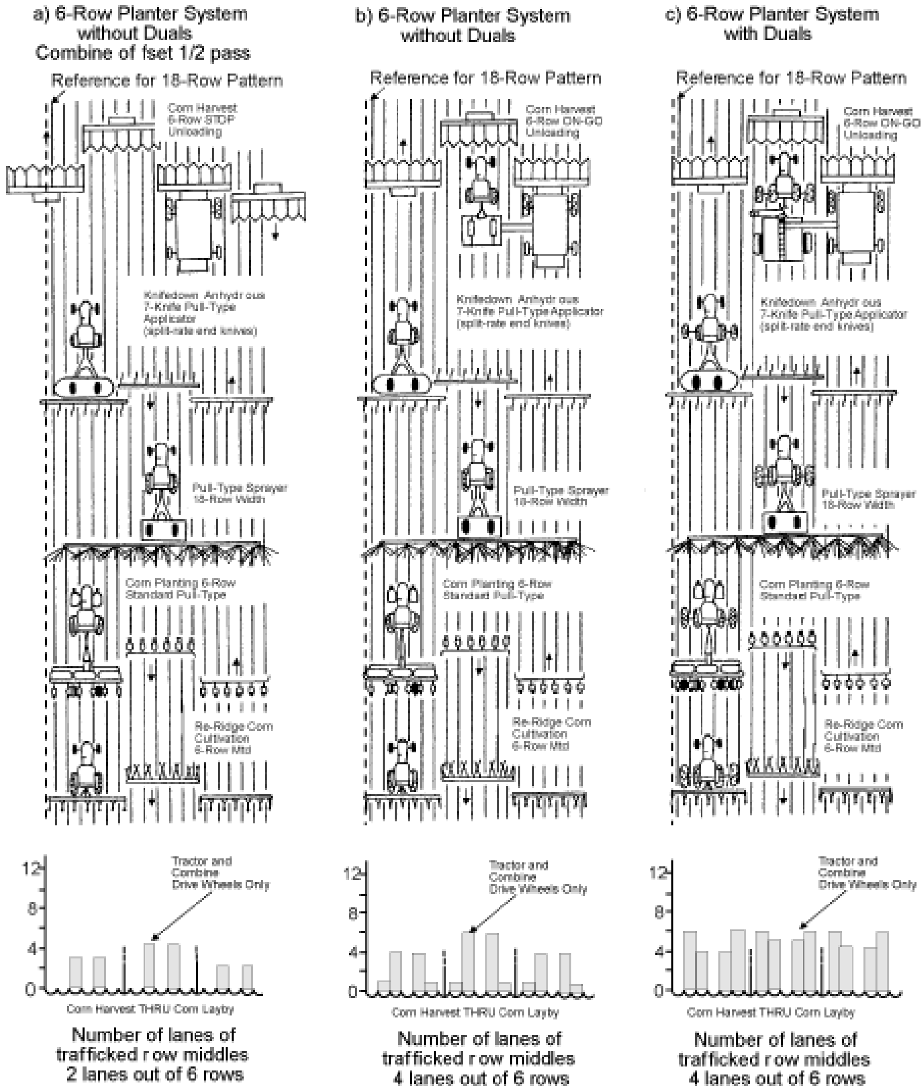

Figure 5. Traffic patterns using 6-row equipment systems. From left to right, a) center combine on guess row, no grain fill vehicles in the field, b) equipment system that uses singles with on-the-go unloading, c) equipment system that uses duals and on-the-go unloading.

If duals are added to the tractor as shown in *Figure 5c*, the same lanes will be trafficked, but the number of passes on these lanes will be much greater since the duals run in the combine tracks. If these were 30-inch rows, and assuming that each tire path is 20 inches wide, 44 percent of the field would be trafficked. If the combine can be used as in *Figure 5a* where the combine is centered over the "guess row" and duals are not used, only 22 percent of the field would be trafficked. Developing a plan where the tractor and combine lanes match is key for limiting the influence of traffic lanes.

Figure 6c shows a 12-row continuous corn system. The tractor straddled two rows, while the combine straddled four and the anhydrous ammonia applicator covers six. In this strategy, eight of 12 interrows are trafficked. If these were 30-inch rows, and assuming that each path is 20 inches wide, 44 percent of the field would be trafficked. If all field equipment was 12-rows (including the ammonia applicator) and the crop was harvested with a 6-row header, only 22 percent of the field would be trafficked (*Table I*).

In *Figure 6d* a 16-row system is shown. If the on-the-go unload cart was removed from field operations and the anhydrous applicator was replaced with a 16-row unit, only six lanes out of 16 would be trafficked, even if the tractor needed duals. If these were 30 inch rows, and assuming that each tire path is 20 inches wide, 25 percent of the field would be trafficked. This compares to 42 percent trafficked in *Figure 6d*.

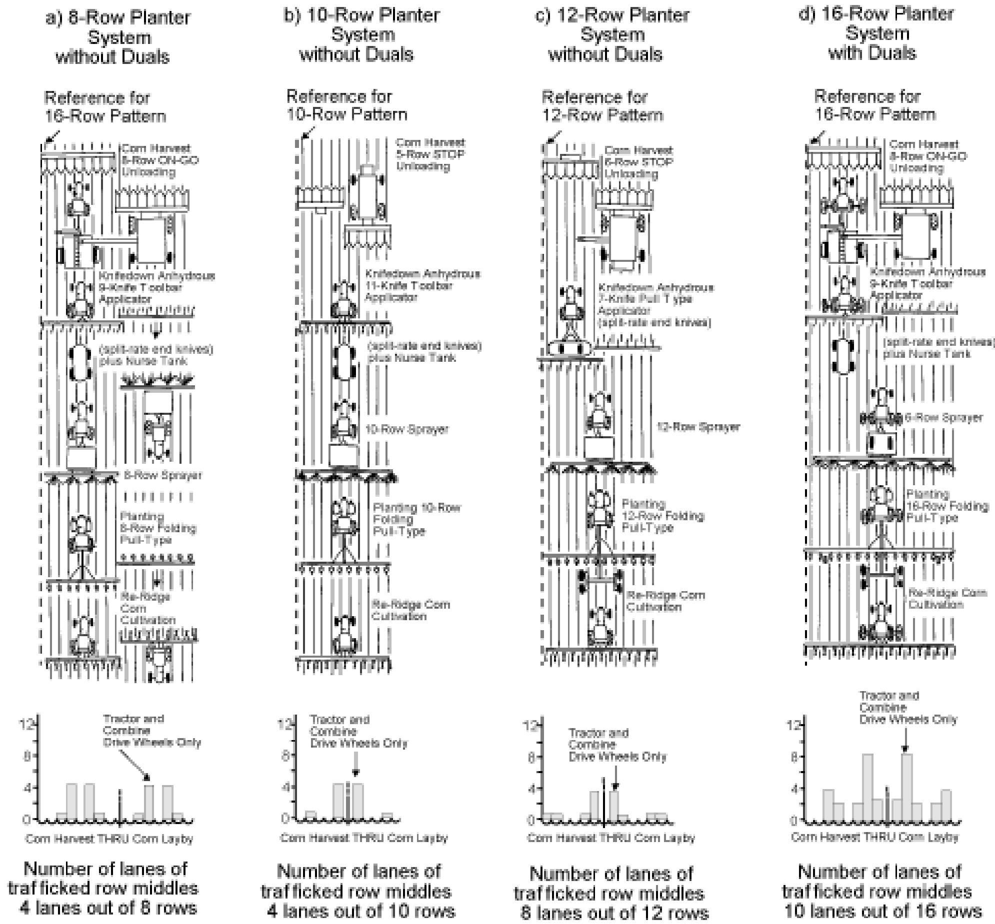

Figure 6. Traffic patterns using 8-, 10-, 12-, and 16-row equipment systems. None of these equipment systems were equipped with duals. From left to right: a) 8-row equipment system with all 8-row equipment and on-the-go unloading, b) 10-row equipment system using an odd-row header and spacing width is the same for combine and tractors, no on-the-go unloading, c) 12-row equipment system, no on-the-go unloading, d) 16-row equipment system with on-the-go unloading.

Other combinations of equipment and practices produce other traffic patterns. Because tire forces applied to interrows result in some compaction in the adjacent root (cropping) areas (at some depth, depending on tire width), it is possible some equipment combinations and traffic patterns are more productive than others. These interactions are still being investigated.

Planning Ahead

Consider controlled traffic in all major machinery buying decisions. Even if controlled traffic is not in the immediate plans, selecting wheels and tires to avoid running on rows adds little cost and can provide immediate benefits.

Develop the traffic patterns of existing equipment using a format similar to *Figures 5* and *6*. Then develop equipment strategies to use controlled traffic in the future. When buying new equipment consider:

1. a combine with tires and wheels that match row spacing. If single tires are too wide, use taller single tires (more load carrying capacity) or straddle duals. For ridge-till, the maximum tire width should be 8 to 10 inches less than the row spacing. For no-till, tires a little wider are acceptable (4 to 5 inches less than row spacing).
2. a platform header the same width as the row crop header.
3. a chemical applicator with same width as planter or double or triple the planter width.
4. a unload grain cart tire spacing matched with the combine and driven on the previous combine tracks.

Summary

All wheels spaced properly for a ridge-till or no-till system is a challenge requiring careful planning to achieve a successful controlled traffic pattern. Acceptable wheel spacings to prevent interrow compaction with ridge-till and no-till systems are available for most tractors and pull-type equipment and for several self-propelled combines. Options for combines, custom fertilizer and pesticide application equipment are becoming readily available.

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