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Adjust Potato Harvester Speed To Reduce Bruising

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Potato growers lose about 20 percent of their potential income through potato injury at harvest. This loss results from reduced potato prices, increased shrinkage in storage, and increased processing costs. From two-thirds to three-fourths of the total tuber damage occurs in the field during harvesting. Applying the principles outlined in this paper has reduced injury by up to 50 percent.

Factors That Influence Bruising

Four general factors influence the amount of bruise damage during harvest: 1) soil conditions, 2) tuber condition, 3) temperature, and 4) harvester operation.

While the other factors may be equally important in controlling the bruise level, harvester operations alone will be discussed here. Recognize that damage due to improper harvester operation is in addition to damage resulting from improper tuber condition, tuber temperature, and soil condition.

Fig. 1 shows the effect of damage susceptibility and harvester operation on bruise damage. Where tuber condition indicates possible high damage levels, proper harvester operation is extremely critical. Where tuber condition indicates lower damage levels, adjustment will have less effect on reducing the bruise level.

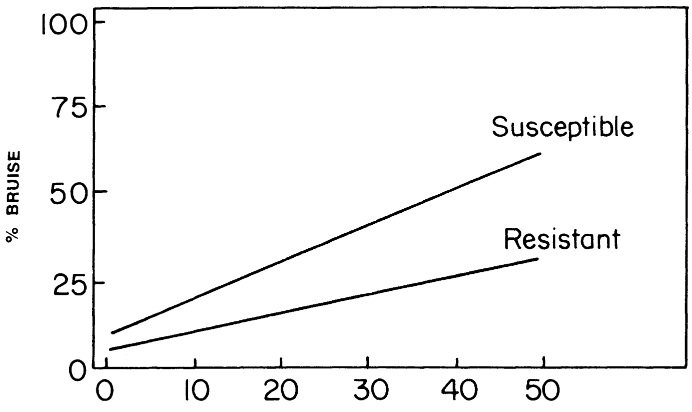

Fig. 1. Effect of harvester operation on bruise damage for different tuber conditions.

Match Tuber Volume and Harvester Capacity

The material (volume) handled by a potato harvester is made up of potatoes and soil. On the primary and secondary chains, the volume is determined by depth of blade and rate of travel. Changes in potato yield do not appreciably affect the volume of material handled on these two chains. Therefore, the ratio of primary and secondary chain speed to forward speed can be nearly the same for all but extremely large differences in potato yields. The factors that modify the volume of soil on these chains are soil types, soil moisture, and soil compaction. These factors determine how easily the soil is separated from the tubers and lost from the chains.

The material (volume) on the remaining chains (rear cross, side elevator, and boom) consists mainly of potatoes. This volume is determined by harvester travel speed and yield per acre. A higher chain speed is needed as yield increases.

Chain capacity is determined by 1) chain dimensions and 2) chain speed. Chain dimensions remain constant on a particular harvester unless a major change is made. Chain speeds can be changed quite easily, and thus speed is the variable used to change the chain capacity.

The variables that determine volume and capacity are forward speed and chain speed. Since the chain speed and forward speed must be coordinated so the volume of material handled is equal to the machine capacity at each point, the desired volume-to-capacity relationship can be expressed as a ratio of the chain

Material in this publication was adapted from Washington State University Extension Publication 646, Reducing Potato Damage During Harvest, by R.E. Thornton, D.A. Smittle, and C.L. Peterson

speed to forward speed. Harvester chain speed to forward speed ratios for heavy soils and various yields are presented in Table 1.

Light, sandy soils require different ratios than heavy soils. At a given forward speed the primary and secondary chain speeds should be slower than the ratios in Table 1. The slower chain speed compensates for the more rapid loss of soil volume on the primary and secondary chains in sandy soil. Adjusted ratios for sandy soil are presented in Table 2.

Making Harvester Adjustments

Proper harvester adjustments require measurements and calculations for:

(1) actual field travel speeds and individual chain speeds (mph).

(2) desired chain speed (mph).

(3) percentage change needed.

Actual Forward and Chain Speeds

Forward Speed. The tractor speedometer may be accurate enough. Use your own judgment. If there is no speedometer or if there is excessive wheel slippage you can measure forward speed by finding the circumference of a wheel and timing the speed of rotation.

1. Measure tire circumference by marking a **non-powered** wheel with spray paint. Move the machine ahead so the wheel makes three complete turns and measure the distance traveled. Divide by 3 to get tire circumference.
2. Measure forward speed by timing the number of seconds needed to make five revolutions of the

Table 1. Harvester chain/forward speed ratios for heavy soils.

	Yield (cwt/acre)						
Chain	**100***	**200***	**300***	**400**	**500**	**600**	**700**
Primary	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Secondary	.7	.7	.7	.7	.7	.7	.7
Rear cross & elevator	.2	.3	.4	.5	.5	.6	.7
Boom	.2	.2	.3	.4	.4	.5	.6

*The ratios at these yield levels have not been adequately tested and therefore must be considered theoretical values.

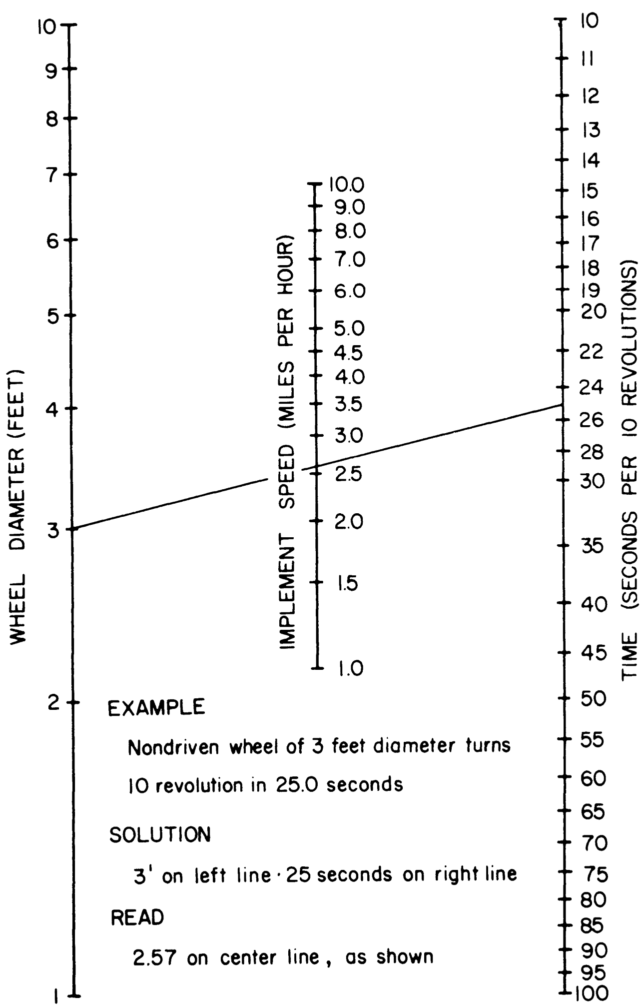

Fig. 2. Implement speed calculator (no slippage allowance).

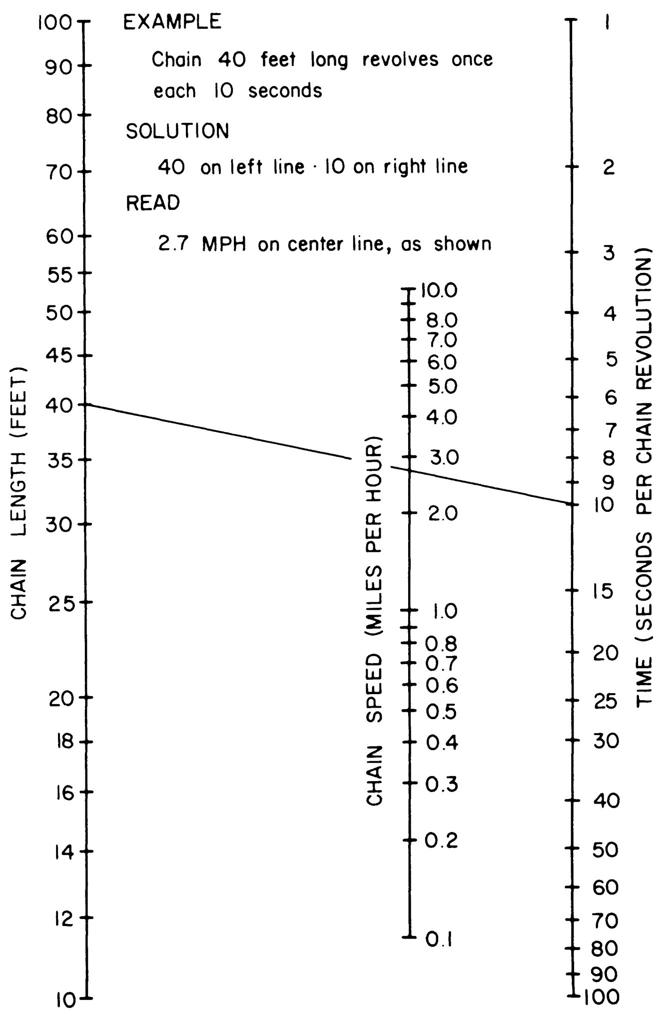

Fig. 3. Chain speed calculator.

Table 2. Harvester chain/forward speed ratios for sandy soils.

Chain	Yield (cwt/acre)						
	100*	200*	300*	400	500	600	700
Primary	.9	.9	.9	.9	.9	.9	.9
Secondary	.6	.6	.6	.6	.6	.6	.6
Rear cross & elevator	.2	.3	.4	.5	.5	.6	.7
Boom	.2	.2	.3	.4	.4	.5	.6

*The ratios are these yield levels have not been adequately tested and therefore must be considered theoretical values.

marked nonpowered wheel. Divide by 5 to get seconds per revolution.

3. Calculate actual forward speed by using the above data with the **Implement Speed Calculator,** Fig. 2. You can also use the following formula to get the forward speed:

$$\text{Forward Speed (mph)} = \frac{\text{tire circumference (ft)}}{\text{seconds per revolution}} \times .7$$

Chain Speed. You need to know how long the chains are and how long it takes to make a complete revolution.

1. Measure chain length.
2. Mark a link of each chain with spray paint and time the revolutions with a stopwatch. Marks are easier to see if made on an elevated flight or on the ends of the links of the primary and secondary chains. Time the primary, secondary, and rear cross chains for 5 revolutions and divide by 5. The extra revolutions increase the accuracy.
3. Determine chain speed in mph by using the above data with the **Chain Speed Calculator,** Fig. 3, or with the following formula:

$$\text{Chain Speed (mph)} = \frac{\text{chain length (ft.)}}{\text{seconds/revolution}} \times .7$$

The relationship of chain speed to forward speed determines the ratio used with the other figures to obtain desired chain speed. Determine the desired chain speed with the following formula:

$$\text{Desired Chain Speed} = \text{forward speed (mph)} \times \text{chain speed ratio}$$

The chain speed ratio can be found in Tables 1 and 2.

Use the following formula to find the percentage change needed to adjust the harvester chains from actual to desired speeds:

$$\text{\% Change Needed} = \frac{\text{desired chain speed} - \text{actual chain speed}}{\text{actual chain speed}} \times 100$$

Example: If the desired secondary chain speed is 1.6 mph and the actual chain speed is 2.0, the percentage change needed is:

$$\frac{1.6-2.0}{2.0} = \frac{-4}{2.0} = .2 \times 100 = -20\%$$

The secondary chain speed must be reduced 20 percent to achieve the proper ratio of chain speed to forward speed. If the secondary chain is the only one not in the correct ratio and if it has a 10-tooth drive sprocket, changing to an 8-tooth sprocket will give a 20 percent reduction and provide the correct ratio. If all chains are about 20 percent faster than needed, either slowing chains by 20 percent or increasing the forward speed by 20 percent would reduce the bruise level.

Results of Harvester Field Adjustments

During the 1972 potato season, harvesters in commercial operations were evaluated to determine if the ratios of chain:ground speed would have an effect on harvester-caused bruise damage. Chain and ground speeds were measured on three harvesters. They were then adjusted to make each chain operate at or near the desired speed. In each case the bruise level was reduced from one-third to one-half.

All of the data collected so far show that a slower rate of harvest is not required if the machine is properly adjusted and operated. One processing company that worked closely with the tests for 3 years reported that the percent of bruised potatoes delivered to their plant has dropped significantly. The average bruise level for this group of growers on contract for each of the 3 years dropped from 48% bruised potatoes to 36% bruised potatoes.

Conclusions

1. Properly adjusting harvester chain speeds can significantly reduce potato bruise damage.
2. Results of these tests have given no justification for reducing harvester field speeds if other adjustments can be properly maintained.
3. The effect of field speeds faster than those encountered in these trials has not been evaluated. It is reasonable to assume that excessive field speeds would increase bruise damage.
4. Harvester models from different manufacturers were not different in the amount of bruise damage produced. Proper adjustment of a particular harvester appears to be more important than make or model.
5. Bruise damage decreased while field speeds increased by nearly 30 percent during 3 years of the harvester trials.

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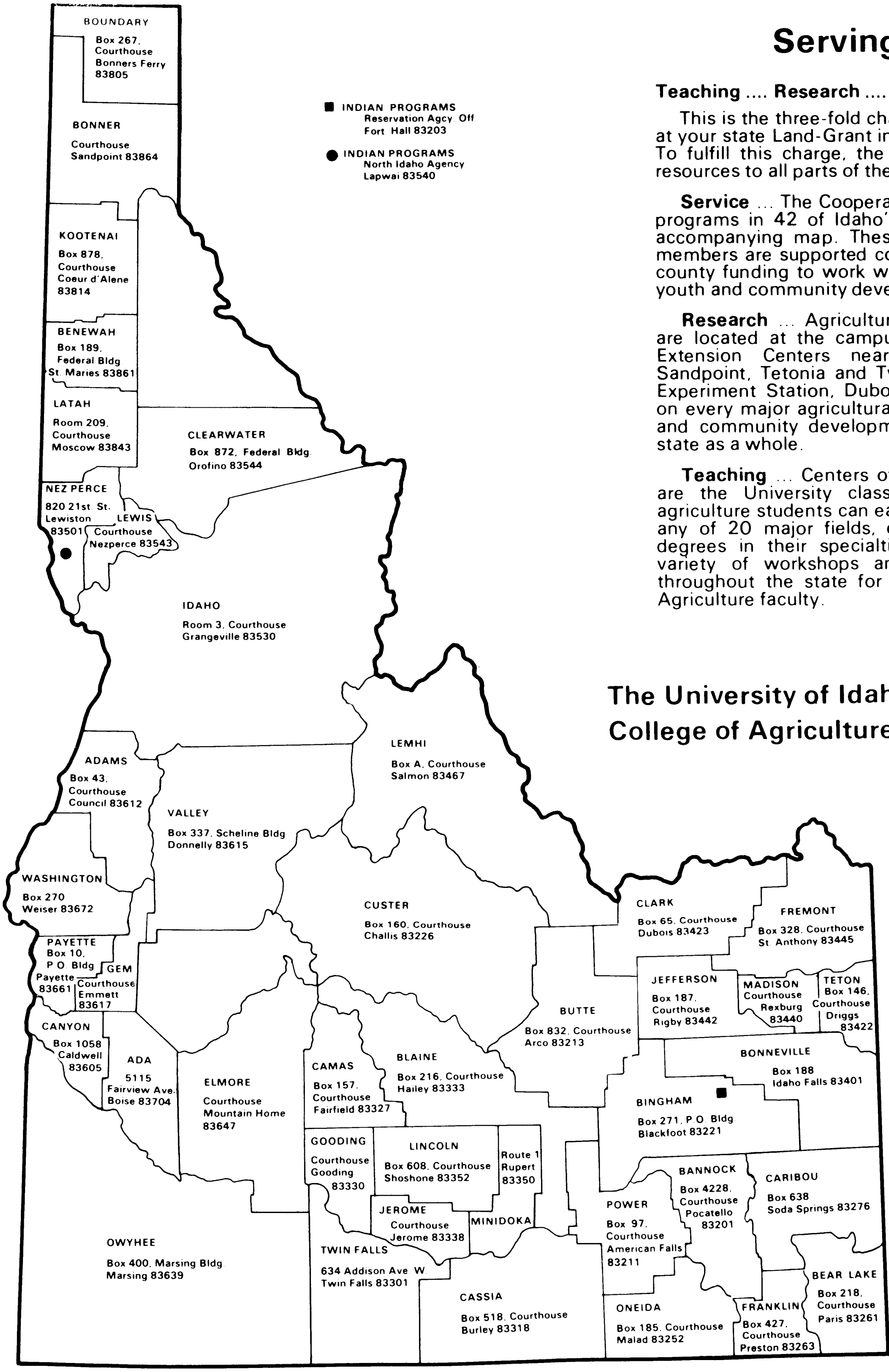

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