Harvester Chain Speed Adjustment

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The best approach to minimizing tuber damage in the harvester is to eliminate nearly all of the soil with the primary chain. Then keep the subsequent chains as full of tubers as possible without spill-out, roll-back, or backfeeding under the previous chain. This approach results in lower tuber damage, and fewer vines and less soil going into the truck.

The following sequence of steps is for use in adjusting chain speeds for proper loading.

Speed Tuning Steps

1. Measure the speed of the secondary, rear-cross, elevator and boom chains in feet per minute. Some measurement methods are shown below. Be certain that your tractor engine is at the speed that it will run during actual harvesting. That should be **at least 1600 rpm** to assure adequate engine lubrication.

2. Match the ground speed to one of those chain speeds, preferably the fastest chain. The ground speed should be such that the chain speeds are in ratio to it as shown in Table 1, based upon yields of 500 to 600 hundredweight (25 to 30 tons) per acre. (For other yields, see Table 2.)

Table 1. Chain-to-ground Speed Ratios

Chain	Chain speed as percentage of ground speed
Primary, sandy soil	100-120%
Primary, heavy soil	120-150%
Secondary*	65%
Rear-cross*, elevator* & boom	50-60%

*But not less than 100 feet per minute.

As a speed matching example, imagine that you wish to match the ground speed to a rear cross that is running at 135 feet/minute. Since the chain speed should be 50 to 60% of ground speed (use 55%), the ground speed should be about 135/.55=245 feet/minute. It can range from 225 to 270 feet/minute, since the chain-to-ground speed ratio can range from 50 to 60%. To get the speed in miles per hour, divide feet per minute by 88 (88 feet/min. = 1 mph), for example:

245 / 88= 2.78 mph.

3. Accurately adjust ground speed to the chosen value (about 2.8 mph in this example). Don't trust the tractor speedometer. Measure ground speed by the wheel circumference method below. If you can't get close to a harvesting ground speed that matches one of your chain speeds, then find one that you can sustain and match the chain speeds to it.

4. Adjust the speeds of the other chains to fit the chain speed-to-ground speed ratios in Table 1.

Elevator: In our example harvester, let's say that the elevator is currently going only 118 feet/minute, but we want it to go about 135 feet/minute, the same as the rear cross. Count the number of teeth in the driver sprocket. Let's say its 12 teeth. We want to speed up the chain, so make the driver sprocket bigger (See Figure 1). Try a 14-tooth driver. You've increased the speed by 14/12 to (14/12) x 118 feet /minute = 137.7 feet / minute. That's close enough.

Boom: Again, in our example, we want the boom going about 55% of ground speed, or about 135 feet/minute. If the boom is currently running at 112 feet/minute and has a 20-tooth driver, then we need to use a bigger driver. If we use a 22-tooth, the speed becomes (22/20) x 112 = 123 feet/minute, a little slow. Try a 24-tooth: (24/20) x 112 = 134 feet/minute, close enough.

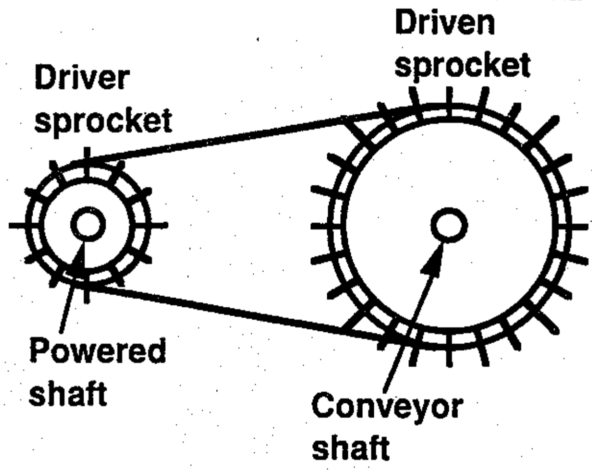

Figure 1. Sprocket drive terminology.

Secondary: The tuber trajectory is critical from chains like the secondary, which load the subsequent chain at 90° (Figure 2). If the chain runs too fast, it throws tubers all the way across the subsequent conveyor. If the chain runs too slow, the tubers back-feed under the conveyor. Backfeeding occurs whenever these chains run slower than 95-to-100 feet/minute. The secondary should go about 65% of ground speed, but never slower than 100 feet/minute. (Thus, ground speed should never be slower than 100/.65=~150 feet/minute, or 1.75 mph.) In our example harvester, the secondary is initially going 122 feet/minute, but we want it going .65x245=159 feet/minute. If the driver sprocket has 14 teeth, let's try one with 17. That gives (17/14)x122=148 feet/minute. An 18-tooth sprocket will give us (18/14)x122=157 feet/minute, which is OK. Note: the **Deviner chain** should be set to run at the same speed as the secondary.

In all of these examples, we've shown changing the driver sprocket, not the driven. The driver sprocket is the one on the powered shaft; so if you add teeth to it, the chain goes faster. The driven sprocket is the one driven by the chain, so if you add teeth to it, you decrease the conveyor speed. For example, if you change a driven sprocket from 32 to 36 teeth, the new speed will be 32/36 times the original speed.

Primary: From Table 1, and for light to medium soil, the primary should be going about 1.2 times ground speed, or 1.2x245=294 feet/minute.

5. After setting the chain speeds, harvest potatoes at the speeds selected. If tuber loading is too low, shift the tractor up one gear. If soil loading is too high, speed up the primary chain 15 to 30 percent.

You may have to adjust primary chain speed as field moisture and soil texture changes, but as long as yields are fairly uniform, the secondary and subsequent chain speeds can remain the same.

Remember, the primary chain is where nearly all of the soil should be eliminated. The rear-cross and subsequent chains should be kept full of tubers to minimize damage. The secondary is the "shock absorber" that will take care of occasional increases in soil loading. **Blade depth** should be just enough to get all of the tubers.

In all of the examples so far, we've used chain speed-to-ground speed ratios optimized for yields of 500 to 600 cwt. (25 to 30 tons) per acre. Table 2 gives ratios for other yields. Note that yield only affects the ratios for the rear cross, elevator and boom. That's because those chains should be handling mostly potatoes. The primary is handling mostly soil, so yield has little influence on its speed adjustment. The secondary is a transition chain and must be operated to properly load the rear cross, so it should always run at about 65% of ground speed, but no slower than 100 feet/minute.

For more than 2 rows going into the harvester (e.g., use of sidecasters), chain speed-to-ground speed ratios for the rear cross, elevator and boom may need to be increased. Note that the guiding principle is to keep chains as full as possible of tubers without rollback, spillout, or backfeeding.

Table 2. Chain speeds as percent of ground speed for a range of tuber yields.

Yield (cwt.)	Rear cross & Elevator	Boom
700	70%	60%
600	60	55
500	50	50
400	50	40
300	40	30
200	30	20
100	20	20

Speed Measurement Methods

1. Chain-length and timing method:

1.1. Measure the total length of the chain in feet, preferably by counting the number of links in the conveyor chain, multiplying by the chain pitch in inches, and dividing by 12 to get feet of chain.

1.2. With the tractor engine running at normal digging rpm, measure how many seconds it takes for the chain to make 5 complete revolutions (Use one revolution for long chains like the side elevator and boom.).

1.3. The chain length multiplied by the number of revolutions and divided by the number of seconds required gives the chain speed in feet per second. Multiply by 60 to get feet per minute, or:

1.4. Length x revs x 60 ÷ seconds = chain speed in feet/minute.

2. Chain pitch and tachometer method:

2.1. Count the number of teeth in one of the head sprockets (the ones that engage the conveyor chain directly).

2.2. Determine the pitch in inches of the conveyor chain (the pitch when it was new is best).

2.3. Use a tachometer to measure the rpm of the head shaft.

2.4. Rpm x no. of teeth x pitch ÷ 12 = chain speed in feet per minute.

3. Wheel circumference method (for measuring ground speed):

3.1. Accurately measure the distance in feet required for the harvester wheel to turn 5 complete revolutions.

3.2. As in method 1, measure the time required for the wheel to turn 5 revolutions when the ground speed is near the desired speed.

3.3. Distance x 60 ÷ seconds = ground speed in feet per minute.

A word about minimum conveyor speed

Any conveyor that feeds another conveyor at 90°, such as the secondary, rear-cross, or elevator, should run **at least 100 feet per minute**. Anything slower will result in backfeeding. As Figure 2 shows, the chain speed should be between 100 and 165 feet per minute for proper loading of the following conveyor. If you drop a tuber only half an inch, it reaches a velocity of 98 feet per minute. So chain speed is not the most important factor in tuber bruise, but drop height is! An 8-inch drop results in a vertical tuber velocity at impact of 393 feet per minute. So be concerned about reducing the drops and keeping conveyors as full as possible without backfeeding, spill-out, or roll-back. The chain speeds can be up to 165 feet per minute if necessary with up-sloped conveyors, and up to 200 feet per minute with horizontal, flightless conveyors like the one shown. As a flight 2.5 to 3 inches high goes around the headshaft, it throws tubers at nearly twice the conveyor speed. So, if you have flights on your conveyors, get rid of them or use very short ones.

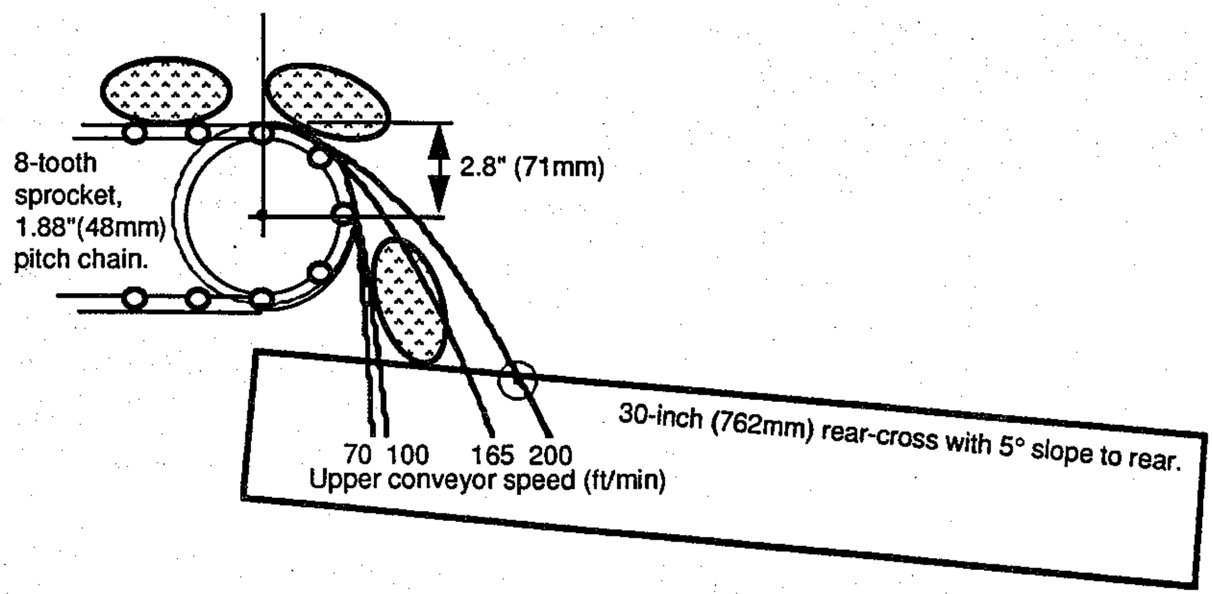

Figure 2. Tuber trajectories for three conveyor speeds and for the head sprocket size and dimensions shown.