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G95-1261 Five Strategies for Extending Machinery Life

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Five Strategies for Extending Machinery Life[1]

Machinery ownership and operation is a major crop and livestock production cost. Several items combined can significantly affect costs, improve machine reliability and improve profit margins.

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How to Get Maximum Machinery Life

This fact sheet discusses five strategies to achieve maximum farm machinery life. These strategies are: machinery maintenance, oil analysis, machinery storage, engine tune-ups, and avoiding modification of tractor engines.

Machinery Maintenance

A midwest study showed that many farmers can reduce machinery repair costs 25 percent by improving routine maintenance procedures. With a yard full of machinery, that savings can be significant. As an example, an $80,000 tractor typically will require about $24,000 in repair costs during 5,000 hours of operation when receiving average maintenance. This cost can be decreased to approximately $18,000 with excellent service management.

Timely preventative maintenance and inspection not only will help reduce major problems and downtime, they also will help identify developing problems while they possibly can be corrected with relatively minor repairs.

Equipment repaired during the winter can save money on service at mechanics' shops. An effective machinery service program requires good record keeping. It shouldn't be based on the operator's feelings or memory as to when a machine needs attention.

The maintenance program must be based on fact as determined by an accurate service record for each piece of equipment as recommended by the operator's manual and adjusted to individual conditions.

To aid record keeping, mount a service record chart for each vehicle and implement in a prominent area of the farm shop or in a service "record book." Identify hour maintenance intervals such as 10, 50, 100, 250 and 500 so it is convenient to identify, perform and record the services needed *(Figure 1)*. Be sure to follow the "Preventative Maintenance Guide" in the operator's manual for each particular piece of equipment (similar to items at the bottom of *Figure 1*). Carry a small notepad in each cab to record problems and observations as they arise.

Figure 1. EXAMPLE MAINTENANCE CALENDAR BASED ON OPERATIONAL HOURS

SERVICE SCHEDULE FOR ______________________

Hours of Operation	HOUR METER READINGS																			
10 Hour Service																				
10 Hour Service																				
10 Hour Service																				
10 Hour Service																				
10 Hour Service																				
50 Hour Service																				
100 Hour Service																				
250 Hour Service																				
500 Hour Service																				
1000 Hour or Yearly																				

Place chart in a prominent place in the shop. Perform the required service and write down the hour meter reading. Continue down the column to the 50-hour level and move to the top of the next column after the next 10-hour interval.

Example: Maintenance to be Performed on Tractors*

Maintenance as Required

1. Inflate Tires
2. Adjust Brakes
3. Clean Cab Air Filter
4. Tighten Loose Nuts or Bolts
5. Repair Worn or Damaged Parts
6. Adjust Headlights
7. Remove Grease, Chaff and Soil

10 Hours (Daily)

1. Check Air Cleaner/Pre-cleaner
2. Check Crankcase Oil Level
3. Check Cooling System Level
4. Lubricate Grease Fittings
5. Check Fuel Sediment bowl
6. Check for Loose or Damaged Parts
7. Check for Leaks
8. Check Drive Belts and Hoses

50 Hours (Weekly)

1. Check Battery Electrolyte Level
2. Check Hydraulic System Fluid Level
3. Check Transmission Oil Level
4. Clean Dry-Element Air Cleaner
5. Clean Inflation Pressure
6. Perform 10-Hour Maintenance

100 Hours (Every 2 Weeks)

1. Change Crankcase Oil and Filter
2. Perform 10 and 50-Hour Maintenance

250 Hours (Monthly)

1. Clean Battery
2. Adjust Clutch Pedal Free Travel
3. Check Belt Tension
4. Check and Adjust Brakes
5. Perform 10 and 50-Hour Maintenance

500 Hours (Every 2 Months)

1. Replace Fuel Filters
2. Perform 10, 50, 100 and 250-Hour Maintenance

1000 Hours (Yearly)

1. Drain and Refill Transmission and Hydraulic System
2. Adjust Engine Governor if Recommended by Manufacturer
3. Clean and Repack Front Wheel Bearings
4. Drain, Clean and Refill Cooling System
5. Check Air Conditioning Components
6. Perform 10, 50, 100, 250 and 500-Hour Maintenance

*Always follow the Operator's Manual Recommendations, as particular maintenance operations will vary with make and type of implement.

Figure 1. Example Maintenance Calendar Based on Operational Hours. (8K PDF)

A large planning calendar is a useful reminder. Use this calendar for noting major repair and service operations to be carried out on each piece of machinery in the months ahead. This system is more effective than depending on memory, especially where more than one operator uses the machines. As repairs are needed, make a list on the calendar.

Cover all charts and the calendars with Plexiglass. Record data with a grease pencil; at the end of the year the plexiglass can be erased and the chart and calendar reused. Maintenance charts may not solve all maintenance problems and they do require work to keep them up-to-date. If extending economic machinery life is the objective, timing of proper maintenance, as recommended by the manufacturer, is the best way.

Oil Analysis

A detailed look at a sample of engine, transmission or hydraulic oil is a valuable preventative maintenance tool. In many cases it enables identification of a potential problem before a major repair is necessary and downtime during critical operations can be avoided. Oil analysis is a means of monitoring wear and oil contamination. When done on a regular basis it establishes a baseline of normal wear and can indicate when abnormal wear or contamination occurs.

For more details, review *NebFact 95-225, Oil Analysis*.

Machinery Storage

Snow piling around and over machinery during the winter is doing more than covering it up -- it also is eating away at the investment. Equipment stored inside has a significantly higher trade-in value compared to the same equipment stored outside, as shown in *Table I*.

Table I. Greater trade-in value for machinery stored inside compared to unhoused.

	Saving as a Percent of Initial Price	
	TOTAL	**Annual Savings**[1]
Tractors	16%	1.6%
Harvesting Equipment	20%	2.0%
Planters and Drills	12%	1.2%
Tillage Equipment	5%	0.5%
Average Increase	**13.5%**	**1.4%**
[1]Assuming 10 year life.		

The farmer who keeps the most valuable and vulnerable machinery out of the weather can save a lot of money. For example, consider keeping $300,000 worth of tractors, combines and planters inside, and assume 50 percent trade-in value after five years. The equipment's value is approximately $20,250 greater because it was stored inside, assuming the trade-in value is increased by only 13.5 percent.

Inside storage of a small tractor will increase the trade-in value by $400 to $500 per year. Proper storage of a 4-wheel-drive tractor should add $1,000 to $2,000 per year to the resale value. Storage also saves money by reducing repairs and time in the shop.

Machinery stored inside had only 7.6 percent downtime, while unhoused equipment was down 14.3 percent of the time it should have been working. Parts such as belts, tires and hoses deteriorate rapidly when unprotected. Places where water can collect and freeze are problem areas.

To determine the value of stored machinery, sum the increase in trade-in value, value of fewer repair costs and less downtime. Now with these values, determine the value for storage as a percentage of initial price. *Table II* estimates these savings as a percentage of initial purchase price.

Table II. Annual savings due to machinery storage.

	Saving as a Percent of Initial Price			
	Greater Value	**Fewer Repairs**	**Less Downtime**	**TOTAL**
Tractor	1.6	1.5	1.2	4.3%
Combine	2.0	3.5	1.2	6.7%
Planter	1.2	2.5	1.2	4.9%
Tillage	0.5	0.5	0.6	1.6%

To determine whether a new machinery storage building will pay, you must determine a method to allocate building costs. The building may have alternate uses (i.e., temporary grain storage, repair and service area) and will have a longer life than most implements, so the annual cost for the building must be determined. Then, compare costs to the expected increase in value of the machines stored on an annual basis (example shown in *Table III*).

Table III. Example of stored machinery savings versus storage costs.

	Based on Annual Value		
Machinery	**Machinery Savings**	**Storage Cost**	**Net Annual Saving/(Loss)**
Tractor	($80,000 x 4.3%) $3,440	(240 ft² x $.70/ft²) $168	$3,272
Combine/ Header	($100,000 x 6.7%) $6,700	(483 ft² x $.70/ft²) $338	$6,362
6-Row Planter	($13,000 x 4.9%) $637	(225 ft² x $.70/ft²) $158	$479
22-ft Tandem Disk	($7,500 x 1.6%) $120	(263 ft2 x $.70/ft²) $185	($65)

The storage area is taken from: *NebFact 95-226, Estimating Floor Space for Farm Equipment Storage*.
The estimated annual cost of machinery storage (includes depreciation of investment, interest, taxes and insurance).
The estimate for machinery storage was $.70 per ft² annually.

Machines, including tractors, combines, planters, drills, forage choppers, trucks and pickups should be kept inside. Tillage implements should be the last to be placed inside. They take up a lot of space and decline in value only slightly faster when left outside. After five years, tillage equipment kept inside is worth only about 5 percent more than if left outside. Usually, the deterioration that occurs to the tires and bearings is less than the cost of providing building space.

Machine storage building plans are available from the extension office for a small fee.

Engine Tune-Ups

Diesel and gas engines require periodic tune-ups. As engines operate, they lose power and fuel efficiency. To obtain the optimum performance from an engine, the power produced and the fuel consumed should be checked and compared to the University of Nebraska Tractor Test data. Test reports can be obtained from the Nebraska Tractor Testing Laboratory, Biological Systems Engineering Department, L.W. Chase Hall, University of Nebraska, Lincoln, NE, 68583-0726.

Test results include several ratings for each tractor. For comparative purposes, look at the figures that indicate tractor PTO horsepower and fuel efficiency at maximum PTO horsepower. The next step is to test the tractor.

The tractor should be tested on a certified PTO dynamometer found at most equipment dealers. Attach the tractor's power take-off to a dynamometer, warm the engine up and check to see if it produces rated PTO horsepower. If tractor power is down by more than 5 percent, adjustments or a tune-up is needed. A tune-up may include changing air and fuel filters, cleaning and adjusting injector nozzles and adjusting engine timing.

Another important part of tractor operation is checking fuel efficiency. This can be done at the time the tractor is operating on the PTO dynamometer. After the tractor is warmed to operating temperatures, stop the tractor and fill the fuel tank completely full. Operate the tractor at rated speed and load for 30 minutes (longer for more accurate results), then stop the tractor and refill the tank to the previous level, keeping track of the gallons needed. Fuel efficiency will give an idea of the engine's condition.

Fuel efficiency or economy is measured in horsepower-hours per gallon (hp-hr/gal), much as automobile fuel efficiency is measured in miles per gallon. To calculate the efficiency of the tractor, first determine the gallons of fuel used in one hour. For example, a diesel tractor producing 155 hp and using 5.5 gallons in 30 minutes, would use 11 gallons in an hour. Divide the 155 horsepower by 11 gal/hr, which gives a fuel efficiency of 14 hp-hr/gal.

Compare this figure to University of Nebraska Tractor Test data during the PTO tests at rated horsepower. If the current efficiency is 5 to 10 percent less than original, there may be a problem that needs correction. If an engine is showing a 5 percent reduction in fuel efficiency, it is wasting about 5 percent of the fuel. In a 155 horsepower tractor burning 11 gal/hr, this adds up to 0.55 gallons of fuel wasted every hour or 275 gallons wasted every 500 hours of use.

Avoid Modification of Tractor Engines

A tractor engine may be "modified" to get more power. Frequent claims about pulling bigger loads, getting new "life" from older models and more power from new models are true. Engine modification can be done by several means. The most common are overfueling, while others include adding alcohol or LP gas injection, and turbo-charging naturally aspirated engines.

These all sound tempting when an operator is faced with covering more acres in less time. But are the consequences of boosting engine horsepower beyond original ratings worth it? The first problem is warranty. Most manufacturers do not allow any changes from standard specifications without voiding the warranty, so you're on your own with the changes.

The second problem with engine modifications is an almost sure reduction in service life. Every machine design is a compromise. The designer must compromise between strength, reliability and cost to come up with a tractor rugged enough to do a job, but still meet an affordable price.

Power is a function of torque and RPM. Tractors are designed to operate at different travel speeds, but the final drives are not designed for all possible torques theoretically available. If power is increased 20 percent on a tractor, you're assuming the manufacturer built the engine parts, clutch, transmission and final drive 20 percent stronger than originally needed. Speed also has an effect on service life. For the example just stated, the 20 percent increase of power could be used by keeping the tractor weight the same and travel faster. This would reduce the life of the transmission by about 15 percent. Conversely, if one uses the 20 percent additional power for 20 percent larger pulls and drives at a slower speed, the transmission life is reduced by 50 percent. Usually, to take advantage of the increased pulling ability, more ballast (weight) must be added to maintain effective traction. Then, all parts will be overloaded, and service life will suffer *(Figure 2)*. In the end, the tractor probably will end up in the repair shop long before it should.

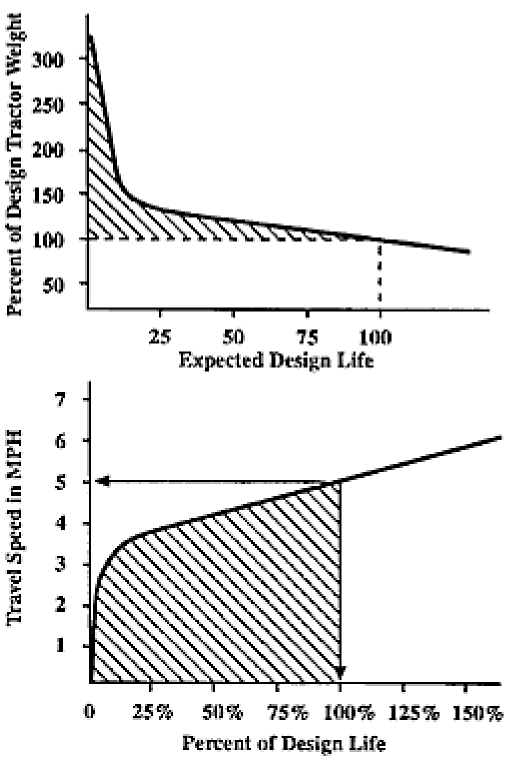

Figure 2. Design life of final drives is reduced with extra ballast and overfueling the engine (top graph). The reduction is a result of overloading the design requirements of the tractor. The major component that determines the design life of a final drive is the tractor's operating speed (bottom graph). Few final drives are designed to operate at maximum power in the lowest transmission gears.

The simplest, cheapest and easiest engine modification is done by changing the injector pump. By pumping in more fuel (overfueling), the power of the engine will probably go up, but another problem arises. At the factory, most tractors are set to their most efficient operational level. If the engine is overfueled, the fuel efficiency almost always will go down. This means the power output for the fuel poured into the engine will be less, so in the long run, the extra fuel will cost money.

If more power is needed, it is better financially to trade for a bigger tractor. Larger tractors are built for higher power from the radiator to the wheels and should give good service. Trying to get more power by modifying a tractor may prove to be extremely expensive.

Summary

This fact sheet has discussed five strategies to achieve maximum life from farm machinery. These practices included machinery maintenance, oil analysis, machinery storage, engine tune-ups, and avoiding modifying tractor engines. No single item will have a large impact, but a combination of practices can have a large impact on costs, improve machine reliability for many years to come and improve profit margins.

[1]Modified from: Hofman, V.L. and Kucera, H.L. 1987. Extend machinery life to save dollars. AE-939,

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