Conservation Storage and Handling of Fuel for Farm Machinery

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energy management in agriculture
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CONSERVATION,
STORAGE &
HANDLING OF
FUEL FOR
FARM MACHINERY

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Current fuel prices and the uncertainty of future supplies have motivated many farmers to adopt (or at least investigate seriously) cropping practices that require less energy input. Being able to halve the fuel used for field operations in corn production, for instance, would result in a savings equal to 2-3 bushels per acre—a significant enough figure in times of narrow profit margins.

There are numerous ways to both maximize efficient use and minimize waste of fuel on the farm. Most of those associated with field operations would be considered simply a part of good equipment management. The other area where good management could pay significant conservation dividends is fuel storage and handling.

This publication reviews what you the farmer should consider relative to your field machinery that will result in greater fuel economy. We will then look at what can be done in how fuel is stored and handled to prevent unnecessary loss and insure safety.

MACHINERY MANAGEMENT FOR FUEL EFFICIENCY

The energy conservation suggestions dealing with field machinery fall into three categories—equipment selection and sizing, equipment maintenance and adjustment, and equipment operation and use.

Equipment Selection and Sizing

A farmer's opportunity to affect fuel efficiency through selection and sizing comes only when a particular piece of equipment is replaced. So it's important that the right decisions be made, because you'll have to live with them for the next 3-5 years.

There may be dozens of factors that could be considered in the process of selecting farm machinery. The ones that impact most directly on fuel efficiency, however, are discussed briefly here. They include: fuel type, engine design, transmission type, four- vs. two-wheel drive, tire size and configuration, implement type and implement size.

Fuel type. In recent years, the farm equipment industry has moved almost exclusively to diesel power plants. Today, only some smaller size tractors are available in either gasoline or diesel models, but combines are virtually all diesel-powered. In terms of fuel efficiency, the change is certainly justified. While the heat value of diesel fuel is only about 13 percent greater than for gasoline, a diesel tractor does 20-30 percent more horsepower-hours of work per gallon of fuel than a comparable size gasoline tractor.

Fuels of the not-too-distant future will likely include alcohol and vegetable oils, either straight or as mixtures with diesel fuel or gasoline. At this point, it appears that these alternative fuels may be less efficient on a per-gallon basis; but the offsetting advantage is that they come from renewable resources produced in this country, rather than from nonrenewable petroleum purchased elsewhere.

Engine design. The fuel efficiency of a farm tractor depends not only on how it is operated and maintained, but also on the original characteristics of its engine and power train. Thus, we find that fuel consumption can differ significantly among different makes of tractor. For instance, results from recent Nebraska Tractor Tests* of diesel tractors in the 90-110 hp range show a 24 percent spread between the most and the least fuel-efficient models. While other factors must also be considered in selecting equipment (like dealer service, initial price, etc.), fuel efficiency ratings should not be overlooked.

Transmission type. Like engine design, transmissions also differ in fuel efficiency. For instance, power loss through the transmission has been estimated at 3-5 percent for sliding gear types, 7-10 percent for power shift (shift-on-the-go) types and 20-25 percent for the hydrostatic types. What is the "right" transmission for a tractor or other self-propelled farm equipment, with an eye toward fuel efficiency, depends on how and where it's used.

The need for power shifting under typical field conditions may be minimized by selecting a tractor with good lugging ability, which is the ability of an engine and transmission to withstand momentary overloads by increasing drawbar pull as engine speed is pulled down. Desirable lugging ability, then, implies a rapid pull increase with a minimal decrease in engine speed.

The Nebraska Tractor Tests show the differences among tractors in lugging ability. In one test comparing three 150-160 hp diesels to meet a 15 percent overload

*All tractors sold in Nebraska must be tested at the tractor test facilities maintained at the University of Nebraska, Lincoln, NE 68508. Write to their Agricultural Engineering Department for additional information or for test reports for specific tractors.
condition (similar to going through a soft spot in the field or up a slight incline), one tractor was pulled down to about 92 percent of its rated engine rpm and another one to about 83 percent of its rated rpm, while a third tractor could not meet the overload condition and had to be down-shifted.

Hydrostatic transmissions (and variable-speed V-belt drives) are used extensively on self-propelled combines and on some tractors to allow the matching of ground speed to crop conditions. Here, the main function of the drive train is simply to transport the combine and harvested grain. So transmission inefficiency is not a big issue, since most of the engine's fuel requirement is for processing the crop (i.e., gathering, threshing, separation and cleaning), not for moving the machine.

With most tractors, on the other hand, the main transmission function is usually to move the tractor and pull an implement (i.e., produce drawbar pull). This makes the hydrostatic transmission less desirable from a fuel efficiency standpoint. However, the tradeoff between fuel economy and speed-matching convenience must be carefully weighed, if the tractor is to be used primarily for feedlot or farmstead work or for such field operations as baling hay and chopping silage.

**Four-wheel vs. two-wheel drive.** Four-wheel drive (4WD) tractors have some natural fuel economy advantages over 2WD tractors of comparable size. First of all, the entire weight of the 4WD can be utilized to produce drawbar pull, while a 2WD tractor must carry a portion of its weight on the nonpowered front tires simply to maintain steering control. Secondly, under soft ground conditions, the front drive wheels on a 4WD improve the tractive surface for the rear drive wheels. This means better traction and fuel economy than for a 2WD tractor (even a dualed 2WD) where all tires must operate on the same soft soils.

Front-wheel-drive conversion kits for 2WD tractors are likely to improve performance somewhat under many conditions. But don't expect a converted 2WD to match the performance of a tractor designed from the ground up as a 4WD.

**Tire size, type and configuration.** On soft ground, wide and/or dual tires on tractor drive wheels, on front wheels of 2WD tractors and on rear guide wheels of selfpropelled combines reduce the amount of tire sinkage and rolling resistance that must be overcome. Radial-ply tractor tires, because they dissipate less internal energy and have a long footprint, appear to be about 4-8 percent more fuel efficient than conventional bias-ply tires; but their cost is significantly greater.

**Implement selection.** The cultural practices a farmer follows determines type and use of implements. Reduced or conservation tillage systems, for instance, not only utilize lower draft requirement tools than the moldboard plow, but also call for fewer tillage passes. The net result is a fuel savings of from one to several gallons per acre (see Table 1). For guidance in selecting appropriate tillage practices for your farm's field conditions and soil types, and for determining the specific fuel requirements of these practices, see Purdue Extension publications AY-210 and AE-110 listed on page 8.

**Matching implements.** Poorer fuel efficiency results when implements are either too small or too large for a tractor. For example, most tillage tools are designed to operate at 4-6 mph. If run at higher speeds (which often happens when an implement is too small for the tractor), draft requirements increase, cutting fuel economy; work quality is also likely to suffer, requiring subsequent fuel-consuming operations. When an implement is too big, the tractor must be weighted heavier, which increases soil compaction as well as fuel consumption. Overloading of a tractor for long periods can also lead to early power train failure, excessive tire wear and costly repairs.

### Table 1. Diesel Fuel Required for Field Operations in Conventional, Chisel and No-Till Systems for Corn on Moderate Draft Soil.

<table>
<thead>
<tr>
<th>Tillage system and field operations*</th>
<th>Diesel fuel required gal./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional system</strong></td>
<td></td>
</tr>
<tr>
<td>Disk stalks</td>
<td>0.45</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>1.85</td>
</tr>
<tr>
<td>Tandem disk</td>
<td>0.55</td>
</tr>
<tr>
<td>Apply anhydrous ammonia</td>
<td>0.70</td>
</tr>
<tr>
<td>Field cultivated</td>
<td>0.60</td>
</tr>
<tr>
<td>Plant</td>
<td>0.50</td>
</tr>
<tr>
<td>Cultivate</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Chisel system</strong></td>
<td></td>
</tr>
<tr>
<td>Chisel plow**</td>
<td>1.25</td>
</tr>
<tr>
<td>Disk</td>
<td>0.55</td>
</tr>
<tr>
<td>Apply anhydrous ammonia</td>
<td>0.70</td>
</tr>
<tr>
<td>Field cultivate</td>
<td>0.60</td>
</tr>
<tr>
<td>Plant</td>
<td>0.50</td>
</tr>
<tr>
<td>Cultivate</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>3.95</td>
</tr>
<tr>
<td><strong>No-till system</strong></td>
<td></td>
</tr>
<tr>
<td>Shred stalks</td>
<td>0.75</td>
</tr>
<tr>
<td>Apply liquid N</td>
<td>0.20</td>
</tr>
<tr>
<td>No-till plant</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>1.45</td>
</tr>
</tbody>
</table>

*Only field operations that differ with tillage systems are listed—i.e., applying P and K, harvesting, etc., would require the same amount of fuel regardless of tillage systems.

**Assumes a coultor-chisel—i.e., chisel plow with gang of coulters at the front to cut through trash.**


**Equipment Maintenance and Adjustment**

Unlike selection and sizing, the opportunity to maximize fuel efficiency through equipment maintenance and adjustment presents itself almost daily. And because they so directly affect fuel economy, maintenance and adjustment should be an integral part of the operator's routine procedures. The major on-going activities discussed briefly here are engine care, cutting tool sharpness, implement adjustment and tire pressure.

Important to proper, efficient maintenance and adjustment are a good set of tools and a good place to work. Having the right hand tools with you in the field allows one to make most minor repairs quickly and safely. A well-
equipped, modern farm shop likewise permits fast equipment servicing during the busy seasons, and thorough preventive maintenance or machinery reconditioning in the off-season. For information on efficient repair facility alternatives and a suggested inventory of tools, see Extension publication AE-104 listed on page 8.

**Engine maintenance.** Tractors, self-propelled field machinery, pickups and farm trucks, family automobiles, even lawn and garden equipment need periodic engine tune-ups and occasional overhaul. Depending on initial condition, a tune-up of gasoline engines (ignition, carburetor, etc.) can result in a 5-20 percent savings in fuel. With diesels, the injectors and injector pumps are the key components to be kept in top operating condition.

Both gasoline and diesel engines need their air filters regularly cleaned or replaced to insure the proper air-fuel mixture for efficient combustion; excessive exhaust smoke may indicate a dirty filter. It's also important that the fuel be dirt- and water-free; this means keeping storage and fuel transport equipment clean and checking filters often. And be sure to perform the routine maintenance tasks recommended in the equipment operator's manual and in the way outlined.

**Cutting tool sharpness.** This has a surprisingly significant effect on fuel efficiency. For example, dull knives in a forage harvester or dull shares on a moldboard plow can increase power requirements—and fuel use—up to 30 percent. Therefore, keep cutterbars on mowers, windrowers and grainheads sharp and properly adjusted; replace plowsshares and other tillage shovels when they become worn and dull.

Use of small-opening screens in hammermills and choppers, and recutter screens will also increase fuel consumption. So consider the trade-off between more finely ground or chopped material that is probably more palatable vs. better fuel economy by using larger-hole screens or eliminating the recutter screen.

**Implement hitching and adjustment.** This can have a 5-20 percent effect on fuel consumption, especially in the case of high-draft tillage tools. Improperly hitched moldboard plows can greatly increase landside pressure, thus the tractor's fuel requirements.

Attempt to maintain side-to-side and fore-to-aft levelness of all tillage implements for greatest operating efficiency as well as work quality (Figure 1). Review the operator's manual for recommended adjustments and how to make them. Keep fasteners tight, shanks aligned and uniformly spaced, and replace any bent or damaged components that affect implement draft.

**Tire inflation pressure.** Maintaining proper tire pressure is so important to fuel efficiency and so easy to do, yet so often neglected. Use the tire-maker's recommended inflation pressure based on total load on tires.

Under-inflation increases rolling resistance, thus power requirements and fuel use. Slight over-inflation of implement tires and the front tires on 2WD tractors will reduce rolling resistance. Over-inflation of tractor drive wheel tires, on the other hand, decreases tractive efficiency, wastes fuel and may cause premature tire failure. For conventional plowing, however, it is generally suggested that inflation pressure be increased 2-4 psi in the downside (furrow) tractor tire, provided this doesn't exceed the maximum recommended pressure.

**Equipment Operation and Use**

Assuming a piece of farm machinery has been properly selected, maintained and adjusted for top performance, fuel consumption can still be affected by how it is operated and used. Following are suggestions that should maximize operating efficiency.

**Engine idling.** Over the course of a season, it's surprising the number of idling hours that can accumulate on tractors, combines and trucks. The real inefficiency is that this practice yields no productive output from the costly fuel energy input. Of course, there are times when letting the engine idle is the practical, even recommended, thing to do (e.g., idling a large engine to allow slow cool-down after heavy use). However, many times it is reasonable and also safer to shut-off the engine for such things as adjustments, repairs, refills, counting rows, refreshment breaks, conversations, etc.

**Heavy-load operations.** When performing high-draft requirement operations, tractor weighting may need to be adjusted to minimize wheel slip, even if the tractor and implement are well matched. Wheel slip is easy to check in the field (Figure 2). Simply count the number of drive wheel revolutions over some convenient distance as the tractor operates with the implement down (loaded), then over the same distance with the implement raised (no-load). Amount of wheel slip is determined using this formula:

\[
\text{Percent wheel slip} = \frac{\text{Loaded revolutions} - \text{No-load revolutions}}{\text{Loaded revolutions}} \times 100
\]

Figure 1. Maintain implement levelness with proper hitching and adjustment for best work quality and efficient operation.
“Optimum” slip for high draft operations on a firm soil surface is about 10 percent, and on loose or sandy soils is about 15 percent. Excessive slippage not only wastes fuel, but can also cause premature tire wear.

Adding wheel weights or liquid ballast will usually reduce slippage, improve performance and fuel efficiency. But don’t overload the drive wheel tires. Consider instead operating tillage tools at a shallower depth or narrowing down the implement by removing an outside shank, folding up winged sections or reducing variable-width plows.

**Light-load operations.** For relatively low draft requirement operations, employing a technique known as shift-up-and-throttle-back can result in a 20-30 percent fuel savings. It works this way: rather than operating at full throttle in a lower gear, one shifts to a higher gear then throttles back to the same ground speed. This produces equivalent drawbar horsepower (i.e., same pull at the same speed), but puts the engine nearer the peak of its torque curve for the new throttle setting. Nebraska Tractor Tests for drawbar performance show that shift-up-and-throttle-back can significantly improve fuel efficiency in small and large tractors alike (Table 2).

Another way to maximize fuel economy under light-load operations is to remove excess tractor weight—cast iron wheel or front-end weights, saddle tanks, front-end loaders, etc. Unnecessary weight increases rolling resistance plus contributes to soil compaction (see Extension publication AY-221 listed on page 8). With a well-equipped farm shop, the job of removing or adding weights is not all that troublesome.

**Soil condition.** Don’t work the soil when it’s too wet. The results are likely to be (1) poor quality work, often requiring extra fuel-consuming trips back over the field; and (2) unnecessary soil compaction that either hurts crop response or increases draft requirements for tillage operations later.

**Tillage depth.** Don’t till too deep; it just takes extra fuel! For instance, if chiseling to 8 inches has given satisfactory results, why chisel to 12-14 inches deep just because the horsepower is available? Also consider varying tillage depth a few inches from year to year; in some soils this can help prevent the formation of plow soles or hardpans at or below the tilled depth.

**Concurrent field operations.** A significant portion of fuel use in most field operations is simply to move the tractor along. Thus, performing two or more tasks with one pass can save up to 40 percent in fuel compared to a separate pass for each task, as well as lessen soil compaction. Some logical combinations of field operations would be: tillage and nitrogen application, tillage and herbicide application, final seedbed preparation (light tillage or leveling) and planting.

**Field harvest unloading.** On-the-go unloading of self-propelled combines may save fuel (1) by eliminating combine travel to and from transport vehicles and (2) by utilizing the same fuel energy to unload as well as to continue harvesting. However, this practice must be weighed both against the fuel consumed by the “chaser” unit or transport vehicles that follow the combine and against the need for greater operator skill to accomplish on-the-go unloading. Soil compaction may also have to be considered.

**Transport vehicles.** Type, size and positioning are three fuel efficiency factors related to the vehicles that haul harvested crops from the field and/or seed, fertilizer and other supplies to it. Concerning type, truck hauling is about twice as fuel efficient as hauling with tractor and wagon; in addition, proper rear axle ratios can significantly improve trucking fuel economy. Concerning size, larger transport equipment usually means fewer trips, thus less fuel used. And finally, anticipating the needs of a field machine and having the transport or delivery vehicle there at the right

**Figure 2.** Measure wheel slip in the field by counting loaded and no-load wheel revolutions over the same distance.

<table>
<thead>
<tr>
<th>Tractor type and maximum DBHP*</th>
<th>Fuel consumption, 50% of pull at Maximum power**</th>
<th>Net fuel savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In rated gear, full-throttle</td>
<td>In higher gear, part-throttle</td>
</tr>
<tr>
<td>4WD-262 hp</td>
<td>13.8</td>
<td>9.8</td>
</tr>
<tr>
<td>4WD-228 hp</td>
<td>13.0</td>
<td>8.8</td>
</tr>
<tr>
<td>4WD-189 hp</td>
<td>9.9</td>
<td>8.1</td>
</tr>
<tr>
<td>4WD-166 hp</td>
<td>7.9</td>
<td>6.1</td>
</tr>
<tr>
<td>2WD-149 hp</td>
<td>8.6</td>
<td>6.5</td>
</tr>
<tr>
<td>2WD-128</td>
<td>6.7</td>
<td>5.4</td>
</tr>
<tr>
<td>2WD-121 hp</td>
<td>6.4</td>
<td>5.5</td>
</tr>
<tr>
<td>2WD-102 hp</td>
<td>5.4</td>
<td>4.2</td>
</tr>
<tr>
<td>2WD-92 hp</td>
<td>4.9</td>
<td>4.0</td>
</tr>
</tbody>
</table>

*Tractors were selected to represent the range in sizes and types available for heavy field work. DBHP means drawbar horsepower.

**Both tests conducted at the same drawbar pull and speed resulting in the same drawbar horsepower.

Time can markedly improve field efficiency (i.e., making the most of valuable field time). Two-way radio communication has proven a valuable asset to coordinate field activity and vehicle positioning.

Business travel. An often-surprising statistic is that the typical family farm uses nearly as much fuel for its business autos and pickups as for all its field operations combined. While much of this travel is necessary, certainly some of it can probably be eliminated or at least better planned.

Get into the habit of planning your trips. During the busy season, use two-way radios to communicate with employees and family members, and the telephone (not the pickup) to track down emergency parts and services or needed supplies. In the off-season, see if you can combine crop surveillance and checking activities with other travel needs.

STORAGE AND HANDLING OF ON-FARM FUELS

Proper storage and handling will contribute significantly to overall fuel conservation on the farm. Unnecessary spillage, evaporation or contamination can easily offset any fuel efficiencies gained through machinery selection, servicing and operation. A safely designed storage facility also reduces the risk of fire or explosion, which could result in property damage or personal injury. This section discusses the considerations involved in safe storage and handling of on-farm fuels.

Underground Storage (Figure 3)

The preferred fuel storage method is underground tanks for at least four reasons. (1) The fuel remains cool year-round thus minimizing evaporation losses. (2) Water will not condense as readily in underground tanks, so the process of gum formation is slowed. (3) Because fire hazard is greatly reduced, underground tanks can be located as close as one foot from another building; this usually permits more convenient location for fuel servicing. (4) An underground tank cannot be accidently struck by a passing vehicle or attract the clutter that often accumulates around aboveground storages.

An underground tank should be located in a well-drained area and protected with a corrosion-resistant coating. Set it on a foundation of crushed stone, surround it with 6-12 inches of sand or gravel tamped in place, and cover with at least 2 feet of earth. If vehicles will be driving over it, cover the tank with at least 3 feet of earth or 18 inches or more of well-tamped earth plus 6 inches of reinforced concrete. Install the vent 12 feet in the air so it discharges away from possible ignition sources; the vent opening should be 1-1/2 inches in diameter.

Pumps for underground tanks should never be located inside a building. In fact, leave at least a 3-foot space between pump and building so any refueling mishap would not endanger the structure. Label the pumps as to the kind of fuel they contain; post "no smoking" signs—and enforce the rule! A tamper-proof nozzle arrangement and lockable master power switch located inside the nearest building will keep children and unauthorized persons from operating the pumps.

Aboveground Storage (Figure 4)

While underground fuel storage provides greater safety and location convenience, an aboveground facility usually costs less, can be moved relatively easily and would not be affected by ground water or limited flooding problems. Great care is needed, however, to insure that the facility will be safe as possible.

Aboveground tanks must be sturdy and designed for fuel storage. Do not use lubricating oil or agricultural chemical drums. Galvanized tanks are suitable for gasoline
storage, but not for diesel; diesel fuel reacts with the galvanized finish causing flakes to form in the fuel which soon clog filters.

Gravity-discharge elevated tanks should be mounted on sturdy, fire-resistant supports placed on a firm, level surface; this support structure should provide a safe way for climbing up to fill the tank and inspect the vent. As a fire safety measure, the bottom opening of gravity-discharge tanks should have the type of safety valve that will close automatically in response to heat from a fire, thus stopping further fuel flow. Also, the hose nozzle should have a self-closing valve for positive fuel shut-off to prevent leaking or dribbling when refueling.

All aboveground storage tanks must also be adequately vented to respond to temperature change. On a hot day, tank vapor pressure could build up to a dangerous level if vents are too small, clogged with dirt or sealed to prevent evaporation loss.

Locate aboveground storages at least 40 feet from other structures to reduce the chances of a building fire reaching the fuel or a fuel fire spreading to your building. (Tanks storing gasoline or other highly flammable fuels should never be located inside buildings). And keep the storage area free of weeds and trash to further minimize fire risk.

Gasoline evaporation losses can be sizable from unsheltered aboveground tanks. For instance, a red
gasoline storage tank exposed to direct sunlight may lose over 9 gallons of fuel a month. Therefore, paint tanks a reflective color such as white or aluminum, and shield them with an overhead canopy unless already located in a shaded spot.

To further reduce evaporation losses, use an approved pressure vacuum valve rather than the standard vented cap. When tank pressure rises, the pressure relief valve is forced open, allowing only enough fuel vapor to escape to relieve excess pressure. When the tank cools or fuel is withdrawn, the resulting vacuum causes the vacuum relief valve to open; this allows air into the tank to nearly equalize inside and outside (atmospheric) pressure, thus permitting a free outflow for fast equipment refueling.

To prevent tampering or fuel theft, be sure the hose nozzle can be locked to the hanger. Also, label the tanks showing the fuels they contain, and post "no smoking" signs.

Maintaining Fuel Quality
Gasoline and gasohol are especially susceptible to deterioration under long-term storage, especially above ground. Fuel stored for more than 30 days will begin to oxidize, forming gum deposits that can clog filters and foul up a machine's fuel system components. Also, the more volatile parts of a fuel mixture will evaporate over time, causing starting problems especially in cold weather.

Winter-blend gasoline, having a greater proportion of "lighter" gasoline than summer blends, can evaporate quite rapidly. Significant losses are likely to occur if stored through the summer in aboveground tanks.

Safe Fuel Handling
Refueling. Refueling while the engine is running or when it's hot, spilling fuel, overfilling the tank or smoking while refueling can all result in fires and/or explosions. Besides being a fire hazard, spilled fuel will also cause irritation and discomfort if it contacts the skin. And excessive breathing of fuel vapor may produce dizziness and headache.

If fuel does spill, wipe clean before starting the engine. After releasing the nozzle valve to shut off flow, keep the nozzle in the equipment fuel tank opening a few moments to drain what's in the hose. Check the fuel tank cap before replacing to be sure its vent opening is not clogged. Then lock up the fuel pump or storage tank to prevent accidents or unauthorized use.

Transporting fuel. Taking fuel to the field or worksite can be dangerous and wasteful without the proper containers. If handling small amounts of fuel is necessary, do so in labeled safety containers, which provide the best protection from spillage or ignition. Label them as to their contents, and don't interchange their use. Putting the wrong fuel in an engine means poor performance at best and major engine damage at worst.

Fire protection. Petroleum fires burn at the surface of the material as it is vaporized by the fire's heat. Applying water will merely cause the flaming liquid to spread over a wider area and vaporize more rapidly, thus intensifying rather than extinguishing the fire. The best way to put out such a fire is to cut off its air. When the flames are out, the fire is out; however, another ignition source can rekindle the blaze.

The extinguishing agents commonly used for petroleum fires are carbon dioxide (CO₂) and dry chemical powders, both of which cut off oxygen to produce a smothering effect. Although these agents are equally effective, the dry chemical extinguisher is better for outdoor use because it's not subject to wind, as is CO₂. indoors; however, CO₂ may be the better choice because it leaves no residue to clean up. For good all-around fire protection, consider an ABC or "all-class" extinguisher.

A fire extinguisher should be at the fuel supply area. When an underground storage facility is near a building, mount an extinguisher just inside the doorway. For a remote facility, it should be housed in a box attached to a post or overhead canopy support. Tractors and combines should always have fire extinguishers on board.

RELATED PUBLICATIONS

Single copies of the following Purdue Extension Publications are available free to Indiana residents from their county Cooperative Extension Service office or by writing to CES Mailing Room, 301 South 2nd Street, Lafayette, IN 47905.

- "Adaptability of Various Tillage-Planting Systems to Indiana Soils" (AY-210)
- "Conservation Tillage to Maintain Soil Productivity and Improve Water Quality" (AY-222)
- "Energy Requirements for Various Tillage-Planting Systems" (ID-141)
- "Estimating Fuel Requirements for Field Operations" (AE-110)
- "Planning Farm Shops for Work and Energy Efficiency" (AE-104)
- "Soil Compaction in Indiana" (AY-221)

For additional information on fuel storage and handling, contact insurance carriers or local fire officials; write the National Safety Council, 444 North Michigan Avenue, Chicago, IL 60611 and request "Safe Use of Farm Fuels" (Bulletin A-025-79).

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