Chapter Two: *GROOMING EQUIPMENT*

The purpose of this section is to give a general overview regarding the various types of equipment that are available for trail grooming in order to help operators understand the general characteristics of the equipment they are operating. For a more detailed understanding of specific trail grooming equipment, operators should consult with equipment manufacturers and refer to the manufacturer's equipment operator's manual.

As touched upon in Chapter One, the grooming tractor is generally a heavy-duty, two or four-tracked vehicle whose primary purpose is to provide the power to pull a grooming drag, power a tiller, or carry a compactor bar across the top of the snow. Some areas also use farm tractors, with or without track conversions, to pull a grooming drag. Other areas use a wide-track, utility snowmobile or a tracked ATV to pull a miniature grooming drag.

There are several companies that manufacture tracked vehicles specifically for snowmobile trail grooming. They include but are not necessarily limited to: Tucker Sno-Cat, Pisten Bully, Camoplast Industrial (formerly Bombardier), Centaur, Lamtrac, and VMC. Some areas also continue to use out-of-production models formerly produced by ASV and Thiokol/DMC/LMC. Additionally, track conversion kits for farm tractors are commercially available from Gilbert, Marcel, Sur Trac, Arrow Trac, and what seems to being a growing number of sources. The grooming tractor should be of sufficient size and power to handle the grooming implement(s) that will be used to groom the trails, without being heavier or wider than what is really needed for the area to help keep operating costs down.

The actual work of grooming the snow on the trail bed is performed by the drag that is towed behind the tractor or by the tiller. There are numerous trail grooming drags commercially available, including but not limited to, TSI Mogul Master, Trailmaster, Arrowhead, AFMI Trailmaker, Maxey, Sur Trac, Sno-Plane, Sno Boss, Trail Plane, Spooner Machine, Easy Pull, and LaCross. Additionally, there are numerous homemade grooming drags in use across the Snowbelt. Tillers are generally available to fit Bombardier/Camoplast, Pisten Bully, and Tucker Sno-Cat tractors. Compactor bars are commercially available from The Shop Industrial (TSI), Tucker Sno-Cat, Pisten Bully, and Bombardier/Camoplast.

Grooming Drags

From the discussion on Grooming Steps in Chapter One, it should be clear that a grooming drag plays a very key role in successful trail grooming. In fact, the drag can often be the most important piece of the grooming equation and typically has a greater impact upon proper trail grooming than the tractor used to pull the grooming drag. Grooming drags have progressed a long ways from the simple "bed springs" and "pipe drags" first used by snowmobile clubs in the 1960s and 1970s in early attempts to smooth trails. Most modern drags are technically advanced devices referred to as "multi-blade drags," as opposed to an older generation of "single blade drags."

Multi-Blade Drags

Regardless of the manufacturer or individual details of design, multi-blade drags have become the current standard for most grooming organizations that use drags. In fact, they are such an important part of the grooming tool box that many believe a good multi-blade drag is the single most important ingredient of a good trail grooming program. If an area doesn't have one, purchasing one could be the single best investment the grooming program can make. Because of the superiority of the multi-blade design, this section will go into great detail to explain its features and operation since full-featured, heavy-duty multi-blade drags must be properly operated to be effective.

As the name suggests, multi-blade drags use at least two or often three or more sets of cutting blades to fully remove moguls and perform the all-important snow processing operation (see Photo 2.1).

Figures 2.1 and 2.2 show the top and side views of a typical multi-blade drag. While design details may vary between manufacturers, the basic principles are illustrated well by this typical unit.

Photo 2.1 Typical multi-blade drag

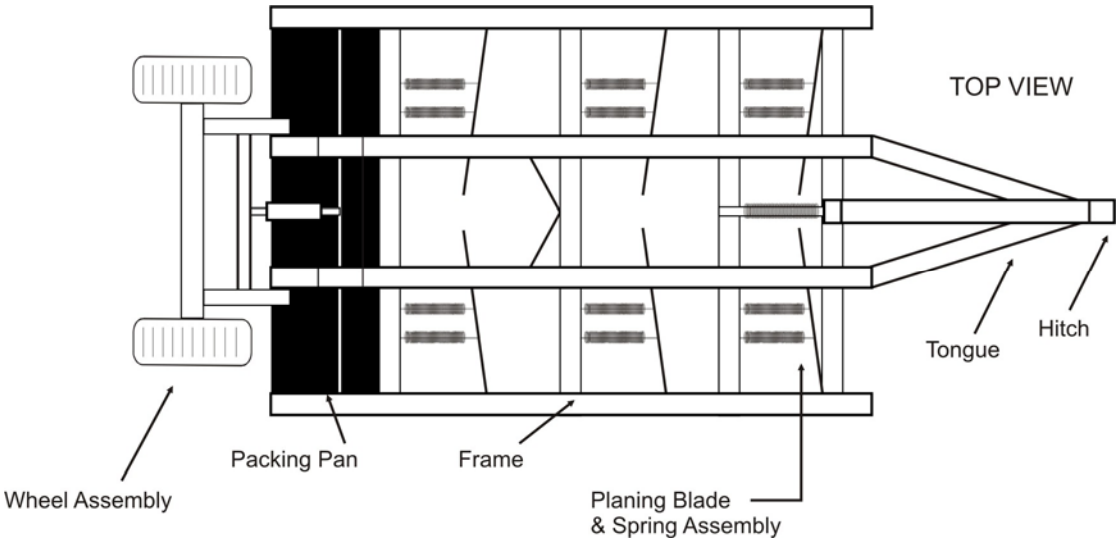

Figure 2.1 Typical multi-blade drag design – top view

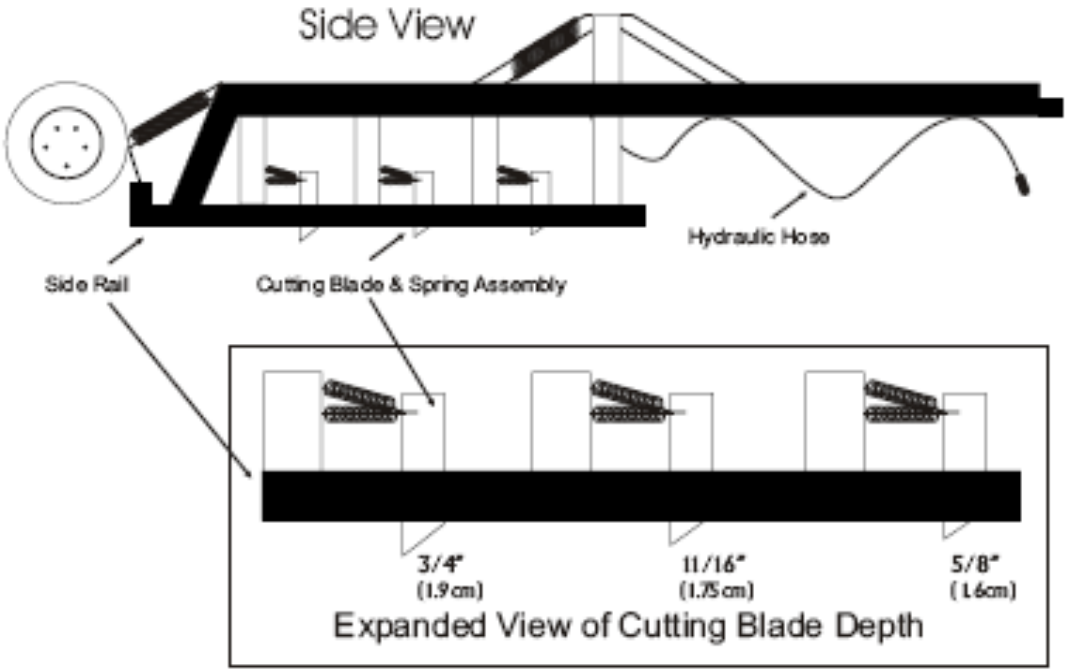

Figure 2.2 Typical multi-blade drag design: side view with expanded view of cutting blades

Drag Width

The width of the drag is dictated largely by the width of the trails that will be groomed and the width of the tracks on the tractor that will be pulling the drag. If the vehicle's track width is 8 feet (2.4 m), then the drag should generally also be at least 8 feet (2.4 m) wide. The width will also be dictated by the narrowest clearing width (between trees, gate posts, or bridge openings) on the overall trail system to be groomed. If there is a bridge that is only 8' 6" (2.6 m) wide, then the tractor and drag must be narrower than this even if the rest of the trail system is 10 feet (3 m) wide, unless the drag has wings that can be raised and lowered hydraulically like the one shown in Photo 2.2.

Photo 2.2 Drag with hydraulic wings

An eight to twelve feet (2.4 to 3.7 m) wide drag is commonly used by many areas since it will groom the entire trail width in a single pass. However on narrow trails with poor sight distance, it may be desirable to use a narrower drag width to provide snowmobile traffic a safe passing corridor. Trails that require a "doubling" (no option for grooming a

loop; it must be groomed to a dead end and then back over the same track) may also be a place where it can be desirable to use a narrower drag, since it requires two passes to complete the grooming run. In this situation, it can be effective to groom at a narrower width so the left track(s) of the tractor are in the center of the trail to help compact snow.

Drag Length

The length of the drag is important in that, the longer the unit is, the less tendency there is for it to follow the contour of the trail since it bridges from high spot to high spot, filling depressions as it goes, which leaves a smoother trail. This is important and one of the primary benefits a drag can have over a tiller. However, there are constraints to the overall length of a drag in terms of the ability to negotiate tight turns.

Generally, the heavier the drag is (without it being so heavy it is not efficient to pull), the better it is able to cut through moguls and compress loose snow after it has been processed by the cutting blades. However, the demands on the grooming tractor increase substantially as width, length, or weight of the drag increases that may make it too heavy for the tractor to pull. Be certain the tractor isn't overburdened with too large of a drag.

Typical Features of a Multi-Blade Drag

The following are brief descriptions of the typical features of a multi-blade drag:

Frame

The frame is typically fabricated from welded steel tubing and painted to inhibit rusting. The frame supplies a rigid foundation onto which the various components are attached and should not bend or twist significantly when stressed by the drag working. If the frame becomes bent or twisted, it can result in the drag cutting or compacting unevenly. Therefore, it is important that the drag's frame be regularly checked and maintained.

The frame is the major contributor to the weight of the overall unit which is an important design criterion. See examples of typical multi-blade drag frames in Photo 2.3.

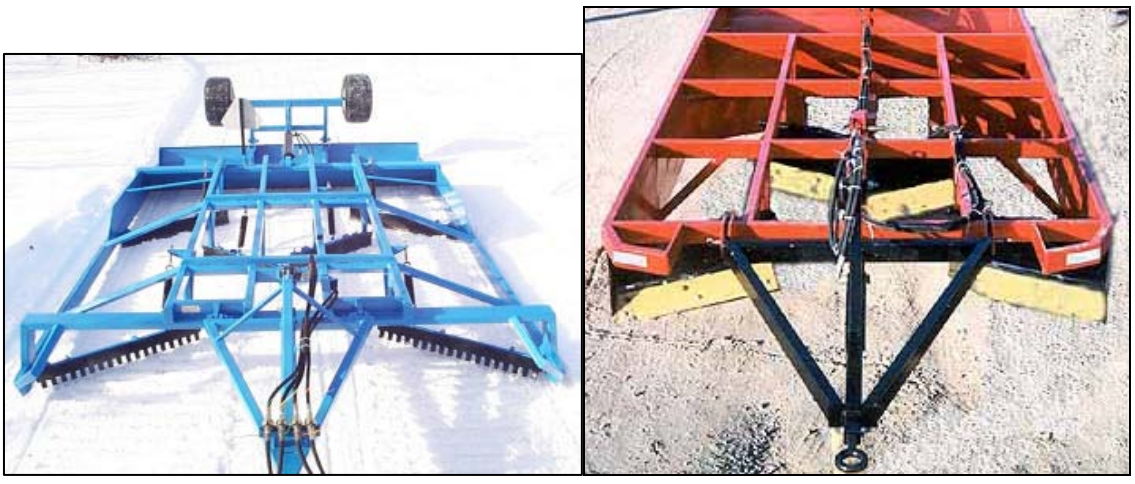

Photo 2.3 Typical multi-blade frames and blade configurations

Side Rails

The outside edges of the frame form the skid surfaces upon which the drag slides and are referred to as the side rails. Side rails are important in that they keep the snow that is being processed contained within the inside of the drag frame. A major difference between multi and single blade drags is that single blade drags do not have side rails.

Photo 2.4 Side rail on a multi-blade drag helps keep snow contained within the drag.

Spring Tripping Blades

As the blades cut off moguls, they can often hit rocks, stumps, or other fixed objects buried in the snow. While not all drags have spring tripping blades (rather they are mounted solid so they do not "trip" when hitting a buried solid object), it is highly desirable that each of the individual cutting blades is spring loaded (see Photo 2.5), so they can trip out of the way if they hit a buried object. This can help prevent damage to the drag, tractor, and the operator.

Photo 2.5 Spring tripping blades

Photo 2.6 Spring shank blades

The cutting blades in some drags are mounted on spring shanks, similar to what are used on agricultural field cultivators and diggers (see Photo 2.6).

Cutting Blades

It is desirable for the cutting blades to be slightly beveled so they cut into the mogul versus being mounted straight up and down where the blade would simply skim over the top of moguls (see Photo 2.7). They are typically mounted in a "stepped" manner where the front row is 5/8" (1.6 cm) below the side rail and the rear row is up to ¾" (1.9 cm) below the side rail. This provides more cutting depth as the frame is lowered. Also note that blades are typically mounted in an angled manner so they transfer snow from the outside of the trail to the center of the trail where wear is usually the greatest from snowmobile traffic.

Photo 2.7 Beveled cutting blades

Photo 2.8 Serrated cutting blades

Some drags also use serrated blades (see Photo 2.8) in the front row(s) which assist in cutting hard or icy trails.

Tongue

The tongue on many drags is hinged so it can move up and down at the drag frame, but not from side to side (see Photo 2.9). The up and down movement is controlled by a hydraulic cylinder operated from the tractor's cab allowing for simultaneous, continuous control of blade cutting depth on multi-blade drags. The tongue may attach to the tractor with either a pintle hitch or a 5th wheel type of hitch. Other drags, particularly those used behind farm tractors, are steered hydraulically by means of a rigid hitch (see Photo 2.10).

Photo 2.9 Pivoting tongue

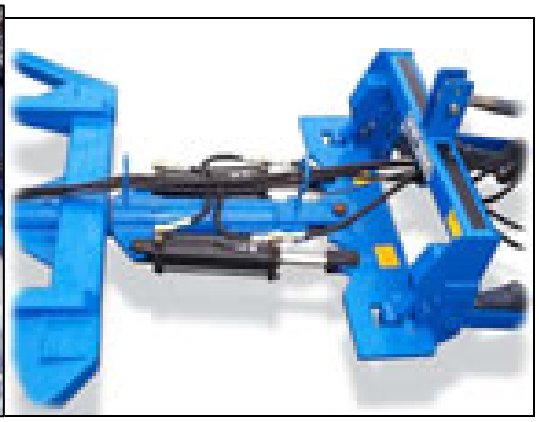

Photo 2.10 Rigid steer hitch

Compactor Pan

The compactor pan should provide for full width smoothing that leaves an evenly finished trail surface free of holes or divots. The front of the pan is angled forward to catch and spread the processed snow evenly across and under the pan (see Photo 2.11). The rear of the pan has a high radiused lip that aids in "ramping" the drag up onto the snow when backing up in soft snow without the aid of the wheels (see Photo 2.12).

Photo 2.11 Angled front of pan

Photo 2.12 Radius lip on rear of pan

The bottom of the compactor pan on a multi-blade drag is typically flat steel with wear bars or runners positioned at the two outside edges. Two to three additional replaceable wear bars are often evenly spaced across the center of the underside to help protect the pan surface. Some pans may also be surfaced with either a plastic comb material or sheets of corrugated steel. However, flat steel or corrugated steel is better than plastic for a pan's bottom since they produce friction which is so important to the trail's set up.

Skegs

Replaceable hardened steel skegs (runners) are normally mounted on the bottom of the compactor pan. These skegs reduce side hill slippage of the drag and also help prevent premature wear of the compactor pan. They are especially important to "drag steer" groomer configurations whereby the drag acts as the steering rudder for the entire grooming unit. Photo 2.13 shows the telltale marks from packer pan skegs.

Photo 2.13 Skeg marks on a freshly groomed trail

Vibrating Pans

Vibrating pans are a relatively new feature on multi-blade drags. They utilize a flow control valve and return system to hydraulically "vibrate" the rear pan in an effort to increase compression and aid trail set up. The hydraulic vibrator is mounted so as to isolate the vibration downward into the trail surface and away from the drag itself. They are most commonly used with agricultural tractors since their hydraulic systems more readily accommodate the operational needs of vibrating pans (see Photo 2.14).

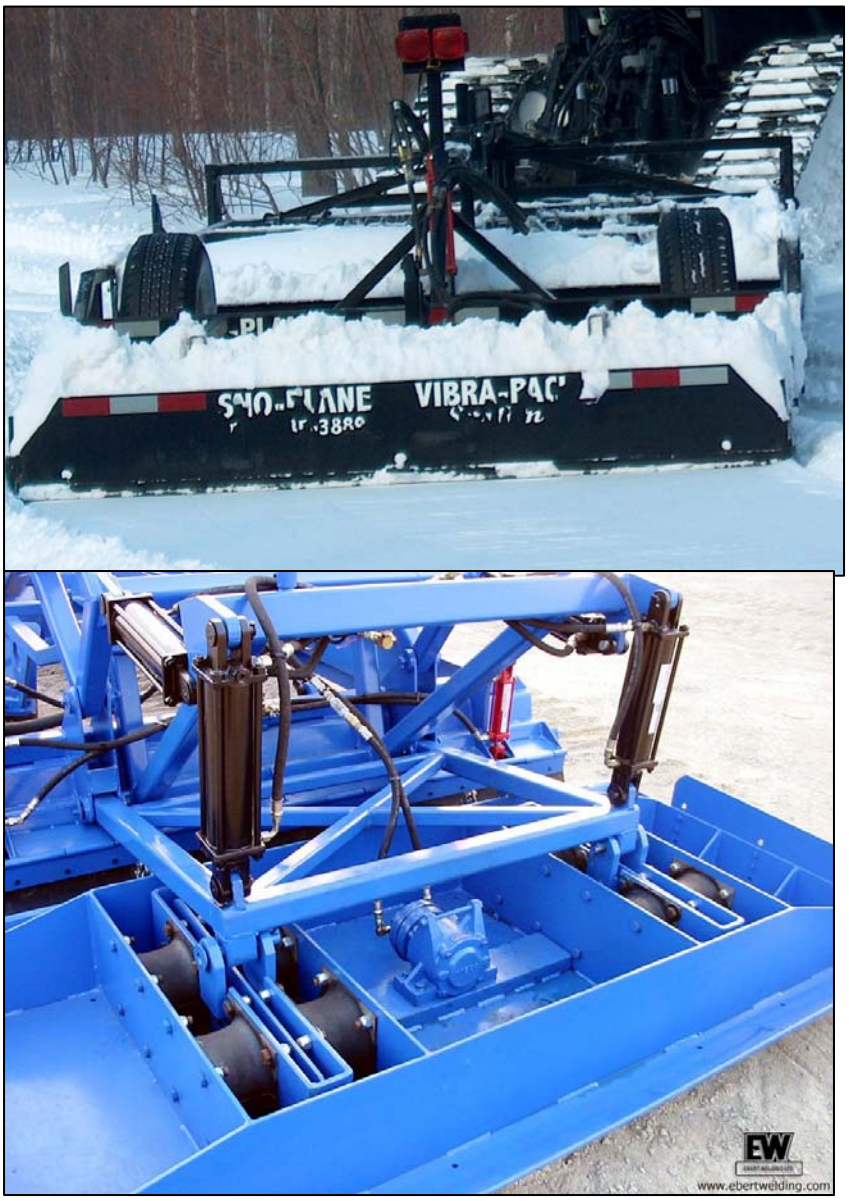

Photo 2.14 Typical vibrating rear pans

Wheel Assembly

The wheel assembly is a set of wheels, mounted either at the rear of the drag or within the frame assembly (see Photo 2.15), that can be raised and lowered by hydraulic controls from the tractor's cab. During normal grooming operations, the wheels are raised so they are out of the way. When crossing roads or railroad tracks, the wheels are lowered so the drag is picked up off the ground. The wheels are also helpful when backing up the drag.

Photo 2.15 Typical wheel assemblies

Some drags use a rear drum roller rather than wheels. The drum is typically operated like wheels in that it can be hydraulically raised and lowered (see Photo 2.16). It also can be used to aid trail compression and compaction.

Photo 2.16 Typical rear drum roller assembly

Quick Release Features

The drag may encounter immovable objects such as stumps or rocks that could damage it, the tractor, or the operator. Consequently, a shear bolt is generally used in the hitch that will break away before major damage occurs (see Photo 2.17 – to the right of the pintle). Quick-release couplings in the hydraulic hoses can also help ensure that the hydraulic system is not torn out in the event the shear pin releases the drag from the tractor.

Photo 2.17 Quick-release couplings and shear pin in tongue of pintle hitch

Single Blade Drags

Photo 2.18 Typical single blade drag

Many earlier drag designs, which are still used in some areas, incorporated a single, full-width cutting blade with the idea that it would carry snow and allow it to drop into depressions. Some designs also incorporated a rolling drum in front of the rear compaction pan. This type of drag can work well in areas with frequent, deep snowfall where grooming requires more continuous work to build new base because of frequent snowfall. However, in areas with heavy moguls, the single blade drag can be less effective due to its limitations for fully cutting and processing moguls. It is important that the tractor be equipped with a front blade to help process moguls in this situation.

Photo 2.19 Typical single cutting blade

Other than number and configuration of blades, the components of a single blade drag are very similar to that of a multi-blade drag. The operation is different than a multi-blade in that the height of the cutting blade is regulated by a hydraulic cylinder versus by the hitch. Additionally, since this type of drag does not have side rails to keep snow contained within the drag, snow can be easily wasted out the sides if the operator attempts to cut and carry too much snow with the single cutting blade.

Tillers

A tiller is mounted on the rear of a grooming tractor and is driven hydrostatically (see Photo 2.20). A tiller typically requires deep snow conditions and is used to break up compacted snow surface, to reduce snow and ice chunks, and to mix old and new snow.

Photo 2.20 Typical rear-mounted tiller

The tiller itself is similar to a garden roto-tiller and consists of a rotating shaft (cutter bar), which has multiple tines that are typically three to five inches (7.6 to 12.7 cm) in length that condition the snow when operated at a high RPM, and a plastic comb or "snow finisher" (see Photo 2.21). The tractor's horsepower must be sufficiently large to operate the tiller.

Photo 2.21 View of the underside of a tiller

Benefits of a tractor equipped with a tiller include the extreme portability, ease of backing, ease of turning around, and ease of plowing drifts. Additionally, the unit can be easily stored and easily hauled on a truck or trailer.

A tiller can work well in moist snow, but if there is dry powder snow, it can sometimes be hard to get a good trail since the snow/trail doesn't stay together. Therefore, it can be important for there to be good moisture in the snow to get good results and "snow pavement" that lasts.

If the trail is heavily moguled, multiple passes may be required since a tiller can only processes to a maximum depth that is equal to the length of its tines (if it has 3 inch {7.6 cm} tines, then that is the maximum processing depth; if it has 5 inch {12.7 cm} tines, it can process to a maximum depth of 5 inches {12.7 cm}, etc.). In such cases, a good front blade on the tractor, and an operator who can cut moguls with the front blade, is required to feed enough snow to the tiller for processing and ultimately creating a smooth trail.

It is easy to build a smooth trail with a tiller, but not necessarily a level trail since the unit will bob up and down mirroring what the tracks of the tractor do. It can sometimes also weave side to side. For this reason, they produce better results on an undulating trail with frequent turns and ups and downs versus on a trail with long straightaway sections.

It is recommended that areas also have a drag to supplement trail grooming with a tiller, since it is rare that season-long grooming conditions (weather, snowfall, moisture, and traffic) are consistently favorable for grooming solely with a tiller.

Photo 2.22 Flex tiller set in a rigid (straight) position with lockout device shown below.

Flex tillers pivot (or flex) in the center and are typically used on downhill ski hills to create terrain features. Some manufacturers provide a lockout device whereby a flex tiller can be locked in a rigid/straight position which is required to groom a flat snowmobile trail surface.

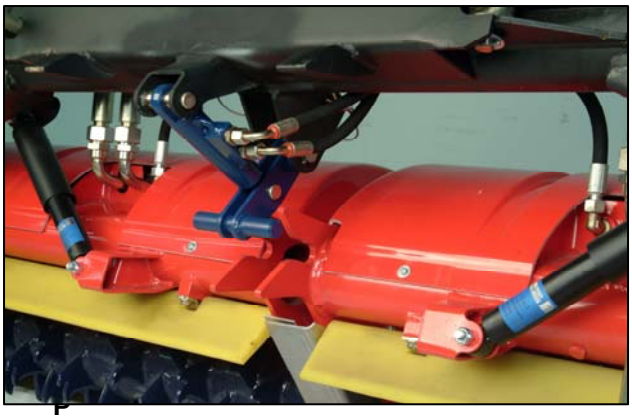

Photo 2.23 Flex tiller lockout device

Compactor Bars

Photo 2.24 Typical compactor bars

A compactor bar, also commonly referred to as a "packer bar," is a very simple, lightweight implement, short in length and attached to the rear of a tractor, which can be hydraulically lifted completely off the snow to allow the tracked vehicle to easily back up and/or turn quickly in tight spaces. Some models also have hydraulic down-pressure to help increase compaction.

It can be used to significantly reduce the time, effort, and cost of opening a snowmobile trail at the beginning of a grooming season by compacting snow on the trail to set up a firm base for future grooming with a drag. In swampy areas, it can facilitate compaction that helps drive the frost into the ground and helps freeze the swampy ground faster. The use of a packer bar generally saves wear and tear on a drag during early season trail set up and also provides for increased tractor maneuverability.

A compactor bar can also be used after exceptionally heavy snowfalls during the season or in areas of extreme drifting when a drag can be too much for the tractor to handle effectively. Some packer bars are designed so they can be mounted on the tractor while a drag is simultaneously hooked to the tractor's pintle hook. With such a configuration, operators can groom with the drag up to a point on the trail where heavy drifting has occurred, unhook the drag, and continue through the area using just the vehicle's front blade and the packer bar to establish an initial trail base. They can then return to the drag, reconnect it to the tractor, and proceed onward while "finishing" the trail with the drag.

Some areas "track pack" a trail route, with just the tractor and no drag, after a heavy snowfall or at the beginning of the season when there is deep snow and no established trail route. It can also be beneficial to track pack early in the season when there is low snowfall since the "crimping" effect of the tracks can help stabilize the snowpack. The use of a compactor bar, particularly when there is deep snow, can greatly increase the effectiveness and efficiency of grooming efforts when there is a need to track pack.

GROOMING TRACTORS

The name “Grooming Tractor” is used to refer to a broad range of tracked and semi-tracked vehicles used to pull grooming drags or to carry tillers and compactor bars. The term “tractor” is used generically to identify the purpose of the vehicle, which is to pull, power, or move a trail grooming implement, and should not be confused with farm tractor conversions that are sometimes also used as grooming tractors. Some areas also refer to grooming tractors as “prime movers.”

Samples of typical grooming tractors are shown below for the purpose of introduction:

Photo 2.25 Typical grooming tractors

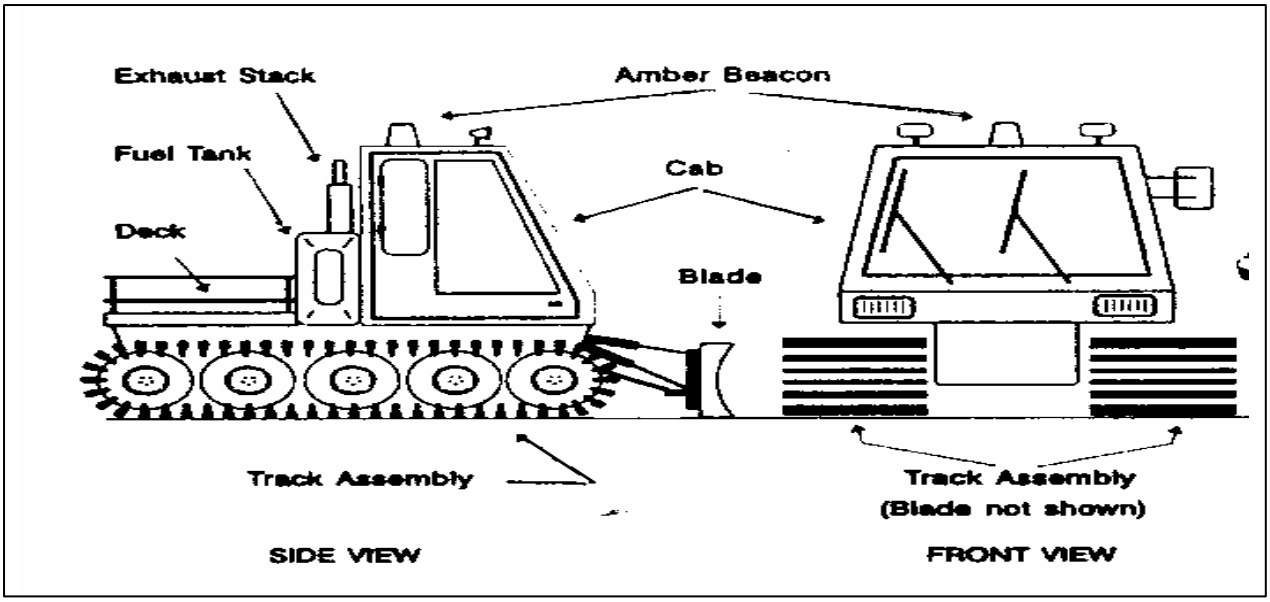

Figure 2.3 Typical components of a grooming tractor

Figure 2.3 shows the side and front views of a typical 2-track grooming tractor. While design details will vary between 2-track and 4-track vehicles, as well as between manufacturers, the basic components of a grooming tractor are illustrated well by this typical unit.

Grooming Tractor Components

Tracks

The tracks on a tractor provide "flotation" that help the vehicle stay on or near the surface of (versus sinking into) the snow (see Ground Pressure, page 40) while providing sufficient traction to pull a heavy grooming drag or to carry an implement such as a tiller.

Historically, most grooming tractor tracks were cleated with a straight steel or aluminum bar (see Photo 2.26 on the next page). Such a track requires that the vehicle be operated in deep snow to avoid damage to the tracks. Oftentimes, ice picks or grousers are added to these tracks to help prevent side slippage and spinout on hills.

Many contemporary grooming tractors are equipped with all-rubber tracks, which allow the vehicles to be operated in all types of terrain without damage to the tracks. Some rubber tracks have a straight bar type pattern, while others have a Z-type pattern to help prevent side slippage and to increase traction (see Photo 2.27 on the next page). Machines equipped with rubber tracks can run on dry pavement, dirt roads, in mud, in water, and in deep powder snow which makes them much more versatile. While they initially may cost more, they typically have a smoother ride which provides additional operator comfort, less operator fatigue, and less maintenance costs and vehicle damage caused by vibration.

Photo 2.26 Example of steel-cleated track

Photo 2.27 Example of rubber track

Steering

Steering is accomplished on some 2-track models by individual braking of the tracks, similar to how a bulldozer is turned. On other 2-track models, steering is accomplished by individually controlling track speed using a hydrostatic drive system. Most 4-track models articulate, so one set of tracks turn inward while the other set turns outward. Farm tractor conversions typically utilize the drag as a steering rudder.

Engine

Motor power for the grooming tractor is provided by a large diesel or gasoline industrial engine. The location of the engine is important when determining the vehicle's center of gravity since it is typically heavy (see Center of Gravity, page 41).

Tractor Cab

The grooming tractor's cab provides a protected environment for the operator. Many also have additional seating for a passenger that is useful for training or for a relief operator on long runs. Most grooming tractors have complex instruments for operating the tractor, as well as hydraulic controls that operate the grooming drag, front blade, tiller, and other attachments. It is important that operators familiarize themselves with all controls to ensure safe and effective operation of the equipment. Vehicles that have an up-front cab style provide better forward visibility for the operator, particularly when using a front mounted blade.

Photo 2.28 Typical controls in a tractor's cab

Front Blade

Many tractors are equipped with a front blade which is a useful accessory to knock down snow banks or drifts and to fill in creek crossings or large depressions in the trail bed with snow. A blade is also useful to keep road crossings and driveways clear of snow deposited by grooming, so as to not create hazards for motorists or obstructions to adjacent landowners' property. A front blade is also essential when establishing trails along hillsides in deep snow areas or when using a tiller.

Photo 2.29 Typical front blade at work

One common misconception about the front blade on grooming tractors is that they can be used as a bulldozer. This is not true and, if used as such, can result in major breakdowns and repairs. Front blades on grooming tractors are typically not as strong as the blade on a bulldozer, so they should never be used as such for pushing large rocks, stumps, or trees.

Cargo Deck

Most grooming tractors have a rear cargo deck to carry utility loads such as tools, chain saws, spare fuel, trail signs, etc. The operator must be aware that overloading the cargo area on the tractor can impact the vehicle's weight, flotation, and center of gravity, so caution should always be used to not improperly load the vehicle.

Photo 2.30 Typical cargo deck used to carry tools, spare signs, and spare fuel

Important Characteristics of Grooming Tractors

There are several characteristics that are important to understanding the capabilities and the proper operation of grooming tractors. These characteristics include:

Ground Pressure

A vehicle that is designed to work in snow must stay on or near the surface rather than sink in and plow through the snow. This is accomplished by spreading the weight of the vehicle out over the tracks, much as a snowshoer's weight is distributed by the snowshoes.

The technical measure of the vehicle's ability to distribute weight is called ground pressure. Ground pressure is calculated by dividing the overall weight of the vehicle by the total area of the track which remains in constant contact with the snow and is most often expressed in pounds per square inch (psi) or kilogram-force per square centimeter (ksc).

Typical ground pressures for moderate-light to heavy grooming tractors range from 0.8 psi (0.056 ksc) to 1.2 psi (0.084 ksc). It is very important that tractor ground pressure not exceed these limits. If ground pressure is too high, the vehicle will sink into snow rather than stay on top. If ground pressure is too low, the unit may not have sufficient traction to pull a drag up hills or through deep, heavy snow.

Overall Weight

Within reasonable limits, the overall weight of the tractor can be compensated for by matching it with the appropriate track area. However, overall weight is a factor in terms of existing bridge loading limits and crossing frozen bodies of water. Because grooming vehicles are typically very heavy, it is recommended that they never be operated on frozen bodies of water without special planning, testing, and training since doing so could lead to equipment damage, serious personal injury, or death.

Engine Horsepower and Torque

Regardless of whether a diesel or gasoline engine is installed in a particular tractor, the key measurements of its capability are its horsepower and torque. Always use the same measurements when comparing horsepower, since there are gross, net, and power-take-off (PTO) measurements. Gross brake horsepower is a good basic unit for comparing the relative power of engines.

Engine torque is an overlooked rating that is very important for all grooming tractors. Torque relates to the ability of the tractor to get a heavy drag moving. The high static loads of modern multi-blade drags require a high degree of engine torque to get a drag moving from a dead stop.

Center of Gravity

A vehicle's center of gravity is a point around which its weight is evenly balanced. Figure 2.4 is an example of the center of gravity for a typical 2-track grooming tractor.

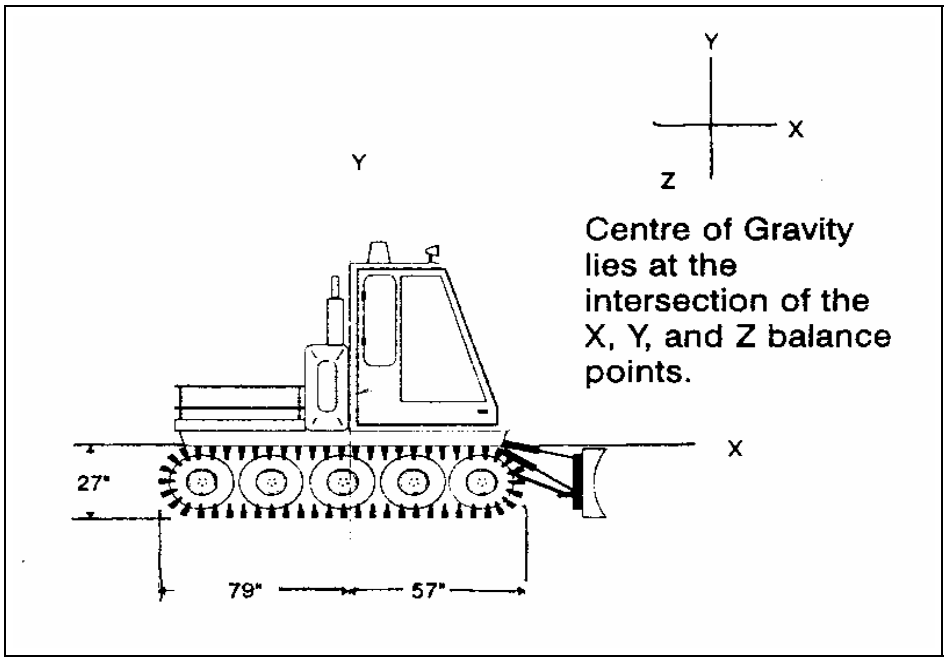

Figure 2.4 Center of gravity for a typical 2-track grooming tractor

A vehicle's center of gravity is significant any time it must operate on a non-level surface such as when climbing or descending steep grades or when side hilling. In terms of stability, the lower to the ground the unit's center of gravity is the more stable it will be on non-level surfaces. Operators should keep this factor in mind to avoid getting into unsafe situations.

Tractive Effort and Coefficient of Friction

Tractive effort is defined as the amount of torque that can be applied to a track before the track looses traction and spins without moving the vehicle forward.

The coefficient of friction between the track and the ground or snow is the limiting factor of when the tracks will loose traction. Coefficient of friction is determined by the overall vehicle weight, the amount of track on the ground, the cross-link design of the track, and the weight distribution along the length of track that is in contact with the surface. The ideal weight distribution on the tracks is having the balance point, from front to rear of the vehicle, at or near the center point of the length of track, as shown in Figure 2.4 above.

When a track breaks traction it is actually shearing the snow through the force that the cross-links are placing on it. Fresh, unpacked snow shears much more readily than hard packed snow. When a vehicle breaks traction, spins out, and gets stuck, it happens because the force required to shear the snow is less than the force required to pull the load. The load is made up of both the drag and the tractor.

Snowmobiles and ATVs as Grooming Tractors

Some areas use either a wide-track/utility model snowmobile or a tracked ATV to groom their snowmobile trails. In these applications, the snowmobile or ATV is typically used to pull a small grooming drag (usually only about 4 feet {1.2 meters}wide) when there are limitations with trail widths that prevent a large tractor from grooming the trails. A snowmobile or ATV may also be used because of funding limitations in the area that preclude the capital expenditures required for larger equipment. While there are limitations as to what can be successfully groomed with a snowmobile or ATV, these units can serve a valuable purpose. One key to success is frequent grooming repetitions to compensate for the cutting and compression limitations that small drags typically have.

Photo 2.31 Typical snowmobile powered grooming unit

Photo 2.32 Typical ATV powered unit

The grooming drag is typically controlled by an electric-hydraulic switch operated from the seat of the snowmobile or ATV. This allows the operator to make drag adjustments just the same as if the operator were in a full-sized tractor cab.

Because the operator is out in the elements, it is important that extra safety precautions are taken for operator safety and that the operator has adequate dry clothing along. It is also important that a tow rope and shovel are carried on the snowmobile or ATV since it is easy to get these units stuck. A spare drive belt for the snowmobile should also be carried since pulling the grooming load can be hard on the snowmobile's clutch and drive belt. All other grooming and safety principles apply, just on a smaller scale.

CHAPTER QUIZ

1. Grooming implements include:
    a) drags and planers
    b) tractors
    c) tillers and compactor bars
    d) a and c above
    e) a, b, and c above

2. The purpose of the front blade on a grooming tractor is to clear rocks, stumps, and downed trees from the trail to make it safe. True False

3. The primary purpose of a grooming tractor is to provide the power to pull a grooming implement like a drag, power a tiller, or to carry a compactor bar across the top of the snow. True False

4. The tractor is the most important piece of the grooming equation and has a greater impact on proper trail grooming than does a drag or tiller used behind the tractor. True False

5. If you were to use only one grooming implement to build a trail that is both smooth and level, it would in most cases be a:
    a) tiller
    b) multi-blade drag
    c) compactor bar
    d) single blade drag
    e) front blade

6. A very simple, lightweight implement that is very maneuverable and useful for initial trail set-up early in the season or deep snow events is a:
    a) tiller
    b) multi-blade drag
    c) compactor bar
    d) single blade drag
    e) front blade

7. Overloading the cargo area on a grooming tractor can impact the vehicle's weight, flotation, and center of gravity. True False

8. Too low of a ground pressure can cause a grooming tractor to sink into snow rather than stay on top of the snow. True False

9. The frame of a drag must be rigid and square to prevent it from cutting or compacting unevenly. True False

10. The cutting blades on a multi-blade drag are typically mounted in a “stepped” position, downward from front to rear. True False

11. The maximum width of a grooming implement like a drag or tiller is:
    a) dictated by the maximum width of the trails to be groomed
    b) dictated by the width and power of the tractor
    c) not important
    d) generally narrower than the tractor
    e) a and b above
    f) none of the above

12. The tracks on a grooming tractor must be large enough to keep it on or near the surface of snow. True False

13. A tractor with a high center of gravity will be stable and safe to operate on steep hillsides. True False

14. When a vehicle breaks traction, spins out, and gets stuck, it happens because the force required to shear the snow is less than the force required to pull the load.
    True False

15. The overall weight of a grooming tractor is:
    a) unimportant
    b) can be compensated for by track area
    c) can cause problems when crossing bridges and ice
    d) b and c above
    e) none of the above