Machinery for Soil Drainage

comparative analyses made of production volumes of various earthmoving machinery used for preparing land for drainage

P. Boving

Production rates—affecting hourly costs—of earthmoving equipment vary with a given piece of work and the type of machine used.

A machine handled by a skilled operator can operate continuously—if there are no delays—for a period of four hours. However, delays or breakdowns can reduce actual productive time, on a seasonal or annual basis, to about 35% or 20 minutes in every hour. The working season varies with geographic location, but should average about 250 working days per season.

To determine a per hour cost figure for excavation machinery the owner must allot 30% for the capital investment, interest, insurance and taxes on the machine; 10% for transport of the machine to the work site; 15% for repairs, maintenance and fuel, oil and grease; 40% for labor costs; and 5% for general management overhead.

Trenchers

Two types of trenchers—wheel, and ladder—are used in excavating for underground tile construction. Wheel trenchers have a maximum digging depth of 5½′ and ladder trenchers have a maximum digging depth of 9′ or more, depending on the boom length. Averaged figures show that wheel trenchers—because of simple, rugged design—have almost twice the digging speed of ladder trenchers.

Trenchers, when excavating only, have a production rate far in excess of the speed of a normal tile or pipe laying crew. Where the work is being integrated with tile laying—to use the minimum length of opened ditch—production rates are restricted severely. Limited experience with drain tile laying crews shows that for average California soil conditions production rates of a wheel trencher—for laid and backfilled tile—should be 2,000′ at a 3′–5′ depth in an eight-hour day. A ladder trencher should do 1,000′ at a depth of 6′–9′ in eight hours. Those figures represent actual outputs, including short moves for location, and servicing of the machines, but without major breakdowns, or delays due to obstructions or hard digging. A typical tile-laying crew consists of the trencher operator, two tile layers, one handyman, one bulldozer operator for backfilling and one field supervisor.

Shovels and Backhoes

Two types of machine shovels are used for general earth excavation. Each type has exact control of the bucket, but one—the ordinary machine shovel—can not excavate far below its track level and works on the ditch banks from the bottom of the ditch. The second type is the backhoe—a machine shovel with reverse action—which can excavate below its track level and work on the ditch banks from above. Production rates of both types of excavators are dependent on bucket size and should be the same with the same size of bucket.

The eight-hour production volume—in cubic yards for both types of shovels—should be 227 with a ⅜-yard shovel, 440 with a ¾-yard shovel and 547 with a 1-yard shovel in moist loam or sandy clay. In sand and gravel the rates should be 214, 414, and 533. In good, common earth, the ⅜-yard bucket should do 187, the ¾-yard, 360 and the 1-yard bucket, 466. In hard or tough—or both—clay the rates would drop to 133, 294, and 386. They would drop still more in wet and sticky clay and would be 67 cubic yards with a ⅜-yard bucket, 187 with a ¾-yard bucket, and 200 cubic yards with a 1-yard bucket. These production rates are figured at the 35% efficiency level. Under average soil conditions the bucket size multiplied by 100—for hourly production at 100% per hour—gives the production rate. For example: a ¾-yard bucket should move 75 cubic yards per hour.

Dragline excavating a drainage ditch.

Draglines

The dragline—another type of excavator—has a cable-controlled bucket and works best in loose material. The dragline can work above or below track level and is a good machine for trimming. Like the power shovels, production rates are controlled by the size of the bucket.

At the 35% efficiency level the eight-hour production volume for a dragline during primary excavation in moist loam or sandy clay should be 187 cubic yards with a ⅜-yard bucket, 346 with a ¾-yard bucket and 427 with a 1-yard bucket. In sand and gravel, rates should be 173, 334, and 414 for the three sizes of shovels. In good, common earth the buckets should move 147, 250, and 360 cubic yards. Again the rates would drop in hard or tough clay to 93 cubic yards, 240, and 293. In wet and sticky clay, the ⅜-yard bucket should move 53 cubic yards; the ¾-yard, 147; and the 1-yard bucket, 200 cubic yards.

Bulldozers

Bulldozers are short distance earthmoving tractors equipped with push or pull types of blades. The blades vary in shape and size, so production varies also. The use of bulldozers for multipurpose work in general construction limits the measurement of their earthmoving capacity because they usually work in shuttle service for a maximum efficient load-carry of about 200′. Their versatility—especially in the hands of a highly skilled operator—is fabulous. On some jobs a pull-type of bulldozer blade is carried by lengthened arms on the front of the tractors. The lengthened

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meats were smaller than those with three or more employees in each of the counties—61% to 82%.

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MALEIC HYDRAZIDE

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lateral buds grew sooner and more rapidly than those close to the tip. In some cases the apical bud was inhibited for several weeks after the lateral buds started growth.

Stem terminals of certain plants may abscise with even moderate concentrations of MH but such abscission is not serious. The young terminal leaves of some plants have poor color and may be unsightly if they remain on the plant for the period of the inhibition. Young terminals of *Pyracantha* and other plants that do not abscise may not develop good green color until after the MH effect has been dissipated.

Nondamaging concentrations of MH did not appear to suppress the development of blossoms of those plants investigated but some distortion of leaves and blossoms has been reported on chrysanthemum.

Several resprays have not shown adverse effects on lemons, ivy and Star Jasmine.

The Chinese Juniper—*Juniperus chinensis* variety *mas* or variety *foemina*—normally produces a small amount of needle-like juvenile type foliage on some parts of the plant, but after being sprayed with 0.20% MH as MH-30 it produced the juvenile type foliage on all parts of the plant. That effect lasted for more than a year before the mature, scale-like foliage that is closely appressed to the stem was again produced. The MH treatment completely changed the appearance of the foliage and also suppressed length growth, which resulted in a more compact plant than those not treated.

The young leaves and shoots of camellia—*Camellia reticulata*, Capt. Rawes—did not show immediate and extremely diminished growth after treatment with 0.35%–0.375% MH as MH-40 but only slight or no inhibition, even though the concentration was almost damaging. Later it was apparent that the tip leaves on some shoots had not expanded to normal size or developed a normal green color. The buds on these shoots showed inhibition nine months later, but buds on older portions of the plant resumed growth so that a more branched and dense plant resulted.

Limited trials have indicated that 0.25% MH-30 is compatible with insecticides: DDT 50% wettable powder at two pounds per 100 gallons; diazinon 25E at three pints per 100 gallons; and malathion 25% wettable powder at 2–3 pounds per 100 gallons. Very high concentrations of malathion seemed to nullify the effect of MH-30. MH-40 was not tried in combination with insecticides.

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EARTHMOVING

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arms provide reach for starting to dig, and to carry the removed soil, or spoil. With the pull-type bulldozer the ditch is excavated, cleaned, or trimmed with the machine moving backwards so the tractor does not tread on the wet portion of the ditch. Also, by graded dumping from the blade, the pull-blade machine can spread the spoil as it backs away from the ditch. Because the bulldozer is used for so many various jobs and production depends on the type of work being done figures can not be stated easily.

Graders

Graders or motor patrols are land smoothing tools not normally used for earthmoving but for earth spreading. Their flexibility permits them to be used for earthmoving by plowing ditch excavations into windrows and then spreading the spoil. Primarily distance type machines, graders have a poor turning radius—compared to other earthmovers —and are not economical as substitutes. Also, their production capacity is low for earthmoving, especially when used for short length production because their size limits adaptability.

Scrapers

Scrapers are semiself-loading and unloading earthmovers. Designed for surface removal of soil—rather than for pit or ditch work—production is controlled by scraper bowl size and length of travel in the work cycle of loading, hauling, unloading, and returning to reload.

Total production of scrapers can be increased by lowering the time consumed in any part of the cycle. The haul and return distances have as much effect because they are fixed for a given job and the machine has a limited top speed. Thus rapid loading and unloading and short hauls will maximize their production. Pusher tractors are normally used during loading to increase scraper production in general construction. Limited space in a drainage channel might prohibit the use of pushers for rapid loading.

The per foot cost for drainage ditch construction can be estimated from a comparison of the production rates of the various machines and their suitability to the working conditions.

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TIMBER

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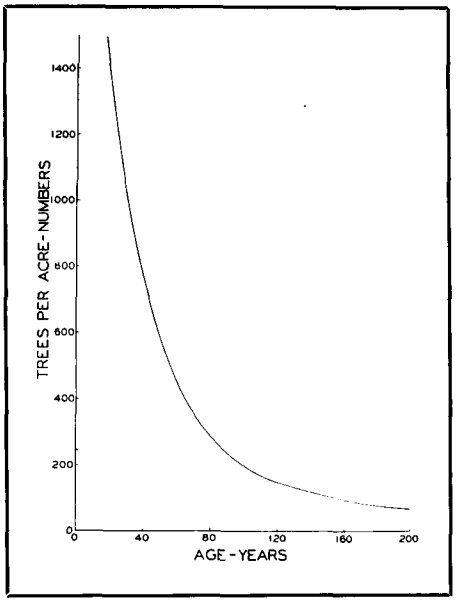
fiber market—will result in a general practice of harvesting younger trees, which will aggravate the forest management problem. The required number of trees per acre at the time of harvest will be greater than it is now in the virgin forest and the number of years necessary for regeneration will become a significant part of the time a tree needs to grow to harvestable age.

Ponderosa pine trees required per acre at time of harvest to fully utilize a good site in the Sierra.



Planned research on the role of fertilizers in the production of timber trees should determine how the soil fertility level affects the potential yield, the initial survival of the seedling, and what relative advantage the seedling may—or may not—gain from fertilizer applications over the associated brush species found on good and poor sites.

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