ment task of establishing staffing levels and justifying these levels is accomplished through the use of this type of analysis.

It was one of the ideals of the study to verify the efficient and economic use of labor and to determine changes that may be needed to ensure that each local unit of the maintenance operation is supplied with an equitable number of work hours according to individual subarea needs. It was not the purpose of this study to attempt to justify a need for additional personnel. Actually, this study does not even indicate a need for additional personnel; it only predicts an ideal distribution of existing personnel. The sole purpose is to document what criteria (variables) are to be used in determining staff distribution and to conduct an investigation to ensure that existing personnel are located where they should be so as to provide an efficient and economical operation that renders necessary services to the motorist.

Lower levels of management are entitled to a logical explanation for the size of their crew. They also deserve to know what actually affects the work and how much it is affected. This automatically provides them with priorities for scheduling, planning, and accomplishment of work. If they know what creates the work as well as what resources are available to get the job done, they are more respected as managers. Knowledge of the variables that have the most influence on the work load of a subarea will enable local managers to understand better why they have been supplied the staff they have according to the amount of each influencing variable within the subarea. This, of course, will enable them to become more effective and efficient managers.

As a result of this study, there is now an exact inventory of conditions, as they pertain to these variables, in each subarea. The maintenance department now possesses a computerized process for distributing personnel for existing, proposed, or revised subarea boundaries or conditions. Whenever subarea boundaries change, or if additional subareas are created, the new parameters may be described to the data bank and a new set of values for all variables of each subarea can be obtained. These revised variable values may then be used in the regression analysis program and a new staffing plan developed.

This plan has generally gained acceptance among district personnel. Some have conducted studies on their own that relate work hours to be accomplished each year to those available in each subarea. These types of investigations have further substantiated the findings of the regression analysis method. At the time of this study, the new plan had not been in effect in Kansas long enough to allow many of the position transfers to be accomplished. Since changes in position locations are accomplished as vacancies occur, the implementation of this plan is incremental, but as time goes on and some of these changes are made, the effectiveness may be measured in terms of improved work accomplishment. The number of work hours required to perform a specified unit of work should be comparable among the subareas. At that point, the task of management to attain optimal staffing and quality of work, with focus on economic considerations, will have been realized.

This study has provided management with a knowledge of the cause-and-effect relation between the variables and the amount of the total resource of labor to be assigned to each subarea. The responsibility of management for establishing staffing levels and justifying these levels has been completed.

Publication of this paper sponsored by Committee on Maintenance and Operations Systems.

Abridgment

Cultural Practices for the Establishment of Grasses From Seed for Roadside Erosion Control

Wayne W. Huffine, Lester W. Reed, Fenton Gray, and Lonnie M. Cargill,
Department of Agronomy, Oklahoma State University

Oklahoma has over 19 350 km (12 000 miles) of federal and state highways and more than 300 000 hm^2 (750 000 acres) of roadsides to maintain. These roadside areas are subject to erosion during and after the initial construction period. In construction, it is a common practice to remove the native vegetation along with the soil that has formed from the parent material in order to stockpile the topsoil for replacement after this phase is completed.

The topsoil is not in the best condition to support good vegetative growth (1, 2). It has been handled at least two times, which results in a disintegration of much of the macrostructure of the soil and exposure of much smaller particles that will erode as soon as the soil is replaced.

Bermuda grass [Cynodon dactylon (L.) Pers.] is commonly used for roadside erosion control. Because of the risk of winterkill during the year of seeding, vegetative parts (sprigs or sod) are commonly planted. The cost of establishing Bermuda grass from sprigs on 1.6 km (1 mile) of Interstate highway [approximately 16 hm^2 (40 acres)] can exceed $50 000.

To reduce maintenance activities to a minimum on highway rights-of-way and maximize the effectiveness of those practices, research was initiated to determine the best cultural methods and species to use in roadside erosion control. Several seeding methods and many grass species are in use on highway rights-of-way, but little is known as to which practice or species may provide the best ground cover.

EXPERIMENT 1

Investigation

An investigation of several seeding methods for the establishment of an erosion-resistant ground cover was initiated in June 1970 at the Agronomy Research Station at Stillwater, Oklahoma, on a Udertic Paleustoll soil (Kirkland silt loam) that had been tilled earlier with a disk plow. The investigation was arranged in a completely randomized block design with three replications. The plots were 5.6 m^2 (60 ft^2) in size. The treatments included all combinations of four seeding methods, two herbicide levels, and two species of grass.

The four planting methods used a John Deere drill, a Brillion seeder, a Nesbit grass seeder, and a brush drag The fourth method covered hand-broadcast seed by dragging a tree limb across the plot. The methods of seeding were evaluated for their effectiveness in stand establishment of seeded weeping lovegrass [Eragrostis curvula (Schrad.) Nees.] and an experimental Asiatic bluestem [Bothriochloa intermedia var indica (R. Br.) A. Camus] referred to locally as B-blend. The John Deere drill and the Nesbit grass seeder were set at a planting depth of 12 mm (0.5 in). The Brillion seeder broadcasts the seed between two sets of corrugated rollers.

The preemergence herbicide propazine, 2-chloro-4, 6-bis (isopropylamino)-s-triazine was applied on the treated plots at the rate of 1.12 kg/hm^2 (1 lb/acre) of active ingredient (ai). Weeping lovegrass was seeded at the rate of 5.6 kg/hm^2 (5 lb/acre) of pure live seed (PLS). The B-blend Asiatic bluestem PLS was seeded at the rate of 2.2 kg/hm^2 (2 lb/acre).

The two grasses were seeded with the Brillion seeder and the brush-drag method on June 19. Rain delayed seeding with the John Deere drill and the Nesbit grass seeder until June 22. Since the Brillion seeder had no agitators, the B-blend Asiatic bluestem was sown by hand, and then the Brillion seeder was run across the plot. Because a grass seedbox attachment with an agitator was not available for the John Deere drill, constant manual seed agitation was necessary when B-blend Asiatic bluestem was seeded. The preemergence herbicide propazine was applied on June 22 after all seeding had been completed, and then approximately 0.6 cm (0.25 in) of water was applied by sprinkler irrigation.

Results and Discussion

As the table below indicates, there were no significant differences among the four planting methods in the establishment of an erosion-resistant stand of grass (1 cm^2 = 0.15 in^2):

	Number of Grass Plants per 929 cm^2	
Planting Method	Weeping Lovegrass	B-Blend Asiatic Bluestem
John Deere drill	31.1	4.1
Brillion seeder	26.1	3.2
Nesbit grass seeder	24.8	1.6
Brush drag	28.8	3.2

But there were highly significant differences in grass population as a result of the use of propazine on weeping lovegrass. The effect of propazine treatment on grass population is given below:

	Number of Grass Plants per 929 cm^2	
Grass	With Propazine Treatment	Without Propazine Treatment
Weeping lovegrass	43.5	17.6 (significant differences at 0.01 level)
B-blend Asiatic bluestem	3.3	2.3 (no significant differences)

By midsummer, seedlings in the weedy plots were smaller, less vigorous, and thinner than seedlings in the plots where the weeds were controlled.

A possible explanation for the fact that no differences were found between planting methods used in establishment of the stands of weeping lovegrass and B-blend Asiatic bluestem is that the seedbed was well prepared and adequate moisture was available during the establishment period. A total of 12.14 cm (4.78 in) of precipitation occurred in July compared with a 30-year average of 9.4 cm (3.69 in) for the month.

Weeping lovegrass produced better stands of grass than B-blend Asiatic bluestem in the first 60 days of establishment regardless of seeding method and with or without a herbicide.

Although they do not differ statistically, these data indicate that the best stand of either weeping lovegrass or B-blend Asiatic bluestem was obtained by seeding with the John Deere drill and protecting from weeds with propazine.

EXPERIMENT 2

Investigation

Seven mulches were applied to a highly erodible Typic Ustchrepts-Udic Haplustoll (Vernon-Lucien) soil complex on Okla-51, 0.4 km (0.25 mile) west of I-35 in Payne County in central Oklahoma, on July 21, 1972. This 8.6 percent north-facing backslope was characterized as being a very shallow soil on soft calcareous clayey materials and very droughty. The seedbed was slightly to moderately compacted before being disked to a depth of 10.2 cm (4 in). At the time of seeding, the soil moisture content averaged about 4 percent.

The treatments included the following (1 kg = 2.2 lb, 1 hm^2 = 2.5 acres, and 1 L = 0.264 gal):

Mulch	Rate of Application
Asiatic bluestem hay	4484 kg/hm^2
Excelsior fiber	4484 kg/hm^2
Excelsior blanket	149.5 rolls/hm^2
MS-2 (3:1)	14.3 kL/hm^2
Aquatain (5.5:1)	7.9 kL/hm^2
Petroset (24:1)	22.6 kL/hm^2
Conwed fiber	1121 kg/hm^2

Results and Discussion

Germination and growth of the weeping lovegrass were first evident in those plots mulched with Asiatic bluestem hay, Excelsior fiber, and Excelsior blanket. One month after seeding, the soil moisture content measured 11 to 12 percent under these three mulches and only about half this amount under the other materials. On March 23, 1973, an estimate was made by eye of the effectiveness of these mulches on soil erosion control. Based on these estimates, which are given in the table below, the most effective protection from erosion was provided by the Excelsior blanket, and the least was provided by the Conwed fiber:

Mulch	Estimated Soil Erosion Control (%)
Excelsior blanket	95.4
Asiatic bluestem hay	77.9
Excelsior fiber	67.5
Aquatain	33.7
MS-2 asphalt emulsion	29.5
Petroset	25.6
Conwed fiber	12.8

EXPERIMENT 3

Investigation

On May 1, 1975, two opposing backslopes in north central Oklahoma on OK-51 west of Stillwater [11.9 km (7.4 miles)] were seeded with Plains bluestem (Bothriochloa ischaemum var. ischaemum). The Zaneis (Argiustoll) soil, which had an AASHO classification of A-6 (11), was seeded at the rate of 30 lb of bulk seed per acre (33.6 kg/hm^2) with a PLS content of 25 percent. About one month before seeding, 224 kg/hm^2 (200 lb/acre) of 10-20-10 fertilizer and 168.2 kg/hm^2 (150 lb/acre) of 0-46-0 fertilizer were applied on each slope. The field design was a split plot with three replications. The main plots were tillage treatments, and the subplots were mulches.

The three tillage treatments included no tillage, disking, and chiseling. The mulches were Conwed 2000, hay applied at 1.15 Mg/hm^2 (0.5 ton/acre), and hay applied at 2.3 Mg/hm^2 (1 ton/acre).

Precipitation for the year in this area totaled 100.7 cm (39.65 in) compared with a norm of 81.7 cm (32.18 in).

Results and Discussion

No significant differences in plant population were detected during the year of establishment on the south-facing slope, but the methods of tillage resulted in significant differences in plant population on the north-facing slope (Table 1). The greatest plant density was observed in those plots that were chiseled in preparation for a seedbed.

After two complete growing seasons, the experiments were again evaluated in 1977. At that time, significant differences in plant density were observed on the south-facing slope as an effect of the mulch that was initially used. The greatest plant population was observed in those plots that had been mulched with 2.3 Mg/hm^2 (1 ton/acre) of hay. In addition, there was a significant interaction between the tillage method and the mulch. The best cultural practices, as determined by the greatest plant population, were disking the soil in preparation for the seedbed and mulching with 2.3 Mg/hm^2 of hay (Table 1).

In the year of establishment, the north-facing slope had a greater plant population for all treatments than comparable plots across the highway on a south-facing backslope. The reason for this difference may have been the more favorable temperature and moisture condition on the north-facing backslope, which favored greater seed germination.

In 1977, the greatest number of plants was observed in those plots on a south-facing slope compared with the same treatments on an opposing backslope. A possible explanation for this difference is that the south-facing slope permitted more plants to survive variations in the weather regardless of the cultural practice used in establishment. However, even though there were more plants on this south-facing slope than on the one that faced north, there were significantly more plants in those plots that were disked and initially mulched with 2.3 Mg/hm^2 of hay. This is probably the effect of a better seedbed, which permitted better root development and consequently greater plant survival.

Table 1. Effect of various tillage methods and mulches on plant density of Plains bluestem.

	Density (plants/m^2)			
	North-Facing Slope		South-Facing Slope	
Treatment	1975	1977	1975	1977
No tillage, Conwed 2000 (2.3 Mg/hm^2)	99	32	62	29
No tillage, hay (1.15 Mg/hm^2)	99	29	56	39
No tillage, hay (2.3 Mg/hm^2)	125	30	57	40
Disked, Conwed 2000 (2.3 Mg/hm^2)	117	32	77	41
Disked, hay (1.15 Mg/hm^2)	87	33	64	37
Disked, hay (2.3 Mg/hm^2)	87	36	73	53
Chiseled, Conwed 2000 (2.3 Mg/hm^2)	119	33	81	37
Chiseled, hay (1.15 Mg/hm^2)	122	30	72	28
Chiseled, hay (2.3 Mg/hm^2)	114	34	60	34
Coefficient of variation, %	29	7.5	43	8

Note: 1 m^2 = 10.76 ft^2; 1 Mg/hm^2 = 0.43 ton/acre.

ACKNOWLEDGMENTS

The research personnel from Oklahoma State University who were involved in this project express their appreciation to the personnel of the Oklahoma Department of Transportation and the Federal Highway Administration for their interest and cooperation in these investigations. Special recognition is due R. T. Sutton, Gary W. Roach, J. E. Barber, and C. Dwight Hixon of the Oklahoma Department of Transportation and Jerry Emerson of the Federal Highway Administration.

The opinions, findings, and conclusions expressed in this publication are ours and not necessarily those of the Oklahoma Department of Transportation or the Federal Highway Administration.

REFERENCES

1. J. B. Beard. Selected Experiments in Roadside Vegetation Establishment Under Michigan Conditions. Ohio Department of Transportation and Ohio State Univ., 31st Short Course on Roadside Development, 1972, pp. 3-13.
2. J. T. Green, Jr., J. M. Woodruff, and R. E. Blaser. Stabilizing Distributed Areas During Highway Construction for Pollution Control. Department of Agronomy, Virginia Polytechnic Institute and State Univ., Final Rept., 1973.

Publication of this paper sponsored by Committee on Roadside Maintenance.