

Grassland Management in New Zealand¹

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GRASS production in New Zealand is basic, not only to agriculture but also to the entire national economy. On a land area (66 million acres) slightly smaller than that of Colorado, but with only a little more than 42 million acres occupied, New Zealand supports a sheep population (33 million head) greater than that of the United States plus about 5 million cattle and smaller numbers of hogs, horses and goats. This entire livestock population is a product of the pastures. Even the pigs are grazed and supplemented with skim milk and whey from the dairy industry.

Of the 2 million acres under cultivation, more than one-third is in "plantations" of introduced timber trees, chiefly Monterey pine (*Pinus radiata*), and nearly one-third is in temporary pasture crops, leaving only about one-half million acres for cash field crops.

In New Zealand, "grassland agriculture" is not simply a term designating some far-distant goal toward which to strive. There is, in fact, a grassland agriculture in the highest sense, an agriculture in which the operation of all but a few specialized farms (fruit, truck, tobacco, etc.) is based on grass production and utilization. Grassland agriculture has in some cases been carried too far. The economy of the nation and the welfare of the farmers themselves would be benefited by wider use of cultivated food crops in rotation with the grasses. It is now

necessary to import substantial quantities of such staples as wheat despite the fact that the average wheat yield is more than 40 bushels per acre and yields of twice that amount are not uncommon. New Zealand farmers exhibit a reluctance to plow up grass that is comparable to the resistance encountered in America to the seeding of cultivated lands to perennial pasture.

Situated almost exactly halfway around the globe from Great Britain, its principal market, New

A perspective of the grazing problems and management practices in the hill country pastures of New Zealand—a country in which grass production is basic to the entire national economy. A view of grassland agriculture under intensive management.

Zealand has had to stress low production costs to compete with much nearer sources of meat and dairy products. High pasture production and efficient utilization of the forage have made this possible. No grain is fed to livestock, but perennial pastures are supplemented with temporary grazing crops in addition to hay and silage made from the pastures themselves during the flush of spring and early summer growth.

Efficient utilization of pasture forage by stock is stressed. Nothing is gained by producing a big forage crop unless it is turned into animal products. The entire agriculture is geared to that idea. Pastures account directly for 95 percent of

New Zealand's exports and for more than 60 percent of its total production.

The New Zealander's attitude toward pasture, which may at first be a little difficult for an outsider to understand, was summed up by Dr. E. Bruce Levy, former head, Grassland Divisions of the New Zealand Department of Scientific and Industrial Research, at a meeting of the New Zealand Grassland Association in November 1952, when he said, "I don't like to see any crop harvested if it can be grazed off by stock." That statement carries several important implications that show why New Zealand is a leader in grassland farming:

1. That sheep and cattle can make better and more efficient use of green, growing vegetation than of harvested crops.

2. That at least as much feed can be produced with pasture as with harvested crops.

3. That grazing is the basis for build-up and maintenance of soil fertility, while the removal of crops has the opposite effect.

4. That it is far less costly to let the stock harvest the crop than to cut and haul it, store it, and perhaps even process it before feeding it and hauling manure back to the land.

Total output of pasture products is high. In 1951 New Zealand's 1,880,000 dairy cows produced a little more than 1½ billion gallons of milk containing nearly 500 million pounds of butterfat (N. Z. Dairy Board, 1951). Total annual meat production is more than one-half million long tons, and wool production is about 400 million pounds a year (N. Z. Gov. Official Yearbook, 1950). For each acre occupied (including the 9 million acres of waste land on farms and the 14 million acres of montane tussock grassland) the output in 1951 was 9 pounds of wool, 12 pounds of butterfat and 30 pounds of meat,

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plus additional quantities of milk, hides, other animal products and cash crops.

The high producing capacity of New Zealand pastures is due largely to a climate favorable to both plants and animals. Lying far enough from the equator to escape the heat of the tropics, its climate is further tempered by the sea so that low temperatures, too, are avoided. Most of the country receives ample moisture, although the area lying east of the Southern Alps in South Island is relatively deficient in rainfall. Elsewhere the precipitation in the occupied portions is mostly between 30 and 80 inches annually and is rather well distributed over the year.

New Zealand perennial pastures may be grouped into two broad categories: (1) the improved pastures grown on flat to undulating "farm" land and (2) the hill country pastures. The former may, in turn, be divided into permanent and temporary improved pastures. The hill country pastures include the natural tussock grasslands and those sown on land formerly forested.

Improved Pastures

Perennial, improved pastures are made up of plantings of the "English grasses" and legumes, the cool season species, chief of which are perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*). Other important ones are cocksfoot (*Dactylis glomerata*), short-rotation rye-grass (*Lolium perenne* x *L. multiflorum*), crested dogtail (*Cynosurus cristatus*), timothy (*Phleum pratense*), prairie grass (*Bromus catharticus*), and red clover (*Trifolium pratense*). These improved pastures are highly productive and are used chiefly for dairy and fat lamb production and to fatten beef animals. Their management is intensive and not a range enterprise. Therefore, it will not be considered in detail in this discussion.

Hill Country Pastures

The hill country pastures of New Zealand fall into two categories: (1) those sown on land originally in native cover and (2) native tussock grasslands. The sown pastures, according to Levy (1951), occupy some 18 million acres of which 12 million have replaced forest, 4 million have replaced tussock, and 2 million have replaced fern or scrub. These acreages include the intensively managed, improved pastures on the flat to gently-sloping land. There is no sharp distinction based on intensity of management, the improvement being carried as far up the slopes and into the "back country" as is economically feasible.

The Sown Pastures

Hill country pasture that has replaced forest or scrub and fern lies mostly in North Island where the native vegetation was predominantly rain forest except for a limited amount of tussock grassland occupying the elevated, central volcanic plateau. These sown grasslands have been developed largely over the past 80 years and there still remain some 3 million acres of standing forest and 2 million acres of scrub awaiting development. Also awaiting development are at least 2 million acres once sown to grass but since allowed to revert to secondary growth. Data are not available on the extent to which tussock grassland can be converted to sown pasture but the acreage is considerable.

Converting the forest to grassland was based on fire. Between the years 1880 and 1910 very large areas of hill country forest were cut and burned (Cameron, 1952). The forests were felled during the winter and burned in the spring when the entire mass was dry enough to give a hot fire, one which would make a "white burn." The grass seed was sown directly into the fresh ash as soon as possible, but if the burn

was not made until early summer, a sowing of white turnips might first be made. The grass would then be sown among the turnips as they were being grazed off in the autumn.

Heavy seeding rates were (and still are) the rule, 30 to 40 or more pounds of seed being applied per acre. The major species have been perennial ryegrass and white clover, but many others also have been added to mixtures, including cocksfoot, crested dogtail, Kentucky bluegrass (*Poa pratensis*), browntop (*Agrostis tenuis*), danthonia (*Danthonia pilosa*), and, more recently, the newer short-rotation rye-grass. In the warmer northern parts paspalum (*Paspalum dilatatum*) is widely used, while white and red clover are used throughout. Lotus (*Lotus uliginosus*) frequently is added to mixtures in wet areas, and subterranean clover (*Trifolium subterraneum*) in drier ones.

Burned areas might not be sown to a uniform mixture. Often the relative amount of browntop was increased in the drier sites and perhaps some Chewing's fescue (*Festuca rubra* var. *commutata*) added, whereas these two and danthonia might be left out altogether on more favorable sites, with timothy and alsike clover (*Trifolium hybridum*) used in their place. The annual suckling clover (*Trifolium dubium*) and certain *Medicago* species are sometimes sown, but the burclovers are not favored as the burs tend to contaminate the wool.

The newly-sown "bush burn" pastures were fenced as soon as possible and grazing was started about two months after seeding because it was necessary to graze off and tread out the new fern and scrub growth that otherwise would overwhelm the grass. Where the fern and scrub were especially persistent, the ratio of cattle to sheep was one to five or one to seven, but "where the country was comparatively easy to hold, one cattle

beast to 10–15 sheep was generally regarded as sufficient" (Levy, 1951).

The botanical composition of the pastures on these once forested areas varies according to the soil fertility and grazing use. Where it has been maintained by fertilization and proper livestock management, the sward is made up mostly of perennial ryegrass, cocksfoot, crested dogtail and white clover. From three to six ewes per acre can be carried throughout the year if some phosphate is applied as topdressing.

Less carefully maintained pastures and those on less fertile areas may contain small amounts of the above species, but they also will have much browntop, danthonia, Yorkshire fog (*Holcus lanatus*), sweet vernal (*Anthoxanthum odoratum*), lotus, suckling clover and weeds. They can carry only one to three ewes per acre plus perhaps one steer or cow for each eight to fifteen sheep. The poorer and drier sites are likely to be dominated by danthonia along with sweet vernal, hairgrass (*Vulpia* spp.), ratstail (*Sporobolus capensis*), New Zealand ricegrass (*Microlaena stipoides*) and annual clovers.

Levy and Suckling (1949) pointed out that the majority of the deforested hills in the North Island are potentially almost as highly productive as the lower, flat and undulating country, capable of grazing four to six ewes and fat lambs per acre. To achieve this productive state requires the fertilizer ingredients from the excreta of at least three to four sheep per acre. Such fertility must come originally from clovers and phosphates. Under proper grazing management it is made available to the grasses throughout the season after passing through the digestive tracts of the animals.

This being a forest climate, natural succession is first to fern and scrub and ultimately to forest. Stocking with sheep alone will not prevent the development of scrub

and, in spite of much time and effort spent in brush eradication, some 2 million acres already have reverted to this secondary growth. The cattle are, in effect, the "implements" for consolidation of the soil and "crushing out" the scrub and fern growth. They also prepare the pasture for the ewes and lambs by "cleaning up" roughage during the autumn and winter so that the new fresh spring growth will be free of old tops and succulent enough for best utilization by sheep. Cattle, then, are not kept in the hill country primarily for the profits they bring when marketed, but to "do a job of work," to "keep the pastures in order." Often they are kept until three or four years of age before being taken to the "easy country" to be fattened on grass for market. Usually they do not bring direct profits, as do the sheep, and farmers may attempt to do without them in order to run a few more sheep. This leads to deterioration.

The most successful grazing management in the hill country consists of rotational grazing with rather heavy concentrations of animals for relatively short periods. "Spelling" (deferment) to create shade at the ground surface encourages the better grasses and discourages the fern and scrub seedlings. It is not uncommon to "spell" an area for an entire growing season and then to graze it off rather closely with cattle in the winter. Another fairly common practice is to graze the sheep year-long and rotate the cattle grazing as required to "keep the pastures in order," or to graze the cattle on a yearlong basis and rotate the sheep grazing. "Set stocking" (yearlong or season-long grazing) is less likely to succeed than rotational grazing, but is widely practiced.

The hill country of North Island is capable of great expansion in livestock production through the development of its pastures and the intensification of its grazing. New

and better power equipment is extending tillage onto slopes formerly considered far too steep to work. Large disks and plows are now available to turn under brush 10 or 15 feet high. In this land of ample moisture, liming, fertilizing and reseeding will double or even quadruple the carrying capacity as the soil fertility is "built up" by legumes and grazing management. Extensive development schemes to accomplish this on government lands are now under way.

Farther up the slopes and in the back country, much is being done through grazing management alone. However, soil fertility remains a serious problem for without phosphates the legumes will not thrive and thus grass growth falls off, allowing fern and scrub to encroach. To meet this need for legumes and improved soil fertility, much hill land has been topdressed by hand and some by means of blowers that distribute fertilizer by wind blast over considerable distances (Hamblin, 1949 and Cameron, 1952). Neither method has given entirely satisfactory distribution and both are costly. More recently a system of aerial topdressing and aerial overseeding has been developed. Today many thousands of tons of superphosphate are applied to hill lands by light planes that land on air strips the farmer himself develops, often on some narrow but relatively flat ridgetop where the fertilizer can be hauled by truck or wagon (Lynch, 1950, 1951). Legume seed, too, is being applied in this manner, and a great extension of this practice can be expected. Extensive application by means of large aircraft operating from a few main centers is being contemplated.

Expansion and intensification of land development and grazing in the hill country will greatly increase New Zealand's output of animal products. They will permit direct increase through the produc-



FIGURE 1. North Island hill country pasture with bulldozed access track, typical of areas fertilized by aerial topdressing. (Courtesy Grasslands Div., N. Z. Dept. Sci. and Ind. Res.)

tion of greater numbers of animals. They will also permit the raising of dairy replacement stock away from the intensive dairy farms of the "easy country" which many workers believe should be reserved for milking cows and for fat lamb production, the replacements all coming from the hill pastures.

Native Grasslands

The tussock or bunch-forming grasses dominate nearly 14 million acres, mostly on the relatively dry, eastern slopes of the Southern Alps. These are mostly crown lands, grazed on an extensive ranching basis, but they, too, have in part been converted to sown pasture. There also exists a smaller area of tussock grassland in the volcanic region near the middle of North Island which is not a climax grassland but a subseres, dating from the period of volcanic activity that ceased there some 2300 years ago. The dominant species are medium to large grasses that occur as fairly widely spaced tussocks with various

forbs and shrubs growing under and among them.

The tussock grasses are mainly species of *Festuca*, *Danthonia*, *Poa* and *Agropyron*. They vary in palatability, some being quite harsh and coarse, but the early settlers soon discovered that new, fresh growth following fire was taken readily by stock. Also, the fires reduced the size and vigor of shrubs and other coarse plants, allowing the native forbs and certain introduced grasses and legumes to spread. As a result, burning has greatly altered the character of the native grassland, weakening the tussocks, opening up the turf, and allowing great increases in soil erosion.

The tussock grasslands, according to Barker (1953), consisted of two general types: (1) a tall tussock grassland on the higher slopes dominated by large, coarse tussock grasses, and (2) a low tussock grassland dominated by smaller and less coarse species and occupying a relatively lower altitudinal zone. Inter-mixed with the tussock grasslands,

occupying the shady, north-facing slopes and the lower gullies, is an evergreen forest dominated in places by species of *Nothofagus* and in others by species of *Podocarpus*.

Land in the high country is not privately owned but is held by the state, the sheep stations being leased on a long-term basis. The lease holders appear to be in complete control and are not required to practice conservative grazing or any other form of range improvement, but are required to obtain a permit before burning. This is an extremely difficult rule to administer, however.

The tussock grasslands once extended down the slopes and across the coastal plain to the Pacific. The coastal plain has been developed largely for arable farming and improved farm pastures, but the lower eastern slopes and valleys of the Southern Alps, known as the "high country", are still tussock grassland. They are used primarily for extensive grazing of sheep, grazing use extending up the slopes to an elevation of 5000 to 6000 feet or a little more. Very little vegetation occurs beyond that elevation and none at all much above 7500 or 8000 feet. Timber line is at 3500 to 4000 feet and above that a narrow zone of snowgrass, a large, coarse *Danthonia* tussock.

The "high country" is used mainly to graze Merino sheep, kept almost solely for their wool. Weather conditions are rather severe and death losses quite high. The lambing percentage is relatively low, so the natural increase usually is not much more than sufficient to maintain the wool flock of ewes and wethers. On the lower slopes, where the environment is less severe, the sheep are mostly cross-breeds, the Romney of the lowlands being crossed on the "cast-for-age" ewes.

Grazing of these native grasslands is on a yearlong basis, some 5 to 10

acres per sheep being required in the high country. The lower slopes and valleys are utilized for winter grazing because snows do not lie on them for long periods. After shearing in the spring, the sheep are put in the higher paddocks, the wethers going to the highest and steepest ones and the ewes with lambs to those less difficult to graze. Shearing in the high country is mostly with "the blades" because mechanical shearers tend to remove the wool too closely, leaving the sheep more susceptible to early spring cold spells. The wethers generally are shorn earlier than the ewes and are turned into the higher paddocks.

Much of this high country is steep. Erosion, characterized by shingle slides, becomes severe where the grazing is not carefully regulated. Heavy movement of shingle into the fast-flowing streams presents a serious problem in the valleys below. It is believed by many conservationists that certain of the most erosive areas should be closed to grazing for watershed protection.

The tussock grasslands on the higher and drier sites do not promise economic response to fertilizers and overseeding. Levy and Suckling (1949) have emphasized that if depleted montane tussock is to be regenerated, there must be strict control of fire and rabbits and livestock must be excluded for several seasons. Since most of this grassland is on crown lands, the government could enforce such measures, but only at the expense of greatly reducing, temporarily at least, the livestock population of the high country. Such enforcement would bring strong opposition, but is probably the only practical solution.

While improvement of the high country consists mainly of regulated stocking and the control of burning to prevent further depletion of the tussock grasses, research is showing



FIGURE 2. Loading a light plane for aerial topdressing. Rapid mechanical loading devices minimize the time planes are on the ground. (Courtesy Grasslands Div., N. Z. Dept. Sci. and Ind. Res.)

that the gentler slopes and valleys can be seeded to improved legumes and grasses and that responses to lime and fertilizers are good. Development by plowing and the establishment of improved pastures is being carried out in areas with as little as 20 inches of precipitation annually. The species sown are the ones used in North Island with tall oatgrass (*Arrhenatherum elatius*) being added in drier sites. Other introduced grasses, such as various species of *Agropyron* and *Bromus* and a number of the native species, are being tested. Just as in North Island, overseeding and topdressing are being carried farther and farther into the hills.

Irrigation is beginning to play a role in the improvement program, small valleys being put to improved pastures or supplemental feed crops and watered by flooding or by overhead irrigation. Even rather steep pastures are being developed for "wild flooding", the water being spilled over the low banks of small field ditches located at intervals along the slopes.

A unique method of hill land improvement consists of building up the fertility and establishing legumes on the steep lands by means of livestock. Heavily fertilized paddocks in the valleys are "closed up"

to allow the legumes to mature seed. Cattle are then pastured briefly on these and driven to the nearby slopes where their excrement deposits both plant nutrients and legume seed. Marked improvement may be noted after one or two seasons of such treatment. This method is, of course, not limited to the tussock grasslands.

Predators and Other Pests

Predators, in the usual sense, are not known in New Zealand since the country had no indigenous mammals except the native bat, although the Maori had brought the Polynesian rat and dog in the 14th century (N. Z. Dept. Int. Affairs, 1945). Early explorers, according to Wodzicki (1950), brought various plants and animals. Later, sealers and whalers operating from shore bases, brought still others, including pigs, goats, horses, cattle and sheep.

The only one of these that could be classed as a predator is the pig. It has multiplied in the wild and often destroys young lambs in the early spring, besides damaging pastures by rooting. There is, however, one other predator, the kea, a native parrot that inhabits the high tussock grassland. It attacks sheep, tearing at their backs until the fat over the kidneys is exposed. Keas eat the fat

and leave the sheep to die. Needless to say, both pigs and keas are hunted by sheepmen.

There are many pests in New Zealand, most of them introduced. The worst one, perhaps, is the rabbit, introduced by early settlers from the British Isles. In some areas it has denuded the land so completely that the only remaining vegetation consists of scabweeds (*Raoulia* spp.) that grow in patches so close to the soil surface that they resemble great, ugly scabs, hence the name. The economic loss from the depredations of rabbits runs into millions of dollars a year. During the 10 years ending June 30, 1943, nearly 126 million rabbit skins were exported. They represented considerably fewer than half of the number destroyed (N. Z. Dept. of Agric. Livestock Div., 1947).

Vast sums have been spent destroying rabbits. They have been brought under control in some areas, but in others they still are limited only by their own destruction of the available feed supply. Organized control is carried on through local "rabbit boards" that subsidize, in part at least, the cost of eradication by professional exterminators.

Another introduced pest (that harms the forest more than the grazing land, however) is the deer. Like rabbits, deer multiply rapidly and have become so abundant in some sections that professional "cullers" are employed by the government to keep the numbers down. On the higher mountain slopes, chamois and tahr have also become troublesome, as has the wallaby in some localities.

Among the serious pests of New Zealand pastures are the grass grubs (*Odontria* spp.) and the grass caterpillars (*Oxycanus* spp.), which cause severe losses of stands on lighter soils throughout the dominion (Kelsey, 1952). Extensive research is pointing to chemical and biological control and control by improved cultural practices.

Weed pests, too, are a problem. Introduced shrubs such as gorse (*Ulex europaeus*), broom (*Cytisus scoparius*), blackberry (*Rubus fruticosus*) and the native manuka (*Leptospermum scoparium*) often occupy depleted pastures, while Nasella (*Stipa trichotoma*), an introduced tussock, is spreading unchecked in others. Research on eradication by various means, including chemicals, and on control by management is being pressed. Biological control of manuka with a scale insect (*Eriococcus* spp.) is giving promising results, while blackberry is controlled somewhat by the hordes of "wild" goats that inhabit certain areas. They take enough of the plant to check its spread by layering.

Losses of stock from plant poisoning are not great in New Zealand although many species of poisonous plants do occur, most of them introduced. Conner (1951) has listed eight important poisonous species, half of them introduced, and 109 additional species known to be poisonous but less important in livestock losses. Of these, only seven are native. An additional 70 species, including 20 natives, are suspected of being poisonous.

Livestock diseases and parasites take a certain toll but there is available a rather adequate veterinary service, and research in this field is being actively carried on. Strict quarantine of all imported animals for a long observational period has prevented entrance of certain diseases, notably rabies. Compulsory, annual dipping of sheep helps control ticks and other surface parasites. An adequate program of extension education, not only on problems of diseases and parasites but also on all phases of livestock and pasture production, is in effect.

Roads and Tracks

The extremely steep terrain makes it difficult in many places to travel over the pastures except

afoot or on horse back, and even the latter method may be impossible on the steepest slopes. This makes any management operation extremely difficult. However, the development of "tracks" bulldozed into the steep slopes is proceeding throughout the back country to permit easier access to the pastures for fencing, weed eradication, fertilizing, rabbit control and mustering. The versatile Land Rover, the British counterpart of the American jeep, has aided greatly in this respect.

Fencing

Since neither sheep nor cattle are herded as are sheep in the United States, but are grazed free in the paddocks, adequate fencing is a necessity for proper control of grazing. Sheep-tight fence is costly and often difficult to build in the steep hill country. It is not uncommon to transport the posts and wire to the site on pack animals or even to carry them by hand in the steepest places. Nevertheless, New Zealand pastures are, on the whole, rather well fenced despite the fact that fencing in the steepest and most remote areas may cost \$2000 or more per mile (Cameron, 1952).

Soil Erosion

The nature of the vegetative cover has been greatly altered. On the steeper slopes the introduced grass cover has not been capable of preventing accelerated erosion, except where extremely careful management has maintained a vigorous and productive sward. Organized efforts at erosion control are centered in conservation districts known as catchment boards that direct erosion research and the application of control measures. Grange and Gibbs (1947) have described the types of erosion in North Island, and Gibbs and Raeside (1945) those of the high country in South Island.

Fertilization with Minor Elements

Fertilization is chiefly with phosphatic fertilizers to encourage maximum growth of legumes and thus produce enough nitrogen to stimulate grass growth. Potash is needed in some areas and most soils need rather heavy applications of lime. Superimposed on these needs in certain areas are minor element deficiencies. The use of cobalt has greatly expanded livestock production in the region around the Bay of Plenty and responses to minute applications of sodium molybdate are being reported from widely scattered trials in many parts of the dominion. Its effect on the growth of legumes is particularly striking.

Crop Improvement

Most of the agricultural plant species are exotics, although native species are important in the tussock grasslands. In spite of the great amount of testing of plant introductions and of improvement by breeding, far more remains to be done. Most improvement research has been directed at the problems of the improved pastures because the greatest accomplishments could be made in those areas. More recently the research on hill country problems of all types has been greatly expanded. Exotic species such as smooth brome, intermediate wheatgrass, and many others are being given new trials in areas where

they had not been tried before, and certain ones doubtless will be found useful. Native species are being studied as well, in the hope of developing better varieties. The facilities for pasture plant breeding and for seed production and certification are available. Their application to hill country problems is now proceeding.

Conclusion

It has been impossible to touch on all phases of grassland management in New Zealand. That would require a review of the entire economy. This has been an attempt to emphasize the management and some of the problems of the hill country pastures, roughly comparable to the range lands in the United States but far more intensively utilized in the more productive areas. Discussion of the improved pastures has been intentionally omitted, but it must be recognized that they play an extremely important role in butterfat production and the fattening of stock. Far more study and research have been directed at their problems than at those of the hill country, but the hill pastures offer a great challenge and of recent years they are receiving more and more attention.

LITERATURE CITED

BARKER, A. P. 1953. An ecological study of tussock grassland. New Zealand

- Dept. Sci. & Ind. Res. Bull. 107. 58 pp.
- CAMERON, I. D. 1952. New Zealand hill country and its relation to the richer pastures of the lower lands. Proc. Sixth Int. Grassland Cong. 1: 556-561.
- CONNOR, H. E. 1951. Poisonous plants of New Zealand. N. Z. Dept. Sci. & Ind. Res. Bull. 99. 141 pp.
- GIBBS, H. S. AND J. D. RAESIDE. 1945. Soil erosion in the High Country of New Zealand. N. Z. Dept. Sci. & Ind. Res. Bull. 92. 72 pp.
- GRANGE, L. I. AND H. S. GIBBS. 1947. Soil erosion in New Zealand. Part I. Southern half North Island. N. Z. Soil Bur. Bull. No. 1. New Series. 28 pp.
- HAMBLYN, C. J. 1949. Blower equipment for hill-country topdressing. N. Z. Jour. Agric. 78: 452.
- KELSEY, J. M. 1952. Grass-grub and grass caterpillar control. N. Z. Dept. Agric. Bull. 244. 20 pp.
- LEVY, E. B. 1951. The grasslands of New Zealand. R. W. Stiles & Co. Ltd., Wellington, N. Z. 334 pp.
- AND F. E. T. SUCKLING. 1949. Some research aspects of soil conservation and the future of the hills. United Nations Conf. on the Conserv. & Utilization of Resources. 13 pp. Mimeo.
- LYNCH, P. B. 1950. Topdressing hill country by aircraft. N. Z. Jour. Agric. 80: 309-312.
- . 1951. Measuring efficiency of topdressing by light aircraft. N. Z. Jour. Agric. 82: 315-320.
- N. Z. DAIRY BOARD. 1951. 27th Annual Report. 87 pp.
- N. Z. DEPT. OF AGRIC., LIVESTOCK DIV. 1947. The rabbit pest and its control. N. Z. Dept. Agric. Bull. 284. 12 pp.
- N. Z. DEPT. INT. AFFAIRS. 1945. Introduction to New Zealand. 271 pp.
- N. Z. GOVT. OFFICIAL YEARBOOK. 1950. Govt. Printer, Wellington. 1120 pp.
- WODZICKI, K. A. 1950. Introduced mammals of New Zealand. N. Z. Dept. of Sci. & Ind. Res. Bull. 98. 255 pp.

A stock pond on the J. O. Broyles farm in the Latah (Idaho) Soil Conservation District. Photograph by JOHN L. SCHWENDIMAN, Pullman, Wash. First prize, Range Landscape, Photography Contest at Omaha, Nebraska annual meeting.

