The New Zealand
Journal of Agriculture.

VOL. 48. WELLINGTON, 20TH JANUARY, 1934. No. 1.

ORCHARD SPRAYS IN NEW ZEALAND.

VII. COMBINATION SPRAYS.

G. H. CUNNINGHAM, Mycologist, Plant Research Station, Palmerston North.

IN New Zealand it is customary to combine orchard sprays with a view to reducing the number of applications. This practice is of advantage owing to the large number of individual sprays comprising the spray programme, necessary to control the different types of insects and fungi present in the orchard. Judicious combination may halve the number of applications, and thus reduce the total spray costs considerably, since application costs are actually greater than the cost of materials. Certain combinations possess the additional advantage of improving the therapeutant value of the individual sprays.

The major factors which determine the advantages or disadvantages of combination are: (*a*) The chemical nature of the spray compounds employed; (*b*) their physical properties; (*c*) the risk of injury to foliage and fruit; (*d*) the concentrations employed; (*e*) the fungous diseases and insect pests present; (*f*) previous or subsequent sprays applied to the plant; and (*g*) the effects of additive compounds of the nature of spreaders, activators, or adhesives. Of these, the aspects of disease and pest control, and of safety to the plant, are of primary importance; consequently combinations are discussed principally from these viewpoints.

The sprays in current employment are (1) lime sulphur, (2) colloidal sulphur, (3) lead arsenate, (4) bordeaux (or burgundy) mixture, (5) nicotine or nicotine sulphate, and (6) petroleum oils.

Lime sulphur is employed as a fungicide and, to a lesser extent, as an insecticide. A 1-per-cent. concentration is moderately effective (though inferior to petroleum oil) as a controllant of scale insects when applied during the dormant period. It is principally employed as a summer fungicide, being applied to pome fruits, stone fruits, vegetables, &c., at concentrations of from 0·083 per cent. to 0·1 per cent. (the former concentration for less tolerant varieties) for control of black-spot of apples, and leaf-rust and brown-rot of peaches, &c. The spray is also of value in combating soft-bodied insects, though seldom used alone for the purpose.

Colloidal sulphur is the most efficient fungicide to employ against mildews. It is also effective against leaf-rust and brown-rot of

stone fruits, and tomato leaf-mould. The spray is applied in the orchard at the concentration of 4 lb. of the paste to 100 gallons of water; under glass 2 lb. give comparable results.

Bordeaux mixture is the most efficient fungicide for the control of fungi other than mildews. Two concentrations are employed, 5–4–50 at green tip on pome fruits and bud movement on stone fruits; 3–4–50 for summer applications to pears, tomatoes, and other small fruits, potatoes, and other vegetables.

Lead arsenate is a stomach poison used to combat chewing insects such as codling-moth, leaf-roller caterpillar, bronze-beetle, and cherry slug. The standard concentration employed in the Dominion is 1½ lb. powder or 3 lb. paste per 100 gallons of water. It may be applied with safety to pome fruits, small fruits, potatoes, and most garden vegetables and flowers; but is unsafe to use on stone fruits other than English plums.

Nicotine or nicotine sulphate may be employed during the growing season on most plants, without risk of injury, to combat soft-bodied insects, such as aphides, leaf-hopper, mealy-bug, and red-mite. The standard concentration recommended is 0·05 per cent. nicotine.

Petroleum oil is employed to destroy insect eggs during the dormant season, and against soft-bodied insects during the growing period. For dormant applications winter oil is applied at a concentration of 4 per cent. against San Jose scale, and 3 per cent. against other scales. Summer oils are applied at concentrations of 2 per cent. on citrus, and from 1·0 to 1·5 per cent. on pome and stone fruits.

Simple Combinations.

1. Lime Sulphur.

(*a*) *Plus Colloidal Sulphur.* — During the past three seasons this combination has been widely used throughout the Dominion. It has proved to be effective in combating black-spot and powdery-mildew of apples, and leaf-rust and brown-rot of stone fruits. At concentrations of 2 lb. of colloidal sulphur to 100 gallons of 0·083 per cent. lime sulphur, satisfactory control of these diseases may be secured without risk of leaf scorch. A "spreader" is unnecessary with the combination.

(*b*) *Plus Acid Lead Arsenate.*—This combination has been employed for many years in the Dominion—since the introduction of commercial lime sulphur, in fact—for control of black-spot and chewing insects of the apple.

Unless prepared in the manner outlined below, the combination is liable to cause severe leaf scorch and fruit russet. Several opinions have been published as to the nature of the changes which take place when these sprays are combined (*q.v.*, Bradley and Tartar, 1910; Robinson and Tartar, 1915; Robinson, 1919; Goodwin and Martin, 1925; Andrew and Garman, 1926; Young, 1926; &c.). The most probable view is that partial exchange occurs between the lime, the sulphur, and the lead, leading finally to the liberation of water-soluble arsenic* and the formation of lead sulphide. The

* Water-soluble arsenic: The exact form in which this occurs is unknown; it is most probably present as soluble arsenic pentoxide (As_2O_5).

former is responsible for injury to plant tissues; the latter gives the combined spray a characteristic colour, indicating that change has occurred.

If prepared in the following manner the combination may be rendered as safe to plant tissues as lime sulphur or lead arsenate alone: First fill the spray-tank with lime sulphur solution. To the required quantity of lead arsenate powder add double the quantity of hydrated lime. Mix into a thin paste with water, and, with the agitator running, pour slowly into the tank. Apply the combined spray as rapidly as possible after its preparation.

The use of hydrated lime with this combination to alleviate injury was advocated by the Department of Agriculture in 1918, and became a regular practice until superseded by lime casein* "spreader." The lime should be of good quality and possess a high $Ca(OH)_2$ content, since, as Farley (1925) has shown, a sample containing much carbonate of lime tends actually to increase the soluble arsenate content of the spray. Thatcher and Streeter (1924) claimed that comparable results were secured when casein (4 oz. per 100 gallons of combined spray) were added to the lime sulphur, the lead arsenate, or to the mixture. Their work led ultimately to the substitution of commercial lime casein for hydrated lime. This has proved a retrograde step, however, since in recent tests this "spreader" has been found to be less satisfactory and more expensive than hydrated lime.

(*c*) *Plus Bordeaux Mixture.*—No advantage is gained, so far as is known, by combining lime sulphur and bordeaux mixture. The possible effects of combination are discussed, however, owing to the belief prevalent in certain localities that severe injury is liable to follow when lime sulphur is applied to apple trees sprayed a few days previously with bordeaux mixture.

As is shown elsewhere (Cunningham, 1934), when equivalent amounts of lime sulphur and copper sulphate are combined, a dark-brown precipitate of copper polysulphides is formed; and an apparently similar precipitate is produced when bordeaux mixture (containing the same amount of copper, in the form of copper hydroxide) is used in place of copper sulphate. This precipitate may be applied to apple trees without injury to fruit or foliage, provided equivalent amounts of the copper salt and lime sulphur are used and the lime sulphur is used at summer concentrations. If, however, the lime sulphur is in excess, the precipitate is redissolved, and a spray produced which contains quantities of soluble copper, which increases with the increase in the excess lime sulphur. When this is applied as a spray to apple trees, slight leaf scorch and somewhat severe fruit russet follows.

It is apparent that increased injury is liable to occur only when the concentrations of copper hydroxide and lime sulphur are such that soluble copper compounds are produced—that is, when the copper of the bordeaux is decreased below a certain amount, or the lime sulphur is increased. Soluble copper is not produced when 5–4–50 or 3–4–50 bordeaux is combined with 0·2 per cent. lime

* Lime casein; frequently sold under the name of "calcium caseinate."

sulphur. Consequently, there is no likelihood of injury occurring when these concentrations are employed in the field. Theoretically, the risk of injury is increased by an increase in the time interval between the bordeaux and lime sulphur applications, owing to weathering and consequent loss of copper salts from the former spray. No method is available for ascertaining this loss, but field tests have shown that no injury follows the use of these sprays when the bordeaux is applied at green tip and followed by lime sulphur at pink or pre-pink stages.

(*d*) *Plus Nicotine or Nicotine Sulphate.*—This combination may be used for combating fungi and soft-bodied insects attacking pome fruit and stone fruit trees. It is safe to employ, since no reaction occurs which is liable to affect the efficacy of either spray, or to induce injury in excess of that caused by lime sulphur alone, either with nicotine sulphate (Andrew and Garman, 1926), or, as we have ascertained, with nicotine. It is unnecessary to employ with the combination an activator to liberate the nicotine from the nicotine sulphate, the lime sulphur acting in this capacity (Worthley, 1927). No advantage is to be gained by the addition of commercial lime casein "spreader" to the combination; and soap—recommended by manufacturers for use with nicotine or nicotine sulphate when applied alone—should not be employed, as it reacts with the lime sulphur to form insoluble calcium soap.

(*e*) *Plus Petroleum Oils.*—No advantage is to be gained by combining lime sulphur with winter oil. The oil is most effective in destroying insect eggs when applied during early dormancy (Cunningham and Muggeridge, 1933), whereas lime sulphur has little, if any, value as a fungicide if applied at this period. The latter may be used alone to destroy insect eggs (at 1 per cent. concentration), but in such a case there is no point to be gained by using the oil spray.

It is unsafe to combine lime sulphur with summer oils emulsified or stabilized with soaps or ammonium compounds. When ammonium compounds have been employed for the purpose, soluble sulphur compounds are produced which are highly toxic to plant tissues (Cutwright, 1929; Gross and Fahey, 1930). If soaps are used as emulsifiers, they react with the lime sulphur, leading to the formation of insoluble calcium soaps and breaking of the emulsion.

Injury is also liable to follow when lime sulphur is applied to trees sprayed previously with summer oil emulsified or stabilized with ammonium compounds, or *vice versa*. The obvious method of avoiding this injury is to employ an oil which does not contain ammonia in free or combined form. This we have demonstrated by applying to apple trees without injury a combined spray of lime sulphur and a straight summer oil emulsified with lime casein. Alternatively, this injury may be avoided by applying the oil spray from five to seven days in advance of the lime sulphur (or colloidal sulphur) spray; or, if sulphur sprays have been applied previously to the trees, by allowing ten days to elapse before applying the oil. Gross and Fahey (1930) claimed that the addition of 5 lb. of hydrated lime per 100 gallons of oil spray (0·75 per cent. concentration) made it safe to apply within a day or so following lime sulphur.

(*f*) *Plus Iron Sulphate.*—The practice of adding iron (ferrous) sulphate to lime sulphur or the lime sulphur plus lead arsenate combination, with a view to minimizing spray injury, was originated in the United States in 1925 (Dutton, 1929). When equivalent solutions of iron sulphate and lime sulphur are combined* the mixture becomes black, and iron sulphide and sulphur are precipitated. When this precipitate is applied to the tree, within an hour or so the iron sulphide is oxidized to free (colloidal) sulphur and a rust-colured basic sulphate. Therefore the effect of the iron sulphate is to convert the lime sulphur to colloidal sulphur. Our experiments have shown that this is accomplished at the expense of the wetting and spreading properties of the lime sulphur, a loss of portion of the sulphur, and a decrease in the fungicidal efficiency of the spray. Consequently this combination is not recommended.

(*g*) *Plus Aluminium Sulphate.*—Aluminium sulphate has been employed in Nova Scotia (Taylor, 1929; Hockey, 1931) with lime sulphur or the combined lime sulphur plus lead arsenate or calcium arsenate sprays. Reduction of injury is claimed when 3·5 lb. of the salt are added to a spray containing 1 gallon of concentrated lime sulphur (polysulphide content not specified). The combination is not recommended, as it is somewhat costly, and produces H_2S gas which is inflammable, toxic to man, and corrodes the brass parts of the spray outfit.

(*h*) *Plus "Spreaders."*—Our experiments have shown that lime sulphur, being a caustic alkali applied as a liquid, has excellent wetting and spreading properties which are not materially improved by the addition of casein or lime casein "spreaders." Soaps cannot be employed, as they are precipitated as insoluble calcium soaps. Consequently no advantage is to be gained by the addition of available commercial "spreaders" to lime sulphur or the lime sulphur combinations discussed above.

2. Lead Arsenate.

(*a*) *Plus Lime Sulphur.* (See section 1 (*b*).)

(*b*) *Plus Colloidal Sulphur.*—This combination may be used when it is necessary to combat chewing insects and mildews. Our experiments indicate that no increase in injury follows the application of 1½ lb. lead arsenate and 4 lb. colloidal sulphur per 100 gallons. A "spreader" is unnecessary with the combination, since the colloidal sulphur contains appreciable quantities of a protective colloid which serves this purpose.

(*c*) *Plus Bordeaux Mixture.*—This provides a good stock spray for combating chewing insects and endoparasitic fungi attacking plants which will tolerate summer applications of bordeaux mixture. No significant chemical reaction occurs in the combination.

The preferable method of making the combined spray is first to prepare a full tank of bordeaux mixture, then with the agitator running, to add slowly the lead arsenate mixed with water to a thin cream.

* To precipitate completely the polysulphides in 100 gallons of 0·1 per cent. lime sulphur, approximately 2·6 lb. of iron sulphate are required.

As the combination has poor spreading and adhesive properties, owing to the physical nature of both components, applications would be materially improved by the addition of a "spreader." Soaps cannot be employed, as they react with lead arsenate to form water soluble arsenic, and with the excess lime of the bordeaux to produce insoluble calcium soaps (Tartar and Bundy, 1913; Morris and Parker, 1914). Casein or lime casein improves spreading, but adversely affects the adhesive properties of the combined spray. Improvement in both factors may be secured by the addition of a low concentration (0·25 per cent.) of a highly refined unemulsified summer oil.

The combination of burgundy mixture with acid lead arsenate is not recommended, for the soda of the burgundy reacts with the lead arsenate to produce appreciable quantities of water soluble arsenic.

(*d*) *Plus Nicotine or Nicotine Sulphate.*—A combination of acid lead arsenate plus nicotine may be used to combat both chewing insects and soft-bodied insects. The combination is safe to apply to all plants which will tolerate lead arsenate, as no significant reaction occurs when the two sprays are combined.

An activator is necessary when nicotine sulphate is employed. For the purpose hydrated lime may be used at the rate of 5 lb. per 100 gallons of spray. Soaps cannot be used, for, as has been shown, they react with the lead arsenate to produce water soluble arsenic.

(*e*) *Plus Petroleum Oils.*—Petroleum oil and lead arsenate may be combined with advantage to produce an insecticide which is effective in combating both soft-bodied insects and chewing insects. The oil additionally improves the adhesive and spreading properties of the arsenate. For this reason the combined spray has recently been widely used in the United States for the control of codling-moth. In fact, adhesion is so improved that removal of spray residues has become a serious problem in that country, necessitating the use of costly washing machinery. Consequently, in the Dominion, the use of the combination is advisable only during the earlier part of the season against chewing insects (as bronze-beetle) which are difficult to combat.

The risk of injury following applications is considerable if the summer oil contains ammonium compounds, owing to the reaction of these with the arsenate to liberate appreciable volumes of water soluble arsenic (Robinson, 1932; Murray, 1932). Oils containing soaps as emulsifiers cannot be employed for the same reason. Consequently the combination is recommended only if prepared as follows: Emulsify a straight (unemulsified) summer oil by stirring into it the lead arsenate, mixing vigorously to form a stiff paste. To this add small quantities of water, stirring continuously until a thin cream is produced. Pour this slowly into the spray-tank (having filled this previously with water), with the agitator running. The spray should be applied as rapidly as possible, without stoppage, for, if agitation ceases, the emulsion will break and the oil form a film on the surface.

According to Pinckney (1923), if the oil is emulsified with soap prepared entirely from oleic acid, no reaction occurs with the arsenate. Unfortunately such a product is not available on this market.

(*f*) *Plus "Spreaders."*—As lead arsenate has poor spreading and adhesive properties, it is advisable to apply it combined with a "spreader." Soaps cannot be used for the purpose, as they react chemically to produce water soluble arsenic. Casein and lime casein are efficient spreaders, but unfortunately do not materially improve adhesion; on the contrary, they tend rather to reduce the volume of lead arsenate remaining on the tree, this loss being excessive when the casein content is in excess of 4 oz. per 100 gallons of spray.

The most efficient of the available "spreaders" are low concentrations of highly refined summer oil or fish-oil. The former may be employed at a concentration of 0·25 per cent., the latter at 4 fluid ounces per pound of arsenate powder (Hood, 1929). Injury is liable to occur if either is emulsified or stabilized with ammonia or soap compounds. It is therefore advisable to use unemulsified oils, and to emulsify them with the arsenate immediately before application in the manner outlined in the previous section.

3. Bordeaux Mixture.

(*a*) *Plus Lime Sulphur.* (See section 1 (*c*).)

(*b*) *Plus Colloidal Sulphur.*—Little is to be gained by the use of this combination, as when both ectoparasitic and endoparasitic fungi are present a preferable spray would be the lime sulphur plus colloidal sulphur combination discussed above. (Section 1 (*a*).)

(*c*) *Plus Lead Arsenate.* (See section 2 (*c*).)

(*d*) *Plus Nicotine or Nicotine Sulphate.*—This combination may be used for combating fungous diseases (excluding mildews) and soft-bodied insects on plants to which bordeaux may be applied during the growing season. At standard concentrations no increased injury is likely to occur, for according to Safro (1915) nicotine (as the sulphate) may be combined with bordeaux without chemical change.

No activator is necessary with this combination, the excess lime of the bordeaux acting in this capacity. A "spreader" is advisable, however. (See section 3 (*g*).) The bordeaux may be replaced with burgundy mixture without risk of increased injury.

(*e*) *Plus Petroleum Oils.*—With winter oil no advantage is to be gained by use of this combination, for the oil should be applied during early dormancy for effective destruction of insect eggs (Cunningham and Muggeridge, 1933), whereas bordeaux is useless if applied before green tip on pome fruits or bud movement on stone fruits.

Summer oil may be combined with bordeaux for combating fungous diseases and insect pests of citrus. This combination has been employed in the United States since 1919, first with kerosene emulsion, subsequently with petroleum oils. The oil should be used at a concentration of 2 per cent., and unemulsified, for if an

ammonium or soap emulsifier or stabilizer is present it reacts with the excess lime of the bordeaux, leading to the production of insoluble calcium soap and the liberation of free oil. To prepare the combination, fill the tank with 3–4–50 bordeaux, and then add the oil, first emulsified with 3 lb. of hydrated lime. The oil and lime should be mixed into a stiff paste, and small quantities of water then added until the mixture assumes the consistency of thin cream. This is poured slowly into the tank while the agitator is running.

(*f*) *Plus Hydrocyanic-acid Gas.*—American workers have shown that severe injury is liable to follow when citrus trees sprayed with bordeaux mixture are fumigated subsequently with hydrocyanic-acid gas (Fawcett, 1914; Woglum, 1923; Butler and Jenkins, 1930). This injury is liable to occur at any time up to six months after an application of bordeaux, and even after eleven months should the spray have been heavy and complete (Woglum, 1929) Although fumigation is not practised in the citrus orchards of the Dominion, the matter is nevertheless of significance as the process is employed for combating insect pests of the glasshouse, where under similar conditions severe injury may occur (Guba, 1926).

Butler and Jenkins (1930) have shown that injury is correlated with the ratio of copper sulphate to lime employed in making the bordeaux mixture. When this ratio is 1 : 0·2 (approximately neutral) injury does not occur, as an insoluble cuprous cyanide is produced; but as the amount of lime is increased the degree of injury is also increased. Beyond the neutral point, soluble cupric cyanide is produced; and in mixtures with ratios greater than 1 : 1, increasing quantities of a soluble double cupric cyanide is formed, injury increasing proportionately. They considered that injury from this source should not occur if a neutral bordeaux spray was employed. This spray is liable to cause foliage injury to plants grown under glass, so that it is advisable to replace bordeaux with sulphur sprays when fumigation is to be practised.

(*g*) *Plus "Spreaders."*—When properly prepared, bordeaux mixture has good adhesive but poor spreading properties. Although both factors may be improved by the use of a suitable "spreader," it is difficult to procure a type which will improve coverage without reacting adversely with the bordeaux. Soaps cannot be employed, as they are converted into insoluble calcium soaps by the action of the excess lime of the bordeaux. Casein and lime casein improve its spreading properties, but actually decrease the adhesion of bordeaux. Recent experiments have shown that a satisfactory agent to employ for the purpose is a low concentration (0·25 per cent.) of a summer oil. This should be unemulsified, and the combination prepared in the manner outlined under section 3 (*e*).

4. Nicotine or Nicotine Sulphate.

(*a*) *Plus Lime Sulphur.* (See section 1 (*d*).)

(*b*) *Plus Colloidal Sulphur.*—This combination may be employed without risk of injury to combat mildews and soft-bodied insects, being especially useful under glass. An activator is necessary when

nicotine sulphate is used. For the purpose soft soap (1 lb. for each pound of colloidal sulphur) may be used with advantage, being additionally an efficient wetting agent.

(*c*) *Plus Lead Arsenate.* (See section 2 (*d*).)

(*d*) *Plus Bordeaux Mixture.* (See section 3 (*d*).)

(*e*) *Plus Petroleum Oils.*—No advantage is to be gained by combining nicotine with winter oil, since the former is effective only against soft-bodied insects.

With summer oil nicotine may be combined with advantage, the combination being superior to either spray when employed against such pests as woolly-aphis, mealy-bug, thrips, or red-mite under glass, both the wetting and spreading properties of the nicotine being improved. If the summer oil is emulsified or stabilized with soaps or ammonium compounds, no activator is necessary with either nicotine or nicotine sulphate.

(*f*) *Plus "Spreaders."*—When nicotine or nicotine sulphate is employed alone it is of advantage with the former, and essential with the latter, to employ an activator. This increases the volatility of the nicotine and liberates it from nicotine sulphate. For the purpose manufacturers recommend soft soap, at from 4 lb. to 5 lb. per 100 gallons of spray. This material is satisfactory for the purpose and possesses the additional advantage of increasing the wetting properties of the spray. It has, however, the disadvantages of being somewhat costly and variable in composition. Cheaper and equally efficient activators are hydrated lime (5 lb. per 100 gallons) or washing-soda (3 lb.). When soap or washing-soda is employed, an interval of ten days should elapse before a lead arsenate spray is applied to the plant.

5. Colloidal Sulphur.

(*a*) *Plus Lime Sulphur.* (See section 1 (*a*).)

(*b*) *Plus Lead Arsenate.* (See section 2 (*b*).)

(*c*) *Plus Bordeaux Mixture.* (See section 3 (*b*).)

(*d*) *Plus Nicotine or Nicotine Sulphate.* (See section 4 (*b*).)

(*e*) *Plus Petroleum Oils.*—So far as I am aware, this combination has not been tested. With winter oil no advantage would be secured by the combined spray. It may be worth testing the efficacy of low concentrations (from 0·1 to 0·25 per cent.) of summer oil as a wetting and spreading agent to improve the efficacy of colloidal sulphur against such diseases as tomato leaf-mould. At present, however, the combination is not recommended, for nothing is known as to the possible reactions which may occur in the spray or subsequently on the tree.

(*f*) *Plus "Spreaders."*—The manufacturers of colloidal sulphurs recommend the employment of soft soap (1 lb. for each pound of the paste) to improve its spreading properties. As the brands we have tested contain appreciable volumes of a protective colloid (one containing 15 per cent. of sulphite lye), this addition appears to be unnecessary.

6. Petroleum Oils.

(*a*) *Plus Lime Sulphur.* (See section 1 (*e*).)
(*b*) *Plus Colloidal Sulphur.* (See section 5 (*e*).)
(*c*) *Plus Lead Arsenate.* (See section 2 (*e*).)
(*d*) *Plus Nicotine or Nicotine Sulphate.* (See section 4 (*e*).)

Triple and Quadruple Combinations.

The complexity of the chemistry of these is such that it is difficult, and frequently impossible, to state what reactions take place. Consequently, the only safe guides are (*a*) efficacy of disease and pest control, and (*b*) safety to plant tissues.

Field tests have shown that the following combinations may be applied during the growing season, at the concentrations recommended, without increased injury or decreased efficiency.

(*a*) *Lime Sulphur plus Lead Arsenate plus Nicotine.*—This produces, at standard concentrations, a combined spray which will combat endoparasitic fungi, soft-bodied and chewing insects. The lime sulphur and lead arsenate should be combined in the manner outlined under section 1 (*b*), and the nicotine (or nicotine sulphate) added immediately before spraying is commenced. As hydrated lime is used, no activator is necessary.

(*b*) *Lime Sulphur plus Lead Arsenate plus Colloidal Sulphur.*—This forms a spray which will combat ectoparasitic and endoparasitic fungi and chewing insects. It may be employed as a standard summer spray for the apple orchard in localities where mildew is prevalent. The colloidal sulphur should be added to the spray-tank after the lime sulphur and lead arsenate sprays have been combined, in the manner outlined in section 1 (*b*). A "spreader" is unnecessary.

(*c*) *Lime Sulphur plus Colloidal Sulphur plus Nicotine.*—A possible combination which is safe to employ, but purposeless, as it does not appear to have a place in the programme.

(*d*) *Lime Sulphur plus Lead Arsenate plus Colloidal Sulphur plus Nicotine.*—This produces a combined insecticide-fungicide which should effectually combat most diseases and pests of the apple, its employment being dictated by the prevalence of black-spot, powdery-mildew, chewing insects, and leaf-hopper or other soft-bodied insect pest. Use standard concentrations; combine the lime sulphur and lead arsenate in the manner specified in section 1 (*b*); add the colloidal sulphur, and finally the nicotine (or nicotine sulphate). No "spreader" is necessary.

(*e*) *Lead Arsenate plus Colloidal Sulphur plus Nicotine.*—A possible combination which might be employed safely where black-spot was absent from the apple orchard.

(*f*) *Lead Arsenate plus Bordeaux Mixture plus Nicotine.*—This may be employed safely on potatoes and tomatoes to combat endoparasitic fungi, chewing insects, and soft-bodied insects. Prepare the spray as indicated under section 2 (*c*), adding the nicotine last. An adhesive, such as a low concentration of an unemulsified summer oil, should materially improve wetting and adhesive properties of the combination.

(*g*) *Lead Arsenate plus Summer Petroleum Oil plus Nicotine.*—This combination is safe to employ, provided consideration is given to particulars set out in section 2 (*e*). It does not appear to have a place in the spray programme, however.

This lists the possible complex combinations safe to employ with standard sprays. Improvements, both in efficacy of disease and pest control, and in safety to plant tissues, will come mainly through improvements in spray applications and in so-called "spreaders," by the aid of which the wetting and adhesive properties of the sprays may be improved. That there is need for improvement in "spreaders" has been repeatedly suggested in the preceding pages.

The effects of hard waters on the preparation of sprays and combinations must not be overlooked, for, according to Heddon (1908), de Ong (1922), Yothers and Winston (1924), &c., these may indirectly cause severe injury. For, if mixed with lead arsenate, water-soluble arsenic may be formed in appreciable quantities; and if used with oil emulsions, may cause these to break, with consequent liberation of free oil.

Hard waters contain bicarbonates and sulphates of magnesium and/or calcium. Temporary hardness is due to the bicarbonates of these alkalies held in solution by excess carbonic acid. This temporary hardness may be removed by boiling the water, the carbonic acid being then liberated and carbonates of the alkalies precipitated. Permanent hardness is due chiefly to the presence of sulphates and chlorides of magnesium and calcium, and cannot be removed by boiling the water. Soaps may be employed for the purpose, but are somewhat costly, and water so treated cannot be employed for the preparation of lead arsenate, lime sulphur, or bordeaux mixture if the soap is used in excess of the amount required to precipitate the alkalies inducing hardness. De Ong (1922) considered that caustic soda was superior to soaps for the purpose; but the same objection applies with its employment, though the water may be used safely for the preparation of oil emulsions. Robinson (1932) recommended the use of hydrated lime to overcome the difficulty of mixing hard waters with lead arsenate, summer oil, or the combination. If the procedures outlined for the preparation of the different combinations are followed, then there is little likelihood of trouble being experienced with the hard waters present in the Dominion. These have little significant effect on lime sulphur, bordeaux mixture, nicotine sulphate, and colloidal sulphur; and if lead arsenate plus hydrated lime is used in combinations little trouble should follow. Breaking of oil emulsions should not occur if the directions given are followed.

LITERATURE CITED.

ANDREW, R. E., and GARMAN, P. (1926): *Connecticut Agricultural Experiment Station Bulletin* 278, pp. 491–508.

BRADLEY, C. E., and TARTAR, H. V. (1910): *Jour. Industrial and Engineering Chemistry*, Vol. 2, pp. 328–331.

BUTLER, O., and JENKINS, R. R. (1930): *Phytopathology*, Vol. 20, pp. 419–429.

CUNNINGHAM, G. H. (1934): This *Journal*, pp. 15–17.

CUNNINGHAM, G. H., and MUGGERIDGE, J. (1933): *N.Z. Journal of Agriculture*, Vol. 47, pp. 8–18, 89–96.

CUTRIGHT, C. R. (1929): *Ohio Agric. Experiment Station Bimonthly Bulletin 14*, pp. 42–44.
DE ONG, E. R. (1922): *Journal of Economic Entomology*, Vol. 15, pp. 339–345.
DUTTON, W. C. (1929): *American Fruit Grower Magazine*, Vol. 49, pp. 3, 32–33.
FARLEY, A. J. (1925): *American Fruit Grower Magazine*, Vol. 45, pp. 12, 15.
FAWCETT, H. S. (1914): *California Monthly Bulletin, State Comm. Horticulture*, Vol. 5, pp. 41–43.
GROSS, C. R., and FAHEY, J. E. (1930): *North-west Fruit Grower*, May and June, pp. 7, 22.
GUBA, E. F. (1926): *Phytopathology*, Vol. 16, pp. 633-634.
HEDDON, W. P. (1908): *Colorado Agric. Experiment Station Bull. 131*, 27 pp.
HOCKEY, J. F. (1931): *Canada Dept. Agriculture, Rept. Dominion Botanist* (1930), p. 106.
HOOD, C. E. (1929): *United States Dept. Agric. Technical Bulletin 111*, 28 pp.
GOODWIN, W., and MARTIN, H. (1925): *Journal of Agricultural Science*, Vol. 15, pp. 307–326.
MORRIS, H. E., and PARKER, J. R. (1914): *Montana Agric. Exp. Station Circular 16*, 56 pp.
MURRAY, C. W. (1932): *Proc. Washington State Hort. Assn.*, Vol. 27, pp. 52–56.
PINCKNEY, R. M. (1923): *Jour. Agricultural Research*, Vol. 24, pp. 87–95.
ROBINSON, R. H. (1919): *Jour. Economic Entomology*, Vol. 12, pp. 429–433.
—— (1932): *Jour. Economic Entomology*, Vol. 25, pp. 995–1001.
ROBINSON, R. H., and TARTAR, H. V. (1915): *Oregon Exp. Stn. Bulletin 128*, 32 pp.
SAFRO, V. I. (1915): *Jour. Economic Entomology*, Vol. 8, pp. 199–203.
TARTAR, H. V., and BUNDY, L. A. (1913): *Jour. Industrial Engineering Chemistry*, Vol. 5, pp. 561–562.
TAYLOR, C. F. (1929): *Quebec Soc. Protection of Plants, 21st Annual Report*, pp. 28–32.
THATCHER, R. W., and STREETER, L. R. (1924): *New York State Hort. Society. Proc. 69th Annual Meeting*, pp. 50-56.
WOGLUM, R. S. (1923): *United States Dept. Agr. Farmers' Bulletin 1321*, 58 pp.
—— (1929): *California Citrograph*, Vol. 14, p. 180.
WORTHLEY, H. N. (1927): *Jour. Econ. Entomology*, Vol. 20. pp. 615–625.
YOTHERS, W. W., and WINSTON, J. R. (1924): *United States Dept. Agriculture Bulletin 1217*, 5 pp.
YOUNG, H. C. (1930): *Ohio Agric. Experiment Stn. Bulletin 448*, 22 pp.

LAMB-FATTENING WITH WHEAT.

SOME POINTS ON ITS ECONOMIC USE IN CANTERBURY.

A. H. FLAY, Canterbury Agricultural College.

EXPERIENCE shows that lamb-fattening with wheat has a place in Canterbury farm economy, and that the practice is sound only under certain conditions. The object of this article is to specify some of these conditions and to indicate the main points to be considered before commencing to feed wheat to lambs.

Green Feed.—It is essential that some green feed should be available to lambs being fattened by the aid of wheat. A thriving lamb requires about 2 lb. of dry matter per day. This cannot be supplied satisfactorily by wheat alone, even though some very small quantity of other feed may be available. Generally, wheat should not supply more than half of the feed. The remainder may be new grass, specially saved top-dressed pasture, fresh growth on old grass, red

clover grazing, or any fair to good stubble. It must be realized, of course, that, provided there is abundance of any of these feeds, lambs will fatten on them without wheat.

If the quality of the feed is low, or the quantity limited, then wheat feeding has much to recommend it. On succulent new grass mixing good-quality oat-straw chaff with wheat assists in preventing undue scouring which sometimes occurs.

Condition of Lambs.—The condition of the lambs is a most important consideration before wheat feeding is commenced. It is readily realized that young, backward, or stunted lambs, would require many weeks of feeding at a cost of approximately 2d. per week for grain—not to mention the farmer's time—to make such lambs prime. Lambs should be in a good forward condition before feeding supplementary grain. The feeds mentioned above would be suitable for putting them in good forward condition. Wheat has its greatest value as a "finishing off" feed.

Cost of Wheat.—The average price received by Canterbury farmers for Solid Straw Tuscan wheat last year (1933) was 3s. 4d. per bushel. The price of seconds of wheat at lamb-fattening time last autumn was (approximately) 2s. 4d. to 2s. 6d. per bushel. When second-grade wheat is worth 9d. to 1s. a bushel less than first grade it is obvious that farmers—certainly those growing their own wheat—should use second-quality grain.

Price of Lambs.—The price of store lambs and of fat lambs, or the margin between these, is most important when any lamb-fattening by the aid of supplementary feeds is being considered, and especially so when a feed such as grain, that has a certain and direct cash value, is to be used.

If a line of store lambs worth, say, 12s. per head were fattened in eight weeks on suitable feed and then realized 16s., the margin would be 4s. per head. There is, of course, always the risk of a small percentage of deaths during this fattening period. With something less than 4s. therefore to be made out of fattening these lambs, it is obvious that fattening costs must not reach this figure—*i.e.*, if the necessary green grass or fresh stubble, and the farmer's time have no value, then about 3s. 6d. worth of wheat can be fed to each of the lambs without loss. At last year's prices this would be about 1½ bushels of second-grade wheat. It would be as well to state here that fresh green grass and the farmer's time do have some value, so that it is desirable for good lamb-fattening that not more than, say, 2s. worth of wheat per lamb be used. At last year's prices this would be about 48 lb. of second-grade wheat.

Amount to Feed.—At last year's prices as much as 48 lb. of seconds of wheat, or 33 lb. of first-grade wheat, may be fed per lamb. It is usually unwise to feed more than ½ lb. wheat per lamb daily. For an eight-week fattening-period the total grain used then would be 28 lb. per lamb. In reality, for the first seven to ten days very little grain is eaten, and it is not until two weeks' feeding has been carried out that lambs, on average, eat as much as ½ lb. per day. In fact it is essential to start feeding with only small quantities, which can be gradually increased to the desired ration by the end of ten to fourteen

days. After each feed troughs should be emptied so that lambs taking readily to wheat will not gorge themselves. This means that the maximum grain required to fatten a lamb in an eight-week period would be about 20 lb. to 25 lb.; at 2s. 6d. per bushel for second-grade wheat this would cost (taking the larger quantity) approximately 1s. per lamb.

During the last two summers several farmers have successfully supplemented their lamb-fattening feed with 10 lb. to 20 lb. of wheat grain. The lambs would have been sold as stores had grain not been used.

Alternatives to Wheat Feeding.—Where rape, turnips, kale, or young grass are grown they can be used for lamb-fattening purposes. They form a good rotation with grain crops and are sometimes essential in maintaining soil fertility. Cultivation and sowing are carried out at a time of the year when the team and teamster have least to do. On many farms, therefore, lamb-fattening by these crops will continue to be the most suitable and profitable method.

It is suggested, however, that if the greatest net returns are to be realized special crops for lamb-fattening, though important on many Canterbury farms, should be kept at a minimum and grain be used along with fresh permanent pastures, new grass, stubble feeds, &c., for finishing off good forward lambs. When good grazing is available, as in the late autumn, and other feeds are finished, the "finishing off" of lambs with grain is most profitable. Store lambs at this time usually have a low value.

The main points as experienced by many Canterbury farmers, fattening lambs by the aid of wheat, may be summarized as follows:—

(1) Green feed: Fresh good grass, red clover, or fair to good stubble must be available.

(2) Condition of lambs: Only good forward stores should be "finished off" with wheat.

(3) Value or price of grain: Only second-quality grain, if possible.

(4) Margin between store and fat lamb prices: For good and profitable fattening it is recommended that the difference between the prices of store and fat lambs be about double that of the value of grain used per lamb.

(5) Quantity fed per day: About ½ lb. wheat per lamb daily should be used. Lambs must not be allowed to gorge themselves at any time, especially when commencing wheat feeding.

(6) Fattening period: It is desirable that this be not more than eight weeks, but ten weeks or more may be profitable. A six-week period is more economical.

(7) Other feeds available on farm: If good-quality red clover, grass, or stubble are available in abundance, or rape, turnips, &c., that have no direct cash value, can be used, then it would be more profitable to fatten all the lambs or a portion of them on these, and to sell the wheat, or not buy it for fattening purposes.

My thanks are due to all those farmers, especially Mr. H. T. Reeves, Hororata, who kept details for the last four years concerning their lamb-fattening.

EFFECTS ON APPLE-TREES OF LIME SULPHUR FOLLOWING BORDEAUX MIXTURE.

G. H. CUNNINGHAM, Mycologist, Plant Research Station, Palmerston North.

MANY orchardists hold that leaf and fruit injury results when lime sulphur is applied to trees sprayed with bordeaux mixture, unless a considerable time interval is allowed to lapse between applications. This belief was promulgated by one who, under the pen-name of "N.Z. Orchardist," in 1919 and 1920 contributed an article to several newspapers* in New Zealand and Australia. In this it was claimed that reaction occurred between the lime sulphur and bordeaux residues on the tree, leading to the formation of copper sulphide, which produced sulphuric acid when in contact with water. This acid was believed to attack and destroy the stalks of fruits and leaves.

The matter was investigated by the Horticulture Division of the Department, and a series of experiments was conducted in orchards at Arataki (Hawke's Bay) and Christchurch. Results secured, which were subsequently published†, showed that under the conditions of the tests, based on current spray practices, no noticeable injury resulted.

Notwithstanding these experiments, the belief still persists among orchardists in certain localities. Consequently several field and laboratory experiments have been undertaken to ascertain whether injury occurs, and, if so, whether it is possible to prevent such under field conditions.

When equivalent solutions of copper sulphate and lime sulphur are combined‡, a heavy dark-brown precipitate is produced, which is soluble in excess lime sulphur. If bordeaux mixture, containing the same amount of copper (in the form of copper hydroxide) is used in place of the copper sulphate, a similar precipitate, also soluble in excess lime sulphur, is formed. This latter precipitate is somewhat different in that it is heavier and less flocculent, possibly owing to the presence of quantities of calcium hydroxide. The precipitate would appear to be composed of a mixture of copper polysulphides and cupric sulphide§.

To ascertain whether injury is liable to occur, the following experiments were undertaken. Trees of the varieties Delicious,

* *Cf.* : *The Nelson Colonist*, 15th October, 1919 ; *The Fruit World of Australasia*, January, pp. 3–4, 1920.

† *New Zealand Journal of Agriculture*, Vol. 19, pp. 371–374, 1919 ; *New Zealand Fruitgrower*, Vol. 3, January, 1920.

‡ We have ascertained that 5 grammes of copper sulphate are required to precipitate completely 9 c.c. of 18-per-cent. calcium polysulphides. Amner's lime sulphur was used in these tests.

§ According to Mellor ("A Comprehensive Treatise on Inorganic and Theoretical Chemistry," Vol. 3, p. 225), a precipitate of cupric sulphide and copper polysulphide, soluble in excess ammonium polysulphide, is produced when copper salt solutions are treated with ammonium or potassium polysulphides. As copper sulphate and lime sulphur behave similarly, it is reasonable to assume that the precipitate is of similar composition.

Jonathan, Sturmer, and Rome Beauty were sprayed in early December with the following compounds:—

(*a*) Lime sulphur alone at 0·1 per cent. concentration.

(*b*) A precipitate obtained by combining equivalent amounts of copper sulphate and 0·1 per cent. lime sulphur.

(*c*) A precipitate obtained by combining equivalent amounts of bordeaux mixture and 0·1 per cent. lime sulphur.

(*d*) A solution containing half the amount of copper sulphate used in (*b*) dissolved in 0·1 per cent. lime sulphur.

Additionally, one tree in each series was sprayed with water daily for fourteen days with a view to increasing the possibility of injury.

No injury has been observed on trees in series (*a*), (*b*), and (*c*). In series (*d*), however, slight leaf-scorch was noticed on Sturmer and Delicious varieties, and fruits of all trees showed somewhat severe injury. This was most noticeable around the periphery of spray deposits, in several instances a ring of small black lesions being produced at this point. This injury is due to the soluble copper compounds present in the spray, and, judging from these experiments, is liable to occur only when lime sulphur is in considerable excess of the copper salt. The fact that no injury followed applications (*b*) and (*c*) is significant. For if the amount of copper sulphate used (equal to 3 lb. per 100 gallons) were applied alone, severe injury would have resulted; and a bordeaux application of equivalent concentration would have produced fruit russet. Combination therefore produces sprays which are at least as safe to apply to trees in leaf as 0·1 per cent. lime sulphur. It is doubtful, though, if anything is to be gained by the combination; for when applied to trees it produces a heavy black deposit which disfigures fruits and leaves. This deposit is very adhesive, when prepared with copper sulphate, persisting for weeks without appreciable diminution, and appears less fungicidal to black-spot than 0·1 per cent. lime sulphur.

These results, while not conclusive, are sufficiently definite to indicate that no injury follows applications of a bordeaux mixture or copper sulphate plus lime sulphur combination, provided the lime sulphur is not in excess. Approximately 3 lb. of copper sulphate are required to precipitate completely the polysulphides in 100 gallons of 0·1 per cent. lime sulphur. Consequently soluble copper compounds are not formed when 3–4–50 bordeaux is combined with 0·2 per cent. lime sulphur, as an approximately neutral compound is produced. By decreasing the copper content, or by increasing the lime sulphur, injury is likely to result, owing to the formation of soluble copper compounds.

Theoretically, therefore, injury would actually be increased by increase in the time interval between bordeaux and lime sulphur applications, owing to weathering of the bordeaux with consequent loss of copper salts. It is not possible to ascertain this loss, owing to the complex of factors involved. Field tests conducted at the Research Orchard, Nelson, and at this Station have shown that no noticeable injury follows application of 0·2 lime sulphur at pink or pre-pink to trees sprayed at green tip with bordeaux 5–4–50. This is substantiated by the earlier experiments conducted at Arataki and

Christchurch. These results suggest either that little loss of copper occurs during this period, or more probably that the copper hydroxide of the bordeaux is after deposition converted into an insoluble compound of the nature of copper carbonate. If such were produced on the tree, then there would be little likelihood of reaction between this compound and lime sulphur, since in our tests no reaction was secured when equivalent amounts of copper carbonate and lime sulphur were combined.

It is safe to conclude, therefore, that injury is not likely to follow when apple-trees are sprayed with either 5–4–50 or 3–4–50 bordeaux mixture at green tip, and followed at pink or pre-pink stages with 0·2 per cent. lime sulphur.

I am indebted to Mr. R. L. Andrew, Assistant Dominion Analyst, Dominion Laboratory, Wellington, for literature references; to Mr. J. D. Atkinson, Research Orchard, Nelson, for carrying out several field tests; and to Mr. E. E. Chamberlain, of this laboratory, for the preparation of the materials employed in tests conducted at this Station.

INVESTIGATIONS IN PASTURE PRODUCTION.

VI. STUDIES OF EFFECT OF SULPHATE OF AMMONIA AND FREQUENCY OF CUTTING ON PRODUCTION OF PASTURE UNDER SYSTEM OF MOWING ONLY.

A. W. HUDSON, Crop Experimentalist, Plant Research Station, Department of Agriculture, Palmerston North.

THREE experiments which have been described fully in Part VI of Bulletin No. 31 of the Department of Scientific and Industrial Research, and which were carried out at the Marton Experimental Farm, will be described briefly in this article. Unlike the experiments discussed in II to V of this series, the yields of which were measured under the system of alternate mowing and grazing, the experiments described herein were under mowing only. It was not intended to keep them going for more than one season, during which time the effect of mowing only was not expected to influence the botanical composition greatly. However, circumstances arose which rendered it desirable to maintain the trials for about three years.

It is appropriate to discuss some points common to all experiments at this stage. All three experiments were laid down on the same pasture in the same enclosure. All had treatments receiving sulphate of ammonia, the quantities and frequency of application differing with the different experiments, however.

The three experiments will be designated A, B, and C respectively. A and B were carried on for about two years and ten months, and C for about three years and two months.

The pasture was an excellent one for the class of soil, consisting almost entirely of perennial rye-grass and white clover. In spite of the drastic treatment of mowing with removal of herbage the rye-grass persisted without any apparent diminution in the number of plants,

although it produced very little except in the autumn, winter, and spring, when rye-grass growth, relative to that of clover, is more prolific. At other times of the year white clover dominated the production, except when the grass growth was stimulated by recent applications of sulphate of ammonia. Generally speaking, all sulphate of ammonia applications increased production for periods of from a few weeks to a few months after application, depending on the time and amount of the application. The period of beneficial effect of each application of sulphate of ammonia was generally followed by a period of slumping in production which coincided with a reduction in the amount of clover growth and more or less unthrifty appearance of the grass. Weed growth was reduced appreciably by the sulphate of ammonia.

The quantities and frequency of application of sulphate of ammonia were greater than those used or advocated in practice; consequently the undesirable effects shown are undoubtedly more marked than would occur where, say, 1 cwt. of sulphate of ammonia is being used once in two or three years on the same pasture for the production of out-of-season grass. It is probable that under most conditions the latter practice does not result in sufficiently serious slumping to outweigh the benefits derived from the production of early or late season grass, so long as common-sense management, including the use of lime, phosphate, and/or potash where necessary, is carried out.

These trials indicate, however, that sulphate of ammonia cannot be used regularly and intensively without undesirable consequences.

EXPERIMENT A.—AN INVESTIGATION INTO THE EFFECT OF APPLYING FREQUENT HEAVY DRESSINGS OF SULPHATE OF AMMONIA IN CONJUNCTION WITH CARBONATE OF LIME.

This experiment was commenced on the 15th November, 1929, and continued until 23rd September, 1932, a matter of two years and ten months.

The object of the trial was to determine whether the effectiveness of sulphate of ammonia applications would be influenced by the time or frequency of applying the lime used to check soil acidity. (About 1½ to 2 cwt. of ordinary ground limestone is required to check the acidifying effect of 1 cwt. of sulphate of ammonia.)

Heavy and frequent applications of sulphate of ammonia were used to intensify any differences which might result.

The treatments under trial were: (1) No sulphate of ammonia; (2) and (3)* sulphate of ammonia 2 cwt. per acre three times a year.

All plots received a basal dressing of 16 cwt. of ground limestone before the trial commenced, and super at 4 cwt. per acre, and 30 per cent. potash at 2 cwt. per acre were applied annually.

Applications of sulphate of ammonia were made on the following dates: 18th November, 1929; 2nd April, 29th July, and 15th December, 1930; 24th April and 5th August, 1931.

* Treatment 2 received 12 cwt. of ground limestone per acre once a year while the sulphate of ammonia dressings were being applied. Treatment 3 received 4 cwt. of ground limestone mixed with the sulphate of ammonia when it was applied (12 cwt. per acre per annum).

No further applications were made after that in August, 1931, because slumping in production, following the period of increased growth resulting from the nitrogen application, was becoming progressively worse, and it was decided to determine the duration of the slumping.

Each treatment was replicated twelve times, and during the period under review forty-seven cuts of successive growths were taken.

The yields from Treatment 1 (no sulphate of ammonia) for each of three seasons were as follows :—

Pounds per Acre.

——	1929–30 : 15/11/29 to 11/10/30 (330 Days).	1930–31 : 11/10/30 to 9/10/31 (363 Days).	1931–32 : 9/10/31 to 23/9/32 (350 Days).
Green herbage	29,073	34,376	26,015
Dry matter	*	6,212	5,223

* Dry matter not determined.

The effect of the sulphate of ammonia applications on the total yields for each of the above periods is indicated from the relative yields which follow :—

Treatment.

Season.	No Sulphate of Ammonia. 1.	Sulphate of Ammonia plus Lime annually. 2.	Sulphate of Ammonia mixed with Lime. 3.	Remarks.
1929–30 : Green herbage	100	103·7	108·2	6 cwt. sulphate of ammonia used on 2 and 3.
1930–31—				
Green herbage ..	100	99·3	100·4	6 cwt. sulphate of ammonia used on 2 and 3.
Dry matter ..	100	108·1	108·5	
1931–32—				
Green herbage ..	100	76·8	78·3	No sulphate of ammonia used on 2 and 3.
Dry matter ..	100	83·3	84·4	

Dry-matter determinations were carried out over the second and third periods. Over each period as a whole the dry-matter content of the herbage from the sulphate of ammonia treated plots was higher than from No Sulphate of Ammonia as is indicated by the following figures :—

Percentage of Dry Matter in Herbage.

——	No Sulphate of Ammonia. 1.	Sulphate of Ammonia plus Lime annually. 2.	Sulphate of Ammonia mixed with Lime. 3.
1930–31	18·1	19·7	19·5
1931–32	20·1	21·8	21·6

As a result of this, the yields of dry matter show results more favourable to the sulphate of ammonia dressings than the yields of green herbage do.

Each dressing of sulphate of ammonia increased production for several weeks after its application. However, the slumping following the period of increase offset a good deal of this increase, especially in the third season, when the applications of sulphate of ammonia were discontinued.

Production from Treatments 2 and 3 slumped below that from Treatment 1 from early October, 1931, to about the end of May, 1932 (eight months). All treatments produced at about the same rate during June, July, and early August, 1932; but slumping occurred again from the middle of August until the 23rd September when the trial was abandoned.

The lime used checked any acidifying effect of the sulphate of ammonia on the soil, which was practically neutral in its reaction in the top 2 in., but slightly acid at 4 in. to 6 in. depths in all treatments. It can be concluded, therefore, that the influence of sulphate of ammonia on soil acidity as a factor in causing the undesirable effect on yield was eliminated.

EXPERIMENT B.—AN INVESTIGATION INTO THE EFFECT OF FREQUENCY OF CUTTING ON THE PRODUCTION FROM PASTURE AND THE USE OF SULPHATE OF AMMONIA UNDER DIFFERENT FREQUENCIES OF CUTTING.

A period of two years and ten months from the 15th November, 1929, to the 23rd September, 1932, was covered in this investigation.

The objects were (i) to determine the effect of frequency of cutting on yield and (ii) to determine whether frequency of cutting had any influence on the response to sulphate of ammonia.

Cutting was carried out at two different stages: (*a*) when considered suitable for sheep-grazing, and (*b*) when suitable for cattle-grazing. These will be referred to as the "sheep" and "cattle" stages respectively. In the latter, cutting was done half as frequently as at the sheep stage.

The fertilizer treatments under trial were—1 and 3: No sulphate of ammonia; 2 and 4: Sulphate of ammonia at 1 cwt. per acre three times a year.

Treatments 1 and 2 were cut at the sheep stage of growth, and Treatments 3 and 4 at the cattle stage.

All plots received 16 cwt. per acre of ground limestone prior to the commencement of the trial, and 4 cwt. of superphosphate and 2 cwt. of 30-per-cent. potash salts were applied each year.

Applications of sulphate of ammonia were made on the following dates: 18th November, 1929; 2nd April, 29th July, and 23rd December, 1930; 13th May and 12th August, 1931.

Sulphate of ammonia was not used after the application in August, 1931, for the reason stated in the discussion on Experiment A.

There were nine replications of the plots of each treatment, and during the period of two years and ten months forty-nine cuts were taken on the series cut at the sheep-grazing stage and twenty-five on the cattle series.

Production.—The production from Treatment 1 (no sulphate of ammonia, cut at sheep stage) is shown below for each of the three seasons.

Pounds per Acre.

—	1929–30: 15/11/29 to 30/10/30 (349 Days).	1930–31: 30/10/30 to 5/10/31 (340 Days).	1931–32: 5/10/31 to 23/9/32 (354 Days).
Green herbage	28,421	31,232	27,908
Dry matter	*	5,503	5,433

* Dry matter not determined.

The yields of the other treatments relative to Treatment 1 as 100 were as follows:—

—	Sheep Stage.		Cattle Stage.		Remarks.
	No Sulphate of Ammonia. 1.	Sulphate of Ammonia. 2.	No. Sulphate of Ammonia. 3.	Sulphate of Ammonia. 4.	
1929–30: Green herbage	100	100·8	114·4	112·6	3 cwt. sulphate of ammonia used on 2 and 4.
1930–31—					
Green herbage	100	101·6	103·2	106·4	3 cwt. sulphate of ammonia used on 2 and 4.
Dry matter ..	**100**	**105·1**	**100·2**	**105·2**	
1931–32—					
Green herbage	100	89·8	112·7	102·8	No sulphate of ammonia used on 2 and 4.
Dry matter ..	**100**	**92·9**	**115·4**	**106·4**	
Green herbage for whole period	100	97·6	109·8	107·3	
Dry matter for two seasons	100	99·0	107·7	105·8	

Cutting less frequently at the cattle stage has resulted in about 10 per cent. greater production of green herbage over the whole period. The superiority of the less-frequent cutting was most marked in the spring months, but resulted in slightly lower production during the winter.

The sulphate of ammonia has had practically no effect on the total production. The beneficial effect which followed each application was followed in turn by slumping in production. This was not so severe as in Experiment A, however, where double the quantity of sulphate of ammonia was applied at each dressing. The effectiveness of the sulphate of ammonia was not influenced appreciably by the frequency of cutting.

EXPERIMENT C.—AN INVESTIGATION INTO THE EFFECT ON PASTURE PRODUCTION OF ANNUAL APPLICATIONS OF SULPHATE OF AMMONIA TO DIFFERENT PLOTS AT TWO-MONTHLY INTERVALS THROUGHOUT THE YEAR.

The experiment described on next page was carried on for three years and one month from the 14th August, 1929, to the 22nd September, 1932.

Experience indicated that the most useful place for nitrogen on grassland in New Zealand was in the production of out-of-season winter and spring grass, and that nitrogen was more effective when used for this purpose.

The trial was planned to determine the effect of sulphate of ammonia applications made at approximately two-monthly intervals throughout the year. On account of the system of mowing adopted, the results obtained are more applicable to grassland under haying conditions than under grazing.

The treatments were—

(1) No sulphate of ammonia.

(2) to (7) Sulphate of ammonia 2 cwt. per acre with an interval of about two months between the application to one treatment and the next in order to receive it.

All plots received 16 cwt. of ground limestone at the commencement of the trial and 4 cwt. of superphosphate and 2 cwt. of 30-per-cent. potash salts each year.

The sulphate of ammonia dressings were applied each year as under :—

Treatment (2) : July or August.
Treatment (3) : September or October.
Treatment (4) : November or December.
Treatment (5) : January or February.
Treatment (6) : March or April.
Treatment (7) : May or June.

There were twelve replications of each treatment, and during the period of three years and one month, fifty-three cuts were measured.

It is proposed to discuss only the salient features of the results.

Although each of Treatments (2) to (7) received 6 cwt. of sulphate of ammonia (three applications of 2 cwt. each) during the period covered, none of them differed in yield by more than about 5 per cent. from the No Nitrogen treatments. Every application increased production for a time, the periods of increased production varying from about six to twenty weeks. Applications such as those in September–October made at the commencement of periods of high natural production were characterized by relatively big increases in daily rate of growth for short periods ; those, such as the May–June ones, made prior to periods of naturally slow growth, although great in their effect relative to the No Nitrogen production, caused smaller rates of daily increases which extended over longer periods.

The beneficial effect from every application was followed by a period of slumping in production. The intensity of the slumping increased progressively with successive applications of sulphate of ammonia.

The dry-matter content of the herbage from nitrogen-treated plots was higher over the period as a whole, during which dry matter was determined than that from the No Nitrogen plots. The dry-matter yields as percentages of the green-herbage yields of Treatments (1) to (7) respectively were : 18·7, 18·9, 19·1, 19·3, 19·3, 19·4, 19·4.

VII. THE INFLUENCE ON PRODUCTION OF CONTINUOUS MOWING OF A PASTURE WITH REMOVAL OF HERBAGE COMPARED WITH A SYSTEM OF ALTERNATE MOWING AND GRAZING WITH "FEEDING BACK" OF HERBAGE ON TO THE PASTURE, OVER A PERIOD OF THREE YEARS.

THE technique of measuring pasture production under a system of alternate mowing and grazing with the feeding back of the herbage was described in the first article of this series. (This *Journal*, August, 1931.) The disadvantages of mowing only, with the removal of the cut herbage, were also discussed in the above-mentioned article, and the removal of lime, phosphate, potash, and nitrogen commented on.

Two experiments on adjoining portions of the same pasture at the Marton Experimental Farm lend themselves admirably to a comparison of the effect on production over a period of three years of mowing only versus the alternate mowing and grazing technique.

During the first two years the treatments compared in the respective experiments received the same quantities of fertilizers. There was a small difference in the third season, which is of no consequence in relation to the differences in yield which resulted between the two experiments.

The experiments will be designated A and B. The following quantities of lime, phosphate, and potash were applied during the three years :—

—	Ground Limestone.	Superphosphate.	30 per cent. Potash.
	Cwt.	Cwt.	Cwt.
A	16	16*	8
B	24	12	8

* The fourth application of 4 cwt. was made only four months before the end of the period under discussion, and did not have time to exercise much effect on yield.

The production from each experiment during each of the three seasons resulted as follows :—

—	Pounds per Acre.	
	A. Under Mowing only.	B. Under Alternate Mowing and Grazing.
1929–30 : Green herbage	33,756	24,100
1930–31—		
Green herbage	36,488	43,786
Dry matter	6,610	7,781
1931–32—		
Green herbage	28,273	42,238
Dry matter	5,469	8,107

The poorer yield of B in 1929–30 is attributed to a weakness in the alternate mowing and grazing technique. This was discussed in the *Journal* for August, 1931 (p. 90), and eliminated by a modification of the technique in 1930–31.

In 1930–31 both experiments yielded more than in the previous season, due to a better season, and also, in the case of B, to the improvement in the technique. In 1931–32 production from A, under mowing only, fell away markedly, whereas that of B was maintained.

The writer is of the opinion that production of a pasture can be as satisfactorily maintained under the system of alternate mowing and grazing as under intensive rotational grazing.

The above is discussed more fully in Part VII of Bulletin No. 31 of the Department of Scientific and Industrial Research. A more up-to-date description of the technique now practised has been published by the Imperial Agricultural Bureau (Herbage Plants), Aberystwyth, Wales, in Bulletin No. 11, pages 21 to 31.

(Conclusion of Series.)

POTATO-MANURING EXPERIMENTS IN THE SOUTH ISLAND.

SEASON 1932–33.

Fields Division.

THE programme of potato-manuring experiments for 1932–33 comprised six trials, four of which were located in Canterbury while two were carried out in Southland. This programme was a continuation of the one initiated during the previous season, the results of which were given in the Journal for February, 1933, in which trials were designed to further investigate the effect of varying the quantities of sulphate of ammonia and sulphate of potash.

TYPE OF EXPERIMENTS.

Apart from one experiment, the trials were virtually of the same type, differing only in respect of one treatment, and for convenience are grouped under Type A experiments. The single exception is designated Type B.

Type A.—To determine the effect of varying the quantities of sulphate of ammonia and/or sulphate of potash.

Treatments per Acre.

1. Superphosphate (44–46 per cent.) 3 cwt.
2. (*a*) Super 3 cwt. plus sulphate of ammonia 1 cwt.
   (*b*) Super 3 cwt. plus sulphate of potash 1 cwt.
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.

Five experiments of this type were carried out.

In three of the Canterbury experiments Treatment 2 (*b*) was omitted, while Treatment 2 (*a*) was not included in the two Southland trials. In one experiment a supplementary trial in which super 3 cwt. per acre was compared with No Manure was laid down alongside the main trial.

Type B.—To determine the effect of increasing the quantity of super from 3 cwt. to 5 cwt. and the amount of sulphate of ammonia from 1 cwt. to 2 cwt.

Treatments per Acre.

1. Super 3 cwt.
2. Super 5 cwt.
3. Super 5 cwt. plus sulphate of ammonia 1 cwt.
4. Super 5 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.
5. Super 5 cwt. plus sulphate of ammonia 2 cwt.

One experiment of this type was laid down. Treatment 1 was compared with Treatment 2 in plots alongside the remainder of the trial.

Size of Plots and Number of Replications.

In all trials single-row plots were used and each plot was 2 chains in length, except in one experiment where the length of plots was only 1 chain. In the majority of experiments twenty replications of treatments were sown. The trial in which plots were 1 chain in length, however, contained forty replications, while in another instance the area available allowed of only fifteen replications being laid down. The supplementary trials super 3 cwt. versus no manure and super 3 cwt. versus super 5 cwt. referred to above only contained ten replications.

In order to reduce the influence of possible " fertility slope " on yields, the experiments were divided up into series each containing four to ten replications. Treatments were arranged to run in opposite order in each alternate series.

Interpretation of Results.

Results were examined statistically, using " Student's " method. Differences are stated to be either " significant," in which case they can be accepted with confidence, or " not significant," when they are not necessarily due to the treatment, but may be due to natural variation.

Economic Aspect of Results.

It is not considered advisable to discuss the economic aspect of the results at this stage, but rather to summarize the effects of the fertilizers after several seasons' trials have been completed.

Results of Experiments.

The yields from individual treatments in the Type A experiments are given in Tables 1 to 5, and those in the Type B experiments are given in Table 6. Other details in connection with each experiment precede the tables. Although in most cases three grades of potatoes were weighed—*i.e.*, table, seed and small—only the weights of the first two grades are shown, but small potatoes are included in the totals. Differences between the various treatments are shown in Table 7.

Results of Type A Experiments.

1. *Co-operating Farmer: C. Redmond, Kimberley.*

Variety: Aucklander Short Top. Date planted: 2nd November, 1932. Twenty replications of plots. Previous crop: Grass, three years. Crop dug and weighed: 10th May, 1933.

Table 1.—Results of C. Redmond's Experiment.

Treatment per Acre.	Yield in Tons per Acre.		
	Table.	Seed.	†Total.
No manure*	3·9	2·0	5·9
1. Super 3 cwt.	5 3	2·6	7·9
2. Super 3 cwt. plus sulphate of ammonia 1 cwt.	5·4	3·2	8·6
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.	5·4	3·3	8·7
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt. ..	5·2	3·3	8·5
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	5·6	3·2	8·8
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.	5·6	3·3	8·9

* Used in supplementary trial in comparison with super 3 cwt. Yields have been adjusted to show true differences from super 3 cwt. which were significantly in favour of the latter by 1·4 tons table, 0·6 tons seed, and 2 tons total potatoes.

† Total yields include yields of "small" potatoes in all tables.

2. *W. A. McPhail, Mitcham (Canterbury).*

Variety: Dakota. Date planted: 19th October, 1932. Previous crop: Grass, three years. Crop dug and weighed: 22nd June, 1933. Forty replications of plots.

Table 2.—Results of W. A. McPhail's Experiment.

Treatment per Acre.	Yield in Tons per Acre.		
	Table.	Seed.	Total.
1. Super 3 cwt.	1·7	2·0	5·6
2. Super 3 cwt. plus sulphate of ammonia 1 cwt.	1·7	2·1	5·7
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.	1·9	2·2	6·1
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.	1·9	2·1	6·0
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	1·9	2·2	6·4
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.	2·0	2·2	6·2

This was a poor crop on account of the long continued dry spell which occurred in this district during practically the whole period of the experiment.

3. *Boys' High School, Timaru.*

Date planted: 10th November, 1932. Previous crops: 1931–32, oats; 1929–31, grass. Crop dug and weighed: 26th May, 1933. Fifteen replications of plots.

Table 3.—Results of Experiment at Timaru Boys' High School.

Treatment per Acre.	Yield in Tons per Acre.		
	Table.	Seed.	Total.
1. Super 3 cwt.	4·2	2·6	6·8
2. Super 3 cwt. plus sulphate of ammonia 1 cwt.	4·6	2·7	7·3
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.	4·7	2·6	7·3
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.	5·3	2·5	7·8
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	4·9	2·6	7·5
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.	5·0	2·6	7·6

4. *J. Cooper, Croydon (Southland).*

Variety: King Edward. Date planted: 19th October, 1932. Twenty replications. Previous crops: 1931–32, turnips; 1930, grass. Crop dug and weighed: 5th July, 1933.

Table 4.—Results of J. Cooper's Experiment.

Treatment per Acre.	Yield in Tons per Acre		
	Table.	Seed.	Total.
1. Super 3 cwt.	3·9	3·5	11·1
2. Super 3 cwt. plus sulphate of potash 1 cwt.	4·1	3·7	11·3
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.	4·8	4·0	12·3
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.	4·7	4·3	12·3
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	4·8	4·3	12·8
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.	4·7	4·2	12·2

5. *S. Kokay, Tuatapere (Southland).*

Variety: Up to Date. Date planted: 13th October, 1932. Twenty replications. Previous crop: 1931–32 and 1930–31 turnips after stumping. Crop dug and weighed: 24th May, 1933.

Table 5.—Results of S. Kokay's Experiment.

Treatment per Acre.	Yield in Tons per Acre.		
	Table.	Seed.	Total.
1. Super 3 cwt.	1·3	2·3	4·6
2. Super 3 cwt. plus sulphate of potash 1 cwt.	1·3	2·6	5·1
3. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt.	1·2	2·8	5·2
4. Super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.	1·6	2·8	5·5
5. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	1·6	3·2	6·1
6. Super 3 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 2 cwt.	1·6	3·0	5·7

Results of Type B Experiment.

Particulars and yields of the Type B experiment were as follow:—

6. *High School, Rangiora.*

Variety: Aucklander Short Top. Date planted: 19th October, 1932. Previous crops: 1931–32, wheat; 1930–31, wheat; 1929–30, potatoes. Crop dug and weighed: 15th March, 1933. Twenty-one replications.

Summary of Yields.

Treatments.	Yields in Tons per Acre.		
	Table.	Seed.	Total.
1. Super 3 cwt.	1·2	4·8	6·0
2. Super 5 cwt.	1·4	5·0	6·4
3. Super 5 cwt. plus sulphate of ammonia 1 cwt.	1·8	5·9	7·7
4. Super 5 cwt. plus sulphate of ammonia 2 cwt.	2·0	6·1	8·1
5. Super 5 cwt. plus sulphate of ammonia 2 cwt. plus sulphate of potash 1 cwt.	2·1	6·0	8·1

There were only ten replications of the comparison super 3 cwt. versus super 5 cwt., and the differences between these treatments were not significant.

Other differences are embodied in Table 7.

Table 7.—Summary of Differences between Treatments in Type A and Type B Experiments showing (A) Effect of Nitrogen, and (B) Effect of Potash.

Treatments compared. (For explanation of abbreviations see footnote.)*	Differences in Tons per Acre in each Experiment. (Number as in text.)					
	1.	2.	3.	4.	5.	6.†
A. EFFECT OF NITROGEN.						
A1. Effect of First Hundredweight of Sulphate of Ammonia—						
Increase of P_3N_1 over P_3—						
Table	0·1	0·0	0·4	..	..	**0·4**
Seed	**0·6**	0·1	0·1	..	..	**0·9**
Total	**0·7**	0·1	0·5	..	..	**1·3**
Increase of $P_3K_1N_1$ over P_3K_1—						
Table	..	..	..	**0·7**	−0·1	..
Seed	..	..	..	0·3	0·2	..
Total	..	..	..	**1·0**	0·1	..
A2. Effect of Second Hundredweight of Sulphate of Ammonia—						
Increase of $P_3K_1N_2$ over $P_3K_1N_1$—						
Table	0·2	0·0	0·2	0·0	0·4	0·2‡
Seed	−0·1	0·0	0·0	0·3	**0·4**	0·2
Total	0·1	0·3	0·2	0·5	**0·9**	0·4
Increase of $P_3K_2N_2$ over $P_3K_1N_1$—						
Table	0·4	0·1	−0·3	0·0	0·0	..
Seed	0·0	0·1	0·1	−0·1	0·2	..
Total	0·4	0·2	−0·2	−0·1	0·2	..

Table 7.—Summary of Differences of Treatments, &c.—continued.

Treatments compared. (For explanation of abbreviations see footnote.)*	Differences in Tons per Acre in each Experiment. (Number as in text.)					
	1.	2.	3.	4.	5.	6.†
B. EFFECT OF POTASH.						
B1. Effect of First Hundredweight of Sulphate of Potash—						
Increase of P_3K_1 over P_3—						
Table	..	..	..	0·2	0·0	..
Seed	..	..	..	0·2	0·3	..
Total	..	..	..	0·2	0·5	..
Increase of $P_3N_1K_1$ over P_3N_1—						
Table	0·0	0·2	0·1	..	..	0·1
Seed	0·1	0·1	−0·1	..	..	−0·1
Total	0·1	**0·4**	0·0	..	..	0·0
B2. Effect of Second Hundredweight of Sulphate of Potash—						
Increase of $P_3N_1K_2$ over $P_3N_1K_1$—						
Table	−0·2	0·0	**0·6**	−0·1	**0·4**	..
Seed	0·0	−0·1	−0·1	0·3	0·0	..
Total	−0·2	−0·1	**0·5**	0·0	0·3	..
Increase of $P_3N_2K_2$ over $P_3N_2K_1$—						
Table	0 0	0·1	0·1	−0·1	0·0	..
Seed	0·1	0·0	0·0	−0·1	−0·2	..
Total	0·1	−0·2	0·1	−0·6	−0·4	..

Figures preceded by a minus sign (−) signify *decreases*. Increases printed in heavy type are statistically significant.

* The symbols P, K, and N refer to super, sulphate of potash, and sulphate of ammonia respectively. The figure given after each symbol represents the quantity in hundredweights of the fertilizer applied, thus $P_3N_1K_2$ represents super 3 cwt. plus sulphate of ammonia 1 cwt. plus sulphate of potash 2 cwt.

† In this experiment 5 cwt. super was used.

‡ Increases of super plus sulphate of ammonia 2 cwt. over super plus sulphate of ammonia 1 cwt.

Comments on Table 7.

Effect of Nitrogen.—In two experiments, Nos. 1 and 6, 1 cwt. of sulphate of ammonia added to super has had the effect of increasing yield significantly although in the first mentioned this only occurred in seed and total potatoes.

In experiment 4 sulphate of ammonia at 1 cwt. added to super plus potash has increased the yields of table and total potatoes significantly.

The yields of seed and total show significant increases by the addition of a further 1 cwt. sulphate of ammonia to super plus sulphate of ammonia 1 cwt. plus sulphate of potash 1 cwt. in Experiment 5, although in the same experiment 1 cwt. of sulphate of ammonia added to super plus potash had little effect.

Effect of Potash.—1 cwt. sulphate of potash added to super plus 1 cwt. sulphate of ammonia gave a significant increase in total potatoes in the case of Experiment 2. The addition of a further 1 cwt. sulphate of potash to super plus 1 cwt. sulphate of ammonia plus 1 cwt. sulphate of potash gave a significant increase in table and total potatoes in Experiment No. 3 and in table potatoes in Experiment 5.

SUMMARY.

The results of six experiments on the manuring of potatoes conducted in the South Island during the season 1932–33 are given.

In one experiment in which super at 3 cwt. per acre was compared with no manure, the former caused a significant increase in yield of 1·4 tons table, 0·6 tons seed, and 2·0 tons total potatoes.

Super at 5 cwt. per acre was compared with super 3 cwt. in one trial. Increases in favour of the former, however, were not significant.

Sulphate of ammonia at 1 cwt. per acre used as an addition to super in four trials gave a general average increase over super alone of about 4 cwt. table, 8 cwt. seed, and about 13 cwt. total potatoes. Differences were significant in only two of the trials, however.

Two experiments were designed to test the effect of using 1 cwt. sulphate of ammonia as an addition to super plus potash and in one of these significant increases in table and total potatoes were obtained. The use of 2 cwt. sulphate of ammonia in a complete fertilizer resulted in a significant increase in yield over 1 cwt. sulphate of ammonia in only one experiment out of five.

Sulphate of potash at 1 cwt. per acre gave no significant increases in the two trials in which it was used as an addition to super alone, and of four experiments in which 1 cwt. of sulphate of potash was added to super plus sulphate of ammonia in only one was a significant increase obtained, and then only in total potatoes.

When 2 cwt. of sulphate of potash was used in comparison with 1 cwt. in a complete fertilizer significant increases from the larger quantity were obtained in two experiments, although such increases were confined to the mixtures containing the smaller quantity (1 cwt.) of sulphate of ammonia.

Thanks are due to the farmers who co-operated in carrying out the foregoing experiments. The field-work in connection with the trials was carried out under the direction of Mr. R. McGillivray, Fields Superintendent, Christchurch, and Mr. R. B. Tennent, Fields Superintendent, Dunedin, by the following instructors: G. G. Calder, Christchurch; E. M. Bates, Ashburton; W. C. Stafford, Timaru; W. Faithful, Gore; and A. A. Hume, Invercargill.

A. W. Hudson, Crop Experimentalist.
J. W. Woodcock, Assistant Crop Experimentalist.

BOYS' AND GIRLS' AGRICULTURAL CLUBS.

WORK IN 1932–33 SEASON.

R. P. CONNELL, Fields Division, Department of Agriculture, Palmerston North.

APPARENTLY because of their intrinsic worth, the Boys' and Girls' Agricultural Club organizations are standing splendidly the test of the current difficult times. This is indicated to some extent by the following facts:—

1. In the season 1932–33 throughout the Dominion 255 more entries were judged than in the season 1931–32 in which more entries were judged than in any previous year.

2. In every administration district in which clubs function there was an increase in the number of entries judged. The number of entries judged in recent years is indicated in the following table :—

District.	Season 1931–32.			Season 1932–33.		
	Crops.	Stock.	Total.	Crops.	Stock.	Total.
Wellington - Taranaki - Hawke's Bay	705	1,481	2,186	659	1,607	2,266
Canterbury	65	20	85	76	102	178
Otago-Southland	393	238	631	463	250	713
	1,163	1,739	2,902	1,198	1,959	3,157

1. Wellington - Taranaki - Hawke's Bay Area.

In the Wellington-Taranaki-Hawke's Bay area an appreciable decrease in crop entries was offset by a greater increase in stock entries, with the result that there was a net increase of eighty entries judged. The prime cause of the decrease in crop entries was a reduction in the assistance which the Department of Agriculture was able to give the club work, associated with the view that the limited assistance available would go further in work relative to stock than in work relative to crops. The rapid development of the calf club activities is reflected in the fact that, while 651 entries were judged in 1929, the number judged in 1932 was 1,607.

The entries judged in the calf club competitions in the area during the past two seasons were :—

District.	Season 1931–32.	Season 1932–33.
North Taranaki	288	309
South Taranaki	524	418
Wanganui - Main Trunk	190	192
Manawatu	227	231
Horowhenua	59	114
Hawke's Bay	92	140
Wairarapa	101	203
Totals	1,481	1,607

The completed entries in crop competitions in the same area were :—

District.	Season 1931–32.	Season 1932–33.
North Taranaki	36	58
South Taranaki	217	197
Wanganui - Main Trunk	148	192
Manawatu	241	154
Wairarapa	28	..
Southern Hawke's Bay	35	58
Totals	705	659

In addition, a cow-judging competition conducted in South Taranaki attracted 222 entries, and in Manawatu a calf-judging competition, at the championship fixture, attracted 35 competitors.

Crop Competitions.

North Taranaki.

The fifty-eight entries judged were made up as follows: Mangels, 40; carrots, 13; swedes, 5.

The heaviest crop of mangels was grown by Phyllis Baker, Pukearuhe, with a yield of 152 tons 16 cwt., the variety grown was Prizewinner.

Three varieties of carrots were grown: Guerande, White Belgian, Holmes Improved. The heaviest crop was grown by Richard Purdie, Pukearuhe, with a yield of 52 tons 1 cwt. of Matchless White variety.

The swede crops generally were not good, there being considerable neck development and dry rot visible on the roots. The winning crop was grown by Esma Thomason, Egmont Village, and yielded 41 tons 6 cwt. per acre.

South Taranaki.

The entries judged were: Mangels, 62; carrots, 56; vegetables, 46.

Two varieties of mangels were grown in each plot for the purpose of a variety trial. The varieties were Prizewinner Yellow Globe and Orange Globe. The sixty-two plots judged gave the following average results: Yellow Globe, 78 tons 3 cwt. per acre; Orange Globe, 69 tons 13 cwt. per acre.

The average yield of both varieties shows the splendid figure of 73 tons 18 cwt. per acre, which is a record average for the competitions, the previous record being 71 tons 19½ cwt. established in 1928–29. The heaviest crop was grown by L. Gulliver, Whakamara, and yielded 158 tons 5 cwt. per acre.

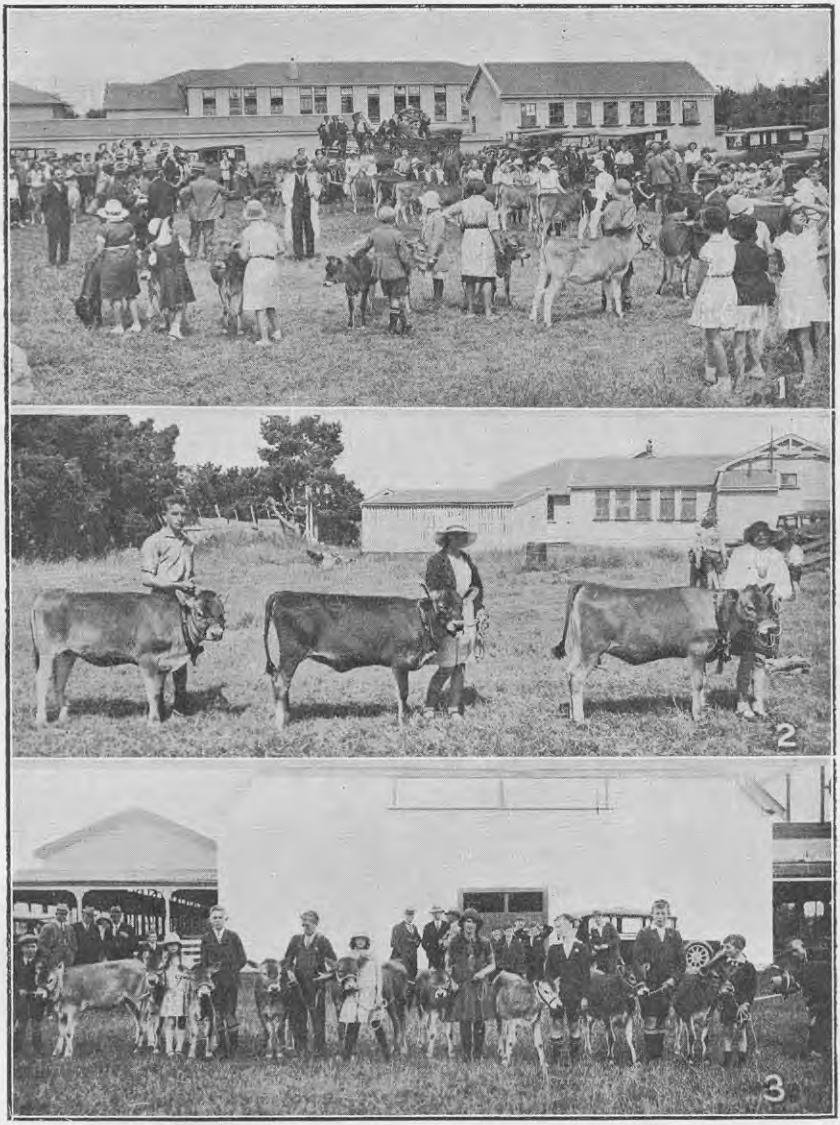
This season a variety trial was conducted on the carrot plots, each being sown with two varieties—namely, Guerande and 100 Ton White. The Guerande carrots were not thinned, and the average yield from this variety was 42 tons 18 cwt., while from the 100 Ton White it was 40 tons 19 cwt. The average yield of both varieties shows the figure of 41 tons 18 cwt.

The heaviest crop of Guerande was grown by D. Gulliver, Whakamara, and yielded 78 tons 8 cwt. per acre. Norman Langlands, Auroa, grew the heaviest crop of 100 Ton White—yield, 61 tons 7 cwt. per acre.

In the vegetable competition forty-six entries, mainly drawn from the pupils attending the town schools, were judged. The crops selected were carrots, parsnips, beetroot, table swedes, silver beet.

Manawatu.

A total of 154 mangel plots were presented for final judging. Three existing records in this competition were broken during the season. The existing yield per acre for the district was exceeded in two instances by M. Lind, Rongotea School (163·5 tons per acre), and by P. Petersen, Makino (151 tons per acre). The number of plots, thirteen, which reached the 100 ton per acre mark, is a record. The average of 67·5 tons is the highest average yield per acre reached in the competitions. The performance of M. Lind won him the Stuart Wilson Cup.



TOP.—A GENERAL VIEW OF THE HOROWHENUA CHAMPIONSHIP GATHERING, 1933, AT LEVIN.

CENTRE.—WINNING GROUP, HOROWHENUA ASSOCIATION, 1933, SHANNON SCHOOL.

BOTTOM.—A CALF CLUB CLASS AT MANAWATU-OROUA CHAMPIONSHIPS, PALMERSTON NORTH.

Southern Hawke's Bay.

In the mangel-growing competition forty-three entries were judged. The average yields of the varieties grown were: Prizewinner Yellow Globe, 54 tons 1 cwt.; Red Intermediate, 50 tons 2 cwt.; Long Red, 44 tons 18 cwt. The average for the plots was 49 tons 14 cwt. The heaviest crop, that of Phylp McCulloch, yielded 106 tons 14 cwt. per acre.

Wanganui.

The total entries received numbered 155, comprising: mangels, 76; swedes, 33; carrots, 46.

The average yield per acre of mangels was 62 tons. The heaviest crop was grown by B. Schwass, Alton, yielding 119 tons per acre. The average yield of swedes was 50 tons per acre. The heaviest crop was grown by H. Amon, Manutahi, and yielded 65¼ tons per acre.

The average yield of carrots was 28 tons per acre. The heaviest crop was grown by N. Blackie, Waitotara, and yielded 53 tons per acre.

CALF CLUB CHAMPIONSHIPS.

The championship winners in the various districts were:—

District.	Class.	Winner.
Wanganui	Open	E. Sims.
Manawatu	Dairy type	Wm. Scott.
	Rearing and attention	Molly Slattery.
Wairarapa	Dairy condition	Arnold Goss.
	Dairy type	Arnold Goss.
Horowhenua	..	Edith Close.
Southern Hawke's Bay	Dairy type	Alan Arrow.
	Dairy condition	Tom Upston.
South Taranaki ..	Dairy condition, Jersey/Ayrshire	Phyllis Stallard.
	Dairy type, Jersey/Ayrshire ..	Gwen Nicholson.
	Dairy condition, Shorthorn/Friesian	Peter Gould.
	Dairy type, Shorthorn/Friesian ..	Ethel Newlove.
	Two-year-old in milk	Myra Wren.
North Taranaki ..	Jersey/Ayrshires—	
	Condition	Pat. Locke.
	Dairy type	Phyllis Baker.
	Shorthorn/Friesian—	
	Condition	Martin Rea.
	Dairy type	Lily O'Byrne.
	Pedigree Jersey—	
	Condition	Douglas Hale.
	Dairy type	Keith Hammond.
	Pedigree Ayrshire—	
	Condition	Lorna Ashman.
	Dairy type	Florrie Stanley.
	Pedigree Friesian—	
	Condition	Ron O'Byrne.
	Dairy type	Ron O'Byrne.

2. Canterbury Area.

The following table summarizes the work in the boys' and girls' clubs during the past two seasons:—

Competition.	Entries judged.	
	1931–32 Season.	1932–33 Season.
Potatoes	65	68
Mangels	..	8
Calves	20	31
Poultry	..	71
	85	178

A new feature was the work with poultry clubs which, introduced as an experiment, attracted favourable attention. It is felt that the experience being gained in the carrying-on of calf and crop competitions will lead to future expansion in the club work.

The principal results were :—

(*a*) Potato championship—Sutton's Cup : Annabelle Gray.
(*b*) Best calf : B. Graham.
(*c*) Best poultry project : T. Woodfield.

3. Otago and Southland Area.

In the Otago and Southland area the entries both in the crop and stock competitions increased.

OTAGO.

Calf Competitions.

A total of 100 calves was judged in comparison with 98 in the previous season. The championships were won by—

Friesian : Max Dick, Weston.
Jerseys : Nancy Goodlet, Wakari.
Shorthorns : Jean Tisdall, Ngapuna.
Ayrshires : A. Gillies, Hampden.

Crop Competitions.

A total of 287 entries was judged, this being a substantial increase over the 200 entries judged in the previous season. The results are summarized in the following table :—

Competition.	Number of Crops finally weighed.	Average Yield per Acre.	Highest Yield per Acre.
		Tons. cwt.	Tons. cwt.
Potato	165	16 0	41 3
Chou moellier	10	39 2	66 0
Carrot	91	20 14	69 10
Mangel	21	54 13	112 10

The principal awards were :—

Championship : Thomas Landreth, Katea School (95½ points).

Special awards—

Most points in field-work : J. Robinson, Waitaki Boys' High School (49 points ; maximum, 50).

Most points in record-keeping : Thomas Landreth, Katea School (29 points ; maximum, 30).

SOUTHLAND.

Calf Competitions.

A total of 140 calves was judged in 1932–33 in comparison with a total of 122 in 1931–32. The 1932–33 principal awards were won by—

Invercargill Show Championships—

Large Breed, Friesian-Shorthorn class : John McBride, Mimihau School.

Small Breed, Jersey class: Gilbert Mortimer, Makarewa.
Small Breed, Ayrshire class: T. Muirhead, Waimatuku.
Championship: R. Hassed, Otautau.

Pig-feeding Competitions: An interesting pig-feeding competition, which will be described in a separate report, was also conducted.

Crop Competitions: In the crop competitions the completed entries were 176, in comparison with 193 in the previous season. The results are summarized in the following table:—

Crop.	Number of Crops judged.	Average Yield.	Highest Yield.
		Tons. cwt.	Tons. cwt.
Potatoes	75	18 8	42 3
Chou moellier	13	36 8	63 0
Carrots	77	16 4	47 5
Mangels	11	63 10	105 4

The principal awards were—

Potato-growing (variety, King Edward)—
Intermediate division—
Championship: Ritchie Hassed, Otautau (95 points).
Special awards—
Most points in field-work (maximum, 50): James Robertson, Winton District High School (50 points).
Most points in record-keeping (maximum, 30): Mervyn Hamilton, Lora Gorge School (27¾ points).

Chou moellier growing (variety: Green Stem)—
Intermediate division—
Championship: Eileen Hassed, Otautau (93¼ points).
Special awards—
Most points in field-work: Alex. Buchanan, Browns School (49½ points).
Best record-keeping: Eileen Hassed, Otautau (27¼ points).

Carrot-growing (variety, Red Intermediate)—
Junior division—
Championship: Bessie Nicholson, Isla Bank School (90¾ points).
Special awards—
Most points in field-work: Ella Valli, Waimahaka School (50 points).
Most points in record-keeping: John Robertson, Winton District High School (24½ points).

Mangel-growing (variety, Prizewinner Yellow Globe)—
Championship: Walter Hassed, Otautau School (90¼ points).
Special awards—
Most points in field-work: Allan Lapthorne, Browns School (50 points).
Most points in record-keeping: Linda Evans, Long Bush School (25½ points).

REGISTRATION OF FERTILIZERS IN 1932-33.

J. A. BRUCE, Inspector of Fertilizers, Department of Agriculture, Wellington.

ONE of the principal objects of the Fertilizers Act, 1927, is to inform the primary producer of the true plant-food content of the numerous types of commercial fertilizers. This object is attained by compelling vendors to guarantee the quality and to disclose any filler that they might use in the fertilizers they sell.

True and accurate specifications of every brand of fertilizer sold in any quantity of 5 cwt. or more are required to be registered each year in June with the Director-General of Agriculture or, in the case of a new fertilizer, before being offered for sale. When he has secured a certificate of registration of the brand, the manufacturer, importer, or brand-owner may offer his fertilizer for sale. The retailer or secondary vendor may also proceed with the selling of fertilizers after he has received a notification that such brand is in order and has been registered by the manufacturer or other principal vendor responsible for the quality of the article placed on the market.

On the sale of 5 cwt. or over of the fertilizer, the vendor or his agent must ensure that the purchaser is supplied with an invoice certificate in which the registered brand and plant-food content, &c., is declared in accordance with the specifications given in the sworn statement filed with the Department. Any vendor failing to supply a purchaser with the correct invoice certificate is liable to prosecution. The purchaser, moreover, has the right to refuse acceptance of the fertilizer delivered to him if the bags are not properly branded or the correct invoice certificate is not forthcoming.

The statutory control exercised over the quality of fertilizer is very necessary. Few realize the magnitude of the fertilizer industry in this Dominion and the large amount of material that is used throughout the country. For instance, during the twelve months ended 15th October, 1932, it is estimated that roughly 437,000 tons of fertilizer were used on farms in New Zealand. Of late years the annual production of superphosphate alone has been in the vicinity of a quarter of a million tons, and the sale of mixed fertilizers runs into many thousands of tons each year In addition, during the year ended 31st March, 1932, for example, the meat freezing and preserving and boiling-down works together produced 30,950 tons of manure. This figure, however, includes mixtures of by-product fertilizer with superphosphate, rock phosphate, and other fertilizers, and therefore covers more than the actual production of the works. The number of primary fertilizer vendors registered—*i.e.*, those selling under their own brands—was 282, this including various branches of certain firms. Secondary vendors registered totalled 415.

The principal fertilizer used in New Zealand is superphosphate, which is produced by eight works operating throughout the Dominion. Superphosphate is manufactured from rock phosphate, chiefly from Nauru and Ocean Islands, and sulphuric acid which also is produced at the works. Large quantities of sulphur are imported from foreign

countries for its manufacture. The greater bulk of the nitrate of soda brought into New Zealand from Chile appears to be used for this purpose.

According to official figures there were thirty-five meat-freezing and meat-preserving works operating in the Dominion during the year ended 31st March, 1932, and thirty-two boiling-down works.

By-product fertilizers are the result of boiling down condemned carcasses, bones, blood, offal, &c., which are then dried and ground and placed on the market as fertilizer. Bonedust and blood and bone manure are the chief fertilizer products of the above establishments and are still very popular in New Zealand as constituents of mixed manures and with market-gardeners, orchardists, small growers, home gardeners, &c.

Judging by the large number of brands registered, it would appear that a good trade is carried on with mixed fertilizers—in fact, the number of registered brands on the market seems excessive when due consideration is given to the size of New Zealand in comparison with other countries. The total for 1932–33 was upwards of 1,650 distinctive markings. With greater standardization this number could be considerably reduced and this would lessen to some extent the present cost of manufacturing mixed fertilizers. On the whole, the fertilizer registration position is now much more satisfactory than it has ever been previously since the registration of fertilizers was inaugurated many years ago. However, there is still room for improvement in the manner in which a number of applications are submitted. On many occasions it has been found necessary to return vendor's statements and to issue warnings regarding the sale of unregistered or incorrectly described fertilizers. Attention of vendors has repeatedly been drawn to the necessity of supplying correct invoice certificates to all fertilizer consumers on the sale of every 5 cwt. or more of fertilizer.

No doubt the system of selling fertilizers in New Zealand is a great advance on what was formerly in vogue, and is probably better than in some other parts of the Empire. Certainly the use of filler has been reduced to a minimum, New Zealand being ahead of most other countries in making vendors declare the nature and amount of filler in their fertilizers. The analyses of fertilizers since the 1927 Act was passed have risen substantially all round.

Some undesirable practices, however, especially in regard to the improper advertising of fertilizers by a certain class of vendor, still persist and are apt to act as a drag on the trade, hindering the expansion of the proper and economic use of the various classes of fertilizers, so essential to a prosperous agriculture in the Dominion. The good work of instructional and advisory officers connected with fertilizer practice is often undermined by propaganda of the wrong type which is widely distributed at frequent intervals. There is, too, the antiquated custom of advertising plant-food as equivalent to some associated chemical compound, which, besides serving to confuse purchasers, is not at all applicable to some of the newer class of synthetic preparations such as phosphate of ammonia and concentrated superphosphate, the sale of which is gradually extending in several parts of the world. Many instances of this antiquated marketing practice can be quoted—for example, even high-grade superphosphate, which is usually

advertised to contain 44–46 per cent. soluble phosphate, contains actually about 34 per cent. monocalcium phosphate or water-soluble phosphate which is equivalent to 44–46 per cent. tricalcium phosphate (insoluble in water). The standard term, phosphoric acid, as specified by the Act, should be employed for all phosphatic fertilizers, and in the case of the high-grade local superphosphate this amounts to about 20 per cent. Basic slag is usually advertised in this country under a grade mark representing its average or range content of phosphoric acid—*e.g.*, 15 per cent., 17–20 per cent., or 20–22 per cent., as the case may be—and not so often on its equivalency to tricalcium-phosphate—like superphosphate. As in the case of slag, a vendor who rightly chooses to adhere to the standard terminology and procedure laid down by the Fertilizers Act when taking orders or advertising rock phosphate for sale is placed at a disadvantage when other vendors adopt the system of expressing the quality of their phosphates in the higher terms of tricalcium phosphate. For instance, some vendors advertise North African phosphate as a 26–29 grade (phosphoric acid) while others adopt the higher numerals 58–63 (tricalcium phosphate) for this same grade. The position is similar in respect to nitrogenous and potassic fertilizers. It is still quite common to see fertilizers containing nitrogen including even blood and bonedust, &c., the nitrogen of which is not in ammoniacal form, advertised to contain so much ammonia instead of nitrogen, and in the case of potassic fertilizers as containing so much sulphate of potash instead of actual pure potash (K_2O). All this is very confusing to the farmer, and provision is urgently needed for a compulsory adherence to standard methods of description. In certain other fertilizer-consuming countries each individual fertilizer on the market is specifically defined in a schedule embodied in the fertilizer law, and all statutory statements, markings on packages, and advertisements embodying claims of quality must be in strict accord with the prescribed standards.

For a number of years the Association of Official Agricultural Chemists in the United States of America has been formulating definitions of terms and materials and striving to bring about greater uniformity in the expression and interpretation of results of fertilizers; the purpose behind this being a clarification of terms so that buyers and sellers may talk the same language.

With many mixtures, particularly those of lime and superphosphate, the practice has occasionally been noted whereby the analyses are merely calculated on the basis of the proportions in which the various components occur, no account being taken of any possible chemical reactions which may take place between the various ingredients. Such mixtures are often-times declared to contain soluble phosphoric acid in much greater amount than in which it actually occurs, and registration of such mixtures has had to be refused because they were guaranteed to contain soluble phosphoric acid whereas there was practically no water-soluble phosphoric acid present.

It is fortunate in one way that to-day it is being more fully realized by the community as a whole that the manufacturing and mixing of fertilizers is essentially a highly specialized chemical industry which must be under strict regulation or supervision if products of the desired or correct composition are to find use in the intelligent and economic feeding of soil and plants.

The problem of the consumer is always a difficult one; for even if he has made up his mind on particular plant-foods for his soil or crops he has still to find out what combination of quick-acting plant-foods with more slowly acting ones will be the most economical and otherwise satisfactory for his particular purpose on the farm. On the other hand, in spite of the great problems and the disappointing conditions of agriculture at the present time, some consolation may be taken from the fact that generally prices of fertilizer are very much lower than formerly, and, furthermore, there is a far greater fund of information available to the farmer than ever before; his main fertilizer problems are rendered less difficult now than was the case not so long ago even though of course a tremendous amount has still to be found out in regard to what happens to fertilizer after it is distributed on the land. As far as the purchase of fertilizer is concerned, however, there is not so much excuse now for this class of commodity to be either bought or sold blindly.

Unfortunately, in the past buyers have shown very little discrimination in accepting particulars of fertilizers which were not registered, and which were entirely lacking in information as to their branding, composition, and source. Under the present Act, every buyer should at least have the assurance that the products delivered to him are reliable and of the composition stipulated. It is therefore highly desirable that a sample of every brand of fertilizer sold in any appreciable quantities in the Dominion should be annually sampled by an Inspector, analysed, and results published in pamphlet form as is usually done elsewhere. The analysis can also be checked with the registered particulars or invoice certificate of the vendor, and appropriate action taken if the guarantees are not substantially met by those responsible.

As the vendor's guarantee must be given on the invoice certificate, the farmer is enabled to note whether the guarantee given is in accord with that under which he purchases the fertilizer. In special circumstances it is his right also under the Act to have the fertilizer sampled by an Inspector and examined. If it is found deficient in the guarantee of plant-food content, the buyer would by arrangement with the vendor be entitled to a rebate of the difference between the relative commercial value based on the analysis and the actual price paid for the material. This is apart from any legal proceedings which may be instituted under the Act. A point of great importance which should be borne in mind when fertilizers are bought, especially if being carried long distances, is that *purchase should be made on the basis of the value of the plant-food they contain and not on the bulk which may be had for a certain price.* In other words, the price per ton of any fertilizer is no indication of its relative cheapness unless reference is made to its fertilizing values. An article on the Choice and Purchase of Fertilizers appearing in the April, 1933, issue of the *N.Z. Journal of Agriculture* gives in broad outline the general procedure which may be adopted to advantage when buying fertilizer.

The urgency for official analysis of fertilizer is particularly apparent in cases where fertilizers are sold in bulk (unbagged) which in these times of financial stress is naturally becoming an increasingly popular

means of selling with the purpose of economizing on bags. In large transactions of this nature one or two or more firms may send anything up to 5,000 tons of a certain fertilizer—*e.g.*, phosphate—under a stipulated guarantee of quality in lots of, say, 5 to 100 tons or more to merchants, farmers, and dairy companies. Without chemical analyses of a number of suitably chosen samples from all parts of the shipment, there is no reliable check, and if the guarantee were deficient on the greater bulk of the material to the extent of, for example, 2 per cent. (two units) this would mean a loss to the farmers using the material of some thousands of units of plant-food valued perhaps at 3s. a unit. There is always, of course, the possibility of the consignment not being of uniform quality throughout—for instance, the moisture content may vary considerably in different parts of a shipment and some purchasers might be placed at a disadvantage in buying and transporting material which is not of the plant-food content they contracted to get. If suspicions were aroused as to the value of the guarantee, by the time arrangements were made at headquarters for official samples to be taken, the stocks of the fertilizer might well be disposed of. It is therefore necessary for sampling officers to be at the ship's side immediately it arrives.

Several cases have also come under notice where various fertilizers are sold with a branded guarantee which is not in accord with the invoice certificate guarantee. Sulphate of ammonia, for instance, carrying a brand embodying a claim of 20·6 per cent. nitrogen has at times been guaranteed to contain only 19 per cent. of nitrogen (a difference of $1\frac{1}{2}$ units valued at about 10s. per unit) in the registration statement and invoice certificate. In cases like this samples must always be obtained and analysed to ascertain the true position before suitable action is taken.

To any one who has closely studied the various classes of fertilizers on the market in New Zealand the great number of differently named and branded mixtures is indeed a revelation. As has been pointed out on many previous occasions, two mixed fertilizers carrying distinctive crop names may differ by $\frac{1}{2}$ or perhaps 1 per cent. in guaranteed plant-food content, and in other cases one fixed fertilizer formula will be offered for sale under several different names such as "rape, grass, orchard, and potato" manure for crops having widely different nutritional requirements. It can easily be understood that a multiplicity of brands as is evidenced in a small country like New Zealand, is most uneconomical from the point of view of their preparation, branding, and distribution. Standardizing of mixtures from experimental data published by or on record at the Department of Agriculture and various research institutions should be taken advantage of more freely by both manufacturers and merchants.

Improvement in the advertising of fertilizers generally is a matter of great importance which in the opinion of not a few is best tackled by constantly educating the farmer and fertilizer salesman in matters relating to soils and fertilizers.

In practically all countries where fertilizers and soil amendments such as lime are employed to any extent, various scales of charges are made to principal vendors, manufacturers, importers, &c. An extract from a summary of the financial statement of the Fertilizer Control

Fund of the Missouri Agricultural Experiment Station for the year ended 31st December, 1930, is quoted as being typical of the position in many States of America :—

	Dollars.
" Receipt from sale of tags	27,765
Total expenditure (including salaries, &c.)	22,477
Net revenue	5,288 "

It is interesting to note that the total sales of fertilizer in Missouri for that year were only 51,880 tons.

There is no doubt that with suitable amendments to the present Fertilizers Act and the carrying-out of the proposals of the National Expenditure Commission to charge a reasonable and equitable scale of fees to brand-owners for registration of brands, a more efficient regulation of the trade for the betterment of fertilizer industry and agriculture should be secured. It would not be altogether satisfactory to consider the subsidizing of all classes of fertilizers as in Australia until a reduction in the innumerable brands on the market is obtained ; and a means to this end is the charging of appropriate registration fees to secure a limitation or reduction of brands.

With the rapidly extending use of all types of fertilizers by home gardeners, small growers, market-gardeners, &c., throughout the Dominion, it is a matter of considerable moment that due consideration be given to the question of placing the sales of quantities of fertilizer up to 5 cwt. under some sort of control so that the purchaser may be in a position to know that he is getting value for the money he spends. It should be quite obvious to all that in the case of a substance like fertilizer, which must be bought entirely on its analysis, a close check is necessary on its quality. The purchaser is entitled to the utmost protection and to feel that he can use the goods he is purchasing with every confidence to get the results desired.

NOTES ON RECENTLY OBSERVED EXOTIC WEEDS.

H. H. ALLAN, Botanist, Plant Research Station, Palmerston North.

(6) Saffron Thistle and Marsh Thistle.

Carthamus lanatus synonym *Kentrophyllum lanatum* (Saffron Thistle).—This thistle has its native home in Europe, especially the Mediterranean region, and in North Africa. It affects stony sunny localities and dry pastures, and is a close relative to the safflower (*C. tinctorius*), but lacks the properties that make that species useful for dyeing purposes. It is an annual plant, when well grown forming a prickly bushy mass up to 3 ft. in height. The upper parts are more or less clothed with spider-webby hairs, and the yellow flower-heads are surrounded with prickly leaves similar in shape and appearance to those of the stem, but closely clasping the head. This feature, together with the details shown in the illustration (taken from Volume 5 of the *Agricultural Gazette of New South Wales*) will serve to make its identification easy.

FIG. 1. SAFFRON THISTLE.

1, leaf; 2, 3, 4, 5, bracts of flower-head; 6, florets; 7, anther, with bristly appendage; 8, fruit, with stiff pappus, and withered floret; 9, pappus scale.

It was early naturalized in Australia, and in the States of South Australia, Victoria, and New South Wales has proved a great nuisance. The recommendations given for its control are to cut and burn the plants before they come into full flower. No doubt sodium chlorate spraying in the early stages of growth would prove effective.

In New Zealand it has recently been observed by Mr. S. Freeman near Masterton, and by Mr. J. B. Hogg near Wanganui. In both places it appears to be infrequent, and steps should be taken to prevent its getting a hold. It has also been observed near Hamilton.

FIG. 2. MARSH THISTLE.

Cirsium palustre (Marsh Thistle).—This species is also called *Carduus palustris* and *Cnicus palustris*. The Second Schedule of the Noxious Weeds Act consists of a list of species that become "noxious weeds when so declared by local authority." In the terms of this schedule any species of *Carduus* or *Cnicus* may be declared noxious. Most modern taxonomists place the group of thistles concerned under two genera, but adopt the name *Cirsium* in place of *Cnicus*. Others use only the name *Carduus*, treating the cirsiums as a sub-genus. The question is a technical one, but is not altogether of academic interest

only, as the divergence of naming might create the possibility of legal argument in disputed cases. The " Californian " thistle is referred to in the First Schedule of the Act as *Cnicus arvensis*, but it is as well to point out that it is exactly the same species as is referred to by present-day botanists as either *Carduus arvensis* or *Cirsium arvense*.

Marsh thistle is a native of Europe and West Asia, found mainly in damp ground, and on the margins of streams and ponds. It is of tall, erect habit, usually with a single purplish-green stem, branching towards the top. The leaves are deeply divided, with numerous brownish prickles and a pale midrib. The leaf-margins bear purple-based spines. The stem is winged, and carries spinous rudimentary leaves. The flower-heads are somewhat egg-shaped, clothed with narrow bracts, and bearing purplish florets. It is a biennial, and in its first year shows a rosette of prickly leaves spreading over the ground, as does the common Scotch thistle.

In Europe it has given trouble in sour ground and damp pastures. As each plant bears some seven thousand seeds, it tends to spread rapidly in situations suitable to it. It is avoided by stock, whether in pasture or in hay. Drainage of the ground goes far to check its spread. Spraying should be effective where drainage is not an economic proposition.

In New Zealand it was reported as occurring in Westland and Southland in 1911, where it might be expected to give trouble. There does not, however, appear to be any further reference to it. Mr. V. D. Zotov has observed it established in damp pastures along the upper Tiritea Stream, near Palmerston North. It also occurs near Woodville.

(7) **Wild Onion,** *Allium triquetrum*.

This rather handsome relative of the onion is frequently grown in gardens, whence it has made its escape in a number of localities in the North Island. It readily establishes in cool, damp spots, and in recent years has proved aggressive. The strong onion-like odour renders it an unwelcome entrant into dairying land.

This Allium is a native of the Mediterranean region and of North Africa, and in Algeria is used as a vegetable, under the name " bibrous." Trabut recommended its cultivation in southern Europe, as a vegetable "*très fin et très interessant.*" Farrer also spoke of it as promising " to develop into a popular vegetable." This promise does not seem to have been fulfilled. Introduced into England towards the end of the eighteenth century, the plant finds favour as a member of the wild garden and for growing under trees. In certain parts of the southern counties it is now found as a hedgerow plant, and it also grows wild in Guernsey.

Allium triquetrum is a characteristic member of the lily family, and is easily distinguished from the other alliums by its triangular stems. The bulbs are about $\frac{3}{4}$ in. in diameter, with pale coats, and produce numerous offsets. The leaves are narrow, bright green, with white sheathing bases, and are 18 in. long or thereabouts. They possess a distinct keel, and the margins are at such an angle that the leaves appear in section as a triangle with slightly hollowed sides. The stems are also triangular in section, with acute edges and somewhat hollowed sides. The flowers are borne in stalked clusters at the tips of the stems.

At the base of each cluster is a spathe consisting of two delicate, pale, narrow valves that twist and point downwards as the flowers develop. In a well-grown plant there are about twelve flowers to a cluster, each on a slender spreading or drooping green stalk. The flower segments are about $\frac{1}{3}$ in. long, six in number, white, with green midribs. There are six stamens and a three-celled ovary.

How aggressive this plant may be is shown by a case brought to my notice by Mr. R. O. Dalrymple, of Bulls, where a bed of periwinkle is being ousted by an upgrowth of a mass of the allium. Where once a plant gets a hold on dampish pasture land its control is a matter of great difficulty, as the bulbs may be well below the surface of the ground, and immune from sprays in ordinary strengths.

In 1899 Kirk recorded the "wild onion" or "sweet-scented garlic," *Nothoscordum fragrans*, an American plant, as "spreading in the warmer portions of the colony, and is not unlikely to become a very serious pest." This species does not appear to have been met with since. It is possible that the plant Kirk was referring to was really *Allium triquetrum*, but one would fain hope that attention was so promptly and thoroughly paid to Kirk's remarks that the sweet-scented garlic was cleaned out. Kirk observed: "In gardens the plant should be dug up, care being taken not to break the plant. Amongst grass it should be treated the same as Californian thistle—viz., kept shaved off level with the ground: with such treatment it will in a few seasons die out. If, however, wild onion once get possession of good land its eradication is very difficult; therefore, tackle it on first appearance."

FIG. 3. WILD ONION.

On right: Above, section of stem; below, section of leaf.

N. fragrans resembles *A. triquetrum*, but differs in the absence of the onion-like odour, the more numerous seeds in each cell of the ovary, and in the more greenish flowers with brownish midribs. A watch should be kept for it, but the treatment to be meted out is the same. Ewart, in "The Weeds, Poison Plants, and Naturalized Aliens of Victoria," gives the following recommendations: "The plant can best be suppressed by cultivation and by the growth of leafy fodder or root crops. The ground must be worked well between each crop, so that the bulbils are not allowed to develop. Two years' treatment will be necessary to suppress it fully. Poisons are useless. The plant is not itself poisonous, but is useless for fodder, and a great nuisance on grazing land." The recommendations of Wild (*New Zealand Journal of Agriculture*, Vol. 37, 1928, pp. 93–96) for the control of crow garlic (*Allium vineale*) are worth studying in connection with the present species, especially the question of heavy stocking of infected pasture. Korsmo suggests spraying dense growths with a 5-per-cent. sodium-chlorate spray. It is probable that several sprayings would be required to effect any real measure of control.

METHODS OF CYANIDING IN GLASSHOUSES.

ECONOMICAL CONTROL OF WHITE-FLY.

J. MUGGERIDGE, Entomologist, Plant Research Station, Palmerston North.

THE most economical way of dealing with infestations of white-fly in glasshouses (Speyer, 1929), apart from biological control methods, is by fumigation with hydrocyanic (prussic) acid gas. The gas is generated by dropping one part by weight of sodium cyanide (98 per cent. purity) into glass jars placed at regular intervals upon the paths of the house, each jar containing 4½ parts by volume of 33 per cent. sulphuric acid. One-fifth to one-quarter of an ounce of sodium cyanide gives off a quantity of gas into a space of 1,000 cubic feet sufficient to kill all the adult flies and about 90 per cent. of the scale stages, but the eggs are not killed. A second fumigation is therefore necessary from a fortnight in warm to three weeks in cool weather after the first.

One-quarter of an ounce of sodium cyanide to the 1,000 cubic feet space is the maximum which can be used with safety upon most glasshouse plants, and as the gas is easily decomposed in the presence of light it is essential to start fumigation at dusk, and to air the houses thoroughly by opening the doors and ventilators at dawn. While no further precaution than the latter is called for in the case of plants with coarse or leathery foliage, the tender foliage of the tomato plant will not stand, without grave injury, concentrations of the gas sufficient to kill the scale stages of the insect, unless water is withheld from the roots for a considerable time before fumigation—that is to say, the plants to be fumigated must actually require watering when fumigation is started. Moisture upon the foliage, however, is of no concern. Cucumber and allied plants which require water continuously will not stand fumigation with a greater concentration of gas than is obtained from ⅛ oz. of sodium cyanide to the 1,000 cubic feet space, an amount sufficient only to kill a good proportion of the adults, the eggs and scale stages being left alive.

Though prussic acid gas is extremely poisonous to man, there is no danger from the practice of cyaniding provided ordinary precautions are taken. The sodium cyanide should never be wrapped in paper or cardboard before being dropped into the acid. The ventilators should be closed and a door left open; the cyanide charge is then dropped into the acid, and the operator leaves the house comfortably, closing and locking the doors. On opening up at dawn the ventilators should first be opened from outside, but if this is not possible, the door or doors should be opened for twenty-five to thirty minutes before any attempt is made to enter the house to open the vents from inside.

It is inadvisable to fumigate on windy nights, as the gas is liable to become very unevenly distributed.

THE DRY METHOD.

The foregoing method, which is usually referred to as the jar method, is now apparently largely superseded by the dry method or

slow process generation of hydrocyanic acid gas. Directions for the adoption of this method are as follows :—

Dry powdered sodium bicarbonate and high-grade sodium cyanide (98 per cent. purity) in a fine state of division, are thoroughly mixed together in proportion of three parts sodium bicarbonate and one part sodium cyanide by weight.

One ounce of the mixture to every 1,000 cubic feet space is distributed upon the paths of the houses, which must be dry. As the generation of cyanide is slow, the operator can treat a considerable number of houses in a block single-handed.

The mixture should not be touched with the hands ; when distributing, it should be shaken from a large tin, the operator walking backwards to avoid getting the powder upon his clothing. The ventilators may be opened during distribution, and closed immediately after. The houses should be locked up for the night.

The mixture should be distributed at dusk, water having been withheld from the plants, so that they require moisture at the root. Fumigation on rainy, but not necessarily on windy, nights is to be avoided. The ventilators should be opened from outside at dawn the next morning, and left open for not less than one hour. The residual sodium carbonate may be left on the paths. Heat may be put on during fumigation if conditions demand it.

APPOINTMENT OF DIRECTOR, LIVE-STOCK DIVISION.

CONSEQUENT upon the retirement of Mr. J. Lyons, Mr. W. C. Barry, M.R.C.V.S., has been appointed Director of the Live-stock Division of the Department of Agriculture. For nearly the past eight years Mr. Barry has been District Superintendent of the Department for the Wellington District, which includes Wellington, Hawke's Bay, Taranaki, Marlborough, and Nelson.

Mr. Barry came to New Zealand in 1915 as a Government Veterinarian and was first stationed at Christchurch with supervision over some of the Canterbury meatworks and the milk-supply of the City of Christchurch. During the war he was engaged in active service with the New Zealand Expeditionary Forces in Egypt as a Captain in the Veterinary Corps, and on repatriation resumed his former activities in Christchurch. For some time he was lecturer on veterinary science at Canterbury Agricultural College, Lincoln. In 1921 Mr. Barry proceeded to Auckland to fill a vacancy in the Department's veterinary service, and acted in the capacity of District Superintendent at Auckland for a few months prior to his transfer to a similar position in Wellington early in 1926.

Noxious Weeds Order.—The Waitomo County Council has declared hemlock (*Conium maculatum*) to be a noxious weed within its jurisdiction.

The reappointment by His Excellency the Governor-General of Mr. C. H. Hewlett as a member of the Board of Governors of Canterbury Agricultural College, is gazetted.

Special Orchard-tax payable in the Rangiora Fruitgrowing District.—By order issued in exercise of the powers conferred by subsection (3) of section 4 of the Orchard-tax Act, 1927, it is provided that, in addition to the general orchard-tax payable under section 3 of the said Act, the occupier of every orchard within the Rangiora commercial fruitgrowing district shall in each year be liable to pay a special orchard-tax calculated at the rate of 2s. for every acre or part of an acre comprised in his orchard and planted with apple-trees, pear-trees, or quince-trees.

SEASONAL NOTES.

THE FARM.

The Pastures.

OFTEN in January and February tall woody or fibrous growth, consisting largely of flowering organs, is prominent on many pastures. If this growth is not removed the plants on which it occurs devote themselves largely to seed-production, whereas if it were removed they would tend much more freely to produce leafage. At this season, both in dairying and in fat-lamb production, there is often an acute need for leafy feed. Hence topping of pastures with its consequent transference of the activity of the sward to leaf growth from seed-production is often advisable. If dry conditions seem likely to persist for any considerable time after such topping, it should be carried out at a height which will serve to remove the stemmy portions at the same time as the bottom leafy portions of the sward are undisturbed—this necessitates cutting at a considerably greater height than is adopted in ordinary mowing. Apart altogether from the occurrence of tall, stemmy growth, topping of pastures may be advisable to remove as completely as is possible, without exposing the swards to the danger of drying out, all the aerial portions of shade-creating weeds such as spear thistles, docks, fat-hen, and red-shank or willow-weed. If weeds of this type are not checked in some way they are likely to weaken greatly the pasture plants in their immediate vicinity, and possibly to create vacant patches on which inferior plants later may become established. If, however, they are mown in the manner suggested, they cease to create the shade which is harmful to the valuable pasture plants.

The preparation of ground for the sowing-down of grass in autumn is a matter of seasonable moment. In general the most economical means of providing the mellow, firm seed-bed that assists in begetting the fullest success in pasture establishment consists, in part at least, in commencing the preparation of the seed-bed far enough ahead to allow time for natural weathering agencies to play a considerable part in the breaking-up and firming of the soil. Clovers which are essential in fully successful permanent pastures call particularly for consolidation, the widespread value of which is illustrated by the fact that the best portions of pastures, in respect both to grasses and clovers, are often to be found round the headlands, which have necessarily been subjected to greater consolidation by the passage of horses and implements.

The purchase of pasture seed mixtures is of such importance that it receives the personal attention of efficient farmers. Instead of being left to the last moment before the seed is to be sown, the purchase of seeds should be undertaken early enough to ensure that there will be time to obtain seed of desirable strain, purity, and germination capacity. As the strain of seeds is a character of fundamental importance which has come into the foreground during recent years, it is fortunate that the official system of certification of seeds has made the quest for desirable strains of the more important pasture species a relatively simple task in practice. The basic fact is that an ever growing mass of field experience shows that, as a rule, it is false economy not to use certified seeds when supplies are available. During the current seed harvest certified seed of rye-grass and cocksfoot will be described either as "mother" grade or as "permanent pasture" grade, while in respect to both white and red clover there will be an additional grade termed "first harvest, permanent pasture." The

" mother " seed should be used by all who contemplate the future production of certified seed, as it not only gives greater assurance of purity of strain, but also enables certified seed to be harvested at the minimum interval after sowing. Care should be taken to preserve the printed statements inserted in sacks of machine-dressed mother seed. These printed statements are known officially as " insert slips," and constitute essential evidence at a later stage, when application for seed certification is being made, that the required mother seed was used originally. The other grades of certified seed are quite suitable for all pasture purposes apart from certified-seed production. The purity of certified seed, especially in the case of mother seed, should be taken into consideration, for the purity of lines of certified seed varies considerably. It is also a sound precaution to ascertain the germination capacity of certified seed—though occasional lines are of quite low germination, they are not generally quoted at a price which is correspondingly low.

Some of the grassland on many farms may, with distinct advantage, be top-dressed with phosphates in February or a little later—generally such top-dressing increases the autumn and winter supplies of fresh leafy feed, and, even should dry conditions occur for a considerable period after the distribution of the phosphates, their influence will not be lost but merely postponed until the required soil moisture is provided.

Considerations relative to Seed Mixtures.

In recent years authoritative views in respect to seed mixtures for permanent pastures have been substantially modified. One of the major changes is the limitation in the number of species recommended in specific mixtures. This change is a result of more thorough knowledge. The object of the earlier practice of using a wider range of species was to increase the likelihood of including those actually needed. But with greater knowledge not only of the species really needed, but also of those not needed, under a particular set of circumstances, it is possible with safety to narrow the range of species sown, and thereby, without sacrificing efficiency, to bring about a welcome saving. Another important change is the greatly increased weight given to strain differences within a species. In this respect the informed view in respect to pasture plants is now paralleling that which has for long obtained in respect to many arable crops. Ordinarily only a slip-shod farmer would have been content to sow wheat or turnips or maize as such without seeking some knowledge of the sort of wheat and so on. But even the careful farmer, usually, of necessity, sowed perennial rye-grass, cocksfoot, white clover, &c., without giving any consideration to the possibility of different sorts of perennial rye-grass, &c., being of different values. With recent intensification of attention upon strain differences within pasture species this is now ended. A further important change is represented by the view that cocksfoot should be so widely used in greater quantities than were customarily included in seed mixtures in the past that cocksfoot is now a major constituent in the great majority of the sowings of permanent pastures. These three changes suffice to suggest that in determining upon pasture seed mixtures it is advisable to keep abreast of current knowledge which at times is ignored in the advice that is tendered to prospective purchasers of seed mixtures, about which detailed information is available from district officers of the Fields Division.

The Breeding Ewes.

In the North Island farmers undertaking fat-lamb production usually put out the rams at the end of February or early in March. If the ewes tend to be overfat they should be put on a scant diet early enough to bring about a sufficient reduction in condition. Flushing the ewes for about ten days before the rams go out is of known value, for investigations have

shown that the highest birth-rate is secured when ewes are in moderately good condition which is improving at the time of mating. Flushing can be carried out by providing some succulent feed such as rape after the first feeding-off of the lambs, or by putting the ewes on the best available short pastures and thereby providing them with more nutritious food—*i.e.*, better keep, at the appropriate period. The better keep by its stimulating effect tends to beget a greater proportion of twins produced in the earlier part of the breeding season. The farmer need not forego the benefit of flushing in respect to ewes that are becoming too fat. His course then is to confine such ewes to poorer rations up to within about a fortnight of putting them to the ram—the flushing being done as described above.

February a Difficult Period in Dairying.

One measure of efficiency in feeding a dairy herd is the rapidity of the decline in production of butterfat in late January and February. Even in some of the most favoured dairying districts the daily production of butterfat in February is only about 75 per cent. of what it is in December. Such a rapid decline in production is not natural, even for cows which are not of particularly good dairy type, and there is ample evidence that in general the rate of fall at this stage could be greatly minimized by feeding in closer accordance with the needs of the producing cow. Improvement could be expected if it were more thoroughly realized that diets which consist essentially of pasture that is long and stemmy, or of overmature special forage crops such as maize, millet, and lucerne in the flowering stage, or of silage made from grass cut when it was approaching the stage typically adopted for hay, are fundamentally unsuitable for cows of reasonable production. Such diets favour body-fat production rather than butterfat-production, and their use explains why at this season cows which are at all inclined to beef commence putting fat on their bodies instead of into the bucket. There seems to be no easy course that will lead to the satisfactory avoidance at about February of diets which are unfitted for efficient butterfat production. The maintenance as far as possible of pastures in a short leafy condition is of assistance, but such pastures alone seldom are adequate and usually require supplementing by such measures as the feeding of young succulent lucerne or red clover before it has developed much woodiness that accompanies flower-production, the feeding of young millet or the feeding of soft turnips. The fact that an avoidable decline in production at this stage is reflected unfavourably in the production for the whole of the remainder of the season seems at times to be overlooked. Otherwise, it would be difficult to explain why the use of suitable crops which are available is postponed, either because they may be more acutely needed later on or because they would eventually give greater yields. The point of practical moment is that later they may not be so acutely needed. Definitely in these circumstances a present pound of butterfat is preferable to a problematical future pound, and in February, as a rule, it is sound practice to make the fullest possible use of the succulent feed available.

Seasonal Work with Lucerne.

At times in February it is advisable to mow young lucerne which was sown in November or December. Generally such a mowing is necessitated by a vigorous development of weeds which tend to "choke" the lucerne seedlings by lessening their supply of moisture and of direct light. But if weeds do not threaten damage to the lucerne seedlings in this manner, then such an early first mowing should not take place. During the young stages of the crop, leafage, if unchecked, assists considerably in building up an extensive root system which is capable of serving well in subsequent difficult periods. One of the critical periods in the life of lucerne seems to occur at the first spring following the sowing of the crop, and an extensive

root system built up during the first summer is extremely useful at this critical spring period in assisting the crop to compete against invading weeds. In some districts, especially those in which grasses and clovers are not among its serious competitors, lucerne has been sown with success in February. Good germination is favoured by the warmth which the soil then possesses. Further, the crop sown in February is likely to escape much of the competition from certain weeds such as fathen, which at times greatly interferes with the establishment of a spring-sown crop. Where the grass grub is prevalent it is desirable that the land to be sown with lucerne in February should have been free from grass or cereals during the earlier part of the summer when eggs of the grub were being deposited.

As a rule, a suitable time for the cultivation of lucerne is after the second cut of the season; the essential objective of cultivation is normally the suppression of weeds, and the dry conditions which commonly obtain at about the time of the second cut assist considerably in weed control. If weeds are not making inroads in lucerne, cultivation at any time is likely to be not merely unnecessary, but actually undesirable.

Good results may be expected from top-dressing lucerne with phosphates in summer. Generally summer top-dressing benefits lucerne almost exclusively, whereas the benefit of spring top-dressing may be shared between lucerne and other plants which in lucerne are weeds irrespective of their worth under different conditions.

Late Sown Turnips and Catch Crops.

If further forage-crop production is desirable, valuable work in respect to additional cropping may be carried out during the coming few weeks. In many localities there is still time to sow such turnips as Hardy or Imperial Green Globe and White Stubble. Swedes are less satisfactory for late sowing. Often vacant land offers valuable opportunities for the growing of catch crops. For instance, land in oat stubble, if cultivated as soon as the crop is removed and then sown in Western Wolths rye-grass and red clover will provide autumn and spring feed, which is often of marked value and especially to farmers operating under Canterbury or similar conditions. Black Skinless barley sown at the rate of 2½ bushels an acre develops so quickly that it provides good feed for dairy cows or sheep in about eight weeks. Often it can suitably be sown immediately after oats in February and is then likely to provide feed at a period when it is welcome. Garton oats similarly used are also widely suitable as a green feed catch crop, provided it is not planned to obtain a further growth after the first feeding-off of the crop. Algerian oats rightly are popular for later sowing and later feeding. With all of these crops it is usually distinctly profitable to apply superphosphate at the rate of 1 to 2 cwt. an acre.

General Cropping-work.

All crops sown in rows wide enough apart to allow of intertillage call for summer cultivation at regular intervals until the development of leafage makes cultivation impracticable. No general rule as to the frequency of carrying out this cultivation can be enunciated; on soils which contain a considerable amount of fine silt or clay and which, hence, readily become caked on the surface, a short, heavy, beating rain may so consolidate a loose surface as to make it in need of tillage even though it had been cultivated shortly prior to the rain. The ideal result is the maintenance of a continuously loose surface layer of soil which checks the loss of moisture from the soil and so is of particular value under dry conditions. Hence summer surface-tillage is of distinct value irrespective of its obvious use as a means of controlling weeds.

While summer cultivation continues to be a useful practical means of dealing with weeds such as fathen, docks, willow-weed, &c., occurring in

such crops as carrots, mangels, and potatoes, it seems worth mentioning that summer cultivation alone is not satisfactory as a means of ridding land of persistent perennial weeds such as sorrel, yarrow, creeping fog, and other "twitchy" weeds. Although summer cultivation can be employed usefully to weaken greatly weeds of this type, it is not a satisfactory means of completing their destruction, and it should as a rule be associated with subsequent practices such as the growing of dense shading crops which are suited to carry on the weakening process initiated by the summer cultivation. Included among the crops suitable for this purpose are: (1) Italian rye-grass and red clover sown in the autumn and eventually saved for hay; (2) Algerian oats, autumn sown, and eventually cut for chaff or hay. If after such dense crops the weeds still promise to cause trouble, they may often be dealt with satisfactorily by growing one of the following crops, which should be well tended and well nourished so as to exert the maximum weakening influence on the weeds: Mangels, potatoes, rape, chou moellier, oats and peas, or oats and tares. The position summarized is that a suitable rotation of crops which is spread over a number of seasons and which pays its way throughout is preferable, as regards both effect achieved and outlay necessary, to an intensive effort devoted to summer fallowing which, at times, was looked upon as a standard measure against persistent weeds.

A further fact of seasonable moment in dealing with weeds is that often direct attack upon such weeds as sorrel, brown-top, creeping-fog grass, and similar "twitchy" weeds is inadvisable. The best mode of dealing with them often is to sow the land in pasture and by appropriate top-dressing and management to make the conditions so favourable to the growth of the grass that the resultant vigorous sward gradually weakens the weeds and so lessens their activity that even though they may not be eliminated the damage they do becomes negligible.

—R. P. Connell, Fields Division, Palmerston North.

THE ORCHARD.

Seasonable Spraying.

MANY growers throughout the Dominion make a very grave mistake by discontinuing spray applications many weeks too soon. Presumably this is done for economic reasons, the theory being that the cost of spraying towards the latter part of summer and early autumn is not warranted.

This theory, however, is a penny-wise and pound-foolish one. The discontinuing of spray applications too early in the season will inevitably result in a far greater percentage of rejected fruit during the process of grading. The result of a few insect stings, injury of leaf-roller caterpillar or pin-head black-spot individually or collectively, is all that is required to reduce otherwise extra-fancy fruit to the reject class. In view of these circumstances, it is recommended that spraying operations as outlined in the November notes be carried on as late as possible. At the same time, however, prospective shippers should take into consideration the necessity of reducing spray residue on fruit intended for export to a minimum. This may be accomplished to a certain extent by leaving a margin of time of, say, ten to fourteen days between the last spray application and first picking of each variety. Varieties intended for cool or ordinary store should be kept well covered with the spray referred to above until just prior to picking.

Cover Crops.

To obtain the maximum benefit a cover crop should be ploughed under as soon as it reaches the flowering stage, while the correct time to

plough such a crop under is about the last week in May or early June. Therefore, those growers who intend sowing such a crop are recommended to take the foregoing remarks into consideration and sow accordingly. Cover crops are to be recommended and should take a definite place in the routine of orchard practice, for they not only improve the physical condition of the soil and subsoil, but add organic matter to it. Leguminous cover crops such as lupins (blue or white), peas, or vetches are recommended, as they supply nitrogen as well as organic matter to the soil. A seeding of from 40 lb. to 50 lb. lupins per acre is recommended, and seedings of vetches 1 bushel, oats 1½ bushels, and field peas 60 lb. per acre should be sufficient for this purpose. A dressing of superphosphate from 2 cwt. to 3 cwt. per acre will greatly benefit the cover crop by ensuring an abundance of top growth for turning under.

Fruit Export.

During the coming month, February, fruit-export activities will commence, therefore growers are well advised to anticipate the arrival of this busy period by having all necessary material to hand such as cases, nails, strapping wire, labels, straw-boards, and the various stamps necessary for branding cases. Advantage should be taken of every spare hour and wet day in nailing the cases together and attaching the labels. It is a good plan to soak the labels in water and attach them to the case while wet; this is a simple operation. Place the labels one by one in a pan of clean water, apply the paste to the end of the case (not to the label) with a brush, take a label from the pan of water and place it in position and wipe off with a squeegee or clean cloth and allow to dry before stacking away. The grader should be overhauled, cleaned, and well oiled before it is required for use, and similarly the engine or other power employed for driving the grader. If this work is completed before the packing-season commences it will save considerable time, and possibly much confusion later on.

In making the first packing of fruit for the season care must be taken not to remove from the trees immature, undersized fruit or fruit not carrying the necessary colour requirements. This can be avoided only by very careful picking, carried out by experienced pickers. These pickers should be familiar with the essentials that must be observed when picking fruit for export—*i.e.*, colour requirements, maturity, size, freedom from disease, and blemish. The right degree of maturity for picking for export is a most important and to some extent a difficult point to decide, chiefly owing to the thousands of miles that must be covered before the fruit reaches its destination. The most reliable guide when deciding if the fruit is sufficiently mature for picking is the distinct change from green to light yellow of the ground colour, plus the ease with which the fruit parts from the tree. Pickers should be instructed to keep their finger-nails closely trimmed, and to use the palm of the hand as much as possible, not the thumb and fingers, when gathering fruit. By taking hold of the fruit in this manner and giving it a sharp turn upwards, the fruit if sufficiently mature for picking should break clean away from the spur with the stem intact. Considerable loss results if the fruit is carelessly and roughly removed from the tree: not only is the stem pulled from the fruit in this manner, but fruit spurs provided by nature for future crops are broken off.

Growers in their own interests should make every endeavour to eliminate as nearly as possible the heavy percentage of bruised or otherwise injured fruit that is usually to be found in almost every packing-shed. This injury is caused by rough, careless, and thoughtless workers, either in the orchard or shed or both, and can no doubt be reduced to a minimum if reasonable care is taken during the process of harvesting and packing fruit. The

overfilling of picking-bags and orchard boxes should be avoided, also the dropping of cases of fruit. In fact, rough or careless handling of fruit of any description should not be tolerated in the packing-shed or orchard.

—J. W. Whelan, Orchard Instructor, Palmerston North.

Citrus Culture.

As a result of the prolonged spell of dry weather the young growth on citrus trees will be retarded and a loss of young fruit and foliage may also occur in situations where the moisture content of the soil is much below normal. The maintenance of a soil mulch by surface cultivation is essential to conserve moisture. The destruction of weeds is also very necessary, as much moisture escapes from the soil through these. Should the dry weather continue some additional mulch will be required to conserve the moisture. Stable manure is preferred, but if this is not available, hay, straw, or any litter will serve the purpose. Care should be taken not to allow the material to come in contact with the trunk of the tree, as bark injury may be caused by such contact.

Young shoots should be pinched back to a suitable point so as to encourage side lateral growth. If left to mature, these shoots often grow 3 ft. or more before developing side laterals which in such circumstances usually grow only on the extremity, leaving an undue length of wood unfurnished. By pinching out the growing point of these shoots as suggested laterals are forced nearer the base and growth encouraged where it is most useful. Should the weather become humid, spray with Bordeaux 3–4–40 to check verrucosis.

Where red scale is present spray with a summer oil 1–40 when the young scales are on the move. From two to three applications at an interval of three weeks are recommended.

—L. Paynter, Orchard Instructor, Auckland.

POULTRY-KEEPING.

Management of the Developing Pullets.

NEXT month should see many of the pullets exhibiting such signs of beginning to lay as making a cackling noise, showing a red developed comb, a fullness of the abdominal region, and generally an adult appearance. No time should be lost therefore in getting the young birds into their permanent winter quarters. It is very essential that they be well settled down before their productive season commences, as any change of quarters at the time they are commencing to lay is a common cause of their going into a moult with the adult birds, and this at a time when eggs rapidly advance in price. The same result may be brought about by changing the food, or by subjecting the birds to fright by rough handling, &c. It will thus be seen that the more uniform the treatment pullets receive just before and after they have attained a laying stage the less risk there will be of their going into a premature moult.

Of course the very early hatched pullets will probably be laying before this, especially where the common mistake has been made of providing them with a highly forcing diet, and in most cases they will moult in the late autumn even when given the best care and attention. As a rule, however, the moult is a light one, and if the birds are well fed and managed they will soon recover and become productive again. When the pullets are commencing to lay they should be watched for a time, and discouraged from laying their eggs in odd corners of the house instead of in the nests.

Generally speaking, if one bird is allowed to lay its eggs on the floor of the house, others are apt to do the same. This means that the eggs are apt to be covered up in the litter, and are not gathered in a fresh condition. The placing of an obstruction where the bird has acquired the habit of laying, and having the nests slightly darkened will tend to break the habit. Nest-eggs should also be provided, but these will not tend to make hens lay when they do not want to, as is often supposed by the inexperienced person. A nest-egg, however, often induces a pullet when commencing to lay to produce her egg in the nest instead of in odd corners in the house.

Feeding the Chickens.

A common and mistaken idea held by many people in these days is that chickens cannot be successfully reared on a simple ration consisting of sound grain materials, green food, animal food, and clean water. It is frequently claimed that for chickens to do their best, the use of certain chemicals, tonics, and stimulants is imperative, and that chickens fed with these will make greater progress than where a plain simple ration is fed. This may be the case where the chickens concerned are constitutionally weak and pampering is necessary to rear them. The most successful men to-day will admit that the chick reared by the hen, under natural conditions, has the best start in life, as it matures naturally and has therefore a greater opportunity of developing a sound and vigorous constitution. The chick artificially stimulated with tonics, chemicals, &c., may for a time show quicker development so far as size is concerned, and may even, as is often claimed, come to lay at a much earlier age but this is because it is a more forced product. There is here a distinct analogy between the plant reared under natural conditions in the open and provided with natural food, making for hardiness and resistance to disease, and the hot-house plant which has only the advantage of size and early maturity due to the artificial forcing to which it has been subjected. The most important advance made in recent years in artificial brooding has been the elimination of forcing conditions as much as possible, removing the risk of the chicks securing too much warmth and giving them only a sufficient degree of heat to enable them to thrive, and while guarding against extremes of temperature, introducing the hardening-off process by degrees, with as little delay as possible. Even allowing that, as a result of feeding stimulants, &c., the birds do come to lay earlier, the ultimate advantage of this is doubtful. One weakness in egg-production to be guarded against is the small size of many eggs at the present time, as indicated by the fact that eggs that weigh about 1¾ oz. have to be exported in order that sufficient of the summer surplus may be shipped overseas, for the maintenance of paying values on the local market. It is certainly not to the unduly forced bird that we must look for improvement in this respect. It is not the early maturing diminutive bird that should be aimed for, but the bird with good bodily development that has the power to last out one or more long heavy-laying season, as well as the power to resist disease; and these birds as a rule lay a decent-sized egg. It is not when a bird commences to lay, but the number of eggs she will lay in two or more seasons under ordinary conditions, and while her product is of good marketable size commanding the highest prices on the overseas market, that is the factor which determines her value. The old hen which has passed the experimental stage in rearing chickens when on a free range, gives a striking lesson worth following in regard to feeding the artificially produced chick. If the crop of a chicken being reared under natural conditions is opened up a good variety of food such as soft seeds, tender shoots of grass, insects, and worms will be found. This also provides the lesson that it is unnatural for a baby chick to eat hard grains such as broken maize, wheat, &c. With such foods, where the artificially produced chick is concerned, it is always wise to moisten the grains with hot water or milk in a covered receptacle

and allow them to swell before being fed to chicks during the early stages. If there is any doubt on this point, a batch of chicks should be divided, giving one-half hard dry food and the other half food that has been moistened before feeding and watch results. The aim of the poultry-producer should be to rear his birds in such a way that they will possess desirable size, constitutional vigour, and be producers of standard grade eggs—*i.e.*, eggs over 2 oz. in weight—during their productive period. To achieve this end the birds should not be encouraged to lay before they are six months old.

I would again emphasize that the chief essentials in successful chick-rearing under artificial methods are to have the chicks hatched at the right time from healthy breeding stock, uniform temperature under the hover, a proper system of ventilation without draught, feeding only sound grains, succulent green material, sea-shell, gravel grit, charcoal, a fair proportion of animal food, clean water to drink or milk preferably fresh, strict attention to cleanliness, and clean ground to run on. Given these conditions, the young birds will require no medicines, tonics, &c., at any rate so far as New Zealand conditions are concerned.

Lameness in Young Ducklings.

Several complaints have reached me of late regarding lameness and loss of leg-power in ducklings that were being reared by artificial means. This may be due to having the drinking-vessels insufficiently deep to allow the birds to get their heads well under the water to keep their nostrils from becoming clogged up with food, &c. Another cause and the most common one, is dampness in the sleeping-quarters and allowing ducklings to sleep on wet bedding-material. Curing leg trouble is out of the question, and the only safe course is to prevent it. The first step in this direction is to provide drinking-vessels which will allow the young birds to get their heads well under the water. Further care must be taken to keep the bedding-material in a dry state, and with this in view, the drinking-vessels should be placed well away from the sleeping compartment. This will go a long way towards preventing the droppings from the birds after drinking coming in contact with the bedding. In furtherance of this end, a good plan is to have a low wooden frame covered with small-mesh wire netting on which to stand the water-fountain, while a flat dish is placed underneath. Then the droppings, when the ducks are drinking, will fall into the dish. This will help greatly to keep the quarters in a dry state and the birds healthy.

It goes without saying that if brooder ducklings are to make sound development and be free from lameness and other troubles, it is necessary that they be well supplied with fresh crushed oyster or other sea-shell from the day they are placed in the brooder right throughout their growing stage.

—*F. C. Brown, Chief Poultry Instructor, Wellington.*

THE APIARY.

Taking Surplus Honey.

WHERE the beekeeper has succeeded in getting his colonies into good order for the honey-flow there should be some honey for extracting by the end of the month. If the stocks of surplus combs on hand are not sufficient to harvest the crop, there is a danger that the immediate requirements of the bees may not be met. It is well, therefore, to look over the upper stories and note which contain sealed honey. These can then be removed and extracted, and returned to the hives to be refilled.

In this early extracting great care must be exercised not to remove any combs but those which are fully sealed, as in the height of a honey-flow much unripe honey will be present in the hives, and this, if extracted, is likely to ferment. The practice of extracting from unsealed combs during a flow cannot be too strongly condemned, as it results in the production of honeys of poor flavour, coarse grain, and low specific gravity. All partly sealed combs should be left on the hives until after the flow, in order to get the honey in them well ripened.

Extracting during a flow has advantages, providing the above precautions are taken, as fewer combs are required and little or no robbing has to be contended with during the tedious process of removing honey from the hives. Where ample stocks of combs are on hand to meet the demands of a large flow the hives can be supered as required, and then the work of dealing with the crop may be left until the end of the season. If this practice is followed the beekeeper will be assured of a well-ripened honey of good quality and high grade.

Use of Bee-escapes.

For removing honey from the hives there is no better device than the bee-escape. The usual practice followed when the time for extracting is at hand is to remove the frames one by one. If excluders are used much time will be saved in picking over the combs. As the combs are taken from the hives shake the bees in front of the hive, brush off the remaining ones, and place the combs in a hive body for removal to the honey-house. Some beekeepers practise removing full supers, which are bumped on the ground to cause the bees to fall from the combs. This is not a good plan, as during the operation many bees are killed, combs are broken, and robbers are soon in evidence. Others practise smoking between the combs excessively, in order to get the bees out of the supers. There is danger in this method of demoralizing the colony, resulting in it being an easy prey to the robber bees, and causing the attendant risk of injuring the quality of the honey by tainting it with smoke.

There is no more satisfactory way of getting the bees out of the supers than by the use of escapes, and when their advantages are weighed it is a matter of surprise that they have not been more largely adopted. There is no stinging, smoking, brushing, or robbing when the honey is removed. Escapes are now made for the greater part of wire cloth. The advantage of this is that it allows the warmth from the bees to pass into the super during the night, thus keeping the honey warm; the bees can also clean up the drips of honey that fall from the burr combs. In inserting the escapes gently prize up the super from the brood-chamber and insert the device. A puff of smoke will suffice to control the bees while the operation is being performed. If this is done late in the afternoon the bees will have gone down to the brood-chamber before the following morning, and the honey may then be taken off without disturbing them. A word of caution to those who have not formerly used the escapes: Should there be brood in the super combs the bees will not leave, and the escapes will not prove effective in ridding the supers.

Honey-tanks.

For the preparation and care of the honey after extracting it is necessary to provide suitable tanks. These should be made of tinned steel and externally soldered, in conformity with the regulations under the Sale of Food and Drugs Act. It has been proved by experience of late years that deep narrow tanks are the most suitable. These tanks obviate to a great extent the disagreeable necessity of straining the honey, and help to eliminate both froth and scum, which render the honey unsightly when it rises to the surface.

Extracting.

To carry out extracting expeditiously two people should be engaged—one to do the uncapping and the other to operate the extractor. In the process of uncapping the comb is placed on the cross-bar on top of the uncapping can. The projecting screw point prevents the frame from slipping and acts as a pivot on which to revolve the combs. The comb should be placed with one end resting on the pivot and tilted slightly forward, in order to allow the cappings to fall away from the combs as they begin to peel off. For removing the cappings what is known as the Bingham knife is usually first favourite. Provision must be made to keep the knife warm, and this can be accomplished by immersing it in hot water. The knife should have a keen edge, and be thoroughly clean before starting operations. Uncapping should commence at the bottom and the knife proceed with a forward and backward motion, the same as when using a saw. Make a practice of uncapping as wide a surface as possible, and endeavour to remove the entire surface of the comb without once removing the knife. A little experience will enable the operator to cut below the surface of the cappings, and it should be remembered that the cleaner the cut the freer the honey will be of wax particles when extracted.

After the combs are uncapped the problem of dealing with the cappings must receive consideration. Where these are stored for a indefinite period the honey may granulate or take up moisture from the atmosphere and thus become a total loss. If the beekeeper does not possess one of the melters in general use he should improvise some means for straining the cappings. A hive-body covered with coarse wire cloth at the bottom and placed in a tray with a lip provided at one end to drain off the honey will answer the purpose for small quantities of cappings. For dealing with large quantities it is well to install a good melter, but before doing so the beekeeper should satisfy himself that it will not impair the quality and colour of the honey.

Returning the Combs.

After the combs are extracted they should be placed on the hives in the evening. If this practice is followed the bees have a chance to clean them up during the night, and robbing is not likely to follow. Nothing will excite the bees more than wet combs placed on the hives during the day ; they promote wholesale robbing, and, moreover, the bees take advantage of the opportunity to enter the honey-house every time the door is opened.

—E. A. Earp, Senior Apiary Instructor, Wellington.

HORTICULTURE.

Vegetable Crops.

WINTER crops planted out during the past month will require careful attention to keep them clean of disease, pests, and weeds and get them growing strongly. To do this, hoeing occasionally to destroy weeds before they pass the seedling stage and conserve moisture ; also a light dressing of nitrate of soda or sulphate of ammonia as may be necessary, will be of great assistance. Seedling crops so soon as they appear above ground will also require similar attention. Such operations, carefully carried out, following the sowing of seeds of good strain, in land that has been well-prepared, are the main factors in successful cropping.

Cabbage and cauliflower for spring cutting should now be sown in seed-beds. These must not be forced, but grown steadily to produce sturdy plants. Select a piece of land that is warm and well-drained and have it ready for setting out with these plants during the month of April.

Tomato Crops.

It is a common experience to grow excellent crops of tomatoes under glass, with little difficulty, for the first two or three years after the house has been built. Then troubles of many kinds arise in the course of future cropping and the fine assurance one had acquired begins to disappear. The initial success is largely due, no doubt, to the fresh soil and clean house facilitating the work. An important problem is how best to maintain these facilities.

It may be done by thoroughly cleaning the house promptly as soon as the present crop is finished. This is best commenced by fumigating the house with burning sulphur to destroy all fungous spores that would otherwise infect the following crop. Screened agricultural sulphur is burned at the rate of 10 lb. per 10,000 cubic feet. It should be distributed in a number of small heaps on the surface of the ground and ignited after pouring a small quantity of methylated spirits on the centre of each heap. It is best carried out during a quiet evening with no wind. Close the house up tight, ignite the sulphur, retire, and lock the door, placing, if necessary, a wet sack to stop any opening there may be under the door. The following day open all doors and ventilators; cut the plants through a few inches above the surface of the ground and carry out all tops and strings and burn them as soon as they are dry. Then sweep the house clean of all dust and rubbish, and carefully dig all roots and burn them. The cleansing of the house is then completed by washing the interior down, or spraying it well, with cresylic acid emulsion. This is made by placing one gallon of pure cresylic acid and 8 lb. potash soft soap in a bucket and heating it over a fire until all the soap is dissolved. This concentrate is used at a rate of one part to 50 parts of water. It should be carefully applied with good pressure to every part of the roof, walls, and surface soil. The ventilators should be left open while this is done, but should be closed down tight for four days when spraying is finished in order to retain the strong vapours. The house may then be opened up and planting commenced, if desired, fourteen days after treatment.

From experience during the growing season, the examination of the roots when digging them, one will obtain a good idea of the conditions of the soil so far as pests and diseases are concerned. If these are present they may be destroyed by sterilizing the ground with steam; or for fungous diseases saturating the soil with a solution of formalin; or, in the case of insect troubles, by fumigation with carbon bisulphide or saturating the soil with a solution of Restar, using it at a rate of 1 pint to 10 gallons of water. In the latter instance the Restar solution may be used in the place of cresylic acid emulsion for washing down as well as soil pest control.

As work of this kind may be done most effectually in a well-built house in good repair, any repairs needed should receive attention, all cavities and crevices being properly puttied and woodwork painted periodically.

After the above-mentioned interval market crops may be planted or a green cover crop for turning under.

Small Fruits.

In warm localities in the North, strawberry planting is done during the month of April, but in colder and southern districts the latter end of February, or as soon as plants are available, they should be set out.

This should only be done in land that is thoroughly clean, well supplied with humus, smoothly graded, and well settled to a firm bed. At the last ploughing, or digging, turn under a good dressing (2 oz. or 3 oz. to the square yard) of blood and bone manure, and harrow or cultivate in a dressing of superphosphate and sulphate of potash when working down weeds.

Two or three weeks later planting may be done. Where beds are down only for one year the plants are set rather close, 24 in. by 9 in., but for vigorous varieties or where beds remain down for a few years 30 in. by 12 in. is generally more suitable. The plants should be set firmly when the land is dry enough to be free from any stickiness.

Established beds should be cleaned up, all runners removed, and a dressing of fowl-manure in a friable state cultivated in.

The Homestead Garden.

Where spring-flowering bulbs have been lifted for replanting, the work should now be completed as soon as possible. As with most plants of small to medium size, they look best when planted in rather large groups of one variety. Occasionally, where the conditions are suitable, a very large group looks well, as in the case of wood hyacinths, grape hyacinths, or daffodils planted in grass.

Lilies have a very short resting period, and where planting is contemplated it should be done as soon as the flower stem ripens, taking great care to allow the bulbs to dry as little as possible in the process. *Lilium candidum*, known here as the Christmas lily, is now mature and is one of those ready at the present time for replanting. These handsome plants usually require little attention once they are established in a suitable position, and many are not the least fastidious. *L. auratum*, *L. speciosum*, and *L. longiflorum* are stem-rooting kinds which should be planted rather more deeply than *L. candidum*, which forms no roots on the stem above the bulb.

Groups of bearded iris with their rich colours make a good display during spring or early summer. They also should be planted now; they are great lime lovers, and should be planted with the upper half of the rhizome showing above the ground.

Roses generally receive the consideration of planters. Whether they are planted on the smallest or largest scale, no plants probably afford so much pleasure for the cost incurred. They are best selected now while the mature plants are in blossom so that the colours and habit may be definitely ascertained, as it is not possible to plant effectively without that knowledge. Also for a permanent crop such as this, the land should be trenched and thoroughly prepared, so that a commencement with this work may be made at any time now in readiness for planting during the month of May.

As a guide to selection the following result of a plebiscite taken recently in Melbourne is of assistance. The voting gave the twelve best roses as Lorraine Lee, pink and orange; Etoile de Hollande, dark red; Shot Silk, cerise and orange; Chateau de Clos Vougeot, scarlet; Golden Emblem, pure yellow; Ophelia, salmon flesh; Sunny South, pink flushed carmine; Dame Edith Helen, fragrant pink; Madam Abel Chatenay, carmine rose shaded salmon; Mrs. Herbert Stevens, white; Mrs. Bryce Allen, carmine rose, fragrant; Madame Butterfly, pink shaded yellow, fragrant. These are all excellent varieties, but might very well include more yellows such as Rev. F. Page Roberts, Lady Hillingdon, and Angele Pernet.

The list of best climbing roses included Black Boy, crimson scarlet; Miss Marion Manifold, crimson; Paul's Scarlet; Climbing Lady Hillingdon, and Climbing Ophelia.

Roses are often planted widely spaced in the mixed border; this method is not effective in appearance, neither does it provide the right conditions for good growth unless the plants are of exceptional vigour such as Hugh Dickson or Frau Karl Druschski. A better practice has been to plant in well-prepared beds, but one variety in each; this is rather a limiting factor unless the rose-garden is very large. In many instances it would be best to plant groups, each of one variety, in harmonizing colours in each bed, taking care to plant the dwarfer kinds in front of the more vigorous varieties planted in the centre, setting them respectively about 2 ft. and 4 ft. apart. Beds about 6 ft. wide are most suitable; it is not generally advisable to make them wider.

—*W. C. Hyde, Horticulturist, Wellington.*

WEATHER RECORDS: DECEMBER, 1933.

Dominion Meteorological Office.

NOTES FOR DECEMBER.

THE first half of December was very dry and warm, many parts of the country having no rain at all. In Marlborough, especially, and to only a slightly less extent in Nelson, the situation prior to the 17th was very serious, and although some good rains fell thereafter, they were too late to save large areas of crops. Pastures are generally in the dry condition usual about a month later in the summer.

Rainfall.—There were some heavy falls in eastern districts of the North Island on the 1st, but otherwise it was extremely dry until the 16th. From then onwards stormy and wet weather prevailed, and the situation was considerably improved. Over most of the North Island, however, the total rain for the month was much below average. There were some exceptions in South Taranaki, Hawke's Bay, and East Cape districts. In the South Island there was still a deficit at the end of the month in northern Nelson and Marlborough and in southern coastal districts. In Canterbury, Westland, and much of the interior of Otago, on the other hand, the normal was exceeded, and the soil is in a satisfactory condition.

Temperatures.—Owing to the high temperatures of the first half of the month, the cold weather of the last seven or eight days was not sufficient to lower the average below the normal for December. Though the mean temperature was everywhere above normal, it was in the interior and in Westland that the warmth was especially marked. Some frosts occurred during the last week, especially in the interior of the South Island.

Sunshine.—Except at scattered places in eastern districts, sunshine was generally considerably above the average. Nelson had 320·3 hours, Blenheim 304·7, and Lake Tekapo 296·0 hours.

Storm Systems.—The month opened with high pressure over New Zealand, but a series of small cyclones passing to the east of the Dominion on a south-easterly course was responsible for the prevalence of southerly winds and cool temperatures during the first day or two. Between the 5th and the 7th a shallow westerly depression passed, but produced very little rain. Following another spell of high pressure, there was a second shallow depression on the 10th, but again scarcely any rain resulted.

The third depression, however, which dominated the weather between the 15th and 18th, was much more vigorous. It produced practically general rains with many heavy falls, and marked the end of the drought.

The next storm was experienced between the 21st and 24th. It became very deep after crossing New Zealand, and was followed by strong southerlies which were responsible for a cold Christmas, conditions in the South Island being almost wintry; rain was widespread and hailstorms did some damage, especially in the South Island. Heavy snowfalls occurred on the mountains. Banks Peninsula received a white coating, and even in Christchurch there were some snow showers.

The fifth and last storm raged from the 27th to the 30th. It, again, became very deep after passing to the eastward, and the southerlies which resulted far surpassed those of its predecessor in severity. The gale commenced in the south on the 28th and did not die out over the North Island until the night of the 30th. In many places it rose to a whole gale, being one of the worst southerlies experienced for many years. Once more there were heavy snowfalls down to low levels on the mountains and numerous hailstorms. Heavy rain fell at many places. Much damage was done to fruit and crops and vegetation generally by the cold, the hailstones, and the persistent gales.

RAINFALL FOR DECEMBER AND CALENDAR YEAR, 1933, AT REPRESENTATIVE STATIONS.

	December, 1933.				Calendar Year.	
	Total Fall.	Number of Wet Days.	Maximum Fall.	Average December Rainfall.	Total Rainfall.	Average Rainfall.
North Island.						
	Inches.		Inches.	Inches.	Inches.	Inches.
Kaitaia	1·25	7	0·55	2·61	44·31	54·31
Russell	1·31	6	1·00	2·60	71·47	49·94
Whangarei	1·51	6	0·47	2·98	57·94	60·51
Auckland	2·15	6	0·98	2·91	42·49	44·87
Hamilton	2·31	8	0·73	3·55	44·91	49·54
Rotorua	1·30	8	0·66	3·76	50·83	54·98
Kawhia	3·97	8	1·10	3·34	53·53	53·72
New Plymouth	4·12	11	1·61	4·28	51·64	59·80
Riversdale, Inglewood	5·98	12	2·28	7·57	87·10	104·17
Whangamomona	3·24	8	0·61	5·72	67·90	77·55
Hawera	3·46	9	0·87	3·37	43·06	45·21
Tairua	1·48	7	0·75	4·34	69·78	64·44
Tauranga	1·74	7	1·04	3·62	49·85	52·37
Maraehako Station, Opotiki	2·96	7	1·36	2·91	63·31	53·37
Gisborne	2·01	7	1·30	2·31	43·33	45·13
Taupo	1·77	9	0·78	3·17	32·52	43·87
Napier	3·43	7	1·82	2·31	29·34	35·02
Hastings	1·80	7	0·74	1·93	27·36	31·86
Whakarara Station	1·96	7	0·85	..	..	..
Taihape	2·95	9	0·70	3·30	35·63	36·93
Masterton	1·11	10	0·26	2·89	31·07	38·54
Patea	3·96	10	0·84	3·59	48·36	44·81
Wanganui	1·35	6	0·52	2·70	36·62	36·11
Foxton	1·35	6	0·52	2·67	29·35	32·51
Wellington	0·89	9	0·34	2·84	38·62	41·08
South Island.						
Westport	10·11	12	3·74	8·45	96·62	96·80
Greymouth	14·06	14	4·22	8·72	103·10	101·55
Hokitika	11·08	15	2·39	10·44	124·42	115·24
Ross	17·74	14	3·77	11·99	157·50	135·49
Arthur's Pass	21·87	11	..	14·34	181·09	161·91
Okuru, South Westland	..	..	..	11·14	..	144·47
Collingwood	6·15	12	2·84	8·21	83·53	95·74
Nelson	2·42	6	1·22	2·98	32·38	37·84
Spring Creek, Blenheim	0·93	7	0·34	2·14	19·60	30·28
Hanmer Springs	4·12	11	1·31	3·94	32·21	45·30
Highfield, Waiau	2·59	8	0·87	2·67	22·28	33·28
Gore Bay	3·28	8	1·70	2·66	24·23	31·27
Christchurch	2·96	12	0·82	2·15	18·85	24·99
Timaru	3·31	10	1·77	2·43	20·00	22·64
Lambrook Station, Fairlie	2·43	7	1·19	2·54	23·83	24·87
Benmore Station, Clearburn	2·76	9	1·14	2·31	24·86	24·64
Oamaru	2·32	12	0·87	2·24	21·36	22·01
Queenstown	3·37	10	1·32	2·53	31·50	30·46
Clyde	1·56	7	0·43	1·79	16·91	15·22
Dunedin	1·86	17	0·38	3·54	34·85	36·77
Wendon	3·66	9	0·95	2·78	32·11	29·96
Gore	..	..	..	3·29	..	34·34
Invercargill	3·30	15	0·83	4·07	48·95	45·75
Puysegur Point	3·93	16	0·74	7·14	76·70	85·26
Half-moon Bay	3·53	13	0·84	5·01	60·08	58·79

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

TREATMENT FOR DISTEMPER IN DOG.

W. S. S., Masterton :—

About five weeks ago a sheep-dog, aged seven years, fell sick with a sort of pneumonia, discharge of yellowish matter at nostrils, and severe stomach pains. I managed to nurse him through (whatever the illness was), and have been giving him cod-liver oil, but he has developed a " chattering of the jaws " when he is asleep as well as awake. He is working all right, but does not seem able to shake off this snapping of the teeth. Could you give me a remedy ?

The Live-stock Division :—

Your sheep-dog has been affected with distemper. A sequel to distemper is what is known as chorea, the nervous symptoms of which are characterized by twitching of certain muscles or groups of muscles. In this case the muscles of the jaws are affected and this accounts for the " chattering " movements described in your letter. Chorea in dogs does not rapidly respond to treatment. It is advisable not to overwork the dog, to give as much rest as possible, and to provide a dark quiet sleeping-kennel. In addition, the following mixture may be given in doses of one tablespoonful every night for a few weeks. After using one bottle of medicine an interval of a week is advisable before repeating the mixture. The mixture is prepared by adding two drachms of iodide of potassium and two drachms of sodium bromide to an 8 oz. bottle of distilled water. This medicine may be obtained from any chemist. A gradual improvement should be anticipated rather than an immediate cure.

GOOSE-GRASS IN YOUNG PASTURE.

G. M., Willowbridge :—

In the spring of last year I sowed three bushels of Hawke's Bay certified mother seed with an oat crop. There is a large amount of goose-grass showing since the ryegrass has come out in ear. How can I eradicate the goose-grass ? Would you advise me to cut it before the seed ripens ?

The Fields Division :—

In cases in which farmers have reported the presence of goose-grass early, and have taken the advice to graze for the first season instead of endeavouring to save a seed crop, the results have been quite good, and the goose-grass was prevented from running to seed and the next season the crops were almost pure rye-grass. Goose-grass seed can be dressed out of rye-grass and for that reason you may harvest the crop. Some goose-grass seed may fall, but if you keep the field grazed next season you will find very little goose-grass will be in evidence in the future in your pasture.

DIETETIC TROUBLE IN PIGS.

J. H. A., Mangatoki :—

I am having trouble with some of my pigs. They appear to be unsteady on their feet, and sometimes go down as though they had a big weight on their back, frequently kneeling on the ground. Their food consists of grass, whey, and a little meat-meal. Advice would be appreciated. Note.—The boar was the same when he was young. Would that have anything to do with it ?

The Livestock Division :—

Your pigs are apparently affected with a form of rickets bordering on paralysis. Young pigs require more minerals and more protein in their diet than older pigs. It is advisable, therefore, to increase the ration of meat-meal per head daily, and it is also necessary to see that the pigs have a run on green pasture. In all probability the boar was affected in the same way when younger. The condition is a dietetic one, an improved food-supply bringing about recovery.