

University of Arizona
Agricultural Experiment Station*

FIFTEENTH ANNUAL REPORT.

For the Year Ending June 30, 1904.
(With subsequent items)

Consisting of the Reports of the Departments of

Administration,
Agriculture and Horticulture,
Animal Husbandry,
Botany a n d
Chemistry*

Tucson, Arizona, December 31, 1904*

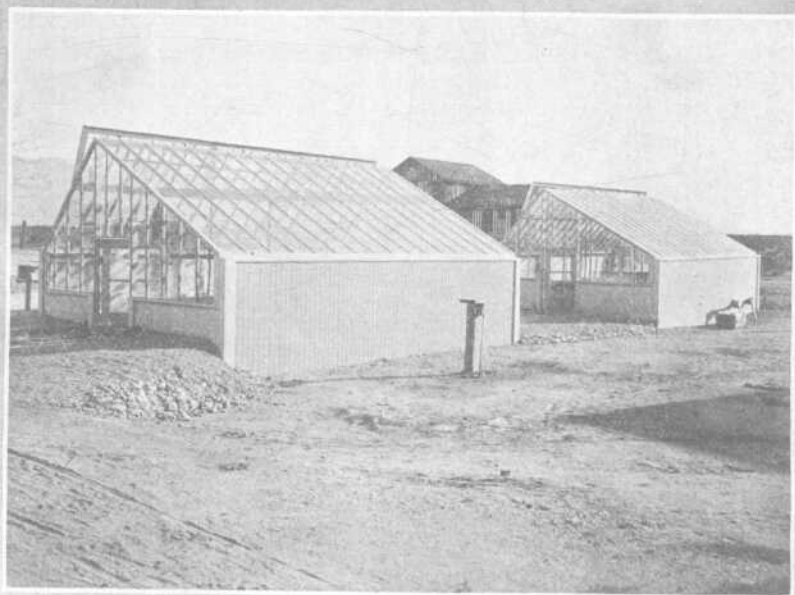
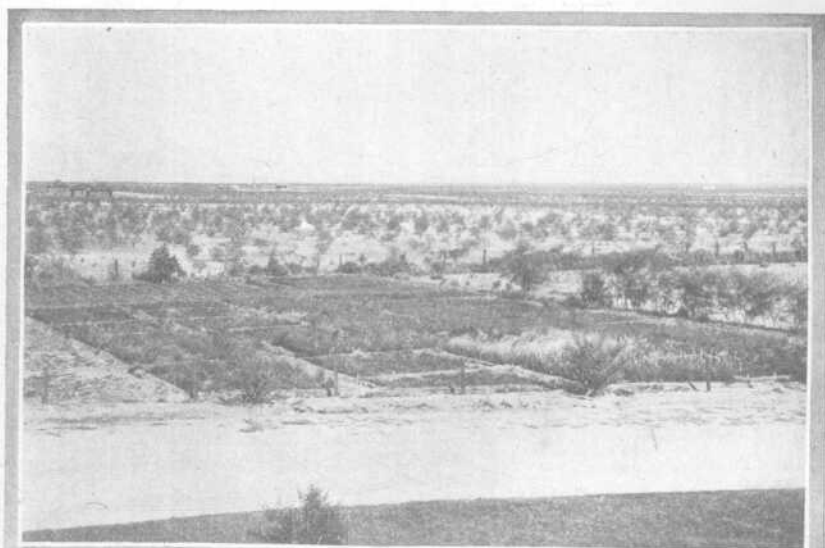
LETTER OF TRANSMITTAL.

To His Excellency, Alexander O. Brodie, Governor of Arizona:

SIR : In accordance with the Congressional act of March 2, 1887, I submit herewith, the Fifteenth Annual Report of the Arizona Agricultural Experiment Station, for the fiscal year ending June 30, 1904.

Very respectfully,

R. H. FORBES,
Director.



New duplicate greenhouses and grass garden, University grounds,
Tucson, Arizona.

FIFTEENTH ANNUAL REPORT,

ADMINISTRATIVE.

The work of the Arizona Station for the year ending June 30th, 1904, has been characterized, for the most part, by quiet and substantial progress along well established lines of inquiry.

The Department of Agriculture and Horticulture, through Professor McClatchie, has, to some extent, completed the general studies in progress for years past, and the results are now available in an unusually comprehensive and valuable publication on "Relation of Weather to Crops," the only thing of its kind treating, in so complete a way, the farm interests of the Southwest.

In continuing with these investigations it is intended in future to intensify within the broad outlines laid down by Professor McClatchie, by more particular study of those varieties of crop plants and trees adapted to the peculiar conditions of this region. This naturally implies advances in plant breeding to such an extent as equipment and facilities may permit. Enough is known of the widely varying degrees of endurance of different varieties of some species of crop plants under our severe conditions, to indicate the necessity for extensive work in selection and development of the most resistant and productive kinds.

The Department of Animal Husbandry has continued with the feeding experiments on steers which were initiated by Professor True four years ago, with a view to further confirmation of the somewhat unexpected results obtained formerly. Thus far it appears, from an economic point of view, that there is no advantage to feeders in securing the balanced rations, made up of forages containing the proper proportions of carbohydrates and proteids, which are in vogue in localities where proteids are costly and carbohydrates are cheap. In the Southwest, because

of the luxuriant growth of alfalfa, these conditions are reversed, A publication by Professor True relating to these matters is immediately forthcoming, and will embody the results of some four years work along these lines.

The Department of Botany, in charge of Professor Thornber, has pursued established lines of work in the study of range grasses and forages, and in working up miscellaneous subjects relating to economic plants of this region. In particular, a special development for the year has been the study of the utilization of native cacti for forage by singeing and thus making them available to cattle in times of drouth when other forages fail.

Two new greenhouses, duplicates in construction, and arranged so that conditions of plant growth within them may be varied for experimental purposes, were added to the botanical equipment during the year, and afford desirable facilities for studies of the influence of different conditions of growth upon plants.

The Chemical Department, as is usual and inevitable, has devoted much time to routine work which the public demands, especially the examination of irrigating waters. Observations on the Colorado River for the year have been continued and brought nearly to completion, and a publication on the work is forthcoming. Research work has been undertaken in the study of the composition of the fruit of the date palm, and the succession of chemical changes occurring in the date during the ripening process. The economic object of this work is, the rationale of the ripening process being established, to put in practice such cultural methods for the date palm and such methods of handling the ripening fruit, especially late varieties, as to secure the most desirable finished product.

Pumping investigations, conducted by Professor S. M. Woodward, have been brought to completion, and the results published in a bulletin on the cost of pumping for irrigation in this region. This is an exceedingly valuable piece of work, and should prove influential in hitherto undeveloped districts where ground water is within economic pumping distance of the surface.

UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION

TIMELY HINTS FOR FARMERS. No. 54.

JANUARY 30, 1905

PEAR CULTURE.

No fruit is more easily grown in Arizona than the pear. The tree is little affected by the heat of the region, and the blossoms are seldom injured by frost; it is free from diseases or insect pests, bears more regularly than any other fruit, ripens good fruit through a longer season, and is longer-lived than any other. The shipping of this fruit may never become especially profitable; but for the local market, and for home use it is the fruit of the region. When its value as food, whether eaten raw, stewed or baked, is fully appreciated, the trees will be set more extensively, and the fruit will be used more freely. The fact that the different varieties furnish good fresh fruit from early August to the end of January makes the pear especially adapted to family use.

The principal defect that the pear has in this region is the development of hard "knots" that are embedded in the flesh and become more pronounced as the fruit matures. The different varieties vary in the extent to which they are subject to this fault, some being rendered nearly or quite worthless by their presence, while a large number are free from them.

As most pears become thoroughly mellow only after being removed from the trees, some difficulty is experienced in getting them into a marketable condition without letting them decay. The weather is so warm during much of the pear season that all of the injured fruit de-

cays very rapidly. If, however, care be taken not to pick the fruit until it is thoroughly mature, and to handle it very carefully, much difficulty may be avoided. Varieties differ very much in the length of time required for mellowing after being picked, and in the perishableness of the fruit, some quickly becoming ready for eating, with little loss, and others mellowing so slowly that a large percentage decays before they become palatable.

In considering the merits of varieties of pears that a grower contemplates setting, several factors need to be taken into consideration in this region—productiveness, regularity of bearing, time of ripening, freedom from "knots," perishableness, and quality of fruit. If the pears are to be grown for market, external appearance must also be given due weight. Some varieties bear well, but the fruit is unfit for food, while other varieties produce good fruit, but in too small quantities.

In southern Arizona pear trees do best when set during February; and in other parts of the Territory, they should be set later. In so dry a climate the stems are apt to dry out and start slowly if set out too early, thus being exposed to the atmosphere before the season of rapid growth begins. When set, the stems should be cut to a stub twelve to fifteen inches high, the roots thoroughly pruned and the young tree set in the soil with the roots as near as possible the same distance below the surface as they were in the nursery. They should be irrigated soon after setting and given water frequently enough during the summer to keep them growing thriftily. In fact there is little danger of irrigating them too much the first season.

The second season the young trees should be pruned to three prong-like shoots that should come off from the stub the first summer. These first limbs should be left only twelve to fifteen inches long. Frequent irrigation is still necessary in order to secure good growth, but less frequent application of water is needed than the first season. After the second season the trees need less and less water during the summer.

In southern Arizona pears begin ripening in June. The first to mature its fruit at the Station Farm is the Madeline, but in this section the quality is hardly good enough to warrant setting it for family use, and it is too perishable for shipping far. A few other varieties ripen during June, but none can be especially recommended. No varieties tested at the Station Farm ripen during July, but during August a large number of varieties come to maturity. One of the first and best

is the old standard variety, Clapp's Favorite. It bears regularly and heavily, and the quality is good. It usually begins ripening about the middle of August and continues in season for a week or two. It ripens well but is liable to rot from the core outwards. Another good variety ripening about the same time is the Flemish Beauty, but its merits are apparent only after the fruit has been off the tree some time. One of the best pears that ripens during the latter part of August is the Howell, but for market purposes the Le Conte is best. Its season is from the latter part of August to the middle of September. It is smooth, free from "knots," and mellows well off the tree. The flesh is somewhat coarse, but the quality is quite good. The tree is very vigorous and prolific, the foliage being heavy and of a deep green color.

The Anjou follows the Le Conte, its season being from the early part of September to about the twentieth. It is somewhat subject to "knots," but on the whole the quality is good, the flesh being fine grained and juicy.

The Seckel ripens during the latter part of September, and is one of the most desirable varieties for home use. It is most too small for market, but the flavor is so exquisite that it is highly prized.

During the early part of October the well-known Bartlett begins to ripen, and will supply the table for several weeks. It is somewhat subject to "knots" in southern Arizona, but is such an excellent variety that it will naturally have a place in every orchard.

During the latter part of October the Beurre Bosc becomes mellow, if picked from the tree. This is a good-sized russet-colored pear of most excellent quality, one of the best of the autumn pears. The trees at the Station Farm are comparatively small, and have not yet borne heavily, but in other regions it is a very productive variety.

The Josephine and the Nouveau Poteau ripen during November, the former during the early part, and the latter mellowing so unevenly as to furnish fruit for dessert through the month. The Josephine is a very watery pear, while the Nouveau Poteau, before being cooked, is quite dry and mealy. Both are very sweet. The Nouveau Poteau is a most excellent pear for baking, becoming deliciously juicy under the influence of heat.

During December the popular variety, Winter Nelis, gradually mellows, furnishing fruit for the table throughout the month. It is one of the most desirable varieties for the orchard, bearing regularly, and producing fruit of the finest quality.

The Patrick Barry mellows during January, and may be kept

longer under favorable circumstances. The tree is very prolific, and the quality of the fruit is good.

The widely-cultivated Keiffer's Hybrid has not proven satisfactory in this region, producing heavy crops of fine looking fruit that never becomes edible.

ALFRED J. McCLATCHIE.

Farmers' Institute courses were conducted for three weeks of February, 1904, at Thatcher Academy. This effort excited some interest, but the full benefit of this line of endeavor can only be realized by putting it in the hands of a competent specialist who shall be charged with its proper organization. The institute appropriation of \$2,300.00 made by the Twenty-second Legislature will enable this to be done. When the value of these institutes is brought out and understood, they will prove to be an important extension of the benefits of the University in agricultural directions.

COOPERATIVE WORK.

As in past years cooperative work has been continued with the United States Department of Agriculture, and with the United States Geological Survey. Up to the present these partnership arrangements have afforded highly satisfactory results, although the correspondence incident to their management has cost much time.

The experience of the Arizona Station in its cooperative relations with the Department of Agriculture during the past six years has led to a clear perception not only of the benefits but of the possible disadvantages of cooperation, and to the adoption of a definite policy regarding it. In a general way it may be stated that when an opportunity presents itself for furthering experimental results through cooperation, the Station desires such an arrangement provided it is so situated as to afford a full half of the valuable considerations, in scholarship or material facilities, required to carry on the work, in the results of which, therefore, it justly participates on equal terms with the other party to the cooperation. A parasitic or merely nominal relation is by all means to be avoided for the reason that such a relation is damaging to the morale of the lesser party thereto. It is also to be observed that unnecessary cooperations are undesirable, that is to say; investigations which can just as well be arranged and carried through independently by an experiment station, should be so managed, thereby avoiding the complications and loss of time incidental to complex arrangements, and maintaining a desirable spirit of individuality and capacity for initiative in the Station.

THE TEMPE DATE ORCHARD.

This undertaking, in cooperation with the United States Department of Agriculture, has continued to prosper as in former years. Three additional shipments of sixty-two suckers in fifty-six varieties from the French Sahara and the Libyan Desert have been installed; and a net crop of some 300 pounds of fruit, chiefly Rhars, was harvested from the young trees established in 1900. The following summary, from data taken June, July and August, 1904, indicates the condition at that time of the various shipments received

	No of trees living.	No of varieties living	No of new suckers	No. trees blooming	Dead.
First importation, August, 1899					6
Second importation, July, 1900	278	19	678	144	127
Third importation, May, 1901	6	3	12		12
Fourth importation, October, 1901	23	6	67		12
Fifth importation, June, 1902	79	36			133
Sixth importation, May, 1904	41	39			
Seventh Importation, July, 1904	13	13			
Eighth importation, August, 1904	8	4			
Totals	448	105 net, not counting kinds twice received.	757	144	290

Comparing these figures with those for one year ago (see Fourteenth Annual Report) it is observed that from the first five importations thirteen weak trees perished; while the number of suckers in the importations of 1900 and 1901 increased from 495 to 757. The sixth and seventh importations from the French Sahara, May and July 1904, are in most excellent condition, and the eighth importation, from the Libyan Desert, August, 1904, is in fair condition.

The total number of varieties now installed is 105, nearly all of which are assured of survival.

Anticipating the early availability of funds from the \$11,000.00 appropriation made for the benefit of Experiment Station work by the Twenty-second Legislature, arrangements were made whereby ten additional acres of land were purchased for the orchard, two 12 inch tubular bored wells were put down, and plans for a pumping plant and workman's residence were drawn up. These improvements will be carried promptly to completion when the funds are finally deposited.

GRAZING RANGE WORK.

As heretofore, range study has been continued in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture. Experimental work in conservation of moisture and in grass planting has been continued on the small enclosed tract near Tucson; while certain ideas, particularly that of the homestead leasehold for grazing range areas, have been advocated in press articles and on various public occasions. The discussions thus brought forth indicate a considerable following for this idea which is, briefly, that stockmen, in purely grazing regions, should be allowed to lease for long terms sufficient territory to afford them a living, thereby creating an incentive to improve their holdings.

It is objected by some that long tenure leases will close those public lands now thought to be purely grazing lands to future agricultural development—that such development is now occurring in sections formerly thought to be unreclaimable, and is likely to continue indefinitely and to an unexpected extent. It may be stated, however, that there is probably no more reason why grazing leaseholds should stand in the way of the agricultural homesteader, than that they should stand in the way of the prospecting miner. The right of way and the opportunity to make good are just as possible to agriculturists, apparently, as to miners in a parallel situation under the well-tried mining laws of our Western country. With suitable provision, as in Australia, for allowing the grazing leaseholder homestead rights on his leasehold, no

hardship is implied; but an easy transition from grazing to agricultural pursuits in regions capable of higher development.

Again to recur to the subject of permits, it is thought by some that the solution of the range question lies in the extension of the permit system—that all public lands should be apportioned to grazing interests by permit until taken up by homestead. This idea is at least debatable. In the first place, to carry it out on the enormous grazing domains of the West implies the creation of a numerous official body over whose work it would be impossible, in the nature of the case, to exercise close control. The permit system, moreover, giving stockmen tenure of their range from year to year only, puts the industry on a less permanent basis even than under the free range regime, and in addition adds a tax to the already severe conditions under which, in this day of decline, stockmen are laboring.

In this connection, the stockman no more than the farmer wishes to be officially regulated in the technical management of his business. Give him his territory, define his rights, make scientific knowledge and advice available to him just as is now done for the farmer; *but* give him the *management* of his own business. With an enlightened self-interest to guide him, under a reasonable system of tenure, the stockman will work out his own salvation and that of the country he must live on, better in the long run, than though he were closely regulated by a governmental bureau.

Still again, answering those who imagine that the interests of the farmer are jeopardized by those of the grazing-leaseholder, attention may be called to opposing facts. For instance, the irrigation farmer is vitally interested in the condition of his watershed. A bare watershed, whether grassy or forested originally, means more violent floods, severer drouths, and muddier irrigating water entailing increased cost to maintain ditch systems. An improved condition of grassy watersheds, therefore, which probably constitute four-fifths of the watersheds of the West, confers a great and direct benefit upon irrigation farmers, and this improvement will probably be brought about by proper protection of the stockman upon his grazing range.

As to the feasibility of range improvement, there is already excellent evidence in the results obtained on the large range reserve south of Tucson, Arizona. This reserve, containing 49 square miles of diversified lands, was in an overgrazed and barren condition when fences were built less than two years ago. Protection from the ravages of cattle, horses and sheep for this time has resulted in a remarkable restoration of forage grasses; and, viewed from the tops of neighboring mountains, the fenced area is in a manifestly improved condition.

There can be little doubt, therefore, that the scientific and economic basis on which range administration must rest is sound. It only remains to put in operation a suitable system of ten ure whereby the natural wealth of our grazing regions may be made available to our people.

PUBLICATIONS.

The following titles were issued during the year ending June 30th, 1904:

Bulletin 46, October 12, 1903. The Underground Waters of Arizona—their Character and Uses.—By W. W. Skinner.

Bulletin 47, November 28, 1903. Timely Hints for Farmers, collected, edited and illustrated edition for 1902-1903 —By the Station Staff,

Fourteenth Annual Report, December 30, 1903 —By the Station Staff,

Bulletin 48, June 10, 1904. Relation of Weather to Crops. —By A. J. McClatchie.

Timely Hints for Farmers:

No. 48, October 1, 1903. Bee Products in Arizona.—By E. H. Forbes.

No. 49, October 15, 1903. Sugar Beet Culture — ~~By~~ A. J. McClatchie.

No. 50, December 16, 1903, Some Practical Suggestions Concerning Seed Germination —By J. J. Thornber.

No. 51, January 25, 1904. Potato Culture.—By A. J. McClatchie.

No. 52, May 4, 1904. Singed Cacti as Forage.—By J. J. Thornber.

The mailing list, not including official names, has increased to about 4,900. Of these 3,156 are in Arizona and 3,737 in the southwestern states including Arizona. This represents the class of people, for the most part actively engaged in farming,

who make use of the results of our work. Names in other states and foreign countries number 1,168 and frequently represent those who are investigating the resources of Arizona with reference to location here. A supplementary list of 1,547 southwestern stockmen has also been made up for use with publications especially relating to their interests.

Correspondence requires much time for answering, the Station serving, in fact, as a kind of correspondence school for a considerable number of those in need of information.

FINANCES.

The income of the Station for the year ending June 30th, 1904 was:

Balance from 1902-1903.....	\$ 262.66
Receipts from the Treasurer of the United States.....	15,000.00
Receipts from the Territorial Fund.....	313.39
Farm sales, live stock and milk.....	446.83
Farm sales, fruit and plants.....	84.50
Greenhouse sales.....	8.30
Miscellaneous fees, receipts, etc.....	128.67
Overdraft.....	119.40
Total.....	\$16,363.75

Although the above income has been fairly adequate to the support of existing lines of work, the delay incident to the sale of the \$11,000.00 bond issue has held back the improvements planned for the Station Farm and the Cooperative Date Orchard* For the continuation of irrigation investigations the sum of \$3,000 for the next two years is desired; for publications \$1,500; and for the extension of Station investigations in other parts of the Territory \$1,800,—all of which will greatly amplify and strengthen the existing organization.

The following statement of expenditures shows that \$7,391.04, or nearly half of the income, has been expended in connection with the Station Farm; \$726.64 upon the Date Orchard; and \$8,246.07 for the maintenance of scientific laboratories and office.

R. H. FORBES,
Director.

EXPENDITURES BY SCHEDULES AND DEPARTMENTS FOR THE YEAR ENDING JUNE 30, 1904.

	Administrative.	Agriculture and Horticulture.	Animal Husbandry.	General Farm Expenses.	Botany.	Chemistry.	Entomology and Meteorology.	Date Palm Orchard.	Miscellaneous.	Totals.
Salaries	1388.20	1889.70	1500.00		1043.04	1989.92	50.00	2.50		7873.86
Labor	158.58	1375.38	1086.70		895.60	198.29	28.45	169.66	3.25	3913.91
Publications										
Postage and stationery	133.37	17.17	12.35	21.00	5.58	25.04	.11	22.40		237.02
Freight and express	67.32	45.60	7.75		81.11	25.47		1.15		228.40
Heat, light and water			1.50		49.33	57.00				107.83
Chemical supplies	1.50	5.10	7.80		11.40	26.30				52.10
Seeds, plants and sundries	19.12	142.05	25.25	467.50	29.85			8.75		225.02
Fertilizers								4.27		471.77
Feeding stuffs		64.25	128.74							192.99
Library	4.97					.15				5.12
Tools, implements and machinery	4.99	128.48	120.40		29.15	9.45		32.85	.20	387.68
Furniture and fixtures	58.37	1.65	7.15			11.60				79.27
Scientific apparatus	4.00	18.15	7.38		14.67	42.75		.15		97.20
Live stock			9.50							9.50
Traveling expenses	207.70	6.20	4.25	2.80	8.55	157.00		123.60		564.30
Contingent	38.57		2.25							40.82
Building and repairs			34.91		419.03	5.80		29.27		513.71
Publications	228.37	24.70	69.27		64.43	254.80		14.60		747.92
Publications		116.35						302.44		302.44
Office work	266.09									266.09
Date orchard, labor	1.60	8.20	7.50	15.00				15.00		313.39
Telephone service				506.30				726.64		1,050.36
Total cost of departments	2583.25	3842.98	3011.76	506.30	2751.74	2314.27	171.21	726.64	25.60	16,363.75

\$16,000.00 U. S. Appropriation.

Sales Fund.
Territorial Fund.

DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

The work of the year has been largely a continuation and partially a consummation of that of previous years. The field work has been very much curtailed by a lack of irrigating water. The shortage from September to the end of the year prevented the growing of many annual crops, practically all of the available supply being needed to keep alive the perennials already growing upon the Farm, and a few others set during the year.

EFFECT OF WEATHER ON CROPS.

The study of the effect of the weather upon crops has been continued throughout the year, and a bulletin prepared entitled "Relation of Weather to Crops" giving the results of the previous years' observations along this line. The collation of the data and the preparation of the manuscript for this bulletin occupied most of the time of the writer during a large part of the year. The publication is virtually a consummation of the observations made upon the behavior of the various crops under local climatic conditions during the past six years. Since the Issuing of the bulletin the records along several lines are being continued, and will furnish comparative data for future reference.

STRAWBERRIES.

A large part of the time during autumn and early winter was devoted to experiments in growing strawberries. Not being willing to accept the discouraging results of previous years as conclusive, former experiments were repeated and new ones made, various cultural methods being tried. A machine was devised for making furrows with small Intervening ridges for receiving the plants, and various varieties thus tested by a method entirely new to the region* Not only were test plots of all promising

varieties set upon the Station Farm, but plants were set upon a large scale upon land being cultivated privately by the writer.

On account of previous failures, special precautions were taken at every step in the work, but the season proved to be a more unfavorable one than that of any previous year during which berries have been grown in the Valley. Fall-set plants nearly all succumbed before spring, and winter-set ones died during the past summer. During the summer of 1903, the most trying weather was during August, while during the summer of 1904, the especially trying weather was previous to August, the weather of the latter month being comparatively favorable for plant growth.

It seems evident that until the climatic conditions of the region change, strawberries cannot be grown successfully in the vicinity of the Station Farm. With a return of less arid seasons and with an improved water supply, it is probable that this fruit may, in future years, be grown as profitably as it was a few years ago, for it does not seem reasonable that conditions have so changed permanently that what was once grown successfully in the Valley cannot again be grown.

PEARS.

Especial attention has been given to the different varieties of pears in the Station orchard. Their adaptability to our climatic conditions, their regularity of bearing, their productiveness, and their longevity have been studied. The suitability of the different varieties of fruit for market and for home use, have also been considered. Particular attention has been given to the culinary properties of the various varieties, both raw and when stewed or baked. Material has thus been collected for a brief bulletin that is being prepared upon the subject, and is to be issued soon.

DATES

The date trees, both young and old, upon the Station Farm have received much attention during the year, the younger ones becoming more and more interesting as they develop. Three of the old Egyptian date trees bloomed the past spring, and are well loaded with fruit. Several five-year-old seedlings bloomed, only one of which proved to be a female. Three varieties of four year

old Algerian dates fruited the past summer, Rhars, Deglet Noor, and Itima. Six three-year-old trees in the young seedling orchard bloomed, three of which proved to be females. This orchard has received especial care, vacancies having been filled and extra plants removed, thus leaving the rows ten feet apart in each direction. It has become evident that if plants one to three years old are moved with sufficient earth, they grow well when transplanted at any time during the warm weather of late spring and summer.

MISCELLANEOUS

Experiments were made in growing vegetables upon the small ridges made with the machine devised for the strawberry experiments, and excellent results obtained. Instead of sowing the seed upon the side of a furrow, it could thus be sown in the center of the narrow ridges that received water from both sides. A good stand of plants was thus easily secured.

A young orchard consisting of peaches, plums, apricots and apples, twenty-four trees of each variety, was set during the winter, and the most of the trees made a good start. By keeping them well wrapped with paper, they were protected from sunscald and from borers.

Berseem was sown both during fall and during spring, but the results indicate that the plant is entirely unsuited to the region, since it endures neither the frosts of winter nor the dry heat of spring and summer.

A. J. McCLATCHIE,
Agriculturist and Horticulturist.

DEPARTMENT OF ANIMAL HUSBANDRY.

The main object in view in this year's work has been to add to our information regarding that combination of forages, and the method of feeding them, yielding the best results under the peculiar conditions obtaining in this region.

STEER FEEDING.

The work in steer feeding for the year consisted chiefly of two sets of comparative tests, (1) a comparison of soiling with the ordinary pasturage methods of feeding alfalfa to steers intended, chiefly, for the California market; and (2) a continuation of the comparison of straight alfalfa, and combined alfalfa and carbohydrate rations, under the conditions existing in this region. The animals used in making these tests were twelve range yearlings, grade Shorthorns and Herefords of fair quality, from northern Arizona ranges. Before beginning the tests of feeding methods, described in detail below, these twelve steers were run in one bunch upon alfalfa pasture to put them in good uniform condition and were finally divided into three lots of four each, as nearly alike as possible in weight and feeding qualities.

SOILING STEERS.

The period during which soiling was compared with regular pasturage extended over portions of the time from August 3, 1903, to June 20, 1904. During the winter, when the alfalfa ceased to grow, the soiling lot was carried over with hay, green alfalfa being resumed with the renewal of the crop in spring. The pasturage lot was allowed to run during this whole period of nearly eleven months on a sufficiency of pasturage which however, was necessarily very meagre during December and January, being supplemented at that time with a little foxtail hay.

The results can be summarized to advantage by dividing the total time of the experiment into three periods, the first embracing

the time of late summer and fall pasturage, the second the period of close winter pasturage and pickings, the third the time of fresh strong spring and early summer pasture.

TABLE I—SUMMARY OF COMPARATIVE RESULTS WITH PASTURAGE AND SOILING LOTS OF FOUR STEERS EACH.

<i>Date of period</i>	<i>Steers used.</i>	<i>Weights at be ginning.</i>	<i>Materials fed.</i>	<i>Weights at end. Gain.</i>
Aug. 3, 1903 to Oct. 26, 1903	Lot 3 on pasture	2215	Fresh alfalfa pasture, good to poor	2700 545
	Lot 2 on soiling	2170	Alfalfa hay, 4798 lb.; alfalfa soiling, 6717 lb.	2400 230
Oct. 27, 1903 to Feb. 1, 1904	Lot 3 on pasture	2760	Dry winter pasture and fox- tail pickings	2790 30
	Lot 2 on soiling	2400	Alfalfa hay, 8227 lb.	2745 345
Feb. 2, 1904 to June 20, 1904	Lot 3 on pasture	2790	Excellent fresh alfalfa pas- ture	3050 1190
	Lot 2 on soiling	2745	Alfalfa hay, 3477 lb.; alfalfa soiling, 27,090 lb.	3350 605

Total gains of Lot 3 on alfalfa pasture, 1765 pounds.

Total gains of Lot 2 on alfalfa soiling and hay, 1180 pounds.

The gains made by Lot 3 fed on pasture only during the whole experimental period are conspicuously greater than those made by Lot 2 fed by soiling alfalfa and feeding hay. This difference is especially noteworthy when it is considered that during the second or winter period, Lot 2 was carried on alfalfa hay with moderate gains, while Lot 3 was subsisting without material gain on what they could pick up from bare pasture.

Although at first glance this result is adverse to the practice of soiling under our conditions, this is probably not entirely the case. It must be remembered that range cattle are not at ease in a feeding enclosure such as must be used in soiling, being favored by the comparative freedom of open pasture.

The real merits of soiling can only be tested by using tame, valley bred steers, taking kindly to confinement. With such

animals only will it be possible to ascertain whether the additional cost of handling green feed will be compensated by increased beef-production from a given area of growing alfalfa.

Of especial interest also, in this experiment is the fact that during the winter period Lot 2 required 8227 pounds or $4\frac{1}{8}$ tons of alfalfa hay to make a gain in live weight of 345 pounds. At an average price for hay during this time of eight dollars a ton, and for steers of four cents, this means that it cost \$33.00 worth of hay to produce \$13.80 worth of beef. It is evident that so far as these results can indicate, with anything like the present market conditions for beef and hay, the feeding of hay is a ruinous procedure so long as cattle can barely subsist on pickings during the time of short winter pasture. This is possible in the mild climate of the Southwest to an extent impossible in the colder regions of the north where hay is essential for carrying feeders through. It is also to be remembered that the culture of alfalfa irrigated with fertilizing river waters, improves rather than depletes the soil and the sale of hay from the land is not therefore an impoverishment.

COMPARISON OF ALFALFA STRAIGHT WITH MIXED RATIONS.

In view of the fact that other feeds than alfalfa are produced to advantage in Salt River Valley, notably sorghum, Egyptian corn, and small grain hay, a comparison was made between alfalfa and mixed rations during the period from August 3, 1903 to June 20, 1904. Table II summarizes the observations made during this time.

TABLE II—SUMMARY OF COMPARATIVE RESULTS WITH ALFALFA AND MIXED FEEDS ON TWO LOTS OF FOUR STEERS EACH.

<i>Date of Period.</i>	<i>Steers used.</i>	<i>Weight at beginning.</i>	<i>Materials fed.</i>	<i>Weight at end.</i>	<i>Gain.</i>
Aug. 3, 1903 to Oct. 26, 1903	Lot 1 on mixed rations	2195	Barley straw, 339 lb.; heads Egyptian corn, 150 lb.; Egyptian corn stalks, 610 lb.; Barley grain, 317 lb.; Wheat hay, 2,411 lb.; Alfalfa soiling, 4,265 lb.; Sorghum hay, 2,286 lb.	2425	230
	Lot 2 on alfalfa	2170	Alfalfa hay, 4,798 lb.; Alfalfa soiling, 6,717 lb.	2400	230
Oct. 27, 1903 to Mch. 14, 1904	Lot 1 on mixed rations	2425	Wheat hay, 5,997 lb.; Sorghum hay, 3,840 lb.; Alfalfa hay, 477 lb.; Barley grain, 20 lb.	2560	135
	Lot 2 on alfalfa	2400	Alfalfa hay, 11,449 lb.	2890	490
Feb. 2, 1904 to June 20, 1904	Lot 1 on mixed rations	2560	Egyptian corn, 85 lb.; Sorghum hay, 290 lb.; Soiling alfalfa, 25,487 lb.	3200	640
	Lot 2 on alfalfa	2890	Alfalfa hay, 255 lb.; Alfalfa soiling, 27,090 lb.	3350	460

Total gains of Lot 1 on mixed rations, Aug. 3, 1903, to March 14, 1904, 365 pounds.

Total gains of Lot 2 on alfalfa, Aug. 3, 1903, to March 14, 1904, 720 pounds.

The most marked feature of the above table is the fact that during the winter period Lot 2 on alfalfa hay made over three times the gain of Lot 1 on mixed feed. This is chiefly due to the evidently superior relish with which the animals consumed the alfalfa ration, the waste from the mixed rations, especially sorghum hay, being very great. When both lots were placed on soiling alfalfa during the last period of the experiment, Lot 1, previously on the less palatable rations, made rapid gains upon the more advanced batch of steers, but did not overhaul this latter batch in gains made, and in appearance during this period.

These facts indicate the superiority of alfalfa hay over the other hays known in this region.

As in Table I, however, it is shown that the cost of feeding alfalfa hay under present market conditions is ruinous, 490 pounds of gain worth at 4 cents, \$19.60, having been produced from $5\frac{3}{4}$ tons of hay worth \$46.00 at \$8.00 a ton.

COMPARISON OF METHODS OF PRESERVING MILK SAMPLES.

Comparisons were made of potassium bichromate and formalin as preservatives of milk samples for testing by the Babcock method.

These experiments covered a period of sixteen weeks commencing March 31, 1903, and extending well into the heat of the summer. It was with hope that formalin would prove a better preserving agent in that it would keep the milk in a more fluid state, and the reading of the percentages of fat in the test bottles would be clearer than when the bichromate was used. While the formalin proved an excellent preservative it was found in no way superior to the bichromate. In the average of sixteen weekly tests of six samples each, made where the preservatives were used under exactly the same conditions, there was an average difference of only .025 per cent, ranging from none to .3 difference in the fat readings. So far as the fluidity of the different samples was concerned the writer could see no difference in favor of either preservative, and both gave clear readings in the test bottles when the temperature at which the test was conducted, was not too high.

In conclusion it might be well to say that, as both preservatives render the samples more or less poisonous, the potassium bichromate is to be preferred as it colors the milk giving warning of its presence, and is also easily and accurately measured.

MISCELLANEOUS.

Economy in Alfalfa of Soiling Versus Pasturage.

Similar adjacent alfalfa fields having been chosen, one was pastured and the other fed by soiling. The average of the two soiling tests gave 50 pounds of green alfalfa to make one pound of gain in the four steers fed. In the pastured area an estimated

amount of 52 pounds of green alfalfa was required for one pound of gain. These tentative figures, obtained with range steers, could doubtless be improved upon with tame valley-bred animals.

The Dairy Herd.

As in former years the dairy herd records have been kept in detail. The performance of the whole herd—those four animals available for comparison, is about the same as last year, being 1,221 pounds of butter fat in 1903-1904 as against 1,252 pounds in 1902-1903.

Pasturing Sheep on Weedy Ground.

For the past year a flock of fifteen ewes has been pastured on weedy corners and ditch banks, being held to their ground by portable fencing. They were effective in clearing up weedy places and checking growth of vegetation along ditch banks, but with no profit from a feeders point of view.

T. F. McCONNELL,

Animal Husbandman.

DEPARTMENT OF BOTANY .

CONDITIONS UPON THE RANGE.

No cultural operations or seed-sowing have been done during the year on the small range enclosure in the vicinity of Wilmot, since it is desirable to get results from work already done, before more work is undertaken along the same lines. During three and one-half years protection from grazing animals, permanent improvement, i.e. the reclaiming of the mesas by perennial forage plants, has been very slow and discouraging. The rainfall on this enclosure for the year ending June 30, 1904, was 7.65 inches, of which amount 6.24 inches fell during the months of July, August and September 1903, leaving 1.41 inches for the remaining nine months. The above-noted timely and abundant summer rainfall promoted a fair growth of plants over the ranges, principally annuals, however, the growth on the lower areas where the storm-water collects after heavy showers being especially good. The few perennial grasses were limited to these latter situations, which is a fact worthy of note in range study. The very scant rainfall from October to June, 1904, already commented upon, was insufficient to maintain the winter-annual vegetation, growth of which began late in September, and hence there was no herbaceous growth upon the mesas during this period.

Of the twenty species of forage plants sown on the disced areas which were occasionally flooded by storm-water as a result of the dams, the following merit favorable mention: *Andropogon leucopogon*, *Bouteloua rothrockii*, and *Panicum texanum*. Good stands of *Andropogon leucopogon* were secured in every instance, and by late fall some of the larger plants were maturing seed. *Bouteloua rothrockii* made a more rapid growth, and matured a large amount of seed, but the species did not stand as heavy on the ground. *Panicum texanum* is a coarse, rapid-growing annual which matured at the rate of one and one-half to two tons of dried

forage an acre, three months from the time of sowing. Poor stands of *Bouteloua hirsuta*, *B. oligostachya*, *B. curtipendula*, *Pappophorum apertum*, and *Leptochloa dubia* were obtained; the plats of *Sporobolus wrightii*, *S. cryptandrus* and *S. cryptandrus flexuosa* showed a fine stand of small seedlings late in October, which died out during the prolonged drouth. No seedlings of *Epicampes ligulata* and but few of *Chaetochloa composita* were ever noted. The fair to excellent stands of the above mentioned species which were grown, under more favorable conditions, in the forage garden from the same lots of seed, are sufficient proof as to the quality of the seed. Moreover, the seed was sown two to four times as thick on the range as in the forage garden.

Numerous breaks or washouts caused by gopher holes have occurred in those storm-water embankments constructed to retain a maximum amount of water on a minimum area. No less than fifteen such breaks, ranging from two to twenty feet in extent, resulted during the past year. In some instances, dams twenty to twenty-four inches in height were washed out when the water against the embankment stood only twelve inches deep.

WORK IN THE FORAGE GARDEN.

Close attention has been given to the forage garden on account of its bearing on the range problem. It goes without saying that if a plant does not show up favorably in the forage garden with a limited amount of irrigation, it is useless to attempt to grow it upon the range without irrigation. Of the one hundred and fifty varieties of native and introduced plants tried, less than one-third of that number have made any showing. It is worthy of note that the native species have proved superior to the introduced ones in every case, the significance of which fact is apparent at once.

SINGED CACTUS AS A FORAGE.

A preliminary statement in the form of Timely Hint No. 52, which deals with this subject, was issued last May in advance of the completed work, it being warranted under the circumstances. It was shown that with a Beever and Hindes prickly pear burner 7,000 to 11,000 pounds of singed cactus forage could be prepared

daily at a cost of two dollars and forty cents, which represents the gasoline used. Determinations made in the Experiment Station chemical laboratory show seventy-five to eighty per cent water in this class of forage. The singed plants were immediately browsed closely by the half starved range cattle, the trunks and woody branches of the chollas alone remaining, while the prickly pears were eaten nearly to the level of the ground. Careful singeing was recommended in order to preserve this class of forage plants from extinction. It is believed that this experiment solves the problem of spineless cacti for this region, the introduction and growth of which had thus far proven unsuccessful.

SEED GERMINATION.

Timely Hint No. 50 entitled "Some Practical Suggestions Concerning Seed Germination" was published last December. It was shown that the extremely moisture-resistant seeds of many of our native species, as palo verde, acacias, mesquites and allied plants may be made to germinate immediately, if treated with water at 85-88 degrees C. (185-190 degrees F.) for two to six minutes, according to the degree of resistance shown by the seed coat. As would be expected, the same results were obtained by the slow and laborious method of scratching or nipping the seed-coat with a sharp knife, or abrading with a grindstone, since the principle in either case is essentially the same, namely; to render the more or less impervious seed-coat permeable to water, without injuring the enclosed plantlet. It was also demonstrated that seeds like the walnut, hackberry, soapberry, umbrella tree, date palm, grape and Virginia creeper, which on account of the covering are not affected by the treatment with hot water as described above, also such other seeds as the ash, box elder, and Chinese sumach which would be injured by the hot water, may be made to germinate readily and uniformly when planted in the spring, if stratified, i.e. buried in layers in moist sand in boxes or trenches during the winter months. In connection with seed germination it will be of scientific interest to note that seeds of *Acacia*, *Prosopis*, *Robinia*, *Gleditsia*, and *Gymnocladus* were made to germinate readily when immersed for a short time in concentrated sulphuric

acid in which a liberal amount of chromic acid had been dissolved, and then neutralized in a dilute solution of potassium hydrate, and washed in running water for twelve hours previous to planting.

MISCELLANEOUS.

Distribution of Eucalypts.

During the past spring this department distributed two thousand plants of *Eucalyptus rudis*, and *E. tereticornis* to interested planters in the Santa Cruz, upper Gila, Colorado and Salt River valleys. It is hoped by these means to demonstrate the practicability of planting Eucalypts in southern Arizona.

Failure of English Walnuts.

The possibility of growing English walnuts under conditions similar to those about Tucson, when grafted on stocks of the native species (*Juglans rupestris*) was suggested by the flourishing condition of similarly grafted trees growing in the Upper Gila valley at Safford. A trial was made with twelve trees representing several standard French and English varieties, under most favorable conditions on the University grounds, with the result that the trees were dead or dying from the extreme heat before the close of the summer months.

The White Grub.

Large white grubs, the larvæ of the goldsmith beetle, (*Cotalpa laningera*) have caused much trouble on the University grounds and about Tucson during the past summer. The roots of Bermuda grass and the fog-fruit were eaten off in small areas, resulting in the sudden appearance of dead patches in lawns. Likewise, seedling Eucalypts, rose-bushes, chrysanthemums, cannas, and various other cultivated ornamentals have suffered. Intermittent flooding of the infested areas for four days killed only ten per cent of the grubs, while flooding, followed by a heavy application of kerosene emulsion, in the proportion of one to twelve, resulted in partial success. Fumigation with carbon bisulphide, when sufficiently strong to destroy all the grubs, injured or killed Eucalypt seedlings growing in flats, while a strong tobacco decoction had no apparent effect upon the pests.

The Tomato blight, (Bacillus solanacearum).

The tomato blight, a bacterial disease, causing the wilting and yellowing of leaves, and later, the dying of plants, has been reported very destructive from widely separated agricultural regions of southern Arizona. In several patches about Tucson, which the writer had occasion to examine, less than five per cent of the stand remained. Preliminary spraying experiments with bordeaux mixture were begun last spring at two ranches along the Rillito, and will be continued next year on a larger scale.

J. J. THORNER,

Botanist.

DEPARTMENT OF CHEMISTRY.

The examination of daily samples of the waters of the Colorado River from February 13, 1903 to December 31, 1904, inclusive, has been nearly completed, and, upon the purely agricultural side the results will afford much light upon the question of maintenance of fertility in soils irrigated with these waters. Although this is the least remembered contingency relating to farming in this country at this time, looking to the future of the Colorado River lands, it may be stated to be worthy of careful consideration. Along the Nile, notwithstanding the rich sediments for which that river is famous, nitrogenous fertilization is a serious problem. It is there found necessary to include a leguminous crop in rotation, as will doubtless be found to be the case along the Colorado. Alfalfa, however, is already a staple crop in this region, although it cannot be grown upon overflowed ground.

SESBANIA.

In connection with the maintenance of fertility in the Colorado River region, *Sesban macrocarpa*, commonly known as wild hemp, is of unusual interest. This annual leguminous plant is described by various botanists as growing in wet or moist soil from Pennsylvania to Missouri and southward into Florida and Texas, thence extending into Arizona, Mexico, Central America and Panama. The conditions along the Colorado River seem unusually favorable to its development, so much so that great areas of overflowed lands are occupied by this plant to the exclusion of most other vegetation. Growth is begun in July after the subsidence of the great spring and early summer flood. The plants are confined quite sharply to areas which have been under water, and along ditch banks, forming deep and almost impenetrable thickets. In the delta, west of the river, in Lower California, these *Sesbania* jungles, as observed by the writer, may be found several miles across, and are an impressive and interesting phenomenon.



FIG. 1. Single plant of *Sesban macrocarpa*, at maturity, showing tall fibrous stalk and numerous seed pods.

Possible Uses.

The stalks of *Sesbania* contain a long and strong fiber, the manufacture of which has been attempted in a crude way, thus far without success. Experimentally it appears possible to prepare an excellent fiber, but as yet of unknown application in the arts. Practically the manufacture of this fiber failed because of crude methods and inadequate decorticating machinery.

For green manuring the plant offers considerable promise. Consistently with its leguminous character the roots were observed (July, 1904, and subsequently) to be excessively tuberculous, indicating the usual association of desirable nitrogen fixing germs with this species. The

green plants, even when so tall and strong that horses are with difficulty forced through them, are easily brought down with a disc harrow to a condition in which they may then be plowed under.

It was observed that the root system is shallow and spreading, the plant being chiefly found in moist soil with ground water near the surface. When cut the plant withers with excessive rapidity,

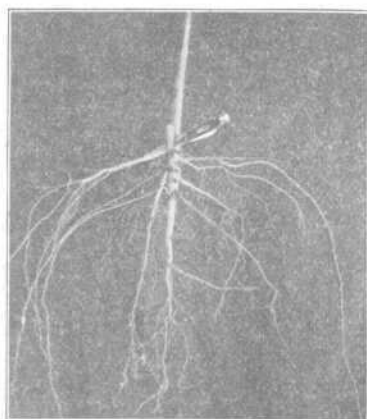


FIG. 2. Root system of *Sesban macrocarpa*, at maturity, showing numerous large tubercles.

in all these respects presenting characters which indicate that it requires an abundant and constant water supply. This may limit its introduction into other regions but indicates its peculiar fitness for the Colorado bottom lands.

These observations, published at this time largely because of the generous interest in the subject of Mr. D. G. Fairchild of the Department of Agriculture, indicate that *Sesbania* is worthy of further investigation with reference to its utilization here and elsewhere.

CACTI AS FORAGE.

Continuing with examinations of range forages, the following conventional analyses of various cacti are of interest in connection with the study of the utilization of these plants for stock, especially in time of shortage of other feeds:

Laboratory number.	Name.	Water in green material dried at 100° C.	Material air-dried at 100° C.					
			Water.	Ash.	Protein, N x 6.25.	Fiber.	Nitrogen-free extract.	Ether extract.
		%	%	%	%	%	%	
3255	Cholla, without fruit, <i>O. fulgida</i>	77.40	1.72	18.77	7.06	7.34	63.62	1.49
3256	Cholla, fruit, <i>O. fulgida</i>	78.90	2.59	12.24	6.50	14.20	58.95	5.52
3257	Tasajo, without fruit, <i>O. spinosior</i>	74.04	1.94	17.82	6.81	9.95	61.60	1.88
3259	Tasajo, fruit, <i>O. spinosior</i>	78.40	2.54	12.86	6.75	20.84	50.73	6.28
3258	Prickly pear, stems, <i>O. engelmannii</i>	76.40	3.42	17.71	3.75	11.11	62.35	1.66
3200	Sicilian spineless, stems, from Univ. grounds	88.00	2.30	23.75	7.75	11.49	52.60	2.11

The ash content of these cacti is very high, comparing with that of saltbushes grown in this region, and accounting for the purgative effect of this forage upon cattle. The proteids are distinctly less than in the saltbushes, but the carbohydrates, included in nitrogen free extract, are greater. Very interesting are the high percentages of ether extract, which includes fatty substances, found in the fruit of *O. fulgida* and *O. spinosior*. The prepared samples are perceptibly oily in character and the circumstance suggests a reason for the readiness with which cattle devour the fruit.

LEAD POISONING OF CATTLE.

Attention having been called to numerous fatalities among the range cattle near Cochise, Arizona, with symptoms of poisoning, inquiry was made into the cause. Cattle generally, at that time (January, 1904) were said to be fat and range conditions good. The losses being stated to occur at and near a quartz stamp mill of that vicinity, from whose tailings pond the animals drank, samples of the waste mill waters with tailings in suspension were received from complaining parties, together with portions of stomach, lungs, and offal of a perished animal.

Evidence. The waters from the tailings pond contained no cyanides and faint traces of copper.

Two samples of tailings (averaging 13 per cent of the sample of mixed solids and water) were next examined and found to contain a faint trace of arsenic (about 1 part arsenic in 35,000 of tailings), a strong trace of copper, and no mercury, but 3.21 per cent and 2.64 per cent, respectively, of lead. The material being carefully panned, heavy, white carbonate of lead, probably cerussite, was isolated in quantity.

The offal, stomach, heart and lungs of a dead animal were next examined. No arsenic was found, but a plain qualitative test for lead was obtained. The symptoms of the dying animals, as described by those concerned, were those of lead poisoning.

Conclusion. Assuming the correctness of the statements made and the genuineness of the materials forwarded, which there seems to be no reason to doubt, it may be concluded that since lead was present in the tailings in considerable amount in the form of the easily

decomposed and consequently poisonous carbonate, since the animals drank the water containing these tailings, since lead was found in a carcass perishing near the tailings pond with symptoms like those of lead poisoning, and since no other sufficient cause of death could be ascertained, there is no reasonable doubt that the carbonate of lead in these mill tailings is responsible for these losses and that animals should be excluded from this and similar supplies.

PICKLING OLIVES.

With a view to clearing up some of the difficulties attending the pickling of olives in this region, standard methods have been tested and an improved procedure recommended for the preparation of this valuable fruit. Thus far attempts to manufacture olive pickles in Arizona have not been very successful, due in part, no doubt, to inexperience, but probably also partly due to the unfavorable climatic warmth. The particular addition made to standard methods of extraction of bitterness and salting, was the processing of the finished product. This consists simply in heating the olives with their brine in Mason's jars to a temperature of 175 degrees for thirty minutes, thereby sterilizing them and enabling them to keep indefinitely.

The results of this work have been published (October 1, 1904) as Timely Hint No 53, by Mr. Skinner.

MISCELLANEOUS.

The usual assortment of miscellaneous samples has been examined from time to time, principally waters intended for irrigating or technical uses. Bulletin 46 by Mr. Skinner is a systematic collection of data relating to underground waters in the Territory, the discussion of which makes evident some interesting peculiarities of an arid region water supply.

No charges are made for analytical work, the results of which are of general interest and may be published. Compensation is required for private work and the receipts are turned over to the Station.

R. H. FORBES,
Chemist.
W. W. SKINNER,
Associate Chemist.