University of Arizona

Agricultural Experiment Station.

TWELFTH ANNUAL REPORT.

For the Year Ending June 30, 1901.

Consisting of the Reports of the Departments of

Administration,
Agriculture and Horticulture,
Animal Husbandry,
Botany and
Chemistry*

Tucson, Arizona, October 17, 1901.

UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION.

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. . . . . Clerk

The Bulletins of the Station are sent to all residents of Arizona applying for them.

Address,
THE EXPERIMENT STATION,
Tucson, Arizona.

LETTER OF TRANSMITTAL.

To His Excellency, N. 0. Murphy, Governor of Arizona:

SIR: In accordance with the Congressional act of March 2, 1887, I submit, herewith, the Twelfth Annual Report of the Arizona Agricultural Experiment Station, for the fiscal year ending June 30, 1901.

Very respectfully,

R. H. FORBES,
Director.

CONTENTS.

Sacaton grass (*Sporobolus wrightii*) protected by fence in Santa Cruz valley, showing its value for the restraint of flood waters. Photo by D. Griffiths. See range improvement, pp. 333.

TWELFTH ANNUAL REPORT.

DEPARTMENT OF ADMINISTRATION.

IN GENERAL

During the year just completed, the Arizona Station has proceeded along the lines and upon the principles stated and emphasized in the eleventh annual report,—according to which the different members of the Station staff have been enabled to carry on their investigations in those localities best suited to the accomplishment of results

Notable progress has been made in all departments of effort, and, though interruptions have occurred, the advantages of organization and of well-defined experimental objects have enabled the Station to hold to its general plan without serious loss of time or achievement

Freedom from political interference during the past two years, moreover, has made it possible for the scientific staff to maintain that spirit of loyal service and devotion to agricultural interests, which should always characterize the true, professional experiment station worker

With such favorable administrative conditions, actuated by such motives, and with fine natural opportunities, the Arizona Station is steadily adding to, and applying, and diffusing knowledge of southwestern agriculture A fitting maxim, indeed, for an investigator enlisted in the service of a hungry, growing, young western commonwealth is *Not "science for science's sake,' merely , but, science for humanity' s sake* Such a maxim accords well with the fact that the sole reason for the maintenance of an agricultural experiment station, both in law and in ethics, is the needs of the agricultural public to whose service it is dedicated

Herewithal, it is not to be understood that station work must be "practical" in the business sense of the term. It is for the investigator, working in economic fields by slow and costly methods, to ascertain useful facts; it is for the farmer, placed in possession of these facts, to make them pay.

PUBLICATIONS.

The publications of the Station, as last year, are divided into two sets,—the longer and more technical bulletins and the brief, though most carefully written, "Timely Hints for Farmers."

The longer bulletins serve for the record and discussion of the more important investigations of the Station. They are of value to other scientific workers and to a minority of farmers whose leisure and interest permits them to read. Through these men, also, whatever of value may be contained in such bulletins slowly reaches the great majority of those for whom it was intended.

The "Timely Hints," however, directly appeal to the busy, everyday farmer whose time, and whose common-school education perhaps, do not permit him to master a lengthy and technical bulletin. They are short because, if they are read at all, it will be during a pause from other work. They are in newspaper type because that best fits the popular eye. They are in plain language because they are intended for all to understand. They have vitality because they are, as far as possible, founded upon our own experiments and observations. Above all, they aim to convey timely information which will be of immediate utility to as many as possible of those who receive them.

During the year ending June 30, 1901, nineteen publications have been distributed to the names on our mailing list, in whole or in part as advisable, as follows:

Eleventh Annual Report, 45 pages; including a discussion of the principles on which the work of the Station is conducted, and notes on forage crops, vegetables, winter irrigation, stockfeeding, dairying, sugar beets, irrigating waters, and other agricultural subjects, by various members of the staff.

Bulletin 36, 21 pages; Experimental Work with Sugar Beets during 1900, by R. H. Forbes.

Bulletin 37, 36 pages; Winter Irrigation of Deciduous Orchards, by A. J. McClatchie.

Timely Hints for Farmers:

No. 19, Oct. 1, 1900. Let's Go to School Again.—By ft. H. Forbes
No. 20, Oct. 15, 1900. Stinking Smut of Wheat and Its Prevention.—By David Griffiths.
No. 21, Nov. 1, 1900. The Use of Chemical Preservatives in Milk—By Gordon H. True.
No. 22, Nov.15. 1900. The Open Range and the Irrigation Farmer.—By R. H. Forbes.
No. 23, Dee. 1, 1900. The Value of a Dairy Herd Record.—By Gordon H. True.
No. 24, Dec. 15, 1900. The Use of the Babcock Test.—By Gordon H. True.
No. 25, Jan. 1, 1901. Plant Lice.—By T. I). A. Cockerell.
No. 26, Jan. 15, 1901. Suggestions Concerning Date Culture.—By A, J. McClatchie.
No. 27, Feb. 1, 1901. The Spring Vegetable Garden.—By A. J. McClatchie.
No. 28, Feb. 15, 1901. Some Trees and Plants for Barren Places.—By R. H. Forbes.
No. 29, Mar. 15, 1901. The Use of Hand Separators on the Farm.—By Gordon H. True.
No. 30, Apr. 1, 1901. Well Waters for Irrigation.—By R. H Forbes.
No. 31, Apr. 15, 1901. Home-Made Fertilizers.—By W. W. Skinner.
No. 32, May 15, 1901. Wild Barley.—By A. J. McClatchie.
No. 33, June 1, 1901. The Australian Saltbush in Arizona.—By David Griffiths
No. 34, July 1, 1901. Millets.—By A. J. McClatchie.

These writings have been distributed to a mailing list of some 3000 persons in Arizona and other states, while the bulletins have in addition been sent out to the official list of some 1500 names. In this way the office has forwarded something over 60,000 pieces of mail during the year.

In addition, there is a large correspondence with the farmers of the Territory, as well as with prospective settlers from other states, who appeal to the Station for reliable information relating to the agriculture of this region.

EDUCATIONAL VALUE OF STATION WORK.

In view of the difficulties which have retarded the development of the school of agriculture in the University, the Experi-

ment Station has endeavored in various ways to make its work of educational value to the public, although not itself responsible for results along this line.

The field operations at the Station farm, in the date orchard, and with sugar beets, together with the explanations of those in charge, have afforded excellent object lessons to numerous visitors.

The publications of the Station, also, are full of reference to those principles of agricultural science involved in the subjects treated; and the Timely Hints especially, distributed every two weeks for nine months of the year, serve as lesson sheets for a class of some 3000 Arizona readers.

In order to afford a more systematic and complete course of reading than the Station publications afford, a carefully selected library of books and papers, giving a fairly complete treatment of farming in the various departments, was offered at cost ($2.91) to those who desired. Small response to this opportunity was made, but it is believed that experience will greatly improve this branch of service.

Institute work, which last year's experience proved highly desirable in many localities, was crippled this year for want of traveling funds. On a few occasions the Station staff has assisted on agricultural programs, but could be much more useful with sufficient means to travel.

PERSONAL.

The Station staff, with one exception, remains the same as during the year. Dr. David Griffiths, botanist, after remaining nine months, followed his predecessor to the U. S. Department of Agriculture, and has been succeeded by Professor John J. Thornber, whose study of problems relating to range reclamation in Nebraska should enable him to continue this important line of botanical work in Arizona with little interruption.

SCIENTIFIC INVESTIGATION.

The year's investigations have followed the lines laid down two years ago. The department of chemistry has nearly completed an extensive study of the irrigating waters of the Territory—a study the inferences from which relate to the future of

agriculture in the irrigated regions of Arizona. The work with sugar beets has also been brought to completion, and will be laid aside during the current year.

The department of botany, with the co-operation of the Division of Agrostology, U. S. D. A., for part of the year, has begun the important work of studying grazing conditions in the Southwest, and has made progress along several lines of inquiry relating to range problems. The range reserve of 350 acres near Tucson, although it has been under fence but eight months, shows in marked degree the recuperation of native vegetation when protected from stock. It is hoped that this study will grow into large importance as affecting the declining value of the ruinously managed ranges of the Southwest.

Questions relating to entomology and meteorology have from time to time been referred to the consulting members of the staff. This arrangement, so far as it goes, is very satisfactory, combining economy with a fair degree of service.

The department of agriculture and horticulture has operated upon the Station farm near Phoenix, having increased in usefulness and grown in favor in that very suitable location. The investigations of forage plants, grains, orchard management, and duty of water all relate closely to the welfare of this region. In the same place, the department of animal husbandry, now in its second year, has continued and extended its operations. The acquisition of 28 acres of land for feeding work has afforded facilities for the handling of a satisfactory number of animals, and for the increase of the number of experiments.

Both of the last named departments, however, as, indeed, the Station as a whole, are working under financial limitations. Improvements, however, have been made in modest amount, and are additionally assured to a considerable extent during the current year.

THE DATE PALM ORCHARD.

After one year's operations, the large shipment of palms received and planted at the orchard south of Tempe and at the Station farm, gives evidence of the probable outcome of the experiment. The extremely dry summer of 1900, and the exceptionally cold, ensuing winter imposed severe difficulties upon the

work; but unusual efforts were made for the preservation of the trees. Because of the deficiency of Irrigating water, a 4-inch San Jose pump was installed in the orchard, and water was hauled in barrels to the suckers as needed during the year. This task was undertaken by Mr. Harry Walker, of Tempe, to whose conscientious attention is largely clue the satisfactory condition of the orchard at the present time.

In all, there were 384 suckers planted south of Tempe and 21 at the Station farm, making a total of 405 trees, comprising 26 varieties. A careful examination made July 13, 1901, nearly one year after planting, revealed the condition shown in the following table:

CONDITION, JULY 13, 1901, OF THE SHIPMENT OF DATE SUCKERS RECEIVED JULY 17, 1900.

Varieties.	*Living, mostly growing vigorously.*	*Living, but very feeble*	*Dead*	*Total of each variety.*
Rhars	157	14	23	194
M'Kentichi degla	2	2	2	6
Arechti	5	2	2	9
Deglet nour	59	13	15	87
Hamraia	3	2	2	7
Tentebusht	4	0	1	5
A man	6	1	4	10
Tennessim	2	0	0	2
Rhazi	5	1	0	6
Timdjouert	5	0	2	7
Safraia	ft	0	0	6
Halloua	2	1	2	5
Itima	7	1	2	10
Azerza	3	2	3	8
Tazizaout	2	0	0	2
A'oochet	0	1	0	1
El kattar	0	1	0	1
Retbet regaia	1	0	0	1
Beida hammam	0	0	1	1
M'ch' degla	0	0	1	1
Tidmamet	1	0	0	1
Kerbons	1	0	0	1
Taurarbet	1	0	0	1
Bent kabeda	1	0	1	2
Bent kebala	1	0	0	1
Tadala	2	0	2	4
No name	11	2	10	23
	286	43	73	402
			Not judged,	3
			Total,	405

From this statement, it appears that 71 per cent of the suckers, including 22 varieties, are established; 11 per cent are yet doubtful; and 18 per cent are dead. This result is quite satisfactory considering the experimental methods of shipment employed, the two months' journey during the hot season, and the unfavorable conditions at the time the plants arrived.

In tracing out the causes which influenced final results it appears:

1. That it is much better to transport the suckers immediately after cutting them from the parent tree than to grow them in tubs or garden before shipment. The two methods resulted as follows:

	Growing and living.	*Doubtful.*	*Dead.*
Biskra and Ourlana purchases shipped immediately after cutting,—333 plants....	75%	11%	14%
Yahia and Rossier lots grown one year before shipment, — 69 plants	52%	9%	39%

Also, a small lot of 6 palms grown 1 year in tubs at Algiers, were received in the tubs of earth in 1899, at Tempe, having been necessarily somewhat jarred in transit. Five of these perished slowly, and the remaining one, after starting to grow, being moved a few inches to straighten a row, also died. It seems that at the time when the date sucker is creating its root system, it is sensitive to disturbance, being much more hardy immediately after severing from the tree and before its vitality has been expended in the output of new roots.

2. The different methods of packing employed present no marked advantages over each other. Those palms which were shipped with no packing whatever, came through as well, or better than, those carefully bound in wet moss or packed in charcoal. As a precaution, however, against unusual delay in transit it is probably safer to bind coverings of wet moss about the bases of the suckers and provide for renewal of moisture on the road.

3. Fumigation with hydrocyanic acid gas for the destruction of scale, does not readily injure the hard, dry foliage of the date palm. These suckers were subjected for 1 to 12 hours to .3,

.4, and .5 per cent fumigations with scarcely any apparent and no lasting injury; while the scale insect, July, 1901, appears to have been nearly or quite (?) all killed.

4. Alkaline soil does not hinder the establishment of the suckers. Comparison of results in the extremely alkaline Tempe orchard and the fresh soil of the Station farm shows the following:

	Growing and living.	*Doubtful.*	*Dead.*
Tempe orchard — 384 suckers	71%	11%	18%
Station farm — 21 suckers	72%	5%	23%

—an almost identical condition.

Reliable comparisons could not be made as to the shipping endurance of different varieties, although it is noted that a larger per cent of Rhars (82 per cent) is now active than of Deglet Noor (70 per cent). Size apparently had little to do with results, some of even the largest as well as the smallest individuals perishing. Very small suckers, however, are less desirable for field operations.

The main points observed thus far in caring for the suckers have been to plant not deeper than their greatest diameter; and to water assiduously after planting. Water was applied daily for the first six weeks, and frequently thereafter. Decided growth was not apparent until the following April.

A further consignment of 18 large plants, in 5 varieties, from Egypt, by mail, was received and planted in July; but the future of this lot is not yet evident.

FINANCIAL.

It has been difficult, with the funds available, to accomplish the work which could not, and would not, be ignored. Certain items of income outside the Hatch fund, however, have helped us through.

The resources for the year have been:

Receipts from the Treasurer of the United States	$15,000,00
Balance on hand July 1, 1900	262.70
Proceeds from sale of S steers	867.65
Greenhouse sales	59.40
Sales of milk, fruits, etc	411.41
	$16,101.16

EXPENDITURES FOR THE YEAR ENDING JUNE 30, 1901, BY DEPARTMENTS.

	Administrative.	*Agriculture and Horticulture*	*Animal Husbandry.*	*General Farm Expenses.*	*Botany.*	*Chemistry.*	*Entomology.*	*Date Palm Orchard.*	*Sugar Beet Culture.*	*Miscellaneous.*	*Totals.*
Salaries	1350.00	1700 04	1500 00		550 00	1993.35	100.00				7193 39
Labor	217.33	1339.10	896 20		166.63	8 75		467.22	550 90	300 00	3946.13
Publications	195.19	260 39	21 00		16 90	113 84	9.50			180 34	797.16
Postage and stationery	152.74	35.43	15 00		4.00	7.00					214 17
Freight and express	2.55	22.40	47.55	14.13	1.05	82 19	3.09	3.25	17.34	50.69	244.24
Heat, light and water										125.05	125 05
Chemical supplies			16 50		.19	93.40					110.09
Seeds, plants and sundries		71 31	22 22		34.40			22.80			150.73
Fertilizers				300 00				9 69			309 69
Feeding stuffs				100.73	2 15				18 25		121 13
Library	82.43				2.44	2.50		.40			87 77
Tools, implem'ts and mch'y		52.75	103.50	228.76	50.40	1 10		66 65	24 95	3 00	531 11
Furniture and fixtures	40.50					6 00				2 70	49 20
Scientific apparatus		6 58	11 83		98 02	119 98				27.11	263 52
Live stock	115.90										115 90
Travelling expenses	105.85		16 15		35.40			81.00	163.15		401 55
Contingent					163.25					120 00	283 25
Building and repairs			755.44	32.95	239 10			123 30	5.54	75	1157 08
Totals	2262 49	3488.00	3405.39	676 57	1363 93	2428 11	112.59	774 31	780 13	809.64	16101 16

The expenditures have been about equally divided between the departments of agriculture and horticulture and of animal husbandry, operating at the Station farm; and the office, scientific laboratories, and miscellaneous undertakings of the Station at Tucson and elsewhere.

Preceding is the statement by classified items, and by departments and separate lines of work.

R. H. FORBES,
Director

DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

The work of the year has consisted of the following: A continuation of several lines of experiment begun three years previously,—orchard management, date culture, the growing of wheat, corn, melons, and potatoes, and the culture of Eucalypt trees; a continuation of one line begun one year previously,—the relation of temperatures to growing crops; and of an investigation of four subjects taken up during the past year,—cotton culture, strawberry culture, the "duty" of irrigating water, and a study of evaporation from water and from soil surfaces. Three lines of experiment were considered to have been pretty thoroughly worked out for this region, and have not been continued during the past year,—sugar-beet culture, vegetable growing and green-manuring.

DATE CULTURE.

The heavy fruiting of several of the date trees upon the Station farm, and of many trees in other parts of the region about Phoenix during the past year, furnished an excellent opportunity to make some observations regarding date culture that heretofore had been hardly possible. In the first place, it seems now to be pretty well established that most date trees of the valley, especially the heavy-fruiting ones, bear only on alternate years. During the summer of 1900 all or nearly all female trees in the valley bore a full crop, while during 1899 very few bore dates, and during 1901 comparatively few are bearing heavily. The principal enemy of the date thus far has been the birds, and it seems pretty well established that it will be necessary to protect with a covering of light cloth each Individual bunch, at least until dates are produced in larger quantities than at present. The quantity of dates produced at the Station farm gave an opportunity to make some experiments in packing and marketing this fruit. It was found that the dates ripening during early autumn (Septem-

ber and October) could be packed directly from the tree, while those ripening during the cooler and moister weather of late autumn and early winter needed some drying before being packed. One of the principal difficulties encountered was too rapid drying of the dates after being packed, due to the extreme aridity of our atmosphere. It was found necessary to pack them in boxes surrounded with paraffine paper and keep them well covered, else they would soon become too dry to be eaten conveniently. The production of a large quantity of dates also furnished plenty of seeds for planting, and experiments were made as to the best time of year for sowing the seed. Judging from present indications, they make the best growth if planted during January or February, but may be planted any time during winter, spring or early summer. The results of some of the above observations and some suggestions regarding date culture were embodied in a "Timely Hint" that was issued during January.

FIELD CROPS.

The more abundant supply of irrigating water during the past year has made it possible to grow many field crops that an insufficient supply of water had prevented the growth of, during the past year or two. The testing of varieties of wheat was continued the past year, twelve varieties having been sown last autumn. The wheats grown belong to three classes,—local milling wheats, foreign milling wheats, and macaroni wheats. As heretofore, the Sonora wheat of the region was used as the standard with which to compare the rest as to length of season, yield, etc. Three foreign milling wheats compared very favorably with this variety in all respects. One variety from Japan—Onigiri—ripened with Sonora and gave a slightly heavier yield, and one Australian variety—King's Early—ripened earlier than Sonora and gave a heavier yield. Two other Australian varieties—Early Baart and Allora—ripened earlier than Sonora, but did not give quite as heavy a yield. An American variety—Ruby—ripened a little later than Sonora and gave a heavier yield. Of the macaroni wheats, the Nicaragua and Perodha gave the heaviest yields, equaling Sonora in this regard.

Considerable attention has been given to the growing of corn, both Indian and Egyptian. The Egyptian corn has been planted each month of the present spring and summer, Indian corn having been in some cases planted the same date. As was to be expected the spring plantings of Indian corn gave a very small yield, while the Egyptian corn bore heavily. As the latter variety produces two or more crops of grain upon the same stalks, the yield during the past season will not be known until its end.

The testing of varieties of melons has been continued, as well as a test made as to the amount of water needed to grow them. A record was kept of the dates of applying water, the amount applied, the number of melons produced per acre, the weight of the crop per acre, and the cash returns per acre As heretofore, the Augusta proved to be the earliest variety, and at the close of the fiscal year (July 1st) had given the heaviest yield and the largest cash return. The yield during the remainder of the season and the cash returns from the same must be awaited before the results of the season will be known.

During the present season several varieties of Egyptian cotton are being grown—varieties that are grown in Egypt by irrigation and are reputed to produce high grade cotton. At the end of the year (July 1st) the crop is in excellent condition and gives promise of a good yield.

IRRIGATION.

Much attention has been given during the past year to the vital subject of irrigation. Besides the experimental field work, a study has been made of such phases of the engineering and legal departments of the subject as are of special importance to farmers. For, not only must the farmer apply economically the water he receives, but the canals and ditches (and reservoirs, if they exist) supplying him with water must be properly constructed, and there must exist just laws providing for the delivery to him of the water to which he is entitled.

The great importance to the farmer of storing flood water, and the danger of attempting to cultivate more land than a reservoir or reservoirs could store water for, suggested a study of the capabilities of reservoirs whose construction is now contem-

plated on the streams supplying the Salt river valley with water. The results of the study indicated that the estimated area that could be watered from these prospective reservoirs was somewhat too high, and that the water-shed of the Salt river and its tributaries does not supply water enough to irrigate thoroughly over 250,000 acres, just about the area under the present canal systems of the Salt river valley. It is the purpose of the writer to present in a bulletin during the coming year the results of the study that lead to the above conclusions.

The experiment in the winter irrigation of orchards was continued through the year, and a bulletin embodying the results of the past two and one-half years' experiments issued last May. Work is under way during the present season having for a purpose the determination of the amount of the winter-applied water that is used by the trees and the amount that is lost by evaporation from the soil. Experiments have also been made in irrigating strawberries by different methods but the work has not been continued long enough yet to indicate clearly what the results are to be.

Especial attention has been given to the study of the duty of water. All the water flowing upon the Station farm has been measured as it crossed the farm line, and the amount applied to each crop has also been measured. For this purpose a self-recording water register was installed in the ditch conducting water to the farm, and gauged measuring boxes were placed wherever needed in the ditches conducting water to the various parts of the farm. A record has been kept of the length of time water flowed through any particular box upon any particular crop, the depth of the stream in the box noted, and the quantity of water applied at each irrigation thus determined, A record of the yield of each crop has also been kept, and so far as practicable a record of the cash return, or at least the cash value, of each crop. A bulletin embodying the results of these experiments is contemplated for the future.

RELATION OF TEMPERATURES TO CROPS.

During the past two years quite careful observations have been made and complete records kept of the effect of high and **of**

low temperatures upon the various crops growing upon the Station farm. During this period six to eight sets of self-recording maximum and minimum thermometers have been stationed at various points on the farm. One set was placed within a few inches of the soil, one set five feet above, and one set ten feet above the surface. Other sets were placed in various situations among growing crops. Besides keeping records from these thermometers, a record was made from the Government Weather Bureau thermometers kept in the regulation thermometer shelter.

Observations were" made and notes taken upon the effects of low temperatures upon various crops, and of the temperature at which sensitive crops were killed by frost. Observations and records were also made of the high temperatures injuring or killing plants sensitive to heat.

EVAPORATION EXPERIMENTS.

During the past year a beginning has been made in a study of the rate of evaporation from water and from soil, under the varying degrees of temperature, of relative humidity, and of wind velocity. A record is being kept of the evaporation from a tank of water, by making measurements morning and evening; and cylinders of two sizes and depths filled with soil and placed with their rims even with the surface of the outer soil, are weighed morning and evening. The soil in the cylinders is irrigated and otherwise treated as nearly like the soil of fields as possible. The purpose is to obtain data that will be a basis for the intelligent handling of field soils. When sufficient data are obtained, the intention is to prepare a bulletin embodying the results.

A. J. MCCLATCHIE,
Agriculturist and Horticulturist.

DEPARTMENT OF ANIMAL HUSBANDRY.

STEER FEEDING.

Experiments in steer feeding begun last year have been continued, following the same general plan, with a view to determining the comparative merits of feeding alfalfa alone and feeding it in combination with more carbonaceous materials, such as sorghum and grain hay.

The bunch of steers used in the experiments reported last year were carried through two more experimental periods. The first of these was preliminary to the second. During this period, from September 5 to October 9, the eight steers were all fed alike on alfalfa pasture and mixed barley and alfalfa hay, 10 6 lbs. of hay per day being eaten by each steer. Under this treatment the animals in Lot I made an average gain of 1.49 lbs., each, per day, and those in Lot II, 1.21 lbs.

PASTURE AND ALFALFA HAY VS. PASTURE AND WHEAT HAY.

The second period referred to above was one of nine weeks, from October 9 to December 11, during which Lot I was fed alfalfa hay and Lot II wheat hay, in addition to alfalfa pasture. The results are given in the following table :

Lot	*reed*	*Steers*	*Weight at beginning*	*Pounds gain*	*Daily lbs. gain*
I	Alfalfa pasture and alfalfa hay, 8415 lbs.	2	1104	84	1 28
		4	1085	66	
		5	1171	100	
		8	947	72	
II	Alfalfa pasture and wheat hay, 6874 lbs.	1	1243	70	,83
		3	1035	56	
		6	1067	50	
		7	1013	32	

SUMMARY.

For seventeen weeks during this series of experiments alfalfa was fed against wheat hay or sorghum, to animals on

pasture. During this time the four steers having only alfalfa gained 127 pounds more than the other four.

For sixteen weeks alfalfa hay was fed against combinations of alfalfa hay with corn fodder, Kaffir corn or sorghum, during which time the four animals receiving the other feeds in combination with alfalfa gained 59 pounds more than those having alfalfa only.

During the thirty-three weeks that alfalfa only was fed against combinations of alfalfa and other forages,the animals having only alfalfa gained 1.55 lbs. per day while those receiving the combination gained 1.46 lbs. per day.

In May a car load of range cattle was purchased of Col. H. C. Hooker of Willcox and with them experiments along this line will be continued.

THE DAIRY HERD.

On June 19th, 1900, six two-year-old heifers of unknown breeding were purchased. They had all been bred to calve at from eighteen to twenty-four months of age, had been in milk for about six weeks when purchased and were in very poor condition. Since their purchase the milk from each cow has been weighed and tested for butter fat and a record kept. During the year for which the record is given below the only feed received by the cows other than pasture was hay during the last two weeks in September and first two weeks in October, and sugar beets for two weeks in November and December. For three weeks in July and two weeks in August and September, instead of

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NOTES.—At the close of the last experiment the eight steers referred to above were sold to a San Diego buyer for Christmas beef at $4.30 per cwt., $3.75 and $4.00 being the prevailing prices at the time.

These steers were from ten to fourteen months old when purchased and during the year fed gained 3817 lbs., an average of 477 pounds.

Steers No. 2 and No. 6 made the greatest gain—503 lbs. each—while steers No. 7 and No. 8 made the least gain—448 lbs. each.

Steer No. 6 made the greatest per cent gain over his original weight —82 per cent—No, 8 being second with 78 per cent gain.

Steers Nos. 1 and 5, the oldest and heaviest animals, ranked third and fourth in pounds of gain, and seventh and eighth in per cent of gain.

ONE YEAR'S RECORD OF THE STATION HERD.

Month		*No. 1*	*No. 2*	*No. 3*	*No. 4*	*No 5*	*No. 6*
July	Lbs. milk	494.2	447.4	334 0	449.8	451.6	462.1
	% Fat	3.55	4 85	5.75	4 24	4 47	4 33
	Lbs. fat	17.53	21.68	19 19	19.06	20.17	20 00
Aug.	Lbs. milk	545.0	525.9	402 5	546.6	569 1	544 5
	% Fat	3.52	4 17	5 21	4 26	4.52	3 92
	Lbs. fat	19 21	21.92	20 96	23 33	25.71	21 32
Sep.	Lbs. milk	478 0	430.6	377.6	474.1	465.4	440 4
	% Fat	3 6	4.77	5.39	4 3	5.2	4 65
	Lbs. fat	17.18	20.54	20 35	20 39	24 24	20 49
Oct.	Lbs. milk	426 0	389.0	328 6	478.6	379 3	381 1
	% Fat	4 06	5.66	6 66	5.0	6.13	5.67
	Lbs. fat	17.72	22.04	21.89	23.93	23.24	21.62
Nov.	Lbs. milk	391.3	352 7	298.9	433.1	321.2	268 7
	% Fat	3 92	5 52	5.94	5.05	5.7	6 35
	Lbs. fat	15.22	19.52	17.76	21.86	18 30	17 05
Dec.	Lbs. milk	412 9	362 5	279.9	480.6	388.0	405 7
	% Fat	4.42	6 26	7 28	5.00	6 00	5 99
	Lbs. fat	18.27	22.70	20 39	24.56	23 26	24 32
Jan.	Lbs. milk	410.1	443 5	306 8	535.8	375.6	470.3
	% Fat	4.56	5.86	7 10	5.07	6.15	5.86
	Lbs. fat	18.48	26.10	21.78	27.19	23.08	27.54
Feb.	Lbs milk	351 3	296 6	228.9	365 8	221.8	344 3
	% Fat	4.83	6 78	7 75	5.71	7 45	6.42
	Lbs. fat	16.99	20 34	17.74	20.81	16 53	22.11
Mar.	Lbs. milk	394.2	339.6	286.6	472.9	274.3	443 6
	% Fat	4.64	6.13	7.17	5.42	6.74	6.11
	Lbs. fat	18.29	20.82	20.55	25 64	18.49	27 12
Apr.	Lbs. milk	380 8	385.1	181.9	510 1	234 0	413.8
	% Fat	4.79	6.05	6.94	5 45	7.0	6 41
	Lbs. fat	18 27	23.29	12.69	27.82	16 04	25 55
May	Lbs. milk	413 0	441.7		561.8	9 5	451.5
	% Fat	4.79	5.87		5 41	5.7	5 95
	Lbs. fat	19.81	25.91		30.41	53	26 85
June	Lbs. milk	391.0	409.2	599 5	501.5	685.0	427.6
	% Fat	4.78	5.58	4.59	5.07	4.47	5.57
	Lbs. fat	18.70	22.73	27.40	25.44	30 64	23 81
Total	Lbs. milk	5087.8	4823 8	3625.2	5810 7	4374.8	5053.6
	% Fat	4.24	5 54	6 08	5.00	5.5	5.5
	Lbs. fat	215.66	267.59	220.70	290.45	240.24	277.79

running on pasture, the cows were kept in corrals and alfalfa was cut and fed to them. They have had no shelter. So it may be said that our cows during this year have received about the same treatment given his cows by the average ranchman. The record, as showing the difference in value of the different cows, is especially interesting when it is known that cow No. 1 is most often selected by dairymen as the best cow in the herd.

RECORD.

In addition to the tabulated record the following chart will be of interest. Two cows of the herd calved before the end of the year and four proved not to be in calf. In the case of these four cows, therefore, the conditions affecting the production of butter fat and milk were the same for each throughout the year, and Fig. 1 is intended to show graphically their monthly variations in pounds of milk given, per cent of fat, pounds of fat and cash return during the year.

It will be observed that the first line, showing the variations in pounds of milk given, is the most irregular. This line shows the average daily milk yield of the four cows for each month of the year.

The second line, showing the variation in per cent of fat in the milk, indicated that as a rule an increase or decrease in milk flow was accompanied by an opposite change in the per cent of fat. In November, however, a decrease in milk flow was accompanied by no change in per cent of fat. In December there was an increase both in the flow and in the richness of the milk, while in June there was a decrease in both. Speaking generally, there was a gradual increase in the per cent of fat from August to May, after which there was a decrease.

This may be taken as an indication that the highest per cents of fat in milk are not maintained during the heat of summer.

The third line, showing the production of butter fat, is notably the most even, the amount of butter fat given being more constant than the amount of milk given or its quality.

The figures for which the fourth line stands were obtained by multiplying the pounds of fat given, and shown in the third

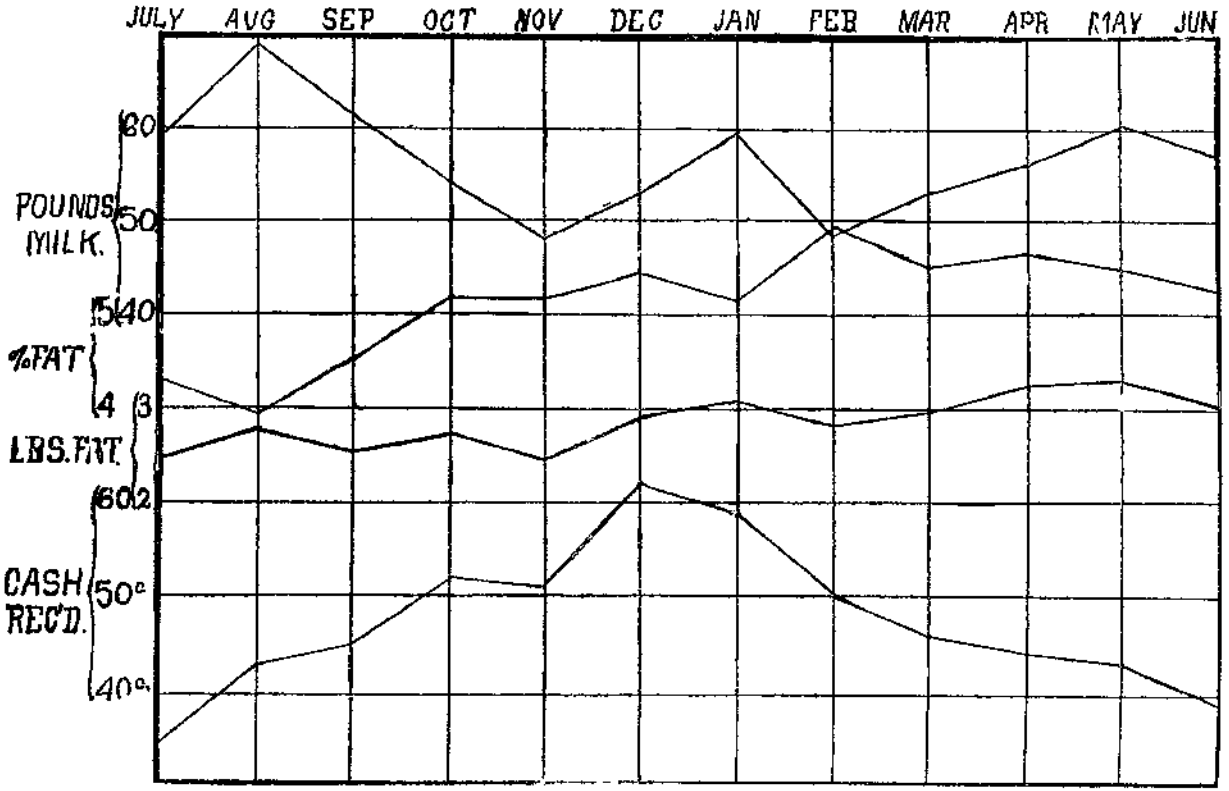

Fig. 1. One year's record of four cows of the station herd.

line, by the price of butter fat at the creameries for each month. Here is illustrated the great advantage of winter dairying and the importance of having cows at their best during that part of the year when prices are invariably highest.

FEEDING SUGAR BEETS.

A few sugar beets on hand, as a result of experiments in growing them for sugar production, gave an opportunity for trying them as feed for cows. It was planned to feed beets to three of the cows on pasture for two weeks, to the other three cows for the following two weeks, and then compare the product of the six cows with and without beets during the month covered by the trial. Two conditions operated to lessen the value of the experiment; first, cow No. 2 refused to eat beets; second, a very trying storm from which there was no shelter, caused all the cows to drop off in both milk and butter fat to such an extent that one could not consider the variations during that period as due to feeding. Fig. 2, herewith, upon which the lines show the variation in production of butter fat by weeks for each of the six cows of the herd during the period of feeding, and the weeks immediately preceding and following, may be studied with interest. The effect of exposure to storm (during the second week of the trial, ending November 27th,) upon the production of butter fat is most clearly shown. This was not so great in the case of the two cows receiving beets. The increase shown

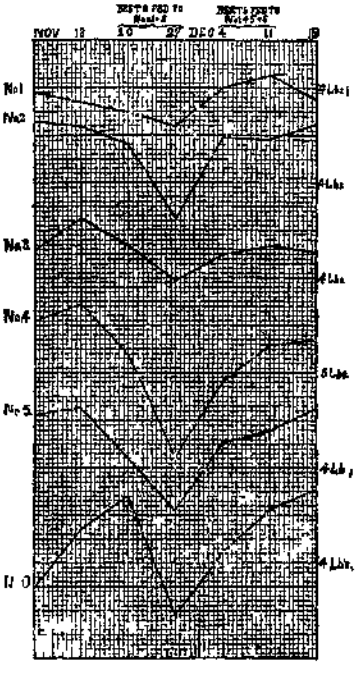

Fig 2 Showing effect of storm upon butter fat production

by cows Nos. 4, 5 and 6 during the two weeks immediately after the storm, when they were fed beets, is to be noted. There is no way of determining, however, how much of this gain is due to normal recovery following adverse conditions, and how much to additional feed.

Cows Nos. 1 and 3 ate 775 lbs. of beets each and cows Nos. 4, 5 and 6, 625 lbs. each.

SOILING.

Soiling experiments planned were seriously interfered with by the very severe drouth of the summer and fall. Our experience seems to point to the fact that feed may be very much economized by cutting and feeding instead of pasturing. Especially is this the case in seasons of shortage in irrigation water when it is impossible to irrigate any considerable part of a field at a single run of water. More experiments along this line are under way and will be reported in detail later.

DEHORNING COWS.

On January 30 the cows of the herd were dehorned by Mr, John Elvey by use of the Newton dehorning clippers. Again a storm prevented the observation of a change in condition, for rain fell on eight of the eleven days following the operation.

By referring to the tabulated record and to Fig. 1, it will be seen that a very serious falling off in amount of both milk and butter fat took place during the month following dehorning.

The per cent of fat in the milk increased but not sufficiently to overcome the decrease in amount of milk given.

How much of this falling off in butter fat is due to dehorning and how much to storm we are unable to determine.

GORDON H. TRUE,
Department of Animal Husbandry.

DEPARTMENT OF BOTANY.

RANGE IMPROVEMENT.

This division of the department's work has been conducted in co-operation with the Division of Agrostology, U. S. D. A., according to arrangements made with the U. S. Secretary of Agriculture.

The range improvement work in Arizona, being of a different character than that usually contemplated, and being in a region more completely divested of range grasses than probably any other in the entire country, required considerable careful study beforehand in order to discover the proper locality for experimentation. Accordingly, considerable time was spent in a survey of the surrounding country in the vicinity of Tucson, for the purpose of determining which of three typical areas (mesa, foothill, or river bottom) would be the most favorable and give the most conservative and valuable data upon which to base judgment of the results obtained by experimentation. Finally, a rather favorable mesa area was selected at an altitude of about twenty-six hundred feet above sea level, and about four hundred feet higher than the city of Tucson. This tract, which was subsequently reserved from entry at the request of the Honorable James Wilson, United States Secretary of Agriculture, is described in the government surveys as Sections 26, 27, 34 and 35, T. 14 S., R. 14 E., Gila and Salt river meridian.

Somewhat diagonally through the center of this area runs the Southern Pacific railway, and a short distance to the east of it is located Wilmot siding. The soil is a clay loam, mixed with considerable sand, and subtended at a depth of two to two and a half feet by a calcareous hardpan known among the Mexicans by the significant name, "Caliche." The slope, which is rather gentle, has a general northwesterly direction, and is traversed by three more or less distinct, broad, shallow depressions which receive the drainage of a considerable area of land to the southeast. Such a region, with broad, shallow washes, was purposely se-

lected. It was the intention to attempt to conserve water flow on the mesa, and to discover what can be done towards preventing "run-off" of water during the rainy season of July and August. Such washes, although the most favorable for the growth of vegetation of all kinds, are nevertheless typical of large tracts of desert not only in the Santa Cruz, but in the San Pedro, Gila and Salt river valleys as well.

A triangular portion of this reservation, consisting of three hundred and thirty-six acres, adjoining the Southern Pacific right of way, has been placed under a substantial four-wire fence. The area compasses nearly all varieties of exposure, drainage and soils, and is, in short, a typical mesa region in every respect. The advantage taken of the railway fence enabled us to enclose the tract at a minimum cost. Two miles of fence, at an approximate cost of $150.00 a mile, covers practically the entire expense of the enclosure.

Recognizing that the greatest probability of success would attend our efforts if we restored as nearly as possible Nature's conditions, rather than attempt to introduce foreign plants (always of questionable adaptability), a special effort was made to secure native seed for experimentation; seed of those plants which we know grew in the region in greater or less profusion before the advent of the white man with his destructive herds of cattle and sheep. Accordingly, the writer made a short trip into the Sulphur Spring valley in October, and secured some eighty bushels of seed of a great variety of native forage plants. These were shipped to the Division of Agrostology, cleaned, and returned in January.

All the cultural operations which have been performed thus far were conducted during the month of January, and under very favorable auspices as far as climatic conditions are concerned. Fifty-two acres of the reservation is now under cultivation, and it is the intention to operate on more ground next season. The cultivated portions are distributed over the fenced area in four localities, each portion being subdivided into plots varying in size according to the quantity of seed available. The salt bushes have been planted in an area by themselves, in the edge of one of

the broad washes described above. Considerable seed of foreign plants was put in here; but about half of the ground planted was put into native seed collected in the vicinity of Tucson and Tempe.

The main cultivated areas are two in number and extend in long strips four hundred feet wide directly east and west, and consequently diagonally across the shallow washes. These have been subdivided into rectangular plots of variable size, and sown mainly with seed of native grasses, but also with the more promising drouth-resisting varieties from other regions.

The cultural operations are vastly more simple than those usually employed. This is necessarily so, because *improvement of the range at the least possible expense* is the desideratum here, and not the growing of the greatest amount possible per acre. The production of forage is so small here at best that one is obliged to measure his pasture by square miles, rather than acres, and the operations in range improvement must be on a correspondingly large scale. It has been deemed wise, therefore, to operate simply, but on comparatively large areas. The only implements used are disc and fine tooth harrows Every possible combination of these has been employed. In some cases, the seed was sown directly on the mesa with no previous preparation of the soil; in others, discing or harrowing preceded planting. In all cases the seed was covered by discing or harrowing, or by both combined. As far as possible, all cultural operations extended lengthwise of the long strips, and therefore, diagonally across the washes. The gangs of the disc harrow were set so as to ridge up the ground as much as possible. This method spreads the run-off of water over more land, and the ridged condition holds it to a greater extent than any other method would do.

Similar cultural operations have been conducted on unseeded areas, to ascertain the effect on the native vegetation which springs up immediately after a season of rain.

The fifty-two acres under cultivation are divided into sixty plots on which have been sown about forty species of forage plants.

A small grass garden has been started on the University grounds, in which nearly all of the varieties sown on the reser-

vation have been planted in small quantities. Here moderate irrigation is practiced. One of the objects of this garden is to form a check upon the seeded plots on the reservation.

Owing to the diversity of climatic and soil conditions which obtain in southern Arizona, it has been thought wise to extend operations over a greater variety of territory than would be possible in the immediate vicinity of the University. Consequently, a plan was inaugurated to co-operate in the matter of range improvement with farmers and ranchers who were located in favorable situations. Aside from the work performed directly by the writer, experiments are being conducted at nine other stations in southern Arizona. In all of these cases those interested are doing the work with seed distributed from this Station.

In connection with the range work, three precipitation records are being taken, in order to determine to what extent variation in this particular obtains. The extremely local condition of rainfall during the summer season is a matter of common observation. It is, therefore, necessary that the relative rainfall of different areas be known in order to render more intelligently the significance of the experiments conducted upon them.

THE AUSTRALIAN SALTBUSH.

Encouraged by the experiments which have been conducted with this plant, the Station made a distribution of seed to those who applied for the same according to the offer made in Timely Hint No. 33. This valuable forage plant is now well distributed over the Territory, and it is hoped that if it proves to be adapted to this climate, it is well established, A portion of the seed distributed was furnished by the Division of Agrostology, U. S. D. A., and the remainder was kindly donated by the authorities of the California Experiment Station to whom acknowledgments are due.

PARASITIC FUNGI.

Considerable attention has been paid to this important line of investigation. While our correspondence has not been great

with reference to any one plant disease, yet there are indications that considerable injury is being done by a goodly number of these pests in the Territory. The greatest amount of correspondence results from root rots of various forms.

The experiments conducted last year by Professor Tyler have been continued the present year and preparations are being made for still further investigations later in the season. The investigations of Professor Tyler were on the whole encouraging. The plot upon which experiments were conducted with various chemicals produced, according to reports of Mr. Grossetta's foreman, the best crop of alfalfa on the ranch. No distinction was observable, however, in the effect of the different chemicals used. The experiment is simply encouraging and does not indicate positive results because the treated plot received about four times as much water as any other portion of the field. The successful crop may be due entirely to the action of an abundant supply of water. However, even if this is true the experiment is valuable.

Experiments are being conducted on Mr. Grossetta's ranch again this year mainly for the purpose of determining the utility of the ditching system and also for the purpose of ascertaining whether areas over which the disease has passed can be successfully reseeded.

Small plots of alfalfa have been planted on the University campus with seed obtained from various sources. Inoculation experiments will be conducted on these plots during the month of August for the purpose of determining the communicability of the disease under variable moisture conditions.

ECONOMIC CACTI.

The writing on this line of investigation was quite exhaustive in the last annual report. Being plants of very slow growth, no special results can be expected for years to come. Many of the plants which were set out last year have died either from drouth or depredations of animals. These have been replaced as far as possible by other plants from the same source.

SCIENTIFIC.

Parallel with the economic work of the Station, considerable investigation of a purely scientific nature has been conducted. However, it is very difficult to state at this time how much economic bearing apparently pure scientific truths may have in the future.

A collection of about 400 plants bought by the University some time ago has been mounted and distributed in the herbarium together with some 300 sheets which were previously mounted. The working capacity of the herbarium has therefore been increased by about 700 sheets.

During the past favorable season a special effort has been made to secure specimens of the local flora. Since the first of September about 1200 numbers of plants (1500-2700) have been collected. These are, of course, to some extent duplicates of plants already in the herbarium, but even so they are very valuable in studying variation, distribution, etc. The grasses from these collections have been sent to Professor F. Lamson-Scribner, U. S. Department of Agriculture, who has recently published a pamphlet containing the results of his determinations. The collection he reports to be a large one for the time employed in its gathering. It contains about a half dozen species new to science.

The writer has published one paper * in which a new species of ergot collected on galleta grass at Cochise was described. This may be of some economic importance, for it is well known that the closely related common ergot of the wheat grasses is very injurious to cattle in some of the prairie states.

DAVID GRIFFITHS,
Botanist

*Bull Torr. Bot. Club, 28 April 1901

DEPARTMENT OF CHEMISTRY.

IRRIGATION WATERS.

The examination of the water of the Salt, Gila and Colorado rivers, the three principal sources for irrigation purposes in the Territory, has been completed during the year. The work is being tabulated and studied, and the results are to be published in the near future. Some idea of the scope of the work may be gained when it is understood that samples were taken daily for one year, so far as possible, from the three above mentioned rivers, and sent to the Station laboratories of the University, where the examination to which they were subjected necessitated the making of over two thousand analytical determinations.

The year during which samples were taken proved to be in some respects an unfortunate selection, owing to the fact that it was abnormally dry, the rainfall in the watershed of the Salt river being less than one-half of the average for the five or more years for which the records have been kept. It therefore follows that all the figures obtained are below what they would be for a normal year. However, being a dry year, the amount of water used by the canals more nearly approached the total volume of the river ,* hence, the flow of Salt river at all times being known, the quantitative data for the effect of irrigation upon the lands of the Salt river valley are available, because the various amounts of silt and soluble salts carried upon the land very nearly approaches the total amount carried by the river.

The quantitative silt determinations, both by weight and volume, made upon these waters bear upon the discussions relating to storage reservoir construction. Our observations, though made during a year when the total silt was much smaller than the average, are accurate, afford a reliable basis from which to make estimations, and will yield a maximum figure for the life of specified reservoirs upon the streams stated.

The results will be of much value to the agriculturist, and to prospective investors, not only showing the character of the irri-

gation water but indicating probable future effects from the soluble salts that it may contain, both injurious and beneficial. It is of interest to note that the nitrogen, potash, and phosphoric acid, the three essential plant foods carried upon the valley by the Salt river during the period for which we examined it, had a market value of about one million dollars.

Thus this river in a measure stands in a somewhat similar relation to the valley farmer that a fertilizer factory does to his eastern brother.

There are other questions of importance which will be discussed more in detail in a station bulletin concerning this work, which will be issued in the near future.

SUGAR BEETS.

Experimental sugar-beet culture was continued in the vicinity ot Pima and Safford, Arizona, during the season from January to August, and this line of work was brought to a satisfactory close. This year's investigations conclude a thorough examination into the possibilities of sugar-beet culture in the Territory, carried on for five years past. The results place Arizona in an intermediate position as to the quality of beets produced for the support of factories in other states.

Aside from quality of beets, certain agricultural and factory conditions, such as the advantage of irrigation over precarious rainfall; and fuel, water and limestone supply, may secure a place for the Territory among future sugar producers.

The following table states the results obtained at Pima and Safford this year:

Plot.	Date of planting	Date of harvesting.	Kind of soil.	Sugar in beets.	Purity.	Tons per acre.	Variety of seed
	1901			%			
1	Feb. 6	July 25	Alkaline, peaty, black soil	11.45	79 3	29.8	Kleinwanzlebener from Chino
2	" "	" "	" " "	10.45	77.4	38.4	" "
3	" 19	" 11	Clay loam	13.97	84.8	11.4	" "
4	" "	" 25	Sandy loam	12.73	82.5	16 4	" "
5	Jan. 31	Aug. 12	Sandy loam	12.81	77.1	31.1	" "
8	Feb. 26	July 22	Silty loam—in sugar beets last yr	12.97	85.5	13 0	" "
9	" "	" "	Silty loam—new alfalfa ground	12.47	81.9	13.8	" "
10	" "	Aug. 14	" "	14.8	84.1	12.3	K W. Wohanka Ertragreicher
11	" "	" "	" "	14.37	82.3	15.7	K W. Wohanka Zuckerreicher
12	" "	July 22	" "	14.8	84.5	11 3	Vilmorin, 3941 U. S.D. A.
13	" "	" "	" "	14.77	85 5	14 2	K. W. Russian, 4416 U S. D. A.
14	" "	Aug. 14	" "	14.14	81.7	16.1	K. W. Russian, 3943 U.S. D. A.
15	" "	" "	" "	16 15	85.3	18.1	K. W. Dippe, 2868 U. S. D. A.
16	" "	" "	" "	13.3	80.1	22 7	K. W. Chino
17	" "	" "	" "	15 18	83.5	15 0	Vilmorin, 3941 U. S. D. A.
20	" "	" "	" "	13 47	80.4	25.6	K. W. Chino
22	" "	July 23	" "	11.38	76.9	22.5	K. W. Chino
			Average of all plots,	13.48	81 9	19.3	

The varying figures from these seventeen plots show the influence of soil, seed, and cultural methods upon beets produced in the same neighborhood, and will be discussed in a final bulletin on the subject.

The average result,—13.48 per cent of sugar in beets, 81.9 purity and 19.3 tons per acre, amounts to 5211 pounds of sugar per acre in a satisfactory condition of purity. This is above the average for the United States at large; but, so far as quality is concerned, is of course below the extraordinary crop which, after three years' drouth, has just been harvested in California.

MISCELLANEOUS.

Aside from the numerous samples of irrigating waters and sugar beets, attention has been devoted to miscellaneous samples of soil, milk, cream, silts, honey and minerals to the number of thirty-seven.

Requests for analytical work for private parties are received occasionally, which are attended to as time permits. When the results are of public interest and we are permitted to publish them, no charge is made; otherwise, compensation is received for such work, the proceeds being expended for the benefit of the Station.

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

SUPPLEMENTARY — THE DATE PALM ORCHARD.

Referring to the date palm orchard on page 315, which, it should have been repeated, is co-operative between the U. S. Department of Agriculture and the Arizona Experiment Station:

As this report goes to press another carload, consisting of 35 very large date palms, has been received from Mr. D. G. Fairchild, Agricultural Explorer for the U. S. Department of Agriculture. Owing to the lateness of the season, these trees have been stored in the greenhouse at Tucson for the winter, and will be transplanted to the orchard next spring. The Egyptian agent from whom these trees were secured, contrary to instructions, shipped them rooted in tubs of earth in the old-fashioned way. The consignment in this shape weighed about 25 tons.

It is to be remembered that Mr. W. T. Swingle's shipment of last year, from Algiers, tabulated on page 316, also occupying a car, consisted of 440 suckers packed in wet moss and boxed.

It is due to Mr. Swingle's good judgment and experimental courage, in employing this mode of shipment, for the first time, that an economical method of importation has thus been demonstrated. His success will no doubt materially encourage the importation of suckers by private parties and thus hasten the development of the industry. R. H. F.