

ANNUAL REPORT
for
YEAR ENDING NOVEMBER, 30TH, 1923,
of

E. S. Terville,
County Agricultural Agent,

PINAL COUNTY

ARIZONA.

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Section (4) STATUS OF COUNTY EXTENSION ORGANIZATION.

(1) Form of Organization-distinctive features.

In Pinal County extension work is done, as far as organization is concerned, through the County and local farm bureaus. These are not in the proper sense of the term, extension organizations, for, while it is true that the Agent assisted in their organization, it is also true that it was understood from the beginning that the farm bureaus were private farmers organizations, and in no sense dependent for their existence upon extension service. On the other hand, the matter is somewhat complicated owing to the fact that the County Farm Bureau is organized under the laws of Arizona as a public institution, having the right in effect to levy taxes and expend the same. It may therefore be said that no one within the county has a very clear conception of the various relationships existing. As, however, complete harmony has so far prevailed, the matter has not as yet come up for final determination.

It may be stated that so far the policy of the Bureau has been to be largely educational and not political or business.

In the Agent's work he makes use of the County and local bureaus as extension committees. In other words, when he desires some bit of co-operative work he appeals directly to the organization, and that organization appoints the necessary committees, officials or project leaders. These people are, therefore, responsible to the farm bureaus rather than to the Agent.

(2) Function of Local People, Committees and Project Leaders in Developing the Program of Work.

It has been the policy of the Agent to throw as much responsibility as possible on the committees and local bureaus. Where the work is progressing satisfactorily, the Agent offers no assistance or interference. In those cases where the Agent works directly with committees or project leaders, the effort is made to convey the idea that they are doing this work for their bureau, and that the Agent is merely assisting them and the bureau. Out and dried methods for carrying out demonstrations in which the plan is worked out by the Agent, operated by the co-operating project leaders and reported as an extension demonstration, have not proven successful in this district. They appear to secure a certain antagonism which results in a stressing of minor points of failure rather than in a main point of success. This condition is perhaps emphasized by the fact that agriculture within the county is in a stage of development, and that practically all demonstrations carry with them a considerable element of experiment. It has, however, been noted that when a farmer, perhaps as a result of a suggestion received at a farm bureau meeting or in conversation with the Agent, becomes interested in some plan and puts it across himself, that the facts readily become public property and meet with a more cordial reception. These facts explain the policy of encouraging individual farmers to try out plans has been used, rather than the orthodox demonstration method. When these fail no comment is heard, when they succeed they are given ample publicity in the local press and in the farm bureau meetings. The farmer in each case being given full credit for the work done.

(5) General policies, Including Relationships to other Organizations.

It has come to be pretty generally understood that the services of the County Agent are available to any and all organizations within the county. Numerous pieces of work have been done by the Agent in co-operation with local chambers of commerce, the woman's clubs, the farmers private business organizations and other semi-public groups of citizens.

Such a policy is perhaps more servicable in this county than in old and established counties, as the development of all industries is here dependent upon the development of an agricultural area. Such development is now in progress.

Section (14) PROGRAM OF WORK, ANALYSIS OF LOCAL CONDITIONS, GOALS ESTABLISHED, METHODS EMPLOYED AND RESULTS ACHIEVED.

(1) Factors Considered and Methods Used in Determining Program of Work.

After three years of close contact with conditions as they exist in the agricultural areas of Pinal County, the Agent has become convinced that the farmers of this district have one overshadowing problem, which though not exactly peculiar to this county alone, is not a problem for the general run of farmers throughout the country. Local ranchers must study the proper care of poultry, the best method of handling the dairy cow, modern systems of fruit culture, pest and disease control and other similar matters. These are general farm problems. The problem that is not general is the one connected with the correct use of irrigation water. Of course, many other counties use irrigation, but a close study of conditions will show that irrigation practices must differ widely in various irrigating districts.

part 5 In a further study of local conditions it became apparent that there are two sciences of irrigation, two distinct parts. The first is that one generally known as Irrigation Engineering and deals with the securing of water and the general laws of its control, also, the building of dams, the location and construction of canals and the construction of irrigation systems on the ranch. On this part of the science of irrigation we have no valuable scientific information. The other part of the science of irrigation deals primarily with the course and action of the water after it passes beneath the surface of the ground. This part of the science is really the basic part. The first thing an irrigator should know is the duty he wishes his irrigation water to perform. If he needs his water 6 feet in the ground he has quite a different problem to that should be only require it 2 feet in the ground. Furthermore, he must know whether a stream of water down a furrow, how deep this water will penetrate and how far it will move on each side of this furrow to wet the intervening soil. He must also know how much a quantity of more or less expansive water will be his ground, wet or it is likely to remain there for the use he desires or whether it will pass rapidly out of reach. These facts must be apparent that the irrigator should have a practical working knowledge of that part of the science of botany which deals with the root habits of the plants he is trying to grow and a similar working knowledge of that part of the science of Soil Chemistry which deals with the movement of water within the soil. Strange, however, to say such knowledge is by no means general, and unfortunately seems to be rather difficult to obtain.

number of young apricot trees. Results are not yet apparent but were not expected this season.

Some work was done in assisting the Experiment Farm Division of the University of Arizona in checking up on their sulphuric acid experiment, in which an effort was made to discover if such treatment would increase the penetrability of the soil to water.

On 2 ranches seed was distributed for the purpose of testing varieties of legumes suitable for green manure and their general effect on future crops. Only one of these tests was successful, but it produced fairly good crops of all varieties planted. However, the Whip-poor-will cow pea and the Black Eyed pea proved to be the best growers of the lot used. The ground will be planted to Irish potatoes this coming winter.

Varieties of winter peas and winter vetch have been secured, and will be tried out in a vineyard. Summer legumes are not suitable for vineyard work. The varieties being used are winter vetch, Colorado Special pea, Strategem and Notts Excelsior pea.

The use of green manure is not growing rapidly in popularity, owing to the fact that it costs as much to raise a green manure crop as any other crop, and the expense is considerable. A steady propaganda through the local papers, at farmers' meetings, etc., is being carried on to encourage a more careful use of such barnyard manures as are available. Results from this use, especially on land somewhat alkaline, have been very limited.

(b) Farm Crops.

Work with general farm crops has been very largely confined to a study of the best systems of irrigation for these crops. For instance, in the matter of cotton, the problems of obtaining a stand, reducing shedding and maturing the crop, are all largely problems of irrigation and are discussed under H. Some attention was paid to cotton varieties, but there is so little difference between the three varieties grown here, Hartsville, Acala and Lebane when all factors are considered, that variety is likely to remain a matter of personal choice. An effort to keep the seed pure was not highly successful. Unfavorable conditions at the local gin were largely responsible. The local cotton growers are of too transient a character to carry out any continued policy.

Considerable publicity was given to the use of copper carbonate for smut control, and a number of ranchers have used it. A trip was made through another cotton growing section where the leaf worm had done real damage and arrangements have been made to be on guard against this enemy another year.

(c) Horticulture.

In this department grapes and deciduous fruits occupied the Agent's attention. In the matter of grapes, the Final Fruit Growers' Association, a grape shipping organization, controls practically the whole industry, and the Agent works through them. Demonstrations in training and pruning were held at the farm bureau demonstration vineyard, where a

goodly attendance was secured. The development in this line is more fully described on page A. ~~Y~~ A1

The development of the deciduous fruit industry is largely in the hands of the Casa Grande Fruit Products Association, Inc. This organization is also a marketing Association formed this year. It is on a purely co-operative basis and possessed the rather novel feature, that while only now purchasing trees for its members, it has already secured the stock subscription for the building and equipment of its proposed canneries and other sales equipment. It is, of course, understood that no building will be done until the fruit is ready, but on the other hand no trees will be planted until the marketing facilities are assured. A 5 acre orchard, including some 7 varieties of fruit was planted last spring under these auspices and a car load of nursery stock has been ordered for ~~January~~ ^{January} delivery. The young trees were pruned during the summer by a University of Arizona Specialist and the orchard will be made a demonstration orchard. The Agent pruned trees in some half-dozen small orchards and it is expected that the practice of pruning, which has received no attention to date, will become more popular.

The grape leaf hopper has become a real menace and threatened the extinction of the grape industry locally. The vines showed serious injury as early as April, 1st, completely contradicting the theory that the insects that winter over eat no leaves. At the suggestion of Doctor Vorhies of the University of Arizona, the Agent constructed a cage of a size 3 X 3 X 4 feet, open on one side and covered on all other sides, except the bottom, with double wire mesh. The bottom was made of tin. By carrying the trap against the wind and allowing the vine to enter on the open side, the hoppers flow against the sides which had been painted with oil, and remained. The trap saved one vineyard. A spray pump was purchased on a semi-co-operative basis and used on the older vineyards. Where properly used at the proper time, the hopper was controlled until after the grapes had been harvested. One spraying did this, but one spraying will not control for the entire season judging from this year's results. In company with Doctor Vorhies, the Agent tried out a dust sprayer which gave results equal to the liquid. However, it is difficult to apply on account of continuous winds.

The dust spray was also tried out on melon aphid, and in one case a patch was entirely cleared up. In another case the work was not followed up and the results were small.

The assistance of Plant Pathologist J. C. Brown, University of Arizona, was enlisted in studying a form of grape decay resembling grape shrivel. No results have to far been secured, although it was noted that a heavy foliage was to a considerable extent a protection.

Little work of consequence was done with vegetables, as vegetable growing, excepting lettuce, is still on a small scale here.

Further work in horticulture will be described under marketing.

(d) Forestry.

No work done in this Division.

(e) Animal Husbandry.

The Valley does not lend itself to anything extensive in this line. Grain prices are on an average too high to justify fattening of any animals by its use. Range cattle are brought in and pasture finished on winter grain and alfalfa, and sheep are being brought in to some extent from the hill country to winter and lamb in the Valley.

Practically no extension work has been done in these departments.

(f) Dairy Husbandry.

Some encouragement has been given to dairy farming where an attempt is being made to practice it on a somewhat intensive scale. Market conditions for dairy products have greatly improved, and have made dairying a possibility. However, its success will depend upon cheaper crop production, and this in turn will depend upon improved irrigation methods. It is therefore, at bottom, an irrigation problem.

(g) Poultry Husbandry.

Poultry is one of the class of live stock that can stand purchased feeds, and has therefore been encouraged more than any other line of livestock. Two classes of poultry are engaging the Agent's attention. One, ~~the~~ hen for egg production, the other the turkey.

In the matter of egg production, the Agent has divided the work into two classes; first, the caring for routine work such as improved feeding, housing, brooding and health of the flock, and, second, the encouragement of better egg laying stock by the use of only trap-nest brood males. This latter work is set forth in tabular form on page B. Besides the facts here given, culling has been consistently advocated and the results obtained have been reasonably successful. A factor in this work that is giving trouble, is that the extreme hot weather of summer has a tendency to throw the birds out of production unnaturally. It therefore frequently happens that when culled in August as non-producers, they return to fairly heavy laying in the early fall, thus discrediting the whole system of culling. This needs special investigation.

Some especially good results were secured in the control of a disease generally, but perhaps improperly called roup. Balanced feeding, with an ever present supply of a palatable bulky feed, has never failed to produce the desired results.

In the matter of turkey production, encouragement has been given, as there is ample evidence to show that the local climatic, food and marketing conditions are highly satisfactory. The Agent accompanied a representative of local growers to the Salt River Valley, where 35 head of high grade breeding stock were purchased. During the past year there has been a noticeable improvement in the feeding of turkeys to bring them to a finished condition for the holiday marketing season. There has also been a noticeable improvement in the practice of growers selecting for market only those birds that are at the side ready to go. This has resulted in an offer by one of the largest coast firms of a premium above the market, ranging from 3 to 5¢ per pound.

Continuous propaganda has been carried on for the control of insects, especially the blue bug, with ^{fairly} satisfactory results.

(1) Rural Engineering.

Irrigation work will be described under this head, although the particular kind of irrigation which has received attention is not properly speaking, an engineering problem and does not come within the scope of work of the irrigation engineer. The type of work that has engaged attention deals with the actual application of water to the land, and especially its movement after it passes beneath the surface. A study of the root habits of plants and that part of soil chemistry which deals with the water holding properties of the soil is a necessary basis for a study of such irrigation methods. The irrigator who does not know how deep his water penetrates or its lateral movement, how long it remains in the soil or whether or not it continues to reach rapidly out of reach, is in no position to decide how much water to apply or how often to apply it. Neither can he get very far if he does not know whether the root system he is attempting to feed extends one foot or six feet beneath the surface.

The work done in this line has been pretty fully covered in a report by the Agent to the Irrigation Committee of the Pinal County Farm Bureau, and this report is attached hereto, marked page C to C6.

(i) Rodents, Inedible Animals and Birds.

The distribution of poison for rabbits, ground squirrels and coyotes has been about all of the work done in this division. A tabulated statement is given on page D of this report. Two rabbit drives were held which were not encouraged by the Agent and were not very successful. The plan is not highly feasible. A local rancher reports good success by driving into his alfalfa field at night with his automobile lights turned on and shooting the rabbits as they hesitate in the glimmer of the light. Sixty-nine rabbits were obtained in one night. A considerable number of coyotes were poisoned as well as a number of pet dogs.

(j) Agricultural Economics.

Four parties were secured who have kept books on their poultry in co-operation with the University of Arizona, Poultry Department. These reports are not yet complete. Last year there were two co-operators and the results showed a net profit of over \$3.00 per hen in each case. These results will be checked up again this year. Arrangements have been made for securing exact figures on yields and returns of cotton on considerable areas. But as the crop is not yet all harvested, no final report has been made.

The local poultry association that has been marketing local eggs for some time, closed business on August, 1st. It was financially solvent, showing a balance above all liabilities of \$118.22, but as the egg supply during the fall is so near the local demand, the association could not induce the members to pay the 5¢ per dozen charge, when the stores were willing to take the eggs without such charge. The association saved the local egg market during the past two heavy producing seasons and it is not yet known what course will be taken when the heavy season returns.

The Pinal Fruit Growers' Association marketed most of the local grapes this year, shipping out about 5 car loads. Most of the grapes went

Last, but not least, about one car load was shipped out locally by express. The average net returns to grower above all costs was \$59.60 per ton, which is a considerable advance over most districts that shipped grapes this season. The Association is purely co-operative and has already arranged for a somewhat improved marketing system for 1924. A complete analysis of the figures presented on the books of the Association for this year was made out by the Agent, and was the basis upon which the new marketing system was formed. A much increased production is expected next year as new vineyards are coming into bearing.

(c) Community Activities.

Community activities ^{are} very largely included within the scope of work of the local and county farm bureaus. The County Bureau is active and meets regularly every month. It is composed of two representatives from each local, of which there are five in the County. The County Bureau handles nearly all phases of community life other than the marketing of products. This matter is left up to organizations created especially for this purpose. Besides regular work, such as promoting plans for increased water supply, arranging for various cultural demonstrations, instituting a study of irrigation methods and pest control plans, the County Farm Bureau this last year received an appointment from the County Board of Supervisors to act as Fair Commissioners. The work of the County Bureau pertains first to business. The local bureaus carry out in their local organizations the plans made by the County Board and matters that pertain to their district, secure information of various farming problems in which the locality is interested and provide entertainment for the community as a whole.

(d) Miscellaneous.

Under this heading I would refer to the County and State Fairs. The County Fair was organized by the Agent in 1921. The exhibit was contained in a small room and the total expense amounted to \$100.00. In 1923 the exhibits filled a building 40 by 150 feet, and further included in another building an exhibit of over 200 head of poultry. The total expense of this fair was about \$2000.00. As a result of this collection of products the County's exhibit at the State Fair this year was much larger and better than it has been before and gave the county a standing of third place. The success of these two exhibits can be largely attributed to the farm bureaus. Where such organizations do not exist the exhibit collected was small.

Owing to the fact that the county as far as its agriculture is concerned is in the pioneer state and requires a large amount of organized effort for its development and settlement, it was necessary for the Agent to devote a considerable amount of time in co-operation with such organizations as the local chambers of Commerce, the Lower District Board, local women's clubs and other organizations not strictly farm organizations. With Chambers of Commerce the work consisted in bringing these organizations into closer contact with the farmers' organizations, in assisting in the compilation of data for publications to be issued and in the general effort to spread a more definite knowledge of agricultural conditions through the non-agricultural sections. The work with women's clubs was largely of a similar nature. With the Lower Board efforts were directed mainly along organization lines and the spread of correct information secured by the board to the people of the district which they served.

Under this heading also might be listed the work done in publicity. For the past two years the Agent carried space in the three valley papers,

ranging from one-half to three columns per issue (weekly). This copy was carried under the heading "Farm Bureau Notes." It consisted, usually, of short items varying in length from a half-dozen lines to half a column. The space was supplied free by the newspapers, as the material is considered of news value.

(V) OUTLOOK AND RECOMMENDATIONS, INCLUDING SUGGESTIVE PROGRAM OF WORK FOR 1922 L.A.R.

A comparison of the outlook at the present time compared with that of two years ago, or even of one year ago, makes a most striking contrast. Two years ago we were resting more or less easily at the bottom. Today we are rapidly ascending a boom wave. Thirty-five to Forty cent cotton (short staple) is sure to create a boom. Cotton growing conditions here, while somewhat expensive, are more or less ideal, and profits from cotton at quoted prices are large. Reasonably good land properly cared for, has made a bale of cotton per acre this past season and frequently this yield has been exceeded. Just what the course will be is hard to say, but judging from past experience there will be a strong tendency towards one crop farming and a complete neglect of every other line. Ranchers will buy their hay, vegetables, meat, milk and eggs. The attitude of the banks may possibly be counted upon to check this movement somewhat, and the Agent together with all local organizations will use influence to check it. However, it is confidently expected that there will be a considerable drop in interest in all lines of agriculture other than cotton production.

Under such conditions it is difficult to outline a policy, and the situation, therefore, ^{must} be handled as it develops.

In a general way, however, it will be the policy of the Agent to devote as much time as can be spared to the study of irrigation problems and the investigation of local irrigation conditions. In other lines the policy will be to endeavor to make successful those branches of agriculture that have recently been started. Of these we might mention intensive poultry farming, including turkeys, intensive dairying, grape production and deciduous fruit growing. There are not so many of these but that it will be possible for the Agent to keep in fairly close touch. It is hoped thereby to so demonstrate the success of these ventures that when the boom finally breaks, the community can turn at once to these proven lines and not flounder about as it did in 1921.

(VI) SUMMARY OF ACTIVITIES AND ACCOMPLISHMENTS.

The preceding Report may be briefly summed up in the following manner. Organized extension work is done chiefly through farm bureaus, but the Agent co-operates with other public and semi-public bodies within the county. The program of work can be fairly clearly defined, except that the rapid growth from extreme commercial depression to a condition approximating a boom, makes necessary somewhat rapid changes in policy. In the main the program consists in carrying along plans for the development of improved methods in general farm practice and endeavoring to see that such improved methods are used to stimulate further development and further improvement. This may be termed the routine work of the Agent. It is of a miscellaneous nature and changes from time to time as necessity may arise. A slight exception to this general condition may be found in the poultry division where special efforts are being made to induce the use only of male birds in the flocks, whose flocks have no production records. Besides this part of the program, which has already been referred to as routine, all available time has been and will continue to be spent on the main project, irrigation. The nature and scope of this work could not be dealt with in a summary, but it may be said that it refers not to the question of irrigation engineering, but to that phase of the subject which deals directly with the application of water to the land and the duty of that water as long as it functions as an agent of plant growth.

Speaking briefly of the various projects that have been tried, a few items may be noted. Commercial fertilizers have been tried out to some extent and results so far of a negative nature. The use of legumes for soil improvement is receiving some attention, as are backyard manures. The poultry industry is developing in size and efficiency. This latter is the result of improved feeding methods and improved breeding. Commercial live stock has received less than attention. Rabbits and predators are in a certain sense confined to the district of poison. Most work on the back has been successful fight against the grape leaf hopper. Co-operative nesting has been confined to poultry and grapes and has been reasonably successful. Regular demonstrations showing correct methods of the care of grapes and deciduous fruits have been established and are part of the regular program. The county farm bureaus are active and are the recognized rural district organizations. The county fair has grown considerably and is a recognized success. The general feeling is that the county is entering on a cotton boom and that mixed farming will receive less attention from the farmers as a whole than in the past, but an attempt will be made to hold interest in these lines as high as possible.



Yearling Malaga Vines



Grape Growers at Demonstration



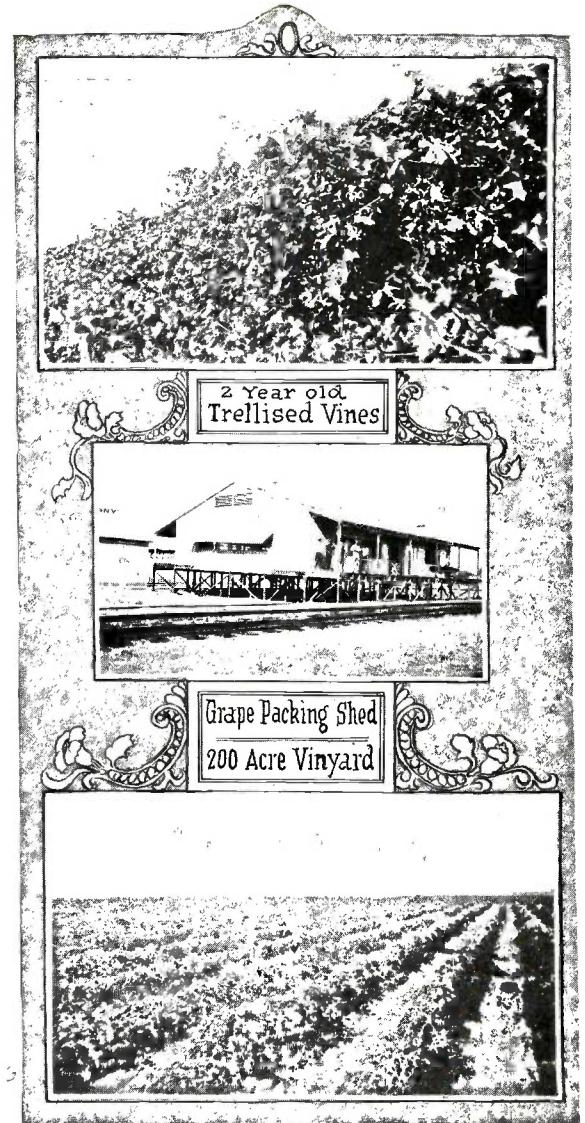
THE accompanying cuts give a further idea of the development of the table grape industry in the Valley. At the top appears a sectional view of a ten-acre tract of yearling Malagas. At the right center is shown this year's production of one of the vines shown as "Two-Year-Old Trel-lised Vines" on the opposite page. The other pictures were taken at the Farm Bureau Pruning Demonstration, held in February, 1923. They illustrate the interest and the business-like attempt of the growers to put their industry on a sound commercial basis.

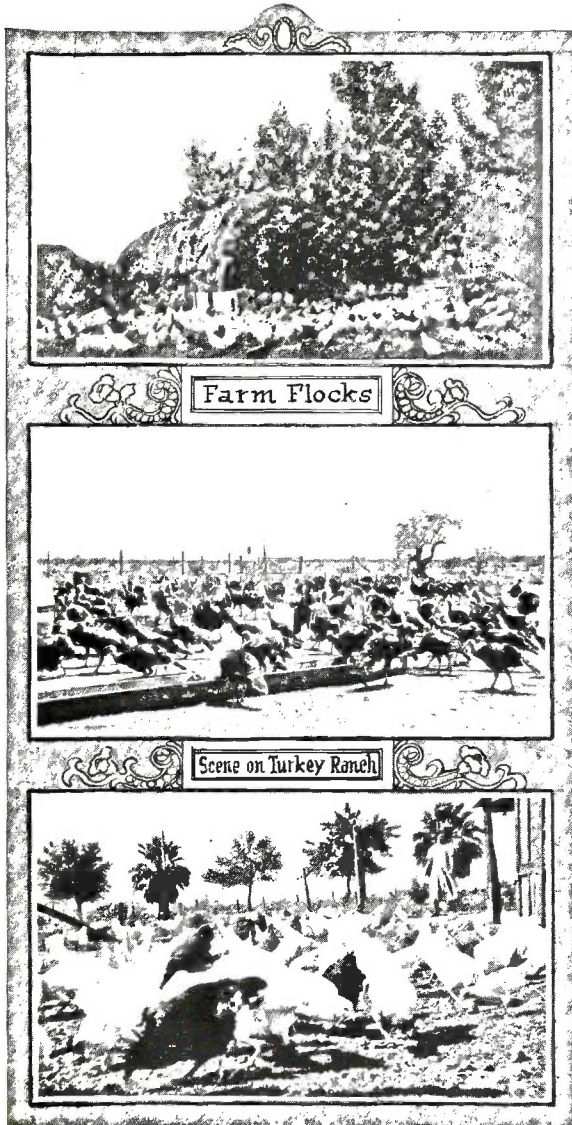
Views on the Farm Bureau Demonstration Vineyard in the Casa Grande Valley.

THE production of table grapes on a commercial scale is now well established. As these grapes appear on the market from two to three weeks ahead of those from the well-known grape sections, they find a favorable market. This year, 1923, the first grapes were shipped out June 27th.

Malagas and Thompsons are the two most popular varieties, but other varieties are being tried out.

The upper picture shows the splendid development attained in a two-year-old vineyard, and the lower picture is a view in a 200-acre vineyard in the center of the Valley. In the center is shown the grape-packing shed at Casa Grande, where the co-operative association, known as the Pinal Fruit Growers' Association, pack and ship their product.





THERE are some real reasons why this district is well adapted to poultry production. Of these there should be mentioned, first, this one: that the mild fall and winter allows of an egg production in this "off-season" much above that usually attained in other sections of the country. This "off-season" is naturally the season of high prices. The second advantage is the mild, dry springs, which make easy the production of young stock.

Turkeys do exceedingly well when given proper attention. A large local producer has just contracted his turkeys on the Los Angeles market for the Thanksgiving trade at a flat 5-cent premium price. None of these birds have ever seen the inside of a building.

The chickens shown in the accompanying cuts are farm flocks, while the turkeys are a part of "one-thousand-bird flock."

POISON DISTRIBUTION, 1923.

	No of Farmers and Stockmen.	Quarts Poisoned Grain.	Oz. Strychnine Distributed.	Tablets Poison.	Acres Treated
Rodents.	140	53	81 7-12		5367.
Predatory Animals.	14	--	--	500	10,240.

POULTRY.

Table showing the relative condition of the flock in the County with reference to egg production breeding in 1920 and 1923. (T. N. stands for Trai Nest, and refers to yearly records, mostly above 200 eggs).

	(1) No. of T. N. Hens.	(2) No of Hales of T. N. Breeding	(3) Hens Sired by (2).	(4) No of Owners of (1).	(5) No Owners of 2.	No owners of 3.
Nov., 30th, 1920.	0	1	50	0	1	1
Nov., 30th, 1923.	70	19	650	3	11	8

Mr. George Nime and W. I. Davidson, Committee on Irrigation, Pinal County Farm Bureau.

Gentlemen:-

The small amount of work that I have so far been able to do for your Committee has brought out the fact that we have undertaken a task that will not be completed in any short period of time. I have therefore decided to submit to your Body a Progress Report giving an account of the work done up to this time. It will be noted that this work is very incomplete and that nothing has yet been learned which will serve as a basis from which to draw conclusions.

To re-state briefly the plan of work as it is now outlined, I would say that we still have as our three main subdivisions those upon which we originally started: (1) A study of the root development of our common crop plants under irrigation; (2) A study of the penetration of irrigation water into the soil and its movement thereafter; (3) The possibility of the storage of water within the soil for use at a later period when for any reason water is not supplied. I will deal with these three phases of the work in order, given

(1) A STUDY OF THE ROOT DEVELOPMENT OF OUR COMMON CROP PLANTS UNDER IRRIGATION.

Practically all of the work done in this line has been that of studying reports of investigation work done by authorities along these lines, notably, Professor J. E. Weaver, Botanist, University of Nebraska; Professor W. J. Burr, Agronomist, University of Nebraska and Edwin C. Miller, Botanist, Kansas Agricultural College. Summing up their reports very briefly, I would state that Professor Weaver shows by very extended and careful examination of roots, mostly in the Middle West and in Colorado, that the more common grass roots extend usually to depths varying from 3 to 8 feet, oftentimes penetrating hardpan (it is suggested by Professor Weaver that this later penetration occurred during some abnormally wet season when the hardpan was softened by the rainfall). In his reference to crop plants he shows working depths of roots at from 5 to 8 feet, with greater maximum depths. Professor Burr states that he has found

winter wheat roots to a depth of 7 feet at North Platte. Professor Burr further states as follows, "Regarding the root development, I feel safe in saying that in the main it is limited by the zone of moist soil, rather than by any inherent characteristics of the plant." Edwin C. Miller of the Kansas Agricultural College, in a work entitled, "Comparative Study of the Root Systems and Leaf Areas of Corn and the Sorghums," gives us some very interesting material on the root development of corn and sorghums, showing these plants to regularly extend their roots in the soils he used to depths of 6 feet and slightly over. Four feet showed large working root systems. Other works on root development have been asked for but not yet received.

A condition was found locally that appears interesting. A piece of old alfalfa was examined, and the soil at a depth of 6 feet was found quite wet. In spite of this, few, if any, alfalfa roots apparently extend below the 2 feet level. There was no reason as far as could be seen for believing that the soil was the cause of this lack of further development. Further work is now planned which will allow us to dig out a number of the roots from this field and a similar number from a field where the water requirement per ton of hay has this year been much less, in fact about one-half of the field under discussion.

While very little work has been done in this line, all of it has emphasized the practical necessity of a study of root development, and has given some grounds at least for the belief that the training of a root system is just as practical and just as much under our control as the development of a steer.

(2) A STUDY OF THE PERMEATION OF IRRIGATION WATER INTO THE SOIL AND ITS MOVEMENT THEREAFTER.

In this line of work I have not been nearly so successful in obtaining information as in #1. As a matter of fact, I have so far obtained nothing that deals with this subject from a field standpoint, except as it may have been touched upon by investigators studying other somewhat related problems. It is highly

probable that it is my own fault and that I will later discover printed literature on this subject.

We have, however, developed a method of studying penetration under field conditions which gives promise of being of much service. The plan now known as the Final Field Penetration Test was first discussed at the Signal Peak Farm Bureau and later tried out at the George Scheerer ranch. It consists in making use of a form constructed of a piece of tin 10 inches wide and having a length that when both ends meet forms a circle of approximately 27 inches in diameter. When placed upon the ground and lashed around, an application of 2½ gallons of water within the form will give approximately a 1 inch irrigation. Numerous 4 and 6 inch irrigations were applied and after noting the time required for the water to disappear and allowing from 24 to 48 hours for final settling, a hole was dug directly across the watered section. The exact extent of penetration, vertical and horizontal, was then noted. Some interesting results were obtained. *In* a sandy soil merging into clay beneath the surface, the moisture outline represented, somewhat, a hexagon with the greatest depth on the vertical middle line and the greatest width about 1 foot below the surface. In some very tight land the moisture line appeared to resemble the outline of a washtash with wide top flanges. In another soil less tight, the outline resembled more that of an egg with the large end upwards. In all cases there was a more or less rapid pinching in of the moisture line to the center vertical depth. The work illustrated, *that* ~~easy~~, it is possible in certain soils to have a surface wet while large sections below the surface may remain quite dry. This, of course, refers to furrow irrigation. It is planned to begin at once a rather extensive study, using these forms to ascertain if something practical can be obtained in the way of an improved knowledge of moisture penetration in furrow irrigation.

While little definite information was obtained on the matter of the continued movement of soil water, it would appear that many authorities believe that water stored at considerable depths in the soil, say 4 to 6 feet, remains more or less constant over a considerable period, unless absorbed by roots that actually penetrate

this area.

Some soil samples were taken on land irrigated from the ditch and the results obtained showed the penetration of water near the head of the border to be approximately 2½ feet, at the middle of the border 3½ feet, and near the lower end of the border 5 feet and better, the extent not exactly determined. In a pump irrigated field the penetration near the head of the border was found to be 6 plus feet, while that at the lower end of the border was very small, no moisture appearing at the time of the test. A soil examination of the ditch water land showed for physical analysis a coarser structure at the head of the land than near the foot. However, a chemical analysis of this same soil for some reason showed a much larger lime content at the foot of the border than near the head. It has been suggested that this lime content was responsible for the superior penetration. This test will be duplicated.

All that can be said so far as a result of tests made, is that the water distribution beneath the soil in our general irrigation areas is far from even, and that there would seem to be an opportunity for a good deal of work in studying further this distribution.

(3) THE POSSIBILITY OF WELL STORAGE OF WATER WITHIN THE SOIL FOR USE AT A LATER PERIOD WHEN FOR ANY REASON WATER IS NOT SUPPLIED.

This phase of the subject is naturally one requiring a considerable period of time for the development of any results that can be of value. Reports of the test work of some investigators have been secured and may be briefly listed as follows: in U. S. Bulletin #1139, entitled, "The Storage of Water in Soil and its Utilization by Spring Wheat," much interesting data was secured. In brief it may be summed up by quoting the authors to the effect that wheat roots feed uniformly through the first 4 feet of soil when moisture is present to that depth. Cases were noted where the wheat roots fed in the 5th and 6th feet. In a letter from Professor Edwin C. Linder of the Kansas Agricultural College, he states, "From my knowledge and experience at Garden City Kansas, I am inclined to believe that under these

conditions (a heavy fall irrigation and no further irrigating water) sufficient water could be stored when it is plentiful to produce a crop of grain. At Garden City, Kansas, sorghums were produced to maturity when grown on land that had received nothing but fall irrigation that penetrated at least to the first 6 feet of soil." In a letter from Professor W. J. Burr, University of Nebraska, he states, "Regarding the storing of water in the subsoil, we feel it is entirely feasible and practical."

Such sentiments appearing so frequently in the writings of wellknown authors encouraged us to request the Experiment Farm, University of Arizona, and the Federal Station at Sacaton, that they institute a set of experiments to test the plan under local conditions. While these experiments vary somewhat, in the main, they may be described as follows:

Plot #1. Planted to winter wheat. Irrigated before planting to secure a penetration of 6 feet. The plot to receive no further irrigation.

Plot #2. The same as plot #1, except that the soil is refilled with water about March, 1st and no further irrigation after April, 1st.

Plot #3. The same as #1, except that the irrigation water is applied as needed up to April, 1st.

Plot #4. Irrigated before planting to secure a 3 feet penetration and regularly irrigated thereafter up to April, 1st.

At Sacaton, the rate of seeding varying from 40 to 80 lbs. per acre, will also be tested on these plots, as well as the plan of planting dry and irrigating up.

These experiments should give us some valuable data, providing we do not have too much rain during the winter which would result in producing a crop irrespective of the irrigations used.

At the request of the Grape Growers' Association, a plan is being worked out with the Department of Horticulture, University of Arizona, to try out the effect of water storing and reduced watering during the growing season on the

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ripening period of the grapes.

On the whole, these irrigation studies appear to be developing a line of information of practical importance, and it is hoped that it may be possible to concentrate on this work to considerable extent.

A list of references, naming books and bulletins that have been found especially valuable is appended to this Report. They are selected from over 40 publications secured by the writer, dealing with some phase of irrigation.

Respectfully submitted,

E. S. Turville,
County Agr. Agent.

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LIST OF REFERENCES
Found
ESPECIALLY SERVICEABLE.

- The Storage and Use of Soil Moisture. I. W. Durr.
Report of work at North Platte, University of Nebraska.

- The Storage of Water in Soil and Its Utilization by Spring Wheat.
C. H. Matthews.
U. S. Bulletin #1139.

- Water Stress Behavior of Pima Cotton in Arizona. C. J. Higgins.

- Use and Waste of Irrigation Water. C. E. L. Smith.

- Winter Irrigation of Deciduous Orchards. Alfred J. McClatchie.

- Bulletins #161 & 162, Utah Experiment Station.

- Water Holding Capacity of Irrigated Soil. Bulletin #185 Utah College
of Agriculture.

- "Comparative Study of the Root Systems and Leaf Areas of Corn and Sor-
ghums" and other works. Edwin S. Linder.

- Relation of Hardpan to Root Penetration in the Great Plains.
J. A. Weaver.