NAVAJO SERVICE

LAND MANAGEMENT SURVEY

UNIT — 3

AGRONOMY BRANCH REPORT

WR 1643

1936-1937 (?)

INDEX

	Page
Acres farmed by Navajos, Hopis, and Piutes	1
Acres farmed by Government	1
Acreage per capita for Unit	1
Acreage of irrigated, flood irrigated, and dry farms	6
Acreage of Class A, Class B, Class C & Class G Land	6
Acreage of each crop produced in Unit	13
Agricultural concentrations divided into five areas	6
Tuba City, Area No. 1	6
The Upper Moencopie Diversion	7
The Lower Moencopie Diversion	8
Pasture Canyon	8
Reservoirs north of Tuba City	9
Moenave Demonstration Area, Area No. 2	9
Coal Mine Mesa, Area No. 3	10
Willow Springs and vicinity, Area No. 4	10
Cedar Ridge, Area No. 5	11
Classification of Agricultural Land	5
Classification of Land taken from Unit No. 4	5
Cultural Practices	4
Definition of terms used in survey sheets	26
Drainages	2
Elevation	2
Erosion within the Unit	4
Farm Pests, Weeds, Rodents, and Insects	14
General location of the Unit	1
Growing Season	3
Legend used in Land Classification	28
Method of location and numbering farms	4
Population, number of Navajos, Hopis, and Piutes	1
Projects for immediate work	20
Percentage of range land, waste land, and farm land	1
Rainfall Records	2
Recommendations	15
Subjugation Costs	19-20
Suggested Crops	14
Summary	24
Survey notes on each farm	33
Table showing acreage and percentage of different crops grown and the population in each of the Agricultural Areas	12
Temperature Records	2
Topography	1
Types of Agricultural Land defined	5
Yields of crops grown	13

WR 1644

NAVAJO SERVICE
AGRONOMY BRANCH REPORT
ON
LAND MANAGEMENT UNIT # 3

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Location:

Land Management Unit #3 lies in the extreme western section of the Navajo Reservation. Its confines are approximately the 35°30' parallel on the south, the 36°45' parallel on the north, the 111°45' meridian on the west, and the 111° meridian on the east. This boundary covers the unit under the proposed change and the report is made on the basis of the changed boundary as proposed.

Area:

The area of the unit under the new boundary is 1750800 acres, including 7,340 acres within the Moenave Demonstration Area.

About 16 % of the Unit is waste land. 83 % is range land and .12 % is farmed at present.

Population:

The population of the Unit is approximately 2181 or 298 consumption groups. There are 1980 Navajos, 249 Hopis and 12 Piutes within the Unit.

The Navajos farm approximately 1,154 acres, the Hopis, 619 acres, and the Piutes have 4 acres. The government owns approximately 400 acres in the vicinity of Tuba City. There is approximately 1 acre per capita farmed at the present time.

Topography:

Most of this Unit consists of plateau. The only mountainous portion is Grey Mountain which lies in the southwestern section of the Unit. The country from Cameron north, west of highway #89 slopes generally to the east. Gully erosion is not serious due to the type of soil and exposed rock. This section is bounded on the west by the Colorado River canyon and on the east by the Echo Cliffs. The rolling country north and west of Tuba City is fairly sandy and has been greatly modified by wind erosion.

WR 1645

CV-6417-201 NN002618

Active dunes are present and there are only a few drainages. Deep canyons are found in the vicinity of Coal Mine Mesa and Howell Mesa. There is a wide, rather flat area along both sides of the Little Colorado River above Cameron and along the west side of the Denibito Wash. Part of the central section is classed as bad lands.

Drainage.

The largest drainage in this Unit is the Marble Canyon section of the Colorado River. This river forms the north western foundry and flows generally south. The second largest drainage is the Little Colorado River which flows northwest through the southern section of the Unit. Approximately two thirds of the area drains into this river. The third important drainage is the Moencopi Wash which flows southwest and enters the Little Colorado River near Cameron.

Temperature:

Temperature records were only available from one station within the Unit, which is Tuba City, and Lee's Ferry which is just across the Colorado River. Records are also available from Kayenta, Flagstaff and Grand Canyon, outside of the Unit. These records are shown as follows:

Year	Station	Temperature Range		
		Maximum	Minimum	Average
1935	Tuba City	104°	+ 3°	55.9°
1935	Lee's Ferry	109°	+13°	61.5°
1935	Kayenta	100°	+ 2°	52.2°
1935	Flagstaff	92°	-10°	45.7°
1935	Grand Canyon	91°	- 6°	49°

Elevation:

The elevation within the Unit ranges from 3200 feet at Lee's Ferry to 7000 feet on Grey Mountain.

Rainfall:

Rainfall records are available from one station within the Unit at Tuba City. These records can be taken as representative for most of the farm land because it is located where it will get very similar rainfall.

WR 1646

CV-6417-201

NN002619

The following is the record observed at Tuba City over a 29-year incomplete record:

Month	Precipitation During the Driest Year. (1924)	Precipitation During the Wettest Year. (1906)	Average Precipitation for the Period
December	.82 inches	2.23 inches	.58 inches
January	.16 "	.53 "	.55 "
February	.00 "	.34 "	.54 "
March	.12 "	1.59 "	.54 "
April	.09 "	.19 "	.43 "
May	.02 "	.34 "	.53 "
June	.00 "	.00 "	.19 "
July	.00 "	1.73 "	.34 "
August	.10 "	1.26 "	.93 "
September	.14 "	1.37 "	.84 "
October	.13 "	.27 "	.68 "
November	.00 "	2.92 "	.78 "
Total	1.58 "	12.57 "	6.92 "

Growing Season:

The growing season as observed at Tuba City over a 24-year period is shown as follows:

Average date of last killing frost in spring	April 23
Average date of first killing frost in autumn	Oct. 19
Latest date of killing frost in spring	May 9
Earliest date of killing frost in autumn	Sept. 19
Average length of growing season	179 days

(Data was obtained from University of Arizona Extension Circular #76.)

WR 1647

CV-6417-201 NN002620

The above dates can be taken as generally indicative for the Unit as a whole.

Erosion:

Wind erosion is the outstanding erosion problem found within the Unit, and damage from gullying is noticeable on a few of the flood irrigated farms. The soil on the farm land varies from a sand to clay loam or light clay. The majority of the farms, however, have a fairly sandy soil which aids considerably in crop production. Agricultural soil is fairly abundant with the limiting factor for agricultural development being to supply sufficient water for farming.

Cultural Practices:

There are two principal kinds of farmers found within this Unit, the Hopi and the Navajo.

The Hopi's not only practice a more modern type of agriculture, but they are more efficient users of the available farm land and water. Their land is usually bordered or terraced and protected where necessary against damaging flood waters. They raise a large variety of crops, but corn is probably the principal crop grown.

The Navajos, in most cases, get by with as little work as possible in producing their crops, and often this is done to such an extent that the productivity of the farm land is greatly reduced. Corn is the principal crop grown by the Navajos; however, they do produce a few squash, melons, and other vegetables on the more productive lands.

Very little farm machinery is used by either the Hopis or Navajos. The only common implements are the plow, the blade cultivator and hand tools, such as the hoe, shovel, etc.

Method of Location and Numbering:

Each farm was located on quadrangle half tones, made from aerial mosaics and numbered, using the same numbers as those used on the agricultural survey, and water spreading survey during 1935. On large areas where more than one farm was included under one number, the tracts were broken down, using the decimal system to number them. Additional tracts of agricultural land not previously located were numbered, beginning with the number where the water spreading survey left off. A number was placed on each farm to correspond with the number on the map.

Potential land adjacent to present farms is not always located accurately on the map. It is shown and colored principally to indicate potential land near the present farm.

WR 1648

CV-6417-201 NN002621

Agricultural Land Classification:

The farming on this Unit consists primarily of irrigated and flood irrigated land. Dry farming is not found to be very successful due to the lack of sufficient rainfall, which averages about 6.9 inches. A very noteworthy feature of this Unit is that the acreage of irrigated land is more than twice the acreage of flood irrigated. This gives a reason for two immediate conclusions:

1. The farming is more concentrated into large areas.

2. The farm land as a whole has a higher per acre value.

On this survey, 110 farms were located, which represent a total of 1,713 acres of present agricultural land, and 184 acres of potential land. Besides this, there are 464 acres of present land and 20 acres of potential land, which comes into this Unit from Unit #4 under the boundary change. This makes the total acreage of present land, 2,177 acres, and potential, 204 acres. This acreage will be aided into this Unit and used throughout the report.

The following table shows the land in detail taken from Unit No. 4:

Classification	Present Acreage				Potential Acreage			
	Class A	Class B	Class C	Class G	Class A	Class B	Class C	Class G
Irrigated	0	0	0	0	0	0	0	0
Flood Irrigated	216	5	6	0	15	0	0	0
Dry Farm	228	4	5	0	5	0	0	0
Total	444	9	11	0	20	0	0	0
Costs	69 acres		$14,20.00		13 acres		$265.00	

The farm land is divided into three types, and four classes under each type, according to the legend of land classification attached to this report.

1. Irrigated land includes all farming done where permanent water is supplied for irrigation.

2. Flood irrigated land includes all farming done where water is supplied by accumulated runoff from rains.

3. Dry farming includes all farming done where no extra water is supplied besides the rainfall.

WR 1649

CV-6417-201 NN002622

The following table is compiled to show the acreage of each type of land, and the acreage classified under each type:

Type of Land	Present Acreage	Potential Acreage
Irrigated	1195	101
Flood Irrigated	688	97
Dry Farm	294	6
Total	2177	204

Classification	Present Acreage				Potential Acreage			
	Class A	Class B	Class C	Class G	Class A	Class B	Class C	Class G
Irrigated	1146	13	4	32	96			5
Flood Irrigated	451	220	6	11	77			20
Dry Farm	271	18	5		6			
Total	1868	251	15	43	179			25

Agricultural Concentrations:

This Unit is divided into five agricultural areas as follows:

1. Tuba City and vicinity
2. Moenave Demonstration Area
3. Coal Mine Mesa
4. Willow Springs and vicinity
5. Cedar Ridge

The following is the general observations on each of these areas:

1. Tuba City and vicinity:

The farm land located in this area represents the most valuable agricultural asset within the Unit. Water for irrigation is supplied from three principal sources: 1st, the Moencopi Wash; 2nd, Pasture Canyon; and 3rd, two small reservoirs immediately north of Tuba City

WR 1650

CV-6417-201 NN002623

a. The Moencopi Wash.

At present, there are approximately 780 acres of land being farmed from the water supplied by the Upper Moencopi Diversion. Of this acreage, 340 acres are government owned, 358 acres are Navajo owned, and 82 acres are Hopi owned. The land is all bordered and border irrigation is practiced. As a general rule, the flow of the Moencopi Wash, during the growing season, is no more than sufficient to handle the present land and no potential land is proposed under this diversion.

Flood water passes over approximately 100 acres of this land in about the central section of the farming area. This, however, is more of a detriment to the land than an advantage because of the heavy soil it deposits and the head erosion it causes. To remedy this, it is possible, and may be advisable, to cut a channel through the farm land to carry the flood water into the Moencopi Wash.

At several locations on the farm land on each side of the Wash, head erosion is cutting back into the farms from the main Wash. This needs control before severe gullies work their way into the area. On the lower farms on the south side of the Wash, there is need for contour dikes to carry the flood water away from the farming area to prevent the depositing of heavy, raw, soil materials.

Sloughing along the Moencopi Wash is encroaching on the farm land, and, at one location, is moving near the main irrigation channel. All the planting that could be carried out to help stop this sloughing through the farm area should be done. There is no subjugation work needed on the farm land other than the proper handling of water and proper tillage practices as could be carried out by someone charged with the supervision of the area.

White top weeds have been reported in two locations through this area and several fields were seriously infected with cocklebur. Control measures should be taken immediately on each of these weeds, especially the white top, for it can spread very rapidly and become a serious problem throughout the whole farming area.

Alkali is noticeable on about ten acres of this farm area, and seems to be increasing. Proper farming practices and crops should be encouraged to check the concentration and spread of this alkali.

WR 1651

CV-6417-201 NN002624

The Lower Moencopi.

A diversion dam has been constructed in the Moencopi Wash below the present upper dam, but no land has been subjugated. The soil at this location is not of the very best quality, but there is approximately 330 acres of Class B land, as classified by the Soils Branch, and about 70 acres of Class C land which could be cultivated if the water proves sufficient to subjugate this amount. The farming under this diversion will be dependent on using fall and spring irrigations with the exception of a very few occasions when all the flow is not diverted for use at the upper diversion during the growing season. In view of this fact, it is proposed that the acreage be limited to 50 acres and if the project proves successful, the acreage can be increased later to the extent of the water supplied.

Due to the fact that the water for this area can only be depended upon during the fall and spring months, it is very likely that such crops as fall wheat, rye, millet, and sudan grass would prove more successful. However, it would probably be a very good idea to try other crops on a small scale, and if they prove successful, their acreage can be increased. It might ever be worth while for the government to operate a small experimental and demonstration plot at this location which could help demonstrate to the Indians in this locality the most successful crops and the proper tillage practices.

To properly subjugate this land, it will be necessary to fence the area, level and border the land and lay out a system of ditches. The main channels from the dam have already been constructed.

Planting is needed near the dam to help protect the banks from sloughing off and protect the dam from side cutting.

2. Pasture Canyon.

The water from Pasture Canyon is used principally by Hopi farmers. They have approximately 196 acres, the Navajo's, 14 acres, and the government, 25 acres, which makes a total of 235 acres under this water source.

The government land in this canyon is located near the head of the canyon and is all meadow or grass land used for pasture. Most of the area is swampy, with a high water table. It is proposed to put in a drainage system through this area to drain the water into ditches and run it directly to the reservoir. By doing

WR 1652

CV-6417-201 NN002625

this, the ditches would probably drain the land sufficiently that garden crops and fruits could be successfully produced, where grass is now grown.

Below the government farm a large sand dune is moving into the canyon and endangering the water supply and reservoir. This should be fenced and planted as much as possible to reduce the danger of the sand dune moving into the canyon.

A definite ditch is needed from the reservoir to the Hopi farms rather than using the old gully bottom where the water meanders around and suffers a loss due to seepage and evaporation.

No work is needed on the Hopi farms except the proper supervision of water usage. As a general rule, the available water is no more than sufficient to handle the present farms. However, if the water supply is increased by proper drainage and storage, there is more land nearby which could be placed under irrigation.

3. Reservoirs north of Tuba City

The land irrigated from these two reservoirs is all government owned. It comprises approximately 35 acres. It is located within Tuba City and is used by different Government employees and agencies within the Navajo Service.

No work or treatment is proposed on this area.

2. Moenave Demonstration Area. -107 ac

Water from small springs and seeps is supplied for all the farms within this area and represents a very valuable agricultural asset to this Unit. Storage reservoirs have been constructed at the three following locations to make use of this available water:

a. At Moenave Day School
b. Moenave Demonstration Area Camp
c. East of Moenave Demonstration Area camp along the Tuba-Moenave road.

The farm land under each of these reservoirs is terraced or bordered and well taken care of so that no work is needed. However, at the Moenave Day School, at the SCS camp and at the locations of Farms 16 and 17, along the Tuba-Moenave road, reservoir sites have been located by the Engineering Branch, which could store the water for use during the growing season, that ordinarily runs to waste six months out of the

WR 1653

CV-6417-201 NN002626

year. Suitable farm land is available for expansion to the limit of the water developed at each of the reservoir locations and can be developed at a very reasonable cost. This land would require leveling and bordering and a system of ditches.

The acreage now farmed in this area is 107 acres and the estimated acreage that could be put under cultivation by the increased storage of the reservoirs is 36 acres. All of this land is inside of the Moenave Demonstration Area fence.

3. Coal Mine Mesa.

The farming in this area is of an entirely different nature than that found at Tuba City and Moenave. The owners are dependent entirely upon flood water to produce their crops. Most of the Indians have their farms located near gullies or gully fans where they can get the benefit of runoff from the rain storms. Most of the land in this section is fairly sandy and favorable for farming where water is supplied. At the present time, there are very few borders or water spreaders on these farms and work is needed to spread the water more uniformly over the farm land to prevent it from starting a channel through the lower parts.

4. Willow Springs and vicinity. 4-1 ac

This area is very similar to the Moenave Area except that it hasn't been as highly developed. Water is supplied from springs, and, at most of the farms, there is some type of a reservoir which is used to store the water long enough to get a good stream for irrigating. None of the reservoirs ar large enough to store the flow during the winter months.

The land now being farmed is on a 2-6% slope, but it is either terraced or bordered. At several of the farms flood water often cuts down through the farm and washes out the borders. This can be diverted around the side of the farm with a little work, and should be done to protect the land now under cultivation. The storage capacity can be increased on the reservoirs now in use, and at the location of Farm #11 (Quad.19) a reservoir can be constructed to store water for irrigating this farm.

The acreage in this area is only 44 acres, but this land is valuable because it is supplied with permanent water for irrigation, and the agricultural land within the Unit is limited by the amount of available water.

WR 1654

CV-6417-201 NN002627

5. Cedar Ridge.

This area is comparable to the farm land found on Coal Mine Mesa. The farms in this area are all located along one general drainage which flows north from Cedar Ridge along Highway 89. These farms are dependent upon flood water to produce their crops, but on some of them the gully has cut down and the farms only get water when the water overtops the gully banks. However, at the location of farms 11, 12, and 13 (Quad.85), it is possible to border the land and utilize the available water which just takes a natural course over the land at the present time. Farm land is very scarce in this vicinity and every effort possible should be made to protect the present land.

WR 1655

CV-6417-201 NN002628

The following table shows the population, acreage (present and potential), and percentage of the different crops grown in the five agricultural divisions of the Unit.

Division	Population	Consumption Groups	Acreage and Percentage of Total										
			Present	Potential	Corn	Sudan Grass	Alfa.	Orch.	Beans	Veg.	Squ.	Mel.	Idle.
Tuba City			1151 52.87%	63 30.88%	590 51.26%	225 19.56%	42 3.65%	45 3.92%	17 1.45%	87 7.56%	14 1.22%	18 1.56%	113 9.82%
Moenave			75 3.45%	35 17.16%	25 33.33%	0	7 9.33%	21 28.00%	0	14 18.68%	1 1.33%	3 4.00%	4 5.33%
Coal Mine Mesa			779 35.78%	86 42.16%	470 60.34%	0	0	0	0	0	2 .26%	25 3.20%	282 36.20%
Willow Spring			44 2.02%	3 1.47%	22 50.00%	0	2 4.54%	6 13.64%	0	7 15.91%	0	0	7 15.91%
Cedar Ridge			128 5.88%	17 8.33%	109 85.16%	0	0	0	0	0	2 1.56%	0	17 13.28%
Totals			2177 100%	204 100%	1216 55.86%	225 10.34%	51 2.34%	72 3.31%	17 .78%	108 4.96%	19 .87%	46 2.11%	423 19.43%

WR 1656

CV-6417-201

NN002629

Agricultural Crops Produced:

Owing to the fact that this survey was conducted during the winter months, it was impossible to determine exactly the crops grown during the previous season. However, estimates were made as nearly as possible, and the following acreages of the different crops obtained:

Crop	Acres	Percent of Total
Corn	1216	55.86%
Idle	423	19.43%
Sudan Grass	225	10.34%
Vegetables	108	4.96%
Orchard	72	3.31%
Alfalfa	51	2.34%
Squash	19	.87%
Melons	46	2.11%
Beans	17	.78%
Total	2177	100.00%

Yields:

No actual measurements of crop yields were made on this Unit; therefore, the yields to be listed are estimates compared with the yields of other districts studied, and information from people within the Unit. For this reason, the figures should by no means be taken as definite.

Crop	Present Average Production	Expected Average Production
Corn	20 bu. per acre	25 bu. per acre
Sudan Grass	3 tons per acre	4 tons per acre
Alfalfa	2 tons per acre	3 tons per acre
Squash	4,000 lbs. per acre	5,000 lbs. per acre
Melons	4,000 lbs. per acre	5,000 lbs. per acre
Beans	300 lbs. per acre	400 lbs. per acre

WR 1657

CV-6417-201 NN002630

The expected increased production can be accomplished by the following:

1. More efficient use of the available water.

2. Crop rotation and strip cropping where wind erosion is serious.

3. Proper seed bed preparation.

4. Proper seed selection.

5. The introduction and use of simple farm machinery.

6. Fall plowing to reduce the damage being done by cutworms.

Suggested Crops:

Suggested crops to be produced on this Unit will vary somewhat with the type of farming. On the irrigated land at Moenave, Tuba City, and Willow Springs, fruits, vegetables, alfalfa and various grains can be grown. The more valuable products should be encouraged. On the remaining portion of the farm land, corn is the principal crop recommended, but beans, squash, melons and fruit trees can be grown at the more favorable locations where water is sufficient.

Farm Pests, Weeds, Rodents and Insects:

At two locations on the Upper Moencopi farms, white top weeds have been reported and need immediate control to prevent them from spreading further through the farming area.

Another weed noticed on the Moencopi farms was the cocklebur. This weed infests the pasture land and the idle land along ditches and fences and spreads into any fields which happen to be idle a season.

Loco was noticed on some of the farms in the Willow Springs vicinity. However, this could probably easily be controlled if farms land was properly cultivated.

Rodent control is needed on practically all the farms. The pocket gophers and kangaroo mice are the most common. Prairie dogs are not a serious problem at the present time on the farm land.

The one outstanding crop insect pest which is active on the farms of this Unit is the cutworm. Damage is reported from all of the farm areas and control measures are needed.

WR 1658

CV-6417-201 NN002631

The codling moth is active on the few fruit trees within the Unit and control measures are needed to produce fruit crops.

The grasshopper damage was very light during the last season according to what information could be obtained. However, the farmers, especially those in concentrated areas, should be on the guard for outbreaks of these insects and check them immediately.

Recommendations:

The following are the agronomy recommendations for the farm land within this Unit:

1. The following projects should be handled under direct government supervision:

   a. The Upper Moencopi project.
   b. Pasture Canyon project.
   c. Moenave farm area.
   d. The Lower Moencopi project.
   e. The farms in vicinity of Willow Springs.

2. Wind break plantings should be encouraged for all the farms wherever possible.

3. Navajo farmers should be encouraged to grow a larger variety of crops on their more productive lands.

4. The introduction and use of ordinary farm machinery such as: discs, harrows, grain drills, listers, mowing machines, and rakes, needs to be encouraged, especially in the more concentrated farm areas where one implement could be used on several farms.

5. Rodent control for both pocket gophers and kangaroo mice should be carried out on practically all of the farms.

6. Cutworm damage should be controlled wherever possible by fall plowing or where this is not possible, listing the land at right angles to the prevailing winds would help reduce the damage.

7. Provisions should be made whereby the fruit trees of the district can be sprayed. This will probably need to be handled by the government because the Indians themselves cannot afford to invest in spraying equipment for just the few trees that each owner has. The spraying is needed to protect the trees against damage by the codling moth.

WR 1659

CV-6417-201 NN002632

8. Flood water storm ditches need to be constructed across about the central section of the Upper Moencopi farms to handle the runoff from the bluffs north of the farming area. This would prevent the danger of silt being deposited on the land and the crops being destroyed by flood water from this source.

9. Head erosion which is cutting in towards the farms from the main wash needs to be checked before serious damage results.

10. Contour dikes should be constructed on the lower farms on the south side of the Moencopi Wash to carry away the flood water and heavy soil materials which are now being deposited on the farm land.

11. As much planting as possible should be carried out along the Moencopi Wash and the drainages into it through the farm area with the aim of protecting the farm land against the sloughing of this wash.

12. Immediately below the diversion dam, there is a necessity of relocating the main irrigation channel due to the Moencopi Wash cutting in near the ditch. It seemed more feasible to relocate the ditch than to try and stabilize the wash. (For more details of the necessary work, consult the Engineering report on Unit #3.)

13. White top weeds found in this area should be controlled immediately. If they cannot be checked by keeping them plowed under or hoeing, chemicals should be used before they become a serious problem.

The cockleburs found within the area should be controlled by the owners of the infested fields, and they should be required to keep their fields clean of these weeds as much as possible.

14. The alkali problem on this area may look small at the present time, but the infested areas should be treated before the area is larger , and control becomes more expensive. It is recommended that a detail survey be made of the cause of this alkali and from the findings, the proper corrective measures can be ascertained.

15. <u>The Lower Moencopi</u>

In view of the fact that a diversion dam has been constructed on the Lower Moencopi and is ready for use, it is proposed that at least 50 acres be leveled off and subjugated as soon as possible. Such crops as wheat, corn, rye and Sudan grass

WR 1660

CV-6417-201 NN002633

would probably be the most successful in this area because of the type of irrigation this area will receive. In connection with the other farming of this area, it is suggested that a government experimental and demonstration plot of 10 to 15 acres be handled for the purpose of determining the most suitable crops for the area and for demonstrating and encouraging the Indians how to practice a more modern type of agriculture.

This entire area should be fenced to protect the farm land proper, and the land adjacent to the farms. This will give the vegetation a chance to protect the farming area against serious wind erosion.

16. Pasture Canyon

The area in Pasture Canyon, which is now being used by the government for pasture, needs some drainage ditches to carry the water directly to the reservoir rather than spread out and cause a swampy area as now exists. These drainage ditches would probably drain the area sufficiently that crops could be raised successfully. It has been suggested that this area be turned over to some of the advanced school boys to use for various crop projects. This would be a very worthwhile project and could do much toward training the boys for future farming.

17. Below the government pasture, a large sand dune is working its way into the Canyon, and is endangering the water supply. This should be fenced further back to the west, and all the vegetation possible encouraged to grow on it.

18. The ditch between the reservoir and the farm land should be laid out in a definite course to the farming area rather than let it meander around and take its course along the old gully bed, for a great deal of water is lost in this way both through seepage and evaporation.

19. Moenave.

Reservoirs should be constructed at Moenave Demonstration Area camp, at Moenave Day School, at the location of Farm 16, and Farm 17, Quad 19 (111°15 - 36°15'). For more details as to location and construction, see Engineering report). These reservoirs would store the winter water from springs for use during the growing season. By the construction of these reservoirs, approximately 30 to 35 acres of additional irrigated land could be farmed. The land would need leveling and bordering.

WR 1661

CV-6417-201 NN002634

20. Planting of useful plants should be carried out at all the seeps and springs which are not being used for irrigation and all waste water ditches which handle the excess water.

21. Coal Mine Mesa.

The larger flood irrigated farms on Coal Mine need some sort of a water spreading structure to provide a uniform distribution of the water over the land. These should be taken care of to prevent the fields from gullying.

22. Willow Springs.

At the location of Farm #7, Quad 19, the flood water needs to be controlled if farming is to be continued on this piece of land because at present a gully is forming which is endangering the farm area. If it is too expensive to protect the farm, the stream from the spring should be planted and used to produce various fruits.

23. At the location of Farm #8, Quad.19, the lower reservoir storage should be increased and the flood water from the east side controlled. The owner could do this work himself and with the increased storage, he could probably irrigate two or three more acres.

24. At the location of Farm #9, a dike should be constructed to divert the flood water away from the farm, and a reservoir should be constructed to store the water for irrigation.

25. Farms 10 and 10.1 , Quad. 19, both need flood water control. Farm #10.1 is receiving the greatest damage because the water is washing out the terraces and forming a gully. The reservoirs at these farms are small but they can probably handle the land now being farmed. However, the owners should clean these reservoirs out and gradually increase the size of them as much as possible.

26. At a suitable location between Farms #11 and #12, a reservoir needs to be constructed to store the water during the winter months to be used during the growing season. This farm, at present, gets very little water. When the reservoir is built, the owner should construct borders for irrigating the land.

27. The flood water needs to be diverted from the gully which goes through Farm #12, Quad 19. This would not require very much work and is needed to protect the farm land from being cut into by a large gully.

WR 1662

CV-6417-201 NN002635

28. The owners of farms #20 and #21 should be encouraged to construct small reservoirs to store the water and get a good head for irrigating their farms. They also need to repair their present terraces and more fully utilize the small amount of available land they have.

29. Useful plantings should be made in all the seeps and springs in this area which are not used for irrigation. All ditches and channels which carry the water when it is not being used should also be planted. Various fruit trees and shrubs would probably be the most useful, but the basket willow might also be introduced in a few places for use in basket weaving.

30. Cedar Ridge.

Farms #1.1, 1.2 and 1.3, Quad 85 should be bordered for flood irrigation. A gully runs on these farms at the present time, and the water is very unevenly spread. Below Farm 1.3, the gully gets too large to divert and handle on the farms in that vicinity; for this reason, the water should be used as much as possible on the upper farms and checked before a gully cuts through them. On the balance of the farms in this area, contour listing should be encouraged to help hold the small amount of water on the land which it receives.

31. At the location of Navajo Springs, Quad 87, a detailed investigation should be made of the amount of water. If it is sufficient, a reservoir can be constructed and farm land would probably be available near the highway. However, a soils survey to determine the depth and nature of the soil would be advisable.

Cost of Development:

The total cost of the agricultural development within this Unit, involving leveling, furrowing, bordering, terracing, or uniformly spreading water, as the case may be on the present farm land, is approximately $5,665.00. The estimated cost on the potential land is approximately $2,795.00. These costs do not include diversion or ditches.

WR 1663

CV-6417-201 NN002636

This cost is further broken down as follows:

Type of Land	Acreage of present land to be treated	Acreage of potential land to be treated	Average Cost Per Acre	Cost on present land	Cost on potential land.	Total Cost on present and potential land
Irrigated	106	98	$13.14	$941.00	$1740.00	$2681.00
Flood Irrigated	421	59	9.89	4724.00	1055.00	5779.00
Dry Farm	0	0	0	0	0	0
Total	527	157	11.51	5665.00	2795.00	8460.00

Estimated costs on each tract can be obtained from the Agronomy survey notes.

The following table was used as a guide in making the above cost estimate:

Slope	Leveling Only	Leveling and Bordering	
		Flood Irrigated	Irrigated
Less than 1%	0 - 6	8 to 12	8 to 10
1%	6 - 10	14 to 20	14 to 18
2%		20 to 30	18 to 25
3%		30 to 45	25 to 40
4%		40 to 60	35 to 50
5%		50 to 75	40 to 70

The following is a list of outstanding projects within the Unit which need immediate work. They are listed according to priority:

1. EXPANSION AT OLD MOHAVE (DAY SCHOOL)
   Farm #6. Quad. 19. (111°15' 36°15')

   Expansion of this farm will be made possible by the construction of a water storage reservoir. Three possible sites have been located by the engineering branch. This reservoir could store the permanent water which ordinarily runs to waste at least six months of each year. The engineers estimate the average size of this stream to be approximately 1/2 second ft.

WR 1664

CV-6417-201 NN002637

There are, at present, two reservoirs but they are inadequate to store the water over the winter months for use during the growing season.

Approximately 30 acres are under cultivation with the present system and it is estimated that 15 additional acres can be subjugated and irrigated from the additional storage. It might be noted that there is more land which could be subjugated if the water proves to be in excess.

The slope on this land is fairly level, averaging about 1%. The soil varies from a sand to sandy loam. Wind erosion is active on the area and needs wind break planting. This area is capable of producing all kinds of crops and should be used for those crops which will produce the greatest returns. Leveling and bordering will be required. The estimated cost for this work on the land is $15 per acre.

2. LOWER MOENCOPI EXPANSION

At the location of Farm #4, Quad. 19, (111°15 36°15') a diversion dam has been built in the Moencopi Wash. This is below the upper Moencopi diversion dam.

During the growing season all the water is diverted at the upper dam except flood waters. For this reason, farming at the location of the lower diversion will be dependent upon the use of fall and spring irrigations.

The soil at this location is not of the very best type for farming. It is rated Class "D" by the Soils Branch. It varies from a light clay loam to a clay.

The slope is about 1% but the land is very hummocky.

Leveling and bordering will be required for proper subjugation of this area. The estimated cost is $18 per acre. There are approximately 400 acres of suitable land which can be subjugated, but it is proposed that the development be limited to 50 acres until the project has proven successful.

3. DRAINAGE AND SUBJUGATION IN PASTURE CANYON
Quad. 71 (111°36°15')

This area, known as Pasture Canyon, comprises farms numbered 14, 15, 16, 17, 17.1, Quad. 71. At the location of Farms 17 and 17.1, is the source of water which supplies the Hopi reservoir and Hopi farms. The water seeps up throughout this area and meanders its way to the reservoir.

WR 1665

CV-6417-201 NN002638

It is proposed to put in a system of ditches to drain this area and carry the water directly to the reservoir. If this is done, the land which is now a greasy swamp can be leveled up and used to produce fruit and garden crops.

Approximately 25 acres could be brought under cultivation in this area. The estimated cost of leveling is $5 per acre. Where additional irrigation water is needed it is recommended to furrow irrigate.

4. DEVELOPMENT OF FARMS 16 & 17
Quad. 19 (111°15' 36°15')

Farms 16 and 17 located below the bluff on the road between Tuba City and Moenave. Reservoir storage sites have been located at each of these farms to store the water supplied by permanent spring. At Farm 16, there is water for approximately 5 acres and at Farm 17, enough water for about 10 acres.

The soil is sand to sandy loam, and the slope averages about 1 to 4%. The land will need to be leveled and bordered and a system of ditches laid out.

The estimated cost on the farm land is $17 per acre.

5. EXPANSION AT MOENAVE S. C. S. CAMP FARM #5
Quad. 19 (111°15' 36°15')

Expansion at the location of Farm #5 and more water for the present farm can be made possible by the construction of a reservoir at the site chosen by the Engineering Branch. Potential land is located just below the present farm and needs very little work. The soil is fairly sandy and the slope is about 1-2%. The estimated cost for developing the farm land is $10 per acre.

6.

Spread the floodwater more evenly on the farms on Coal Mine Mesa.

On Quad. 7' (111°36°15') Farms Number 2, 6, 22, 24, and need a more uniform distribution of water. This can be accomplished in most cases by a spreader at the head

WR 1666

CV-6417-201 NN002639

of the field. The soil on these farms is fairly sandy and the slope varies from 1 to 3%. The present acreage of these farms is 215 acres, which can be increased 5 acres by properly handling the available water. The estimated cost on this land is $10 per acre.

7. WILLOW SPRINGS AND FARMS IN VICINITY

The farming in the vicinity of Willow Springs is similar to that found around Moenave. Water is supplied from small springs and all the farm land is bordered or terraced.

Most of the farms have some sort of a small reservoir for storing the water to get a good head for irrigating, but none of them have a large enough reservoir to store the winter water. At the location of Farm #11, Quad 19 (111°15°36°15'), it is possible to construct a reservoir at the upper end of the farm which can store the water from Farm #12 during the winter time. The soil on this farm averages a sandy loam, and the slope is not over 2%. The land is fairly level but bordering will be necessary.

At the location of Farm 10 and 10.1 in this same vicinity, immediate work is needed to divert the flood water away from the present farm land because, at the present time, the flood water breaks through the terraces and causes a great deal of damage. A means of storing the winter water would be very beneficial but on this survey no suitable sites were located for this purpose.

8. CEDAR RIDGE FARMS.

At the location of Farms 1.1, 1.2, and 1.3, Quad. 85 (111°30'36°30'), the flood water which is their source of water fans and takes a natural course through these fields. The lower spots get too much water, and the higher spots go dry. Bordering is needed on these farms to give a more uniform distribution of water and to help hold as much as possible on the land. The soil is a sandy loam to clay loam, and the slope averages 1 to 2%. The acreage involved is about 45 acres of present land and 6 acres of potential. The estimated cost for bordering is $25 per acre.

WR 1667

CV-6417-201 NN002640

Summary:

1. Land Management Unit #3 is located in the extreme western section of the Navajo Reservation.

2. The area of the Unit is 1,750,800 acres, of which 280,128 acres are waste land, 1,453,164 acres are range land, and 21,77 acres are farm land.

3. The population of the Unit is 2181 .

4. There is about 1 acres per capita now being farmed.

5. The topography of the Unit consists mostly of low rolling sandy country.

6. The principal drainage of the Unit is the Little Colorado River.

7. The mean temperature at Tuba City is 55.9°.

8. The elevation ranges from 3200 ft. to 7000 ft.

9. The average rainfall at Tuba City is 6.9 inches.

10. The average length of the growing season is 179 days.

11. Wind erosion affects all the farm land within the area.

12. The soil on the farms averages a sandy loam.

13. The cultural practices are mostly native.

14. The acreage of irrigated land is twice the acreage of flood irrigated land.

15. The present acreage being farmed in this Unit is 2177 acres. The acreage of potential land located is 204 acres.

16. The five agricultural divisions of the Unit are: Tuba City and vicinity, Moenave Demonstration Area, Coal Mine Mesa, Willow Springs and vicinity, and Cedar Ridge.

17. The farm land along the Moencopi Wash represents the most valuable agricultural of the Unit.

18. Potential land is limited to the amount of water that can be supplied.

19. All the irrigation projects need direct government supervision.

WR 1668

CV-6417-201 NN002641

20. On the Upper Moencopi farm area, control measures are needed to check:

    a. Head erosion
    b. Alkali damage
    c. White top and cocklebur infestations
    d. Flood water damage.

21. Storage reservoirs need to be constructed on the Moenave Area.

22. The farms on Coal Mine Mesa need a more uniform distribution of flood water.

23. Part of the farm land near Cedar Ridge needs bordering.

24. The estimated total cost of subjugation is $8,460.00, which is divided as follows:

    $5,665.00 on present land.
    $2,795.00 on potential land.

Attached is a legend of land classification and definition of terms used in the agronomy survey sheets.

Approved:

J. O. Woods
Chief Agronomist

Submitted:

H. M. Ivory

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Agricultural Aide

WR 1669

CV-6417-201

NN002642