

**MAPPING THE MARICOPA AGRICULTURAL CENTER
USING A GEOGRAPHIC INFORMATION SYSTEM**

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INTRODUCTION

The Maricopa Agricultural Center (MAC) is a 854 hectare (2110 acre) research/demonstration farm owned and operated by the University of Arizona College of Agriculture. The research part of the farm has 167 hectares (413 acres) of tillable land, which is used to conduct an array of experiments in an arid environment using different irrigation technologies. The demonstration portion of the farm has 575 hectares (1422 acres) of tillable land, and the best technologies available are used to demonstrate and evaluate crop types in a commercial environment.

Large quantities of data/information have been collected on MAC Farm. Analysis and manipulation of data/information which exists in a space-time framework, such as MAC Farm, needs to be stored, manipulated, and displayed. A Geographic Information System (GIS) can accomplish this task, and this paper describes the system in-place at MAC farm.

Procedure Used to Develop a GIS Data Base

Our objectives were to map the farm in an absolute coordinate system using the Universal Transverse Mercator (UTM) grid. The UTM system divides most of the earth's surface into zones 6 degrees of longitude wide. Each zone is further divided into grid squares measuring 100,000 meters on a side, and any point can then be located by specifying the X, Y coordinates (VandenDolder, 1987).

Most of the state of Arizona lies in grid zone 12S, which covers a rectangular area from long 114° W. to 108° W. and from lat 32° N. to 40° N. U.S. Geological Survey 7 1/2 minute quadrangle maps published since 1957 have UTM grid lines on the maps and these can be used to spatially locate areas. In Arizona the meter distance in the Y Northing has had a constant of 3,200,000 subtracted from the absolute UTM number. This change was initiated by the Arizona State Land Department for ease of handling data. They run the ARC/INFO Geographic Information System from a Prime 9950 mainframe computer, and provided us with the UTM coordinate of all the section markers (Figure 1). Therefore all Y coordinates listed in this paper have this constant subtracted from each number.

Many organizations are choosing less expensive microcomputer platforms to accomplish tasks previously performed on mainframe computers. Advances in computer technology have lead to increased performance and storage capabilities on microcomputers, allowing users the option of having their computer located in their office. We chose micros because of their low hardware and maintenance costs. The software, pc ARC/INFO, was selected for its general compatibility with many of the systems operating throughout the state, as well as its overall flexibility in accepting a wide variety of data formats such as DXF files from AutoCAD, ERDAS, raster files, etc.

The initial objective was to spatially locate the permanent markers for section corners that delineated the farm boundaries. These points were surveyed by the public land survey (township, range, section) system and served as our basic reference points. MAC farm is located in Sections 17, 18, 19, and 20, Township 4 South and Range 4 East. A total of 11 section or quarter-section corners defined the boundary of MAC farm, and these are listed in Table 1. We then contracted a surveying team to precisely locate other points on the farm that defined field boundaries, location of wells, etc. The surveying procedure used coordinate geometry and a Topcon GTS-3C electronic distance measurement instrument to precisely locate these points. This instrument measures distances and calculates angles by bouncing a laser beam off retroreflectors placed over the points (Moffitt and Bouchard, 1975).

We placed flags about the farm at specific points and the survey team computed the coordinates for these points. Table 2 lists the coordinates for field boundaries and Table 3 the thirteen wells found on the farm. Some permanent markers were put in place by driving rebar into the ground with a securely mounted identification cap on top. The field identification number listed in Table 2 is stamped on the cap with a "GIS" notation to identify the marker, and these markers can be used when very accurate locations are required.

Results and Discussion of GIS Applications on MAC Farm

This system provides us with a permanent spatial record to locate fields or research plot boundaries; monitor cropping histories and crop yields; keep records of soil test data; keep water-related statistics such as water usage and change of water quality over time; etc. Map products can be produced that show applications related to monitoring soil-water-

plant conditions on the farm. Extensive remotely sensed data collected by satellite or low flying aircrafts has been collected over MAC, and this data is being referenced to the precise locations reported in this paper.

The most important map product produced to date is the basic MAC Farm map (Figure 1) which accurately defines farm boundaries. We further produced a map that overlays a 100 meter grid on this map, and it can be used to locate areas that do not require precise spatial accuracy. These maps are available upon request from the authors.

One example that demonstrates the utility of this GIS system is presented in the paper by Post et. al (1988) and in the dissertation by A. Suliman (1989). These authors digitized the basic soil map showing the distribution of soil series found on the farm, and the % sand and % clay data from over 700 surface horizon samples were overlain on this map. This provided these researchers with a rapid and efficient way of analyzing, manipulating, and displaying a large amount of information.

This system also has unique application to a major multidisciplinary remote sensing effort being coordinated by the University of Arizona to evaluate the use of remote sensing techniques as an agricultural management tool. Many satellite images were collected and are being evaluated, and the GIS described in this paper will be extensively used as part of this project.

SUMMARY

This paper described the Geographic Information System in-place on the Maricopa Agricultural Center. The need to aggregate and organize spatial data is essential as data bases grow larger and require sophisticated analysis techniques. The GIS is an effective tool for reaching a wide array of goals and objectives related to the operation of the Maricopa Agricultural Center.

LITERATURE CITED

- Burrough, P.A. 1986. Principles of Geographical Information Systems for Land Resources Assessment. Clarendon Press, Oxford.
- Moffitt, F.H. and H. Bouchard. 1975. Surveying. Sixth edition. Educational Publishers, New York.
- Post, D.F., C. Mack, P.D. Camp, A.S. Suliman. 1988. Mapping and characterization of the soils on the University of Arizona Maricopa Agricultural Center. In: Proceedings of the 1988 Meetings of the Arizona Section American Water Resources Association and the Hydrology Section, Arizona-Nevada Academy of Science: 18:49-60.
- Suliman, A. 1989. Spectral and spatial variability of the soils on the Maricopa Agricultural Center, Arizona. Ph.D. Dissertation, University of Arizona.

VandenDolder, E.M. 1987. Maps: the earth on canvas. In: Arizona Bureau of Geology and Mineral Technology Field notes, Geological Survey Branch, Tucson, Arizona. 17(4):1-8.

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Table 1. Control points in universal transverse mercator coordinates and latitude - longitude. The X, Y units are meters.

CONTROL POINTS	UTM-X	UTM-Y*	LONGITUDE	LATITUDE
1	<u>407061.2</u> **	457976.8	111°59'44"	33°03'29"
2	410280.9	<u>457934.0</u> **	111°57'40"	33°03'29"
3	408654.5	459547.3	111°58'43"	33°04'21"
4	409475.0	461225.6	111°58'12"	33°05'15"
5	408664.2	457931.9	111°58'42"	33°03'28"
6	410275.3	458741.9	111°57'40"	33°03'55"
7	409467.3	458741.5	111°58'11"	33°03'55"
8	409462.0	459548.6	111°58'12"	33°04'21"
9	407069.4	459609.9	111°59'44"	33°04'22"
10	408670.4	461231.5	111°58'43"	33°05'15"
11	407076.9	461243.0	111°59'44"	33°05'15"

*A constant of 3,200,000 must be added to the Y Northing to convert it to the absolute UTM coordinates.

**Represents UTM coordinates for furthest point west and south on MAC.

Table 2. Maricopa Agricultural Center field boundaries and permanent markers UTM coordinates.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*
RESEARCH FARM					
1W-1	SW	408687.4	457946.4		
1W-2	NW	408686.6	458145.0		
1W-4	SE	409066.5	457947.4	409066.5	457947.4
1M-1	SW	409090.5	457947.3		
1M-4A	SE	409471.3	457995.9		
1M-4B	SE	409396.8	457989.9		
1M-4C	SE	409396.3	457948.1		
1E-1	SW	409470.7	457948.3		
1E-3	NE	410267.5	458145.7		
1E-4	SE	410267.1	458001.3		
1E-4	SE	410229.6	457950.0		
2W-1	SW	408689.3	458150.2		
2W-2A	NW	408687.6	458337.9		
2W-2B	NW	408698.2	458354.1	408698.2	458354.1
2M-4	SE	409467.6	458152.1	409467.6	458152.1
2E-3	NE	410265.3	458351.5		
2E-4	SE	410267.0	458153.6	410267.0	458153.6
3W-1	SW	408716.6	458356.1		
3W-2	NW	408715.3	458532.1		
3M-4	SE	409465.2	458358.4	409465.2	458358.4
3E-3	NE	410263.4	458534.0		
3E-4	SE	410263.6	458359.4	410263.6	458359.4
4W-1	SW	408714.7	458540.0	408714.7	458540.0
4W-2	NW	408713.0	458709.3		
4W-3	NE	409461.5	458709.0	409461.5	458709.0
4W-4	SE	409463.2	458540.7	409463.2	458540.7
4E-3	NE	410263.6	458713.8		
4E-4	SE	410264.7	458542.7	410264.7	458542.7
7-1	SW	408675.9	458769.7	408677.9	458768.3
7-2	NW	408675.2	459153.8		
7-3	NE	408926.5	459151.8	408927.8	459151.8
7-4	SE	408925.7	458768.5	408925.7	458768.5

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*

RESEARCH FARM

10-1	SW	408675.5	459164.2	408675.1	459163.2
10-2	NW	408678.9	459551.5	408678.2	459551.5
10-3	NE	408931.1	459548.4		
10-4	SE	408930.5	459162.4	408930.5	459161.5
101-3	NE	409451.3	458869.3	409451.3	458869.3
101-4	SE	409407.2	458768.3	409407.2	458768.3
109-3	NE	409452.4	459147.9	409452.4	459147.9
113-4	SE	409450.9	459158.1	409450.9	459158.1
114-1	SW	409198.3	459159.7	409198.3	459159.7
121-3	NE	409450.7	459474.1	409450.7	459474.1

DEMONSTRATION FARM

11-1A	SW	409159.3	459848.7		
11-1B	SW	409156.5	459908.8		
11-1C	SW	409091.7	459908.3		
11-2	NW	409094.0	460369.5		
11-3	NE	409458.0	460367.2	409460.4	460366.9
11-4	SE	409453.8	459844.9		
13-1	SW	408668.7	459569.1		
13-2	NW	408677.1	460368.3		
13-3	NE	409083.9	460366.7		
13-4	SE	409080.8	459566.4	409081.8	459566.4
15-1A	SW	408371.6	459575.2		
15-1B	SW	408373.0	459632.8		
15-1C	SW	408309.6	459633.9		
15-2	NW	408322.6	460389.5		
15-3	NE	408669.4	460385.0		
15-4	SE	408658.1	459570.9	408659.1	459570.9
17-1	SW	408092.9	459586.7		
17-2	NW	408096.7	460403.0		
17-3	NE	408279.9	460397.7	480280.9	460397.7
17-4	SE	408274.4	459579.3	408275.4	459579.3

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*

DEMONSTRATION FARM

18-1A	SW	407914.7	459589.6		
18-1B	SW	407901.0	459609.2		
18-2	NW	407901.7	460410.3		
18-3	NE	408087.4	460404.7		
18-4	SE	408083.9	459582.8	408084.9	459582.8
19-1	SW	409264.4	460380.2		
19-2	NW	409268.8	461219.5		
19-3	NE	409459.2	461217.6	409459.8	461217.6
19-4	SE	409453.7	460379.2		
20-1	SW	409073.8	460379.7		
20-2	NW	409066.6	461219.6		
20-3	NE	409259.0	461217.2	409259.6	461217.2
20-4	SE	409255.8	460378.5	409255.8	460378.5
21-1	SW	408875.9	460378.7		
21-2	NW	408867.7	461222.7		
21-3	NE	409057.8	461220.6	409058.5	461220.6
21-4	SE	409064.0	460379.5	409064.0	460379.1
22-1A	SW	408712.4	460380.2	408712.4	460379.6
22-1B	SW	408676.7	460387.6		
22-2	NW	408700.1	461224.0		
22-3	NE	408858.3	461223.0	408859.0	461221.5
22-4	SE	408866.7	460380.5	408867.7	460379.5
23-1	SW	408322.6	460389.5		
23-2	NW	408337.2	461223.7		
23-3	NE	408691.1	461222.4	408691.1	461222.4
23-4	SE	408669.4	460385.0		
25-1	SW	408096.6	460412.1		
25-2	NW	408099.6	461226.9		
25-3	NE	408303.0	461220.9	408303.7	461220.9
25-4	SE	408280.4	460406.1		

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*

DEMONSTRATION FARM

26-1	SW	407901.9	460419.5		
26-2	NW	407902.3	461228.0		
26-3	NE	408090.8	461227.2	408091.8	461227.7
26-4	SE	408087.4	460412.7	408088.0	460412.7
27-1A	SW	407133.1	457984.8	407133.1	457984.8
27-1B**	SW	407113.3	457985.4	407113.3	457985.4
27-2	NW	407134.3	458233.9		
27-3	NE	408632.8	458195.9		
27-4A	SE	408633.6	457975.4	408635.6	457975.4
27-4B	SE	408556.0	457973.7		
27-4C	SE	408531.4	457949.3		
28-1	SW	407134.9	458244.4	407134.9	458244.4
28-2	NW	407135.6	458513.5		
28-3	NE	408632.9	458473.6	408633.6	458473.6
28-4	SE	408632.6	458205.6	408632.6	458205.6
29-1	SW	407135.9	458523.4	407135.9	458523.4
29-2	NW	407135.9	458770.7		
29-3	NE	408632.3	458732.8	408632.3	458732.8
29-4	SE	408631.7	458484.6		
30-1	SW	407137.0	458778.3	407137.0	458778.3
30-2	NW	407137.0	459029.4		
30-3	NE	408627.5	458994.5	408628.5	458994.5
30-4	SE	408623.5	458738.9		
31-1	SW	407135.6	459039.1	407135.6	459039.1
31-2	NW	407136.9	459285.5		
31-3	NE	408631.3	459252.8		
31-4	SE	408626.7	459004.3	408626.7	459004.3
32W-1	SW	407139.2	459294.5		
32W-2	NW	407140.3	459576.4	407140.3	459576.4
32W-3	NE	407845.8	459557.8	407845.8	459557.8
32W-4	SE	407844.8	459278.3	407844.8	459278.3

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

27-1B** Marker at point CAP canal enters farm.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*

DEMONSTRATION FARM

32E-1	SW	407854.3	459280.8		
32E-2	NW	407854.9	459541.9		
32E-3A	NE	408597.9	459503.7		
32E-3B	NE	408631.8	459464.3		
32E-4	SE	408631.4	459261.2	408631.4	459261.2
33-1	SW	407094.8	459628.7	407094.8	459627.7
33-2	NW	407095.4	459821.2		
33-3	NE	407844.4	459801.4		
33-4A	SE	407844.0	459686.4	407844.0	459686.4
33-4B	SE	407731.9	459688.1		
33-4C	SE	407729.1	459611.3	407730.1	459610.9
34-1	SW	407095.3	459829.2	407095.3	459828.2
34-2	NW	407095.6	460022.3		
34-3	NE	407845.1	460014.0		
34-4	SE	407844.0	459809.8	407845.0	459809.5
35-1	SW	407095.7	460030.8	407097.7	460029.8
35-2	NW	407096.0	460255.3		
35-3	NE	407746.0	460222.7		
35-4	SE	407844.0	460021.5	407846.1	460021.1
36-1	SW	407095.6	460234.2	407099.9	460233.2
36-2	NW	408096.4	460426.4		
36-3	NE	407845.2	460424.0		
36-4	SE	407844.5	460231.6	407846.0	460230.6
37-1	SW	407096.1	460435.2	407097.8	460434.3
37-2	NW	407097.9	460693.1		
37-3	NE	407847.7	460688.1		
37-4	SE	407845.2	460432.2	407846.7	460431.7
38-1	SW	407097.9	460701.9	407103.9	460700.9
38-2	NW	407097.2	460961.0		
38-3	NE	407846.8	460957.5	407848.8	460952.5
38-4	SE	407844.8	460699.6	407847.8	460698.6

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

Field I.D.	Field Corner	Field Boundaries		Permanent Markers	
		X Easting*	Y Northing*	X Easting*	Y Northing*

DEMONSTRATION FARM

39-1	SW	407098.4	460969.4	407103.6	460969.0
39-2	NW	407098.9	461221.5		
39-3A	NE	407822.7	461213.7		
39-3B	NE	407852.4	461183.4		
39-4	SE	407851.6	460966.3	407851.6	460965.5

Table 3. Location of MAC Farm wells.

<u>Well Description</u>	<u>X Easting*</u>	<u>Y Northing*</u>
#1 SE Corner F-1	410255.0	457974.7
#2 South-Central F-1	409441.8	457955.9
#3 South Side F-6	409039.2	458771.3
#4 Near Headquarters	409445.5	459504.3
#5 East Side F-11	409451.3	459949.4
#6 East Side F-19	409463.4	460853.4
#21 SE Corner F-27	408574.4	457959.7
#22 South Side F-27	408201.7	457960.8
#23 South Side F-27	407846.0	457973.0
#24 South Side F-29	408272.2	458489.1
#25 SE Corner F-30	408623.5	458738.9
#26 SE Corner F-33	407810.0	459632.1
#27 East Side F-38	407845.0	460822.1

*Units are expressed in meters. A constant of 3,200,000 should be added to the Y Northing to convert it to the absolute UTM coordinates.

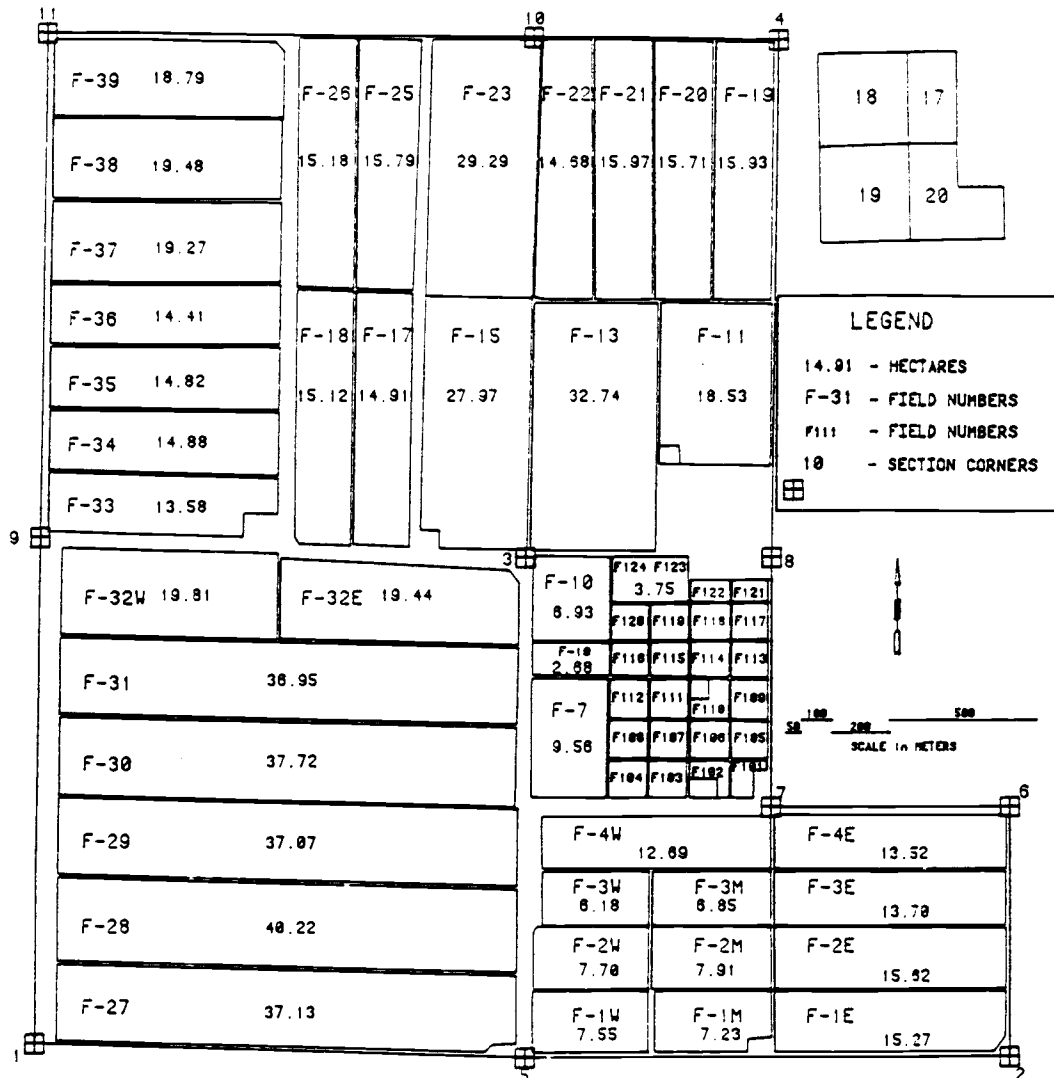


Figure 1. MAC field boundaries map noting the area in hectares in each field.