USE OF AERIAL PHOTOGRAPHY AS APPLIED TO THE AGRICULTURAL CONSERVATION PROGRAM OF THE AGRICULTURAL ADJUSTMENT ADMINISTRATION

BY
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THE EFFICIENCY OF AERIAL PHOTOGRAPHY IN MEASURING AREAS CAN NOW BE STUDIED WITH SOME DEGREE OF ACCURACY BY COMPARING THE COUNTIES IN OHIO NOW EMPLOYING THAT METHOD OF MEASURING AREAS FOR THE AGRICULTURAL CONSERVATION PROGRAM WITH THE COUNTIES USING THE OLD GROUND TRAVERSE METHOD.

PREBLE COUNTY IS NOW USING THE PHOTOGRAPHS FOR THE SECOND YEAR WHILE MADISON, GREENE, MIAMI AND OTTOWA* ARE USING THEM FOR THE FIRST TIME THIS YEAR.

TO MAKE A MORE FAIR COMPARISON WE SHALL DIVIDE THE COUNTIES INTO TWO GROUPS. THE FIRST GROUP SHALL INCLUDE PREBLE, BUTLER, MONTGOMERY, DARKE AND MIAMI WHOSE SIZE OF FARMS AND TYPE OF AGRICULTURE AGREE. THE SECOND GROUP SHALL INCLUDE MADISON, GREENE, CHAMPAIGN, FAYETTE, PICKAWAY AND UNION WHOSE SIZE OF FARMS AND TYPE OF AGRICULTURE ARE COMPARABLE.

GROUP I

	Total Cost of Measuring (1)	No. of Farms Measured (2)	No. of Acres Measured (3)	Cost per Acre (4)	Possible Savings (5)
Preble	$ 3,487.00	2400	175,000	0.0199	---
Miami	4,051.00	2044	173,000	0.0234	---
Butler	10,560.00	1726	112,000	0.0943	$ 7,900.00
Montgomery	11,489.10	2200	150,000	0.0765	8,000.00
Darke	15,130.00	3754	226,000	0.0670	10,000.00

COLUMN (3), "NO. OF ACRES MEASURED", WAS OBTAINED BY MULTIPLYING THE TOTAL NUMBER OF CROP ACRES IN THE COUNTY, AS REPORTED BY THE LAST U. S. CENSUS, BY THE PERCENTAGE OF FARMS MEASURED IN THE COUNTY, AS REPORTED BY EACH COUNTY COMMITTEE. THIS FIGURE MAY BE IN ERROR. HOWEVER, ALL OF THE COUNTIES WILL BE ON THE SAME BASIS AND THE DIFFERENTIAL BETWEEN THEM SHOULD BE ACCURATE. THE LAST COLUMN OF THE ABOVE TABLE INDICATES THE AVERAGE POSSIBLE SAVING FOR EACH COUNTY HAD THEY USED AERIAL PHOTOGRAPHY RATHER THAN THE GROUND TRAVERSE METHOD.

PREBLE AND MIAMI OF THE ABOVE COUNTIES USED AERIAL PHOTOGRAPHY WHILE BUTLER, MONTGOMERY AND DARKE USED THE GROUND TRAVERSE METHOD OF MEASURING THE FARMS. PREBLE WAS PHOTOGRAPHED LAST YEAR AND THE COST OF THE PICTURES WAS CHARGED TO THE OLD AGRICULTURAL ADJUSTMENT ADMINISTRATION. THEREFORE, THEY ARE ABLE TO SHOW EVEN A LOWER COST THIS YEAR. LAST YEAR PREBLE WAS ABLE TO SHOW, INCLUDING THE COST OF PHOTOGRAPHS, AN APPROXIMATE 20% SAVING IN COST OF MEASURING. THEREFORE IT WOULD BE UNFAIR TO CHARGE ANY OF THE PHOTOGRAPHY TO THIS YEAR'S MEASURING.

ON THE BASIS OF COST PER ACRE IN MIAMI COUNTY (USING MIAMI RATHER THAN PREBLE BECAUSE MIAMI IS USING AERIAL PHOTOGRAPHY FOR THE FIRST TIME THIS YEAR), IT IS APPARENT THAT BUTLER, MONTGOMERY AND DARKE COULD HAVE SAVED APPROXIMATELY $26,000 THIS YEAR, OR AN AMOUNT EQUAL TO THE COST OF PHOTOGRAPHING 10 COUNTIES.

IT IS INTERESTING TO NOTE THAT PREBLE HAS SAVED APPROXIMATELY $10,000 THIS YEAR BY HAVING AERIAL PHOTOGRAPHY. THE $10,000 WAS COMPUTED BY COMPARING THE COST PER ACRE IN PREBLE WITH THE AVERAGE COST PER ACRE OF ITS THREE NEIGHBORS, DARKE, MONTGOMERY AND BUTLER. ONE WOULD CONSIDER THIS $10,000 A FAIRLY GOOD RETURN ON A $2500 INVESTMENT A YEAR AGO.

GROUP II

	Total Cost of Measuring (1)	No. of Farms Measured (2)	No. of Acres Measured (3)	Cost per Acre (4)	Possible Savings (5)
Greene	$ 6,336.00	1900	215,000	0.0295	---
Madison	6,684.00	1111	161,000	0.0415	---
Union	10,067.00	1700	134,000	0.0750	$ 5,300.00
Champaign	8,314.00	1330	112,000	0.0743	4,350.00
Pickaway	8,102.00	1472	188,000	0.0432	700.00
Fayette	6,702.00	1177	149,500	0.0448	800.00

(* OTTOWA'S COSTS ARE NOT AVAILABLE AT PRESENT).

Greene and Madison of the counties in Group II used aerial photography while the remainder used the ground traverse method of measuring.

The difference between cost per acre in Madison and Greene can best be explained by noting the number of farms measured in each county. The total cost in both counties is about equal which is to be expected for the total area of both counties was photographed. Yet Greene County had many more acres to measure and therefore spread the total cost over a greater number of acres, thus reducing the cost per acre.

When the average cost per acre of Greene and Madison is compared with the costs in the other counties, the accumulated saving in these other counties amounts to approximately $11,000. This is not as large as the saving of the counties of Group I, yet it indicates quite a definite saving.

The size of the farms in Group II is probably the main reason for the difference in savings between Groups I and II. The counties in Group II, especially Pickaway and Fayette, have many large farms which are much cheaper to measure per acre by the ground traverse method than farms in Darke and Montgomery by the ground traverse method. For example, it would take considerably less time per acre to measure a 50 acre field than a 10 acre field by the ground traverse method.

Accuracy

The accuracy of aerial photography has been proven beyond the slightest doubt in Preble and Madison Counties. There is no record available at the present time of any accuracy check in other counties.

Preble County

To check the accuracy of aerial photography in Preble County, nineteen fields were picked at random in the county and measured with a transit and tape. The error of closure of each field was then calculated and its area determined, by double meridian distances. The errors of closure were all within 1 in 5000 which is the recognized limit for good farm surveying.

The total acreage of the 19 fields calculated from the results of the transit and tape survey was 156.69 acres. The total calculated acreage of these fields by means of the aerial photographs was 156.11 acres, a difference of 0.58 acres which is equal to 0.37 of one percent of the acreage. Naturally, this 0.37% is an average figure and some of the fields were off more than this figure. However, the largest difference found in acreage was 0.13 of an acre in a 25.43 acre field or 0.51% error.

Madison County

Madison County Ohio was photographed during the late fall and early winter of 1936 under the direction of the Agricultural Conservation Program in order to determine the area of the farm land controlled by the Program.

Those in charge of the aerial photography decided to run ground control on approximately every fifth or sixth photograph to determine the correct scale of the negatives. From this information, the scale of the intermediate negatives was found by interpolation. When the scale of each negative was determined, an enlargement ratio was calculated for each photograph which would enlarge each to a scale of 660 feet per inch. The accuracy of all of this calculation was based on two very important assumptions; namely, first "That all photographs were free of tilt" and second "That the aeroplane flew at a constant elevation between control lines". Madison County is relatively flat and topography was no problem.

No sooner had the first enlargements arrived in the county when those people working with them found that a large percentage of the field measurements taken from the photographs differed from the measurements made in the field, by ground traverse method in previous years, by more than five percent.

The county committee then decided to take more control in the field and control each photograph as closely as possible. At least three, and whenever possible four, control lines averaging about a mile in length were measured on each photograph by means of an odometer attachment on an automobile. When this information was compiled, some remarkable facts came to light. Outstanding among these facts was that both assumptions (tilt and constant altitude) on which the above method of control was based were very false. The average tilt for the complete job was found to be approximately two degrees, and it was not uncommon to find photographs with five and six degrees tilt. The elevation of the plane might vary 100 feet in one flight line.

WITH AT LEAST THREE CONTROLS ON EACH PHOTOGRAPH ACCURATE DETERMINATION OF THE DIRECTION AND AMOUNT OF TILT ON THE PHOTOGRAPH WAS POSSIBLE. EACH PHOTOGRAPH WAS STUDIED CAREFULLY AND THE SCALE AT THE AXIS OF TILT AND THE RATE OF CHANGE OF THE SCALE FROM THIS AXIS WAS DETERMINED. THEN AS EACH FIELD WAS MEASURED WITH A PLANIMETER A CONSTANT WAS APPLIED WHICH CORRECTED THE AREA MEASURED ON THE PHOTOGRAPH.

IN COMPUTING ACREAGES, MOST OF THE FARMS WERE MEASURED IN PORTIONS. THIS WAS DONE FOR VARIOUS REASONS; NAMELY, DIFFERENT PORTIONS HAD DIFFERENT FACTORS, THE FARM SOMETIMES HAD TO BE MEASURED ON TWO OR MORE PICTURES, AND THE FARM AREA EXCEEDED THE LIMIT OF THE PLANIMETER.

AFTER THE PICTURES HAD BEEN CONTROLLED, A CHECK ON THE ACCURACY WAS MADE BY COMPARING 5707.0 ACRES WHICH HAD BEEN MEASURED DURING THE PAST SUMMER BY THE FEDERAL GOVERNMENT. THESE SURVEYS ALL HAD AN ERROR IN CLOSURE OF 1 IN 7,000 OR BETTER.

A. CORRECT ACREAGE AS REPORTED BY GOVERNMENT GROUND SURVEY..... 5707.0
B. CORRECTED ACREAGE FOR ENTIRE AREA OBTAINED FROM PHOTOGRAPHS.... 5707.1
C. SUM OF DIFFERENCES BETWEEN THE SURVEYS OBTAINED BY ADDING ERRORS IN INDIVIDUAL FARMS, WHICH ARE COMPENSATING UNDER B ABOVE..... 12.5
D. UNCORRECTED ACREAGE FOR ENTIRE AREA OBTAINED FROM PHOTOGRAPHS.. 5768.2

NATURALLY, THE TOTAL AREA GIVEN BY THE GOVERNMENT SURVEY COMPARES SO CLOSELY WITH THAT GIVEN BY THE AERIAL SURVEY ONLY BECAUSE THE ERRORS ON THE INDIVIDUAL FARMS TEND TO BALANCE THEMSELVES. IT IS INTERESTING TO NOTE, HOWEVER, THAT IF THE ERROR WAS ACCUMULATIVE RATHER THAN COMPENSATIVE ITS TOTAL WOULD ONLY BE 12.5 ACRES IN THE 5707.0 ACRES OF .22 OF 1%.

A TABULATION OF THE INDIVIDUAL PARCELS INDICATES THAT THE UNCORRECTED PHOTOGRAPHIC RESULTS MAY EASILY BE 5% IN ERROR WHILE THE CORRECTED RESULTS ARE WELL UNDER 1% IN ERROR. IN ALL PROBABILITY IF THE AREAS CHECKED HAD BEEN BROKEN INTO SMALLER AREAS, SUCH AS FIELDS, THE UNCORRECTED RESULTS WOULD SHOW EVEN A GREATER ERROR. THIS IS BECAUSE IN LARGE AREAS THE ERROR TENDS TO BALANCE ITSELF.

SOME CONCLUSIONS CONCERNING AERIAL PHOTOGRAPHY

1. SPECIFICATIONS SHOULD CONTAIN A RIGID CONTROL OF TILT AND THESE SPECIFICATIONS SHOULD BE ENFORCED.
2. IF ACCURACY IS DESIRED, EACH PHOTOGRAPH SHOULD BE CONTROLLED INDIVIDUALLY.
3. ACCURACY WITHIN 1% CAN BE ATTAINED BY MEANS OF AERIAL PHOTOGRAPHY.
4. THE ACCURACY IS UNDOUBTEDLY GREATER THAN THE GROUND TRAVERSE METHOD EMPLOYED BY THE AGRICULTURAL CONSERVATION PROGRAM.
5. ANY OHIO COUNTIES HAVING AT LEAST 75,000 ACRES OF LAND TO MEASURE CAN MEASURE AS CHEAPLY WITH AERIAL PHOTOGRAPHY AS WITH THE GROUND TRAVERSE METHOD. COUNTIES HAVING OVER 75,000 ACRES TO MEASURE WOULD SHOW A SUBSTANTIAL SAVING.
6. AERIAL PHOTOGRAPHS AFFORD A VERY EFFICIENT METHOD OF FILING THE RESULT OF MEASURING.
7. AERIAL PHOTOGRAPHS ARE VERY USEFUL IN LAND APPRAISAL.
8. EVERY ACRE OF LAND IN THE COUNTY IS MEASURED -- NONE IS MISSED.
9. A COUNTY ONCE PHOTOGRAPHED CAN BE USED FOR 8 TO 10 YEARS THUS AFFORDING A GREATER SAVING AFTER THE FIRST YEAR.
10. AERIAL PHOTOGRAPHY IS GROWING IN POPULARITY EACH DAY AND IT WILL SOON BE USED BY OTHER COUNTY OFFICES, ESPECIALLY THE AUDITOR & ENGINEER.

COMMENT ON ARTICLE BY C. S. COBLENTZ

APPARENTLY IN DETERMINING THE SCALE AND TILT OF PHOTOGRAPHS AS DESCRIBED BY MR. COBLENTZ, ALL CORRECTION FACTORS ARE OBTAINED BY USE OF GROUND MEASUREMENTS. IN THIS CONNECTION, HE POINTS OUT THAT FOR HIGH ACCURACY IT IS NECESSARY TO ESTABLISH CONTROL IN EVERY PICTURE.

IT WOULD BE INTERESTING TO KNOW WHAT THE COMPARATIVE COST WOULD BE OF EXTENDING A RADIAL CONTROL PLOT WHICH WOULD GIVE THE SAME ACCURACY OF SCALE CHECK TO THE PHOTOGRAPHS. WITHOUT GOING DEEPLY INTO THE SUBJECT, IT WOULD SEEM THAT WHERE COUNTIES ALREADY HAVE A REASONABLE AMOUNT OF EXISTING GROUND CONTROL, AND WHERE A HIGH PERCENTAGE OF THE ACREAGE WITHIN SUCH COUNTIES IS TO BE MEASURED, THERE IS A GOOD POSSIBILITY OF MAKING FURTHER MATERIAL ECONOMIES THROUGH EXTENDING A RADIAL CONTROL NET AS A BASIS OF SCALE CHECKING EACH PHOTOGRAPH. THE EDITOR WOULD BE GLAD TO RECEIVE COMMENTS ON THIS SUBJECT FROM MEMBERS OF THE SOCIETY.

THE EDITOR.