AN AGRICULTURAL USE VALUE, COMPUTER ASSISTED, MASS, FARMLAND APPRAISAL SYSTEM

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WILLIAM HENRY DOUCETTE, JR.

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ABSTRACT

AGRICULTURAL USE VALUE, COMPUTER ASSISTED,
MASS, FARMLAND APPRAISAL SYSTEM

By

William Henry Doucette, Jr.

The author developed and analyzed an agricultural use value, computer assisted, mass, farmland appraisal system referred to as an Agvalue System. The heart of an Agvalue System is a computer generated Land Value Map (abbreviated LVM). The procedures require the appraiser to interpret the LVM using a transparent overlay portraying pertinent information, e.g., property boundaries and soil map spot symbols. This information is transferred to an appraisal card.

A pilot study used seven Agvalue System procedures to appraise forty-five farmland parcels of, 10.1 to 100.0 acres in Alpine Township of Kent County, Michigan. Agvalue System Procedures are shown below grouped according to least variability and smallest mean difference compared to appraisal values calculated with the Michigan Tax Manual procedure using 1973 soils information and their actual acreages on the properties.

Group	Procedure Number	Soil Survey; Computer Cell Size; LVM Interpretation Method
I	7	1973; 2.5 acre; broken cell.
	5	1973; 10 acre; broken cell.
	8	1973; 2.5 acre; full cell.

Group	Procedure Number	Soil Survey; Computer Cell Size; LVM Interpretation Method
II	3	1926 revised; 10 acre; broken cell.
	6	1973; 10 acre; full cell.
III	4	1926 revised; 10 acre; full cell.
	2	1926; 10 acre; broken cell.

The pilot study showed that all the Agvalue System procedure values were highly correlated to the Tax Manual appraisal values. All Agvalue System procedures resulted in less variable appraisals more like the Tax Manual values than did the Kent County Equalization appraisals of the same properties. The Agvalue System essentially allows for the use of the Michigan State tax manual procedure en masse on all farms in a township at a cost of between $250 and $380 per year above current expenditures.

Net income information was also assembled and capitalized to estimate the true agriculture use value component of cash value. Agricultural use value appeared to be only one component of cash value. The Gross Agricultural Productivity measures reflect other use values in addition to agricultural use value. Supplied with net income data the Agvalue System can be used for an income approach to farmland valuation.

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INTRODUCTION

> "Property taxes provide an excellent example of the double objective use of taxes. In theory they provide public revenues and neither favor nor punish particular groups of taxpayers. But in practice, they often have important impacts on ownership and land use decisions."
>
> Barlowe & Alter, 1976

The use to which land is put influences both its value and the means to determine its value. As an example, land used for urban purposes such as commercial or residential is evaluated quite differently than land in agricultural uses, farmland. Farmland, no matter where its location, will have an agricultural use value as a component of its total value. The same farmland may also have other use values such as for recreation and/or potential use values, e.g., subdivision lots. An important distinction is that farmland once converted into other uses essentially loses its agricultural use value, perhaps permanently. Farmland can be thought of as a basic economic input to agricultural production, agricultural use value, and at the same time as vacant land awaiting suburban development, a potential use value. Under Michigan's ad valorem property tax, farmland is valued for all uses, present and potential. Thus, farmland in Michigan is particularly difficult for the assessor or equalization officer to appraise equitably and fairly with several use values.

The tax assessor needs to interpret the available information in terms of the use value components of the total value of a farmland tract. The Michigan State Tax Manual lists eight "specific factors" that influence the farmland value of a parcel within a given region (16). They are:

1. Productivity of the soil
2. Slope
3. Drainage
4. Management practices
5. Parcel size and shape
6. Quality and availability of water supply
7. Proximity to trading centers
8. Proximity to transportation facilities

The first four factors are highly interrelated and are basic components of agricultural productive capacity. All of these specific factors can be considered as basic resource information about a region that can be and often is routinely collected. The assessor must collect the information he feels is important in determining farmland values and the equalization officer attempts to have the assessors of his jurisdiction use similar information so that he can equalize the tax burden.

The assessor seeks a means of comparing farmland tracts using common characteristics. The agricultural use value of a property is comparable, via agricultural productive capacity, to other farmland properties of known value. The agricultural productive capacity for farmland property can be determined based on the regional land use pattern (cropping pattern)[1], the soil yield capacities, and other resource and economic data for the various land types. Land types are differentiated based on soil type, topography (slope), and land use information which are inventoried with soil surveys and remote sensing

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[1]Regional cropping pattern is the areal proportion that each of the major crops grown occupies of the total acreage of cropland. Definitions of new terms are found in Appendix A.

techniques. Agricultural productive capacity can be used to directly compare subject properties to properties of known sale value (Market Data Approach) or with additional economic data an estimate of income can be calculated and capitalized (the Income Approach). The use of agricultural productive capacity in assessing farmland has been limited by the necessary bulk of resource information and the enormous amount of labor required. Farmland, thus, is often assessed using blanket values for such broadly defined land classes as cropland, wetland, and woodlots with out further differentiation of agricultural productive capacity.

The purpose of this study was to develop, analyze and demonstrate an agricultural use value, computer assisted, mass, farmland appraisal system hereafter referred to as the Agvalue System. The Agvalue System incorporates agricultural productive capacity and was designed to meet the needs of appraisers, assessors and equalization officers.

Potential advantages of the Agvalue System may be:

1. An increase in the frequency of tax appraisals on any one agricultural tract, yearly if desired.
2. Reduction of the man hours necessary to calculate farmland appraisals using soils and land use information.
3. Refinement and standardization of the data base (soils and land use) utilized in appraisal procedures.
4. Generation of land value maps essential to a detailed permanent, and standardized record of property appraisals and tax assessments.
5. Provision of a net income farmland appraisal capability.

A pilot study of an Agvalue System[2] was performed on a sample of

[2]The Agvalue pilot study operated under the title of "The Michigan Agricultural Use Valuation Pilot Project" and was sponsored by the West Michigan Regional Planning Commission, The Michigan Agricultural

farmland properties in Alpine Township of Kent County which is North and West of Grand Rapids. The pilot Agvalue System utilized computer generated resource maps provided by the West Michigan Regional Planning Commission headquartered in Grand Rapids, Michigan. The pilot study encompassed a number of combinations of computer storage cell sizes, soil information and resource map interpretation techniques. The pilot study data was used to analyze the Agvalue System for appraisal effectiveness, computer information quality, and costs.

The pilot Agvalue System study addressed the following objectives:

A. Develop an Agvalue System

   1. Procedures

      a. Market data comparisons

      b. Income capitalization

   2. Computer techniques

      a. Devise an easily understood Land Value Map (LVM)

      b. Develop simple LVM interpretation techniques the appraiser can use to calculate property values

B. Agvalue System Analysis

   1. Examine and characterize computer cell information quality.

   2. Compare the farmland values generated by several Agvalue System procedures (different combinations of computer cell size, soil information sources, and LVM interpretation techniques) to farmland values calculated by the Tax Manual procedure and the Kent County Equalization appraised values.

   3. Estimate the Agvalue System costs.

The Agvalue system is a step towards a more complete use of agricultural productive capacity in farmland evaluation. The appraisal

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Experiment Station, and the Remote Sensing Project of Michigan State University, 1975 through 1977.

of farmland is not totally quantified by agricultural use value. Subjective judgement on the part of the appraiser remains a significant factor in an Agvalue System. The Agvalue System simply allows for more accurate information to be considered in the appraisers judgment.

The pilot Agvalue System study is concerned with farmland appraisals for tax assessment. However, the Agvalue System is not limited to tax assessment and can be used equally well by planning groups, insurance companies, banks, etc.

REVIEW OF LITERATURE

Efforts to gauge the productive capacity of agricultural lands for purposes of tax assessment date back to the earliest annals of mankind. Fenton's (9) background material indicates that during the reign of the Yao Dynasty, 2357-2261 B.C., in China, agricultural lands were classified into 9 classes, apparently on the basis of their known productivity. Agricultural productivity and the size of individual land holdings were used as a basis of taxes paid to the state. The exact nature of the classification system used over 40 centuries ago is not now determinable.

V. V. Dokuchaiev, the father of modern soil science, presided over the Russian program to relate tax assessment to agricultural productivity a little over a century ago according to Simonson (24). Fenton (9) in his review places the founding of the science of pedology with the Russian tax assessment scheme. Dokuchaiev's program involved: 1) the establishment of a natural classification of soils and 2) the interpretation of those soils according to their agricultural productivity. The soils as mapped and analyzed were rated on a scale ranging from 15 for the poorest to 100 for the best to indicate their natural agricultural productivity. The agricultural productivity ratings were used to assess agricultural land for taxation.

Fenton's background material (9) also includes a brief on the work of R. Earle Storie of the California Agricultural Experiment Station. Storie developed a unique method of rating soil productivity specifically for California Soils, known today as the "Storie Index." The "Storie Index" is based on the following soil characteristics: a) soil profile, b) texture of the soil surface, c) the slope, and d) other characteristics such as alkali content, nutrient level, erosion, microrelief. The most favorable condition associated with each characteristic is rated at 100 percent and less favorable conditions are rated accordingly less than 100 percent. The percentage ratings for each characteristic are multiplied together to arrive at the "Storie Index." Storie Index numbers were interpreted via a classification system consisting of six percentage range classes. Soils with a "Storie Index" between 80 and 100 are in class 1 (excellent), 60 to 79 in class 2 (good), and so on.

J. O. Veatch and I. F. Schneider addressed the possible criteria for the economic rating of agricultural land in Michigan 35 years ago (32). Their qualitative criteria are listed below.

1. Net income from land
2. Money value of agricultural products
3. Measured yields of crops
4. Selling price of land
5. Values assessed for taxation purposes
6. Value of farm buildings
7. Physical character of the land.

Veatch and Schneider advocated the use of measured yields of crops correlated to the physical character of land, as used for their agricultural land classification map. They noted that "the physical basis has an advantage in that all land, whether in farms or not may be classified; and that favorable qualities or limitations for agricultural use may be inferred from the chemical and physical properties of the soil which may not be revealed at a particular time by selling price, assessed values, yield of crops, or farm improvements."

Reliable estimates of the other criteria were not available during that era. In comparing two economic rating procedures--one based on the average value of land as given by the United States Census of Agriculture for the years 1930 and 1935 and the other based on the physical character of the land, they surmized that extraneous factors, such as speculative values for nonagricultural use determined the high ranking of Wayne, Oakland and Macomb counties of southeast Michigan. Extraneous factors plague the appraisal of farmland in most of southern Michigan today.

The economic rating or agricultural productive rating of farmland is a tool valuable to today's tax assessor. Michigan assessors are required to assess all taxable property at fifty percent of true cash value (18). True cash value is defined as the usual selling price at a private sale between a willing seller and an informed buyer. The two approaches to establish the true cash value of farmland, the market data approach and the income approach, are facilitated with a knowledge of agricultural productivity.

The market data approach as explained in The Appraisal of Real Estate (1) compared properties of unknown value to the sale prices for similar properties. The agricultural productivity when quantified is a means to compare properties. The market data approach has two limitations. First, a number of recent farmland sales are required as a justifiable basis of value. An insufficiency of sales will preclude the use of the market data approach. Michigan law requires three recent sales to establish value, where recent is often interpreted to be within the last year.[3] Second, the market data approach arrives at land value via a residual technique. The estimated values of buildings, other improvements, and nonagricultural land are subtracted from the sale price leaving the residue as the value of the agricultural land. The estimation of building values and nonagricultural land values adds an increment of variation to farmland values.

Agricultural productivity can also be expressed in terms of net incomes for use in the income approach. The Appraisal of Real Estate (1) explains the theory behind the income approach as: the value of a property is the present worth of the net income it will produce during the remainder of its productive life.

$$\text{Present worth} = \frac{\text{Benefits}_1}{(1 + r)^1} + \frac{\text{Benefits}_2}{(1 + r)^2} + \frac{\text{Benefits}_3}{(1 + r)^3} + \frac{\text{Benefits}_n}{(1 + r)^n} \qquad (1)$$

Benefits_1 = Benefits (rent in this case) for year 1

r = capitalization rate

n = the year at which the present worth of benefits is approximately 0.

As presented in Barlowe (2), the present worth calculation attempts to quantify in today's dollars the total future income flow from the property. This calculation is dependent upon two critical assumptions: a) the economic rent of farmland and b) an appropriate capitalization rate. The income approach is restricted by our ability to calculate

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[3]Personal communication with Mr. Frank Moss, Director of the Eaton County Department of Property Description and Equalization, Charlotte, Michigan.

reasonable economic rents and to agree on a uniform capitalization rate. The income approach is used, particularly in commercial forestland taxation (3, 31).

According to Barlowe (2), the income approach to farmland value is the theoretical true present use value. The income approach seeks to quantify the economic return to the land, also termed economic rent, for its role in the agricultural production process. The economic land rent once derived is capitalized at a specific rate to determine value as demonstrated by Equation 2 below.

$$\text{Value} = \frac{\text{rent}}{\text{capitalization rate}} \qquad (2)$$

Fenton (8) describes two methods to calculate economic rate, the landlord method and owner operator method. The landlord method relies on a common landlord-tenant rental agreement whereby a rent is easily calculated. The owner-operator method calls for a reasonable estimate of net income after accounting for all production costs. Although both methods have been used, the landlord method is usually preferred due to the difficulty in estimating production costs. Fenton's study in Iowa employed the landlord method with three assumptions concerning a rental agreement.

1. The landlord receives 1/2 of all crops.
2. The landlord pays 1/2 of seed, chemical and fertilizer expenses.
3. The landlord provides facilities for grain and hay storage.

Thus the net income In, calculation is:

$$\text{In} = 1/2\,(YP - C_{\text{seed}} - C_{\text{fertilizer}} - C_{\text{chemicals}}) - C_{\text{storage}}$$

Y = Yield, P = Commodity Price, and C = Costs

This method is rather simple but is limited in that a single rental agreement must predominate the region.

Another approach to value not usually used in land valuation is the cost approach. The cost approach involves estimating the nomimal value of land and adding the reproduction costs for improvements (1). The historic cost of land or the expense of making it useable are not usually considered valid estimates of land value. Organic soils though, may be treated as a special case because their agricultural productivity is primarily a result of improvements.[4] The value of organic soil can be estimated by adding the reproduction costs of the needed improvements, or the amortized value of improvements, to the nominal value all land is worth in the particular assessment jurisdiction.

Priest (21) developed a method to evaluate farmland based upon soil and land use information. The land use in terms of kinds and proportions of crops grown was determined for each soil management group and slope class in Eaton County, Michigan. With the determination of the agricultural land use pattern, net incomes were estimated for each soil management group and slope class. The net incomes were multiplied by a capitalization factor of 7 to arrive at value. The computed land values compared favorably with both the Michigan State Tax Commission's appraised land values and with farmers' estimates of the vâlue of their land. Priest's soil management group based appraisal method also tended to remove the bias in relative over

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[4]"Appraisal of Organic Soils in Michigan," W. H. Doucette, Jr. Unpublished paper, Michigan State University, East Lansing, 1976. Summarized in Appendix B.

valuation of low value farms and under valuation of high value farms prevalent at that time.

The validity of using the soil management groups as a measure of agricultural productivity was investigated by Miller (19). Miller devised a scheme to rate the crop management practices on farms in southern Michigan. He found that the yields for the soil management groups under good management are in general the yields predicted by the Cooperative Extension Service in Bulletin E-550 (16, 1966). Except for the yield on the 3a and 4a groups the yields obtained were within 10% of the yields given in E-550. Yields were much higher than expected for the 4a group and much lower than expected for the 3a group.

Cooper (5) examined the ability of two farmland evaluation procedures employing soil and crop yield information to predict the true cash value of cropland in Eaton County, Michigan. Both the procedure outlined in the Soil Manual for Appraisers (28) and Cooper's revision of this procedure proved to be highly correlated to sales values, r = .96 and .92, respectively. The Soil Manual for Appraisers procedure, referred to as the S.M.A. procedure, utilizes soil management groups and the expected average yield for corn predicted in E-550 (16, 1966) as a basis of comparison in the S.M.A. procedure. As an example an acre of soil with an expected average yield of 65 bushels of corn is valued at 1/2 the value of an acre of soil with an expected average yield of 130 bushels of corn. The relative value of a farm tract is thus directly related to its total expected average yield. Cooper's revised S.M.A. procedure uses the E-550 corn yields minus the yield proportion attributable to the costs of production, a net yield, as the basis of comparison. Cooper found both procedures to be accurate, reliable and reproducible. Furthermore, the S.M.A. or the Revised S.M.A. procedures, particularly the latter, tended to eliminate the bias of relative under valuation of high value properties and over valuation of low value properties noted by Priest.

Assessors must determine the value of large numbers of properties, as much as fifteen times the number a fee appraiser would handle in a year (6). Thus, similar properties are assessed en masse,hence the term mass, in "mass appraisal" techniques. Farmland evaluation techniques using soils and land use information, such as the Soil Manual for Appraisers procedure, are rather labor intensive and as such are not well adapted as a mass appraisal technique. For this reason, common use of agricultural productivity procedures have been inhibited. Computer assisted, mass, farmland appraisal systems, are overcoming the labor intensity constraint and demonstrate considerable utility to assessors.

Computer assisted appraisal of farmland using "data banked" soils information was pioneered in Iowa (8) and Indiana (35). In Iowa a computer storage cell size of .5 acres is used to produce a land value map for each square forty acres. The Iowa system uses a landlord income capitalization method approach with corn being the major crop grown. Each soil series in Iowa is rated according to its corn yielding capability labeled the Corn Suitability Rating. The computer places a value on each forty acre tract.

The Indiana system employs a 2.5 acre computer storage cell and codes the cells according to ownership (35). A productivity index abbreviated PI, based on each soil's "capacity to yield" and production costs is used for comparisons in the market data approach.

PI = Gross return - production costs - conservation costs

The PI also considers the overall crop rotation on each soil as determined from the Conservation Needs Inventory.

Both the Indiana and Iowa system evaluate all farmland as if it were cropland and do not account or adjust for other agricultural uses (woodlots, permanent pasture, swamps, etc.) that may, in fact, have lower values than cropland.

Property tax assessment by computer also allows the use of a powerful statistical tool known as multiple regression. Shenkel (22, 23) reports that for a study of farmland in Arizona using a multiple regression technique with ten variables (including soil productivity, field shape and size, irrigated acreage, total acreage, and distance to the main elevator) the calculated farmland values compared to actual sales values had a correlation, r^2, of .9984 with an average deviation of 7.4%.

In developing or initiating a computerized assessment system, Hamilton (10) suggests answering the following eight questions:

1. What are the objectives of the Department? (How important is farmland?)
2. How can computer appraisals help meet this objective?
3. What system components are necessary?
4. What is the expected cost?
5. When can the system be operational?
6. Are personnel and equipment available?
7. Can the system be maintained and if so at what cost?
8. What new problems come with the system?

PROCEDURES

Estimation of Net Incomes

Net incomes were calculated using three formulas representative of the owner-operator-method. A common rental agreement was not discernable in Kent county, thus precluding the landlord method described by Fenton (8). The owner-operator method to estimate net income requires a considerable quantity of information to document the production inputs. Three formulas were assembled which use a variety of information sources to arrive at a reasonable estimate of the production costs of a marketable crop. Figure 1 outlines the various information sources as packaged for each formula. The custom rate formula will be given emphasis in this study. Each of the five information source components are documented below.

M.S.U. Recommendations and Crop Reporting Service Prices:

Seeding rates are selected from E-489 (11) and corn seeding rates are shown on Table 1.

Fertilizer and lime rates are selected from Extension Bulletin E-550 (16, 1972) and based on the median soil tests results for Kent county furnished by the Michigan State University Soil Testing Laboratory.

Seed, fertilizer and lime rates were priced on a component basis (as in N, P, K) from the U.S.D.A. Crop Reporting Service releases dated March of each year for spring planted crops and August for fall planted crops (29).

Custom Rates:

The custom rates as reported in Rates for Custom Work in Michigan (17) were time series averaged for 1971 through 1975. In years where bulletins were not published points were estimated with a straight line interpolation.

<table>
<tr><th>Cost Item</th><th>Formula 1
(Custom Rate)</th><th>Formula 2
(Enterprise Budget)</th><th>Formula 3
(Hybrid)</th></tr>
<tr><td>1. Material Expenses
Seed
Fertilizer
Lime
Herbicide
Fuel & repair
Hauling
Drying & marketing
Utilities
Miscellaneous</td><td>M.S.U. Recommen-
dations
U.S.D.A.-S.R.S.</td><td rowspan="3">Enterprise
Budget
(Knoblauch)</td><td>M.S.U. Recommen-
dations
Crop Reporting
Service Prices</td></tr>
<tr><td>2. Labor</td><td rowspan="2">Custom
Rates
Reported
by M.S.U.</td><td rowspan="2"></td></tr>
<tr><td>3. Depreciation</td></tr>
<tr><td>4. Interest</td><td>U.S.D.A.-S.R.S.</td><td rowspan="2" colspan="2">Telfarm
Reports</td></tr>
<tr><td>5. Return to capital</td><td></td></tr>
</table>

Figure 1. Information sources for three formulas to estimate production costs.*

*All prices, rates, and estimates are 5 year averages, 1971 through 1975.

Table 1. Corn Seeding Rates

		Yield Ranges				
Silage Grain	in Tons in Bushels	Below 10 60	10-14 60-89	15-19 90-119	20-24 120-149	24 plus 150 plus
Harvest	Population	14,000	16,000	18,000	20,000	22,000
Planting	Population	16,000	18,400	20,700	23,000	25,300
(1.15 x Harvest Population)						

Note: U.S.D.A. Seed Corn Prices are based on per bushel costs - assume 80,000 seeds per bushel in calculating seed costs.

Enterprise Budget:

Selected cash expenses by crop and yield goal are itemized in the Michigan State University Department of Agricultural Economics publication entitled "Enterprise Budgets" (7). The enterprise budget was indexed back through the year 1971 as reported by Wayne Knoblauch (14).

Labor costs were calculated from item 4 of the enterprise budget, family and regular hired labor hours, and the above-average management wages reported by Knoblauch (14).

Telfarm Reports:

Depreciation is listed under power and machinery for cash and non-cash expenses for cash grain farms (25).

Return on investment (Interest) is taken from Table 7 for cash grain farms (25).

Interest paid on borrowed capital is listed under Operator's Farm Costs items, machinery, improvements and crop expenses (26).

United States Department of Agriculture Statistical Reporting Service:

Interest paid for borrowed capital is charged as the opportunity cost for the capital employed in producing the crop (29).

The custom rate formula contains the most assumptions. The major assumption is that custom rates reflect reasonable charges for a given field operation and include the costs to own, maintain, operate, and house the equipment. The material costs are tailored to Kent County soil test results. The return to capital and capital costs are also included. Table 2 details the cost calculation for corn grain using Formula 1, Custom Rates.

The enterprise budget formula uses fewer sources yet these sources are considerably more difficult to interpret. Fertilizer costs for the enterprise budget are based on replacement due to the nutrient loss of harvesting the crop. Formula three is a hybrid of formula one and formula two.

A common practice is to include the property tax as a production

Table 2. Corn Grain, 1971 through 1975 Averaged Production Expenses per Acre Using the Custom Rate Formula

Unit	Unit Price	Texture Class (S.M.G.*)																	
		Loams (2.5), Clay Loams, (1.5) & Clays (1.0)								Sandy Loams (3.0) & Loamy Sands (4.0)								Sands (5.0)	
		Yield								Yield								Yield	
		60 to 89		90 to 119		120 to 149		150 Plus		60 to 89		90 to 119		120 to 149		150 Plus		Below 60	
Seed (1000's)	.2935	18.4	5.40	20.7	6.08	23.0	6.75	25.3	7.43	18.4	5.40	20.7	6.08	23.0	6.15	25.3	7.43	16	4.70
Fertilizer N	.1233	70	8.61	100	12.33	150	18.50	200	24.66	70	8.61	100	12.33	150	18.50	200	24.66	70	8.61
In Lbs P_2O_5**	.1322	25	3.31	25	3.31	25	3.31	25	3.31	25	3.31	25	3.31	25	3.31	25	3.31	25	3.31
K_2O**	.0586	---	---	30	1.75	60	3.52	100	5.86	50	2.93	75	4.40	100	5.86	150	8.79	50	2.93
Lime (tons)	8.54	1.9/5	3.25		3.25		3.25		3.25		3.25		3.25		3.25		3.25		3.25
Herbicides & Chemicals	7.14	---	7.14		7.14		7.14		7.14		7.14		7.14		7.14		7.14		7.14
Subtotal 1			27.71		33.87		42.47		51.65		30.64		36.51		44.81		54.58		29.94
Fixed																			
Planting	4.12		4.12																
Tillage	9.41	min	9.41																
Fert. Spread	1.40	till/	.28																
N. Spread	2.30	1/5	2.39																
Combine	11.14		11.14																
			27.34		27.34		27.34		27.34		27.34		27.34		27.34		27.34		27.34
Variable																			
Drying & Hauling			15.84		22.63		29.41		33.94		15.84		22.63		29.41		33.94		11.31
Subtotal 2			70.89		83.84		99.22		112.93		73.82		86.48		101.56		115.86		68.59
Management	8.0%																		
Interest	6.2%																		
Central Yield			70		100		130		150		70		100		130		150		50
TOTAL EXPENSES	$		80.96		95.75		113.31		128.97		84.30		98.76		115.98		132.31		78.33
	Bu.		36.6		43.3		51.3		58.4		38.1		44.7		52.5		59.9		35.4
NET INCOME	$†		73.81		125.31		173.93		202.44		70.50		122.21		171.32		119.19		32.17
	Bu.		33.4		56.7		78.7		91.6		31.9		55.3		77.5		90.1		14.1

*S.M.G. = Soil Management Group

**Based on median soil test results 1971 through 1975 as follows:

Soil Management Group	P_2O_5	K_2O
1.0, 1.5, 2.5	109	190
3.0, 4.0, 5.0	109	156

†Based on average retail price of $2.21 per bushel, 1971-1975.

cost. However, if taxes are based on property value and a net income is capitalized to determine value, the property tax cannot be known prior to determining net income. Thus property tax has not been included as a cost in these formulas. Property tax expenses can be accounted for in the capitalization rate. The tax rate expressed in the decimal equivalent of millage is divided in half (50% assessment of true cash value) and added on to the capitalization rate.

Agricultural Productivity

The market value procedure recommended in the State of Michigan Tax Commission Manual Chapter IV, Farmland, utilizes agricultural productive capacity to compare farmland properties. The agricultural productive capacity (agricultural productivity) as employed in the tax manual procedure is a function of soil productivity, and land use as shown below.

$$S = \frac{Y_1 P_1}{Y_1^m} + \frac{Y_2 P_2}{Y_2^m} + ,. . . ., \frac{Y_n P_n}{Y_n^m} 100 \qquad (3)$$

S = Agricultural Productivity (unitless) of a soil unit.

Y_1 = Soil Productivity for Crop 1 on a given soil unit.

Y_1^m = Soil Productivity for Crop 1 on the most productive soil unit.

P_1 = Proportion of crop land that Crop 1 occupies of all cropland.

Land use is stated in terms of the proportions (decimal fractions), P_1:P_2:,. . .,P_n of all important crops grown in the area, their yields on specific soils Y_1, Y_2,. . .,Y_n and their yields on the most productive soil for that crop Y_1^m max, through Y_n^m max.

Soil productivity is defined as the capacity of a soil unit for yielding a specified crop under a specified management. Soil Productivity, Y_x, can be conceptualized as follows:

Y_x = function of (Soil Management Group, Slope Gradient, Crop X, Climate and Management)

Y_x is understood to be the soil productivity of a specific unit of land used to grow crop x (land use = crop x) and is expressed in units of yield. Three of these factors (soil management group, slope gradient and climate) are relatively fixed for a unit of land and can be described as a soil map unit. Current estimates of soil productivity for Michigan soil management groups are given as long term (5 year or more) yield averages in Tables 26 and 27 of Extension Bulletin E-550 Fertilizer Recommendations for Michigan Vegetables and Field Crops, (16, 1972). Soil management groups also explained in E-550, are groups of mapped soil series with similar dominant soil profile textures and natural drainage conditions. A detailed discussion of soil management units and their uses can be found in Research Report 254 of the Michigan Agricultural Experiment Station (18). Soil mapping units delineated in most current soil surveys include the soil series--which can easily be placed in a soil management group--and the dominant slope gradient. Slope gradients are expressed in percentages where the percentage is the difference in elevation of the surface over a measured horizontal length (e.g., 5% slope - 5' rise or fall in 100' horizontally).

Management refers to the decisions and implementation of such practices as tillage, applications of fertilizer, pest controls, hybrid seed selection, crop rotations, planting time, harvesting, improvements to natural drainage, etc. The yield potentials reported in Extension Bulletin E-550 are those produced under management practices recommended by the Cooperative Extension Service and the Michigan Agricultural Experiment Station through cooperation with farm managers and the results of agricultural research. The yield potentials reported in E-550 reflect good management as opposed to the most intensive management or poor management.

Agricultural productivity, S from Equation 3 is a number from 0 to 100 that reflects a soil unit's ability to produce a number of crops for a specified cropping pattern. The number, is thus a rating of the agricultural productivity of that soil in comparison to the most productive soil of the region as 100. Since the soil productivity is expressed in gross yields on cropland with a given proportional cropping pattern (crop proportions or land use ratios), the rating is called a gross, cropland, use adjusted, soil productivity (GCSP) rating.

This rating can then be used to compare properties. To give a simplified example one can visualize two 40 acre tracts each consisting of a different soil. Using the gross cropland use adjusted soil productivity (GCSP) rating with a range of 0-100, tract A can be compared to tract B.

A.	B.
Oakville fine sand, 2-4% slope	Kawkawlin loam, 2-4% slope
Rating = 45	Rating = 90

In this example the Oakville fine sand (rating = 45) has one-half (1/2 = 45/90) the GCSP rating of the Kawkawlin loam (rating = 90). Thus if the property B sold for $1,000 per acre one could infer that property A with 1/2 the agricultural productivity capacity would have a farmland value of $500 per acre. It is important to note that this is a cropland-soil productivity rating system. Other agricultural uses such as woodlots, and pasture would be blanket valued or utilize other productivity rating systems. A productivity rating and a productivity index measure the same thing but differently; as used here an index uses decimal fractions and a rating uses whole numbers (index x 100).

The Michigan tax manual productivity rating serves as the prototype for the agricultural productivity indices (GCSPI) constructed in this study. The agricultural productivity indices developed in this study have two additional components not considered in the tax manual rating. First, is a quantitative correction for yield losses on slopes steeper than six percent. Second, is a county specific cropping pattern different from the tax manual crop ratio of 1:1:1:1, corn, wheat, hay, oats. These additional components allow for a more refined and regionally tailored, agricultural productivity measure.

The crop proportions were determined specifically for cropland in Kent County as shown in Table 3. Further, on steep slopes only hay crops are assumed to be grown. The calculation of the use adjusted gross, cropland, soil productivity index for Kawkawlin loam is shown in Table 5.

Substituting net yields after production costs for the E-550 expected average yields on line 1 of Table 5 will result in a Net

Table 3. Agricultural Productivity Indices and Ratings for Kent County, Michigan

Soil Management Group	Slope Class	Gross, Cropland Use Adjusted, Soil Productivity Index	Net, Cropland Use Adjusted, Soil Productivity Index	Tax Commission Productivity Rating	Tax Commission Productivity Group	Kent County Equalization Productivity Rating
1.5a	B	.86	.80	80	4	100
	C	.77	.70			90
	D	.66	.55			80
	E	.53*	.38			70
1.5b	A	.92	.89	90	3	110
	B	.90	.86			100
1.5c		.98	.98	100	1	100
2.5a	B	.86	.82	90	3	110
	C	.78	.71			100
	D	.65	.53			90
	E	.63*	.40*			80
2.5b	B	.92	.90	95	2	115
2.5c		1.00	1.00	100	1	120
3/1b	B	.89	.85	90	3	110
3/2a	B	.84	.78	80	4	100
	C	.75	.67			90
	D	.65	.53			80
3/2b	B	.89	.85	90	3	110
3/2c		.92	.90	95	2	115
4/1c		.82	.74	80	4	100
4/2a&3a	B	.72	.62	75	5	95
	C	.64	.51			85
	D	.52	.36			75
4/2b&3a	B	.76	.68	75	5	95
4a	B	.61	.45	55	7	75
	C	.53	.36			67
	D	.44	.24			59
	E	.38*	.11-*.12			51
4b	B	.64	.51	65	6	85
4c&L-4c		.73	.61	75	5	95
5a	B	.45	.23-.26*	45	8	65
	C	.40	.16-.19*			58
	D	.37*	.12-.12*			51
5b	B	.55	.36-.37*	65	6	85
5c		.65	.52	65	6	85
L-2c		.89	.85	100		100
Mc,M/1c		.77		75		95
M/3c, M/4c		.55		55		75
L/mc,M/mc,Mc-a		.72		75		95

*Cropland considered into all hay only.

Table 4. Percent of Cropland in Various Crops[1] for Kent County

Year	Corn		Wheat	Oats	Hay		Beans		Barley
	Grain	Silage			Legume	Mixed	Soy	Dry	
1970	35.85	6.33	5.88	9.78	25.00	15.00	0.24	1.50	0.42
1971	29.06	12.40	5.58	10.26	25.0	15.0	0.18	1.62	0.84
1972	38.83	4.31	8.10	6.84	25.0	15.0	0.24	1.38	0.36
1973	37.24	6.32	8.04	7.02	25.0	15.0	0.36	0.96	0.12
1974	31.18	7.07	13.49	5.52	25.0	15.0	0.29	1.38	0.11
Mean	34.43	7.29	8.22	7.88	25.0	15.0	0.26	1.37	0.37
Adjusted[2] Mean	35.05	7.56	8.53	8.18	25.0	15.0			
Percent Rounded*	35.0	8.0	9.0	8.0	25.0	15.0	Σ = 100		
Decimal Fraction Equivalent	.350	.080	.090	.080	.250	.150	Σ = 1.00		
All Hay Proportions					.6~~7~~25	.375	Σ = 1.00		

[1]Statistics taken from Michigan Department of Agriculture - Crop Reporting Service (27) 1971-1975. Note that Hay is in constant proportion - Statistics were not available from the Crop Reporting Service and these statistics are from the Census of Agriculture, 1964 & 1969 (30, 31).

[2]Adjusted with the deletion of beans & barley plus holding Hay at 40%.

*Rounded to nearest whole number.

Cropland Soil Productivity Index. The net income information previously generated can also be interpreted in terms of net yields after production cost. A Net-CSP index, using the custom rate formula, is shown in Table 3. The net productivity index has a greater range than the gross productivity index. This increased range indicates that the finer textured soils produce a considerably greater net return than the sandier soils. Note that, e.g., the soil management unit 4aB has a gross productivity index of .61 and a net-productivity index of .45. The 5aB soil management unit has a gross productivity index of .45 and a net-productivity index of .16. The sandier soils are shown to be of little agricultural use value under the specified crops. A management system that includes irrigation or specialty crops such as blueberrys would show a higher Net CSP index and agricultural use value for the sandier soils. The use of irrigation is a special case requiring a substantial capital investment and should only be included in a productivity index applied to a region where irrigation is a common practice.

The net productivity index can also be used in conjunction with an income capitalization approach. The equivalent acres on a farmland tract generated via a net productivity index can be simply multiplied by the capitalized value of the soil with an index of 1.00. The combined use of a net cropland soil productivity index and capitalized net income facilitates the use of a net income approach.

As a further note, a productivity index as constructed herein will need to be re-evaluated about every five years to account for changes in soil productivity and the cropping system.

Table 5. Calculation of the Gross Cropland Use Adjusted, Soil Productivity Index (GCSPI) for Kawkawlin Loam on B Slopes (2-6%)

Average	Corn Grain Bu.	Corn Silage Tons	Wheat Bu.	Oats Bu.	Alfalfa Hay Ton	Grass Hay Tons
1. Expected gross avg. yield[1]	109	17	55	90	5.5	4.0
2. Base gross yield (for the soil with the highest expected average yield in the county.)	130	20	60	110	6.0	4.2
3. Gross yield ratio (line 1 ÷ line 2)	.84	.86	.92	.82	.92	.95
4. Crop proportion of the total cropland[2]	.35	.08	.09	.08	.25	.15
5. Crop contribution line 3 x line 4	.29	.07	.08	.065	.23	.14
6. Summation of line 5.			.88			
7. Weighted GCSP index (line 6 ÷ .979, the highest summation for any one soil).			.90			

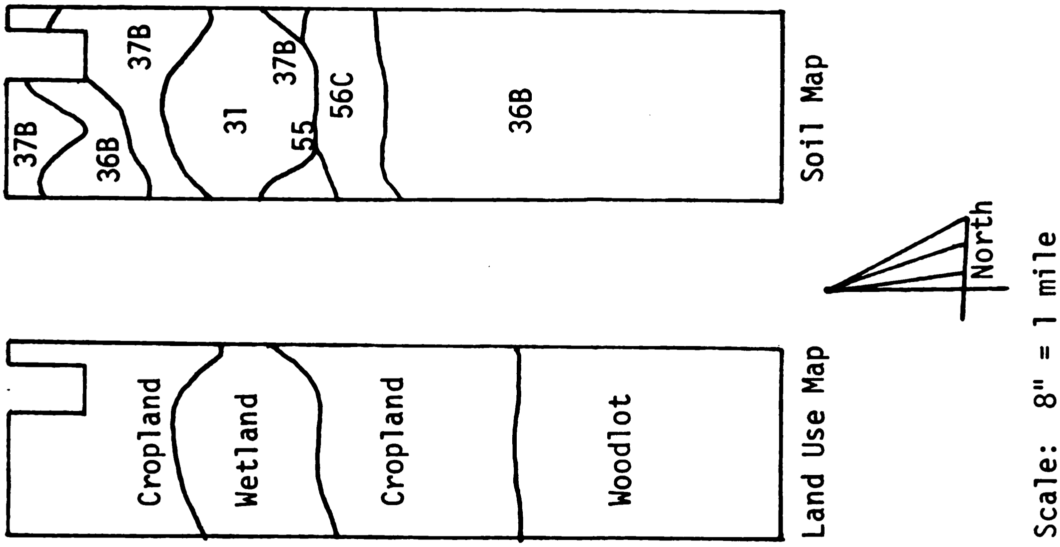
[1]Under good management as recommended by Michigan State University for areas with 140 frost free days or more and with adequate drainage. Expected average yields reported in M.S.U. Extension Bulletin E-550, Fertilizer Recommendations for Michigan Field Crops (16, 1972).

[2]As reported by the Michigan Department of Agriculture, Crop Reporting Service for Kent County 1970-1975. The hay estimate is taken from the 1964 and 1969 Censuses of Agriculture (30, 31).

Table 3 lists the various productivity ratings and indices for Kent County. The GCSP Index appears in column 3. The Kent County Department of Equalization modified the Tax Commission productivity rating by changing the 100 soil to a Soil Management Unit 1.5aB. The Kent County productivity rating also allows for lower ratings on slopes steeper than 6%.

The Manual Procedure

Chapter IV of the State Tax Manual (18) provides a detailed description of a farmland appraisal procedure. The trial appraisal study for the Agvalue system utilized a modified tax manual procedure, called the "manual procedure." The sample of farm properties used in the study was the same as the Kent County Department of Equalization 1975 appraisal study, so the field inspection, determination of building values, and preparation of appraisal cards were already completed and available. The manual procedure as used in this study was performed using 1973 soil maps and the use adjusted, gross cropland soil productivity index. Figure 2 illustrates the manual appraisal procedure for a parcel in the study. Two maps are utilized in the procedure, a modern 1973 soil map and the current land use map. The land use map was interpreted from an aerial photograph. Below the maps, is an inventory of the soil-land use units. The inventory includes the acreage in each soil management unit--land use class, its productivity index, and a calculation of equivalent cropland acres. Equivalent cropland acres are simply the acreage in each soil-cropland unit, multiplied by the GCSP Index. The equivalent cropland acres are totaled. In Kent County orchard lands are evaluated as cropland due to a state law that removes fruit trees from



Inventory

Soil Map Unit Symbol	Soil Management Unit	Land Use	GCSP Index	Acreage	Equivalent Cropland Acres
31	L-2c	Wetland		7.2	
36B	2.5aB	Cropland	.86	8.0	6.9
		Woodlot		13.2	
37B	2.5bB	Cropland	.92	6.4	5.9
56c	2.5aC	Cropland	.78	3.2	2.5
55	L-4c	Wetland		.4	
				38.4	15.3

Value of Equivalent Acre: $\frac{\text{Residual to Cropland}}{\text{Equivalent Cropland Acres}} = \frac{\$16,000}{15.3} = \$1050$

Rounded and assessed at 50% = $525

Assessment: 7.6 acres wetland @$150 = $1,140
13.2 acres woodlot @ $200 = 2,640
15.3 quivalent acres @ $525 = 8,033
$11,813

Rounded to $11,800 as value of the land.

Figure 2. An illustration of the Manual Procedure: Resource Inventory.

ad valorem taxation. The other farmland acres of upland woodlots, wetlands, forested wetlands, and pasture are summed and appraised at blanket values of $200, $150, $150 and $150 per acre, respectively.

Up to this point in the procedure, the property could be part of the market sales price study or a property of unknown value. For a sales price study property the value of the blanket valued acreages are subtracted from the residual value to land leaving the total value attributed to the cropland acreage. The total cropland value is then divided by the summed equivalent cropland acres resulting in a per acre value of soil with a productivity index of 1.00. The average value of an equivalent acre from the sales price study containing several recently sold farmland properties can then be used to establish the value of cropland on any farmland parcel in the jurisdiction. The procedure to establish the cropland value involves multiplying the equivalent acres on a subject property by the value of an equivalent acre found in the sales price study.

Once the soil-land use inventory has been completed the acreages can be carried indefinitely on an appraisal card, until either the land use changes on the property ownership or the productivity index changes. In this way for any future year the assessor need only determine the value of an equivalent acre, the other blanket values and multiply the per acre values by the acreages previously inventoried. A yearly multiplier could also be used to change each use value such as is done with building values.

Computer Land Value Map (LVM)

The heart of the Agvalue system is a computer generated Land Value Map hereafter referred to as LVM. The LVM can display a variety of information including land use, soil management units, productivity indices and of course land value. Figure 3 illustrates a portion of an LVM generated from the resource Data Bank of the West Michigan Regional Planning Commission. The Data Bank consists of geo-coded dominant soil management unit and land use according to the coding listed in Tables 6 and 7, respectively. Geo-coding is the procedure of storing information about the earth's surface in a computer file using grided cells of equal size, in this case ten square acres, such that the information can be easily referred to.

The assessor uses the land value map, as a replacement for individual soil and land use maps in the manual procedure. The individual soil-land use cells are uniform in size and easily summarized by each ownership unit. The 10 acre cell LVM has a scale of four inches to one mile, (a common scale for modern soil surveys) and encompasses an entire township on a 24" x 24" map.

The LVM is interpreted using a transparent overlay with roads, property size, and special notes on the land value map. In preparing the overlay one must be aware that each section, as represented in the computer, is a perfect 640 acre square. Many sections are not so perfect in size or shape. The recommended procedure is to place property lines on the transparency, one section at a time, as if the section were a perfect square. The resource information was coded into the computer data bank in a similar manner. The odd size or shape of a property can be corrected by indicating the actual

Horizontal Cell Coordinates

Vertical Cell Coordinates	9	10	11	12
1	5250 ORCH 15AB	5250 ORCH 15AB	5250 ORCH 15AB	5250 ORCH 15AB
		A - 79 ac.		
2	5250 ORCH 15AB	5250 ORCH 15AB	5250 ORCH 15AB	5250 ORCH 15AB
3	3360 CROP 4 BB	4463 CROP 15AB	5250 ORCH 15AC	5250 ORCH 4 AB
		B - 101 ac.		
4	5250 ORCH 25AB	4515 CROP 25AB	4515 CROP 25AB	4515 CROP 25AB
5	5250 ORCH 25AB	5250 ORCH 25AB	4515 CROP 25AB	4515 CROP 25AB
		C - 59 ac.		
6	4830 CROP 25BB	4830 CROP 25BB	4515 ORCH 25AB	4830 CROP 25BB
7	4515 CROP 25AB	4514 CROP 25AB	4515 CROP 25AB	4095 CROP 25AC
	D - 38 ac.		E - 39 ac.	
8	4515 CROP 25AB	4515 CROP 25AB	4515 CROP 25AB	4095 CROP 25AC

10 acre cell:
- 5250 ← Land value for the entire cell $5250.
- ORCH ← Land use code "ORCHARD"
- 15AB ← Soil Management Unit Code, 1.5aB.

Figure 3. A segment of a Land Value Map with property boundaries overlayed.

Table 6. Land Value Map (LVM) Soil Management Unit Coding

Soil Management Unit	Computer Map Code	Soil Management Unit	Computer Map Code	Soil Management Unit	Computer Map Code
1.0aA	10AB	3.0aA	30AB	4.0cA	40CA
" B	10AB	" B	30AB	5/2aA	52AB
" C	10AC	" C	30AC	" B	52AB
" D	10AD	" D	30AD	" C	52AC
" E	10AE	" E	30AE	" D	52AD
" F	10AF	" F	30AF	" E	52AE
1.0bA	10BA	3.0bA	30BA	" F	52AF
" B	10BB	" B	30BA	5/2bA	52BA
1.0cA	10CA	3.0cA	30CA	" B	52BA
1.5aA	15AB	3/5aA	35AB	5/2c	52CA
" B	15AB	" B	35AB	5.0aA	50AB
" C	15AC	" C	35AC	5.0aB	50AB
" D	15AD	" D	35AD	" C	50AC
" E	15AE	" E	35AE	" D	50AD
" F	15AF	" F	35AF	" E	50AE
1.5bA	15BA	3/5bA	35BA	" F	50AF
" B	15BB	" B	35BA	5.0bA	50BA
1.5cA	15CA	3/5cA	35CA	" B	50BA
2.5aA	25AB	4/1aA	41AB	5.0cA	50CA
" B	25AB	" B	41AB	5.3aA	53AB
" C	25AC	" C	41AC	" B	53AB
" D	25AD	" D	41AD	" C	53AC
" E	25AE	" E	41AE	" D	53AD
" F	25AF	" F	41AF	" E	53AE
2.5bB & 2.5bA	25BA	4/1bA	41BA	" F	53AF
2.5cA	25CA	" B	41BA	5.7aA	57AB
3/1aA	31AB	4/1cA	41CA	" B	57AB
" B	31AB	4/2aA	42AB	" C	57AC
" C	31AC	4/2aB	42AB	" D	57AD
" D	31AD	" C	42AC	" E	57AE
" E	31AE	" D	42AD	" F	57AF
" F	31AF	" E	42AE	L-2aA	L2AB
3/1bA	31BA	" F	42AF	" B	L2AB
3/1bB	31BA	4/2bA	42BA	" C	L2AC
3/1cA	31CA	4/2bB	42BA	" D	L2AD
3/2aA	32AB	4/2cA	42CA	L-2bA	L2BB
" B	32AB	4.0aA	40AB	" B	L2BB
" C	32AC	" B	40AB	L-2cA	L2CB
" D	32AD	" C	40AC	L-4aA	L4AB
" E	32AE	" D	40AD	" B	L4AB
" F	32AF	" E	40AE	" C	L4AC
3/2bA	32BA	4.0aF	40AF	" D	L4AD
3/2bB	32BA	4.0bA	40BA	L-4bA	L4BA
3/2cA	32CA	4.0bB	40BA	" B	L4BA
				L-4cA	L4CA
				M/1c	M1CA
				M/3c	M3CA
				M/4c	M4CA
				L/Mc	LMCA
				M/Mc	MMCA
				Mc	MCA
				Mc-a	MCAA

Table 7. Land Value Map (LVM) Land Use Coding

Land Use Code Number	Land Use Class	Land Value Map Use Coding
21	Cropland	CROP
24	Inactive agriculture	CROP
22	Orchards-Horticultural	ORCH
31	Deciduous Forest	DFOR
32	Evergreen Forest	EFOR
33	Mixed Forest	MFOR
41	Forested Wetland	FWET
42	Wetland	WET
52	Shrub, Bushland, Range	BUSH
62	Open water	WWWW
( )	*Pasture	PAST

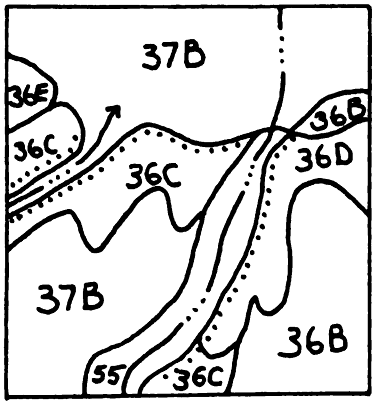
*Not presently classed or coded but would commonly correspond to cropland with greater than 18% slopes or cleared wetlands.

Note: Properties in other land use are neither shown on the farmland value maps nor is a value placed on such properties.

property size on the overlay. The rectangular surveying shifts errors of measurement to the north and west portions of each section and township.

The transparency can also be used to indicate special notes about the landscape. Wet spots, escarpment symbols, rivers, drainage ditches etc. placed on the transparency will assist the assessor in determining value. For example, in Figure 4 an escarpment is shown on the soil map that controls a small stream. The data bank does not include this information and as a result a value somewhat higher than desirable is computed. The assessor must make such corrections in the computed values.

With the transparency in place the assessor has two methods for interpreting information from the LVM: <u>broken cells</u> and <u>full cells</u>. For the <u>broken cell</u> method the exact proportion of each cell



Soil Map
(scale 8" = 1 mile)

4830 CROP 25BB	4830 CROP 25BB
4830 CROP 25BB	4515 CROP 25AB

LVM, 10 acre cells
(scale 4" = 1 mile)

Spot Symbol Legend

Intermittent Stream

Escarpment, slopes greater than 18% with less than 100 feet length.

Note: The area of the escarpments and small areas enclosed with escarpments will have little agricultural use value and must be adjusted on the LVM to show a reduced value. The escarpment and intermittent stream symbols can be transferred to the transparency from the soil map for use in the Agvalue System.

Figure 4. A forty acre tract as shown on a soil map and on a Land Value Map.

that falls within a property boundary is determined and summarized. Figure 5 illustrates the broken cell method, note that the upper most cell is broken from 10 acres to 8.5 acres in the inventory to adjust for the actual size of the property. In the <u>full cell</u> method the assessor notes the exact acreage for the property and chooses the contiguous cells, covering the property area, that most nearly coincide with the property boundaries for the summation. The summation is then multiplied by a correction factor (area of property/area of contiguous cells) to adjust to the exact property size. Figure 6 illustrates the full cell method, not that the cells are not broken

4830 CROP 25BB
1500 WET L2CA
4515 ORCH 25AB
2000 FOR 25AB

Soil Land Use Inventory

Acreage	Soil Management Unit	Land Use	Assessment
8.5	25BB	Cropland	4057
10	25AB	Orchard	4515
10	25AB	Forest	2000
10	L2CA	Wetland	1500
		Total Farmland Assessment	$12,072

Figure 5. A 10 acre broken cell appraisal of the property shown in Figure 2.

1207 CROP 25BB	1128 CROP 25AB
1207 CROP 25BB	1207 CROP 25BB
375 WET L2CA	375 WET L2CA
375 WET L2CA	375 WET L2CA
1128 ORCH 25AB	1128 ORCH 25AB
1128 ORCH 25AB	1128 ORCH 25AB
500 FOR 25AB	500 FOR 25AB
500 FOR 25AB	500 FOR 25AB

Soil Land Use Inventory

Acreage	Soil Management Unit	Land Use	Assessment
7.5	25BB	Cropland	3621
2.5	25AB	Cropland	1128
10.0	L2CA	Wetland	1500
10.0	25AB	Orchard	4515
10.0	25AB	Forest	2000
		Sub Total	$12,764
			x .96

Adjustment Factor $\frac{38.4}{40.0} = .96$

Total Farmland Assessment = $12,253

Figure 6. A 2.5 acre <u>full cell</u> appraisal, of the property shown in Figure 2.

in the inventory, but are adjusted after the subtotaling. The broken cell method requires more time and greater accuracy of the transparency, but proved to be a better approximation of the manual approach than the full cell method when similar soil information is used. A smaller cell would be needed to offset the lower accuracy of the full cell method.

The Pilot Study of an Agvalue System

The Agvalue System was used to appraise a random sampling of farmland properties previously selected for the Kent County Department of Equalization Appraisal Study of Alpine Township in 1975. Alpine Township is north and west of the Great Grand Rapids Area and is considered part of the Northwestern Fruit and Dairy Farming Area (12). The soils of Alpine Township have developed primarily on loamy glacial tills with some sandier inclusions in the south and east. Alpine Township was selected from the other townships in the West Michigan Planning Region using the below listed criteria:

1. Agricultural and forest land uses are predominant. Inclusion of urban, suburban, and recreational uses are minimal.
2. Ownership units are predominantly 40 acres or larger. Government ownership is minimal to none.
3. Township and county officials (assessors and equalization persons in particular) are willing to cooperate.
4. A modern, medium intensity soil survey exists for the township.
5. A land use inventory capability exists.

The forty-five properties represented 2,193 acres and were subgrouped by parcel sizes as follows: thirteen small sized parcels, 10.1 to 33.2 acres; seventeen intermediate sized parcels, 37 to 60 acres; and fifteen larger sized parcel, 67 to 100 acres. Parcels smaller than 10.1 acres are as a rule not in farmland uses. Farm parcels in Michigan can be substantially larger than the 60 to 100 acre sized parcels examined in this study. In areas where individual farmland parcels are commonly larger than 100 acres in size, the appraiser should expect the computer assisted appraisal to more closely approximate the manual approach as a result of less variation in the computer cell descriptions of the landscape. Simply stated, as more computer cells are utilized in a single appraisal the chance for compensating errors in cell entries increases, making the summarized information more like the actual maps used for cell coding.

The Agvalue System pilot study examined how well the combinations of: cell size (10 acre or 2.5 acre), soil information sources (modern 1973 (27), series 1926 (34), or series 1926 updated), and LVM interpretation method (broken cell or full cell), approximated the manual procedure with the 1973 soils information. The combinations used are listed in Table 8, and will be referred to as Agvalue procedures. The land use information in each Agvalue procedure was for 1975. Slope data for the 1926 soil map must be interpreted from the contours on the soil map, but for this study all slope units were from the 1973 soil maps. The variety of soil information sources used in the study typify the kinds of soil information available for the nine counties of the West Michigan Planning region. It was desirable to know if the older soils information could be used with reliable and accurate results.

Table 8. Pilot Agvalue System Combination of Procedures

1. Equalization Appraisals
2. 10.0 acre cells, 1926 soils, broken cell
3. 10.0 acre cells, 1926 updated, broken cell
4. 10.0 acre cells, 1926 updated, full cell
5. 10.0 acre cells, 1973 soils, broken cell
6. 10.0 acre cells, 1973 soils, full cell
7. 2.5 acre cells, 1973 soils, broken cell
8. 2.5 acre cells, 1973 soils, full cell

Modified - Updating of 1926 Soil Survey Legend

As expected, the soil concepts utilized in the 1926 soil survey have undergone evolutionary changes resulting in the more modern soil concepts. The process of updating a soil survey legend describes the soil mapping units on the old survey in terms of the classification system presently used. Generally speaking, the older 1920-1939 series soil surveys have less detail than a modern soil survey (scales of 1" = 1 mile and 4" = 1 mile, respectively) resulting in map units that are more broadly defined at the smaller scale.

The current method of legend updating as performed by the Michigan Agricultural Experiment Station utilizes a point-transect sampling of each of the soil mapping units. Between 30 and 50 representative observations using modern soil taxonomy are taken systematically from the major mapping units and summarized. The summarized observations indicate the composition of the mapping units and may indicate that the mapping unit name needs to be revised.

For this study an actual updating was not performed but soil names were revised utilizing the 1959 Conservation Needs Inventory soil maps of 72 quarter sections in Kent County. For each of the conservation needs inventory soil maps point observations representing the center of each square ten acres were made using a dot grid. Identical dot grid observations were made on the 1926 soil survey map. The 1152 observations were summarized by the 1926 map units indicating the proportions of modern taxonomic units as found on the 1959 maps. Figure 7 is an example of this data summarized for the Isabella sandy loam. Quite often the names of the 1926 map units were changed to describe the range of currently recognized soils found in the older reports. Table 9 lists the old and modified-updated legend for Kent County using the modified update method.

Published name: Isabella sandy loam
Updated name: Isabella sandy loam - Mancelona loamy sand

Unit	Name	Observations Number	Observations %	Observations S.M.G.	GCSP* Index
4463	Isabella s.l.	9	16.7	2.5a	.86
4805	Nester	7	13.0	1.5a	.85
2341	Spinks s.	6	11.1	4a	.61
6345	Brimley l.	4	7.4	2.5b-s	.92
2602	Mancelona l.s.	3	5.5	4a	.61
3653	McBride s.l.	3	5.5	3a	.74
3203	Newaygo s.l.	3	5.5	3/5a	.74
6423	Twining s.l.	3	5.5	1.5b	.90
	Subtotal	38	70.4		
	Others	16	29.6		
	Total	54	100.0		

*Gross, cropland use adjusted, soil productivity index.

Figure 7. A sample compilation for modified updating an older soil survey legend.

Table 9. Kent County 1926 Soil Names and Modified-Updated Soil Names

Map Symbol	Published Name	Modified-Updated Name	Soil Management Group	GCSP* Index
As	Allendale s.l.	Rimer s.l.	4/1b	.76
Bs	Bellefontaine s.l.	Boyer l.s.-Isabella s.l.	4a-2.5a	.69
Bl	Bellefontaine l.	"	"	.69
B	Berrien l.s.	Newaygo s.l.	3/5a	.74
Bo	Brookston l.	Conover l. - Gladwin s.l.	2.5b-4b	.78
Bc	Brookston s.l.	"	"	.78
C	Coloma sand	Spinks-Wainola l.s.	4a-4b	.62
Cs	Coloma l.f.s.	"	"	.62
Cl	Conover l.	Conover l.	2.5b	.92
F	Fox s.l.	Fox s.l.	3/5a	.74
Gd	Genesee f.s.	Mancelona l.s.	4a	.61
GF	Genesee f.s.l.	"	"	.61
G	Genesee s.l.	"	"	.61
Gm	Granby s.l.	Epoufette-Mancelona l.s.	4c-4a	.67
Gp	Greenwood peat	**		--
Gi	Griffin l.	Edmore s.l.	4c	.73
Im	Isabella s.l.	Isabella-Mancelona l.s.	2.5a-4a	.77
IL	Isabella l.	Isabella-McBride l.	2.5a-3a	.77
Ks	Kent s.l.	Kent-Miami loams	1a-2.5a	.81
Mi	Miami l.	Kalamazoo s.l.	3/5a	.74
Ms	Montcalm s.l.	Montcalm l.s.	4a	.61
Na	Newton s.l.	Edmore s.l.	4c	.73
Os	Oshtemo s.l.	Boyer l.s.	4a	.61
Ps	Plainfield sand	Plainfield-Mancelona l.s.	5a-4a	.53
Pl	Plainfield l.s.	"	"	.53
Ss	Saugatuck sand	**		--
Si	Selkirk silt loam	**		.82
Ws	Wallace sand	**		--
Cm	Carlisle muck	Carlisle m. Miami l.	Mc-2.52	.48
Cm	Carlisle muck, shallow phase	"	"	.48
Rp	Rifle peat	Rifle peat-Montcalm l.	Mc-4a	.48

*Gross cropland, use adjusted, soil productivity index.
**No observations

Note: The modified-updated names are kept simple and describe the range of soils as found in the 1957 Conservation Needs Inventory mapping units of the 1926 soils map.

The modified-legend updating results in a larger range of currently recognized soils than an actual updating according to Laurin and Whiteside for a study in Hillsdale County, Michigan (15). The larger range occurs in part, due to mapping scale errors on the 1926 soil maps which result in erroneous observations for supposedly identical spots on both map sheets. In many cases then, the observations may not represent identical points in the landscape. Laurin and Whiteside also note, however, that the renaming of map units were the same for both the updating and modified updating where 30 or more observations were made. The modified-updating procedure assumes that the inclusions in mapping units will be the same in 1926 as in 1959. The 1959 maps are treated as pure units (without inclusions).

The name changes in the modified updating resulted also in changes in the productivity index(es) applicable to each map unit. The updated productivity indexes represent the proportionally weighted average productivity of the soils in the updated names.

Topographic Slope Interpretation

Slope classes were not mapped on some of the 1921 to 1939 series soil surveys. The following procedure was followed to determine the slope class for 10 acre cells using United States Geological Survey Topographic Maps with 20 foot contour intervals.[5]

A. Place a 10 acre square grid over the map (660 feet to a side.

[5]Courtesy of West Michigan Regional Planning Commission, Grand Rapids, Michigan.

B. Using the distance between contour lines as a unit, estimate the maximum number and/or portion of units within a cell, measuring parallel to one of the sides. Be sure not to double count for changes in slope aspect.

C. Code the slope class according to the following scheme:

Contour Units Per Cell	Slope Class	Slope Percent
0 - .659	A	0 - 1.99
.660 - 1.979	B	2 - 5.99
1.980 - 3.959	C	6 - 11.99
3.960 - 5.939	D	12 - 17.99
5.940 - plus	E	18 - plus

RESULTS AND DISCUSSION

Selecting an Approach to Farmland Value

The discussion of the approaches to value are briefly summarized as follows:

a. The market data approach using agricultural productivity as a means of comparison is a dependable and accurate approach to appraising farmland.

b. The income approach is in theory the true agricultural use value approach but is difficult to calculate and thus is seldom used. A net-productivity index used in the market data approach is a hybrid of these two approaches.

c. The cost approach though not suitable for most agricultural land is suitable for organic soils and reclaimable lands.

Michigan farmland, excepting the special case of organic soils, is suitably assessed with the market data approach. The question then is which agricultural productivity index to use for comparisons, the net or gross cropland use adjusted, soil productivity index (GCSPI or NET-CSPI)? The Net-CSPI would reasonably be chosen as the basis of comparison for agricultural use value. Cooper (5) found that gross CSPI values were slightly better correlated to sales price than net CSPI (.97 versus .92), and that the Net-CSPI values were more equitable than the gross CSPI value, i.e., higher valued properties were less undervalued and lower valued properties were less over valued from the 50% equity line. When the nominal value of land is $150 per acre (assessed) a net CSPI of .29 becomes the cut off for assessing at agricultural use value which includes soil management units 4aD, 4aE and all 5a's. The gross CSPI will show that only undeveloped organic and alluvial soils are assessed at the nominal rate and that all other soil management groups are evaluated considerably above the nominal value. Which CSPI is best will need to be decided by individuals responsible for the appraisals.

The equalization personnel cooperating in this study have chosen a gross CSPI for market value comparisons. The reasons given are that a gross CSPI is easier to construct and seems to fit the sales data better. Again, Cooper indicated that both gross and net CSPI's were highly correlated to the sales price data with a slight advantage in favor of the gross CSPI. A rationalization for favoring the gross CSPI may be that it accounts for use values other than for agriculture which are present in sales prices. If this rationalization is correct then a gross CSPI is better suited to Michigan's ad valorem tax laws. The difference between gross CSPI values and Net-CSPI values could be attributed to other present and potential use values.

Little attempt has been made to place a value on the use value components of farmland other than for agriculture. All land in Kent County has some nominal value for such uses as recreation, wildlife, or the simple appreciation of ownership. Land with the lowest Net-CSPI, and consequently, little agricultural use value, may have a relatively high nominal value. Conceptually, the other use values become less significant as the agricultural use value increases.

The market value approach using a single variable, CSPI, to explain the variability of sales values should be monitored closely. The assessor is encouraged to use a statistical tool known as multiple regression to examine several variables including, CSPI, that can explain the variability of sales prices. To date, the gross-CSPI and Net-CSPI have proven sufficient for the assessors needs. Initially, this study was to have included a multiple regression analysis of sales data using the variables listed in Table 10. An insufficient number of sales to establish a normally distributed sample precluded that multiple regression analysis.

Table 10. Agvalue System Multiple Regression Variables

Dependent:

- Total sale value
  - Value to buildings
  - Residual to land

Independent:

- Total acres, mean field size.
- Acreage into each land use
  - Cropland
  - Permanent Pasture
  - Orchards
  - Forest
  - Wetland

  Equivalent cropland acres
- Relative agricultural productivity per land use.
  e.g., CSPI
  (gross and net)
  - Capitalized net income
- Location (distance to)
  - Rural center(s) (markets and supplies)
  - Expanding urban fringe
  - Major roads
- Value of vacant subdivision land.

The primary consideration in selecting an approach to value and a CSPI is that appraisal results are highly correlated to the sales prices or capitalized net-incomes representative of the region. It is imperative to understand that an approach or procedure that works well today may at some point in the future prove unsuitable.

Capitalized Net Income Estimates, Use Value Components of Cash Value

The net income estimates were useful to examine the agricultural use value component of the Kent County equalization assessed value of \$525 per acre (\$1,050 per acre cash value), for the GCSPI 1.00 soil management unit, 2.5cA. Using Equation 2, on page 10, the net income estimates from each formula were capitalized at three rates for the GCSPI 1.00, 2.5c.. soil management unit (SMU) displayed in Table 11.

$$V = \frac{In}{r} \tag{4}$$

where:

V = value

In = net income

r = capitalization rate (decimal fraction).

Table 11. Estimated Net Income Capitalized for Each Formula on a 2.5c.. Soil Management Unit

Formula		Net Income Per Acre	Value as Capitalized at		
			.05	.10	.14
Custom Rate	1	\$125.58	\$2,512	\$1,256	\$897
Enterprise Budget	2	\$124.02	\$2,480	\$1,240	\$886
Hybrid	3	\$135.26	\$2,705	\$1,353	\$996
Average		\$128.28	\$2,566	\$1,283	\$916

The indicated cash value of \$1,050 per acre of SMU 2.5cA if assumed to be 100% agricultural use value represents the estimated net income capitalized at .122 (12.2%). However, assuming that Priest's 14% capitalization rate is acceptable today, the \$134 difference between cash value ($1,050) and agricultural use value ($916) is the value attributed to other uses on this prime agricultural land. In contrast, the soil management unit 5aC with a GCSPI of .40 is assessed at $210 an acre, $420 per acre, true cash value, and its capitalizated net income (at 14%) is $147. The difference of $273 is attributed to other use values. Thus, as the agricultural use value component of cash value decreases the other component use values increase in value.

The choice of an acceptable capitalization rate is a major problem encountered with net-income capitalization. Returning to Equation 2, as the capitalization rate increases, the capitalized value decreases. (The reverse is also true.) It is common practice to distinguish between an urban capitalization rate and an agricultural rate. The obvious difference used to justify this practice is that an urban use has a shorter life span than an agricultural use. Cooper (5) and Priest (21) relied on the sales value and its yearly inflation rate for agricultural properties in Michigan. In Iowa, the capitalization rate is set by the State Board of Tax Review (8). Another approach is to equate the capital lending rate to agricultural enterprises with the capitalization rate. There are several other schemes to derive the capitalization rates available to assessment personnel. The decision as to the capitalization rate should be in line with the State Tax Commission's responsibility for equitable-standardized valuation throughout the State of Michigan. Each major land use--cropland, permanent pasture, woodland, orchard--may have a separate capitalization rate.

Pilot Agvalue System Study Results

The researcher is interested in documenting the relative adequacy or quality of information contained within the Land Value Map (LVM). Different computer storage cell sizes were expected to contain different quality of information in terms of property boundary-cell boundary fit and fidelity of soil map agreement. Property boundary fit may be a deciding factor in choosing the data bank cell size.

Table 12 lists three parameters of property-cell fit and the data for 2.5 and 10 acre broken cells generated in the pilot study. No guidelines are offered at the present to interpret these parameters. The data do show that as the cell size decreases the number of broken cells per property increases yet the broken cell acreage decreases as does the percentage of cells broken.

Table 12. Property Boundary-Cell Boundary Fit, for 45 Properties in Alpine Township

	10 Acre Cell	2.5 Acre Cell
Broken Cells/Property	0.78	1.98
Broken Cell Acres/Property	7.78	4.89
% of Total Cells Broken	14.1	8.8

A general measure of LVM fidelity of soil map agreement is to determine the areal proportion of a cell that is in agreement with the dominant soil unit as coded. Table 13 shows the fidelity of agreement statistics for a random sampling of 60, 2.5 and 10.0 acre cells. The 2.5 acre cells have a greater fidelity of soil map agreement than the 10 acre cells. An LVM composed of 2.5 acre cells would be expected to more accurately reproduce the soil map than a 10 acre cell LVM.

Table 13. Computer Cell Fidelity of Agreement with the Base Map (1973 Soil Survey) in Percent

Item Tested	10 Acre Cell	2.5 Acre Cell
Soil Management Unit*	58.4*	75.1*
Soil Management Group	68.3	79.1
Slope Class	73.1	83.5
Drainage Class	77.8	85.0
Topographic Map Slopes	70.0	---

*Soil Management Units are the basis of agricultural use valuations.

In counties where soil surveys do not show slope phases a slope classification is determined from topographic maps as outlined in the procedures. Slopes were interpreted from topographic maps for the fidelity of agreement sample of 60 ten acre cells. A comparison of the slope class distribution on the soil map, on 10 acre cells of dominant soil map interpreted slopes, and on 10 acre cell topographic map interpreted slopes is given in Table 14. The topographically interpreted slopes have a distribution skewed to the A and B slopes and totally miss the small areas of steeper slopes. However, A and B slopes are interpreted identically when determining productivity, and the resulting fidelity of agreement is 70.0% (Table 13). For appraisal purposes the topographically interpreted slopes are a reasonable approximation of the soil map slopes in Kent County, excepting the occasional escarpments and hilly areas with less than twenty foot drop.

Table 14. Distribution of Slope Classes on 600 Acres in Alpine Township

Slope Class	Actual Soil Map Acres %	10 Acre Cells	
		Soil Map	Topographic Map*
A	47.3	40	200
B	362.2	380	310
A&B	409.5	420	510
C	152.7	150	90
D	37.0	30	0
E	0.8	0	0
Total	600.0	600.0	600.0

*20' contours

Although the relative quality of LVM information with 2.5 acre versus 10 acre cell sizes are essential to characterize an area, more important are the land values calculated by the Agvalue procedures that employ the different cell sizes. The pilot study Agvalue System land values were statistically analyzed using simple regression analysis (Table 15) and analysis of variance (Tables 16 and 17).

The regression data shown on Table 15 indicate that each of the procedures duplicate the manual procedure values quite well, although some are relatively better than others. The regression correlations indicate how well the procedures fit the manual procedure in terms of a straight line relationship. In the regression equation, $Y = bx + c$, Y is the dependent variable, b and c are constants. Simple correlation r^2 is the proportion of variation of

Table 15. Pilot Study Regression Data, Manual Procedure = Dependent Variable

Agvalue Procedures Number	Independent Variable	Regression Equation	r	r^2
1	Equalization Appraisals	.896x _ 512	.944	.891
2	1926 Soils 10 Acre Cells Broken	.924x + 500	.960	.922
3	1926 Updated Soils 10 Acre Cells Broken	1.025x + 354	.973	.947
4	1926 Updated Soils 10 Acre Cells Full Cell	1.011x - 327	.966	.933
5	1973 Soils 10 Acre Cells Broken	.967x + 100	.991	.982
6	1973 Soils 10 Acre Cells Full Cell	.918x + 276	.980	.960
7	1973 Soils 2.5 Acre Cells Broken	.998x - 325	.994	.988
8	1973 Soils 2.5 Acre Cells Full Cell	.979x + 746. ~~.957x + 204~~	.990 ~~.982~~	.981 ~~.961~~

Y explained by x. A simple r of .99 for Agvalue procedure 5 means that procedure 5 explains 98% of the variation of the manual procedure which would be difficult to improve upon. The regression data does not display the amount of relative variation of each procedure about the manual procedure. The analysis of variance, Table 16, helps to display the desired variation characteristics.

Mass appraisal systems by their very nature are expected to have a substantial amount of variation. Assessors and equalization officers are elated with an average deviation of ±10% for assessed values relative to sales values. The manual procedure is accepted as a reliable and accurate "state of the art" means of estimating cash value of farmland. It is imperative to select mass appraisal procedures which optimize accuracy and costs. The variation parameters which measure the precision with which the Agvalue System procedures duplicate the manual procedure, in terms of percent deviation, are displayed in Table 16. Equation 5 is the formula for the percent deviation calculation which allows each appraisal to be treated as a comparable item for statistical analysis.

$$\%\ \text{deviation} = \frac{\text{(computer-assisted procedure value - manual procedure value)}}{\text{manual procedure value}} \times 100 \qquad (5)$$

Table 16 shows that procedure 7, using 2.5 acre computer storage cells of soils information and breaking cells, best approximates the manual procedure. This procedure is within 5.6% (standard deviation) of the manual value for two-third's of the cases studied and has a value range of 31.5% (+25.9% to -5.6%) about the manual values. The mean deviation of 2.8% tells us that this procedure on the average is

Table 16. Pilot Study Results of the Agvalue System Procedures, 1 through 8

	Equalization Appraisals	1926 Soils 10 Acre Cells Broken	1926 Updated Soils 10 Acre Cells Broken	1926 Updated Soils 10 Acre Cells Full Cell	1973 Soils 10 Acre Cells Broken	1973 Soils 10 Acre Cells Full Cell	1973 Soils 2.5 Acre Cells Broken	1973 Soils 2.5 Acre Cells Full Cell
	1	2	3	4	5	6	7	8
45 Parcels								
Mean Deviation in % From Manual Procedure	11.0a.	7.3abc	- 3.3bc	2.8bc	3.8bc	7.8ab	2.8c	3.5 bc ~~4.1abc~~
Minimum	-23.3	-20.3	-21.5	-16.9	-11.5	-20.0	- 5.6	-11.5
Maximum	65.9	52.2	24.1	59.0	26.4	39.2	25.9	27.9
Range	89.2	72.5	45.6	76.0	37.9	59.2	31.5	39.4
Variance	407d	244cd	132bc	251cd	65ab	124bc	40a	~~69ab~~ 53 a
Standard Deviation	20.2	15.6	11.5	15.9	8.1	11.1	5.6	~~8.3~~ 7.34
13 Parcels - 10.1 to 33.2 Acres in Size								
Mean Deviation in % From Manual Procedure	13.5	12.7	- 2.8	8.3	7.3	11.3	4.7	6.4
Minimum	-18.9	-11.4	-16.9	-16.9	- 3.7	- 3.4	- 2.7	- 2.7
Maximum	61.1	52.2	21.7	59.0	25.4	39.2	16.3	25.3
Range	80.0	63.6	38.6	76.0	29.1	42.6	29.0	28.0
Variance	628	377	146	416	93	164	47	70
Standard Deviation	25.1	19.4	12.1	20.4	9.6	12.8	6.8	8.4
17 Parcels - 37 to 60 Acres in Size								
Mean Deviation in % From Manual Procedure	7.5	1.1	- 7.4	- 2.5	.2	5.3	1.3	2.4
Minimum	-12.5	-13.4	-21.5	-15.4	-11.5	-20.0	- 5.6	- 5.6
Maximum	32.1	21.6	12.0	20.4	13.3	30.2	8.4	17.0
Range	44.6	34.0	23.5	35.8	24.8	50.2	14.0	22.6
Variance	203	95	72	107	38	123	12	32
Standard Deviation	14.2	9.7	8.5	10.4	6.2	11.1	3.4	5.6
15 Parcels - 67 to 100 Acres in Size								
Mean Deviation in % From Manual Procedure	12.8	9.7	.776	4.0	4.8	7.6	2.9	3.9
Minimum	-23.3	-20.3	-16.5	-10.3	- 1.2	- 6.4	- 5.3	-11.5
Maximum	65.9	41.0	24.1	46.0	26.4	26.4	25.9	27.9
Range	89.2	61.3	40.6	56.3	27.6	32.9	31.2	39.4
Variance	486	255	171	248	54	90	65	113
Standard Deviation	22.0	16.0	13.1	15.7	7.4	9.5	8.1	10.6

Note: Similar statistics with a letter in common are not significantly different at the .05 level.

overvaluing the parcels in comparison with a manual appraisal. All the Agvalue combination procedures 2 through 8 (in Table 8) agree better with the manual procedure than do the equalization appraisals.

A Bartletts F test proved that the Agvalue procedures had heterogeneous variances. An F max test was used to detect any significant differences between variances. The existence of heterogeneous variances also required a special T test to detect significant differences in the mean differences, $\bar{Y}$, as shown in Equation 6.

$$t's = \frac{(\bar{Y}1 - \bar{Y}2)}{\sqrt{\frac{1}{n}(s_1^2 + s_2^2)}} \tag{6}$$

These statistical tests allow for grouping the Agvalue system procedures, for the 45 parcels, with both similar mean differences from and variances about the manual procedure. The Agvalue procedures were so grouped and are ranked according to smallest mean difference and least variance in Table 17.

The variation in these procedures is primarily an expression of how well the land values based on the computerized soil information describes a modern soil survey and land use map. The cell sizes (10 acre and 2.5 acres), whether the soils map used for coding was modern (1973) or an older (1926) soil survey (with or without updating), and whether broken or full cells were used, also influence how well a computer procedure estimates the manual procedure with a modern soil map.

Group IV on Table 17 indicates that the Equalization Study values of the 45 properties in Alpine Township were more variable about and had the greater mean difference from the manual procedure

Table 17. Ranked Groupings of Agvalue System Procedures and Equalization Study Values

Group	Procedure	Mean	Variance	Soils, Cell Size, LVM Method
I	7	2.8c	40a	1973, 2.5 acre, broken cell
	5	3.8b,c	65a,b	1973, 10.0 acre, broken cell
	8	3.5 ~~4.1a~~,b,c	53 ~~69~~a~~,b~~	1973, 2.5 acre, full cell
II	3	-3.3*b,c	132b,c	1926 updated, 10 acre, broken cell
	6	7.8a,b	124b,c	1973, 10 acre, full cell
III	4	2.8b,c	251c,d	1926 updated, 10 acre, full cell
	2	7.3a,b,c	244c,d	1926, 10 acre, broken
IV	1	11.0a	407d	Equalization Study

*Assumes an Agvalue procedure that under estimates the manual procedure values is equally desirable as an Agvalue procedure that overvalues.

Note: Similar statistics with letters in common are not significantly different at the .05 level.

than any of the Agvalue System procedures. This result is explained by the facts listed below.

a. The resource information consisted of 1926 soils information with very general slope classes interpreted visually by personnel untrained in slope class interpretation.

b. The objective of the Equalization Department is to equalize the values assessed to similar properties throughout the county. Thus, emphasis is given to uniform procedures not to exacting detail of specific appraisals. The result is a dependence upon compensating errors in the studies throughout the county to achieve equity.

The Equalization Study procedure included land use classification based on aerial photograph interpretation and on site investigation. It is not clear if the equalization personnel were trained in aerial photograph interpretation.

An Agvalue System if implemented in the Kent County Department of Equalization using updated 1926 soil information with topographically interpreted slopes and a broken cell LVM interpretation would bring future equalization studies significantly closer to the "state of the art" tax manual procedure.

Other sources of variance: The LVM's in the pilot study were interpreted without the site specific, detailed information used in the manual procedure as recommended to be included on the LVM interpretation transparent overlay, e.g., the spot symbols. As a result, the manual appraisals have accounted, on specific occasions, for interpretations of land use that differ from the land use coded into the data bank. One example of this is a lowland flood plain of about 2 acres, map unit 55, enclosed by escarpments and split between 2, 10 acre cells (Figure 4). The appraiser will value the land at a nominal $150 an acre but the computer will indicate a value of

$451-483 an acre. The result is a $678 value difference which must be accounted for on the appraisal card. Using site specific information on the overlays should improve the accuracy of the Agvalue System procedure(s).

Agvalue System Costs

Usually the availability of soils information is a limiting factor for choosing a procedure. The modern soil surveys are most desirable, yet many counties must rely on older published surveys dated from 1920 to 1940. Where the older publications must be used the author recommends updating the legend. This makes the available soils information more useful, with modern interpretations, and is quite inexpensive (about 5% of the cost of a new soil survey).[6]

The expected initial costs for preparing a data bank of coded soils and land use information and programming the computer to print out a LVM is highly variable. The Iowa costs are posted at $4,000 per township and Indiana uses a figure of $608 (35). Remember that these systems can also perform appraisals, without land use information, whereas the West Michigan Regional Agvalue System does not. Table 18 indicates the West Michigan Planning Commission's initial costs for a data bank. Initial costs are highly dependent upon the computer system, computer language, coding format, plus the variables and services included. Fortunately, public agencies such as the West Michigan Planning Commission have developed resource

[6]Estimated at $10,000 for Hillsdale County, Michigan in 1976. Personal communication with Dr. E. P. Whiteside.

Table 18. West Michigan Regional Planning Commission Data Bank Initial Costs for a Township*

	10 Acre Cells	2.5 Acre Cells
A. Data Collection & Coding		
1. Soils and Slope**	35	105
2. Land use	57	171
3. 10% contingency & corrections	9	27
4. Subtotal A	$101	$303
B. Keypunching		
1. Soils and Slope	24	96
2. Land use	36	144
3. 10% contingency & editing	6	24
4. Subtotal B	$ 66	$264
C. Computer Loading		
1. Programmer/Analyst	23	23
2. Computer time	10	40
3. Computer programming	2	2
4. Supervision	5	5
5. 10% contingency	4	7
6. Subtotal C	$ 44	$ 77
D. Miscellaneous	$ 4	$ 4
E. Grand total	$215	$648

*Costs based on estimates for a Data Bank accomodating 52 townships (3 counties).

**For older soil surveys without slope information, double these costs to account for the interpretation of slopes from topographic maps.

data banks and Agvalue Systems as a service to their constituent members. The data banks (e.g., land use) must be updated periodically, an additional expense. The cost of generating a 10 acre cell LVM with an established Agvalue System is about 10 dollars per township. In addition, the data banks typically have a variety of uses besides an Agvalue System.

An estimate of the initial cost and the labor needed to prepare farmland appraisals for an entire township with 450 to 500 total farmland parcels, using the Agvalue System (first year, consecutive years will require considerably less effort) is shown in Table 19.

These labor figures are influenced by the efficiency of the appraiser and assume: 1) the acreages of each soil and appraised value will be written or cut out and pasted on each appraisal card, 2) the appraiser examines the soil maps and aerial photo for each parcel to check for spot symbol problems to put on the transparency, 3) the appraiser field inspects 5 to 10% of the properties, and 4) the procedures are followed as detailed previously.

An Agvalue System appraisal inventory need not be changed until either the land use or agricultural productivity measure changes. The initial cost can be spread over a number of years with some additional costs added on specific year to year changes. Multipliers can be used in years between Agvalue Appraisal runs. An Agvalue Appraisal run may be sufficient for five years. The choice of cell size is influenced by cost and the average size of parcels. Where properties are predominantly in the 10.1 to 60 acre class the 2.5 acres full cell approach appears to have sufficient

Table 19. Initial Agvalue System Costs for a Township with 450 to 500 Farmland Parcels

Agvalue Procedure	Appraisal Time in Workdays	Appraisal Cost*	Data Bank and LVM Cost**	Total Initial Cost***
2.5 acre Broken Cells	15-20	$1166	$688	$1850
2.5 acre Full Cells	10-15	$ 834	$688	$1520
10.0 acre Broken Cells	12-18	$1000	$225	$1230
10.0 acre Full Cells	8-12	$ 660	$225	$ 890

*Based on a wage of $8.00 an hour for the median number of workdays.

**Data Bank costs from Table 18 and LVM costs of $10 for a 10 acre cell LVM and $40 for a 2.5 acre cell LVM.

***Costs rounded to nearest $10.00.

accuracy and requires less appraisal time to justify the additional coding expenses above the 10 acre cell coding costs. Properties in the 67 to 100 acre plus range can use the 10 acre full cell procedure to good advantage.

The choice between broken or full cell appraisals may be a choice of where to spend a similar amount of money to achieve the needed level of precision. For example, a 10 acre broken cell 1973 soils information procedure is similar in precision to a 2.5 acre, full cell 1973 soils information procedure in duplication of the manual procedure. In this case the costs for initial data banking are greater for the 2.5 acre cells over the 10 acre cells but the appraisal time spent calculating property values from the resulting farmland value maps are greater for the 10 acre broken cell method. Table 19 shows that the 2.5 acre full cell procedure in fact will cost approximately $290 more than the 10.0 acre broken cell procedure for a township.

Summary of the Pilot Agvalue System Results

1. The use of 1926 soil series information with 1973 soil map slope information resulted in farmland values highly correlated to the "state of the art" manual procedure farmland values, particularly when the soil legend has been updated.

2. Topographically interpreted slopes are reasonable but somewhat biased approximations of commonly mapped slope classes and only a slight loss in assessment accuracy is expected. The procedure used in this study resulted in slope class designations skewed towards the A and B slopes and often failed to detect the steeper slopes. The 20' contour intervals maybe too gross for farmland slope classes. But, the current procedure of interpreting slope classes from topographic maps should be critically re-evaluated before further use of the bank.

3. Given the same information the broken cell procedure is a better duplicator of the manual procedure than a full cell procedure.

4. In general, the 10 acre cell procedures appear to be well suited for the large size parcels; the 2.5 acre cells having some advantage on the small sized parcels.

5. The Agvalue System results in assessed values more closely approaching the "state of the art" manual procedure values than the Equalization Study values.

6. Agvalue System appraisal runs in groups I and II of Table 17 which very closely duplicate the manual procedure can be initially implemented for a township at an estimated cost of $1200 to $1900. This figure spread out over five years means that essentially "state of the art" assessments can be procured for $250 to $380 a year for a township above the current year to year costs.

CONCLUSIONS

1. True agricultural use value as measured by capitalized net income is only one component of cash value. Gross agricultural productivity measures such as the gross cropland use adjusted, soil productivity index (GCSPI) account for agricultural use value and other use values in estimating cash value of unsold properties.
2. An Agvalue appraisal system essentially allows for the use of the "state of the art" tax manual appraisal procedure en masse on all farmland in a jurisdiction at reasonble costs in the rage of $250 to $380 per township per year above current expenditures where:
   a. land use is remotely sensed (aerial photo interpretation)
   b. either modern soils information, or older 1920-1939 series soil surveys with updated legends and topographic slope information available.
3. Due to better quality resource information, all Agvalue System procedures appraised values more closely approached the tax manual procedure appraised values than did the Kent County Department of Equalizations appraisal study values. Future equalization studies using an Agvalue System would have less dependence upon compensating error.

4. a. The Agvalue System procedures have similar accuracy and costs for both 10 acre (broken) and 2.5 acre (broken and full) cells using a modern soil survey. The 2.5 acre cells were slightly better suited for properties in the 60 acre and less size range and the 10 acre cells slightly better suited for properties greater than 60 acres in size.

   b. The older 1926 soil survey with a modified-updated legend information using 10 acre, broken cells was similar in accuracy to modern soil information using 10 acre, broken or full cells.

5. With proper economic data, and a net agricultural productivity measure an Agvalue System can be used for an income approach to farmland value.

Recommendations

Agvalue Systems can be substantially improved with further research as identified below:

1. The current dependency upon a gross agricultural productivity measure in the market data approach should be evaluated with a detailed study of the various component use values to cash value including a multiple regression analysis of the quantifiable variables.
2. Development of inexpensive and easy to operate information handling systems that can store information at the ownership level and effectively produce an appraisal card on each farmland parcel illustrating and summarizing the

resource information.

3. Development of a combined data bank and geo-coded remote sensing capability to detect land use to the individual crop. This capability would enable the regional cropping pattern to be specific to soil management groups, as well as better establish the use made of a unit of land.
4. Development of a procedure to interpret and geo-code slope classes off topographic maps with accuracy similar to geo-coded soil map slope classes in describing the landscape.

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APPENDICES

APPENDIX A

GLOSSARY OF FREQUENTLY USED TERMS

Broken Cell Appraisal: The Land Value Map resource information, equivalent cropland acres in particular, is summarized one cell at a time and where only a portion of a cell lies within the property being appraised, just that portion of a cell is listed in the resource inventory (see Figure 5).

Cell: A geo-coded, computer storage unit corresponding in this study to either 10 or 2.5 square acres. A collection of cells containing resource information, e.g., land use, soil management unit, and farmland value, make up a Land Value Map (Figure 3).

Cropping Pattern, Regional Cropping Pattern: The individual proportions that the major crops occupy (on an areal basis) on all cropland for a given area. (see Table 4), e.g., 20% corn, 20% wheat, 60% hay.

Equivalent Cropland Acres: The area of a given soil converted into the acreage of the most productive soil (GCSPI 1.00, soil management unit 2.5c) that will have an equivalent agricultural productive capacity. Equivalent Cropland Acres = Acreage of soil unit x agricultural productivity index.

Full Cell Appraisal: The Land Value Map resource information, particularly equivalent cropland acres, is summarized for the contiguous cells that most closely correspond to the property boundaries. Since contiguous cells seldom correspond to the exact property boundaries a total acreage adjustment factor is used (see Figure 6)

$$\text{Adjustment Factor} = \frac{\text{Actual area of property}}{\text{Area of Contiguous Cells}}$$

Geo-Coding: A referencing to locate a given area on the earth system and used to store information in a "data bank."

Data Bank: Geo-coded resource information as stored in a computer usually on magnetic tape.

GCSPI: Gross, cropland use adjusted, soil productivity index.

Land Value Map, LVM: Selected resource information printed out by cells and spacially arranged as they represent the landscape and were geo-coded, see Figure 3.

Mass Appraisal Technique: Appraising similar properties in one large group as opposed to individual appraisals.

Net-CSPI: Net, cropland use adjusted, soil productivity index.

Nominal Value of the Land: A minimal value that all land is worth, assumed to be $300 per acre cash value for Kent County in 1975.

Productivity Index: A decimal fraction used to measure productivity relative to a base productivity.

Productivity Rating: 100 x a productivity index.

Soil Management Group: Michigan soil series are grouped according to dominant texture of the soil profile and natural drainage conditions. Numbers from 0 to 5.7 indicate the dominant textural class of the profile, 0 being fine clay and 5.7 being sand with little or no subsoil development at the extremes.

Natural drainage is indicated with lower case letters following the number as in 2.5a, where:

a = well and moderately well drained soils
b = somewhat poorly drained soils
c = poorly and very poorly drained soils.

Natural drain refers to the depth to the water table and its expected flucuation during the year.

Special characteristics are shown as lower case letters after the natural drainage, as in 2.5c-s according to the following:

a = naturally very strongly acid
c = soils calcareous at or near the surface
h = subsoils hardened or cemented
s = stratified with fine sands and silts

Soil Management Unit: the soil management group plus slope class as in 2.5aA. Common Michigan slope classes are:

A = 0-2% slope
B = 2-6% slope
C = 6-12% slope
D = 12-18% slope
E = 18-25% slope
F = Greater than 25% slope

APPENDIX B

APPRAISAL OF ORGANIC SOILS IN MICHIGAN: A SUMMARY

Michigan's organic soil resources are a special case for farmland appraisal. Organic soils in Southern Michigan are preferred for specialty agricultural uses primarily high value, intensively managed crops such as celery, carrots, mint, onions and sod. Because of the specialty crops the commonly used agricultural productivity indices based on a field crop cropping pattern are not applicable for market data approach comparisons. Furthermore, organic soil rating systems presently in use are not related to agricultural productivity, such that different types of organic soils can be compared. To make matters worse, the income flows from specialty crop farms are not available to attempt an income approach to value thus, the approaches to value typically used in farmland appraisal have dubious utility in appraising organic soil resources. A more thorough understanding of the nature of organic soil resources will suggest an appropriate approach to appraise them.

Under intensive agricultural use Michigan's organic soils have a finite life span. Organic soils once placed into intensive cropping (including field crops) where the soil is tiled and drained will begin to shrink and dehydrate , and to decompose. This is known to soil scientists as "subsidence." Subsidence rates for Michigan can vary from 1/2 to 2 inches per year on cultivated organic soils depending upon management and the initial status of the soil. During the first year of cultivation a loss of 12"-15" to subsidence is not unusual.

Wind erosion can also contribute to the loss of this fragile soil. Due to subsidence and wind erosion, fifty inches (50") deep typically would have a productive agricultural life of only 50 years.

Organic soils in Michigan are initially very poorly drained with the water table at or near the surface most of the year. Several capital inprovements are necessary to control the height of water table. Unimproved organic soils will have a saturated root zone which limits its use to extensive uses such as pasture. Improved organic soils have a controlled water table to permit an unsaturated root zone of desirable depth for intensive cropping (usually 28" to 32"). The trade-off is that the drained organic soil is subject to more subsidence and wind erosion than an undrained organic soil. To provide an adequate root zone yet minimize subsidence and wind erosion the following improvements are required.

1. Surface drainage ditching,
2. Subsurface tiling,
3. Water table control structures, and
4. Erosion control systems including irrigation and wind breaks.

Organic soils are difficult to appraise as approached currently. Little means of comparison exist for the market value approach and income estimates are not available to capitalize for the relatively few specialty farms. Yet, knowing that organic soils have a limited agronomic life span and require substantial capital improvements in order to be brought into production indicates that the cost approach may have validity.

The cost approach involves first, a current cost estimate to reconstruct a property and second, depreciating the current cost estimate to arrive at present value. The depreciation factor is influenced primarily by the longevity of the property and is usually a judgement on the part of the appraiser. The cost approach is well suited for buildings and other properties where costs to reconstruct are readily determinable. Farmland, though, is a natural resource with conceptually an unlimited life span unless put into other uses and no reasonable cost can be assigned to artifically reconstruct the soil. Michigan's organic soil deposits may be treated as improved land and then the cost approach is suitably used.

Tax assessors routinely label undeveloped organic soil deposits as swampland or wetland and assign to these lands a nominal value in the range of $300 an acre, cash value. A proposed cost approach for developed organic soil deposits combines the nominal value of the land with the depreciated cost of the many improvements. Costs and expected life span of the various improvements listed previously are available from the Soil Conservation Service and local contractors.

APPENDIX C

APPRAISED VALUES IN DOLLARS FOR VARIOUS SIZED PROPERTIES BY NINE PROCEDURES

Codes

PNumber - Property Number
TAcres - Total acreage of Property

Conventional Appraised Values in Dollars
Manual - The Manual Procedure
1. Equal - the 1975 Kent County Equalization Study

Agvalue System Appraised Values in Dollars
2. TEN26, 10 acre cells, broken cell method, 1926 soil information
3. TENU26, 10 acre cells, broken cell method, 1926 soils information with updated legend.
4. CFCA26, 10 acre cells, full cell method, 1926 soils information with updated legend.
5. TEN73, 10 acre cells, broken cell method, 1973 soils information
6. CTENFCA3, 10 acre cells, full cell method, 1973 soils information
7. T0573, 2.5 acre cells, broken cell method, 1973 soils information
8. CT05FCA3, 2.5 acre cells, full cell method, 1973 soils information

Table C.1. Appraised Values in Dollars for Small Sized Properties by Nine Procedures

Case No.	PNUMBER	TACRES	MANUAL	EQUAL 1	TEN26 2	TENU26 3	TEN73 5	T0573 7	CFCA26 4	CTENFCA3 6	CT05FCA3 8
1	1	16.9	6248	5691	7630	6828	6098	6178	6828	6033	6211
2	2	20.0	8873	7197	9030	8080	9188	8899	8080	9188	8899
3	3	33.2	13776	13272	12199	11695	13263	13868	15626	17897	15006
4	4	25.0	8311	9204	12653	10115	10422	9581	13217	9451	10411
5	5	27.3	10718	12285	10233	9481	11179	10836	12176	14906	10790
6	6	18.2	8033	8427	9535	7462	7797	7982	9555	7835	7972
7	7	11.1	4883	4986	5012	4484	5012	4895	4484	5012	5012
8	8	29.8	9188	14513	13043	9188	10807	9923	11622	10431	10114
9	9	10.8	4305	5995	4876	4363	4876	4876	4363	4876	4876
10	10	20.0	5493	8850	7143	6430	6487	6386	6430	6487	6386
11	11	20.0	8715	10000	8190	7240	8925	8480	7240	8925	8480
12	12	20.0	8638	7750	9030	8080	10080	9478	8080	10080	9478
13	43	20.0	8610	9600	8610	7660	8610	8610	7660	8610	8610
Subtotals		272.3	105791	117770	117184	101106	112744	109992	115361	119731	112245

Table C.2. Appraised Values in Dollars for Intermediate Sized Properties by Nine Procedures

Case No	PNUMBER	TACRES	MANUAL	EQUAL 1	TEN26 2	TENU26 3	TEN73 5	T0573 7	CFCA26 4	CTENFCA3 6	CT05FCA3 '8
14	13	50.0	21315	21484	20945	19320	21895	20587	19320	21895	20587
15	14	49.0	20318	23474	20223	17464	19384	21451	20490	23009	21507
16	15	56.0	24510	21455	21228	19252	21785	25067	25181	28431	27775
17	16	40.0	15375	17750	16115	14330	15698	15813	14330	15698	15813
18	17	40.9	14210	16201	12456	12581	14612	15399	15818	18502	16625
19	18	56.0	21615	19382	21609	20440	21851	21811	20440	21708	21787
20	19	50.0	23835	22501	22575	20200	23678	23782	20200	28350	23782
21	20	40.0	17535	18000	19530	16280	17432	17537	16280	17432	17537
22	21	38.2	11813	14803	12029	11117	12331	11990	11059	12267	11928
23	22	37.0	12863	12850	13214	13699	14570	12819	13699	14570	12819
24	23	52.8	16195	21276	16801	15983	14328	15773	19494	16978	15773
25	24	48.3	18905	17403	16462	16693	18935	17849	16789	15119	17854
26	37	40.0	16784	17880	16590	14940	16695	16840	14940	16695	16840
27	38	40.0	16728	17250	16585	14150	17220	17246	14150	17220	17246
28	39	40.0	12610	16658	15330	14120	11972	13056	14120	11972	13056
29	42	40.0	15173	17561	17955	15380	16118	15550	15380	16118	15550
30	44	40.0	18823	18000	18060	16160	18060	18297	16160	18060	18297
Subtotals		758.2	298107	313928	297707	272109	296564	300867	287850	314024	304776

Table C.3. Appraised Values in Dollars for Large Sized Properties by Nine Procedures

Case No	PNUMBER	TACRES	MANUAL	EQUAL 1	TEN26 2	TENU26 3	TEN73 5	T0573 7	CFCA26 4	TENFCA3 6	CT05FCA3 8
31	25	67.5	17609	23269	22148	21571	17978	17170	25708	17542	17860
32	26	71.9	28313	21703	29423	25915	28074	30948	25915	28074	30948
33	27	80.0	30853	31189	35595	31120	31269	29913	31120	31269	29913
34	28	76.0	32483	32850	25902	27114	36813	32426	30364	36808	32426
35	29	78.9	18356	30445	24592	22765	23209	23116	22765	23209	23116
36	30	79.6	34688	38902	35890	31323	36670	34071	31323	36671	34071
37	31	70.0	29897	31920	30135	26810	30372	30227	26810	34755	30376
38	32	79.4	28945	31964	32728	28524	30280	28427	28524	32728	28427
39	33	72.7	21315	31921	30058	26457	23741	24289	26567	25684	22664
40	34	79.5	27583	32358	32347	29316	27335	28991	29316	32347	28991
41	35	75.9	31156	32258	33224	28744	31533	31801	31812	31684	32638
42	36	81.2	31656	32418	29750	30673	32829	32139	30673	32829	32139
43	40	60.0	23705	26289	25225	23740	23415	22442	23740	23415	22442
44	41	90.0	31298	28890	28899	28915	30940	30978	30130	29280	28468
45	45	100.0	41318	44830	45465	40040	42474	40479	40040	42474	40479
Subtotals		1162.6	429175	471206	461381	423027	446932	437417	434807	458769	434958