Calculating Agricultural Use Values for Missouri Farmland

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Introduction

Calculating the productive use value of agricultural land can be an extremely difficult task, since no published data exists for comparison to alternative computational methods. Current agricultural land prices may provide some indication of use value, but they are subject to speculative forces that may cause them to not provide a good estimate of agricultural use values at various points in time.

This report will provide the background necessary to show that agricultural use values should reflect the expected future stream of returns generated by the land and discounted to current dollars. Given that no one can foresee the future, assumptions need to be made to convert this forward-looking theoretical formula into a computable process. That is often accomplished by utilizing historical observations to proxy future returns.

This report reviews literature on farmland values and how different states, including Missouri, have calculated agricultural use values. Following the review will be an explanation of the new process developed for Missouri agricultural use values at the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri–Columbia (MU).

The specific objectives are to:
1. review the theoretical and empirical literatures on farmland values,
2. explain general methodologies of farmland use value estimation,
3. document other states' methods and procedures in assessing agricultural land use values,
4. examine past MU approaches in estimating Missouri's farmland use values, and
5. discuss the new land use valuation approach for Missouri.

Theoretical Background and Previous Research on Farmland Values

There has been a large amount of economic and financial literature generated regarding agricultural land values. However, relatively few papers have theoretically explored the farmland's use value and are usually restricted to the importance in preserving farmland rather than an evaluation method for their value.

Most studies have concentrated on revealing the determinants of farmland market values (farmland prices) and examining the validity of underlying methodologies which provide an economic reasoning of the determinants of farmland prices. This report reviews studies on farmland prices since they provide a direct and indirect basis on existing formulas/procedures of agricultural land use values.

The early studies of farmland prices (Herdt and Cochrane; Tweeten and Martin, etc.) were based on structural, simultaneous equation models of supply and demand for farmland. Herdt and Cochrane (1966) used the number of voluntary farm sales per 1000 farms as a quantity. They used the average price of farmland and buildings per acre as a price of farmland in their structural model of farmland prices.

Herdt and Cochrane included unemployment rates to represent non-farm employment opportunities, the rate of return (interest rate) on long-term bonds to reflect the return on non-farm investment, and the number of farms which showed a change in the total amount of farmland as supply shifters in the supply equation.

Demand shifters affecting expected income from farmland are: interest rates, reflecting the discount rate of future income from farmland; land in urban uses, representing the effect of urbanization; general price index; the ratio of the index of prices received to prices paid, reflecting the effect of farm-price support programs; and the United States Department of Agriculture (USDA) productivity index, which quantifies farm technological advances. Their empirical results showed that farm technological advances and government price support programs were the major forces raising farmland prices.

Tweeten and Martin (1966) analyzed US farm real estate price variations using a set of five equations: land price, land in farms, cropland, farm numbers and farm transfers. They treated farm numbers and transfers, as well as the land in farms, as quantity variables. Their empirical results indicated that the US farmland price boom in the 1950's and early '60's could be attributed to the pressures for farm expansion which capitalized benefits from government programs tied to acreage restriction.

Pope et al. (1979) reviewed these earlier studies and re-estimated them using more recent data. The conclusion is that theses models were ineffective to explain farmland prices. Falk (1991) pointed out the inelastic farmland quantity as an inherent problem of these approaches that attempted to identify a classic supply equation in the farmland market where the price elasticity of farmland quantity is very low.

Burt (1986) noted, *"The amount of farmland available may change gradually over time, but these changes are relatively insensitive to farm prices because they emanate from government appropriations (reclamation and highway developments) and urban growth (p.11)."*

On the other hand Melichar (1979), Featherstone and Baker (1987), and Robson and Koenig (1992) attributed the failures of these models to the use of net farm income as an indicator of the residual return to land affecting farmland prices. Melichar states, *". . . net farm income is not an appropriate measure of the return to either land or production assets . . . because a significant farm real estate is owned by nonoperator landlords, their net rental income should be added (p.1087)."* Robson and Koenig pointed out the erroneous assumption that the reported value of farmland (market value) is equal to returns from farmland's use in agriculture in these approaches. They also noted that agricultural income is a major source for farmland use value rather than market value.

The problems of many of these early studies led researchers to adopt financial economics in explaining farmland values. Even though many theories of asset price determination have been applied to farmland market analysis, most studies can be represented by a simple present value model obtaining the current value of assets (farmland) as a function of the discounted sum of the expected value of future returns of assets.

A general expression of the present value model of farmland prices, if land owners are risk neutral and the discount rate is constant, (p.148, Clark et al.) is:

(1) $\qquad V_t = \sum_{t=0}^{\infty} (\frac{1}{1+r})^{t+1} E_t (R_{t+1})$,

where V_t is the value (price) of farmland at time t, R_t is the net return (or rents) to owning farmland at time t, E_t is the expectation operator conditioned on the information available at time t, and r is the discount rate.

If net return, R_t grows perpetually with constant rate g while the discount rate, r is greater than the growth rate of net return (r>g), then the geometric series of equation (1) can be solved as:

(2) $\qquad V_t = E_t \frac{(1+g)R_1}{(r-g)}$.

Equation (2) says that the farmland values in time t is determined by an estimate of base net return, discount rate and growth rate of net return.

Although most studies since the late 1970's are based on the general present value model, there has been little consensus about the determinants of farmland prices in empirical analyses. A common disagreement among the studies stems from different beliefs about the role of speculative forces and interest (discount) rates in farmland price determination.

Barton, Adelaja and Seedang (2005) describe speculation in farmland as *the tendency of farmland owners to acquire, dispose or hold on to land based on expectations about the appreciation of land (p.2)"*. They maintained that farmland demand is affected not only by productive use demand but by speculative demand, especially for the farmland near urban fringe.

Melichar argued that real capital gains are fully explained by the return to assets using the simple capitalization formula. Doll and Widdows (1981) elaborated on Melichar's analyses and confirmed his result. Melichar's conclusion implies that land value increases in the 1970's were based on the asset earnings (growing net rents stream) rather than speculative forces.

Alston (1986) examined the real growth in US farmland prices in the 1970's as a function of real growth in net rental income to land (cash rents) and increases in expected inflation based on the present value model. With constant rates of tax and interest, he derived a simple capitalization formula: i.e., real land price is equal to expected real net rents divided by a real discount rate. Based on this formula he addressed two hypotheses. First, land prices grow at the same rate as income to land. Second, an increase in the expected inflation rate will increase the real land price.

His empirical analysis suggested that most of the real land price growth can be explained by real growth in net rental income to land and the effect of inflation has been comparatively small, even though increases in expected inflation have had a negative effect on real land prices.

Burt (1986) approximated the structure of the capitalization formula using a second-order rational distributed lag on net crop-share rents received by landlords to explain the dynamics of farmland prices. Based on the statistical results he argued, *"Rents are the underlying source of value, and there is little evidence that farmland prices are driven by the same kind of speculative forces as those for nonincome earning assets such as precious metals and stones (p.25)."*

Featherstone and Baker (1987) examined the dynamic response of real farm asset values to changes in net returns and interest rates using vector auto regression techniques. They hypothesized that there is no overreaction in the farm asset market, i.e. the history of the boom-bust sequence of farm asset values is the result of a rational dynamic response to the information available rather than a process of

over- and undershot farm asset values. Unlike earlier studies, their empirical results reject the null hypothesis, supporting the role of speculative forces on farmland prices.

They argued that if some market participants are focusing on irrelevant aspects of the information set, such as past capital gains rather than movements in returns and real interest rates, asset price bubbles might arise contrary to the present value model that asset values are determined by expected future returns and expected future interest rates.

Barton, Adelaja and Seedang (BAS) hypothesized that the relationship between rate of appreciation and farmland demand is negative, since, when the expected rate of return from farmland value rises, so does the risk (opportunity cost) associated with retaining farmland. They also hypothesized that when the rate of farmland value appreciation exceeds the risk-free T-bill rate, a positive relationship will be observed because of speculative forces. This hypothesis is based on the assumption that, when it comes to speculation, *". . . an individual may actually weigh the benefits of the higher expected return more than the increased risk associated with it (p, 11)."* BAS' empirical result using New Jersey as a case study supports their logic.

The disagreements about determinants of farmland prices in the reviewed studies brought many researchers to examine the plausibility of using a present value model to explain farmland prices movements.

Falk (1991) adopted Campbell and Shiller's (1987) approach to test the validity of the present value model of stock prices to the present value model of farmland prices. Campbell and Shiller (CS) showed that if the dividend of the stock price possesses a unit root, then so must the price of the stock itself in the present value model, i.e. stock prices and dividends should have the same time series representations. Furthermore, prices and dividends should be co-integrated and, if the discount rates were constant, there should be a stable co-integration vector.

Falk's empirical results using CS' method show that although farmland prices and rents have similar time series properties, price movements are much more volatile than rent movements. Based on this finding and other formal tests, he rejected the present value model of farmland prices.

He suggested that the failure of the present value model might be attributed to a rational bubble, reflecting a tendency for price to deviate from its fundamental value as a result of self-fulfilling beliefs that the price depends on a variable that may be intrinsically irrelevant with respect to the assets' fundamental value.

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Clark, Fulton and Scott (1993) also tested the plausibility of present value models using US and Illinois data. They derived the present value model of farmland prices using time series formalization. They demonstrated that the formulas and, hence, solutions of basic present value model are dependent on the expected future returns, which are in turn determined by the stochastic process of farm returns (land rents) (e.g., AR(1) or AR(2), etc). Based on this idea they obtained the same procedure as Campbell and Shiller and Falk in examining the validity of the present value model.

They showed that land prices and rents do not even have the same time series representations, which are a necessary condition for the validity of a present value model. Based on their empirical results, they argued that farm income represented by rents alone could not explain land values. Furthermore, they suggested abandoning a simple capitalization formula in farmland valuations and developing "*. . . a more complex model that allows for rational bubbles, risk aversion, and future shifts in government policy or commodity prices (p. 147)."*

Gutierrez, Erickson and Westerlund (GEW) (2005) tested if the present value model of farmland pricing held for a panel of 31 states from 1960-2000, using unit root and co-integration analysis. GEW used both conventional panel co-integration tests that assume the co-integration vector is stable over time and newly developed panel co-integration tests that allow for structural change.

GEW rejected the constant discount rate version of the present value model when they used conventional panel unit root and co-integration tests. But they could not reject the present value model when they allowed regime changes representing a time varying discount rate. This implies that the present value model of farmland pricing holds so we only need to apply new time series techniques, rather than revising the present value model of farmland pricing.

The treatment of interest rates has been an issue in the analysis of farmland prices. Alston and Falk adopted constant discount rates in their capitalization model. On the other hand, Featherson and Baker used observed real interest rates to reflect a time varying discount rate. Burt and GEW used both constant and time varying discount rates and compared results. Unlike GEW's result, the effect of time varying discount rates on farmland prices in Burt's analysis is not significant. Burt states, *"With the long-run investment characteristics of farmland and the sizable transaction costs involved, market participants are apt to use an estimated long-run equilibrium real rate of interest in the classic capitalization formula to approximate land values. . . . Some economists would question the specification of a constant real rate of interest in an econometric land prices because they are convinced that this rate varies over the business cycle (Tanzi) or with respect to expected inflation (Feldstein). The empirical question is whether farmland investors take*

account of these year-to-year movements in their decisions or think of long-run equilibrium (pp. 12-13)."

General Methodologies Employed in Calculating Farmland Values

Use value and market value of agricultural land are different in many aspects, but the foregoing reviews of theoretical models and elements affecting farmland market values should provide a foundation for agricultural use values estimation procedures.

Market value of farmland is the value determined by the fair transaction between an informed buyer and seller of farmland. It reflects not only the earnings from agricultural use in farmland but also returns from the farmland's non-agricultural use demand and speculative forces.

On the other hand, use (or productive) value of farmland is generally defined as the current value of farmland in agricultural use rather than its full market value.

There are two major reasons why use values rather than market values are applied to assessment of farmland for property tax purpose. According to the Kansas Department of Revenue (KDOR), *"Market values may be too high relative to the income generated by farming the land and market values are periodically unstable, rising or falling more rapidly than the income-generating capabilities of the land (p.1)."*

Generally, there are three approaches used to estimate the market value of real property. They are the market data (sales comparison) approach, the cost approach and the income approach. The market data approach determines market value of real property based on the market sales of similar, neighboring properties that have sold recently. The cost approach derives market value of real property based on the replacement cost of the similar property. Replacement costs of property are usually revealed by the sales of property. The income approach establishes market value of real property based on the current value of the income-generating property which is commonly measured by the net rental income or net operating income of property.

While market data and cost approaches could be applied to farmland use value estimation, this would require market values and replacement costs of farmland to be solely determined by the agricultural use of farmland, an assumption that is clearly questioned by previous literature. The income approach is the most adequate approach to estimate use values, since this method determines the value of farmland based on the present value of potential future income streams of farmland.

Income Approach in Farmland's Use Value Estimation

The expression of the income approach in farmland use value estimation is the same as the general expression of the present value model of farmland prices in equations (1) and (2) in the previous section. If there are no changes in net returns over time in equation (1), the expression can be simplified as:

(3) $V = R/i$,

where V is the use value of farmland, R is the annual net return of farmland, and i is the capitalization rate. According to Ervin and Nolte (1982), annual net returns in the income approach to use value assessment can be estimated by net rental income or by net return to owner-operators.

Net rental Income

If the rental market is perfectly competitive, then the per acre rental rate (cash or share of return) is an indication of the value of farmland. The advantage of this method is that one can rely on actual market rental rate data to derive use values. However, Ervin and Nolte (EN) mentioned that this approach is very complicated in practice, as local rental markets are not always typified as perfectly competitive markets and the observed rental rate is a mixture of a variety of leases, and therefore must be standardized to estimate net rental income.

Owner-Operator Net Income

Owner-operator net income is the gross return from agricultural production minus the total non-land cost of production. Expected gross returns from agricultural production are usually estimated by the historical moving average of yields and prices of crops. Using a historical moving average to estimate future income capabilities is based on the assumption that the future returns will follow the average of present and past returns. EN noted several other assumptions implicit in this method (p.14):

1.   Owner-operator net income is usually calculated for a typical or average operator. Thus, average management is assumed to hold.
2.   The values often assume a given farm size. So, there is no economics of size in this approach.
3.   It assumes that all farmers use approximately the same set of inputs to produce a given crop.

Capitalization Rate

The remaining part of the formula for the income approach in equation (3) is the capitalization rate. Net returns to agricultural land should be divided by the

appropriate capitalization rate to obtain a current-dollar use value of land. Land will generate returns for an infinite number of years. Capitalization is the technique of converting potential future earnings from the land into a current value.

The capitalization rate should be the rate of return that could be earned on other investments. Therefore, both risk and inflation factors must be considered in determining the appropriate capitalization rate. The choice of capitalization rate will effect the resulting use value of farmland. According to a report by the KDOR, most state use valuation programs have applied Federal Land Bank (FLB) mortgage rates on farmland loans.

Farmland Use Values Estimation Procedures in Other States

This section of the report documents and compares other state methodologies of estimating use values of farmland. KDOR reviewed the procedures of farmland valuation for 30 states. According to KDOR's review, most states utilized use value rather than market value approaches to determine farmland values for property tax purposes, and about two-thirds of the states determine use value of farmland by capitalized net income. KDOR categorizes the procedures for farmland assessment by:

- eligibility requirements for states where landlords must apply for the use value taxation (refer to Table 1, p. 35);
- tax recapture when land no longer qualifies for use value (refer to Table 2, p.37); and
- method determining appropriate capitalization rate (refer to Table 3, p.39).

The KDOR report revealed that about two-thirds of the 30 states require that landlords apply to receive use value taxation, and about one-third of the states practice use value taxation automatically for farmland tracts greater than a certain size. Regarding this second category, about one-third of the states require landlords to pay a penalty when farmland is converted to other use.

KDOR's review also showed that most states use FLB interest rate as a capitalization rate, and some states incorporate FLB interest rates with risk components, liquidity adjustments, effective tax rate adjustment and other factors.

Even though KDOR's review provides a broad coverage of other states' practices in use value assessment, it does not supply detailed estimation and implementation procedures. This report does provide thorough procedures for how net returns and use values of farmland are estimated and implemented for selected states, and a portion of this discussion is summarized below.

Iowa

Agricultural real property in Iowa has been assessed by law according to its productive (use) value. The procedures of estimating farmland use values were developed by the Economics Department of Iowa State University (ISU). The ISU approach utilized an owner-operator net income capitalization method which depends upon production, prices, expenses and a capitalization rate. This report summarizes the 1995 ISU report regarding procedures for calculating per acre use value of farmland.

The steps employed are:

1.   Determine the five-year average of total farmland acres consisting of corn, soybeans, oats, government program, hay, tillable pasture, non-tillable pasture and other acreage. Government program payments per acre are the sum of the diverted, deficiency and the Conservation Reserve Program (CRP). Tillable pasture acres are one-forth of the pasture acres and pasture acres are determined by the product of five-year average of total farmland acres, and the percentage of pasture acres relative to the current year's total farmland acres.

2.   Determine the five-year average of crop production for corn, soybeans, oats, and hay. Then, determine yields for these crops by dividing the five-year average production by the five-year average acres.

3.   Determine prices for corn, soybeans, oats, and hay by the five-year average of the per bushel county prices received for corn, soybeans, and oats. The price for hay is the five-year average of the statewide per ton price received for hay.

4.   The total landlord income is the sum of a five-year average of landlord income for corn, soybeans, oats, government payments, hay, tillable pasture and non-tillable pasture. The landlord income for corn, soybeans, and oats is determined by the product of one-half of the five-year average production and five-year average of price. The landlord income for government payments is one-half of the five-year average of the government payments for diverted, deficiency, disaster and CRP program. The landlord income for hay, tillable pasture, and non-tillable pasture is based on the cash rent. The cash rent for hay is assumed to be one-fourth of the hay production multiplied by the five-year statewide average hay price. The cash rent for tillable pasture is equivalent to the product of one-fourth of the hay yield and the five-year statewide average hay price. This product is then multiplied by the tillable pasture acres to arrive at the total tillable pasture income. The cash rent for non-tillable pasture is equivalent to one-half of the product of one-fourth of the hay yield and the five-year statewide average hay price. This price represented by the cash rent

is then multiplied by the total non-tillable pastures acres to determine landlord income for non-tillable pastures.

5. Determine total landlord expenses through the sum of landlord expenses, a fertilizer cost adjustment, and liability insurance expense. Total landlord operating expenses are the total of five-year average expense for corn, soybean, oats, government programs, hay, tillable pasture, and non-tillable pasture.

The five-year average expense for corn, soybean, and oats is determined by multiplying the five-year average crop acres to the 5-year average per acre expense for the corresponding crop. The five-year average per acre expense for these crops are county adjusted per acre expenses for corn, soybeans, oats, and hay. That is, if the county's five-year average yield and the state five-year average yield are different, then the yield difference is multiplied by the five-year state average per bushel/ton facilities cost for the crop. If the county's five-year average yield is greater (less) than the state five-year average yield, the adjusted amount is added to (subtracted from) the state five-year average per acre crop expense.

Total landlord operating expenses for government programs is equal to the product of the per acre expense for the year of the program and the five-year average number of acres in the program.

Total landlord operating expenses for hay, tillable and non-tillable pasture are determined by multiplying the per acre expense to the five-year average number of acres.

The fertilizer cost adjustment is the product of the difference between the five-year statewide average corn yield and the county corn yield and the five-year average of fertilizer expenses per bushel. If the average state yield is larger (smaller) than the county yield, the fertilizer cost adjustment is deducted from (added to) total expenses.

Liability insurance expense is the five-year average of the liability insurance expense per acre multiplied by the five-year average total acres.

6. Total net income is the sum of the total net landlord income for enumerated (corn, soybeans, oats, government payments, hay, tillable pasture and non-tillable pasture) acres and total net landlord income for other acres. Total net landlord income for enumerated acres is determined by subtracting the total landlord expenses (step 5) from the total landlord income (step 4). Total net landlord income for other acres is the net income per acre for other acres multiplied by other acres. The net income per acre for other acres is equivalent to 17 percent of the net income

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per acre for enumerated acres, which is determined by the net landlord income for enumerated acres, divided by total enumerated acres.

7.   Net income per acre results by dividing the total net income (step 6) by the total acreage (step 1). This calculated net income per acre is then reduced by 10.6 percent according to the "net income per acre less dwelling adjustment"; i.e., total net income is multiplied by (1-0.106). This adjusted total net return by dwelling adjustment percentage is in turn reduced by the five-year average of per acre real estate taxes paid during a calendar year; i.e., net income per acre after real estate taxes.

8.   The use value of farmland is determined by the five-year average net income per acre after real estate taxes divided by the appropriate capitalization rate, which was seven percent in the 1995 assessment year.

North Dakota

Agricultural land in North Dakota has been assessed based on the value of crops and livestock produced since the North Dakota legislature (NDL) passed the law regarding agricultural land value for tax purpose in 1981. The North Dakota state statute requires that the Department of Agribusiness and Applied Economics at North Dakota State University (NDSU) is to estimate the average use value per acre for cropland, non-cropland, and overall agricultural land in each county and state.

The methodology specified by the legislature and developed by NDSU is Landowner Share of Gross Returns (LSGR). The LSGR requires, *". . . the proportion of revenue generated from agricultural land that is assumed to be received by the landowner, and is expected to reflect current rental rates. The assumption is that the remainder of the revenue from the land is used to pay operating expenses and provides a return for the farm operator's labor, management and risk (Aakre et al., 2003, p.2)."*

This method applies different weights to the average gross returns from cropland and non-cropland in calculating LSGR and then it is capitalized by an appropriate interest rate to arrive at use value. The legislature specified that LSGR for cropland is 30 percent of gross returns, except for sugar beets and potatoes, which are 20 percent, and for non-cropland, which is 25 percent of gross returns.

The following steps provide detailed procedures for estimating average cropland, non-cropland and overall agricultural land use values.

1.   Calculate the ten-year moving average of acres for different types of land for each county, dropping the highest and lowest years using National Agricultural Statistics Service (NASS) data.

2.	Obtain a ten-year moving average of annual gross returns for cropland (AGRC) and non-cropland (AGRNC) for each county, dropping the highest and lowest years using the NASS data. Total cropland revenue is the sum of the gross revenue from cropland, government payments and CRP payments. Gross revenue from cropland is the product of the price of each commodity and production, which is the result of acres harvested times yield per acre harvested. Only 50 percent of the return on irrigated cropland is included in NASS cropland gross returns to compensate for the additional cost of irrigation. CRP payments in the calculation for total revenue only reflect 50 percent of actual payments received from the Farm Service Agency (FSA), to reflect the effort of landowners to establish and maintain the required CRP conditions.

The gross return from non-cropland is the product of the carrying capacity of non-cropland in the county and the value of beef produced on those acres. The carrying capacity of rangeland is assigned a 0.55 animal unit month (AUM) per acre and a 0.6 AUM per acre is assumed for pasture. This calculated revenue is multiplied by the total acres of the different types of land (range and pasture) in each county. The sum of these two revenue streams is the total revenue for non-cropland.

3.	The LSGR of cropland and non-cropland on each county is calculated by multiplying 0.3 to the AGRC and 0.25 to the AGRNC. The sum of these two values is the LSGR for agricultural land in each county.

4.	The LSGR of cropland, non-cropland and agricultural land on each county is then divided by the cost of production index (CPI). The weighting percentages (30 percent and 25 percent) reflect the amount of returns received by landowners from the crop-share rents minus taxes and expenses of landowners. Thus, each percentage could represent a net return to land. However, in recent years, variable costs of production have increased and the percentage of share in share rents has fallen below 30 percent. To reflect these trends, NDL introduced a cost of production index in 1999. The index used by NDSU is the index for "Items Used for Production, Interest, Taxes and Wage Rates (PITW)."

5.	Obtain the LSGR per acre in each county by dividing the adjusted LSGR of each type of land in step 4 by the average number of acres to each type of land (AAL).

6.	The average annual LSGR per acre in each county is divided by the appropriate interest rate to estimate use value per acre. The legislature specified the capitalization rate as the 12-year moving average of the gross Federal Land Bank (AgriBank, FCB) mortgage interest rate for North Dakota (DR), taking out the highest and lowest values. The legislature specified a minimum of 9.5 percent for the

capitalization rate in 2003, and amended this minimum capitalization rate to 8.3 percent in 2005.

    7.   By multiplying the capitalized average annual LSGR per acre in each county to the number of acres, the county director of tax equalization arrives at reported total values for cropland (RALC) and non-cropland (RALNC).

    8.   Adding total use values of cropland and non-cropland in the county and dividing by total acreage of all agricultural land (RAL = RALC + RALNC), determines the average use value of all agricultural land in the county (AUV).

    The above eight steps can be simplified by the mathematical representation:

AUV = [{(AGRC*0.3 +AGRNC*0.25) / CPI} / AAL] / DR * RAL

Illinois

    Illinois farmland has been assessed according to its use value since 1981. The Illinois Department of Revenue (IDOR) utilizes a landlord net income capitalization approach to calculate the agricultural economic value (farmland use value). This approach obtains use values of farmland per acre by net income based on the soil productivity index (PI) divided by an interest rate. Net income is gross income per acre less non-land production costs per acre. Prices and costs used in calculating net income are five-year average figures. Average yields based on soil productivity indices are used rather than actual yields. The interest rate used is the five-year average of the FLB farmland mortgage interest rate.

    One of the most important factors in the Illinois farmland use value assessment is to determine the PI of each soil. Illinois assigns a PI to each soil based on the detailed modern soil surveys for all 102 counties. PI reflects the relative ability of farmland to produce different yields based on the same technology and management. 'Circular 1156', a soil productivity study published by the University of Illinois (UI) in 1978, has provided average yields for crops, forage and tree crops on various soil types in Illinois. Values of 'Circular 1156' were based on agricultural technology and basic and high levels of management from the late 1960's and 1970's. UI replaced 'Circular 1156' by 'Bulletin 810' in 2000. 'Bulletin 810' is based on 1990's technology and average management levels. It reflects increased crop yields over the years. 'Bulletin 810' was implemented for the 2006 assessment year. Counties in Illinois could choose either the individual soil weighting method or the weighted tract method in implementing estimated farmland use values through the 2004 assessment year.

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IDOR (2003) states, *"The difference between the two methods is in the assessment computation weighting process. The individual soil weighting method weights a soil's assessed value by the number of acres of the soil. The weighted tract method weights a soil's PI by the number of acres of the soil (p. 103)."*

By the 2005 assessment year, only the individual soil weighting method was allowed.

A brief description of the procedure for individual soil weighting methods in farmland assessment is:

1.   Determine the portions of the farmland to be classified into cropland, permanent pasture, other farmland, and wasteland by aerial photograph interpretation and on-site inspection of the parcel.

2.   Measure the acreage of each soil type within each land use category.

3.   Assign soil PI ratings for each soil type identified and adjust the PIs for slope and erosion.

4.   Determine the Equalized Assessed Value (EAV) per acre of each soil type for each land use category. The EAV of cropland per acre is based on the adjusted soil productivity index (PI), and is one-third of its estimated use value. Each year IDOR provides a table that shows the EAV of cropland per acre by PI. Permanent pasture is assessed at one-third of EAV of cropland. For example, soil ID number 17 in the cropland category has an adjusted PI of 100 and EAV per acre of $159.93. Soil ID number 119D in the permanent pasture category has adjusted PI of 86, which has a corresponding cropland EAV per acre of $81.09. Therefore, the EAV of soil ID number 119D in the permanent pasture category is one-third of $81.09, that is, $27.03. Statute requires the EAV of permanent pasture cannot be lower than one-third of the EAV per acre cropland of the lowest PI certified. Other farmland is assessed at one-sixth of the EAV per acre of cropland. Statute requires the EAV of other farmland cannot be lower than one-sixth of the EAV per acre cropland of the lowest PI certified. Wasteland is assessed by its contributory value to the farm parcel.

5.   Determine the assessed value for each soil type in each land use category by multiplying the EAV per acre (step 4) by the number of acres for each corresponding soil type (step 2).

In 1986, Illinois law placed a limit of maximum change of annual EAV per acre at ten percent to provide protection to farmland taxpayers from drastic changes in the farm economy.

History of Missouri's Farmland Use Values Estimation Procedures

All Missouri agricultural real property was assessed at one-third of its market value before the 1985 reassessment year. Missouri changed its statutory method to assess agricultural property from a market value standard to a use (or productivity) value standard in 1985. Since then, MU has provided Missouri farmland use values to the State Tax Commission of Missouri (STCM), which then assesses farmland use values based on MU's recommended values.

Past Methodology (1985-1995)

Ervin and Nolte (EN) provided a methodology for estimating the use values of Missouri agricultural land by request of the STCM beginning in December 1982. The STCM then determined the agricultural use values of eight different soil grades based on the EN recommended values. EN used an income capitalization approach to estimate use values. EN's original methodology was used until the 1995 reassessment year with only slight modifications. EN utilized the owner-operator net income approach to estimate the net return to land for use values of cropland and pastureland classified by the soil grades.

Cropland

The steps of estimating net return to cropland for use value are (1) selection of predominant soils, (2) selection of predominant crops and specification of crop rotations, (3) estimation of gross returns, (4) estimation of crop production expenses, and (5) estimation of net returns to land. Following are detailed procedures for each step.

1.   EN selected a representative sample of soils based on the Land Capability Classification system (LCC) developed by USDA Soil Conservation Service (SCS) to have use-values for each soil type. This system embodies eight classes each for bottomland and upland soils. An important soil characteristic is the PI. The PI rating system, developed by the SCS, provides an index from 0 to 100 for ranking soils on their relative capabilities to produce crops. A soil with a PI of 100 represents a soil with the best combination of properties for growing crops.

2.   The next step in calculating the annual income stream is to define the predominant crops and crop rotations in Missouri. EN chose corn, soybeans and wheat as the predominant crops. They used five-year average planted acreages of corn, soybeans and wheat as a basis to compute rotation percentages. The average

grain crop rotation was specified as 25.28 percent for corn, 54.18 percent for soybeans and 20.54 percent for wheat.

3.   The following step is to estimate gross returns. Estimated gross returns per acre are equal to the per acre yield of each crop times a price of each crop. Yield estimates reflect state average weather, management, and current (1982) technology levels. They used 20-year average crop (corn, soybean, wheat) yields to reflect average weather conditions. Technology effects were estimated by regression analysis: Yields i = f (temperature, rainfall, time), where i are corn, soybean, wheat and time represents technology. Technology effects are measured in bushels of yield increase per year. These regression results are incorporated into the 20-year average crop yield to reflect current technology.

Once average yields have been determined, the next step is to define the average soil on which crops are grown. The SCS PI ranking system was used for that purpose. A Missouri state average cropland PI of 62.5 was calculated. A key assumption in deriving appropriate yields for each soil is that the 1982 state average yield occurs on a soil with the state average PI equal to 62.5. Once this assumption has been made, yield estimates for each individual soil are possible.

The PI of a particular soil is multiplied by a constant bushels per unit of PI (BPI): Soil yield = Soil PI * BPI, where BPI = 1982 state average yield/62.5. This procedure implicitly assumes that yield variations across soils are only due to natural productivity variations. Systematic variations in management by PI, such as fertilization, etc., are not incorporated and therefore would not be reflected in the use-value estimates.

Six-year average crop prices were used, dropping the highest and lowest but keeping the most recent price to minimize price variability from year to year. Current gross returns for each cropland soil were derived by these prices times the appropriate yields and weighting by the crop rotation percentages given earlier.

4.   The next step is to estimate crop production expenses. Expenses are defined as the total non-land production costs incurred in carrying out the crop production process. These costs include both variable and fixed production charges, plus returns to labor, management and non-land capital such as machinery operations fees, fertilizer and lime, herbicides, insecticides, grain storage, hauling charges, drying costs, management fees, and property taxes.

5.   After completing the above steps, EN was able to compute the Net Returns To Land (NRTL) for corn, soybeans and wheat on each soil. EN found the following relationship between PI and net returns for each crop (P.76):
NRTL (corn) = 2.13 (PI) -111.38.

NRTL (soybeans) = 2.60 (PI) -111.33.
NRTL (wheat) = 1.55 (PI) – 71.21.

It is then possible to estimate net returns to land for any soil by substituting the appropriate PI into the above equations. EN (P.81) incorporated crop rotation into the above equations to yield this specification:

NRTL = 0.2528* (2.13 (PI) -111.38) + 0.5418* (2.60 (PI) -111.33) + 0.2054 *
(1.55 (PI) – 71.21) = 2.27(PI) – 103.11

According to the above equation, the net return to land from crop production becomes negative when the PI falls below 46. Soils with those PI numbers are therefore not suitable for crop production.

Pastureland

EN used the pasture rental approach to estimate net returns to pastureland. This approach is similar to the method applied to cropland. Gross income in the pasture rental approach is the product of the Missouri pasture lease price and the pasture yield specified in AUM for each soil. EN states, *"An AUM is the amount of forage required to support one animal unit for one month. Expenses are the necessary costs incurred by the landowner to obtain the lease price specified: establishment costs, original fence costs plus repair and maintenance, real estate taxes, fertilizer costs in some cases, and miscellaneous other costs (p.83)."*

Based on the gross return and expenses, EN (p.85) obtained the following relationship for net returns to pasture land and the soil productivity index (PI):
NRTL (pasture) =0.43 (PI) – 0.31

Use value calculations based on soil productivity index

Net returns to agricultural land should be divided by the appropriate capitalization rate to arrive at a use value for land. The capitalization rate should be the rate of return that could be earned on other investments. EN used the five-year moving average of the FLB mortgage rate on farmland loans.

EN (p.87) compared the NRTL from crop production with those calculated from the pasture rental method for soils with PI's between 40 and 65 to determine the boundary point where the method of estimating net returns for use-value should change from crop production to pasture production. They found the border point to be 56. Thus, the algorithm to estimate agricultural land use-values (AUV) for any Missouri soil is:

If PI>= 56, AUV = [2.27(PI) -103.11] / i
If PI<= 55, AUV = [0.43(PI) -0.31] / i,

where i is the latest 5-year average of FLB mortgage rate on farmland loans.

Implementation of use value

The above use values estimation results allow EN to assess use values of farmland based on the specific PI assigned to each individual soil, but it requires complete data for each parcel of farmland. To simplify, EN correlated PI and eight soil grades based on the Land Capability Classification system (LCC) developed by USDA and assigned use values to each soil grade. For example, soil grade number 1 corresponds to a PI range of 93-100, and use values of soil grade number 1 range from $1040-$1193.

Current Methodology (1997-2005)

MU altered its approach to estimate farmland use values for the 1997 reassessment because of concerns that many of the original assumptions of technology, input costs, etc., were outdated.

The current approach developed by Dr. Kevin Moore applies average rental rate changes to the previous year net crop revenue (NCR) or net pasture revenue (NPR) calculation to represent movements in returns to farmland, instead of directly calculating each year's net return to farmland from agricultural production. These calculated future incomes from the agricultural productive (use) value of farmland are then capitalized into the current use values by an appropriate discount rate.

Even though the cash rental rate does not exactly adjust in accordance with net operating income from farmland, Moore [State Tax Commission of Missouri] argued that a cash rental rate is an appropriate indicator of use values because a cash rental rate is usually negotiated ahead of time and it reflects an expectation of a renter's value for agricultural production from farmland in the future.

A six-year moving average of the USDA's average Missouri cropland cash rent (CCR), taking out the highest and lowest values, is used to calculate the percent change relative to the previous year's average of crop cash rent in soil grades 1-4, and a five-year moving average of the USDA's average Missouri pasture cash rent (PCR) is used to determine the changes of pasture cash rent in soil grades 5-8. A five-year moving average long-term interest rate on farm real estate loan for the Kansas City Federal Reserve District (DR) is used for capitalization.

The current use value estimation procedure can be represented as:

Use value of crop land at t = [NCRt-1 * (1 + (CCRt –CCRt-1)/ CCRt-1)] / DRt.
Use value of pasture land at t = [NPRt-1 * (1 + (PCRt –PCRt-1)/ PCRt-1)] / DRt.

These procedures use the historical moving average of cash rents and interest rates to minimize some of the year-to-year fluctuations, making tax and revenue planning easier for the state. However, using historical averages can result in too slow of an adjustment to tax rates given current market conditions.[State Tax Commission of Missouri].

The recent large increases in calculated Missouri use values from this approach raised some questions, especially whether using rental rate changes to reflect the change in the net operating income from farmland is appropriate. Moore states that, *"The real question would be----Is there some reason to believe that the response of cash rental rates is somewhat structurally different now than it was maybe a decade ago, in that we're seeing much higher spikes in cash rental rates in the last few years, and are those actually good reflectors of net operating income, or expectations of net operating income (p.12, State Tax Commission of Missouri)."*

The New Use Value Approach for Missouri

This section provides a general description of the methodology employed in determining agricultural use values. The reader is referred to an Excel workbook on FAPRI's website (see http://www.fapri.missouri.edu) to follow the detailed procedures used in this new approach.

Calculated use values for land grades 1-4 employ market receipt information (planted area, harvested area, yield and price) for six major Missouri crops, operating and overhead expense data for these same six crops, total government payments, and state CRP area. The six crops used in the calculation (corn, soybeans, wheat, sorghum, cotton and rice) accounted for 98.7 percent of total harvested area (excluding hay) in Missouri during 2005 and 2006. Crop area, yield and price information is sourced from the National Agricultural Statistical Service (NASS) at the USDA. Data for expenses and government payments originates from the Economic Research Service (ERS) at USDA, and CRP area is available from the Farm Service Agency (FSA) at USDA.

Market receipts for a particular crop are determined by the product of harvested area, yield, and market year average price. Information on area and yield for a given market year is available many months before final market year average prices are known. For example, the market year for corn is defined as the one-year period from September of the year in which the crop was planted through the

following August. In December of a given year, reliable estimates are available for corn area and yield, but over half of the marketing year still remains. Therefore, estimates from the FAPRI modeling system are used to provide price information in the most current year, in order to maximize use of the most current available information.

The FAPRI modeling system is an annual multimarket, nonspatial, partial equilibrium model that covers markets for major grains (wheat, corn, rice, sorghum, barley and oats), oilseeds (soybeans, rapeseed, sunflower seed, peanuts and palm oil), cotton, sugar, beef, pork, poultry (chicken, turkey and eggs) and dairy products. Included with this structural model system are satellite models that provide estimates of US farm income, US government outlays for agriculture and US consumer food costs. This model is used to generate annual ten-year baseline projections (e.g., FAPRI 2007) and analyze a wide range of domestic and trade policy questions (e.g., Fabosia et al. 2005).

Crop production expenses are separated into two categories, operating and overhead. Operating expenses include such items as seed, fertilizer, chemical, custom operation, fuel, lube and electricity, repair, interest, hired labor, and miscellaneous expenses. Overhead expenses are calculated as taxes and insurance, general farm overhead, depreciation, and the opportunity cost of unpaid labor. As data for a given year does not become available until September of the following year, estimates from the FAPRI modeling system are used to provide operating expense data for the current year. Overhead expenses are not a part of the FAPRI system, and are computed by employing the percentage change in the general producer price index (forecast provided by Global Insight, Inc., a macro-economic forecasting company www.globalinsight.com) to last year's known level.

Similar to the release of production expense data, government payment data by state for a given year is not available until well into the following year. Therefore, the FAPRI system is used here as well to generate expected government payments for the current year. Government payments defined as "ad hoc and emergency" are excluded from the calculation.

Once total market receipts plus government payments less expenses are determined on an aggregate basis, they are converted to a per acre basis by dividing by the total planted acreage of the six included crops plus CRP acreage. The inclusion of the CRP acreage in the denominator is consistent with the inclusion of all state government payments (less ad hoc and emergency) in the numerator. The resulting calculation yields an estimate of the revenues less expenses per planted acre of all land in grades 1-4 for a given year. Due to the variable nature of agricultural profitability in Missouri, a ten-year average of this calculation is used to proxy the

use value for a given year (e.g. the use value calculated for 2006 is the average of revenues less expenses per planted acre from 1997-2006).

The capitalization rate used to deflate the future stream of expected returns originates from the 10th Federal Reserve Bank district, and is defined as the long-term real estate interest rate charged by banks in this district. Data is provided on a quarterly basis, and therefore three-fourths of the data required for the current year is available in December of a given year. By assumption, the fourth quarter rate is set equal to the third quarter rate, unless current convincing market evidence exists to estimate a higher or lower rate for the fourth quarter. The ten year annual average of this rate is used to be consistent with the ten-year average calculation of use value described above.

Once an expected future use value has been calculated for all land in grades 1-4, the final step is to determine an expected future use value for each particular grade of land. Information regarding the number of acres in Missouri classified as grade 1, grade 2, grade 3 and grade 4, as of 2004, as well as the current relationship between use values for land grades 1-4, was used to convert the calculated use value for all lands grading 1-4 into values for each of the four grades.

This approach in determining the individual use values for grades 1-4 implies that the productivity indices originally developed by EN and used in determining use values by grade correctly represents each grade's productivity. The approach used here for determining individual grade use values results in each grade moving by the same percentage from year-to-year.

Similar methodology was utilized to determine use values for land grades 5-7. Market receipts for these land grades are calculated from Missouri cattle and calf price data, and cattle and calf marketing quantities (data sourced from USDA/NASS). The product of cattle price and cattle marketings is multiplied by 8.25 (assumed average marketing weight for Missouri cattle) and added to the product of calf price and calf marketings multiplied by 4.45 (assumed average marketing weight for Missouri calves).

Expenses for cow-calf operations on a per beef cow basis were gathered from the Livestock Marketing Information Center (LMIC). Due to the timing of data availability, the FAPRI modeling system is employed to determine current year prices and marketing quantities for Missouri cattle and calves, as well as current year operating expenses.

The 2002 Census of Agriculture generated by NASS/USDA reports the number of pasture acres per beef cow in Missouri to be 5.49. Converting aggregate receipts to a per beef cow basis by dividing by the number of beef cows in Missouri

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at the beginning of the year (data from NASS/USDA), subtracting expenses, and dividing by 5.49 yields revenue less expenses per pasture acre for a given year.

Due to the well-documented cyclical nature of cattle and calf prices, a 15-year average of revenue less expenses per pasture acre is calculated, and divided by the 15-year average of the same capitalization rate described above for land grades 1-4. The resulting expected future use value for all land in grades 5-7 is converted to values for each of the three grades by the same process described above for grades 1-4.

Figure 1 provides the calculated use values by grade over the 1995 to 2005 period.

Figure 1. University of Missouri, Calculated Ag Use Values
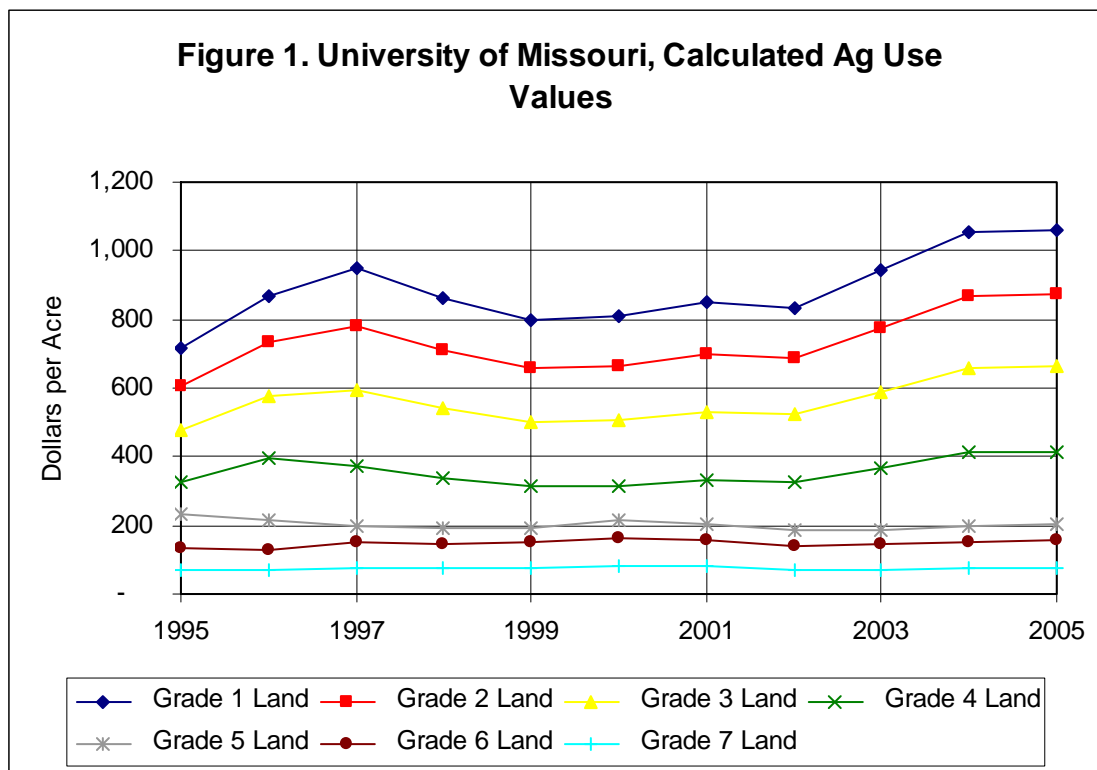
Summary

There remains no precise way to calculate agricultural land use values. Though theory suggests that it should reflect the discounted future returns to the land, it is impossible to predict the future with certainty, and therefore leaves several choices to use in attempting to proxy future returns.

Many other states use a calculation that incorporates agricultural returns and attempts to exclude non-agricultural values. That is the general approach used in this revised approach for Missouri. This approach appears to provide a more modest increase in use values today than the cash rent approach that was being used in the previous calculation.

Interest rates employed in the use formula are critical. In a time of declining interest rates, a situation can arise where the agricultural use values increases despite no change or even declining returns to the land.

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