IMPLEMENTATION OF THE ILLINOIS AGRICULTURAL LAND PRODUCTIVITY FORMULA AND OTHER STATE PROGRAMS[1]

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Abstract. Public Law 95-87 requires that prime farmland be restored to equivalent or higher levels of production as unmined prime farmland in the surrounding area. The productivity formula, developed to evaluate the restoration of prime farmland, was implemented in Illinois for the 1985 cropping season and became part of Illinois permanent program regulations on July 1, 1986. Cooperation between state and federal agencies was necessary for mobilization of the necessary manpower to process crop samples. At the request of coal companies crop loss adjustments to the formula will be performed by crop adjusters certified by the Federal Crop Insurance Corporation. Prime farmland methods for bond release are summarized for 11 other states.

INTRODUCTION

The Illinois Agricultural Land Productivity Formula (ALPF) is unique to Illinois and has application to any state with yield indexes by soil series.[3] Yields by soil series may be corrected for slope and erosion class, landscape drainage, and subsoil problems. Yield reductions for wetter drainage classes, such as frequently flooded and generally wet areas are considered and yields are reduced by a specific percentage of the soil series yield under normal conditions. Yields are reduced to zero for urbanland complexes and for miscellaneous land types.

The Illinois Department of Agriculture (IDOA) keeps a soil master file, a listing of every soil series and mapping unit in Illinois by slope, erosion class, and favorable or unfavorable subsoil occurrence. Individual soil series unique to a specific county or area are coded to reflect the uniqueness of the soil series. Cooperative Extension Service Circular 1156 (Fehrenbacher et al., 1978) lists all soil series in Illinois and gives the estimated crop productivity standard at a high level of management as well as average management of crops (corn, soybeans, oats, wheat, and mixed hay) reflected by the county yield that is reported. Circular 1156 was updated by the University of Illinois in September 1985 (Alexander 1985) providing a more exact listing of new soil series, complexes, and older soil series no longer correlated in Illinois. This revision alleviated the concerns of coal companies that yields for some soil series were too high or too low.

BACKGROUND

The ALPF (Lohse et al., 1985) involved 7 years of extensive development and testing. Coal mining and industrial leaders, the Soil Conservation Service (SCS), the regulatory authority (Illinois Department of Mines and Minerals), the statistical section of the Federal Crop Reporting Service, environmental groups, and the University of Illinois provided advice in developing the formula. Several different methods were developed and tested until the ALPF emerged as the only formula adequately reflecting management yields, weather conditions, the requirements of Public

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[3]This paper is a summary of 12 different states and their programs for bond release on prime farmlands. The information presented herein does not recommend or endorse one state program over another.

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Law 95-87 [(Sections 510(d)(1), 515(b)(7), 515(b)(19), 519(b)(2), and 519(c)(2)] (Public Law 95-87 1977) and the Federal Rule and Regulations (Federal Register 1979). These sections required that revegetation success shall be determined on the basis of crop production using reference areas or other technical guidance procedures which reflect equivalent or higher yields as unmined lands of the same soil type in the surrounding area under equivalent management practices.

In 1980, Illinois passed Public Act 81-1015 (The Surface Coal Mining Land Conservation and Reclamation Act). Sections 1785.17(b)(8), 1816.116(a)(3)(iii), 1817.116(a)(3)(iii), and 1823.15(2)(iii) became part of the regulations on prime farmland restoration as a result of Illinois receiving primacy on June 1, 1982 (Federal Register 1982). On July 1, 1986, the ALPF became law in Illinois and was incorporated in the rules as Appendix A under sections 1816.116(a)(4) and 1817.116(a)(4) of the Illinois Act (Illinois Register 1986). The formula in its entirety was approved for implementation in Illinois by the Office of Surface Mining Reclamation and Enforcement (OSMRE) in December (Federal Register 1986) with an effective date of January 1, 1987. All concerns over validation of yields, whole fields harvesting, methods of sampling, use of specific crops, and statistical testing were alleviated.

IMPLEMENTATION OF THE FORMULA

With approval of the formula (Illinois Register 1986), IDOA faced a logistical problem of coordinating personnel, equipment, and input from coal companies and soil and water conservation districts (SWCD). The ALPF requires that each county SWCD board having permanent or interim program permits submit annually by August 15 of each year a listing of every soil mapping unit in their county, the total acres mapped, and the percentage of total acres in crop production. The crop production percentage must include all row crops (small grains, corn, sorghum, and mixed hay), but must exclude wetlands, wildlife, and timber areas in this percentage. Letters requesting this information are mailed each year as a reminder to all county SWCD boar chairpersons and carbon copied to the District Conservationist (SCS) in each county having active or inactive coal mining affected by the ALPF. Additionally, the information submitted by the county SWCD must be certified and approved by the county board (SWCD), and the document used as the source of information for the acres figures must be indicated. This information is limited to published modern soil surveys or unpublished modern soil surveys where the final correlation is completed and approved by SCS, Bulletin 735 (Runge et al., 1969), or the most recent update of the SCS Conservation Needs Inventory. The Conservation Needs Inventory may include LESA (Land Evaluation and Site Assessment) done under the SCS Farmland Protection Policy (Federal Register 1984).

In addition to SWCD requirements, by February 15 of each year, individual coal companies must submit initial requests for areas and acres to be tested with the ALPF. The coal companies have until July 15 of each year to amend the initial request. However, any changes to the initial request must be approved by the regulatory authority (RA) in concurrence with IDOA.

The information submitted by coal companies must include the following information:

(1) An aerial photo of the fields to be sampled within the permit area on a scale of 1"-500' or larger,
(2) Name of the coal company and the mine,
(3) Permit number,
(4) Crops to be grown within specific field boundaries[4],
(5) Inflexible, fixed, specific field boundaries, set up by management units,
(6) Fields identified by a numbering system used at the mine, and
(7) Number of acres in each field.

Crops to be grown using the formula include corn, soybeans, wheat, oats, and mixed hay. Coal companies wishing to use other crops must contact the regulatory authority for approval. Reference areas are the only alternative for crops not covered by Circular 1156 (Fehrenbacher et al., 1978). Specific approval must be obtained from the regulatory authority to use mixed hay as a crop in the formula. Also, corn must be grown on all cropland a minimum of one year for proof of productivity. Corn was added as a required crop in Illinois because of its historical importance.

Following submittal of sampling areas by individual coal companies, IDOA will digitize all sample fields, determine the exact number of acres in each field, and randomly generate sampling points for crops specified by the coal companies and the formula. Fields of 4 acres or less will be sampled in their entirety, with yields verified by IDOA personnel. Areas to be excluded from the acreage figure in each field include SCS approved conservation practices

[4]Field boundaries, as used in the formula, are defined by the reclamation technique and topographical factors. Field boundaries are subject to regulatory approval. Illinois also requires the responsibility period to start over if boundaries are shifted, but provided an exception for minor adjustments which will not affect the validity of the productivity sampling results.

such as grassed waterways and terraces which will not be cropped. Sample numbers may be increased by the individual doing the sampling to correct the following conditions:

(1) Potential problems only visible in the field at time of harvest,
(2) Operator requests for additional sample points for specific fields,
(3) The use of different hybrids in one field,
(4) Contour changes within one field which would alter the yield, and
(5) Indications of high variation in yields (coefficient of variation greater than 15% has been established for the field).

Additionally, IDOA will be responsible for scheduling personnel for specific field sampling of individual crops. No one state or federal agency has enough personnel to handle all requests for crop sampling at one time, particularly when two or more crops such as mixed hay and winter wheat need to be sampled at the same time. Sampling will be done using the methodology published in the ALPF (Lohse et al., 1985), and an addendum added after the 1985 cropping season.

Agreements of understanding have been singed between IDOA and SWCD resource conservationists (RC) in 18 of the 31 counties in the Illinois coal mining program. Most of the counties without RC agreements are located in counties having only underground mines where reclamation will occur sometime in the future. The Department is pursuing the use of National Association of State Departments of Agriculture (NASDA) personnel under contractual services to IDOA to handle a major portion of crop sampling and laboratory analyses (determination of percent moisture, weighing, and sample thrashing or shelling). NASDA personnel are currently used to layout sample plots and make counts used by the Illinois Agricultural Statistics Service to derive crop yields for state estimates.

In 1987, IDOA will begin monitoring reference fields in the northern, central, and southern mining districts of Illinois as a check against the formula. Actual yields harvested by farmers will be compared to the theoretical yield of the ALPF to determine how closely the formula predicts yields from unmined soil types.

Data collected from each mine, by permit number, will be tabulated annually by IDOA. Copies of harvest yields and an average of individual fields will be summarized and mailed to both the RA and the mining company for each crop harvested. Following the computer generation of the formula for individual counties, the harvest yields from the mines, by permit number, will be tabulated and compared (field data vs formula). Results of the comparison will be entered in Tables 1 and 2. Table 1 summarizes how the data are tabulated by soil series and soil type by mine permit number for both prime and high capability lands (see Table 3 for comparison) and apportions the yield from the formula to reflect 100% or 90% productivity standards (Table 2).

Table 2 will be used to display tabulated field data within a permit area and corrected IDOA sampling data for harvest loss. Evaluation of the information in Table 2 will indicate whether or not the productivity standard has been met for each field or crop. The RA will use a simple 1-tailed t-test to statistically verify whether the crop yield has met the projected yield standard at a 90%

Table 1. Summary of yield tabulations from the ALPF by soil series.

County: Perry
Mine Company: ABC
Mine Name: XYZ
Permit Number: 000
Cropping Year: 1985
Prime or High Capability Lands: Prime

Soil Name	Soil Mapping Unit	Acres	Percent of Unit	Projected Yields					Weighted Final Yields				
				Corn	Soy-beans	Wheat	Oats	Mixed Hay	Corn	Soy-beans	Wheat	Oats	Mixed Hay
				bu/acre				T/acre	bu/acre				T/acre
Cisne	2	6	10.34	96	31	41	0	2.8	9.93	3.20	4.24	0	0.290
Hoyleton	3B	1	1.73	96	30	41	0	2.9	1.66	0.52	0.71	0	0.050
Oconee	113A	47	81.03	100	32	42	0	3.1	81.03	25.93	34.03	0	2.512
Stoy	164B	3	5.17	93	31	40	0	2.8	4.81	1.60	2.07	0	0.145
Belknap	382	1	1.73	103	34	42	66	2.9	1.78	0.59	0.73	-	0.050
							Total Yield		99.21	31.84	41.78	-	3.047
							90% of Total		89.29	28.12	37.60	-	2.743

Table 2. Comparison of yields from individual fields harvested and the ALPF (Table 1) for bond release credits.

County: Perry
Mine Company: ABC
Mine Name: XYZ
Permit Number: 000
Cropping Year: 1985
Prime or High Capability Lands: Prime

	Crops									
	Corn	Soybeans	Wheat	Oats	Mixed Hay	Corn	Soy-beans	Wheat	Oats	Mixed Hay
	bu/acre				T/acre					
Total Yield Per Formula	99.21	31.84	41.78	--	3.047					
90% of Total	89.29	28.12	37.60	--	2.743					
Harvest Loss	3.8	2.49	1.32	NA	NA					
Field	Yields									
Number	T N	T N	T N		T N	Productivity Standard Met (Yes/No)				
1					3.01					Yes
2			42.41 41.09					Yes		
3		37.50 35.01					Yes			
4	30.8 27.0					No				

T=Total, N=Net

Table 3. Comparison of prime farmland and high capability lands reclamation standards and yield requirements.

Standard	Prime Farmlands	High Capability Lands
Definition	Meets the requirements of Public Law 95-87. Applies to both Interim and Permanent program permits.*	Contains all Class I, II, and III lands plus Class IV lands with less than 5% slope. High capability lands include prime farmland, grandfathered, and negative determination lands.
Minimum depth of topsoil and subsoil	48 inches	48 inches
Minimum depth of topsoil	6 inches	8 inches
Rock requirement	No greater than amount originally present before mining	20% by volume no greater than 10 inches in diameter
Clay content	No greater than amount originally present before mining	No greater than 40% by weight
Sand content	No greater than amount originally present before mining	No greater than 60% by weight when the clay content is less than 20% by weight
Productivity restoration requirements		
A. Years required to prove productivity for bond release	3 years within a 10 year window	2 years within a 10 year window
B. Pre-mining yield requirement		*see footnote 6
1. Interim program	100%	
2. Permanent program	100%	

*6 The following information applies to high capability lands:
a) 100% productivity required for all lands grandfathered after July 31, 1982;
b) 90% productivity required for all lands permitted after May 3, 1978 to February 1, 1983 plus grandfathered and negative determination lands permitted before August 1, 1982;
c) Interim program permits include all lands having a post-mining land use of cropland prior to the February 1, 1983 mining date;
d) Permanent program permits include all lands having a post-mining land use of cropland or permanent pasture mined after February 1, 1983.

confidence limit. Confidence limits for the population mean will be determined from the individual sample points in each field (ie, $\bar{X}-t_{\alpha}s_{\bar{X}} \leq \mu \leq \bar{X}+t_{\alpha}s_{\bar{X}}$).

Bond release credits toward the 3 years (prime farmland) or 2 years (high capability lands) within a "10 year window"[5] will be maintained by the regulatory authority. Data accumulation for individual mining companies will be collected and maintained by both the RA and IDOA.

With the checks and balances between the RA and IDOA, the mining company will know whether or not the bond release requirements have been met, whether problems exist within individual fields (such as the need to alleviate subsurface compaction or add conservation practices), and whether outside agencies (universities or SCS) should be contacted to research and solve soil problems in a given area.

The decision for final bond release (phase II) based on the productivity standard, as defined by the ALPF, rests with the regulatory authority.

OTHER PRIME FARMLAND RECLAMATION EVALUATION METHODS

Due to several reasons too extensive to discuss within the objectives of this paper, coal mining state regulatory authorities used a variety of methods to evaluate prime farmland reclamation for reclamation bond release purposes. Each method has advantages and disadvantages from region to region and even mine to mine. The following is a summary of the prime farmland permanent program revegetation reclamation bond release procedures of 11 states. Some states containing prime farmlands are not addressed in this review because prime farmlands have not been mined. In other cases, the farmlands that were mined (or will be mined) did not meet the 5 of 10 years land use requirements and, therefore, do not qualify as prime farmlands. Initial program bond release procedures were not addressed in this review.

Iowa

The farmlands permitted to be mined under the Iowa permanent program were not cropped for the required 5 of the last 10 years immediately before permitting, leasing or acquisition for coal mining and, therefore, were not classified as prime farmlands. However, Iowa has released prime farmlands reclamation bonds under the initial program.

Indiana

The Indiana regulatory authority (RA) allows two methods to evaluate prime farmland reclamation: (1) Estimated crop yields (target yields) adopted from the USDA Soil Conservation Service (SCS) adjusted by soil series and county, and (2) crop reference areas. Vegetation sampling procedures are approved at the time of original mine permitting. Indiana allows the use of "test plots" whereby only parts (test plots) of a larger prime farmland bond release area is planted to the crop(s) designated in the approved mine plan. Each operator has an option to plant all or parts of the bond release area (as approved by the RA) to the designated crop(s). In both cases, the RA allows either 100 percent harvest of the area (test areas included) or harvest estimates based on random sampling. Indiana accepts "weight ticket" in recording crop yields on croplands. Weight estimates of improperly dried hay are not accepted. In the case of haylands, if all hay bales are not to be weighed, a minimum sample of 10 percent of the total bales harvested must be weighed and reported. The bales weighed must be selected in a random manner.

Kansas

Kansas allows the use of both technical standards and reference areas in evaluating prime farmland reclamation success. However, it encourages the use of technical standards and discourages the use of reference areas. The RA has adopted SCS yield estimates by soil series based on county soil surveys. Recently, the SCS reevaluated its Kansas yield estimates for income tax purposes and as a by-product produced what appear to be every accurate and realistic yield estimates for mine reclamation purposes. Vegetation sampling and analysis procedures are approved at the time of mine permit issuance. Kansas allows the use of test plots on prime farmlands. Mine operators have an option of 100 percent crop harvest or randomized sampling yield estimation; however, in the case of hay yield estimates, randomized sampling is required. Hayland yield estimates based on 100 percent harvest will not be accepted as the sole basis of prime farmland bond releases. Kansas requires that all crop yields be either brought to standard moisture content or estimates corrected to estimated standard

[5] 10 year window: Successful years which occur at intervals of 11 or more years will not satisfy the requirement for bond release. The definition for proof of productivity has been further restricted by allowing only one of the successful years to fall within the first four years following the start of the responsibility period. The regulatory authority has also required that the responsibility period begin within 10 years of final grading.

yield estimates. Currently, the Kansas RA does not adjust target yields based on weather changes. Although Kansas does not have formal farmland yield sampling and data analysis guidelines for its operators, it does provide mine operators with references to accepted sampling techniques and data analysis methods. Kansas operators are testing many cropland yield estimation methods being applied in other states. The Kansas RA will evaluate the results of these informal tests and use this information in selecting the methods that are most effective in Kansas.

Kentucky

The Kentucky RA has adopted estimated crop yields from the SCS adjusted by soil series and by county. One year before proposed sampling, each mine operator must propose a crop yield sampling plan to the RA and receive RA approval of proposed yield estimation procedures. The operator must notify the RA of the actual harvest date before harvest thus allowing the RA the option of examining the site before harvest. Kentucky allows the planting of an entire area to crops or the planting of test plots within a greater prime farmland bond release area. In either case, the operator can elect to harvest 100 percent of the field or test plot or random sample plots and estimate yields. The RA allows the SCS "target yields" to be adjusted due to weather changes, but limits the adjustments to a maximum of 15 percent of the target yields. Kentucky does not have formal procedures describing how sampling should be conducted, samples processed, and data analyzed.

Louisiana

Louisiana regulates a very large, new surface mine using in-house technical staff as well as experts from the Agronomy Department of Louisiana State University. Only small areas of prime farmlands exist within the 40-year life-of-mine permit. Prime farmlands have not been mined to date and prime farmland mining will not occur in the near future. Louisiana has adequate time to consider cropland bond release procedures. Louisiana has received and is evaluating bond release procedures from other state regulatory authorities and is cooperation with Louisiana State University, the SCS, and other agencies in preparing cropland bond release procedures.

Missouri

Missouri has prepared a formal reclamation bond release revegetation policy describing how bonds on all mined lands, prime farmlands included, will be released. The Missouri RA has determined that (1) Persinger's soil productivity index, (2) Scrivner's soil productivity index, (3) USDA Agricultural Stabilization and Conservation Service (ASCS) yield records from local farms, and (4) Missouri Crop and Livestock Reporting Service average county yields are not acceptable standards for mine reclamation bond release purposes. Missouri will allow the use of technical standards, but reserves approval of future standards based on future research activities. Considering the rejection of the four standards, crop production on reclaimed croplands will be compared to crop production on approved reference areas until future technical standards are approved. The RA approves yields estimation procedures at the time of original permitting. Any change in standards after a permit application is approved is considered a major permit revision only if a mine operator proposes a standard not previously sanctioned by the RA. The Missouri policy document (dated August 22, 1985) is in effect a thorough and comprehensive guideline to mine operations on reference area selection, technical standards, sampling methods, documentation of procedures, yield moisture content requirements, sample randomization, recommended statistical analysis procedures, and example calculations.

North Dakota

North Dakota (ND) has adopted SCS yield estimates by soil series and adjusted the estimates by county based on USDA Statistical Reporting Service information. The ND RA also accepts the use of reference areas in evaluating cropland reclamation success. The RA approves all crop yield sampling procedures at the time the original permit is approved. ND both allows the use of test plots and allows its operators an option of 100 percent harvest or random sampling estimation as approved in the mine plan. ND accepts weight tickets as verification of crop production. The ND RA will adjust crop target yields based on weather changes and USDA Statistical Reporting Service information. ND has prepared formal draft guidelines intended for the use of its operators in proposing and conducting yield estimation. ND will soon prepare final guidelines.

Ohio

Ohio does not accept the use of reference areas in evaluation of cropland reclamation. The RA has adopted SCS state-wide production estimates by soil series. Adjustments of crop production by county are not made. The operator receives approval of the crop yield sampling plan at the time of original permitting. Each operator must notify the Ohio RA of intent to harvest crops at least 5 days before harvest. The entire prime farmland bond release area must be planted to the crop(s) designated in the approved mine plan. Each operator has an option (as approved in the mine plan) of 100 percent harvest of an entire field or harvest of randomized plots. The Ohio RA

will accept weight tickets as verification of production. The RA provides other verification options to its operators: (1) The Ohio RA will sample production and verify an operator's estimates; (2) The RA will accept production estimation results verified by "certified agronomists"; or (3) The RA will review the qualifications of technical specialists proposed to conduct the sampling and analyses and approve qualifications on a case-by-case basis. Ohio will adjust target yields given the concurrence of the SCS.

Oklahoma

Oklahoma will accept technical standards based upon local county soil surveys or other approved technical standards. Oklahoma has developed a formal reclamation bond release policy. Although that policy does not prohibit the use of reference areas in releasing cropland performance bond, neither does it promote their use. The crop sampling and analysis procedures are approved at the time of approval of the original mine permit application. The RA does not allow the use of test plots, but does allow either 100 percent harvest or random sampling yield estimation. Production verification through the use of weight tickets is allowed. The RA will allow target yields to be adjusted based on weather changes. Most Oklahoma prime soils in the coal fields of eastern Oklahoma have not been planted to crop for 5 of the last 10 years immediately before permitting, leasing, or acquisition for coal mining. Therefore, very few prime farmland permanent program mine permits have been issued. Consequently, Oklahoma's rather comprehensive formal guidelines emphasize non-cropland land uses.

Pennsylvania

Pennsylvania does not accept the use of reference areas; it has adopted SCS yield estimates by soil series by county. Proposed crop yield measurement techniques and data analysis methods are approved at the time of approval of the original mine permit application. Crops selected to demonstrate the reclamation of prime farmlands are selected from crops commonly grown in the area surrounding the mines. The Pennsylvania RA has determined that hayland land uses dominate the cropland land uses in the coal fields of Pennsylvania. Therefore, hay will be planted as the test crop on most mined prime farmlands in Pennsylvania. Crop production must be reported for prime farmlands with cropland post-mining land uses, otherwise production will be interpreted by correlation with ground cover and soil characteristics. The RA has prepared formal procedures on advising operators on how to sample and evaluate vegetative ground cover.

Texas

The farmlands permitted under the Texas permanent program have not been cropped for the required 5 of the last 10 years immediately before permitting, leasing, or acquisition for coal mining purposes and, therefore, were not classified as prime farmlands. Consequently, permanent program cropland bond release procedures are not current issues in Texas.

Conclusion

The bond release methods addressed in this paper are dominantly permanent program methods. Considering that most state permanent programs started in 1981 and 1982, and that at least 5 years would have elapsed after a permanent program permit area would have been mined, very few permanent program prime farmland phase II and phase III bond release applications have been processed to date. This is a new and complicated subject area both in degree of land reclamation required and complexity of bond release evaluations applied. The methods addressed in this paper are diverse. Very soon, these bond release evaluation methods will face the test of time, their attributes and limitations to be displayed. The diversity of the methods available provides the mine reclamation community an opportunity to evaluate the suitability of these diverse methods in providing realistic and accurate information in making critical bond release decisions. Researchers would well serve the mine reclamation community by studying the applications of these evaluation methods and regularly reporting their results so that regulatory authorities, mine operators, and interested citizens can select bond release evaluation methods that best meet mining and reclamation conditions within a given region, state, or county.

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