PHASES II/III
REVEGETATION SUCCESS STANDARDS FOR PRIME FARMLAND

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PRIME FARMLAND

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I. Introduction

This policy describes the criteria and procedures for determining Phase II/III success standards for areas being restored to prime farmland.

Pursuant to Arkansas Surface Coal Mining and Reclamation Code (ASCMRC) Section 823.15, ground cover and soil productivity success of revegetation on prime farmland, shall be determined on the basis of crop production.

The permittee is responsible for determining and measuring production and submitting this data to the Director for evaluation. Procedures for making these determinations are described in this document.

II. Success Standards and Measurement Frequency

A. General Revegetation Requirement for Ground Cover

1. Following prime farmland soil replacement, the soil surface shall be stabilized with a vegetative cover or other means that effectively controls soil loss by wind and water erosion.

2. Ground cover shall consist of the species or species mixture which has been approved in the permit or other acceptable practice as recommended by the USDA Natural Resources Conservation Service (NRCS) for use in that area. Other acceptable practices will require the approval of a revision to the permit. Examples of some acceptable plant species are listed in Appendix L.

B. Crop Production on Prime Farmland

1. The success standard for prime farmland shall be determined on the basis of crop production. Crop production shall be considered acceptable if it is one hundred percent (100%) of the approved success standard at a ninety percent (90%) statistical confidence level for any three of the last four years of the five (5) year responsibility period.

2. Crop production on prime farmland shall be measured by one of the following methods:

a. Randomly selected representative samples, ref; Appendices A, B, E, F, I, & K.

b. Whole site harvest, ref; Appendices C, G, H, I, J, & K.

c. Representative test plots, ref; Appendices A, B, C, E, G, H, I, J & K.

C. Selection of Success Standard

4. The reference crops chosen must consist of forages and/or row crops commonly grown in the area. A hay crop may be used twice. The reference crops chosen shall be selected from crops that are commonly grown on prime farmland. If row crops are the dominant crops grown in the area, then the crop with the greatest rooting depth shall be chosen as one (1) of the reference crops for one (1) of the three years.

   If hay is used for two (2) of the three cropping years, the county NRCS must verify that hay crops are commonly grown on prime farmland in that county. The row crop selected must be verified by the NRCS as the most commonly grown crop with the greatest rooting depth. This verification will be done when the plan is approved by the Director.

5. The sampling techniques shall use a 90% statistical confidence interval (i.e., one sided test with a .10 alpha error).

6. Whenever production is equal to or exceeds the success standard, the statistical confidence interval test does not have to be performed.

7. Areas selected for the success standard or reference area for production shall;

   a. consist of similar plant species and diversity as approved in the permit.

   b. currently be managed under the same land use designation as the proposed mined release area.

   c. consist of soils of the same or similar texture, slope phase, similar soil series, and be in the same land capability class.

   d. the test site and reference area must all receive the same high level of management using acceptable approved practices common to the area.

   e. be located in the general vicinity to the mined test area to minimize weather variations.

8. If the operator does not plan to use a reference area, then the success standard shall be the predicted average yield per acre for the prime farmland soil found in the NRCS soil survey for the county in which the mine is located. The NRCS shall be notified at the time of permit submittal of the area to be mined and if updated soil productivity values

are available then these values shall be used for the standard of success. This yield data may be adjusted with the concurrence of the NRCS for

a. Disease, pest, and weather induced seasonal variation

b. Difference in specific management practices where the overall management practices of the crop being compared are equivalent.

III. Sampling Procedures

A. Random Sampling

1. To assure that the samples truly represent the vegetative characteristics of the whole release and reference area, the permittee must use methods that will provide 1) a random selection of sampling sites, 2) a sampling technique unaffected by the sampler's preference, and 3) sufficient samples to represent the true mean of the vegetation characteristics.

2. Sampling points shall be randomly located by using a grid overlay on a map of the release or reference area and by choosing horizontal and vertical coordinates as described in Appendix A. Each sample point must fall within the release or reference area boundaries and be within an area having the vegetative cover type being measured. ADDITIONALLY, AT LEAST ONE SAMPLE POINT MUST BE MEASURED IN EACH NONCONTIGUOUS PARCEL OF THE RELEASE AREA.

3. The permittee shall notify the Director ten (10) days prior to conducting sampling or other harvesting operations to allow a representative from the State an opportunity to monitor the sampling procedures.

B. Sampling Techniques

1. Sampling Frames (Forage Production)

A sampling frame shall be an enclosure measuring two square feet capable of enclosing the sample location. A sample location shall be established at each of the randomly chosen sites, such that the center of the sampling frame is the random point. The permittee shall clip all the biomass within the sampling frame 2" above ground level. The biomass to be clipped shall be from all plant species growth whose base lies within the sampling frame. This biomass shall then be weighed and recorded. As each frame is clipped and weighed, the biomass shall be put into a bag for later oven drying. Samples shall be oven dried to a constant weight and reweighed to determine dried weight. All data collected

from the clippings within the sampling frame shall be recorded in the format presented in Appendix B.

2. Whole Area Harvesting or Representative Test Plot Harvesting (Forage Production or Row Crops)

If whole release area harvesting is chosen as the method for data collection, the entire area or representative test plots shall be harvested and the system as outlined in Appendices C, G, H and I shall be used for data analysis. This entails counting all bales produced on the areas and multiplying this number by the average weight of a randomly selected number of bales. The number of bales to count and weigh for any site would consist of ten (10) percent, or fifteen (15) large round bales, whichever is greater; or ten (10) percent or fifteen (15) small round bales whichever is greater and converted to lbs/ac by taking their average weight and multiplying that figure times the total number of bales, divided by the number of acres harvested.

To determine which bales to weigh, randomly select a number from one to ten then count and weigh every tenth (10th) bale thereafter until the minimum number or 10% of the bales have been weighed. The first and last bale of any noncontiguous field or site should not be weighed. The bales shall be counted, but if the random number falls on either of the two bales mentioned, either advance one bale or select the immediate bale previous to the last bale produced.

If row crops are being used, the entire test plot shall be harvested. The same statistical analysis procedure described in appendix H shall be followed.

Refer to appendix G, H, and I for hay production. Refer to appendix C, H, and I for row crop production.

3. Manual Sampling on Row Crops

If weather conditions or other factors prevent mechanical harvesting, the Director may approve a manual sampling method for row crops. Generally, this will involve harvesting a statistically adequate number of randomly chosen measured row lengths on the reference plot and the test plot. Operators will not be allowed to use this system without the Director's prior approval. Testing procedures as described in Appendix M will be followed in this sampling method. See attached Appendix M.

C. Establishment of Representative Test Plots

The permittee may establish and harvest test plots to prove productivity if the permittee can demonstrate that the test plot statistically represents the prime farmland areas in

the Phase II/III release area of which it is a part. Representative test plots may not represent more than 400 acres.

This can be demonstrated as follows:

Step 1 - Finding Statistically Representative Plots

1. In order for this system to be used, all the prime farmland areas which are being considered for release must be in grass/legumes.

2. After 12 months have elapsed of the five-year responsibility period, the entire prime farmland area shall be sampled for hay production using the sample frame procedure. A statistically adequate number of samples must be taken over the entire prime farmland area, as outlined in Appendices A and E.

1. Additionally, several sub areas of the prime farmland shall be chosen as possible candidates for the representative test plots. These sub areas must consist of a minimum of three (3) plots, no smaller than one (1) acre each and total at least 5 percent of the entire prime farmland acres or a combined total of 4 acres, whichever is greater, of the area for which Phase II/III release is desired. These areas shall also be sampled using the sample frame method and a statistically adequate number of samples at a 0.1 alpha level.

4. Then, the data from the sample frame procedure of the <u>entire</u> prime farmland area shall be statistically compared to the chosen subplots using a t-test to determine, if the subplots are <u>truly representative</u> of the entire prime farmland area. If the first chosen subplot fails the test, the next chosen subplot shall be compared, and so on, until the required number of plots are found that have statistically equal production to the entire prime farmland area. Variation of the subplots should not vary 10% more or less than the entire prime farmland area being considered representative of the release area. It is suggested that enough subplots be chosen as prospective test plots to guarantee there will be adequate acreage to statistically represent production equal to the entire prime farmland area.

Step 2 - Use of the Test Plots

A. Once statistically representative test plots have been chosen, they shall become the test plots which will

represent all the prime farmland in a particular bond release.

B. Where row crops such as corn, soybeans, or milo are the dominant crops grown on prime farmland in the area, the row crop requiring the greatest rooting depth shall be chosen as one (1) of the reference crops for one (1) of the three years. The State will consult with the county USDA/NRCS in which the site is located to determine which of the three row crops is more commonly grown in their area.

The level of management on the reclaimed area must be the same as the level of management on the area used to establish the success standard.

C. At harvest, the yields from the test plots shall be compared to the yields from the reference area to determine if the test plot yields are equal to or greater than the yield on the unmined prime farmland reference area. If the yield from the test plots is not greater than the yield of the reference area, then a statistical confidence interval test will need to be determined. An example is given in Appendix H. The yield data from the test plots and reference area shall be recorded on a form as outlined in Appendix C and G.

D. Reference Areas

Reference areas must be representative of soils, slope, aspect, and vegetation in the premined permit area. However, in cases where differences exist because of the mixing of several soil series on the reclaimed area or unavailability of a reference area as herein described, yields must be adjusted as outlined in Appendix I. For ease of calculation, this adjustment shall always be made to the reference area yield.

REFERENCE AREA CROPS MUST BE UNDER THE SAME MANAGEMENT AS CROPS IN THE RECLAIMED PRIME FARMLAND AREA. This means:

- the same seed, fertilizer, and pest management techniques shall be used;

- fertilizer rates shall be based on the same yield goal;

- the same tillage methods shall be used for seedbed preparation;

- the same, planting and harvest dates, row spacing, and plant populations shall be used; and

- any other commonly used management techniques not listed

above such as adequate weed and insect control may be used provided the prime farmland test sites and/or test plots, and the reference area are treated identically. Reference areas shall consist of a single plot (whole plot) at least four (4) acres in size. Either statistically adequate subsampling or whole plot harvesting may be used to determine yields. All reference areas must have prior approval from the Director before production data can be used.

Reference area crop yields must be reasonably comparable to the county average for the given crop. Reference yields which are less than eighty percent (80%) of the county average are highly suspect and may be rejected.

Reference areas may be used as a standard for several mines or bond release areas in the vicinity, with prior approval of the Director. Reference areas may be located on undisturbed acreage within permitted areas. If not so located, the permittee must obtain from the landowner(s) a written agreement allowing use of the property as a reference area and allowing right of entry for regulatory personnel.

When release areas and reference plots fall on different soil series, adjustments must be made to compensate for the productivity difference. The NRCS county soil series predicted average yield shall be used for this purpose. For ease of calculation, this adjustment shall always be made to the reference area yield. EACH REFERENCE PLOT SAMPLING FRAME OR WHOLE FIELD REFERENCE PLOT YIELD MUST BE ADJUSTED BEFORE YIELD COMPARISON OR T-TEST STATISTICS MAY BE CALCULATED. See Appendix I.

E. Other Requirements for Productivity Testing on Prime Farmland.

Crops chosen for proving productivity on prime farmland must:

- be selected from crops commonly grown in the county. If row crops are the most common crops in the county, corn, soybeans, or milo shall be chosen for one of the three years as one of the reference crops.

- be fertilized and topdressed according to soil tests;

- be comprised of certified seed, preferably a cultivar which is resistant to common crop specific diseases (e.g., Phytophora root rot on soybeans).

- be properly inoculated with appropriate rhizobia. Herbaceous crops must be an approved grass or grass and

legume mixture;

- receive the same management practices as crops on unmined prime farmland in the surrounding area. This includes proper application and timing of herbicides and insecticides in general use in the surrounding area;

- have crop yields adjusted for moisture (Appendix C or J). Moisture content shall be documented by the individual performing the test and the method used shall be identified. Furthermore, all crop yields must be verified by an individual who is knowledgeable of agronomic practices but is not directly affiliated with the mining company. An affidavit, which must be signed by the individual verifying crop yields, must accompany any submitted yield data. (See attached "Crop Surveyor's Affidavit of Qualifications" form, Appendix K)

All mechanically harvested row crop yield data must be accompanied by:

- a weight ticket from a government certified scale, which includes the name of the scale operator;

- a completed Crop Surveyor Affidavit as shown in Appendix K;

- a statement of the crop moisture content, the system used to make that determination, and the name of the operator;

- copies of the soil amendment test reports and amounts of amendments applied.

IV. Data Submission and Analysis

If the data shows that production success has been met, the permittee shall submit the data to the Director for review in the format shown in Appendices B, C, and G.

When the data indicates that the average crop or average forage production was insufficient, but close to the standards, the permittee may submit the data to the Director to determine if the production was acceptable when statistically compared to the standards using a t test at a 90-percent statistical confidence interval. (See Appendices F and H.)

Remember, row crop and raw sampling frame yield data from reclaimed (mined) areas and reference areas must both be adjusted for moisture. Appendix J. The same data from reference areas must then be adjusted by the NRCS Productivity Adjustment, Appendix I, before statistical comparisons can be made.

V. Maps

A. Whenever a new Phase II/III plan is submitted to the Director, it must be accompanied by maps showing:

1. the location of the area covered by the plan (i.e., the area proposed for release);

2. the location of test and reference areas; and

3. all permit boundaries.

B. Whenever data from a previously approved plan is submitted to the Director, it must be accompanied by maps showing:

1. the location of test and reference areas;

2. the location of <u>each transect and sample frame point</u>;

3. the area covered by the sampling; and

4. all permit boundaries.

VI. Mitigation Plan

Productivity must "pass" at least two sampling years by the fifth year; and three sampling years by the sixth year. If productivity is not achieved by these dates, the permittee must submit a mitigation plan to the Director which includes the following:

A. a statement outlining the problem;

B. a discussion of what practices, beyond normal farming practices, the operator intends to use to enable the area to finally meet the release standards; and

C. a new Phase II/III liability release plan.

If renovation, soil substitution, or any other practice which constitutes augmentation is employed, the five-year responsibility period shall restart when the mitigation plan is approved and the practices are completed.

APPENDIX A

Selection of Random Sampling Sites

The permittee shall use X and Y grid coordinates in establishing the location of sampling sites on the reclaimed area (and on the reference area, if a reference area standard is used).

A grid shall be placed or drawn on the map containing the areas to be sampled. The grid must be large enough so that all of the release or reference area is covered by the grid (see drawing in Figure 1). Also, the grid pattern shall be such that the axes are 200 feet apart or closer.

The X and Y axes shall be numbered in consecutive order beginning at the extreme lower left point of the grid (this point being 1).

The permittee shall generate random number pairs for each X and Y axis combination needed. For example, if five (5) sampling locations are to be established, the permittee must generate five (5) random number pairs.

The random numbers table shown in Table 1 may be used to choose the numbers needed. The table is used as follows:

Step 1) Choose an axis to work on (X or Y).

Step 2) Flip a coin twice to determine a column on which to start (refer to coin flip combinations at the head of each column).

Step 3) By beginning at the top of the column selected, begin reviewing the numbers until a number that falls within the range of those on the chosen grid axis is found. If the range of numbers on the axis is less than 10, then you will only review the last digit of the numbers in the column. If the range of numbers is more than 10 but less than 100, then the last <u>two</u> digits will be reviewed.

Step 4) Record the first number found.

Step 5) Beginning after the last number found, continue down the column until another number is located within the given range. Record this number and continue following the above procedure until the required amount of numbers is found and recorded. If you reach the bottom of the column before you locate enough numbers, proceed to one of the adjacent columns, starting again at the top. When all columns have been used, begin again with the first column used, except review only the <u>first</u> (instead of the last) one or two digits of the numbers in the column.

Step 6) After enough numbers are generated for the first axis chosen, restart the process at Step 1 for the other axis. After enough random number pairs have been generated for each axis, locate the sample points on the grid. If a point(s) falls outside the release or reference area, a new point(s) must be chosen as explained above.

APPENDIX A

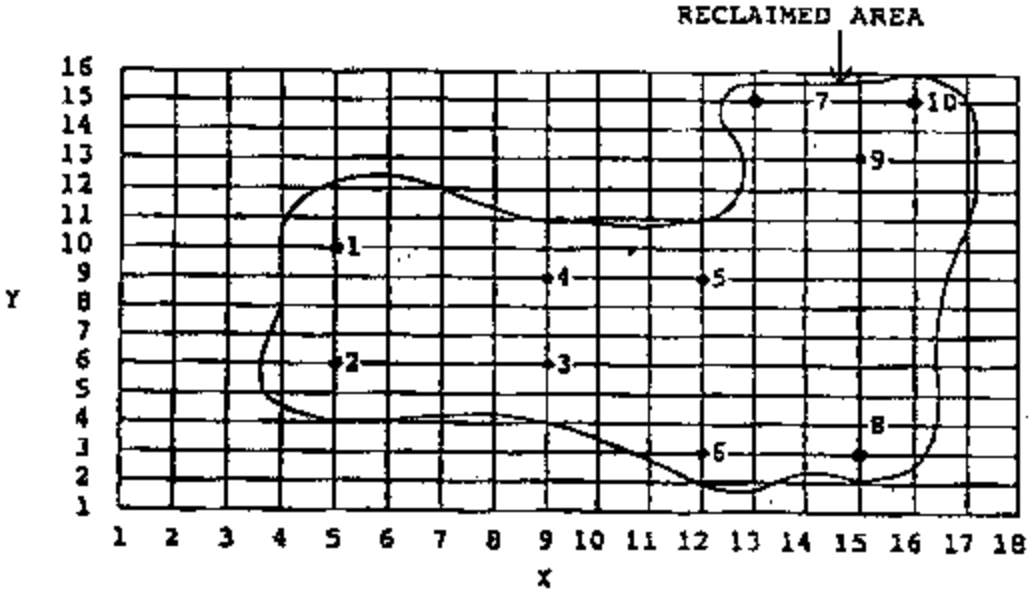
Table 1
A Set of Random Numbers

Heads/Heads Column 1	Tails/Ta ils Column 2	Heads/Tails Column 3	Tails/He ads Column 4
6327	0983	3798	4679
2167	6484	9467	9058
3939	0407	1804	8827
4672	3865	5689	9878
8071	5185	5514	5008
9509	0603	7461	8550
6615	2588	3558	3349
4833	2422	9790	1183
5594	1809	6931	6571
9441	1699	3947	7702
7922	9812	7229	5252
9419	6494	8179	8065
6178	3556	2466	2495
2647	3961	7546	4799
0474	1839	6926	6534
9814	1577	8293	0301
0104	4579	0627	8667
1608	9470	4131	5345
9722	1557	0471	5498
4189	3582	3675	9461
9855	8088	9006	6897
5791	8234	1472	3421
0872	3310	0510	9046
8953	9809	8037	8376
2895	4319	6544	8953
0609	5248	8734	2498
0795	2464	6170	1063
1572	7371	7936	2841
4307	0294	6060	5194
4857	0197	2401	7005
1632	7189	6463	9830
0745	8034	7882	7152
0736	5110	5165	6571
8168	7924	5876	1407
7468	5313	2736	9010
6044	5420	3077	9070
6716	0059	3001	8871
9342	0169	6880	7986
5809	6048	9051	1151
1532	9715	7081	0109
5506	5812	5917	4415
4045	1751	2817	9958
5966	9930	6437	7279
6062	3296	5093	2503
4097	8379	5670	0614
6793	3999	4645	5143
7960	4853	0583	1920
1321	4067	8503	1604

APPENDIX A
FIGURE 1

RANDOM PLOT LOCATIONS GRID OVERLAY

Random Plot	Random Numbers	
	X	Y
1	5	10
2	5	6
3	9	6
4	9	9
5	12	9
6	12	3
7	13	15
8	15	3
9	15	13
10	16	15



APPENDIX B

(Example of format for summarizing sampling frame data.)

SUMMARY DATA FORM FOR SAMPLING FRAMES

Page ___ of ___

Company Name _____

Check One: |__| Reclaimed Area |__| Reference Area

Permit No. _____) If reference area, indicate permit to which data will be compared.

Land Use _____

Acres in Sampling Area (A) _____

Number of Samples Taken (n) _____

Date of Sampling _____

NRCS Productivity Adjustment Up/Down (Appendix I) _____

Sample Number	Wet Weight in Grams	(Reclaimed Area) Oven Dry Weight in Grams (DW)	(For Reference Areas) NRCS Adjusted Weight/In Grams (ADW)
_____	_____	_____	_____
		$\sum$DW	$\sum$ADW

Reclaimed Area Mean $\bar{x} = \frac{\sum DW}{n} =$ _____

or

Reference Area Mean $\bar{x} = \frac{\sum ADW}{n} =$ _____

APPENDIX C

DATA FORM FOR ROW CROP PRODUCTION DATA

Page _____ of _____

Company Name _____

Check: |__| Reclaimed Area |__| Reference Area

Permit No. _____) If reference area,
) indicate permit to which
) data will be compared.

Land Use _____

Acres in Sampling Area (A) _____

Date of Sampling _____

NRCS Productivity Adjustment Up/Down (Appendix I)_____

Weight Tickets/ Pounds or Bushels Strip No.	Unadjusted Weight or Yield/Acre	(Reclaimed Area) Moisture Adjusted Weight or Yield/Acre	(Reference Areas) NRCS Adjusted Weight or Yield/Acre

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Refer to Appendix J to calculate the yield per acre.

APPENDIX D

t - Table

d.f.	t.100
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
inf.	1.282

Note: for the sample adequacy calculations and 1 tail productivity comparisons, use column t.100.

From "Table of Percentage Points of the t.Distribution." Biometrika, Vol. 32 (1941), p.300. Reproduced by permission of the Biometrika Trustees.

APPENDIX E

Example Use of Sample Adequacy Formula for Hay Production Measurements

In this example, the permittee has taken an initial group of ten (10) randomly located sampling frames. The results of the sampling are as follows:

Frame	Oven Dry Weight per Sampling Frame X	X^2
1	72.2	5,212.84
2	80.0	6,400.00
3	22.0	484.00
4	96.5	9,312.25
5	100.2	10,040.04
6	25.0	625.00
7	81.0	6,561.00
8	96.0	9,216.00
9	100.9	10,180.81
10	51.0	2,601.00
n=10	$'X = 724.8$	$'X^2 = 60,632.94$

1) Now we need to calculate the variance, S^2:

$$S^2 = \frac{'X^2 - \frac{('X)^2}{n}}{n-1}$$

or, put into words:

$$\text{Variance} = \frac{\text{Sum of All SQUARED Values} - \frac{\text{Square of SUM of All Values}}{\text{\# of Frames}}}{\text{(Number of Frames - 1)}}$$

From the data in the above example, we calculate:

$$S^2 = \frac{60{,}632.94 - \frac{(724.8)^2}{10}}{9} = 899.94$$

2) Determining sample adequacy:

From the t table, we find t for a sample size of 10.

n-1 = degrees of freedom

10-1 = 9 degrees of freedom for our example

From the t table, locate the t statistic for 9 degrees of freedom = 1.383

The sample adequacy formula is : $N = \frac{(t^2)(s^2)}{(0.1x)^2}$

Where:

$(0.1\bar{x})^2$ = 10% of mean, squared. 10% of 72.48 = 7.248, so $(7.248)^2 = 52.53$

$\bar{x}$ = the sample mean

N = the number of samples which will need to be taken

t^2 = t.100 table value, squared (See Appendix D)

S^2 = variance

Plugging these values into the sample adequacy formula, we get:

$$N = \frac{(1.383^2)(899.94)}{52.53} = 32.76 = 33 \text{ samples needed}$$

Since we already have taken 10 samples and the sample adequacy formula tells us we need a total of 33, an additional 23 samples will need to be taken.

Now, when the 23 additional samples have been taken, a new variance must be calculated and the sample adequacy formula recalculated. This is to ascertain that the additional samples didn't somehow increase the variance and therefore require still more samples. If this happens, the additional samples must be taken and the variance recalculated to determine sample adequacy.

APPENDIX F

Statistical Analysis on Sampling Frame Data

In performing statistical comparisons for hay production when sample areas are harvested, harvest results of the randomly assigned sample areas will be compared using a t-test to one hundred percent (100%) of the target or reference yield, using a ninety percent (90%) confidence interval. The hypotheses should be set up as follows:

Null hypothesis: Crop yield on release area $\geq$ 100% target yield

Alternate hypothesis: Crop yield on release area < 100% of target yield

There are many computer spreadsheets and statistical programs to run t-tests. If one can not be located, contact the Director.

If NRCS target yield is used as a standard, the tonnage of forage produced must be divided by 21,780 to convert it to sample frame weights.

APPENDIX G

Data Form for Forage Crop Production Data Harvested as Baled Hay

Page___ of ___

Company Name: _____

Reference Area: ~ Test Area: ~

Permit: _____ If reference area, indicate permit to which data will be compared.

Land Use: _____

Acres in Harvested Area: _____ Plot or Area Number:_____

Date Hay was cut:_____ Date Hay was baled:_____

Date Hay was weighted:_____

Number of Bales Harvested (B): _____ Number of Bales Weighed (n): ___

NRCS Productivity Adjustment Up/Down (Appendix I): _____

Bale Weight (x)	Bale Weight (x)	Bale Weight (x)	Bale Weight (x)

Mean ($\bar{x}$) = $\frac{'x}{n}$ = _____

Test-area production per acre = $\frac{\bar{B}x}{A}$ = _____

Reference-area production per acre = $\frac{(NRCS)\bar{B}x}{A}$ = _____

If the test area production per acre is equal to or greater than the reference production per acre, the test passes. If the test area production is less than the reference, the statistical analysis needs to be run. Refer to Appendix H.

APPENDIX H

Statistical Analysis on Whole Release Area Harvesting

In performing statistical comparisons for hay production when a whole field is harvested, the weights of either ten (10) percent or fifteen (15) small bales, whichever is greater; or ten (10) percent or fifteer (15) round bales whichever is greater; are converted to lbs./ac. and compared to one hundred (100) percent of the reference or target yield, using a ninety (90) percent or greater statistical confidence level as approved by the Director in consultation with the NRCS follows:

Null hypothesis: Hay yield on release area $\geq$ 100% of the reference or target yield

Alternate hypothesis: Hay yield on release area < 100% of the reference or target yield

Example: Size of release area: 40 acres
Number of bales harvested: 125
Number of bales weighed: 15

Release Area Harvest Data

NRCS Adjusted Weight Per100% Round Bale (x)	x^2	Reference Area or Target Yield
-lbs-		
1,100	1,210,000	
1,000	1,000,000	3,200 lbs/ac
975	950,625	
900	810,000	
1,000	1,000,000	
1,100	1,210,000	
1,000	1,000,000	
900	810,000	
1,025	1,050,625	
1,000	1,000,000	
875	765,625	
975	950,625	
1,000	1,000,000	
1,100	1,210,000	
1,150	1,322,500	
$'x = 15,100$	$'x^2 = 15,290,000$	

$$\text{Mean } (\bar{x}) = \frac{'x}{n} = \frac{15,100}{15} = 1006.7 \times 125 \div 40 \text{ acres} = 3145.9 = \underline{3146}$$

$$\text{Standard Deviation (s)} = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}} = \sqrt{\frac{15{,}290{,}000 - \frac{228{,}010{,}000}{15{,}100}}{14}}$$

$$= \sqrt{\frac{190{,}000\ n}{14}} = \sqrt{13{,}571.4} = 116.5$$

To determine the t-value, refer to Appendix D.

The degree of freedom is the number of samples minus "1".

We had 15 samples, subtracting 1 = 14.

Fourteen (14) degrees of freedom = 1.345 from column t.100.

Therefore, the formula to calculate t value from the harvest data is:

$$\frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{S^2}{n}}} = \frac{|3{,}146 - 3{,}200|}{\sqrt{\frac{116.5}{15}}} = 1.79$$

Since 1.79 > 1.345, the null hypothesis is rejected. Crop yield data from the test area is not equal to or greater than the yield from the reference area.

APPENDIX I

Yield Adjustments for Release Areas Due to Differing Soil Series

When test plots and reference areas fall on different soil series, adjustments must be made to compensate for the productivity difference. The soil productivity shall be established by the NRCS from a site-specific investigation, or derived from established improved management yields for the type soil(s) in the appropriate Soil Conservation Service (NRCS) County Soil Survey. For ease of calculation, this adjustment shall always be made to the reference area yield.

Example 1: Bermudagrass Pastureland

Consider a case in which there are three soil types (or complexes) on a permit site covering 100 acres in Johnson County. The soils types are Cane fine sandy loam (abbreviated CaB), which covers 40 acres; Leadvale silt loam (LeB), which covers 20 acres; and Leesburg-Enders Association (LBD), which covers 40 acres. The appropriate bermudagrass improved management yields from the soil survey manual are:

Soil Series	Yield in A.U.M.*
CaB	6.0
LeB	6.5
LBD	No yield provided

*A.U.M. - Animal unit months. According to the Range Handbook (1997),one A.U.M. is equal to 790 air-dried pounds of grass per acre.

In those cases such as the LBD soils when no yield figures are available, the potential range production for normal years can be used as a substitute production figure. The LBD is an example of a soil complex composed of two different soils with different range yield potentials. The Leesburg portion has a normal potential range yield of 4,345 pounds per acre while the Enders portion has a normal potential range yield of 3,950 pounds per acre. Since these make up roughly equivalent proportions of the soil complex, the two figures can be averaged to make a yield for the soil as a whole.

Using the information provided above, the soil types can be assumed to have the following bermudagrass productivities and weighting factors based on the percentage of area of the site.

Soil Series	Productivity	Weighting Factor
CaB	4,740 lbs/acre	0.40
LeB	5,135 lbs/acre	0.20
LBD	4,148 lbs/acre	0.40

The technical productivity standard is as follows:

(4,740)(0.40) + (5,135)(0.20) + (4,148)(0.40) =
1,896 + 1,027 + 1,659 = 4,582 pounds per acre

The reference area for this permit is located on a Cane fine sandy loam with a productivity of 4,740 lbs./acre. In this situation, the test plot has a productivity that is 3.3% lower than the reference area; therefore, the reference area yield is adjusted downward by 3.3%.

If the reference area is on the Leeburg-Enders Association, the productivity is 4,148 lbs./acre. In this situation, the test plot has a productivity that is 10.5% higher than the reference area; therefore, the reference area yield is adjusted upward by 10.5%.

APPENDIX J

YIELD ADJUSTMENT FOR MOISTURE

Schedule of adjusted moisture contents for some crops:

Corn	15.5%	at	56 lbs/bushel
Hay	Air dry		
Sorghum	13.0%	at	56 lbs/bushel
Soybeans	13.0%	at	60 lbs/bushel
Wheat	13.5%	at	60 lbs/bushel

$$Ya = \frac{100 - M}{100 - A} \times Y$$

where

M = moisture content of harvested grain determined before drying

A = adjusted moisture content, for example, 15.5% for corn

Y = crop yield before moisture adjustment

Ya = crop yield adjusted for moisture

Example:

Given: 8,000 lbs. of corn from 1.5 acre field, moisture content 22%

To determine adjusted yield: $\frac{100-22}{100-15.5} \times 8{,}000 \text{ lbs.} = 7{,}384.62 \text{ lbs.}$

To determine number of bushels: $\frac{7{,}384.62 \text{ lbs.}}{56 \text{ lbs./bu.}} = 131.87 \text{ bu.}$

To determine bushels per acre: $\frac{131.87 \text{ bu.}}{1.5 \text{ acres}} = 87.91 \text{ bu./acre}$

APPENDIX K

CROP SURVEYOR'S AFFIDAVIT OF QUALIFICATIONS AND CROP PRODUCTION YIELDS

Name _____ Profession _____
Business Address _____
_____ Phone _____

Certification

I have sufficient education and/or experience in agriculture to evaluate crop activities employed in the production of farm crops. I was present during the harvest and I concur with the yield results presented in this report. I am aware that there are significant penalties for submitting false information and making of false statements, representations, or certifications in this document and in attachments to this document.

_____
Signature

STATE OF ARKANSAS)
) SS.
COUNTY OF)

Appeared before me this _____ day of _____, _____ _____, to me known to be the person described in and who executed the foregoing instrument and acknowledged that he/she executed the above as his/her free act and deed.

_____
Notary Public

My Commission Expires:

_____

APPENDIX L

Grasses of acceptable plant species* for permanent ground cover on prime farmland

Warm Season Grasses		**Cool Season Grasses**	
Bahiagrass	Paspalpum notatum	Bluegrass	Poa pratensis Poa compressa
Bermudagrass	Cynodon dactylon	Redtop	Agrostis gigantea
Bluestems	Andropogon L. Schizachyrium scoparium	Orchardgrass	Dactylis glomerata
Buffalograss	Buchloe dactyloades	Fescues	Festuca arundinacea Festuca pratensis
Dallisgrass	Paspalpum dilatatum	Ryegrass	Lolium perenne
Gramagrass	Bouteloua gracilis Bouteloua curtipendula	Wheatgrass	Agropylon smithii
Indiangrass	Sorghastrum nutans	**Legumes**	
Lovegrass	Eragrostis curvula	Bird’s Foot Trefoil	Lotus corniculatus
Panicgrass	Panicum virgatum	Clovers	Trifolium pratense Trifolium repens Trifolium hyubridum
		Vetch	Coronilla varia Astragalus cicer

*At any time during the planning, reclamation, and sampling phases, the permittee may make a written request that the SMRD accept plant species not listed here that would also meet the criteria of the ASCMRC 816.111.

Appendix M

Procedure for Manually Sampling Row Crops

A. Corn

1. Randomly select locations to determine sample adequacy. Follow Appendix A and Appendix E instructions. The initial number of samples to take for corn are as follows:

Size of Area(acres)	# Samples
1 - 39	8
40 - 279	12
280 - 639	16
640 or more	28

2. Determine the row width and select the length of row to measure 1/1000th of an acre.

Row Width (inches)	Length of Row per 1/1,000 acre
10	52 feet 3 inches
20	26 feet 2 inches
30	17 feet 5 inches
36	14 feet 6 inches
38	13 feet 9 inches
40	13 feet 1 inch

3. Locate the sample site adjacent to the closest corn stalk.

4. Measure and mark the required row length.

5. Determine the 3rd and 4th ears of the row and tag these ears with a rubber band. If there are less than four ears in the first row, the last ear and next to the last ear should be tagged. In case where a stalk has more than one ear, count the top ear first. (note: an ear of corn is defined as a cob having at least one kernel. The tagged ears will be used to determine the moisture content, and at least 250 grams of grain are needed. If it does not appear that the 3rd and 4th ears will supply 250 grams of grain for a moisture test, then the 5th, 6th, and or 7th ear should be included until at least 250 grams of corn is collected).

6. Husk all ears in the measured length of row and snap the shank off as cleanly as possible. Be sure to include the ears tagged for moisture sampling.

7. Weigh the husked ears using a balance scale to obtain a field weight.

8. After weighing, put the ears tagged for moisture testing into polyethylene bags and seal. Mark the bags by sample and field number.

9. Repeat steps 3 through 8 for each sampling point.

10. All the ears saved for calculating moisture shall be brought to the nearest commercial certified grain handling facility to determine moisture content and bushel weight. Obtain a scale ticket signed by an individual certified to run these tests verifying the moisture and weight per bushel.

11. Calculate the yield per acre for each sample using this formula:

A x B x C x D divided by E = yield per acre

Where:

A = weight of all ears/sample
B = 1,000 (portion of an acre represented)
C = ear corn to shell corn factor
D = Moisture adjustment factor
E = tested sample weight per bushel

An example for figuring the moisture as described in Appendix J is as follows:

$$\text{Adj. factor} = \frac{100 - M}{100 - A}$$

where: M = moisture content of grain at harvest
A = adjusted moisture, example 15.5% for corn

12. Total all adjusted yields and figure an average yield.

13. Use the same above procedure when figuring yields from the reference areas, adjust the NRCS Productivity Adjustment and compare the yields to the test plots.

14. If you are using the county average as your reference yield, that yield must be reduced by the state wide harvest loss factor.

B. Soybeans

Soybean yield estimates are most accurate within three weeks of maturity.

1. Determine the number of feet of row needed to make 1/1000 of an acre from the following table. This will be a sample area.

Row Width (in.)	Length of Single Row =1/1000 ac.	Row Width (in.)	Length of Single Row =1/1000 ac.
6	87 ft 1 in	28	18 ft 8 in
7	74 ft 8 in	30	17 ft 5 in
8	65 ft 4 in	32	16 ft 4 in
10	52 ft 3 in	36	14 ft 6 in
15	34 ft 10 in	38	13 ft 9 in
20	26 ft 2 in	40	13 ft 1 in

2. Count the number of plants in at least ten (10) different randomly selected sample areas and calculate the average. See Appendix A.

   Avg.=_____= A

3. Count the number of pods per plant on ten (10) randomly selected plants from each sample area. Divide the total plants by ten (10) and skip that many plants to count after you count the first plant. Calculate the average.

   Avg.=_____= B

4. Calculate pods/acre by multiplying plant population by pods/plant.

   A x B=_____= C

5. Calculate seeds/acre by multiplying pods per acre by an estimate of 2.5 seeds/pod.

   2.5 x C=_____= D

6. Calculate pounds/acre by dividing seeds/acre by an estimate of 2500 seeds/pound.

   D / 2500=_____= E

7. Estimate yield by dividing pounds/acre by 60 pounds per bushel.

   E / 60=_____= Yield

8. Use the sample adequacy formula, Appendix E, to determine the number of samples to take.

9. Total all the samples and average to determine the yield from the test plot. Conduct the testing on the reference crop by using this same procedure, adjust for NRCS Productivity Adjustment and compare the yields.

C. Grain Sorghum

1. Determine the number of heads per acre. Count the number of heads in 100 ft. of row, then calculate:
   $\frac{\text{\#num. heads}}{\text{100 ft of row}} \times \frac{43.560}{\text{Row space in ft.}} = \text{\#num. heads/acre}$

2. Determine the number of kernels per head. This is a two step process for a) estimating the average number of spikelets per head, and b) estimating the number of kernels per spikelet.

   a. Collect 10 heads from the 100 ft. sample area. Count the number of spikelets (branches from the main rachis) on each head. Total the number of spikelets counted.

      $\frac{\text{Total \# of spikelets}}{10 \text{ heads}} = \text{\# of spikelets per head}$

   b. Collect 9 spikelets from a "typical head; 3 from the top, middle and bottom portions of the head. Count the number of kernels in each spikelet. Total the number of kernels counted.

      $\frac{\text{Total \# of kernels}}{9 \text{ spikelets}} = \text{\# of kernels per spikelet}$

      The estimated number of kernels per head can be calculated: # of spikelets x # of kernels = # of kernels per head per spikelet

3. Calculate the number of kernels per acre using the results of steps 1 and 2.

   # of heads/ac X # of kernels/head = # kernels/acre

4. Determine estimated yield. Sorghum averages approximately 15,000 seeds per pound. Dividing the number of estimated kernels per acre by the approximate number of seeds per pound will estimate the number of pounds per acre.

   $\frac{\text{\# number of kernels per acre}}{\text{15,000 kernels per pound}} = \text{\# of pounds/acre}$

5. Divide the total pounds per acre by 56 to obtain the bushels per acre.

6. The reference plot shall be measured using this same procedure, adjust for NRCS Productivity Adjustment and compare the yields to the test plot yields.

7. The number of kernels per pound will vary due to growing conditions and hybrid. It is not unusual to have sorghum vary from 12,000 to 18,000 seeds per pound. In estimating grain sorghum yields, it is suggested that a range of kernels per pound values be used to get an idea of the estimated high, low, and average yields for a particular situation.

8. Use the sample adequacy formula, Appendix E, to determine the number of samples needed to measure productivity.

APPENDIX N

References

Bonham, Charles D., 1989. Measurements for Terrestial Vegetation. Wiley, New York, 338 pages.

Chambers, Jeanne C., and Ray W. Brown. 1983. Methods for Vegetation Sampling and Analysis on Revegetated Mined Lands. U. S. Forest Service, Intermountain Forest and Range Experiment Station, Odgen, Utah. General Technical Report INT-151.