Nutrient Removal Values for Major Agronomic Crops in Missouri
Report for 2006

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Introduction:

Currently the soil Fertility Group is working on revising the University of Missouri (MU) Fertilizer and Lime Recommendations for Missouri. At this time, there is no research based values for nutrient removal available for major agronomic crops in Missouri. Since the source of nutrient removal values currently used by the MU fertilizer and Lime Recommendations is unknown, it was suggested that we replace the existing values in MU recommendations with data on nutrient removal values from the National Beef Research Council and National Dairy Research council. Since the crop nutrient removal values vary depending on yields, variety grown, and environmental conditions, it would be more appropriate to use nutrient uptake values from Missouri rather than using the national values reported by the National Beef and Dairy Research Councils.

Objective:

- To obtain nutrient removal values for major agronomic crops in Missouri and use them in refining University of Missouri Fertilizer Recommendations.

Current Status:

Table 1 provides a comparison of the current removal rates, the proposed removal rates based on National Beef Research Council and National Dairy Research Council, and the rates recommended by the Potash and Phosphate Institute (PPI, 2002).

Preliminary work was done in year 2006 by collecting grain and forage samples for major agronomic crops in the state of Missouri. The samples were collected throughout the state of Missouri by working in collaboration with Missouri Department of Agriculture Grain Inspection Service Centers, MFA grain elevators, Agricultural Experiment Station Research Center and Farms and researchers. We collected 326 grain samples and 76 forage samples from the state of Missouri. At this time, we have completed N, P, K and moisture analysis on 182 grain samples and the results are presented in Table 2.

Table 2 provides the grain nutrient removal values for major agronomic crops in Missouri in 2006. The N, P and K nutrient removal values for grain crops in Missouri for year 2006 didn't match with the nutrient values provided by the National Beef and Dairy Research Council. (Table 3). The values used by them are from a national data base and it doesn't truly represent the Missouri conditions. This suggests that additional data for grain nutrient removal values should be collected over years for agronomic crops in Missouri to come up with appropriate values to refine MU Fertilizer recommendations.

Need for Future Research:

Since the nutrient removal values vary with weather conditions, yields, management and soil type, we need to collect data over multiple years to have a larger data base to develop appropriate and realistic nutrient removal values representing the growing conditions in Missouri. Samples will be collected from grain inspection services, grain elevators, variety trials, agriculture experiment station farms, and researchers from all parts of the state to get a representative sample pool. There is a dire need for this data before making changes in nutrient removal values for agronomic crops in Missouri. Other states use the data collected from their states to come up with the appropriate values for nutrient removal that represent the growing conditions in their state.

Table 1: Comparison of current University of Missouri, proposed (National Research Council), and Phosphate Potash Institute nutrient removal values for agronomic crops.

		N removal			P_2O_5 removal			K_2O removal		
Crop	Yield Unit	Current	NRC	PPI	Current	NRC	PPI	Current	NRC	PPI
Barley	bushel	0.96	0.87	1.1	0.38	0.33	0.4	0.24	0.29	0.35
Corn Grain	bushel	0.9	0.74	0.75	0.45	0.32	0.44	0.30	0.25	0.29
Corn Silage	ton	9.0	9.9	8.3	3.6	4.1	3.6	9.0	10	8.3
Oats	bushel	0.64	0.6	0.8	0.26	0.26	0.25	0.19	0.17	0.2
Rice	pound	0.013	-	-	0.0065	-	-	0.004	-	-
Sorghum grain	pound	0.014	0.018	0.015	0.0093	0.0067	0.0075	0.006	0.0047	0.0038
Sorghum silage	ton	13.0	10	-	4.6	3.5	-	10	15	-
Soybean	bushel	-	3.4	4.0	0.84	0.80	0.80	1.44	1.30	1.40
Wheat	bushel	1.26	1.18	1.5	0.60	0.50	0.5	0.30	0.30	0.35
Alfalfa-grass hay	ton	-	54	50	10.0	11	14	45	53	54
Bermuda grass hay	ton	50	30	41	9.0	11	11	34	40	45
Clover-grass hay	ton	-	55	45	8.2	13	14	38	57	54
Cool season grass hay	ton	40	38	34	9.0	12	16	34	47	47
Lespedeza-grass hay	ton	-	-	-	8.8	-	-	20	-	-
Sudan grass hay	ton	40	27	36	6.9	8	14	19	52	52
Warm season grass hay	ton	-	-	-	2.0	-	-	14.6	-	-

Table 2: Survey Report of the Grain Nutrient Removal Values for Major Agronomic Crops in Missouri – Year 2006

CORN	N	P	K	Nutrient	Removal	Values
County	%	%	%	lbs N/bu	lbs P_2O_5/bu	lbs K_2O/bu
Gentry	1.395	0.490	0.579	0.660	0.527	0.330
Montgomery	1.491	0.474	0.705	0.706	0.510	0.402
Audrain	1.222	0.300	0.440	0.578	0.323	0.251
Warren	1.407	0.333	0.541	0.666	0.358	0.308
Warren	1.448	0.450	0.620	0.685	0.484	0.353
Audrain	1.265	0.439	0.576	0.598	0.472	0.328
Morgan	1.317	0.468	0.599	0.623	0.503	0.342
Boone	1.555	0.561	0.672	0.736	0.603	0.383
Grundy	1.224	0.284	0.440	0.579	0.305	0.251
Bates	1.252	0.408	0.515	0.592	0.438	0.293
Barton	1.288	0.414	0.522	0.609	0.445	0.298
Saline	1.305	0.391	0.484	0.618	0.420	0.276
St. Francois	1.326	0.412	0.604	0.627	0.443	0.344
Chariton	1.170	0.408	0.564	0.554	0.439	0.322
Randolph	1.205	0.420	0.569	0.570	0.452	0.325
Lafayette	1.295	0.433	0.582	0.613	0.466	0.332
Lafayette	1.209	0.401	0.548	0.572	0.432	0.313
Audrain	1.145	0.419	0.597	0.542	0.451	0.341
Livingston	1.539	0.469	0.679	0.728	0.504	0.387
St. Genevieve	1.350	0.466	0.579	0.639	0.501	0.330
St. Louis	1.485	0.389	0.635	0.703	0.419	0.362
Lafayette	1.176	0.340	0.464	0.556	0.366	0.264
Cape Girardeau	1.362	0.448	0.643	0.644	0.481	0.367
Mississippi	1.551	0.439	0.681	0.734	0.472	0.388
St. Charles	1.319	0.362	0.588	0.624	0.389	0.335
Clark	1.486	0.457	0.742	0.703	0.492	0.423
New Madrid	1.208	0.298	0.468	0.571	0.321	0.267
Scott	1.769	0.545	0.679	0.837	0.586	0.387
Livingston	1.536	0.493	0.711	0.727	0.530	0.405
Lafayette	1.296	0.480	0.661	0.613	0.516	0.377
Randolph	1.487	0.339	0.582	0.703	0.364	0.332
Nodaway	1.484	0.429	0.662	0.702	0.462	0.377
Howard	1.358	0.344	0.581	0.643	0.370	0.332
Cape Girardeau	1.324	0.441	0.614	0.627	0.475	0.350
Mississippi	1.246	0.394	0.585	0.590	0.424	0.333
St. Charles	1.546	0.465	0.657	0.731	0.501	0.375
Clark	1.324	0.387	0.596	0.626	0.416	0.340
New Madrid	1.342	0.404	0.514	0.635	0.435	0.293
Scott	1.342	0.468	0.583	0.635	0.503	0.332
Lafayette	1.328	0.367	0.541	0.628	0.395	0.309
Livingston	1.281	0.404	0.565	0.606	0.434	0.322
Lafayette	1.596	0.412	0.643	0.755	0.443	0.366
Randolph	1.529	0.331	0.608	0.723	0.355	0.347
Nodaway	1.588	0.441	0.708	0.751	0.474	0.404
Howard	1.346	0.334	0.550	0.637	0.359	0.313
Bates	1.515	0.381	0.594	0.717	0.410	0.339

CORN	N	P	K	Nutrient	Removal	Values
Cape Girardeau	1.414	0.486	0.675	0.669	0.523	0.385
St. Charles	1.307	0.325	0.534	0.618	0.350	0.304
Stoddard	1.493	0.378	0.704	0.706	0.406	0.402
Scott	1.612	0.516	0.631	0.763	0.555	0.360
St. Charles	1.656	0.432	0.605	0.784	0.465	0.345
Stoddard	1.472	0.485	0.717	0.697	0.522	0.409
New Madrid	1.674	0.628	0.742	0.792	0.676	0.423
Scott	1.611	0.582	0.673	0.762	0.626	0.384
Stoddard	1.691	0.521	0.837	0.800	0.560	0.477
New Madrid	1.622	0.517	0.702	0.768	0.556	0.400
Scott	1.293	0.531	0.642	0.612	0.571	0.366
Stoddard	1.578	0.489	0.698	0.747	0.526	0.398
New Madrid	1.486	0.518	0.633	0.703	0.557	0.361
Scott	1.144	0.443	0.576	0.541	0.477	0.328
New Madrid	1.392	0.504	0.661	0.659	0.542	0.377
Scott	1.362	0.457	0.584	0.645	0.492	0.333
New Madrid	1.776	0.643	0.753	0.840	0.692	0.429
New Madrid	1.344	0.424	0.630	0.636	0.456	0.359
Mean	**1.409**	**0.436**	**0.614**	**0.667**	**0.469**	**0.350**
STD	**0.157**	**0.075**	**0.079**	**0.074**	**0.081**	**0.045**
N	**64**	**64**	**64**	**64**	**64**	**64**

SOYBEANS	N	P	K	Nutrient	Removal	Values
County	**%**	**%**	**%**	**lbs N/bu**	**lbs P_2O_5/bu**	**lbs K_2O/bu**
Mississippi	4.708	0.405	1.603	2.458	0.481	1.008
Gentry	4.691	0.440	1.516	2.449	0.522	0.954
Atchison	5.256	0.473	1.784	2.744	0.561	1.122
Andrew	6.301	0.464	1.825	3.289	0.551	1.148
Buchanan	5.633	0.550	1.952	2.940	0.653	1.228
Clinton	4.967	0.459	1.794	2.593	0.545	1.129
Pike	4.771	0.450	1.794	2.490	0.534	1.129
Macon	4.603	0.439	1.805	2.403	0.521	1.135
Scott	5.065	0.455	1.805	2.644	0.540	1.135
Warren	5.349	0.477	1.536	2.792	0.566	0.966
Stoddard	4.615	0.425	1.734	2.409	0.504	1.091
Boone	4.500	0.414	1.652	2.349	0.491	1.039
Pemiscot	4.741	0.444	1.859	2.475	0.527	1.169
Barton	5.504	0.448	1.747	2.873	0.531	1.099
Morgan	5.241	0.464	1.502	2.736	0.551	0.945
Boone	4.566	0.456	1.545	2.383	0.541	0.971
Grundy	4.367	0.481	1.651	2.280	0.571	1.038
Barton	4.767	0.435	1.607	2.488	0.516	1.011
St. Francois	3.499	0.431	1.280	1.826	0.511	0.805
Livingston	4.188	0.407	1.492	2.186	0.483	0.938
Chariton	3.774	0.433	1.447	1.970	0.514	0.910
Audrain	4.002	0.434	1.516	2.089	0.515	0.953
St. Genevieve	5.429	0.505	1.743	2.834	0.599	1.096
Livingston	4.693	0.401	1.446	2.450	0.476	0.909
Pemiscot	5.005	0.427	1.665	2.613	0.507	1.047

SOYBEANS	N	P	K	Nutrient	Removal	Values
Holt	4.485	0.502	1.694	2.341	0.596	1.066
Dekalb	5.093	0.467	1.761	2.659	0.554	1.107
Gentry	5.198	0.431	1.655	2.713	0.511	1.041
Nodaway	5.025	0.431	1.727	2.623	0.511	1.086
Saline	4.514	0.385	1.215	2.356	0.457	0.764
Lafayette	3.965	0.467	1.640	2.070	0.554	1.032
Randolph	4.270	0.442	1.350	2.229	0.524	0.849
Nodaway	4.296	0.408	1.603	2.242	0.484	1.008
New Madrid	4.923	0.440	1.631	2.570	0.522	1.026
New Madrid	4.897	0.436	1.619	2.556	0.517	1.018
Pemiscot	5.030	0.423	1.633	2.626	0.502	1.027
Holt	5.175	0.462	1.719	2.701	0.549	1.081
Dekalb	5.028	0.533	1.714	2.625	0.632	1.078
Gentry	4.831	0.349	1.571	2.522	0.414	0.988
Nodaway	5.381	0.449	1.793	2.809	0.532	1.128
Saline	4.753	0.415	1.472	2.481	0.492	0.926
Lafayette	3.985	0.465	1.600	2.080	0.551	1.006
Randolph	4.520	0.417	1.556	2.359	0.495	0.978
Nodaway	4.711	0.447	1.681	2.459	0.530	1.057
New Madrid	4.876	0.426	1.645	2.545	0.505	1.035
Pemiscot	4.853	0.419	1.629	2.533	0.497	1.024
Holt	5.013	0.461	1.772	2.617	0.547	1.114
Gentry	5.470	0.485	1.658	2.855	0.575	1.043
Nodaway	5.344	0.443	1.744	2.789	0.526	1.097
New Madrid	4.956	0.429	1.671	2.587	0.508	1.051
Pemiscot	5.342	0.435	1.672	2.789	0.517	1.052
Mean	**4.827**	**0.445**	**1.642**	**2.520**	**0.528**	**1.033**
STD	**0.510**	**0.034**	**0.144**	**0.266**	**0.041**	**0.090**
N	**51**	**51**	**51**	**51**	**51**	**51**

WHEAT	N	P	K	Nutrient	Removal	Values
County	**%**	**%**	**%**	**lbs N/bu**	**lbs P_2O_5/bu**	**lbs K_2O/bu**
New Madrid	2.007	0.366	0.618	1.042	0.432	0.386
Gentry	1.779	0.309	0.436	0.923	0.365	0.272
Warren	1.759	0.356	0.438	0.913	0.420	0.274
Audrain	1.380	0.286	0.357	0.716	0.337	0.223
Boone	2.116	0.288	0.433	1.098	0.340	0.270
St. Francois	1.909	0.304	0.419	0.991	0.359	0.262
Grundy	1.751	0.245	0.376	0.909	0.289	0.235
Boone	1.747	0.386	0.544	0.907	0.455	0.340
Boone	1.811	0.365	0.546	0.940	0.430	0.341
Boone	1.619	0.332	0.517	0.840	0.391	0.324
Boone	1.542	0.335	0.487	0.800	0.395	0.304
Boone	1.822	0.356	0.533	0.946	0.420	0.333
Boone	1.721	0.357	0.561	0.893	0.421	0.351
Knox	1.558	0.357	0.499	0.809	0.421	0.312
Knox	1.580	0.285	0.342	0.820	0.336	0.214
Knox	1.621	0.307	0.355	0.841	0.362	0.222
Knox	1.539	0.274	0.308	0.799	0.323	0.192

WHEAT	N	P	K	Nutrient	Removal	Values
Knox	1.667	0.299	0.335	0.865	0.352	0.209
Knox	1.689	0.367	0.351	0.877	0.433	0.220
Carroll	1.601	0.326	0.431	0.831	0.385	0.270
Chariton	1.721	0.321	0.495	0.893	0.379	0.310
Randolph	1.602	0.316	0.399	0.831	0.373	0.250
Audrain	1.871	0.382	0.554	0.971	0.451	0.346
Livingston	1.592	0.326	0.465	0.826	0.384	0.291
St. Genevieve	1.971	0.401	0.646	1.023	0.473	0.404
Cape Girardeau	2.067	0.334	0.639	1.073	0.394	0.399
Mississippi	1.624	0.308	0.519	0.843	0.363	0.325
Cape Girardeau	1.799	0.326	0.526	0.934	0.385	0.329
Mississippi	1.734	0.314	0.484	0.900	0.370	0.303
Mississippi	1.638	0.302	0.479	0.850	0.357	0.299
Grundy	2.104	0.315	0.512	1.092	0.372	0.320
Bates	1.625	0.268	0.337	0.843	0.317	0.211
Grundy	1.585	0.326	0.428	0.823	0.385	0.268
Randolph	1.493	0.326	0.427	0.775	0.385	0.267
Montgomery	1.599	0.300	0.433	0.830	0.354	0.271
Audrain	1.774	0.349	0.507	0.920	0.411	0.317
Montgomery	1.628	0.297	0.452	0.845	0.350	0.282
Audrain	1.858	0.347	0.517	0.964	0.409	0.324
Bates	1.836	0.312	0.408	0.953	0.368	0.255
Montgomery	1.648	0.301	0.440	0.855	0.355	0.275
Audrain	1.743	0.372	0.536	0.905	0.439	0.335
Audrain	1.786	0.323	0.480	0.927	0.382	0.300
Barton	2.598	0.396	0.609	1.348	0.467	0.381
Mean	**1.747**	**0.327**	**0.469**	**0.907**	**0.386**	**0.293**
STD	**0.210**	**0.035**	**0.085**	**0.109**	**0.041**	**0.053**
N	**45**	**45**	**45**	**45**	**45**	**45**

SORGHUM	N	P	K	Nutrient	Removal	Values
County	**%**	**%**	**%**	**lbs N/bu**	**lbs P_2O_5/bu**	**lbs K_2O/bu**
Gentry	1.590	0.885	1.019	0.775	0.980	0.598
Audrain	1.819	0.760	0.833	0.886	0.841	0.489
Morgan	2.166	0.868	1.106	1.055	0.961	0.649
Boone	1.932	0.877	1.000	0.941	0.971	0.587
Barton	1.767	0.782	0.872	0.861	0.866	0.512
Livingston	1.856	0.848	1.044	0.904	0.939	0.613
Ray	1.650	0.884	0.994	0.804	0.979	0.583
Grundy	1.469	0.740	0.856	0.716	0.820	0.502
Audrain	1.712	0.948	1.006	0.834	1.050	0.591
Livingston	1.570	0.892	1.083	0.765	0.987	0.636
Audrain	1.602	0.844	1.036	0.781	0.934	0.608
Audrain	1.658	0.870	1.034	0.808	0.964	0.607
Audrain	1.547	0.822	0.979	0.754	0.911	0.575
Audrain	1.522	0.734	0.876	0.742	0.813	0.514
Mean	**1.704**	**0.840**	**0.981**	**0.830**	**0.930**	**0.576**
STD	**0.189**	**0.064**	**0.087**	**0.092**	**0.071**	**0.051**
N	**14**	**14**	**14**	**14**	**14**	**14**

Table 3: Comparison of current University of Missouri, proposed (National Research Council), Phosphate Potash Institute and measured Missouri nutrient removal values, 2006 for major agronomic crops.

		N removal				P_2O_5 removal				K_2O removal			
Crop	Yield Unit	Current	NRC	MO Values 2006	PPI	Current	NRC	MO values 2006	PPI	Current	NRC	MO values 2006	PPI
Corn Grain	bushel	0.9	0.74	0.67	0.75	0.45	0.32	0.46	0.44	0.30	0.25	0.35	0.29
Sorghum grain	pound	0.014	0.018	0.014	0.015	0.0093	0.0067	0.015	0.0075	0.006	0.0047	0.009	0.0038
Soybean	bushel	-	3.4	2.52	4.0	0.84	0.80	0.53	0.80	1.44	1.30	1.03	1.40
Wheat	bushel	1.26	1.18	0.91	1.5	0.60	0.50	0.39	0.5	0.30	0.30	0.29	0.35

Budget - 2007

CATEGORIES	YEAR 2007
A. Salaries	
Senior Lab Technician (10%)	$2,570
Student Labor 120 hrs at $7.25 per hour	$900
B. Fringe Benefits	
Fringe for Lab Technician (30%)	$770
TOTAL SALARIES AND FRINGE BENEFITS	$ 4,220
C. Travel	
Travel to field sites for sample collection	$600
To present research findings at the State, Regional & National Meetings	$600
TOTAL TRAVEL COSTS	$1,200
D. Equipment	$0
TOTAL EQUIPMENT COSTS	$0
E. Other Direct Costs	
Laboratory reagents and supplies	$1,500
Sample analysis (500 samples at the rate of $20 per sample for N, P, K, Moisture and sample processing)	$10,000
Field supplies	$250
TOTAL OTHER DIRECT COSTS	$11,750
TOTAL	**$17,190**