Application of GLUE-Generalized Likelihood Uncertainty Estimation Technique for Calculating DSSAT Genetic Coefficients

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BACKGROUND

1. Each year since 1998, up to 130 corn varieties were tested annually in Georgia
2. Genetic coefficients are required to produce yield-outlook in the coming season using DSSAT-Maize model and climate forecast
3. Genetic coefficients cannot be assessed directly from these tests
4. DSSAT, traditionally has used single optimal value for a genetic coefficients, and thus estimates unique yield

Therefore, GLUE technique was evaluated to estimate genetic parameters as it accounts for their equifinality or multiplicity when used in an over parameterized models likelihood those of DSSAT. GLUE assumes that, there is no perfect inverse unique solution, and hence, that the estimation of a unique set of parameters, which optimizes goodness-of-fit criteria given the observations, is not possible.

METHODOLOGY

1. 1999-2006 Variety trial data for corn cultivar 1851W, the most frequent entry in the trials was selected
2. Prior distributions (mean and variance) for each genetic coefficients needed by DSSAT-Maize model were chosen based on experience and literature
3. 10,000 combinations of genetic coefficients were generated and yields were simulated
4. Error was calculated between each simulated value and measured value. Each error was normalized using the smallest non-zero error and its probability (p_i) was determined. In general, large error translates into smaller p_i.
5. Expected value of a parameter and its variance were calculated

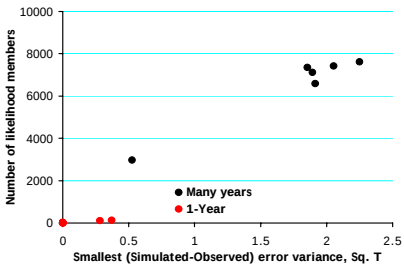
FINDINGS

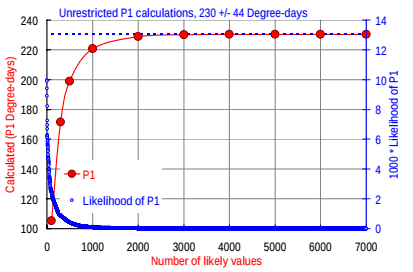
It is likely that, the DSSAT model structure, to some extent, is likely to have errors and that all observations and measurements on which genetic coefficients [GC] calibration is based also is subjected to measurement errors, then there is no reason to expect that any one set of GCs will represent a true parameter set, irrespective of the calibration method used. Using GLUE, it is possible to assess the likelihood or possibility of a particular GC parameter set being an acceptable simulator of the DSSAT system.

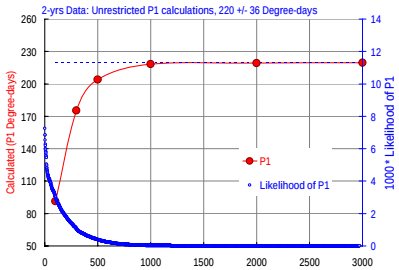
GLUE is one of the potentially simple method for estimating uncertainty in parameter values using the least amount of readily accessible data.

Quantity of data affected Genetic coefficient, errors and number of likely members

Start	End	Error-Variance (Sq. T)	Simulation Runs	Simulated Yield (T)	Observed Yield (T)	P1	P2	P5	G2	G3	PHINT
1999	1999	0.0000	5012	9.65	9.65	217	0.243	975	837	6.6	43.2
2000	2000	0.0002	9850	13.29	13.28	221	0.376	929	897	7.6	27.7
2001	2001	0.3709	9278	14.88	14.27	257	0.261	996	833	9.2	44.9
2002	2002	0.0036	1788	14.83	14.77	138	0.136	969	931	8.5	41.0
2003	2003	0.2820	2679	13.78	14.31	210	0.415	1038	857	8.6	43.3
2004	2004	0.0024	8267	12.33	12.28	265	0.247	963	876	8.0	40.1
2006	2006	0.0000	3709	11.23	11.23	207	0.199	894	759	8.4	51.5
1999	2000	0.5260	3744	11.31	11.47	169	0.232	949	879	7.9	51.5
1999	2001	1.8551	5456	12.68	12.40	242	0.326	932	892	8.8	57.7
1999	2002	2.0539	5456	12.80	12.99	242	0.326	932	892	8.8	57.7
1999	2003	2.2503	9083	12.92	13.26	297	0.441	849	917	9.0	39.2
1999	2004	1.9158	5456	12.59	13.09	242	0.326	932	892	8.8	57.7
1999	2006	1.8933	5456	12.59	12.83	242	0.326	932	892	8.8	57.7







Compared to using all data, fewer years of data resulted in smaller number of likely values and greater variations in estimated values.

Year From	Year To	Likely Members	Average P1	SD P1	Average P5	SD P5	Average G2	SD G2	Average G3	SD G3	Average PHINT	SD PHINT
Initially assumed values			200	50	800	100	700	100	7	1	45	10
1999	1999	15	216	52	891	65	766	69	7.58	0.57	40	6
2000	2000	8	208	11	905	39	849	77	8.37	0.70	32	4
2001	2001	125	248	30	958	48	853	52	8.66	0.62	44	7
2002	2002	4	158	18	980	19	885	38	8.23	0.30	33	7
2003	2003	109	232	42	1006	41	848	37	8.66	0.46	43	6
2004	2004	4	254	12	967	38	893	29	7.91	0.54	43	3
2006	2006	13	211	29	879	45	838	57	7.96	0.65	43	11
1999	2000	2972	219	36	907	76	800	78	8.09	0.78	42	8
1999	2001	7352	240	36	910	78	799	83	8.04	0.78	43	9
1999	2002	7422	231	43	917	75	810	82	8.13	0.76	42	9
1999	2003	7620	230	44	921	74	813	81	8.16	0.76	42	9
1999	2004	6588	232	44	926	72	819	79	8.21	0.74	43	9
1999	2006	7114	230	44	920	74	812	81	8.16	0.76	42	9

Example of initial and calibrated parameter and yield values