TECHNOLOGY EVALUATION AND DEVELOPMENT SUB-PROGRAM
SOIL AND WATER ENVIRONMENTAL ENHANCEMENT PROGRAM

THE USE OF KELP AND MOLASSES IN AN AERATION TILLAGE SYSTEM

FINAL REPORT

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ON BEHALF OF: Agriculture Canada
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EXECUTIVE SUMMARY

The Use of Kelp and Molasses in an Aeration
Tillage System

In 1989 and 1990 two field trials were carried out each year in Oxford County to determine the effects of kelp, molasses and 71B fertilizer solution (1990 only) on soybean plant growth and seed yield in an aeration tillage system.

Results from two years of study indicate that the use of kelp and/or molasses and/or 71B fertilizer solution as a seed and/or foliar treatment in an aeration tillage system did not significantly affect the growth and yield of soybeans.

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TABLE OF CONTENTS

		Page
Executive Summary		i
Acknowledgements		ii
Table of Contents		iii
1.0	Introduction	1
	1.1 Rationale for research	1
	1.2 Study of the effect of kelp and molasses on main crop growth and yield	2
2.0	Deviations from the Work Plan	3
3.0	Materials and Methods	3
	3.1 Site location and characterization	3
	3.2 Experimental design and analyses	4
	3.3 Agronomic practices	6
	3.4 Measurements	6
4.0	Results	7
	4.1 Randomized complete block design trials	7
	4.2 Side-by-side comparison trials	17
5.0	Discussion	25
6.0	Conclusions	25
7.0	Recommendations	25
8.0	References	26

List of Appendices

Appendix A The Natural Fertility Alternative of Formula 71B Fertilizer Solutions
Appendix B Site Management Practices
Appendix C Weather Information

TABLE OF CONTENTS (CONTINUED)

List of Tables **Page**

Table 1:	Soil fertility and particle size distribution results for samples collected at all sites. Kelp and Molasses Study, 1989-1990.	4
Table 2:	Soybean plant emergence at 7 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	10
Table 3:	Soybean plant emergence at 14 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	10
Table 4:	Soybean plant emergence at 21 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	11
Table 5:	Soybean plant height at 14 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	11
Table 6:	Soybean plant height at the first foliar application date (soybean first trifoliate leaf stage, approximately four weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	12
Table 7:	Soybean plant height at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	12
Table 8:	Soybean plant vegetative stage at the first foliar application date (soybean first trifoliate leaf stage, approximately four weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	13
Table 9:	Soybean plant vegetative stage at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	14
Table 10:	Soybean plant reproductive stage at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	14
Table 11:	Visual assessment of soybean leaf colour change at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	15
Table 12:	Visual assessment of soybean pod colour change at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	15

TABLE OF CONTENTS (CONTINUED)

List of Tables (continued) **Page**

Table 13:	Soybean seed yield at 14.0% moisture content at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.	16
Table 14:	Soybean plant emergence as affected by seed or foliar treatments of kelp/molasses/71B fertilizer in a side-by-side comparison trial area in 1989 and 1990.	17
Table 15:	Soybean plant height as affected by foliar treatments of kelp and molasses in a side-by-side comparison trial area in 1989.	18
Table 16:	Soybean plant height as affected by seed treatment of kelp and molasses in a side-by-side comparison trial area in 1990.	19
Table 17:	Soybean plant vegetative and reproductive growth stages as affected by foliar treatments of kelp and molasses in a side-by-side comparison trial area in 1989.	20
Table 18:	Soybean plant vegetative and reproductive growth stages as affected by seed treatment of kelp and molasses in a side-by-side comparison trial area in 1990.	21
Table 19:	Visual assessment of soybean plant leaf and pod colour change as affected by seed treatments of kelp and molasses in a side-by-side comparison trial area in 1990.	22
Table 20:	Soybean seed yield as affected by seed or foliar treatments of kelp/molasses/71B fertilizer in a side-by-side comparison trial area in 1989 and 1990.	23

1.0 INTRODUCTION

It is our understanding that the Technology Evaluation and Development (TED) Sub-program of the Soil and Water Environmental Enhancement Program (SWEEP) was established to facilitate the evaluation of existing agricultural technologies and the adaptation of such technologies for soil conservation and phosphorus load reduction purposes in the Lake Erie Basin. It is intended that TED sponsored investigations will be undertaken mainly at field-scale and within commercial farming operations. Rapid adoption of promising technologies will be necessary for SWEEP to realize its phosphorus reduction goals within the specified time frame. TED also aims to coordinate program efforts with those others currently sponsored by SWEEP in order to minimize duplication, to collect and share relevant economic and social data, and to maximize program effectiveness by considering options for technology transfer to a wide range of farm operators.

In light of the above objectives and in a more specific effort to increase our understanding of aeration tillage systems using the Aer-way system of crop production, Conservation Management Systems (CMS) has been requested to study the use of kelp and molasses in the above system.

1.1 Rationale for Research

Many producers are interested in reducing the inputs required for crop production. "Low input" agriculture is often used as a term to describe this goal. An emphasis is placed on products that are naturally produced as opposed to being commercially manufactured. Kelp and molasses are two inputs that have recently gained profile as potential components in a low input crop production system. One such system is the Aer-way system.

The Aer-way® is a piece of tillage equipment with tined rollers used to aerate the soil. This equipment also helps to increase water infiltration and relieve compaction in the top 17.5 centimetres of the soil. In addition to the use of the Aer-way® equipment, low input fertilizers such as kelp and molasses and cover crops are also included in this system. While cover crops are used to suppress weeds, provide nitrogen, improve soil structure and protect the soil surface from erosion, questions arise as to the efficacy of the kelp and molasses treatments. Do these components of the system have a positive effect on crop performance? The studies as outlined herein provide a preliminary examination of the potential effects of these products on soybean production.

The study outlined in Section 1.1 represents a complementary study to the "Evaluation of Aeration Tillage Systems in Low Input Farming" prepared for TED by Can-Ag Enterprizes. The study, outlined herein, provides statistical data on which to base conclusions; a highly desirable condition that would not likely be possible under the project set-up outlined in the above-mentioned proposal. By utilizing research sites already in place under the Can-Ag study, valuable information regarding the use of kelp and molasses in a low input crop production system was gained. This provides a more efficient use of TED funds while encouraging interaction between projects.

1.2 Study of the Effect of Kelp and Molasses on Main Crop Growth and Yield

Hypothesis:

1. that the presence of kelp and/or molasses at currently recommended rates and time of application will have no effect on main crop growth and soybean seed yield.

Objectives:

i) to determine the effect of kelp and/or molasses on main crop growth and seed yield;

ii) to prepare preliminary conclusions on the efficacy of kelp and/or molasses as essential practices within the Aer-way system of low input crop production.

2.0 DEVIATIONS FROM THE WORK PLAN

In the second year of the study (1990) additional treatments using the 71B fertilizer solution were added upon the recommendation of participating cooperators and the client. The number of treatments increased from four in the first year to six in the second year of the study.

Due to an error in the setting up of the treatments in the side-by-side comparison, the trials were reversed in the second year of the study (see Section 3.2).

Soybean yield data for site 4 were not obtained prior to custom harvest of this field.

3.0 MATERIALS AND METHODS

3.1 Site Location and Characterization

Two sites were chosen in each of the two years of the study. Each year a site was located on the properties of Mint Klynstra (sites 1 and 3) and Dave MacIntosh (sites 2 and 4). Sites 1 and 3 were located on Lot 17 of Concession 3, South West Oxford Township, Oxford County. Sites 2 and 4 were located on Lot 19 of Concession 10, South West Oxford Township, Oxford County.

Soil samples were taken in October of each year to determine soil texture and soil fertility. These samples were analyzed according to the standard procedures used by the Department of Land Resource Science, University of Guelph. The results are presented in Table 1.

Table 1: Soil fertility and particle size distribution results for samples collected at all sites. Kelp and Molasses Study, 1989-1990.

Soil Specifications									
Site	Soil Texture	% Sand	% Silt	% Clay	P (mg/l)	K (mg/l)	Mg (mg/l)	Ca (mg/l)	pH
1	Loam	36.4	49.9	14.0	11	80	259	2790	7.4
2	Silt Loam	19.4	58.2	22.4	10	101	233	2800	7.0
3	Silt Loam	25.4	60.6	14.1	27	695	229	1970	7.0
4	Silt Loam	22.7	55.7	21.6	14	179	201	2535	7.3

3.2 Experimental Design and Analyses

The main trials were set up as a randomized complete block design (RCBD) consisting of four replications in an area of a field treated with the Aer-way system minus the kelp and molasses soybean seed treatment. In year 1 each replicate consisted of four different treatments:

1. foliar applications of kelp and molasses;
2. foliar applications of kelp alone;
3. foliar applications of molasses alone;
4. control, no foliar applications.

In year 2 each replicate consisted of six different treatments:

1. foliar applications of kelp alone;
2. foliar applications of molasses alone;
3. foliar applications of 71B fertilizer alone;
4. foliar applications of kelp and molasses;
5. foliar applications of kelp, molasses and 71B fertilizer;
6. control, no foliar applications.

The dimensions of each plot were 3.7m by 6.1m in year 1 and 4.6m by 4.9m in year 2, within each replicate.

In addition to the above study, a side-by-side comparison trial with 8 paired sample areas was also implemented at all sites. In year one this study was situated in an area of the field treated with the Aer-way system plus the soybean seed was treated with kelp and molasses just prior to seeding. The side-by-side treatments included:

1. seed and foliar treatment applications with kelp and molasses (test);
2. seed treatment with kelp and molasses only (control).

In year two, the study was situated in an area of the field treated with the Aer-way system. The side-by-side treatments included:

1. seed treated with kelp and molasses at planting, foliar application of kelp, molasses and 71B fertilizer (test);
2. foliar applications of the kelp, molasses and 71B fertilizer (control).

For the side-by-side comparison trials the dimensions of each plot were 3.7m by 6.1m for both sites in year 1 and 4.6m by 4.9m at site 4 in year 2. At site 3 the plot size was 4.6m by 1.5m.

The kelp and/or molasses seed and foliar treatments were applied at rates recommended in `The Natural Fertility Alternative of Formula 71B Fertilizer Solution' (Appendix A). The cooperator treated the soybean seed with .73 l/ha kelp and .95 l/ha molasses just prior to planting. Adjustments to the planters were made, if required, to accommodate the treated seed. The foliar treatments were applied by CMS twice during the growing season, once at the soybean trifoliate leaf stage (7-10 cm tall, approximately 4 weeks after planting) and the second at first flower (approximately 6 weeks after planting). The rates applied were .51 l/ha, .95 l/ha and 9.36 l/ha for kelp, molasses and 71B fertilizer, respectively. The foliar treatments were applied using a gas powered mister/fogger back-pack sprayer.

The data collected from the randomized complete block design plots were analyzed using a two-way analysis of variance. Significant differences among treatments were determined using the Least Significant Difference (LSD) test at the 5% level of significance. The sites were analyzed individually. Data collected from the side-by-side comparison trials were analyzed using a paired t-test and are also presented on an individual site basis.

3.3 Agronomic Practices

In late spring of 1989 and 1990 the kelp and molasses study was initiated at two locations in each year. Each participating cooperator had previously used the Aer-way® tillage implement to work their land, as well, rye was used as a cover crop at each site. See Appendix B for a summary of individual site management practices.

Maximum, minimum and mean daily temperatures and daily total precipitation are summarized for the months of May to October of each year in Appendix C. Information for these tables was obtained from the Atmosphere Environmental Service, Environment Canada, Foldens, Tillsonburg and Culloden stations.

3.4 Measurements

i) Soybean plant emergence

The number of plants emerged per square metre (plants/m^2) were counted at one and three locations within each plot for the comparison and RCBD trials, respectively. These data were collected approximately 7, 14, and 21 days after planting (DAP).

ii) Soybean plant height

The height of the soybean plants within a one square metre area were recorded at three locations within each plot for the RCBD trial. Only one location per plot in the side-by-side comparison trial was sampled. Heights were taken from the ground to the tip of the apical meristem (main shoot). Measurements were taken to the nearest half centimetre at approximately 14 DAP and within two days of the foliar treatment applications (approximately four and six weeks after planting).

iii) Soybean plant vegetative and reproductive stage

The soybean plant vegetative and reproductive stages were recorded at two locations within each plot from the RCBD trial and from one location within each plot in the comparison trial. The number of plants within a one quarter of a metre square area were sampled. Vegetative and reproductive stages were recorded according to the method outlined by Fehr *et al*. (1971). These data were collected within two days of the foliar treatment applications.

iv) Physiological maturity

According to Fehr *et al*. (1971) soybean plant physiological maturity is reached when pods start turning yellow and 50 percent of the leaves have turned yellow.

Each plot was visually assessed in mid-September of each year, regarding the amount of colour change of the leaves and pods. Ratings were given from 0 to 10, where 0 equals no colour change (green) and 10 equals complete colour change (yellow and/or brown).

v) Soybean seed yield

All above ground material was hand harvested from within a 3.2 square metre area (sites 1 and 2) and 2.6 square metre area (site 3) per plot in the RCBD trials. One square metre per plot was harvested from the side-by-side comparison trials at sites 1 and 2 and a 1.3 square metre per plot at site 3. These samples were passed through a plot size combine (Hege®) and the seed was subsequently cleaned and weighed. The weights were adjusted to kilograms per hectare at 14.0% seed moisture content.

4.0 <u>RESULTS</u>

4.1 Randomized Complete Block Design Trials

a) Soybean plant emergence

Soybean plant emergence is presented in Tables 2 through 4. At the time of the data collection for the soybean plant emergence none of the treatments had been applied.

There was no significant difference in the number of plants emerged per square metre at 7 DAP at sites 1 and 3. At site 2, significantly fewer plants emerged on the control plots when compared to the number of plants emerged on the kelp only and molasses only plots. The number of plants emerged on the control plots however, was comparable to the number of plants emerged on the kelp and molasses treated plots. A wide variation in rate of emergence existed between all four sites. Wet conditions at planting (site 4) and the near absence of rye residue at site 2 may account for the dramatic differences between these two sites in particular. The coefficient of variation (c.v.) values were quite high for sites 1 and 3. This high value may have been due to poor plant depth control because of the rye residues resulting in uneven germination and emergence of the soybeans.

At 14 DAP there were no significant differences in the number of plants emerged across all treatments at sites 2 and 4. At site 1 the number of plants emerged under the kelp and molasses treatment was significantly greater than for all other treatments. The kelp, molasses and 71B fertilizer treatment plus the molasses only and the kelp and molasses treatments had a significantly greater number of plants emerged than the 71B fertilizer only treatment, but were not significantly different from the control and kelp only treatments at site 3.

At 21 DAP there were no significant differences between treatments at any of the sites. Site 3 had the greatest number of plants emerged per square metre (29.4 to 43.7) followed by site 1 (34.2 to 37.5), site 2 (32.4 to 33.9) and site 4 (27.6 to 33.3). Since soybean plants will branch out to compensate for lower plant densities, no one site was considered at a disadvantage in this regard.

b) Soybean plant height

At two weeks after planting (pre-treatment application) there was no significant difference in the height of the soybean plants between treatments at all sites, as shown in Table 5. Site 1 had the shortest plants. This occurrence may have been caused by competition between the fall rye cover crop (which was still alive at this time) and the soybeans. The other sites did not have this competition.

In general, the soybean plant height at the first foliar treatment application date was about 8.5 to 10 cm across all sites. There was no significant difference between treatments in the soybean plant height at sites 1, 2 and 3, as outlined in Table 6. At site 4 the plants under the molasses only treatment were the tallest (10.1 cm). This result was significantly greater than the result for the 71B fertilizer only treatment and the control, but was not significant when compared to the remaining treatments.

Again, at sites 1, 2 and 3 there were no significant differences in plant height between treatments at the second foliar treatment application date. At site 4 plant height for the kelp and molasses treatment was significantly greater than the 71B fertilizer only treatment, but not significantly greater than for the remaining treatments (Table 7). Site 4 also recorded the tallest plants. This may be due to weed competition which may have caused the plants to stretch. The weeds were removed by hand in order to decrease this competition before the second foliar application. Similarly at site 3, a greater number of plants per square metre than at any other site probably encouraged increased plant height with less branching due to plant competition.

c) Soybean plant vegetative stage

Overall, there were no significant differences in the rate of vegetative growth at the first foliar treatment application date at any of the sites, as shown in Table 8. Plant growth was more advanced at sites 1 and 2 than at sites 3 and 4. This may have been caused by the excessive wet conditions in the 1990 growing season relative to 1989 and the long term average. As noted above plant height was greater at sites 3 and 4 in comparison with sites 1 and 2. The plants may have expended more energy on stem elongation than leaf development causing a delay in overall development. In addition soybean varietal differences at each site may confound differences on a site-by-site basis (see Appendix B for soybean varieties used).

At the second foliar application date sites 1, 2, and 4 had no significant differences in soybean plant vegetative growth stage between treatments (Table 9). At site 3, the kelp, molasses and 71B fertilizer treatment was vegetatively further advanced than the kelp only and molasses only treatments. The remaining treatments were not significantly different from the kelp, molasses and 71B fertilizer treatment. The vegetative stage increased more rapidly at site 4 than at the other sites which may have been due to the weed competition at this site.

Table 2: Soybean plant emergence at 7 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant emergence (plants/m²)			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	3.1 a*	26.0 a	1.4 a	0.0**
Molasses only	1.9 a	26.8 a	0.8 a	0.0
71B fertilizer only	-	-	1.1 a	0.0
Kelp and molasses	2.8 a	25.0 ab	0.7 a	0.0
Kelp, molasses and 71B	-	-	1.9 a	0.0
Control	3.4 a	22.8 b	1.7 a	0.0
c.v.	48.6	6.9	86.7	

‡ Treatments not yet applied at time of data collection.
* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.
** No plants emerged 7 DAP at this site.

Table 3: Soybean plant emergence at 14 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant emergence (plants/m²)			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	30.9 b*	31.0 a	39.0 ab	28.6 a
Molasses only	28.9 b	29.3 a	40.1 a	33.0 a
71B fertilizer only	-	-	35.0 b	26.3 a
Kelp and molasses	40.5 a	28.8 a	40.7 a	30.2 a
Kelp, molasses and 71B	-	-	42.9 a	24.8 a
Control	32.3 b	30.5 a	39.2 ab	29.0 a
c.v.	13.9	8.1	8.2	21.4

‡ Treatments not yet applied at time of data collection.
* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 4: Soybean plant emergence at 21 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant emergence (plants/m^2)			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	34.3 a*	32.4 a	43.7 a	32.0 a
Molasses only	34.1 a	32.9 a	32.9 a	33.3 a
71B fertilizer only	-	-	38.0 a	28.8 a
Kelp and molasses	37.5 a	33.7 a	43.0 a	32.0 a
Kelp, molasses and 71B	-	-	41.5 a	27.6 a
Control	36.6 a	33.9 a	39.4 a	31.6 a
c.v.	11.7	5.0	12.7	14.5

‡ Treatments not yet applied at time of data collection.
* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 5: Soybean plant height at 14 DAP at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant height (cm)			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	1.8 a*	3.7 a	3.2 a	2.8 a
Molasses only	1.5 a	3.8 a	3.2 a	2.5 a
71B fertilizer only	-	-	3.1 a	2.4 a
Kelp and molasses	1.9 a	3.9 a	2.9 a	2.6 a
Kelp, molasses and 71B	-	-	3.2 a	2.4 a
Control	1.7 a	3.7 a	3.2 a	2.6 a
c.v.	22.8	7.1	11.0	16.3

‡ Treatments not yet applied at time of data collection.
* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 6: Soybean plant height at the first foliar application date (soybean first trifoliate leaf stage, approximately four weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant height (cm)			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	10.5 a*	9.6 a	8.7 a	9.7 ab
Molasses only	10.6 a	10.2 a	9.2 a	10.1 a
71B fertilizer only	-	-	9.0 a	7.5 c
Kelp and molasses	10.9 a	9.7 a	8.3 a	8.7 abc
Kelp, molasses and 71B	-	-	8.8 a	8.9 abc
Control	10.5 a	10.0 a	8.8 a	8.4 bc
c.v.	6.8	7.4	8.9	11.1

‡ Foliar treatments applied within 2 days of data collection.
* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 7: Soybean plant height at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant height (cm)			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	20.5 a	18.8 a	27.8 a	25.7 ab
Molasses only	19.8 a	19.7 a	24.8 a	37.0 ab
71B fertilizer only	-	-	27.6 a	32.3 b
Kelp and molasses	20.7 a	19.1 a	27.7 a	42.2 a
Kelp, molasses and 71B	-	-	28.3 a	35.1 ab
Control	20.8 a	19.0 a	27.6 a	36.0 ab
c.v.	8.5	4.8	8.8	12.7

* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

d) Soybean plant reproductive stage

As shown in Table 10, there was no significant difference in the soybean plant reproductive growth stage at the second foliar treatment application date at sites 1, 2 and 4. At site 3, the reproductive stage of the plants treated with the kelp and molasses was significantly more advanced than those plants treated with the molasses only foliar spray but there were no significant differences between the remaining treatments.

Table 8: Soybean plant vegetative stage at the first foliar application date (soybean first trifoliate leaf stage, approximately four weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant vegetative stage*			
	1989		1990	
Foliar application‡	Site 1	Site 2	Site 3	Site 4
Kelp only	2.7 a**	2.8 a	1.0 a	1.9 a
Molasses only	2.6 a	2.8 a	1.0 a	1.8 a
71B fertilizer only	-	-	0.9 a	1.7 a
Kelp and molasses	2.6 a	2.8 a	0.9 a	1.9 a
Kelp, molasses and 71B	-	-	1.0 a	1.9 a
Control	2.6 a	2.7 a	1.1 a	1.8 a
c.v.	4.3	3.5	12.0	9.8

‡ Foliar treatment applied within two days of data collection.
* Adapted from Fehr *et al*.(1971).
** Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

e) Physiological maturity

A visual assessment of soybean leaf and pod colour change (Tables 11 and 12) appears to indicate that no one treatment is consistently superior to another. At sites 1 and 3 for example, the plants treated with the kelp and molasses foliar spray reached physiological maturity slightly ahead of non-treated plants in the control plots. At sites 2 and 4 the reverse trend is apparent. Due to a variety of differences between sites these results are inconclusive. No statistical analysis was performed on the data.

Table 9: Soybean plant vegetative stage at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant vegetative stage*			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	6.4 a**	7.3 a	4.6 bc	6.7 a
Molasses only	6.3 a	7.4 a	4.5 c	6.3 a
71B fertilizer only	-	-	4.8 abc	6.0 a
Kelp and molasses	6.5 a	7.6 a	4.8 abc	6.3 a
Kelp, molasses and 71B	-	-	5.0 a	6.0 a
Control	6.4 a	7.4 a	4.9 ab	6.5 a
c.v.	3.7	4.1	3.9	10.2

* Adapted from Fehr *et al*.(1971).

** Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 10: Soybean plant reproductive stage at the second foliar application date (soybean first flower, approximately six weeks after planting) at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean plant reproductive stage*			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	.81a**	.64 a	.19 ab	1.0 a
Molasses only	.79 a	.66 a	.15 b	1.0 a
71B fertilizer only	-	-	.20 ab	0.6 a
Kelp and molasses	.84 a	.72 a	.36 a	0.5 a
Kelp, molasses and 71B	-	-	.17 ab	1.0 a
Control	.91 a	.58 a	.22 ab	0.6 a
c.v.	9.7	25.5	59.5	48.0

* Adapted from Fehr *et al*.(1971).
** Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

Table 11: Visual assessment of soybean leaf colour change at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Soybean leaf colour change*			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	4.4	7.8	4.8	3.3
Molasses only	4.1	7.9	4.0	3.5
71B fertilizer only	-	-	5.0	2.3
Kelp and molasses	5.0	7.5	5.3	2.3
Kelp, molasses and 71B	-	-	4.5	3.3
Control	4.5	7.4	4.3	3.3

* Soybean leaf colour change: 0 = no colour change (green); 10 = complete colour change (yellow and/or brown).

Table 12: Visual assessment of soybean pod colour change at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Soybean pod colour change*			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	0.8	1.5	3.0	0.5
Molasses only	0.5	2.0	3.5	0.3
71B fertilizer only	-	-	3.5	0.0
Kelp and molasses	1.3	1.8	3.5	0.0
Kelp, molasses and 71B	-	-	3.3	0.3
Control	0.8	2.0	3.3	0.5

* Soybean leaf colour change: 0 = no colour change (green); 10 = complete colour change (yellow and/or brown).

f) Soybean yield at 14.0% moisture

As Table 13 indicates, in the first year of application, there were no significant differences between soybean seed yields across all treatments at sites 1 and 2. The yields at site 1 ranged from 2787 to 3255 kg/ha whereas at site 2 the yields ranged from 2489 to 2637 kg/ha.

At site 3 in 1990, the seed yields from the kelp and molasses treatment (3038 kg/ha) followed by the kelp, molasses and 71B fertilizer treatment (3004 kg/ha) and control (2949 kg/ha) were significantly greater than the molasses only treatment (2434 kg/ha). The remaining treatments, kelp only (2839 kg/ha) and 71B fertilizer only (2709 kg/ha) were not significantly different from the above treatments.

Hand samples for yield of soybeans at site 4 were not taken. Attempts were made to hand harvest but due to wet weather in the fall of 1990 and excessive wet conditions in this field the trial area could not be reached to collect the samples. Unfortunately however, the field was harvested by custom operators under extremely wet conditions. The co-operator and CMS were not aware that this was going to occur.

Table 13: Soybean seed yield at 14.0% moisture content at four locations in Oxford County. Kelp and Molasses Study, 1989-1990.

Treatment	Mean soybean seed yield (kg/ha)			
	1989		1990	
Foliar application	Site 1	Site 2	Site 3	Site 4
Kelp only	2800 a*	2528 a	2839 ab	n/a
Molasses only	2787 a	2489 a	2434 b	n/a
71B fertilizer only	-	-	2709 ab	n/a
Kelp and molasses	3255 a	2637 a	3038 a	n/a
Kelp, molasses and 71B	-	-	3004 a	n/a
Control	2854 a	2618 a	2949 a	n/a
c.v.	13.3	14.3	10.1	n/a

* Values in the same column followed by the same letter are not significantly different (p#0.05) according to the Least Significant Difference test.

4.2 Side-By-Side Comparison Trials

a) Soybean plant emergence

Table 14 indicates there were no significant differences in plant emergence between all treatments at all sites.

Table 14: Soybean plant emergence as affected by seed or foliar treatments* of kelp/molasses/71B fertilizer in a side-by-side comparison trial area in 1989 and 1990.

Comparison Pair No.	1990				1989		1990	
	7 DAP		14 DAP		21 DAP		21 DAP	
	Site 3	Site 4	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
1	-2[+]	0	-6	-4	1	-2	5	-4
2	-1	0	4	-1	14	-13	-2	2
3	0	0	-2	-6	-8	-6	-4	-5
4	1	0	-7	8	-4	4	8	6
5	1	0	7	-14	14	2	6	3
6	3	0	12	2	5	11	5	6
7	1	0	-22	-21	-4	4	-25	-3
8	1	0	-12	-12	14	11	-2	-2
Std. Error (difference)	1.5 NS	NA	11.0 NS	9.4 NS	9.1 NS	8.2 NS	10.6 NS	4.4 NS

* 1989 **Control** treatment = seed treatment with kelp and molasses only.
Test treatment =seed and foliar treatment applications with kelp and molasses.
1990 **Control** treatment =seed treatment with kelp and molasses at planting, foliar application of kelp, molasses and 71B fertilizer.
Test treatment =seed and foliar treatment applications with kelp and molasses.

\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.

NS Not significant at the 0.05 level of probability according to a paired sample t-test.

NA Not available, no plants emerged at 7 DAP.

b) Soybean plant height

In year 1 of the study there were no significant differences between the control and test treatments for all sampling dates (Table 15). In year 2 there were no significant differences between treatments at all sampling dates for site 3 and 14 DAP and the first foliar application date for site 4 (Table 16). There was however at site 3, a significant difference between treatments at the second foliar application date, with the control plots (no seed treatment plus foliar applications) being significantly shorter than the test plots (seed treatment plus foliar applications).

Table 15: Soybean plant height as affected by foliar treatments* of kelp and molasses in a side-by-side comparison trial in 1989.

Comparison Pair No.	Plant height (cm)					
	14 DAP		1st application		2nd application	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1	1.0+	0.9	-2.6	-2.5	-1.1	-2.6
2	1.0	-0.3	2.8	-1.3	0.8	-0.2
3	1.0	0.6	-2.8	-1.2	-0.6	-0.4
4	0.0	0.0	0.1	-2.3	-8.5	-0.2
5	-1.0	1.2	0.0	-2.6	0.6	-0.3
6	-1.0	-0.5	-2.9	-1.0	0.9	-0.4
7	-1.0	-1.8	-2.4	3.2	-0.3	0.3
8	0.0	0.1	4.8	0.3	0.3	-0.1
Std. Error (difference)	0.7 NS	0.9 NS	2.9 NS	1.9 NS	3.1 NS	3.4 NS

* **Control** treatment = seed treatment with kelp and molasses only.
Test treatment = seed and foliar treatment applications with kelp and molasses.

\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.

NS Not significant at the 0.05 level of probability according to a paired sample t-test.

Table 16: Soybean plant height as affected by seed treatment* of kelp and molasses in a side-by-side comparison trial area in 1990.

Comparison Pair No.	Plant height (cm)					
	14 DAP		1st application		2nd application	
	Site 3	Site 4	Site 3	Site 4	Site 3	Site 4
1	-1.4+	-1.3	-2.6	-3.0	-5.1	-10.3
2	-0.8	-0.8	2.8	-0.1	-3.0	0.0
3	0.8	0.8	-2.8	-0.5	-1.5	-6.8
4	0.5	0.5	0.1	-0.5	-0.6	7.1
5	1.2	-0.4	0.0	-1.6	-3.1	-8.3
6	-0.5	0.6	-2.9	1.5	-7.0	8.0
7	-1.8	-0.3	-2.4	-0.8	-0.4	-9.2
8	0.1	0.1	4.8	-0.9	-5.4	-4.4
Std. Error (difference)	0.8 NS	0.7 NS	1.9 NS	1.3 NS	2.4 ++	7.3 NS

* **Control** treatment = foliar application of kelp, molasses and 71B fertilizer.
Test treatment = seed treatment with kelp and molasses, foliar application of kelp, molasses and 71B fertilizer.

\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.

++ Significant at the 0.05 level of probability according to a paired sample t-test.

NS Not significant at the 0.05 level of probability according to a paired sample t-test.

c) Soybean plant vegetative stage

As outlined in Tables 17 and 18, sites 2 and 4 showed no significant differences between the two treatment plots at both sampling dates. The control treatment (seed treatment, no foliar applications) was significantly less advanced vegetatively than the test treatment (seed treatment, foliar applications) at site 1, when data were taken at the second foliar application date. The same trend occurred at site 3, with the control (no seed treatment, foliar applications) being significantly less advanced vegetatively than the test treatment (seed treatment plus foliar applications). There was no significant difference between treatments at the first foliar application date for these two sites.

d) Soybean plant reproductive stage

There were no significant differences between the reproductive stage for the two treatments at any of the sites when measured at the second foliar application date (Tables 17 and 18).

Table 17: Soybean plant vegetative and reproductive growth stages‡ as affected by foliar treatments* of kelp and molasses in a side-by-side comparison trial in 1989.

Comparison Pair No.	Vegetative Stage 1st application		Vegetative Stage 2nd application		Reproductive Stage 2nd application	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1	-0.3[+]	0.1	-2.6	0.0	0.1	-0.2
2	0.1	-0.2	2.8	1.0	0.1	0.0
3	-0.4	-0.4	-2.8	0.0	-0.3	0.2
4	0.0	-0.2	0.1	1.0	-0.3	0.3
5	0.3	-0.3	0.0	-1.0	-0.1	0.0
6	-0.4	-0.4	-2.9	0.0	0.2	-0.2
7	0.2	0.3	-2.4	1.0	-0.0	0.5
8	0.4	-0.1	4.8	0.0	0.1	-0.3
Std. Error (difference)	0.3 NS	0.2 NS	0.4 ++	0.6 NS	0.2 NS	0.3 NS

‡ Vegetative and reproductive growth stages after method developed by Fehr *et al.* (1971).
* **Control** treatment = seed treatment with kelp and molasses only.
Test treatment = seed and foliar treatment applications with kelp and molasses.
\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.
++ Significant at the 0.05 level of probability according to a paired sample t-test.
NS Not significant at the 0.05 level of probability according to a paired sample t-test.

Table 18: Soybean plant vegetative and reproductive growth stages‡ as affected by seed treatment* of kelp and molasses in a side-by-side comparison trial area in 1990.

Comparison Pair No.	Vegetative Stage 1st application		Vegetative Stage 2nd application		Reproductive Stage 2nd application	
	Site 3	Site 4	Site 3	Site 4	Site 3	Site 4
1	0.1+	-0.6	-0.5	-1.8	0.1	-0.1
2	0.1	0.3	-0.4	0.3	0.1	0.8
3	0.2	0.4	-0.9	-0.3	0.0	-0.4
4	0.4	0.0	-0.5	0.6	0.0	0.1
5	0.2	-0.6	-0.5	-0.1	0.0	0.2
6	-0.2	0.3	-0.7	0.1	0.0	-0.4
7	-0.4	0.0	-1.2	-1.6	0.2	-0.2
8	-0.4	-0.4	-1.4	-0.8	-0.3	-0.5
Std. Error (difference)	0.3 NS	0.4 NS	0.4 ++	0.9 NS	0.2 NS	0.4 NS

‡ Vegetative and reproductive growth stages after method developed by Fehr *et al*. (1971).
* **Control** treatment = foliar application of kelp, molasses and 71B fertilizer.
Test treatment = seed treatment with kelp and molasses, foliar application of kelp, molasses and 71B fertilizer.
\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.
++ Significant at the 0.05 level of probability according to a paired sample t-test.
NS Not significant at the 0.05 level of probability according to a paired sample t-test.

e) Physiological maturity

There were no apparent differences for the visual assessment of the leaf and pod colour change at site 3 and for pod colour change at site 4, as shown in Table 19. For the leaf colour change at site 4, it appears that the test treatment plots (seed treatment plus foliar applications) were different than the control treatment plots (no seed treatment, foliar applications). Although the side-by-side comparison strips did not have the weed competition that the RCBD trial area had at site 4, the control strip bordered this area. This bordering effect may have affected the rate of leaf colour change in the control as compared to the test strip. Sites 1 and 2 were not visually assessed for the amount of leaf and pod colour change on the soybean plants.

Table 19: Visual assessment of soybean plant leaf and pod colour change‡ as affected by seed treatments* of kelp and molasses in a side-by-side comparison trial area in 1990.

Comparison Pair No.	Soybean leaf colour change (0-10)		Soybean pod colour change (0-10)	
	Site 3	Site 4	Site 3	Site 4
1	0.0+	4.0	0.0	0.0
2	0.0	4.0	0.0	0.0
3	0.0	1.0	0.0	0.0
4	0.0	5.0	0.0	0.0
5	0.0	3.0	0.0	0.0
6	0.0	5.0	1.0	1.0
7	0.0	2.0	0.0	0.0
8	0.0	3.0	0.0	0.0

‡ Soybean leaf and pod colour change are adapted from the method developed by Fehr *et al*. (1971).

* **Control** treatment = seed treatment with kelp and molasses at planting, foliar application of kelp, molasses and 71B fertilizer.
Test treatment = seed and foliar treatment applications with kelp and molasses.

\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.

f) Yield at 14.0% moisture

Table 20 indicates that at sites 1, 2 and 3 there were no significant differences between the control and test treatment plots for yield data. Site 4 yield data are not available.

Table 20: Soybean seed yield as affected by seed or foliar treatments* of kelp/molasses/71B fertilizer in a side-by-side comparison trial in 1989 and 1990.

Comparison Pair No.	Soybean seed yield at 14.0% moisture (kg/ha)		
	1989		1990
	Site 1	Site 2	Site 3
1	-929.6[+]	701.8	-139.2
2	474.7	-669.1	-501.0
3	-441.2	-288.8	-365.0
4	-371.0	251.9	650.9
5	230.4	-132.1	1135.2
6	-179.5	669.4	622.6
7	-547.2	-308.7	490.8
8	-202.2	-247.7	-204.7
Std. deviation (difference)	441.5 NS	503.0 NS	175.8 NS

* 1989 **Control** treatment = seed treatment with kelp and molasses only.
Test treatment = seed and foliar treatment applications with kelp and molasses.
1990 **Control** treatment = seed treatment with kelp and molasses at planting, foliar application of kelp, molasses and 71B fertilizer.
Test treatment = seed and foliar treatment applications with kelp and molasses.

\+ The numbers in each column represent the difference between the control minus the test treatment for that particular set of data.

NS Not significant at the 0.05 level of probability according to a paired sample t-test.

5.0 DISCUSSION

The rate of soybean emergence and growth, in the early part of the growing season, may have been affected by differences in planting depth and the presence of winter rye competition (site 1) and winter rye root clumps (site 3). Weed competition, at site 4, may have affected the rate of plant growth.

In addition, weather conditions may have also played an important role in growth and development of the soybean plants. In general, throughout the growing season site 1 received more precipitation that site 2 in year one of the study. In year two the growing season was considerably wetter than year one thus affecting emergence and growth of the soybean plants.

6.0 CONCLUSIONS

After the completion of research at four separate locations, it was concluded that the use of kelp and/or molasses and/or 71B fertilizer solution as a seed or foliar treatment on a one year application basis, did not significantly affect the growth and yield of soybeans when included as part of the Aer-way crop production system.

From the side-by-side comparison trials, it was concluded that the use of a seed treatment of kelp and molasses plus foliar applications did not significantly affect soybean plant growth or seed yield on a one year application basis.

It is important to note that this research was performed over two growing seasons with four management practices using four different varieties of soybeans at four different locations.

7.0 RECOMMENDATIONS

1. To repeat the application of kelp/molasses/71B fertilizer solution at the same sites over a two to three year period to achieve comparisons between treatments over years.

8.0 REFERENCES

Fehr, W.R., C.E. Caviness, D.T. Burmood and J.S. Pennington. 1971. Stage of development descriptions for soybeans, *glycine max (L)* Merrill. Crop Science, 11:929-931.

APPENDIX A

The Natural Fertility Alternative of Formula 71B Fertilizer Solutions

WE STRIVE FOR

PERFORMANCE

QUALITY

PROFITS

FORMULA 71B

FERTILIZER SOLUTIONS

The Natural Fertility Alternative Of

FORMULA 71B

FERTILIZER SOLUTIONS

COMBINING SELECT NUTRIENTS WITH BIOLOGICALS

A HANDY GUIDE FOR CROP PRODUCTION

PURPOSE OF THIS BOOKLET

Farming is a complicated business during this time. Expenses are high for machinery - land - fertilizers - chemicals, and seemingly, the prices of farm products are too low. If farmers are to survive the financial crunch of our present economic situation, much consideration needs to be given to the stewardship of the soil and the preserving of our most valuable natural resource THE LAND!! Representatives of Formula 71B are committed to helping the farmer find solutions to problems associated with the soil such as INSECTS - WEEDS - COMPACTION - HIGH SALTS and NUTRIENT IMBALANCES. Independent field research and farmer experience has opened the doors to a host of more natural products which can help the farmer reduce his dependency on harsh chemicals without reducing his yields and profits.

Let us work together to promote "LIFE IN OUR SOIL" - Lasting profits and yields depend upon it!!! If we have problems with excessive weed pressure, insects, and increasing compaction in our soil, let us not **TREAT THE SYMPTOM OF THE PROBLEM** with harsh, deadly chemicals, BUT let us find the REAL problem and remove it thru various Natural Alternatives!!!!

Recommendations and methods contained herein will be dealing with the use of FORMULA 71B Fertilizer/w/Biological Catalyst Concentrates and Black Strap Molasses.

We will be suggesting methods which has proven to be the most effective with farmers throughout the United States and Canada, and 7 full years of intensive testing and research on the CASI Demonstration farm at Dexter, Missouri. These methods and products can help you reduce your dependence on toxic chemicals and help you convert to a more Natural farming operation.

MATTHEW: 5:16 — Let your light so shine before men, that they may see your good works, and glorify your Father which is in heaven.

ADVANTAGES TO CONSIDER

FORMULA 71B PLANT FOOD SOLUTIONS: A high quality fertilizer solution which contains a specific trace mineral and Biological Catalyst package unique in the fertilize industry today. It is non-toxic, non-corrosive and can be used as recommended on or beside the seed, as a seed treatment, as a transplanting solution, and applied as a foliage spray. 71B is used as a method of feeding the plant instead of the traditional methods of Broadcasting dry commercial fertilizers. Inexpensive planter units are available through your local sales representative.

WHY FORMULA 71B DESERVES YOUR CONSIDERATION

Most fertilizer solution companies recommend additional P&K in the form of dry fertilizers from their standard soil test. The philosophy behind Formula 71B is thru the use of a Biological Catalyst, and a Special trace mineral package that enhances biological life, therefore the farmer can then eliminate his need for additional amounts of P&K and even reduce his needs for excessive nitrogen beyond limits that a plant may require naturally. This makes Formula 71B unique since it contains a balance of trace minerals-special enzyme mix and biological catalyst while others do not. The base material in Formula 71B has a background of over 20 years use in the nursery and greenhouse speciality industry. After 7 years of independent testing of the Formula 71B Biological Catalyst and Trace Mineral package with select 9-18-9 and 10-20-10 Fertilizer Solutions, the unique Formula 71B has continually proven to be "a profit leader"!! more and more farmers are changing to the Formula 71B Program. 71B meets the rigid requirements of a high quality liquid plant food product. 71B, like any other plant food solution, cannot guarantee miracles and specific yield increases, but can be used as a tool in a profitable farm operation.

7 ADVANTAGES FOR USING FORMULA 71B FERTILIZER SOLUTION

1. Use on the seed and as a foliage spray.
2. Non-toxic to plants and soil life - Non-corrosive to equipment used for storage and application.
3. Pour or pump into tanks and applicators - no heavy bags to lift or buggies to pull over the fields.
4. Usually cost less per acre considering efficiency of 90-98%.
5. On farm storage.
6. Mix with most chemical herbicides, insecticides, etc. to save time and trips over the field.
7. Usually helps improve yields - protein quality - seed germination and soil life.

FORMULA 71B IS GUARANTEED TO CONTAIN

1. **10% Nitrogen** in form of food-grade Urea of low Biuret Non clay coated source and premium-grade aqua ammonium.
2. **20% Phosphate** in form of P_2O5 phosphoric acid called electric furance grade acid or food grade acid used in the food-beer and soft drink industries and a few liquid fertilizer mfg's (75.9% H_3PO4).
3. **10% Potash Potassium Hydroxide.** It contains highest chemical grade K_2O and finds very restricted use in fertilizers.

CONDITIONS OF SALE AND WARRANTY

Neither seller or manufacturer of Formula 71B makes any expressed or implied guarantees besides product quality claims as noted herein. Buyer assumes all responsibility for safety and proper use and application of products. Limits of warranty extends only to replacement of defective product by manufacturers. In no case shall seller or manufacturer be liable for consequiental, special or indirect damages resulting from use of this product.

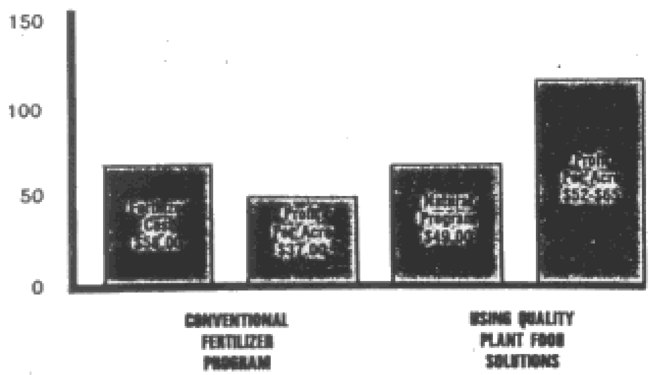
FOR INFORMATION OF APPLICATION RATES AND TIMING FOR VARIOUS CROPS AND PASTURE SITUATIONS, CONTACT:

CONCENTRATION, PLACEMENT AND TIMING FOR HIGHER PROFITS

It takes a certain amount of fertilizer nutrients to reach optimum yields. But quantity of plant food nutrients isn't as important as quality nutrient applications at the proper times. For instance, when you make a ONE-SHOT broadcast of fertilizers, much of it can be missed by developing plants and used to increase insect and weed pressure, giving the farmer an inadequate return on his fertilizer dollars.

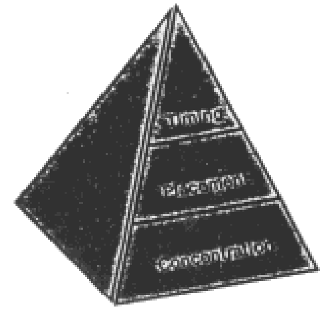
HIGH PLANT UTILIZATION MAKES THE DIFFERENCE.

High Plant Utilization Makes The Difference ....
Normal Cost And Profit Per Acre.
These figures apply to corn, but comparable returns on a high Efficiency - Fertilization - Bio program are common in other crops.



MANAGEMENT TECHNIQUES THAT PAY...to get full value from your fertilizer solutions, start with the proper amount and apply it WHEN and WHERE it is needed most. That's high-efficiency and utilization - the speciality of your Formula 71B fertilizer representative.

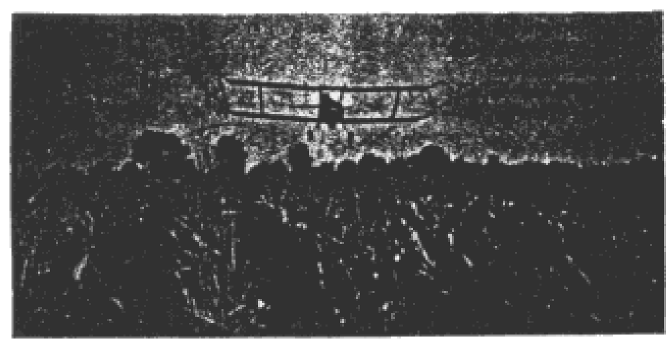
HIGH-UTILIZATION FERTILIZATION



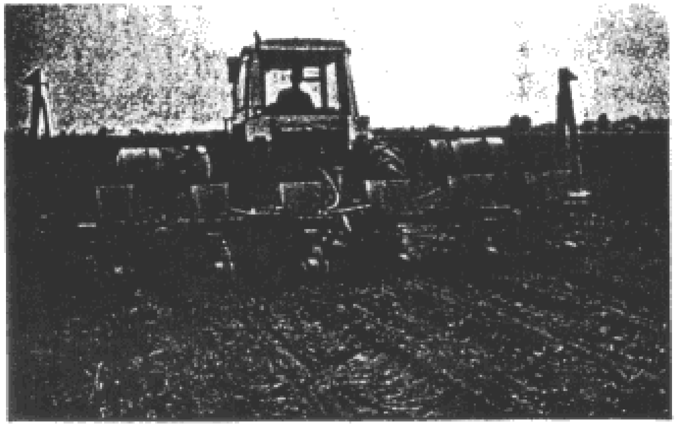
PEAK PRODUCTIVITY

71B's high utilization fertilizer program is based on a three-cornered foundation of concentration-placement-timing.

PRODUCTIVITY means, not more fertilizer, but direct seed applications that place fewer particles of plant food in contact with the soil, to minimize nutrient tie up and maximize fertilizer efficiency.



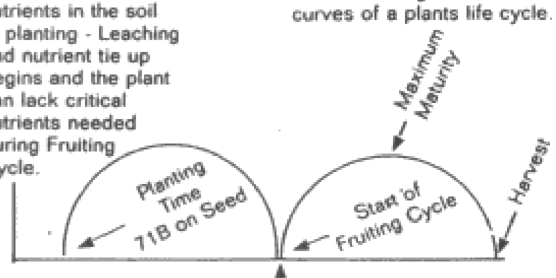
PLACEMENT means that such plant food concentrations are made more accessible to the young seedling by direct seed placement.



TIMING means making foliar applications when plant requirements are high as during pre-boot, pre-tassel, pre-bloom stages of growth.

Dry programs puts most nutrients in the soil at planting - Leaching and nutrient tie up begins and the plant can lack critical nutrients needed during Fruiting Cycle.

Chart showing nutrient demand curves of a plants life cycle.



Foliage Sprays during this period can greatly increase yield potential.

PSALMS: 27:14 — Wait on the Lord: be of good courage, and he shall strengthen thine heart; wait I say on the Lord.

PRODUCTS TO ENHANCE FORMULA 71B FERTILIZER SOLUTIONS

BIOLOGICAL CATALYST CONCENTRATE — for extra performance out of your fertilizer solution, consider using a full biological program, which will increase both performance and efficiency in all crop production. Even though FORMULA 71B FERTILIZER SOLUTION has a proper amount of biological concentrate to enhance the product itself, an additional amount of a select biological catalyst concentrate should be added during field operations for increased performance.

The BIOLOGICAL CATALYST CONCENTRATE should be added to your Formula 71B for both direct seed and foliar applications. Normally, this will act as a plant and yield stimulant, plus quality of grain, hay and forages can GREATLY improve because of increased mineral intake of the plants!!

SECONDLY, Biological Catalyst Concentrates should be added to your soil, crop residues and green manures to improve soil nutrient levels and increase "soil energy" for greater yield potential. **REMEMBER** — soil life and proper nutrient balance is the key to a healthier, more vigorous crop. And there is no better way than to combine FORMULA 71B fertilizer solution with special micro-nutrient and biological energy concentrates designed for greater soil and plant performance.

PURE BLACK STRAP MOLASSES — this inexpensive product of the sugar cane industry should be a part of the Formula 71B fertilizer and Biological Catalyst Concentrate Program... WHY??? pure molasses is an excellent source of energy for both the biological life and the plant. Molasses is very high in natural minerals, enzymes and amino acids, which will increase sugar levels in plants and directly feed Biological Life. Another additional benefit of the molasses/bio mixture, it improves the plants resistance against both insects and disease.

WE STRIVE FOR

PERFORMANCE

QUALITY

PROFITS

PROVERBS: 2:6 — For the Lord gives wisdom, and from his mouth come knowledge and understanding.

METHODS OF USING FORMULA 71B BIOLOGICAL CATALYST & MOLASSES

A. SOIL APPLICATION IN THE ROW: soil application of Formula 71B, Biological Catalyst Concentrate and molasses is very effective as a starter. Simple inexpensive units such as the John Blue Squeeze Pump, Bloomhart PTO Roller Pump System, R & M Electric Pump and Gravity Flow Systems can be mounted on planters and drills. Equipment and options should be discussed with your sales representative.

B. FOLIAR FEEDING TECHNIQUE: 1. Up to 2½ gallons of undiluted material may be applied directly to the Foliage of most crops or mixed in with an equal amount of water to aid in calibration on tractor or high clearance sprayers. No more than 7-10 gallons of water and material need to be applied, to an acre, since excess water could decrease overall fertilize efficiency and make for wasted time in hauling large volumes of water. 2. "FOLIAR SPRAY IN LATE AFTERNOON OR EARLY MORNING when dew is on, NEVER IN DIRECT HOT SUNLIGHT!!! the finer the mist the more the plant will take in. 3. Add a good surfactant (wetting agent) to all foliar sprays for best results and to keep equipment clean. 4. Some weed killers and insecticides can be mixed with foliar spray operations to reduce trips over the field. Always check for compatability of herbicides and insecticides. 5. Best results of Foliar sprays on crops in mid to late stages adjust pH to 6.2 - 6.7 (use food-grade citric acid, or similar quality products for pH balances).

C. TRANSPLANTING SOLUTIONS: 1 gallon 71B, 1 quart Biological Catalyst Concentrate, ½ gallon Molasses per 100 gallon of water is an ideal transplanting solution. Six ounces of this mix may be applied directly to the roots at setting time per plant. Soil should be crumbly, not wet, when packed around roots. Roots need air for best response. This mix is ideal for trees and shrubs at rate of 1-5 gallon (per tree or shrub) depending on size.

D. 71B, Biological Catalyst Concentrate, Molasses used with Herbicides, Insecticides and Fungicides. A mixture of ¾ to 1 gallon 71B, 6 ounces Biological Catalyst, 1 quart molasses/acre can help reduce your chemical need by ¼ to ½. This mix should not be used with sprays containing heavy metals such as arsenate of lead, or mercury, aluminum, chromium. The longer a farm is on a natural fertility program the less chemicals will be needed for weeds and insects.

E. SEED TREATMENT: 1 gallon 71B, 1 quart Biological Catalyst Concentrate should treat 15-25 bushels of seed. Treating of seeds, especially small grains, is an ideal way of giving the young seedling a good start. It also helps improve germination. Treated seeds may not flow as freely and equipment may need to be adjusted accordingly. Treated seed should not be stored or bagged until it is dry. Seed may be treated in the drill boxes as it is non-corrosive. DO NOT SOAK THE SEED - treat it and plant immediately. Soybeans and other seeds should only be treated with Biological Catalyst concentrate.

F. For normal row crop production direct seed and foliar application should give the greatest return per dollar invested. If a farmer has a limited input budget, broadcast soil spray option should be eliminated before cutting other applications.

G. Avoid leaving mixtures of 71B, Biologicals and molasses in tanks for period of time (over 24 hrs.), or over 3 to 6 hours in direct hot sun light because excessive bacterial growth can occur and cause excessive strainer and tip blockage. If mixture must sit, for long period of time place in cool, shaded areas.

High Performance Farming
At Its Best!

ISAIAH: 40:31 — But they that wait upon the Lord shall renew their strength; they shall mount up with wings as eagles; they shall run and not be weary; and they shall walk, and not faint.

RATES PER ACRE ON FIELD CROPS

CORN

1. Plant with 2-4 gallons 71B, 7-10 ounces Biological Catalyst, 1 quart molasses on seed.
2. Foliar spray at 25-32 days after emergence (20-30" tall) with 2 gallon 71B, 5-8 ounces Biological Catalyst Concentrate, 1 quart molasses.
3. Foliar spray again pre-tassel, or early silk stage (optional). As step no. 2.
4. Band or broadcast 7-10 ounces Biological Catalyst Concentrate, 2-4 quart molasses on crop residue/green manure or mix with liquid nitrogen.

NITROGEN: 30-50 pounds pre-plant, 30-75 pounds side dress (10-24" ht.).

SOYBEANS

1. Row apply 10 ounces Biological Catalyst Concentrate, 1 quart molasses, 2-3 gallons of water on seed as a starter.
2. Foliar spray beans at tri-foliate stage (3-4" tall) with 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses (this can be mixed with post-emerge sprays and herbicides can be cut ⅓ to ½).
3. Foliar spray (optional) at pre-bloom or full pod set with 1½ to 2½ gallon 71B, 5-8 ounces Bio, 1 quart molasses.
4. Band or broadcast 7-10 ounces Biological Catalyst Concentrate, 2-4 quarts of molasses on crop residue or green manures (fall or spring applied).

MILO

1. Row apply 1-3 gallons 71B, 7-10 ounces Biological Catalyst Concentrate, 1 quart molasses, 2 gallon water as a starter on or beside the seed.
2. Foliar spray milo at 12-15" and again at 25-35" (pre-boot) with 1½ - 2½ gallons 71B, 5-8 ounces Bio, 1 quart molasses per acre.
3. Band or broadcast 7-10 ounces Bio, 2-4 quarts molasses on crop residue or green manure (fall or spring applied).

NITROGEN: 25-45# pre-plant, 25-55# side dress (10-15" ht.).

WHEAT — OATS — BARLEY — RYE AND OTHER SMALL GRAINS

1. Seed treat as Method E page no. 9 or apply 2 gallon 71B, 12 ounces Biological Catalyst Concentrate, 1 quart molasses, 2-3 gallon water on seed if planting equipment is set up to do so.
2. If No. 1 is not done, foliar spray same material on grain crops (at 3" ht.).
3. Spring foliar spray at 4-8" tall with 2 gallons 71B, 5 ounces Bio, 1 quart molasses. (Apply 10 oz. Bio, if liquid N mixtures not used).

NITROGEN: apply pre-plant 20-30# N (liq. 28), 10 ounces Bio, 2-4 quarts molasses on crop residue (dry Urea can be used).

Spring: apply 20-40 pounds liquid N, 6-8 ounces Bio, 1 quart molasses, or 20-40# dry N.

COTTON

1. Row apply 2-3 gallons 71B, 7-10 ounces Biological Catalyst Concentrate, 1 quart molasses (on/beside seed).
2. Fôliar spray at first Bloom with 1½ gallons 71B, 5-8 ounces Bio, 1 quart molasses per acre.
3. Repeat step No. 2 again in 14-21 days in with your regular spray program to save time and labor. Regular feeding of the cotton plant can hold more squares, give larger bolls and cotton will grade a longer stronger fiber.
4. Band or broadcast 12 ounces Bio, 1 quart molasses on crop residue or green manures (spring or fall applied).

NITROGEN: 20-30 pounds N with 5-8 ounces Bio, 1 quart molasses at 6-12" tall.

RICE

1. Seed treat as Method E Page No. 9 or apply 2-3 gallons 71B, 12 ounces Biological Catalyst, 1 quart molasses through equipment set up on grain drill.
2. When first stam (contact herbicide) is applied add 1 gallon 71B, 6-8 ounces Bio, 1 quart molasses and cut the stam rate by ¼ to ⅓.
3. Foliar spray with 2-3 gallon 71B, 6-8 ounces Bio, 1 quart molasses at pre-boot stage.
4. Use 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses in all fungicide sprays, consult Sales Representative for further information.

NITROGEN: May be applied at desired times, for local area and conditions, up to a maximum rate of 65-110 pound N/acre and Bio, molasses may be added with NITROGEN application. This program will improve milling quality, reduce blight and peck (stink bug) damage, permit earlier harvest by 5 - 10 days, and speeds up stubble decomposition for next years crop.

ALFALFA — CLOVERS
GRASSES FOR HAY

NOTE: Calcium levels should be 75-80% of base saturation and Magnesium levels at 10-12% to establish a good stand.

1. **Planting:** Apply 2-3 gallons 71B, 12 ounces Biological Catalyst Concentrate, 1 quart molasses through seeding equipment OR follow seed treatment Method E page 9.
2. Soil should receive 12 ounces Bio, 2 quarts molasses per acre before planting, if you **do not** do step one.
3. Foliar spray 1-2½ gallons 71B, 7-10 ounces Bio, 1-2 quarts molasses per acre 5-7 days after each cutting. To aid in better insect control plus higher protein and mineral levels. Foliar spray with 1-2 gallons 71B, 10 ounces Bio, 2 quarts molasses at first sign of crown growth in early spring.

PASTURE LANDS

Increased carrying capacity for livestock, higher quality grasses, less weed and insect problems can be achieved by following a good foliar spray program using 71B, Bio and molasses.

1. Early spring as new growth starts - foliar spray with 1½-2 gallons 71B, 10-12 ounces Bio, 1 quart molasses, 4-6 gallons water per acre.
2. Fall applications (late August, Sept. & Oct.) repeat foliar spray as step No. 1. NOTE: certain weed herbicides and insecticides may be mixed with foliar sprays to save trips over the fields.

SUNFLOWERS

1. Plant with 2 gallons 71B, 5-8 ounces Biological Catalyst Concentrate, 1 quart molasses, 2 gallons water per acre.
2. Foliar spray at 18-30" with 2 gallon 71B, 5-8 ounces Bio, 1 quart molasses per acre.
3. Repeat step No. 3 at pre-flower stage of growth.
4. Band or broadcast 12 ounces Bio on crop residue or green manures (spring or fall applied).

NITROGEN: Apply nitrogen at ⅓ to ⅔ regular rates as normal with 5-8 ounces Bio, 1 quart molasses per acre.

PEANUTS

1. Plant with 2-4 gallons 71B, 6-10 ounces Biological Catalyst Concentrate, 1 quart molasses on or beside seed.
2. Band or broadcast 7-10 ounces Bio in with Post or Pre-emerge Chemicals.
3. Foliar spray 1-1½ gallon 71B, 5-8 ounces Bio, 1 pint molasses at pre-bloom.
4. Repeat foliar spray as step No. 3, 10-14 days later.
5. Third foliar spray could be applied with any fungicides type spray if needed. This program will enhance quality, promote earlier harvest, larger and heavier peanuts.

SPECIALTY CROPS & VEGETABLES

SINCE TRADITIONAL METHODS VARY MORE WITH SPECIALTY CROPS THAN REGULAR FIELD CROPS, CONSULT WITH YOUR SALES REPRESENTATIVE FOR SPECIFIC RECOMMENDATIONS AND CONDITIONS.

POTATOES

NOTICE: Potatoes require high levels of Ca and Phosphorus in readily available form for high quality potatoes, and excellent storage ability. Complete soil analysis should be taken and correct levels as required.

1. Treat soil with 12 ounces Biological Catalyst Concentrate, 1-2 quarts molasses and 6-10 gallons water before planting.
2. Row apply 3-4 gallons 71B, 10 ounces Bio, 1 quart molasses per acre as a starter and 4-6 gallons 71B below the seed.
3. Foliar spray at 6-10" high with 2 gallons 71B, 5-8 ounces Bio, 1 quart molasses.
4. Repeat step No. 3 at pre-bloom stage.
5. Repeat step No. 3 after bloom stage and again 10-14 days before digging for higher specific gravity and better chip (12-16 gallon per acre needed for best yields).

SWEET CORN OR POPCORN

1. Follow same recommendations as field corn, page No. 9 except use Nitrogen for a total of 40-70 pounds.

SUGAR BEETS

1. Seed treat as Method E page No. 9 and plant with 3-4 gallons 71B, 5-10 ounces Biological Catalyst Concentrate, 1 quart molasses per acre.
2. If thinning operation is used plants should be foliar sprayed with 1½-2 gallons 71B, 5-8 ounces Bio, 1 quart molasses 7-10 days after thinned.
3. After 14-21 days repeat step No. 2.
4. Spray soil with 16 ounces Bio, 2 quart molasses, 6-10 gallons water on crop residue or green manure (spring or fall applied).

CABBAGE, ONIONS, CARROTS, BROCCOLI, CAULIFLOWER, OKRA, BRUSSEL SPROUTS, ARTICHOKES, LETTUCE, SPINICH, BEETS, RADISHES, TURNIPS

1. Treat the soil with a mix of 12 ounces Biological Catalyst Concentrate, 1 quart molasses.

2. Seed treat as Method E page No. 9, or use a transplanting Method C page 9 as a starter solution in the row.
3. Foliar spray every 7-21 days until harvest with a mix of ¾-1½ gallon 71B, 5-8 ounces Bio, 1 pint molasses per acre.

NOTE: If greens are harvested repeat step No. 3, 7-10 days after first harvest.

TOMATOES

1. Spray soil with 12 ounces Biological Catalyst Concentrate, 1 quart molasses with 6-10 gallons water on crop residue or green manures (spring or fall applied).
2. Use 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses in transplanting water.
3. Foliar spray 14-21 days after planting with 1 gallon 71B, 5-8 ounces Bio, 1 pint molasses.
4. Foliar spray 14-21 days later with same mixture as step No. 3.
5. Foliar spray every 2 weeks thereafter. Use nitrogen as usual except cut rates ⅓-½. After first bloom adjust pH to 6.2 - 6.5 and avoid spraying at heaviest bloom stages (6-9 gallons (total) 71B needed for best yields).

PEPPERS

1. Pepper beds (soil) should be treated with 1½ gallons 71B, 5-8 ozs. Biological Catalyst Concentrate, 1 quart molasses per 300' bed (if beds are gassed apply 1-2 weeks ahead).
2. Use 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses in transplanting water.
3. At early bloom foliar spray 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses per acre.
4. Repeat step No. 3 every 10-14 days until harvest and after each picking. Use NITROGEN as usual except cut rates ½.

TOBACCO BEDS

1. Treat seed beds with 2 gallons 71B, 5-8 ounces Biological Catalyst Concentrate, 1 quart molasses per 300' bed, apply ahead of gassing operation by 1-2 weeks.

SETTING TOBACCO

1. Spray soil with 10-12 ounces Bio, 1 quart molasses and 6-10 gallons water per acre ahead of transplanting.
2. Use ¾-1½ 71B, 5-8 ounces Bio, 1 quart molasses in with transplanting water.

FOLIAR SPRAYS ON TOBACCO

Apply ½-1 gallon 71B, 5-8 ounces Bio, 1 pint molasses per acre in with the regular spray operations (chemicals may be cut ¼-⅓). As the plants mature, use the 1 gallon rate of 71B. **NITROGEN:** rates should be cut ½-⅓ if a good foliar, Bio program is followed.

BERRIES, FRUIT & NUT TREES

A good soil analysis should be taken to insure sufficient amounts of limestone is found in the soil. High grade Calcitic limestone or Gypsum (calcium sulfate) should be used in most cases to correct deficiencies. Most all the plant food nutrients needed by nut and fruit trees can be supplied through the FOLIAR operations. Avoid using too much N on fruit trees, especially pears. If calcium is adequate, very little if any supplemental N will be needed. Excess N may result in low sugar levels and more disease/insect problems will occur.

1. Soil apply 12 ounces Biological Catalyst Concentrate, 1 quart molasses with 10-20 gallons of water/acre.
2. When setting trees use the transplanting solution (method C page 9) in place of straight water.
3. For established orchards, Foliar feed with mix of 2 gallons 71B, 7-10 ounces Bio, 1 quart molasses per acre as early spring dormant spray.
4. Continue step No. 3 through growing season until 8-12 gallons 71B is used (14-21 day foliar patterns are common). NOTE: DO NOT mix any plant food solutions with materials containing heavy metals or sulphur as buring/leaves may occur and fruit could be discolored.

BLACKBERRIES, RASPBERRIES BOYSENBERRIES, GOOSEBERRIES

On established vineyards a total of 2-3 gallons 71B, will be sufficient. Soil should be well limed.

1. Early spring apply 1 gallon 71B, 10 ounces Biological Catalyst Concentrate, 1 quart molasses per acre before leaves appear.
2. After leaves appear and before blooms apply 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses per acre.
3. After fruit is picked, remove any old dead wood for a good start on next years crop, then repeat step No. 2.

BLUEBERRIES AND GRAPES

1. Foliar spray with 2 gallons 71B, 10 ounces Biological Catalyst Concentrate, 1 quart molasses per acre at start of budding, or when leaves begin to show.
2. Foliar again when berries begin to form with 2 gallons 71B, 5-8 ounces Bio, 1 quart molasses.
3. Third foliar spray when berries are ½ grown with same as step No. 2.

OPTIONAL: When a heavy crop of berries has been harvested, or weather has been hotter than normal (stress), foliar spray with step No. 2 after crop has been harvested.

STRAWBERRIES

On established plants step No. 1 should be repeated yearly at first sign of new growth in Spring.

1. Prior to setting plants spray soil with 12 ounces Biological Catalyst Concentrate, 1 quart molasses per acre.
2. Use transplanting solution (method C page 9) at setting time.
3. In late May or early June (just prior to first bloom) Foliar spray plants with 1 gallon 71B, 5-8 ounces Bio, 1 quart molasses, 10-15 gallons water per acre.
4. As berries begin to stop blooming, repeat step No. 3.
5. Late August or early September repeat step No. 3 for next years crop. **NOTE:** DO NOT Foliar spray fruit as it may cause quality damage.

General Notes for Gardens, Lawns, Ornamentals, Flowers, Gardens and lawns benefit greatly from the use of 71B, Biological Catalyst Concentrate and Black Strap Molasses. The undiluted material should not be used, rather the transplanting solution (method C page 9) should be used for all seed sowing and transplanting purposes in the garden, ½ teacup of transplanting solution per plant or a cup full for each 10 foot row of a seed sown crop.

Who Says There's Not Enough?

From rock to availability covers a multitude of sin. In the laboratory the scientist takes a sample and subjects it to extracting solutions as decreed by official manuals. Unfortunately, plants cannot go out and buy those solutions for the purpose of extracting nutrients. A living, dynamic complex known as the living soil must do this. Here is what this life system has to work with.

COMPOSITION OF SOILS

For 1 Plow Acre 6⅔ Inches in Depth
Approximately 2,000,000 lbs., or 1,000 tons of Good Earth

ELEMENTS	SANDY LOAM POUNDS PER ACRE	SILT LOAM POUNDS PER ACRE	CLAY LOAM POUNDS PER ACRE
Organic Matter	20,000	54,000	96,000
Lbs. Nitrogen	1,340# Nitrogen	3,618# Nitrogen	6,432# Nitrogen
Live Portion (Earthworms, Bacteria)	1,000	3,600	4,000
Silicon Dioxide	1,905,000	1,570,000	1,440,000
Aluminum Oxide	22,600	190,000	240,000
Iron Oxide	17,000	60,000	80,000
Calcium Oxide	5,400	6,800	26,000
Magnesium Oxide	4,000	10,400	17,000
Potash	2,600	35,000	40,000
Phosphate	400	5,200	10,000
Sodium Oxide	4,600	26,000	24,000
Titanium Oxide	13,600	18,000	14,400
Sulphur Trioxide	600	8,500	6,000
Manganese	2,500	2,000	2,000
Zinc	100	220	320
Copper	120	60	60
Molybdenum	40	40	40
Boron	90	130	130
Cobalt	50	50	50
Clorine	50	200	200

Compiled by J.L. Halbeisen and W.R. Franklin

Natural Methods Builds Nutrient Availability and Soil Life.

Return Your Soil To "NATURE'S BALANCE"

As a farmer **you have a responsibility** to learn the truth about your soil and how nutrient imbalances affect it.

1. Take a good sample of your soil and get a complete soil analysis - by complete we mean a test showing (%) percentages of all nutrients. Like Potash - Magnesium - Calcium - Sodium - Hydrogen - C.E.C., etc. This will let you know what your traditional soil tests tells you and does not tell you!!!!
2. Contact someone working with Natures Balances to help you understand and apply the following chart to your soil test.
3. If you are truly concerned about how to properly balance your soil .... know how to read and understand a soil audit .... know more about what products to purchase for your farm and attend a CASI Soil Analysis Training Seminar, or other Educational meetings that can assist you in making wise decisions in your farming operations.

NUTRIENT EXCHANGE CAPACITY

Nutrient	Holding Capacity	% of Natural Balance	Ratio to Calcium	University's Say:
Calcium (CA)	1 to 1	70% to 80%	Pointman	65% or Less
Magnesium (Mg)	1.66 to 1	10% to 12%	6 to 1	15% to 40%
Potash (K)	1.03 to 1	2% to 3½ %	23 to 1	5% to 15% (Don't exceed Magnesium)
Sodium (NA)	1.82 to 1	¾ % to 1%	54 to 1	Not over 15%
Hydrogen (H)	— — — —	6% to 10%	— — — —	Who Cares, It's Free!

+ + + + The "Cation" nutrients (listed above) of your soil are a very vital key to HEALTHY soil life!! Nature's Balance regulates the homeostasis process, or to put it simply .... "That's the crops ability to balance its total body functions. Homeostasis should be controlled and stabilized by Calcium!! Excess Mg, or NA produces a very deadly poison within the cell body, which have a destructive effect upon the plant.

For names and addresses of Soil Analysis Ag. Labs contact your 71B sales representative, or CASI, Hwy. 25 S., Dexter, Mo. 63841. Phone 314-624-3709.

AVERAGE COST PER ACRE COMPARISON

NATURAL PROGRAM

	FORMULA 71B	BIOLOGICAL CATALYST	OTHER PRODUCTS	AVG. COST
CORN	2 - 7 gal./acre	12 - 24 oz./acre		
SOYBEANS	2 - 3 gal./acre	12 - 24 oz./acre		
MILO	2 - 6 gal./acre	12 - 24 oz./acre		
WHEAT	2 - 5 gal./acre	12 - 24 oz./acre		
RICE	4 - 7 gal./acre	12 - 24 oz./acre		
LEGUMES	3 - 7 gal./acre	12 - 24 oz./acre		

Some Supplemental N will be recommended depending on calcium availability, organic matter, and soil types as soil tests indicate. Ask your Formula 71B representative for assistance if needed.

DRY COMMERCIAL FERTILIZER PROGRAM

	N @ 17¢ NITROGEN	P @ 18¢ PHOSPHATES	K @ 16¢ POTASH	COST
CORN	120——250	50——100	60——140	
SOYBEANS	0—— 50	30—— 70	40——120	
MILO	75——200	30——100	40——110	
WHEAT	50——125	25—— 60	40—— 90	
RICE	100——250	30—— 70	50——100	
LEGUMES	0—— 40	40—— 80	200——350	

OTHER LIQUIDS and SUSPENSION TYPE LIQUIDS

	GAL./ACRE	ADD. N-P-K	COST
CORN			
SOYBEANS			
MILO			
WHEAT			
RICE			
LEGUMES			

Most 3-18-18, 9-18-9, 10-15-15 liquids recommend additional N-P-K.

CORN ESTIMATES

In the case of number 2 shelled corn, 1/70 acre differences in pounds per plot can be translated into bushels of ear corn per acre because number 2 ear corn weighs 70 lbs. per bushel. Do not make corn yield checks until the corn is ready to be cribbed.

Yield comparisons on corn should consider shelling percentage, moisture of grain and stand count for foliar sprays. For soil applications, stand count need not be considered.

Measure row length according to width of row. Use the following tables. Use two rows from the center of the plot.

WIDTH OF ROW	LENGTH OF 1 ROW	LENGTH OF 2 ROWS	LENGTH OF 4 ROWS
30"	249'	125'	62.5'
32"	233'	116'	58.0'
34"	220'	110'	55.0'
36"	208'	104'	52.0'
38"	197'	98'	49.0'
40"	187'	93'	46.5'
42"	179'	89'	44.5'
44"	169'	85'	42.5'

Number of pounds is equal to bushels per acre for ear corn. For potatoes, use corn method and multiply by 1.16.

Shell 20 lbs. of corn — get weight of shelled corn and multiply by 5 to get shelling percentage. Correct for moisture at 15%.

Use this formula to get bushels of No. 2 shelled corn per acre.

$$\frac{A \times B \times C \times 70}{56}$$

=

Yield of No. 2 shelled corn in bushels per acre

A = lbs. of corn from 1/70 A. plot
B = shelling percentage
C = 100%-% moisture in kernels + 15% permitted in No. 2 shelled corn
70 = part plot is of an acre
56 = wt. of bu. of shelled No. 2 corn

ESTIMATING YIELDS AT HARVEST

Potatoes, Truck Crops, Cotton, Tobacco, Etc.

Harvest 25 ft. of row from three different areas in treated and untreated areas and get difference in ounces. Multiply by figures below to get pounds per acre.

36 inch rows x 363.0 = pounds per acre
38 inch rows x 344.6 = pounds per acre
40 inch rows x 327.0 = pounds per acre
42 inch rows x 311.0 = pounds per acre

Divide total pounds by legal weight per bu. to get acre yield in bushels.

ALFALFA AND HAY: measure as for small grains and count bales of hay.

Tomatoes, cucumbers, squash and other crops. Weigh fruit from a given area and calculate from this formula.

$$\frac{\dfrac{43{,}560 \text{ (sq. feet in 1 acre)}}{\text{width of row in feet X length of row}} \times \text{pounds per plot}}{\text{weight per bushel}}$$

= bushels per acre

CRIB AND BIN CAPACITY

Shelled Corn

RECTANGULAR BIN

Bushels = 0.8 × length × width × average depth (all in feet)

ROUND BIN

Bushels = 0.6283 × diameter × diameter × average depth (in feet)

Ear Corn

RECTANGULAR CRIB

Bushels = 0.4 × length × width × average depth (in feet)

ROUND CRIB

Bushels = 0.3142 × diameter × diameter × average depth (in feet)

Piled Grain

SHELLED CORN

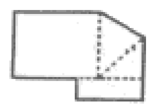
Bushels = 0.2094 × height × diameter of base × diameter of base (in feet)

EAR CORN (shelled basis)

Bushels = 0.1047 × height × diameter of base × diameter of base (in feet)

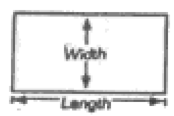
FIGURING FIELD ACREAGE

UNUSUAL SHAPES
Divide into triangles and/or rectangles.
Find the area of each and add.



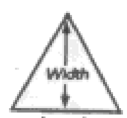
RECTANGLE or SQUARE
1 Acre = 43,560 square feet

$$\text{Acres} = \frac{\text{Length} \times \text{Width (ft.)}}{43{,}560}$$



TRIANGLE

$$\text{Acres} = \frac{\text{Length} \times \text{Width (ft.)}}{2 \times 43{,}560}$$



PARALLELOGRAM
(opposite sides parallel)

$$\text{Acres} = \frac{\text{Length} \times \text{Width (ft.)}}{43{,}560}$$

Problem Solvers - Facts and Figures

UNITS OF MEASURE

12 inches	1 Foot
3 Feet	1 Yard
5½ Yards	1 Rod
1 Mile	5280 Feet
144 Sq. Inches	1 Sq. Ft.
9 Sq. Ft.	1 Sq. Yard
43,560 Sq. Ft.	1 Acre
160 Sq. Rd.	1 Acre
640 Acres	1 Sq. Mile
4 Pecks	1 Bushel
1,728 Cu. Inches	1 Cu. Ft.
27 Cu. Ft.	1 Cu. Yd.
1 Cu. Ft. Water	62.5 Pounds
1 Cu. Ft.	7.48025 Gals.
1 Gal. Water	8.355 Pounds
1 Cu. Ft.	0.8 Bu. grain or shelled corn
16 Ounces	1 Pound
4 Quarts	1 Gallon
2 Pints	1 Quart
8 Ounces	1 Cup
2 Tablespoons	1 Ounce
16 Tablespoons	1 Cup
4 Cups	1 Quart
2 Cups	1 Pint

FORMULAS

Linear:

Circumference = Diameter × 3.1416

Diameter = Circumference ÷ 3.1416

Perimeter = Sum of All Sides

AREA:

Rectangle = Length × Width

Triangle = Length × Altitude ÷ 2

Circle = Radius squared × 3.1416

VOLUME:

Cylinder = Radius squared × 3.1416 × length

Sphere = Radius cubed × 4.1888

Cone = Radius squared × 1.0472

Cube = Length × width × height

METRIC EQUIVALENTS

1 centimeter	*= 0.3937 inch*
1 inch	*= 2.54 centimeters*
1 meter	*= 39.37 inches*
1 yard	*= 0.9144 meter*
1 kilometer	*= 0.62137 mile*
1 mile	*= 1.6093 kilometers*
1 acre	*= 0.4047 hectare*
1 cubic inch	*= 16.39 cubic centimeters*
1 quart liquid	*= 0.9463 liters*
1 ounce	*= 28.35 grams*
1 pound	*= 0.4536 kilograms*
1 kilogram	*= 2.2046 pounds*

FIELD RECORDS

FIELD RECORDS	FIELD NO.	FIELD NO.	FIELD NO.	FIELD NO.	FIELD NO.
LOCATION					
ACREAGE					
VARIETY HYBRID					
DATE PLANTED					
PLANTING RATE					
FERTILIZER					
KINDS					
AMOUNTS					
DATES APPLIED					
INSECTICIDE					
HERBICIDE USED					
DATE HARVESTED					
HARVEST MOISTURE					
YIELD					
MISCELLANEOUS NOTES:					

— NOTES —

APPENDIX B

Site Management Practices

Management Practices for the Kelp and Molasses Study, 1989 and 1990.

Management Practices	Site 1	Site 2	Site 3	Site 4
Previous crop	barley	soybeans	winter wheat	corn
Fall Tillage Cover crop	 rye (141 kg/ha)	Aer-way (1x) rye (82 kg/ha)	Strohm Aerator (2x) rye (141 kg/ha)	Aer-way (1x)
Spring Tillage	Aer-way (2x) Cultivator(2x)	Aer-ways (1x) Cultivator(1x)	Aer-ways (2x) Harrow (2x)	Disc(1x),Aer-way (1x),Cult. (1x)
Planting crop variety date depth row width seeding rate	 soybeans Pioneers 9061 June 3/89 5.0 cm 50 cm 97.4 kg/ha	 soybeans B-152 May 30,1989 3.25-5.0 cm 52.5 cm 80.6 kg/ha	 soybeans Maple Donovan May 30,1990 2.5 cm 52.5 cm 90.3 kg/ha	 soybeans Hyland® T8508 May 27,1990 4.4 cm 53.3 cm 90.8 kg/ha
Planting equipment	Kinze double frame	Whites 5100	John Deere 8200	Whites 5100
Herbicides preplant pre emerge post emerge	metolachlor (2.11 kg ai/ha); linuron (1.05 kg ai/ha) fluazifop-butyl (spot) (.5 kgai/ha)	sethoxydin (.3 kg ai/ha) bentazon (1.07 kg ai/ha) Assist ® surfactant (2L/ha)	glyphosate (1.14 kg ai/ha) bentazon (1.07 kg ai/ha)	metolachlor (1.62 kg ai/ha); linuron (.81kg ai/ha)
Fertilizer preplant at plant (seed treated area)	Agrikelp (.73L/ha) Molasses (2.3L/ha)	Agrikelp(.73L/ha) Molasses(2.3L/ha)	31 t/ha manure before planting rye Ammonium sulphate (3 kg/ha) Agrikelp (.73 L/ha) Molasses (2.3 L/ha) 71Bfert.(4.9 L/ha) H202(100 ppm) GTF Chromium (123 g/ha) NaSe(17 g/ha) Humates(15 g/ha) Soil conditioner (133 g/ha)	phosphate (45 kg/ha) inoculant (Nitragin) Agrikelp (.73 L/ha) Molasses (2.3 L/ha) 71B fert.(4.9 L/ha)

APPENDIX C

Weather Information

<u>Maximum, Minimum, Mean Daily Temperatures for Foldens</u> (near sites 1 and 3)

		1989	1990	Foldens 1951-1980
May	Maximum (ºC)	17.5	16.7	18.1
	Minimum (ºC)	8.2	6.5	6.8
	Mean(ºC)	12.9	11.6	12.5
June	Maximum (ºC)	22.7	22.8	23.5
	Minimum (ºC)	13.8	13.3	12.4
	Mean(ºC)	18.3	18.1	18.1
July	Maximum (ºC)	26.8	24.7	25.8
	Minimum (ºC)	16.2	15.3	14.7
	Mean(ºC)	21.5	20.0	20.4
August	Maximum (ºC)	24.7	24.2	25.0
	Minimum (ºC)	14.7	15.1	13.9
	Mean(ºC)	19.7	19.7	19.7
September	Maximum (ºC)	20.2	19.9	20.8
	Minimum (ºC)	11.2	11.0	10.5
	Mean(ºC)	15.7	15.5	15.8
October	Maximum (ºC)	14.6	13.2	14.2
	Minimum (ºC)	5.9	5.0	4.9
	Mean(ºC)	10.3	9.1	9.7

Maximum, minimum, mean daily temperatures are not available at the Tillsonburg station.

<u>Daily Total Precipitation for Foldens</u> (near sites 1 and 3)

		1989	1990	Foldens 1951-1980
May	Rainfall(mm)	82.0	114.6	67.6
	Snowfall(cm)	4.0	tr.	0.5
	Total(mm)	86.0	114.6	68.0
June	Rainfall(mm)	90.2	112.4	75.1
	Snowfall(cm)	0.0	0.0	0.0
	Total(mm)	90.2	112.4	75.1
July	Rainfall(mm)	36.2	118.2	80.6
	Snowfall(cm)	0.0	0.0	0.0
	Total(mm)	36.2	118.2	80.6
August	Rainfall(mm)	71.4	101.8	100.4
	Snowfall(cm)	0.0	0.0	0.0
	Total(mm)	71.4	101.8	100.4
Sept.	Rainfall(mm)	54.0	94.0	82.1
	Snowfall(cm)	0.0	0.0	0.0
	Total(mm)	54.4	94.4	82.1
October	Rainfall(mm)	65.0	113.0	71.7
	Snowfall(cm)	6.6	0.0	0.6
	Total(mm)	71.6	113.0	72.2

Daily Total Precipitation for Tillsonburg (near site 2)

		1989	Tillsonburg 1951-1980
May	Rainfall(mm)	81.7	61.4
	Snowfall(cm)	0.0	0.0
	Total(mm)	81.7	61.0
June	Rainfall(mm)	81.2	70.6
	Snowfall(cm)	0.0	0.0
	Total(mm)	81.2	70.6
July	Rainfall(mm)	38.4	66.2
	Snowfall(cm)	0.0	0.0
	Total(mm)	38.4	66.2
August	Rainfall(mm)	40.4	66.8
	Snowfall(cm)	0.0	0.0
	Total(mm)	40.4	66.8
Sept.	Rainfall(mm)	72.4	78.7
	Snowfall(cm)	0.0	0.0
	Total(mm)	72.4	78.7
October	Rainfall(mm)	70.5	92.3
	Snowfall(cm)	5.0	0.7
	Total(mm)	75.5	93.2

Maximum, minimum, mean daily temperatures are not available at the Tillsonburg station.

Maximum, Minimum, Mean Daily Temperatures for Culloden **(near site 4)**

		1990	Culloden 1974-1985
May	Maximum (ºC)	16.9	-
	Minimum (ºC)	6.8	-
	Mean(ºC)	11.9	13.3 *
June	Maximum (ºC)	22.9	-
	Minimum (ºC)	13.2	-
	Mean(ºC)	18.1	17.8
July	Maximum (ºC)	24.9	-
	Minimum (ºC)	15.4	-
	Mean(ºC)	20.2	20.7
August	Maximum (ºC)	24.5	-
	Minimum (ºC)	14.5	-
	Mean(ºC)	19.5	19.8
Sept.	Maximum (ºC)	20.2	-
	Minimum (ºC)	10.7	-
	Mean(ºC)	15.5	15.3
October	Maximum (ºC)	13.4	-
	Minimum (ºC)	4.7	-
	Mean(ºC	9.0	8.8

* 1974, 1976 and 1985 data missing.