Problems and Practices of Dry Edible Bean Production in North Dakota and Minnesota, 1987

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INTRODUCTION

Dry edible bean production is a major agricultural industry in North Dakota and Minnesota. In 1987 North Dakota ranked second nationally in production of all dry edible beans and first in production of pinto beans. Minnesota ranked seventh in production of dry edible beans and sixth in the production of pinto beans. Significant production has occurred since 1972 when approximately 55,000 acres were grown. By 1987 acreage had increased more than 800 percent in the two-state area.

During this period technology has advanced, but there has never been a comprehensive survey to determine growers' actual practices or problems. Similar surveys of growers have been done in Michigan (1). Baseline data need to be established so that research can be better directed and industry support better planned. The results of this survey together with results of successive surveys will allow assessment of the impact of new products, new varieties and other changes in technology on bean production.

A single page survey form requesting information on 18 topics related to bean production was developed by Lamey and Peterson. This form was similar to one successfully used by A.G. Dexter, Extension Sugarbeet Specialist, to evaluate sugarbeet problems in North Dakota and Minnesota.

Questionnaires were mailed to nearly 3,600 growers identified through the Northarvest Bean Growers Association. This grower association administers checkoff funds taken from the sale of beans in North Dakota and Minnesota and has the most accurate and current listing of growers.

Survey forms were mailed in November after harvest was completed. The survey was anonymous and purposefully did not request information on yield to preclude any misconception that the survey was for marketing information purpose. The nature of the survey was reviewed at the Northarvest Bean Growers Association annual meeting in January to encourage maximum grower participation.

RESULTS AND DISCUSSION

A total of 862 forms were returned. Of these, 69 respondents indicated they no longer grew beans and 19 forms were so incomplete that they were unusable, which left 774 information-bearing forms. Of the 774, 610 growers were from North Dakota and 159 were from Minnesota. Three growers from South Dakota planting a total of 208 acres responded to the survey.

The total acreage represented by the respondents was 169,039 with 144,679 acres from North Dakota and 23,892 from Minnesota. This represents 38 percent of the total bean acreage in the two states. North Dakota survey acreage was 39 percent of the state's total (370,000 acres) and Minnesota survey acreage was 32 percent of the state's total (75,000 acres) based on USDA Crop Report estimates (2,3).

These results properly represent only one year's production, which may not reflect long-term problems or practices. The data do form a basis for making current estimates. Several years' data will indicate trends and allow analysis of the impact of changing technologies on production.

As the results were compiled, structural problems were noted. Some important questions were unclear or overlooked. For example, a blank for state identification was omitted and growers in counties with the same name from different states could not be distinguished. In these cases the information was attributed to the county which historically produced the most beans. The exception was when the growers indicated the state in some way. This problem introduced a small error into the results which should be rectified in future surveys.

The compilers attempted to do as little editing as possible. Most responses were considered "as is." When grower's responses were unclear or apparently in error (for example, herbicides or micronutrients listed as fungicides) judgements were made and responses modified as well as possible. When there was no basis for judgement, the response in doubt was discarded. Partial data were kept as much as practical. Missing portions of associated data were coded to allow counting but were converted in the tabulate program to equal 0 if any cumulative figures were calculated. As a result, final computations provided sums that did not necessarily cross check.

In this report, all of the tabular data are based on the survey. To extrapolate these data to the entire production for a state, the North Dakota data should be multiplied by 2.56, the Minnesota data by 3.125, and the total data (both states) would be times 2.63.

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DISEASE

When asked to designate their biggest production problem in the 1987 crop, growers clearly ranked disease and weeds as the top two (Table 1). The major varieties grown in the two states are given in Table 2. On these varieties, white mold caused by *Sclerotinia sclerotiorum* was the most serious disease (Table 3). Other significant diseases were rust *(Uromyces appendiculatus* var. *appendiculatus),* bacterial blight (includes halo blight caused by *Pseudomonas syringae* pv. *phaseolicola,* bacterial brown spot caused by *Pseudomonas syringae* pv. *syringae,* and common blight caused by *Xanthomonas campestris* pv. *phaseoli)* and Alternaria leafspot *(Alternaria* spp.).

Bagged and tagged (includes certified and affidavit) seed was planted on 127,217 (88 percent) of the North Dakota surveyed acres and on 23,081 (97 percent) of the Minnesota acres. The remaining acreage was planted with undesignated seed. Blight ranking was compared to seed source (Table 4). It is notable that 78 percent of the tagged seed was grown without noted blight problems while 71 percent of the bin run seed had no significant blight disease.

Table 1. Percentage of growers and acres affected by various production problems in North Dakota and Minnesota in 1987.

		ND		MN	
Rank	Problem	% growers	acres	% growers	acres
1	Disease	44.6	72,614	18.2	9,382
2	Weeds	23.4	33,615	41.5	7,672
3	None	8.5	8,108	13.2	2,069
4	Emergence	6.2	7,022	8.8	1,940
5	Water Damage	7.9	10,799	1.9	183
6	Drought	2.0	2,331	3.8	531

In North Dakota, 3 percent (3,852 acres) of the bean acreage was grown under irrigation while in Minnesota 27 percent (6,351 acres) of the bean acreage was irrigated. The severity of disease was compared to irrigation or dryland production (Table 5). In most cases percentage of acreage in which disease was a problem was similar between irrigated

Table 2. Frequently grown cultivars of beans, acreage and numbers of growers in North Dakota and Minnesota in 1987.

	North Dakota				Minnesota		
	Variety	Acres	Growers		Variety	Acres	Growers
1.	Upland	28,427	227	1.	Upland	7,416	91
2.	Topaz	23,302	217	2.	Fiesta	3,006	25
3.	Nodak	15,142	159	3.	Kidney*	1,900	4
4.	Fiesta	11,863	136	4.	Montcalm	1,672	8
5.	Olathe	11,015	125	5.	C20	1,275	22
6.	Pindak	4,858	53	6.	Harofleet	640	7
7.	Fleetwood	3,907	23	7.	Topaz	590	14
8.	Snobunting	2,954	28	8.	Baby Lima*	500	1
9.	C20	2,474	38	9.	Seafarer	455	13
10.	Hyden	1,062	19	10.	Nodak	325	5

* Undesignated

Table 3. Worst disease (ranked as #1, 2, or 3) on North Dakota or Minnesota beans in 1987.

	North Dakota				Minnesota		
Rank	Disease	Acres	Growers	Rank	Disease	Acres	Growers
#1	White Mold	101,709	378	#1	White Mold	12,972	55
	Rust	5,606	26		Rust	178	3
	Bact Blight	5,687	21		Bact Blight	85	1
	Alternaria	1,411	6		Alternaria	39	1
#2	White Mold	8,679	40	#2	White Mold	1,070	5
	Rust	28,742	109		Rust	2,262	11
	Bact Blight	17,525	52		Bact Blight	768	5
	Alternaria	3,494	12		Alternaria	0	0
#3	White Mold	10,733	39	#3	White Mold	2,604	15
	Rust	13,808	54		Rust	210	1
	Bact Blight	11,924	46		Bact Blight	2,232	11
	Alternaria	4,944	16		Alternaria	200	1

Bact. Blight = bacterial blights including halo blight, common blight or brown spot.

and dryland production. The exception was white mold in which there was 12 percent less acreage classified as having a problem in irrigated compared to dryland production.

The relationship between hailed acres and disease severity is given in Table 6. Compared to nonhailed acres, rust was rated as a significant problem on 9 percent more of the hailed acres. Similarly, bacterial blight was considered a problem on 9 percent more of the hailed acres and root rot on 8 percent more.

Fungicides applied to the bean crop are listed in Table 7. Topsin (14,401 A.), Maneb + Zinc F4 (9,532 A.), Maneb 80 (7,930 A.), and MF-4 (5,434 A.) were the most widely used fungicides. When white mold was considered the most serious disease, Topsin was applied to 12,186 acres, Benlate to 2,950 acres and Mertect to 200 acres (Table 8). While not traditionally recommended for white mold, sulfur was sprayed on 1,400 acres by one grower. When white mold was listed as the second most important disease, Benlate was applied to 130 acres and Topsin was applied to

Table 4. Relationship between seed source and ranking of bacterial disease problem.

Rank of Blight Problem	Seed Source	
	Bagged & Tagged*	Bin Run
1**	4%***	4%
2	11%	18%
3	8%	8%
0	78%	71%

* Generally certified or its equivalent.
** 1 = Most serious of disease problems, 2-3 = successively less serious, 0 = none.
*** Numbers are % of surveyed acreage with ranked blight problem.

Table 5. Relationship between irrigation and disease problems.

	Rank of disease problem	Disease Problems				
		WM	Rust	Bacteria	Alt.	Root Rot
Irrigated (25,542 A)	1	56*	4	3	1	2
	2	6	16	8	2	6
	3	7	7	7	2	4
Dryland (158,717 A)	1	68	3	4	1	2
	2	6	19	11	2	6
	3	7	9	9	3	6

* Numbers are percent of acres in that category. WM = White mold, ALT = Alternaria leafspot.

Table 6. Percentage of diseased acres on fields that had received hail* compared to fields without hail.

	Rank of disease problem	Disease				
		WM	Rust	Bacteria	Alt.	Root Rot
Hailed Acres	1	69	5	3	0	3
	2	6	22	21	0	7
	3	5	10	6	6	11
Nonhailed Acres	1	68	3	4	1	1
	2	6	17	8	2	7
	3	9	8	9	2	5
Total Acres	1	68	3	4	1	2
	2	6	18	11	2	7
	3	8	8	8	3	6

* 19.6% of the acreage received hail. There was no indicator for hail severity, frequency or timing. WM = White mold, Bacteria = Bacterial blight, Alt. = Alternaria leafspot. Root rot includes those caused by Rhizoctonia, Pythium or Fusarium species.

Table 7. Fungicides used on the 1987 bean crop in North Dakota and Minnesota.

North Dakota				Minnesota			
Fungicide	Acres	Sprays	Growers	Variety	Acres	Sprays	Growers
Bravo	210	1	2	Maneb 80	83	3	2
Champion	80	1	1	Manex	100	3	1
Kocide	355	5	5	MF-4	83	1	1
Maneb 80	7,847	26	22	Maneb + Zinc F4	540	6	4
Agsco MN	520	2	1	Benlate Broadcast	160	1	1
Manex	355	3	3	Benlate Banded	500	2	1
MF4	5,351	27	24	Topsin Broadcast	3,623	11	10
Maneb + Zinc F4	8,992	57	42	Topsin Banded	625	4	4
Benlate Broadcast	1,940	20	17	Dithane M22 Special	315	1	1
Benlate Banded	480	7	6				
Topsin Broadcast	7,565	51	47				
Topsin Banded	2,588	16	16				
Mertect Broadcast	345	4	3				
Dithane M22 Special	955	8.5	5				
Sulfur	1,400	2	1				

700 acres. White mold as a third most important disease was treated with Topsin (1,515 acres). A total of 17,681 surveyed acres were treated with a fungicide recommended for white mold control.

Fungicides for rust control are given in Table 9. Maneb compounds were most commonly used (15,565 acres or 9.2 percent of the surveyed acres). Most growers sprayed a single time (average = 1.25 sprays) against rust. Copper compounds were used on only 120 acres and chlorothalonil (Bravo) on 200 acres.

Only 215 acres were sprayed with a copper compound (Kocide) for bacterial blight control.

There was no apparent relationship between method of land preparation and disease (Table 10). In North Dakota, 57 percent of the growers used chisel plow and 42 percent prepared land with mold-board plow. Few (9 percent) used conservation tillage. In Minnesota 46 percent of the growers used chisel plow, 51 percent used mold-board plowing and 9 percent used conservation tillage.

Of the many potential diseases of dry edible beans, growers in North Dakota and Minnesota seem particularly concerned with only five (white mold, rust, bacterial blight, Alternaria, and root rot). Numbers of diseases are kept small through several mechanisms. Breeding programs have provided cultivars resistant to anthracnose and the major virus diseases. Losses due to bean rust have been minimized by planting cultivars resistant to most of the prevalent races in the states. Nematodes are not yet a serious problem in the region although the soybean cyst nematode can affect dry edible bean production.

The use of high quality seed is very important in suppressing seedborne diseases. Of the acreage planted to bagged and tagged seed, 78 percent was judged to have no blight problem. Growers are advised to have bin-run seed tested for amount of bacterial contamination and to plant only the highest quality seed. In North Dakota, results of the dome test (4) are used as the basis of the advisory. Of acreage planted with bin-run seed, 71 percent had no apparent problem from bacterial disease. Almost all bagged and tagged seed has been treated with a fungicide (frequently captan), an insecticide (such as lindane), and streptomycin sulfate which reduces surface contamination by bacterial pathogens. Seed treatment and vigorous seeds reduce the impact of damping off and early season root rots.

The 1987 growing season (May to August) was characterized by wet warm conditions. The moist season was especially conducive for the development of white mold. The moisture also favored high statewide yields (1,400 pounds

Table 8. Fungicide use compared to estimated white mold ranking.

Ranking	Treatment	Acres	Sprays	Growers
#1[1]	Benlate Broad[2]	2,100	20.5	18
	Benlate Band	850	7	5
	Topsin Broad	10,053	58	53
	Topsin Band	2,133	16	16
	Mertect Broad	200	1	1
	Sulfur	1,400	2	1
#2	Benlate Band	130	2	2
	Topsin Broad	325	1	1
	Topsin Band	375	2	2
#3	Topsin Broadcast	810	3	3
	Topsin Band	705	2	2

[1] Worst problem = #1.

[2] Broad = broadcast application. Band = Band application on row.

Table 9. Fungicides applied to beans when bean rust was designated a serious consideration.

Rust severity	Fungicide	Acreage	Number of sprays	Number of growers
#1	Champion	80	1	1
	Kocide	40	1	1
	Maneb 80	455	2	2
	Maneb + Zinc F4	1,560	6	4
	M22 Special	240	1	1
#2	Bravo	200	1	1
	Maneb 80	3,247	15	12
	Agsco MN	520	2	1
	Manex	275	2	2
	MF-4	3,015	11	10
	Maneb + Zinc F4	3,453	21	13
	Dithane M22	825	5.5	5
	Zinc	190	1	1
#3	Maneb 80	493	2	2
	MF-4	221	3	3
	Maneb + Zinc F4	1,091	7	6
	Dithane M22	115	1	1

Table 10. Methods of land preparation and disease rank.

	Rank			
Tillage Type	0	1	2	3
	White Mold			
Chisel plow	59*	53	47	59
Conservation tillage	7	7	7	8
Moldboard plow	35	40	45	33
	Rust			
Chisel plow	55	57	50	58
Conservation tillage	8	0	5	7
Moldboard plow	37	43	45	35
	Bacterial Blight			
Chisel plow	55	52	52	52
Conservation tillage	8	6	6	1
Moldboard plow	37	42	42	48
	Alternaria			
Chisel plow	55	54	35	53
Conservation tillage	7	0	24	0
Moldboard plow	38	46	41	47
	Root Rot			
Chisel plow	54	71	57	54
Conservation tillage	8	6	3	5
Moldboard plow	39	22	40	41

* Number is % of designated acres.

per harvested acre) in 1987 compared to a more typical year 1985 (1,270 pounds per harvested acre). Rainfalls were frequent and extended wet periods within plant canopies were not uncommon. Moderate temperatures favored bean blossom retention and inoculum was plentiful due to an epidemic of white mold in various susceptible crops in 1986.

Although there was much grower concern about white mold, only about 18,000 acres were treated with a fungicide for white mold control. This represents 16 percent of the 114,681 acres identified as having white mold as most serious (#1) problem (Table 3). This may also indicate that once growers recognized their white mold problem, it was too late to attempt control or that fungicide costs are perceived to be too high. For those growers who recognized white mold as their #1 problem and attempted control, most applied fungicide only once. The average of 93 growers applying fungicide was 1.1 sprays. Label instructions generally recommend two applications.

The data (Table 5) indicate reduced white mold under irrigation. The survey did not request information on the irrigation amount, scheduling, etc. In this wet year it is likely that many fields received little supplemental water, yet were classified as irrigated. Most of the irrigated acreage is in Minnesota, and the cultivar mix under irrigation (Table 2) is probably different than the mix on dryland.

Hail was apparently associated with increased intensity (measured as acres affected) of bacterial blight, rust and root rot. Since rain splash spreads bacterial pathogens, rain generally accompanies hail and hail provides wounds needed for pathogen ingress, this association was predictable. The relationships between rust, root rot, and hail are less clear. As an obligate pathogen, *U. appendiculatus* does not require wounds for host penetration. Severe wounding with defoliation can force plant regrowth which provides susceptible tissues longer in the growing season.

Generally the effects of root rot are most severe during drought. In dry soil, adventitious roots form poorly and lack of functional roots above lesioned areas places significant stress on plants. In 1987, moisture was abundant to excessive in some fields and plants were often in standing water for several days following rains. Beans do not tolerate anaerobic, water-logged soil conditions well. Root stress in anaerobic soils may predispose plants to root rots, especially those caused by *Pythium* spp. It is difficult to separate plant death caused by drowning from plant death caused by *Pythium* as a result of excess water.

If hail defoliates plants in their reproductive phase, there is less photosynthate to be partitioned between pods and the plant's metabolic machinery. The amount of photosynthate in the roots could become critically low, the root metabolism become impaired, and root rots become more prevalent.

WEEDS

Weeds were designated as the most serious production problem by 28 percent of all dry bean producers, 23 percent of North Dakota producers and 42 percent of Minnesota producers surveyed (Table 1). Diseases were rated as the most serious problem by 39 percent of all dry bean producers, 45 percent of North Dakota producers, and 18 percent of Minnesota producers. More producers ranked disease as the most serious production problem in North Dakota, while more producers ranked weeds as the most serious production problem in Minnesota. However, diseases were rated the most serious problem on more acres than weeds in Minnesota. The different response between North Dakota and Minnesota growers concerning the worst production problem in dry beans might reflect a difference in the type and severity of weed and disease problems encountered in the two states.

Wild mustard was ranked as the worst weed problem in dry beans by more producers than any other weed in North Dakota or when combined over the two states (Table 11). Wild mustard, foxtails (pigeongrass), and redroot pigweed were frequently mentioned in both North Dakota and Minnesota as the worst weed problem. These weeds are prevalent over the entire region, are often present at high densities, and will cause significant dry bean yield reductions if left uncontrolled. However, all three weeds can be effectively controlled with herbicides in dry beans.

Black nightshade was listed most frequently as the worst weed problem for Minnesota growers. Black nightshade probably is more common in Minnesota than North Dakota because of different cropping systems (more soybean and row crop production) and herbicide use patterns. Season-

Table 11. Weed species listed as the most serious weed problem in dry beans in 1987.

	Total		North Dakota		Minnesota	
Weed Species	Growers	Acres	Growers	Acres	Growers	Acres
	(%)					
Wild mustard	28	34	31	37	14	20
Foxtails (pigeongrass)	17	16	18	17	13	10
Redroot pigweed	10	10	10	10	11	14
Kochia	7	7	8	9	1	1
Black nightshade	6	7	4	5	16	20
Common cocklebur	6	4	4	3	12	8
Common lambsquarters	4	4	3	3	9	10
Wild oats	3	2	3	2	1	2
Canada thistle	2	1	2	1	1	1
Common ragweed	1	1	1	1	2	2

long black nightshade control is difficult to obtain in beans because nightshade continues to emerge throughout the growing season. In addition, black nightshade causes harvest-related problems such as plugged combines and stained beans, which lowers the quality and value of the crop. Therefore, black nightshade is a very serious problem in dry beans. A higher frequency of nightshade in Minnesota than North Dakota might help explain why more Minnesota farmers perceived weeds to be their most serious production problem.

Kochia was listed as the worst weed problem more frequently by North Dakota than Minnesota growers, while common lambsquarters and common cocklebur were listed more frequently by Minnesota growers (Table 11). Common cocklebur and common lambsquarters commonly infest soybean growing areas and grow better with good soil moisture than in dry conditions, while kochia is a more drought tolerant weed better adapted to the drier environment in North Dakota. When growers were asked to list their three worst weed problems (Table 12), the results were similar to the response concerning the worst weed problem.

Herbicide use patterns reflected the most common weed problems and economics of treatment. Treflan, Sonalan, and Basagran were the most widely used herbicide treatments for weed control (Table 13). Treflan and Sonalan are similar herbicides used preplant incorporated for annual grass and broadleaf weed control including foxtails, redroot pigweed, kochia, and common lambsquarters. Treflan and Sonalan are effective and less costly than some other comparable treatments. Basagran is the only herbicide labeled as a postemergence treatment in dry beans and controls several broadleaf weeds, including wild mustard, which is not controlled adequately by most other herbicides used in dry beans.

Amiben, Lasso, and Dual use was greater in Minnesota than in North Dakota, perhaps due to the greater frequency of black nightshade and greater precipitation in Minnesota. Amiben, Lasso, and Dual are effective for early season black nightshade control in dry beans but require greater moisture for activation and consistency as compared to Sonalan or Treflan.

Table 12. Weed species listed as one of the three most serious weed problems in dry beans in 1987.

	Total		North Dakota		Minnesota	
Weed Species	Growers	Acres	Growers	Acres	Growers	Acres
	(%)					
Wild mustard	57	64	65	69	30	37
Foxtails (pigeongrass)	42	44	42	44	43	41
Redroot pigweed	30	33	29	31	37	43
Kochia	24	28	28	31	8	7
Wild oats	23	25	26	27	11	14
Common cocklebur	18	16	14	15	20	33
Common lambsquarters	16	17	11	12	36	43
Black nightshade	14	13	8	9	37	36
Canada thistle	6	5	7	5	3	5
Common ragweed	2	3	2	3	4	5

Table 13. Treatments used for weed control in dry bean fields in 1987.

	Total		North Dakota		Minnesota	
Treatment*	Growers	Acres	Growers	Acres	Growers	Acres
	(%)					
Treflan	61	43	61	44	61	40
Sonalan	48	43	51	46	34	23
Prowl	2	2	2	1	3	10
Amiben	7	6	4	3	20	21
EPTC	8	6	9	6	6	4
Lasso	5	2	1	1	15	13
Dual	1	1	1	1	6	4
Basagran	56	38	56	38	57	37
Sodium chlorate	10	5	8	4	18	11
Post-Plant cultivation	49	50	51	53	43	31
Hand weeding	16	5	12	3	31	16
None	1	1	1	1	1	1

* Herbicides may have been applied as a tank-mixture with other herbicides.

The most widely used herbicide tank-mix reported in the survey was a Treflan-EPTC combination, applied by 4 percent of the growers to about 4 percent of the acreage (data not presented). Other tank-mixtures were used on less than 2 percent of the dry bean acres. However, over half of the Amiben was applied as a tank-mixture with various herbicides to improve the spectrum and consistency of weed control compared to Amiben applied alone.

Spring applications of EPTC and Treflan were more common than fall application. Approximately 10 percent of the total EPTC used was applied in the fall, while about 15 percent of the total Treflan used was applied in the fall (data not presented). The majority of growers rated weed control good or excellent with most herbicides (data not presented).

Cultivation was used on approximately half of the acres for weed control. Cultivation remains one of the cheapest and most effective methods for controlling weeds between the rows. Handweeding was utilized by 16 percent of the growers for weed control on 5 percent of the acres. Handweeding might be the best method for control of light infestations of herbicide tolerant weeds but often is impractical for larger fields or heavy infestations.

Sodium chlorate, which had a Section 18 Emergency Use registration in Minnesota and North Dakota for preharvest desiccation in dry beans in 1987, was applied to 4 percent of the acreage in North Dakota and 11 percent of the acreage in Minnesota (Table 13). More sodium chlorate use in Minnesota might reflect greater weed problems and wetter conditions than in North Dakota. When questioned about the need for a desiccant, 47 percent of the producers indicated no need for a desiccant, 42 percent indicated a need for a desiccant, and 10 percent indicated a desiccant was needed some of the time (Table 14). Minnesota producers perceived a greater need for a desiccant in dry beans than North Dakota farmers. Full label registration presently is being pursued for the use of desiccants in dry beans.

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Table 14. The need for a desiccant as a pre-harvest aid in dry beans.

Need for desiccant	Total		North Dakota		Minnesota	
	Growers	Acres	Growers	Acres	Growers	Acres
	(%)					
No	47	—	52	—	31	—
Yes	42	30	38	26	59	51
Sometimes	10	9	10	9	9	11