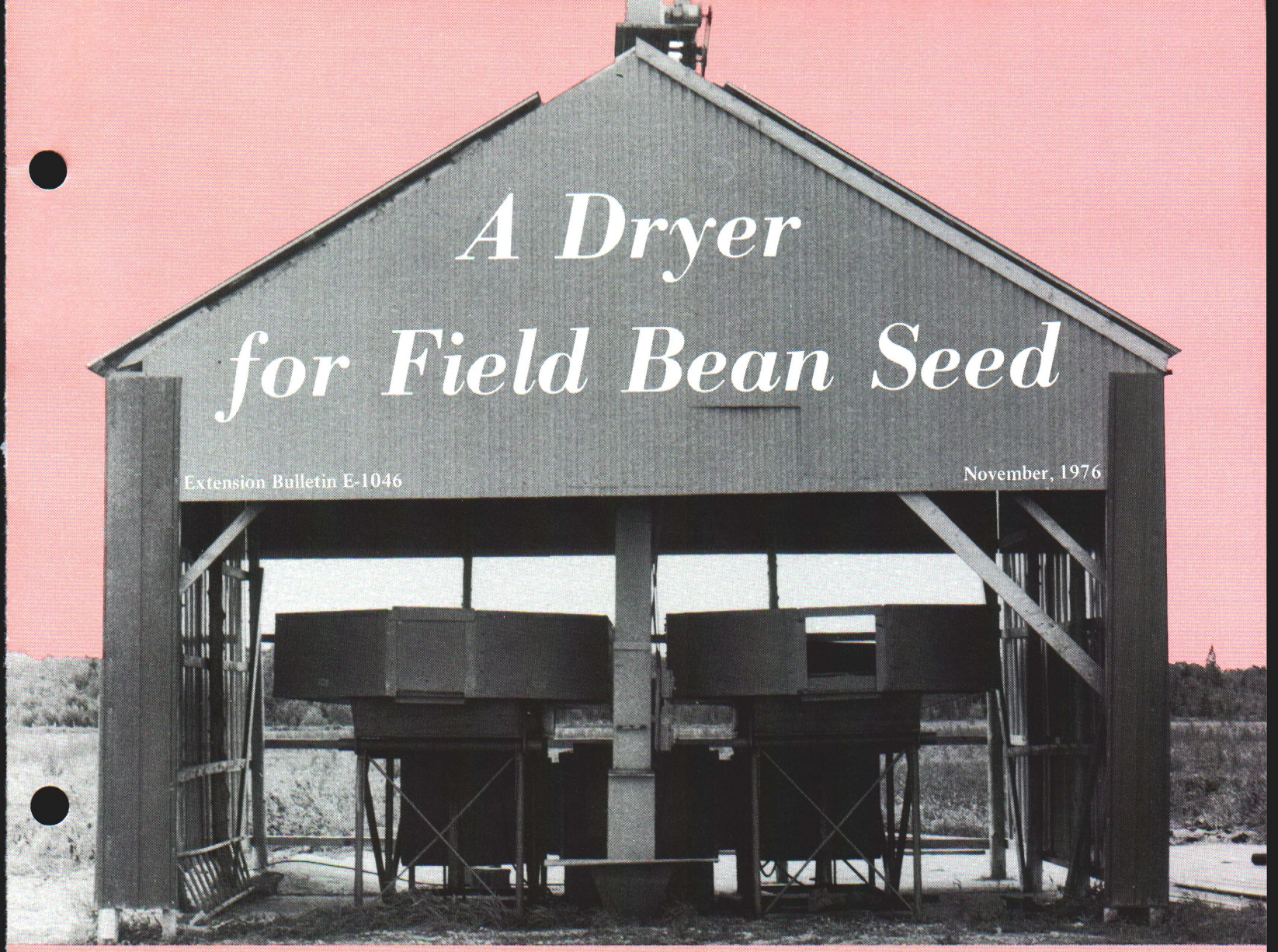
A Dryer for Field Bean Seed

Extension Bulletin E-1046

November, 1976



Completed dryer facility at Garth Briggs farm in Delta County, Michigan.

L. O. Copeland, D. C. Bell, L. V. Nelson,* and R. L. Maddex [1]

THIS REPORT presents a simple batch-type bean seed dryer which can be constructed on the farm. The dryer utilizes a high air-flow, low heat-rise concept that can dry most high-moisture seed lots in about 8 to 12 hours without impairing germination. This dryer was designed to dry dark red kidney bean seed from moisture levels of 21 to 26% down to about 17 to 18% at which they can be safely stored until the next planting season.

Need for Seed Drying

Certified seed of dark red kidney beans has been produced in northern Michigan for about 15 years. Northern Michigan provides excellent isolation from destructive bacterial blight diseases which infest the Michigan commercial bean area. It also has several areas of very productive soils with adequate frost-free growing season for bean seed production.

High-moisture seed at harvest in the past has prevented northern Michigan from reaching its maximum seed production potential. Frequent rains and unpredictable weather following maturity in early October often prevents the seed crop from drying to the 18% moisture levels needed for safe storage. Before the development of this drying capability, growers had to wait for two to three good drying days following frequent rains for the seed crop to dry to safe storage levels. Because of wet and unpredictable weather, an average of about 30% of the annual production was lost for seed purposes due to high seed moisture. In 1969, no seed could be harvested at safe storage moisture levels, and the production was marketed at a lower price as tablestock beans.

This dryer was developed from funds provided through a grant from the Upper Great Lakes Regional Commission to the Department of Crop and Soil Sciences, Michigan State University. The prototype was designed, constructed and evaluated in cooperation with the MSU Department of Agricultural Engineering and Michigan Foundation Seed Association.

[1] *Extension Specialist, Department of Crop and Soil Sciences; Manager, Michigan Foundation Seed Association; Extension Specialist, retired, Department of Crop and Soil Sciences; and Extension Specialist, Department of Agricultural Engineering.*

**Deceased, Nov. 15, 1976.*

Seed Production with this Seed Dryer

This bean seed dryer should permit development of the full potential for bean seed production in northern Michigan by eliminating high moisture seed. Now a seed grower can harvest seed a day or two following rain with assurance that excess moisture can be eliminated by artificial drying. It is suggested that a grower attempt to harvest at about 21 to 22% moisture and subsequently dry the seed to 18%. This would allow safe storage without undue mechanical injury.

Dryer Effectiveness

The effectiveness of this dryer was demonstrated between October 31 and November 31, 1973, when 1,700 cwt of Charlevoix dark red kidney and 300 cwt of Manitou light red kidney bean seed were successfully dried without impairing viability.

Tables 1, 2 and 3 show the results of three drying series during which data were recorded for weather conditions, rate and uniformity of drying, and seed condition and quality before and after drying. These drying series represent a total of almost 300 cwt of seed. Ten additional batches were dried involving 1,700 cwt of seed over a period of about three weeks.

ON-THE-FARM USE

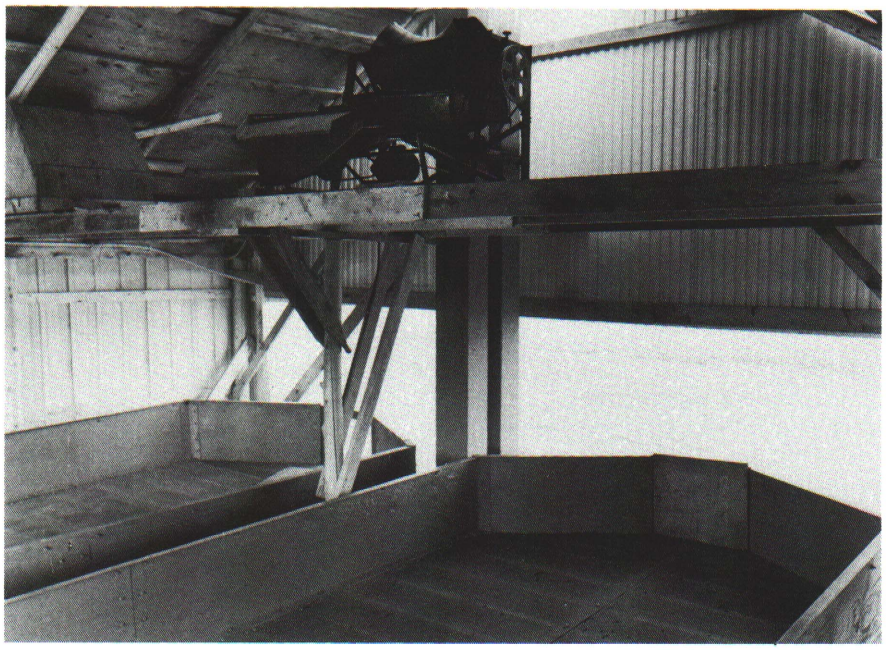
The dryer should be placed on a concrete pad close to other seed processing and handling facilities. Seed may enter the dryer by one of several methods, depending on the facilities available.

Loading the Dryer

Directly from the combine – In most cases, the drying and processing facilities will be too far apart to make this a viable option; however, in some cases it may be feasible.

From rotating palletized boxes – If a forklift with rotating lifts is available, the seed may be dumped into the drying boxes. This method requires dumping the seed from the combine into the palletized boxes on a truck in the field and transporting them to the drying facility.

From bulk containers – Seed arriving in bulk must be dumped into a hopper and elevated into the dryer by means of a belt conveyor or a bucket elevator. Both systems are feasible alternatives for farm use. A third alternative which should be used only in cases of emergency, is loading by hand labor.



Interior view of Delta County drying facility showing overhead scalper location and inside front view of dryer boxes.

From a hopper beneath a rough scalper – If seed is threshed with excess foreign material, it should be rough-scalped prior to drying. This may be done in a specially installed scalper located near the dryer, or it may be done with a fanning mill located in the seed processing plant. If the latter option is used, the seed may be diverted directly into the dryer by a specially installed loading chute below the fanning mill. This option can also be used without the scalping operation.

Unloading the Dryer

The dryer is unloaded by tilting the rear end upward and allowing the entire bed to pivot on the bearings located near the front underside of the box. The seed slides through the front door into a container or hopper box located on near-ground level. If palletized containers are used, they may be transported to a storage or processing location by fork-lift trucks. If the seed is dumped into a hopper box, it may be conveyed to a truck or some other means of bulk transporation, or elevated by a bucket elevator into an overhead bin until further disposition.

Tilting the Dryer

A method for lifting the rear end of the dryer should be determined before the dryer stand is built. Hydraulic cylinder or cylinders located at the rear end of the support stand, approximately 12 feet from the pivot point, would need to provide a lift of approximately 8'6". Locating the hydraulic cylinder at the center of the dryer approximately eight feet from the pivot point would require a lift of approximately 5'6", but would require notching the support frame to allow for a steel saddle under each dryer support beam. The dryer should be tilted to approximately a 45-degree slope for good bean flow out of the dryer. The weight of the dryer filled with beans (18" deep) is approximately 15,000 pounds.

Air Flow and Temperatures

The rate of drying depends upon airflow, temperature rise and initial bean moisture. Evenness of drying through the depth of beans depends on the temperature and humidity of the drying air. A 10-degree temperature rise reduces relative humidity of the air by approximately 25%. The minimum humidity of the drying air should be about 50% with high airflows of 60 CFM* or more per square foot of drying floor area. With lower airflows, the relative humidity should be maintained at 60% or higher. For the most uniform final

**CFM – Cubic feet of air per minute.*

Table 1 – Series 1 – Dark Kidney Beans

Sample Location*	Sample Time	Moisture Content (%) Top	Moisture Content (%) Bottom	Germination After Drying (%) Top	Germination After Drying (%) Bottom
1	4:30 p.m.	21.1	17.9	94	98
	10:00 p.m.	20.2	17.5	97	98
	8:00 a.m.	16.8	13.8	97	94
2	4:30 p.m.	20.9	17.6	96	93
	10:00 p.m.	20.5	17.2	95	93
	8:00 a.m.	16.1	13.8	93	95
3	4:30 p.m.	21.3	18.4	97	98
	10:00 p.m.	20.9	17.8	98	94
	8:00 a.m.	16.6	13.7	95	97
4	4:30 p.m.	20.3	17.8	98	94
	10:00 p.m.	21.5	17.4	98	98
	8:00 a.m.	18.1	14.2	96	97
5	4:30 p.m.	20.7	18.6	95	94
	10:00 p.m.	20.4	16.8	97	97
	8:00 a.m.	15.9	13.9	98	98
6	4:30 p.m.	21.7	18.1	93	96
	10:00 p.m.	21.3	16.7	98	97
	8:00 a.m.	17.3	13.9	96	94
7	4:30 p.m.	21.1	18.3	95	96
	10:00 p.m.	20.4	21.6	97	96
	8:00 a.m.	17.1	13.9	98	98

** Represents sampling grid throughout drying chamber.*

DRYING DATA

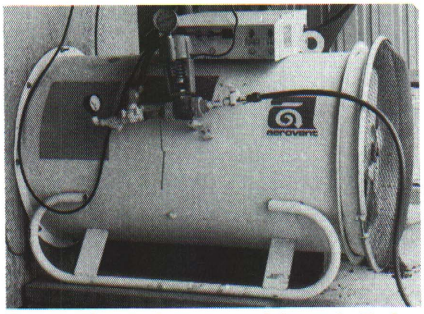
1. Original moisture content of seed – 22.7%.
2. Started drying – 1:00 p.m., Oct. 31, 1973.
3. Finished drying – 8:00 a.m., Nov. 1, 1973.
4. Outside temperature – 55 degrees down to 48 degrees.
5. Outside R.H. – starting 95%; finish – 55%.
6. Drying temperature – 65 degrees F.
7. Bean depth in dryer – 18" to 20".
8. Static pressure – .8 to .9 inches.
9. Air flow per sq. ft. of floor area – approx. 65 CFM.

Table 2 – Series 2 – Dark Red Kidney Beans

Sample Location	Sample Time	Moisture Content (%) Top	Moisture Content (%) Bottom	Germination After Drying (%) Top	Germination After Drying (%) Bottom
1	5:00 p.m.	20.4	18.3	99	93
	11:00 p.m.	18.3	16.1	97	95
3	5:00 p.m.	19.3	17.3	97	97
	11:00 p.m.	19.2	15.7	92	96
4	5:00 p.m.	19.5	17.6	96	99
	11:00 p.m.	19.1	––	99	––
5	5:00 p.m.	19.4	17.9	97	94
	11:00 p.m.	18.1	15.8	98	99
6	5:00 p.m.	20.3	17.9	97	96
	11:00 p.m.	18.9	15.5	98	97
7	5:00 p.m.	19.6	18.2	98	99
	11:00 p.m.	19.3	15.6	98	97

DRYING DATA

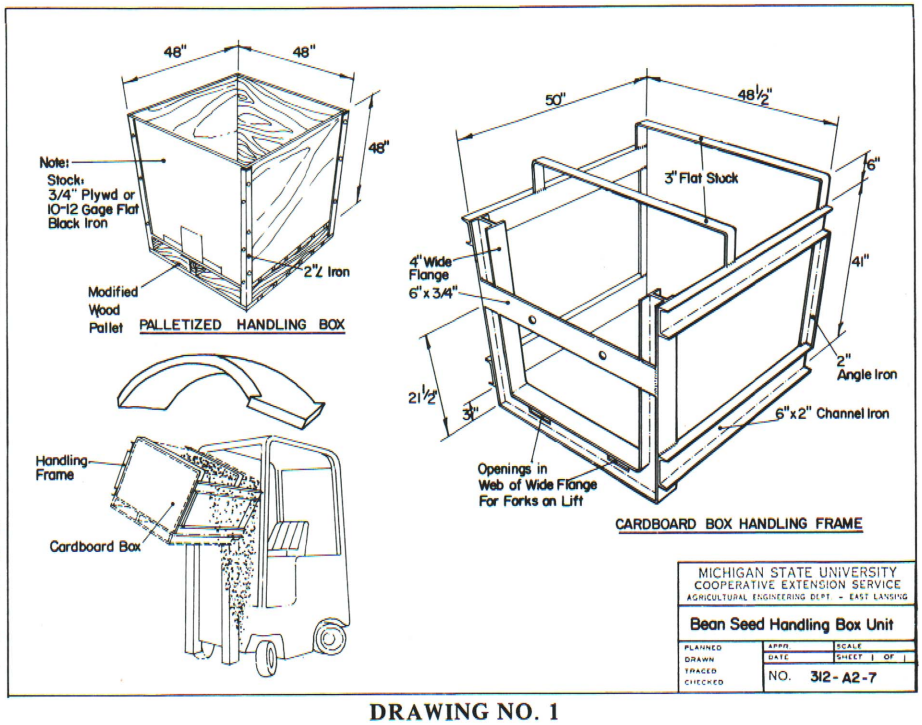
1. Original moisture content of seed – 22.7%.
2. Started drying – 1:00 p.m., Nov. 2, 1973.
3. Finished drying – 11:00 p.m., Nov. 2, 1973.
4. Outside weather – 1:00-5:00 p.m.:
   A. Raining
   B. Temperature – 51.5°F
   C. Relative humidity – 95%
5. Outside weather – 5:00-11:00 p.m.
   A. NOTE: rain stopped about 5:00; thereafter, the relative humidity quickly decreased and temperature decreased more slowly.
   B. Weather (11:00 p.m.): T - 43°F and R.H. - 78%.
6. Drying conditions of air in plenum chamber and entering beans:
   A. Temperature – 62°F
   B. Relative humidity – 56%
7. Bean depth in dryer – 18 to 20 inches.
8. Static pressure – .8 to .9
9. Airflow – approx. 65 CFM per sq. ft. of flow area.



Burner-fan unit at rear of dryer in Delta County (axial type fan).

bean moisture, drying temperatures should be reduced as outside temperature and humidities go down. A desirable temperature rise would be approximately 10°.

The CFM output of a fan drops as static pressure increases. Table 4 shows the airflow for the Aerovent centrifugal fan Model No. CD 270-07 used in the bean dryers located at the Michigan Foundation Seed Association Building near E. Lansing, Michigan.



DRAWING NO. 1

Table 3 – Series 3 – Dark Red Kidney Beans

Sample Location	Sample Time	Moisture Content (%) Top	Moisture Content (%) Bottom	Germination (%) During and After Top	Germination (%) During and After Bottom
1	8:30 p.m.	18.0	17.3	95	99
	3:00 a.m.	17.5	15.7	100	97
	8:30 a.m.	17.3	15.6	97	98
2	8:30 p.m.	--	--	--	--
	3:00 a.m.	17.3	15.8	95	100
	8:30 a.m.	17.3	15.6	97	98
3	8:30 p.m.	18.3	16.6	96	97
	3:00 a.m.	16.7	15.6	99	98
	8:30 a.m.	17.3	15.6	97	98
4	8:30 p.m.	18.6	16.4	98	98
	3:00 a.m.	17.4	16.2	98	96
	8:30 a.m.	17.3	15.6	97	98
5	8:30 p.m.	18.7	16.3	96	97
	3:00 a.m.	17.4	15.5	93	98
	8:30 a.m.	17.3	15.6	97	98
6	8:30 p.m.	18.7	16.6	98	94
	3:00 a.m.	17.7	16.0	92	98
	8:30 a.m.	17.3	15.6	97	98
7	8:30 p.m.	19.1	16.3	98	97
	3:00 a.m.	17.6	16.0	96	95
	8:30 a.m.	17.3	15.6	97	98

DRYING DATA

1. Original moisture content of seed – 21.0%.
2. Drying and sampling schedule: Started drying at 4:00 p.m., Nov. 6, 1974; dried until 8:30 a.m., Nov. 7, 1974. Samples were taken from top and bottom at all locations at 8:30 p.m., Nov. 6 and 3:00 a.m., Nov. 7.
3. Bean depth in dryer – 18 to 20 inches.
4. Static pressure – .8 to .9 inches.
5. Airflow – approx. 65 CFM per sq. ft. of flow area.

Table 4

Motor HP	Static Pressure (inches)	Air Flow CFM*
7.5	0.5	9,600
	1.0	9,375
	1.5	9,100
	2.0	8,825

* *Cubic feet per minute.*

Table 5 – Bean Seed Drying
Delta County – Fall, 1975

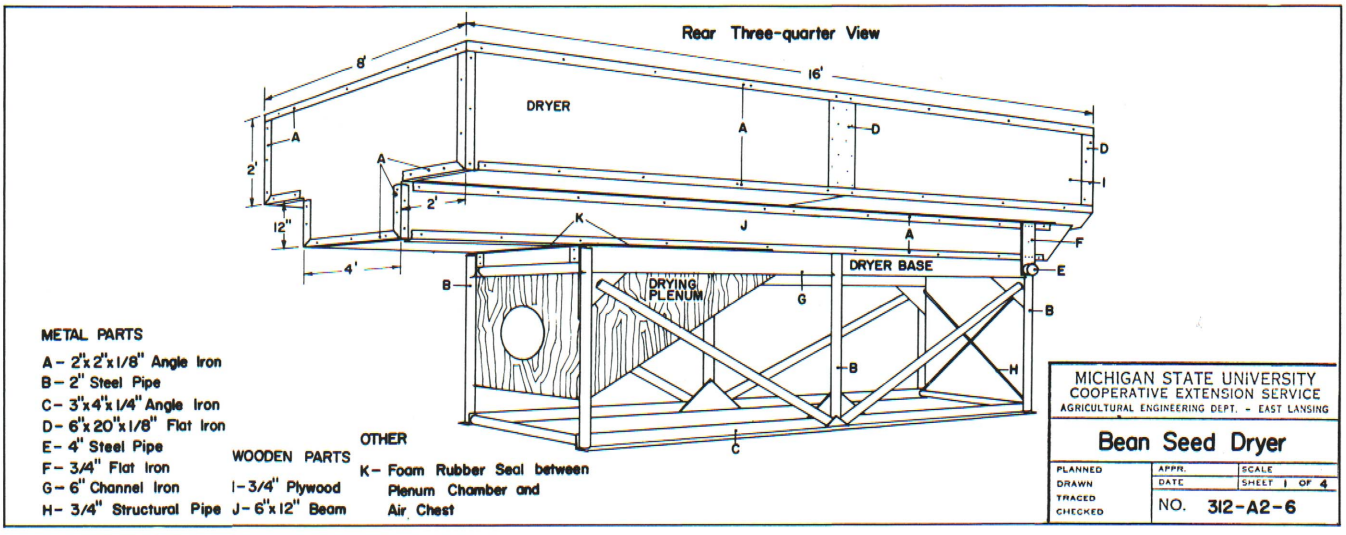
Lot	Kind	cwt	Original MC (%)	Final MC (%)	Outside Temp. (°F)	Drying Temp. (°F)	Drying Time (hrs.)
1	navy	100	26-30	18	70	70	12
2	navy	150	26	18	70-80	70	18
3	DRK	180	30-40	18	60	70	25
4	DRK	180	30-40	18	60	70	25
5	DRK	140	26	18	60	70	12
6	DRK	110	25	18	35	70	10
7	DRK	200	26	18	60	70	20

1,060 cwt Total

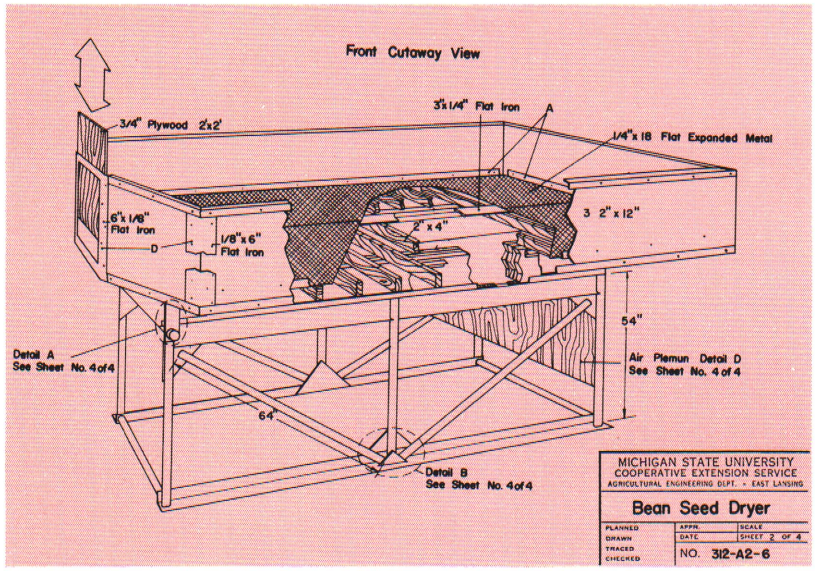
Additional Information

1. Approximate cost of drying (fuel) – 6¢/cwt.
2. Drying charge (to grower) – 25¢/cwt.

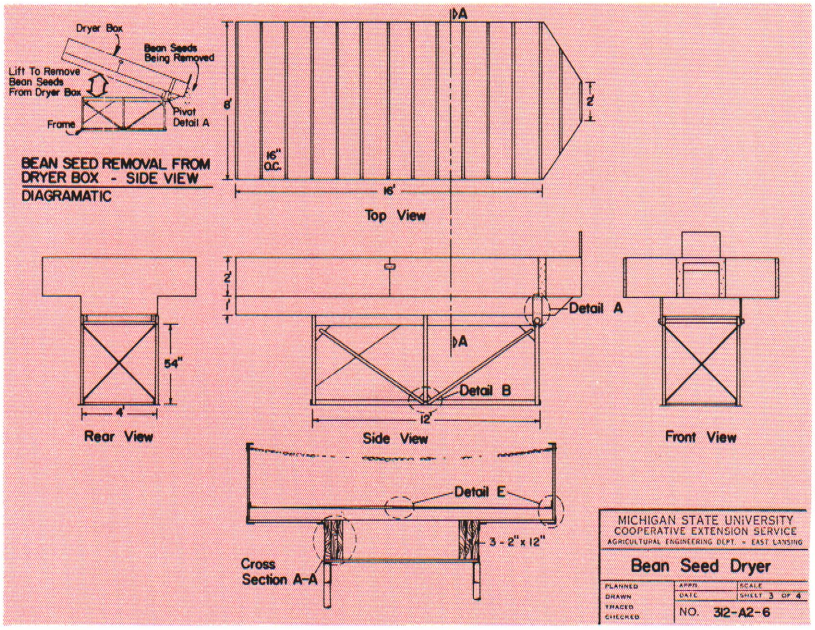
DRAWING NO. 2



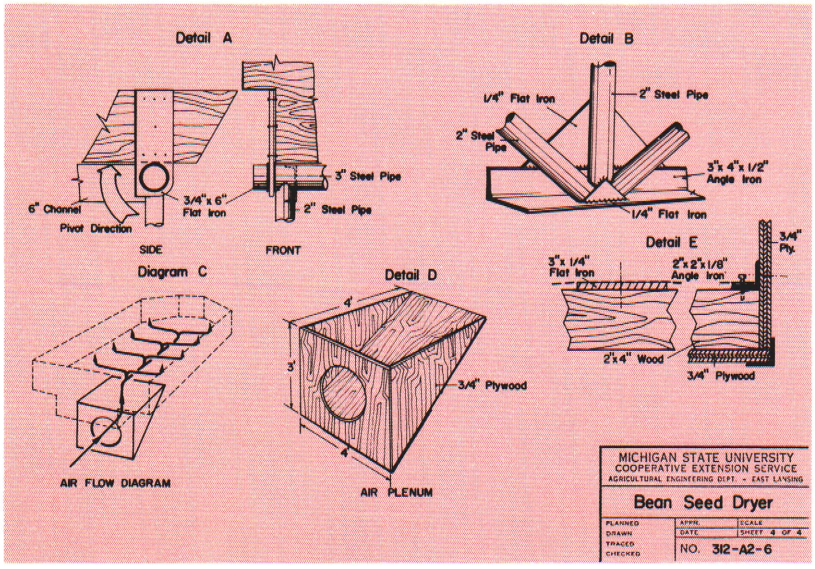
DRAWING NO. 3



DRAWING NO. 4



DRAWING NO. 5



MATERIALS LIST

WOODEN COMPONENTS

8 – pieces 3/4" exterior plywood, 2' x 8'.
(sides and bottom of box)

6 – solid pieces 2" x 12", 17'6" long.
(sides of plenum chamber)

1 – piece 3/4" exterior plywood, 3' (plus) x 8' overall dimensions, 1' x 2' piece cut out on both lower corners.
(rear end of drying box and plenum chamber)

1 – piece 3/4" exterior plywood, 1-1/2" (approximately) x 8'.
(front of plenum chamber)

2 – pieces 3/4" exterior plywood. 3' x 4' x 4'7" (triangular).
(sides of air chest)

1 – piece 3/4" exterior plywood, 4' x 4'7".
(bottom of air chest)

1 – piece 3/4" exterior plywood, 3' x 4'.
(end of air chest)

2 – pieces 3/4" exterior plywood, 2' x 40" (+ or -).
(front pieces to drying box)

1 – piece 3/4" exterior plywood, 2' x 2'.
(door to front of drying box)

2 – pieces 3/4" exterior plywood, 4' x 4' (plus) and 4' x 8'.
(bottom of plenum chamber on each side of opening for air chest)

13 – solid pieces 2" x 4", 7' 10-1/2" long.
(these form the structure for bottom of drying box on top of which the expanded metal is placed)

4 – pieces, 2 x 4's, shorter lengths, cut to length (approximately 16 linear feet).
(these provide base for bottom of drying box toward the point of the front end on which the edges of expanded metal is fastened)

METAL COMPONENTS

Drying Box and Plenum Chamber

220 – linear feet, 2" x 2" x 1/8" angle iron.
(needed as support around top and all corners of drying box and plenum chamber as shown in drawings including support for outer edges of expanded metal screen inside the bottom of drying box)

50 – linear feet, 2" x 2" x 1/8" angle iron.
(needed as support for outside borders of expanded metal sieve in bottom of dryer box over plenum chamber)

2 – pieces, 24" long, 6" x 1/8" flat iron.
(for outer support for two front corners as shown in drawings) (See Drawing 3)

4 – pieces, 20" long, 6" x 1/8" flat iron.
(for structural support for joining two 2' x 8', 3/4" plywood pieces comprising sides of drying boxes, both inside and outside) (See Drawing 2)

5 – 4' x 8' sheets of 1/4 x 18 expanded metal.
(See Drawing 3)

1 – 3" x 1/8" strip.
(for center support of expanded metal in bottom of dryer box 18' long)

Dryer Base

2 – pieces 6" channel iron 12' long.
(these comprise the structure on which the plenum chamber sits) (See Drawing 2-G)

6 – pieces 2" structural steel pipe 54" long.
(these comprise the vertical posts for the base) (See Drawing 2-B)

4 – pieces 2" structural steel pipe 64" long.
(these comprise the angular support between the vertical legs as shown in drawings) (See Drawing 2)

2 – pieces 3" x 4" x 1/4" angle iron 12' long.
(as bottom horizontal brace for legs) (See Drawing 2-C)

2 – pieces 3/4" steel pipe 5'8" long.
(as cross braces for front end of dryer base) (See Drawing 2-H)

5 – pieces 2" structural steel pipe 4' long.
(as horizontal support between posts on each side of dryer base) (See Drawings 2 and 3)

1 – piece 3" structural steel pipe 4'8" long.
(as pivot at top front corner of dryer base) (See Drawing 2-E)

6 – 1/4" steel triangular gussets 24" x 17" x 17" (cut out of a 12' flat steel plate)
(See Drawings 2 and 3)

2 – 3/4" x 6" x 18" flat black iron pivot hinge.
(See Drawing 5, A.)

This information is for educational purposes only. Reference to commercial products or trade names does not imply discrimination or endorsement by the Cooperative Extension Service. Cooperative Extension Service Programs are open to all without regard to race, color, creed, or national origin. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824. Price 35 cents. IP-3M-11: 76-GP