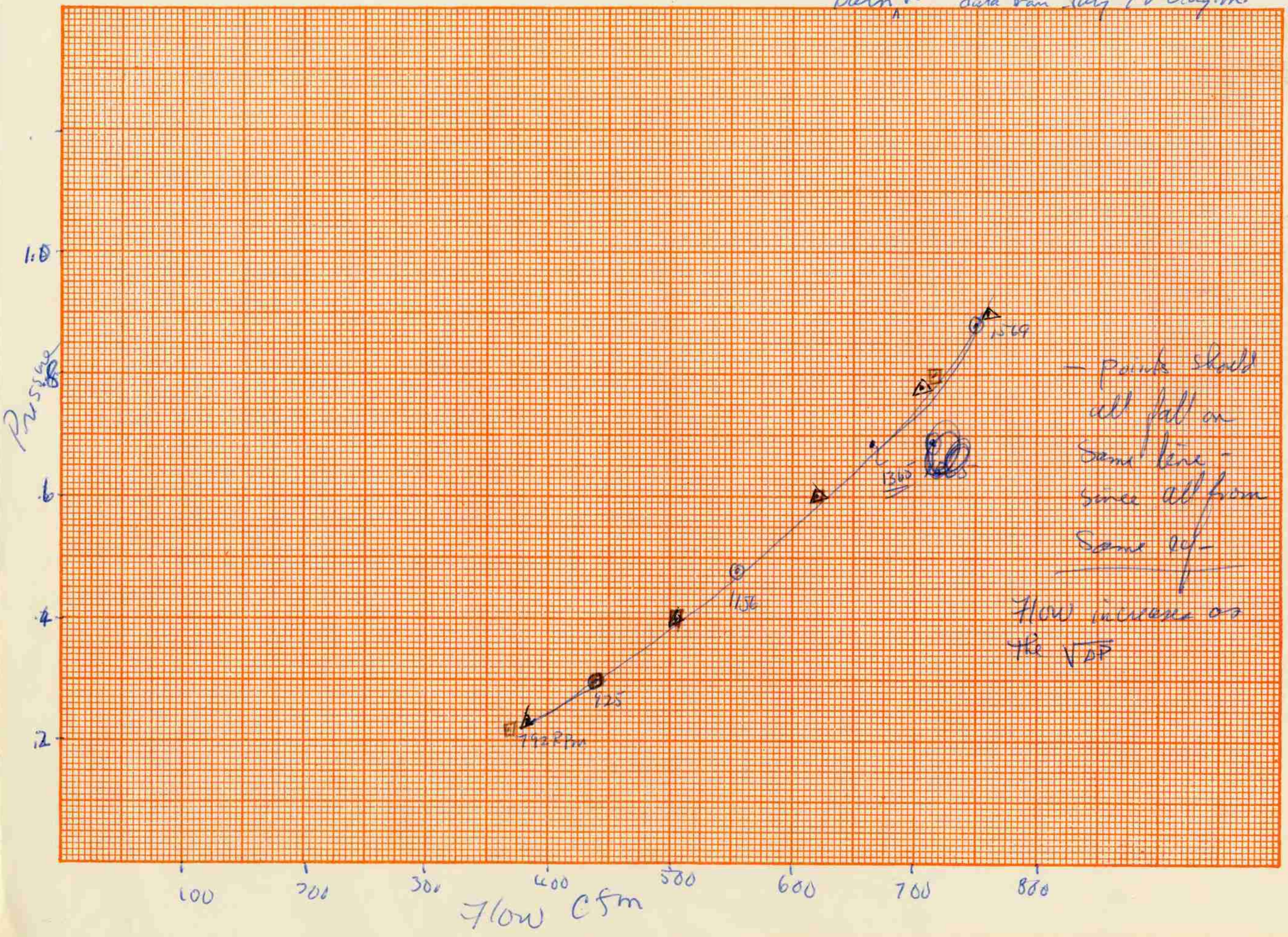
Barn 9,10+11 - data from July 18 Clayton.



6" dia = 28 sq in

$\frac{1}{2}$" gap = 24 sq in - at 1.0 we get 410 cuft

3 x 4# = 12 sqft

40

480 cfm/box

800 lt/box

.5 cuft/lt

400 cuft/box — minimum

172 ± 43%

572

$$\text{Flow} = 1096.5 \; .6 \; A \sqrt{\frac{\Delta P}{\delta}}$$

Know flow for one pressure for 4' box → 30 sq in (1") (750)

— 500 cfm

1¼ 5' — 580 cfm

6'

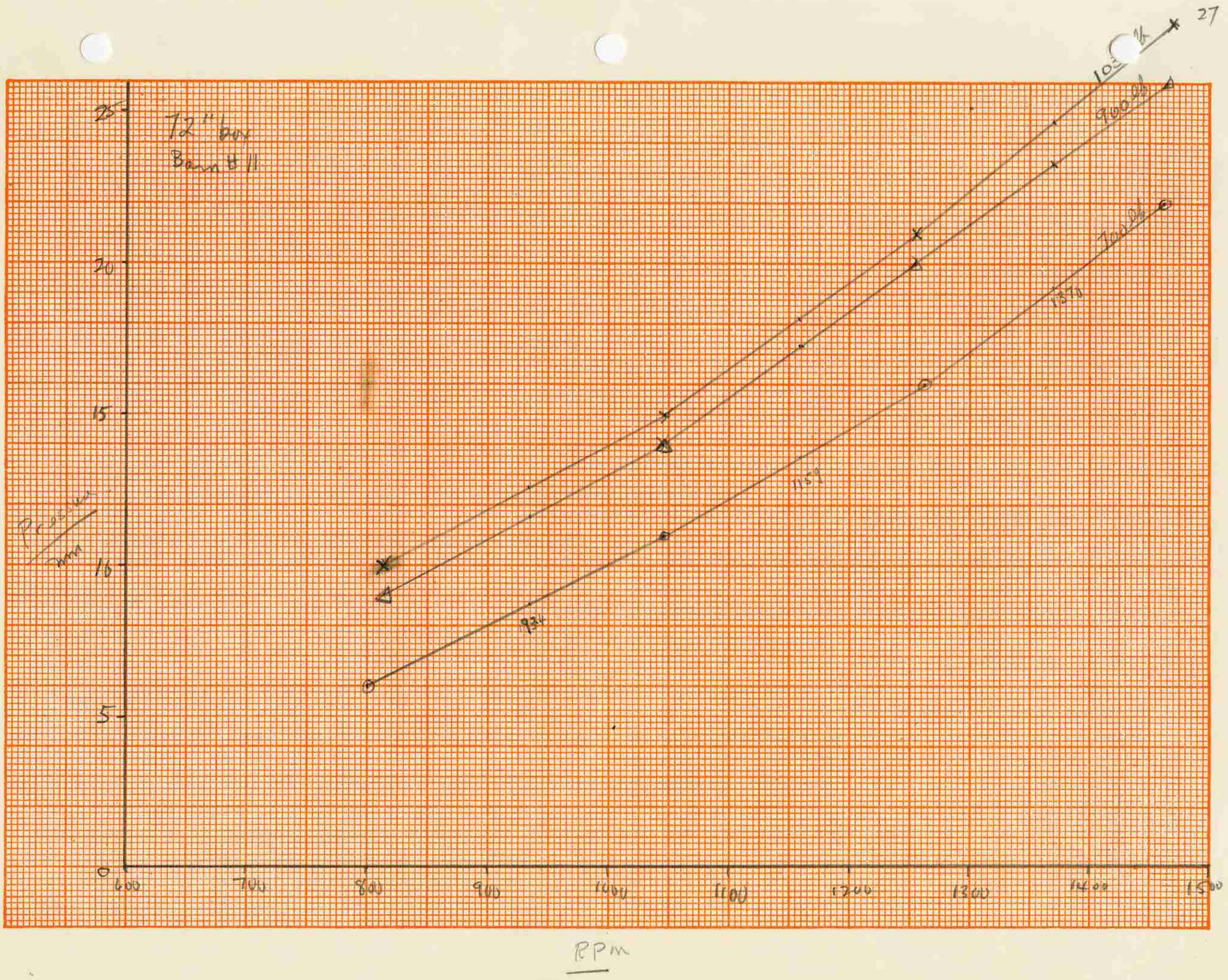
1" → 500 cfm 1 box

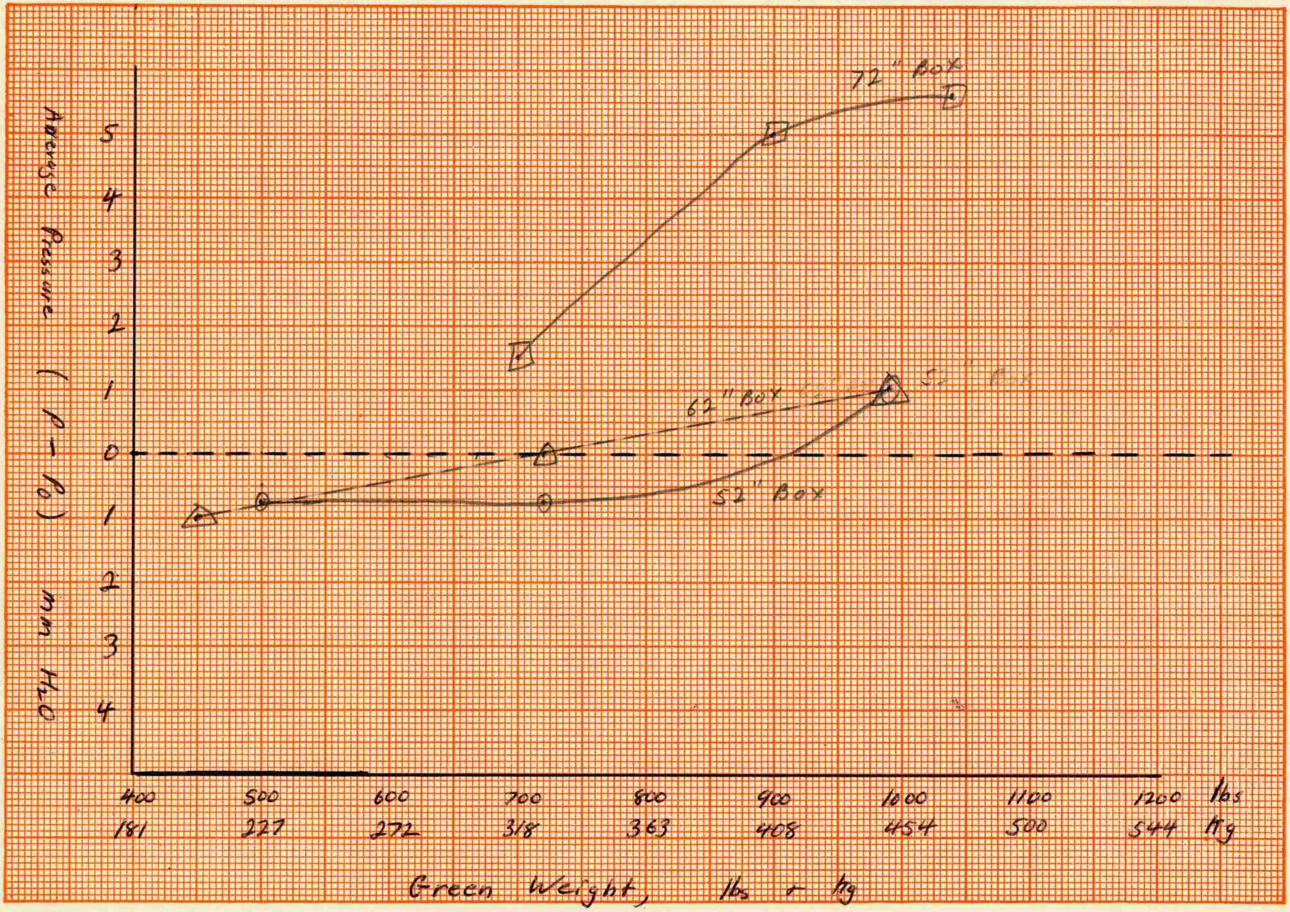
1" → 1000 cfm 2 boxes

← 500 cfm 2 boxes

---

cfm	depth	P
40	4	.6625
40	5	.828 checks


72" box
Barn # 11
Pressure mm
RPM
100 %
900 %
700 %
934
1159
1370
0
5
10
15
20
25
600
700
800
900
1000
1100
1200
1300
1400
1500



72" BOX
62" BOX
52" BOX
52" BOX
Average Pressure (P - P0) mm H2O
5
4
3
2
1
0
1
2
3
4
400
500
600
700
800
900
1000
1100
1200
lbs
181
227
272
318
363
408
454
500
544
kg
Green Weight, lbs + kg

Data taken
July 78
Clayton

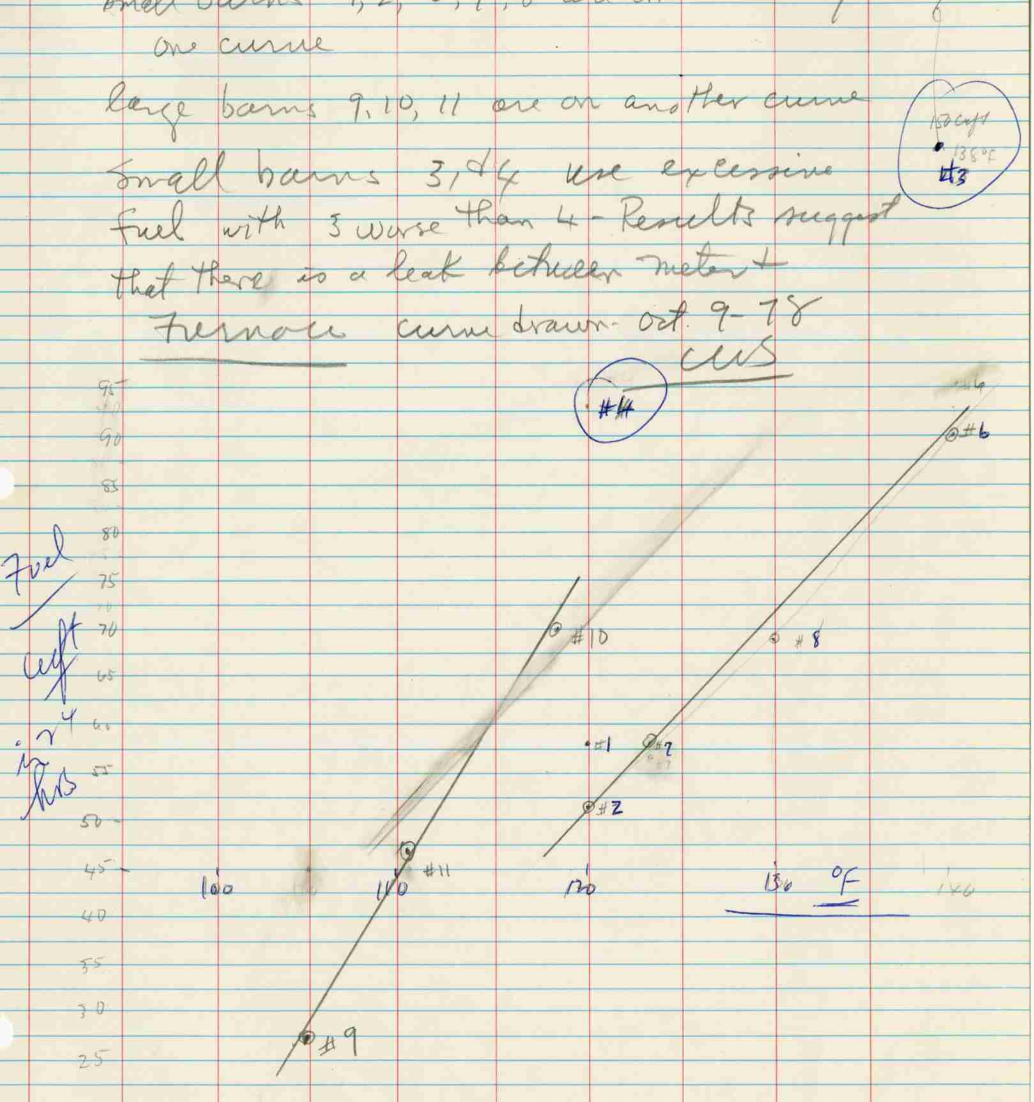
Empty barn characteristics

Small barns 1, 2, 6, 7, 8 are on one curve

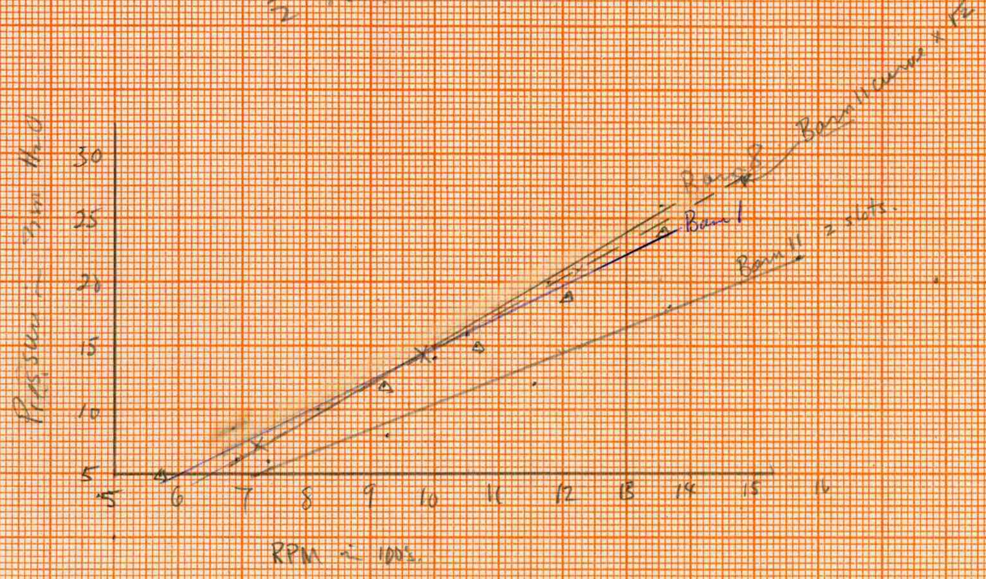
Large barns 9, 10, 11 are on another curve

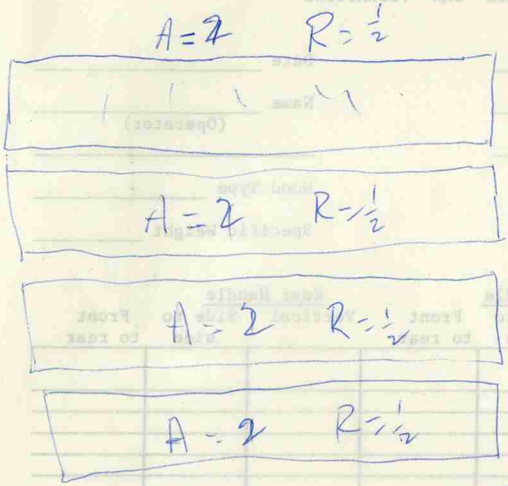
Small barns 3, & 4 use excessive fuel with 3 worse than 4 - Results suggest that there is a leak between meter +

Furnace curve drawn Oct. 9-78
CWS



Barn performance with
1/2" x 48" slots orifices





$$\frac{1}{A} = \frac{1}{A_1} + \frac{1}{A_2} \cdots$$

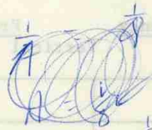
$$\frac{1}{A} = \frac{1}{1} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1} \cdots \frac{4}{1}$$

$$A = \frac{1}{4}$$

~~$\frac{1}{R} = \frac{2}{1} + \frac{2}{1} + \frac{2}{1} + \frac{2}{1} = \frac{8}{1}$~~

or is $R = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 2$

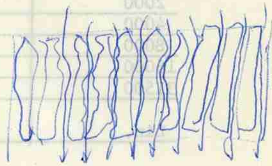
Resistance in series add.



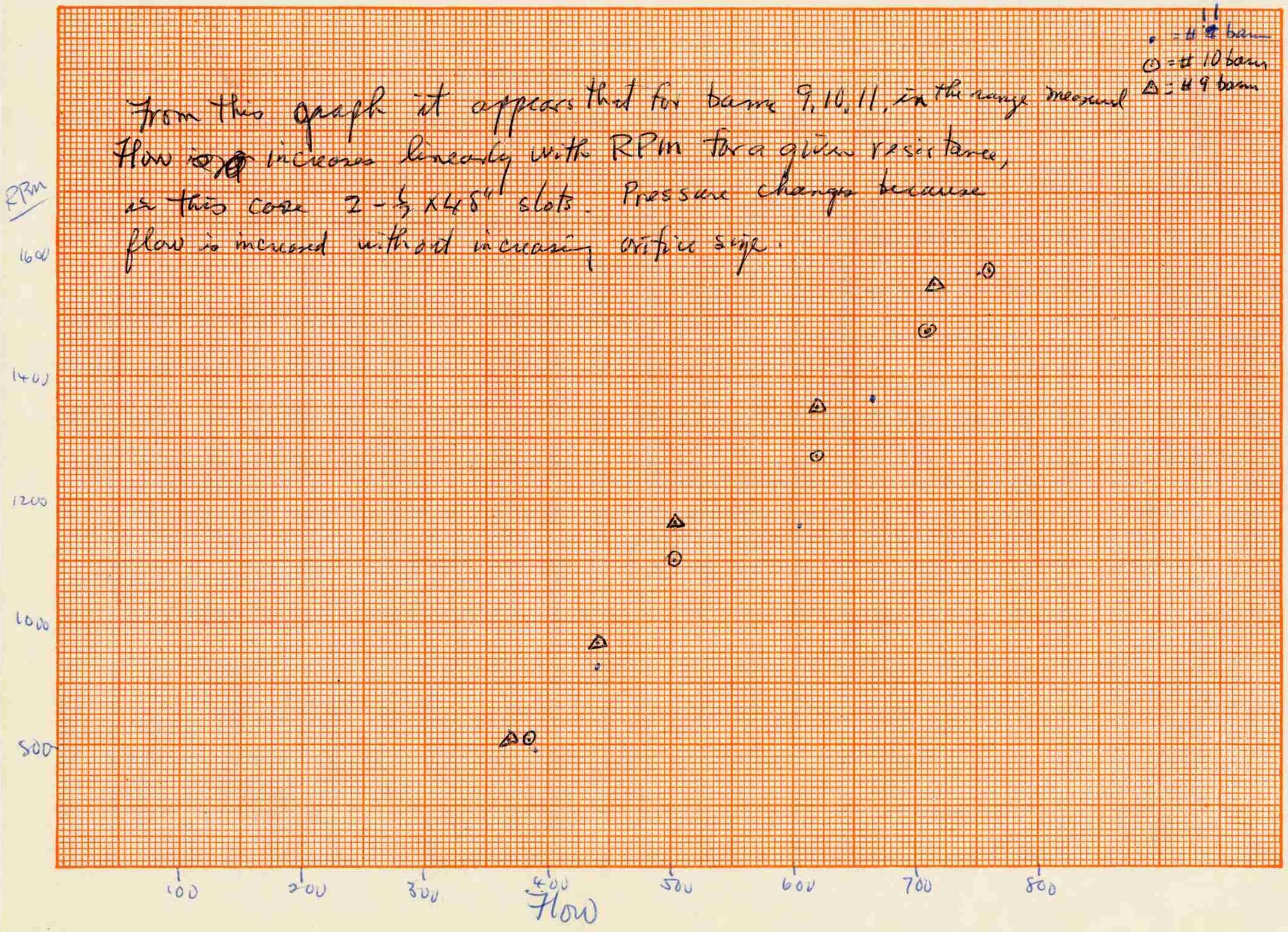
Resistances in parallel

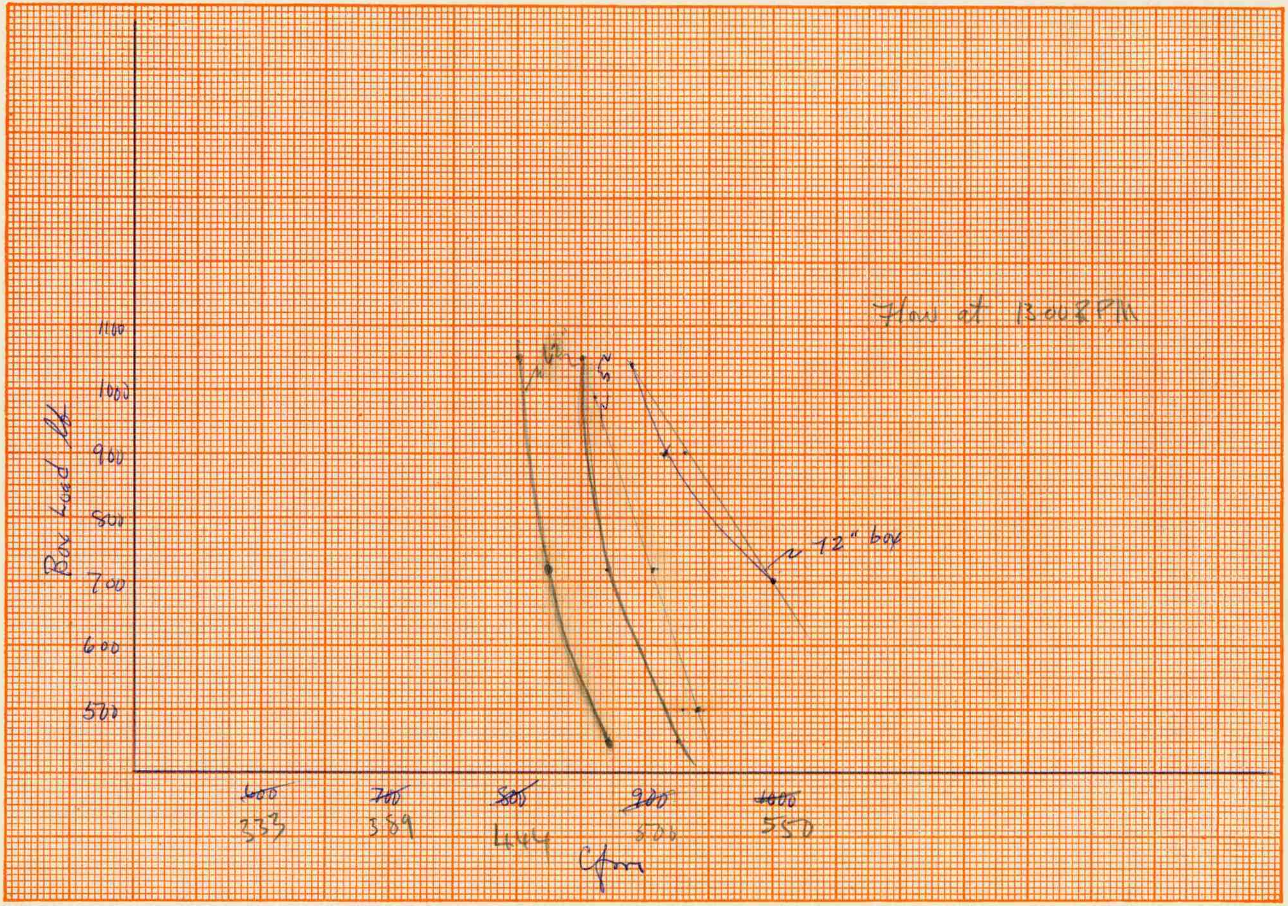
$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots \frac{1}{r_n}$$

1. (a) Conductivity decreases with box height
   (b) Resistance increases with height.
2. (a) Conductivity decreases with density.
   (b) Resistance increases with density.
3. For a constant load
   conductivity will <u>increase</u> with box height
   Resistance will decrease with box height
4. Approach on the basis of a volume resistance
   $R_v = f$(density, cross section and height)

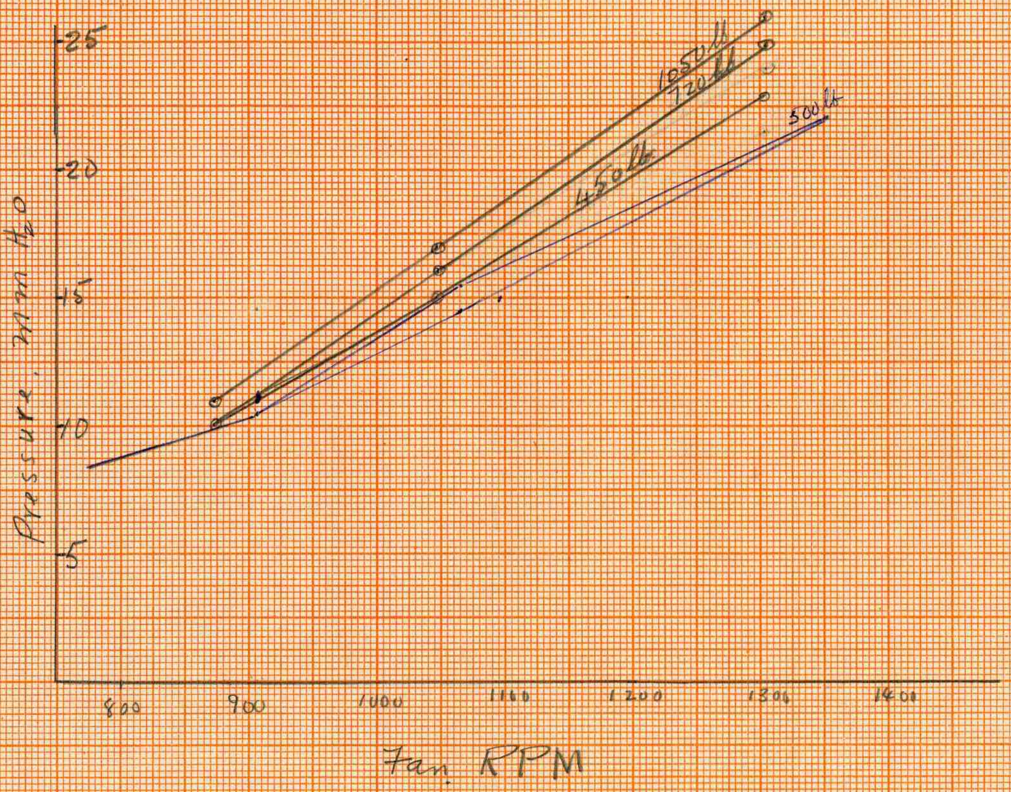


From this graph it appears that for barns 9, 10, 11, in the range measured Flow increases linearly with RPM for a given resistance, in this case 2 - 1/2 x 48" slots. Pressure changes because flow is increased without increasing orifice size.

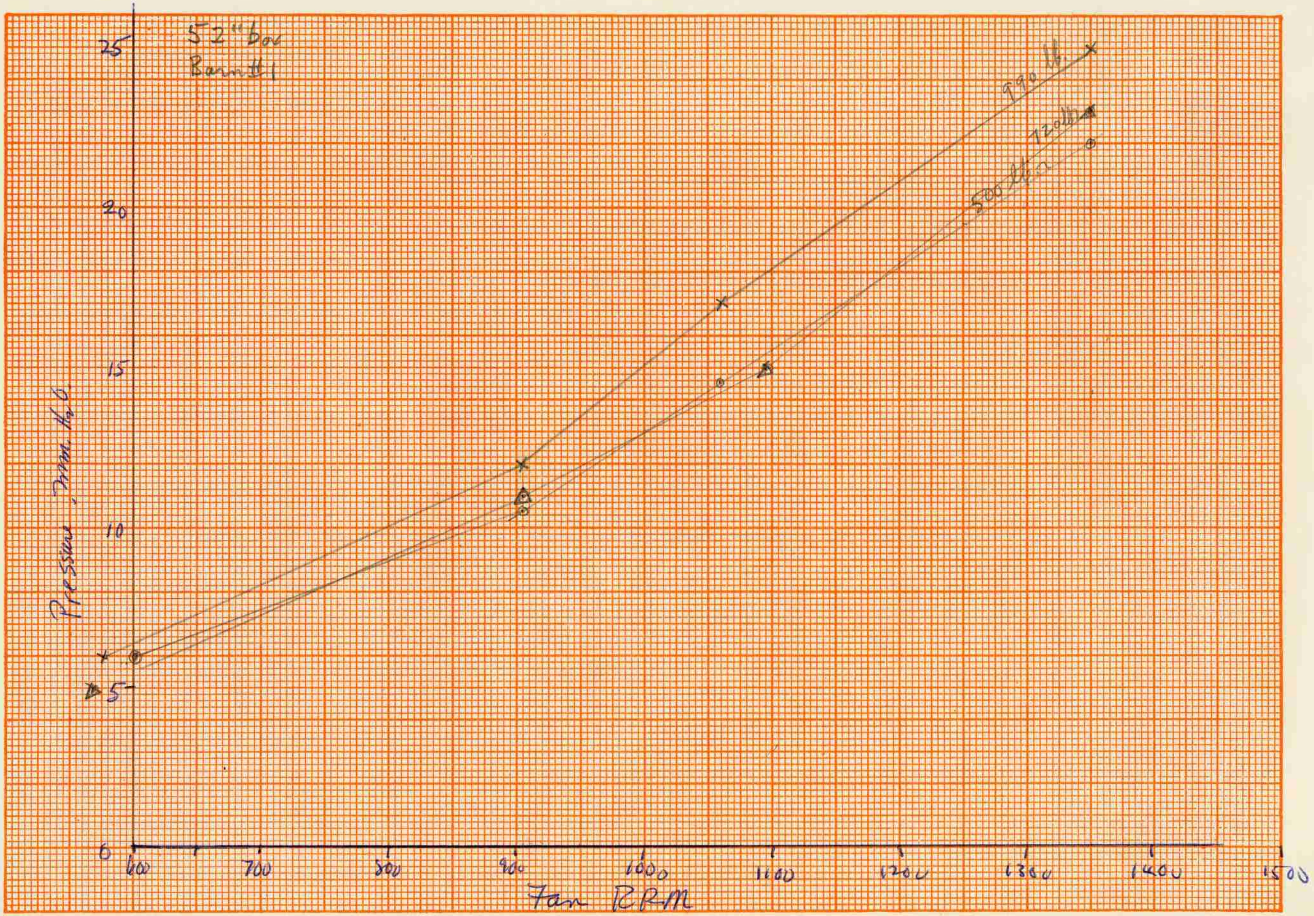




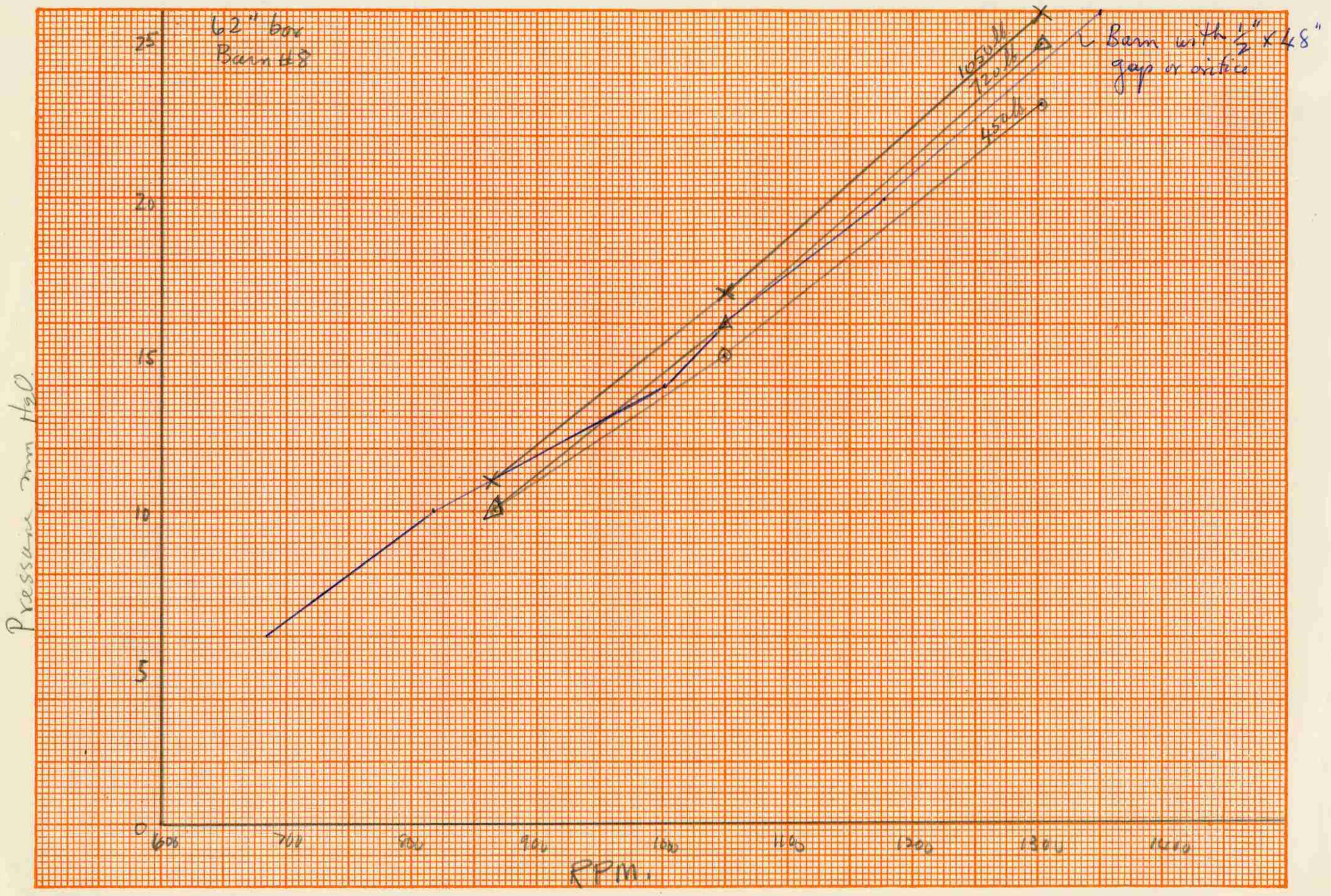
Flow at 1300 RPM
Box Load lb
1100
1000
900
800
700
600
500
12" box
~~600~~ 333
~~700~~ 389
~~800~~ 444
~~900~~ 500
~~1000~~ 550
Cfm



Pressure, mm H_2O
25
20
15
10
5
800
900
1000
1100
1200
1300
1400
Fan RPM
1050 lb
720 lb
450 lb
500 lb



52" box
Barn #1
990 lb.
720 lb
500 lb
Pressure, mm H_2O
0
5
10
15
20
25
600
700
800
900
1000
1100
1200
1300
1400
1500
Fan RPM



62" box
Barn #8
Barn with 1/2" x 48" gap or orifice
1650 cfh
1200 cfh
450 cfh
Pressure mm H2O
RPM.
0
5
10
15
20
25
600
700
800
900
1000
1100
1200
1300
1400

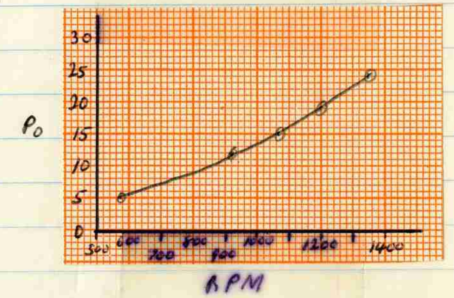
Fan Speed Vs. Pressure Curves

Clayton 1978

June 2, 1978

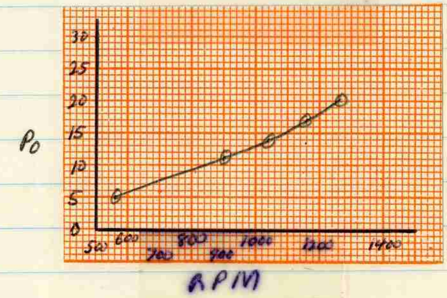
Barn #1

Fan speed (RPM)	P_0 (mm H_2O)
570	5
912	12
1065	15
1205	19
1355	24



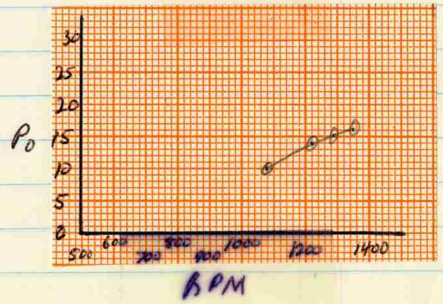
Barn #2

Fan Speed (RPM)	P_0 (mm H_2O)
565	5
901	11
1038	14
1162	17
1265	20



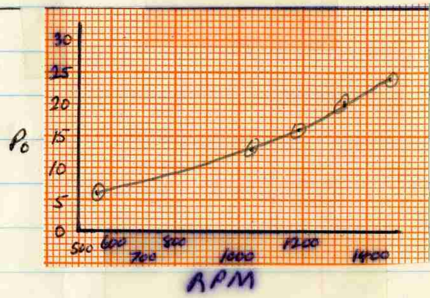
Barn # 3

Fan Speed (RPM)	P_0 (mm H_2O)
1081	10
1225	14
1289	15
1350	16



Barn #4

Fan speed (RPM)	Po (mm H2O)
558	6
1038	13
1188	16
1332	20
1472	24

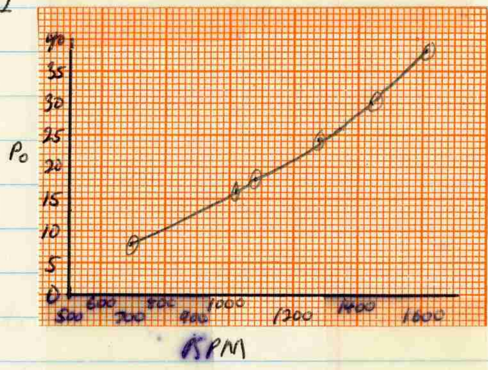


Barn #5

Fan Speed (RPM)	Po (mm H2O)
Not In USE	

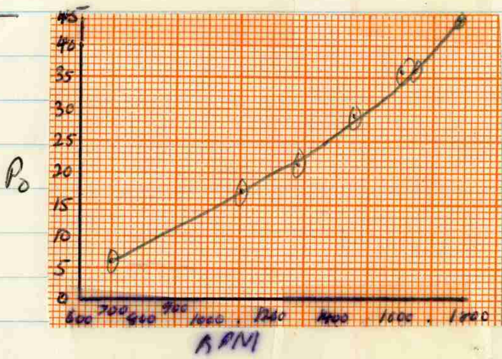
Barn #6

Fan Speed (RPM)	Po (mm H2O)
710	8
1018	16
1084	18
1273	24
1440	30
1608	38



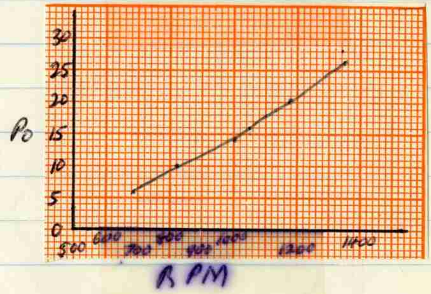
Barn # 7

Fan Speed (RPM)	Po (mm H2O)
702	6
1102	17
1282	22
1448	29
1606	36
1640	36
1785	44



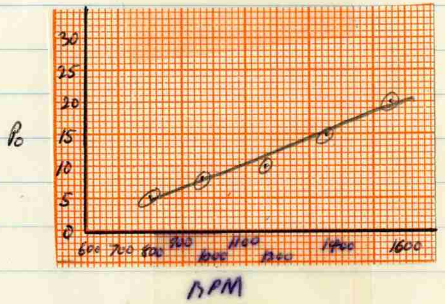
Barn # 8

Fan Speed (RPM)	Po (mm H2O)
685	6
818	10
1002	14
1048	16
1178	20
1352	26



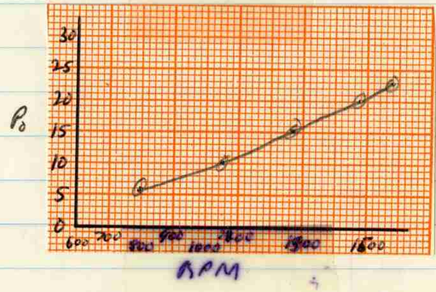
Barn # 9

Fan Speed (RPM)	P_0 (mm H_2O)
803	5
965	8
1159	10
1348	15
1553	20



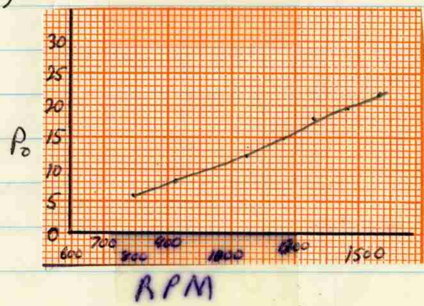
Barn # 10

Fan Speed (RPM)	P_0 (mm H_2O)
805	6
1051	10
1268	15
1475	20
1576	23



Barn # 11

Fan Speed (RPM)	P_0 (mm H_2O)
742	6
925	8
1156	12
1365	18
1569	22



Fan speed versus pressure data June, July
Clayton 1978

Barn #3 (Single box)
(1 - 1/2" gap) (1/2" x 4') gap

BARN # 3 5" Drive

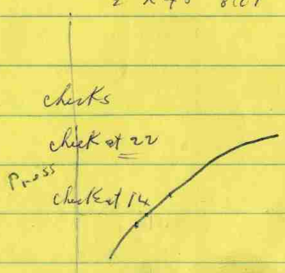
Fan speed	Pressure
1289 rpm	15 mm
1350 rpm	16 mm
1225 rpm	14 mm
1081 rpm	10 mm

BARN # 4 5" Drive

FAN Speed	PRESSURE
1472	24 M.M.
1332	20 MM.
1188	16 MM.
1038	13 M.M.
558	6 M.M

BARN # 1 1/2 x 48" slot

FAN Speed	PRESSURE
1355	24 m.m.
1205	19 m.m.
1065	15 MM
912	12 MM
570	5 MM



Mo[illegible] Drive 4" BARN # 6 4" DRIVE

Speed	Pressure
1608	38
1440	30
1273	24
1084	18
710	8
1018	16

BARN # 2 5" Drive

FAN Speed	PRESSURE
1265	20 mm
1162	17 mm
1038	14 mm
901	11 mm
565	5 mm

Barn # 8 3" Drive

$\frac{1}{2} \times 48'' = 24$ sq in.

Fan Speed	Pressure
1881 rpm	46 mm
1565	36 mm
1340	28 mm
1100	18 mm
926	12 mm

Barn # 7

June 2. 1978

Calibration of New (2 box) barns.

RPM vs. pressure

1. Floor blocked except for 2 - ½" x 4' slots.

Barn # 10 — 100% recirculate — 48 sq in

Fan Speed	Pressure		
1475	.78"	20	
1268	.60"	15 ~~25~~	checks
1051	.40"	10 ~~16~~	- checks.
805	.23"	6	
1576	.90"	23	

Barn # 9 — recirculate

Fan Speed	Pressure	
1553	.80	20
1348	.60	15
965	.30	8
803	.21	5
1159	.40	10

Barn 11 — Recirculate

Fan Speed	Pressure		
1569	.88	22	
1365	.70 or .69	18	- checks
1156	.48	12	- checks
925	.30	8	- checks
792	.23-.24	6	

Barn # 7 — 3½" Drive

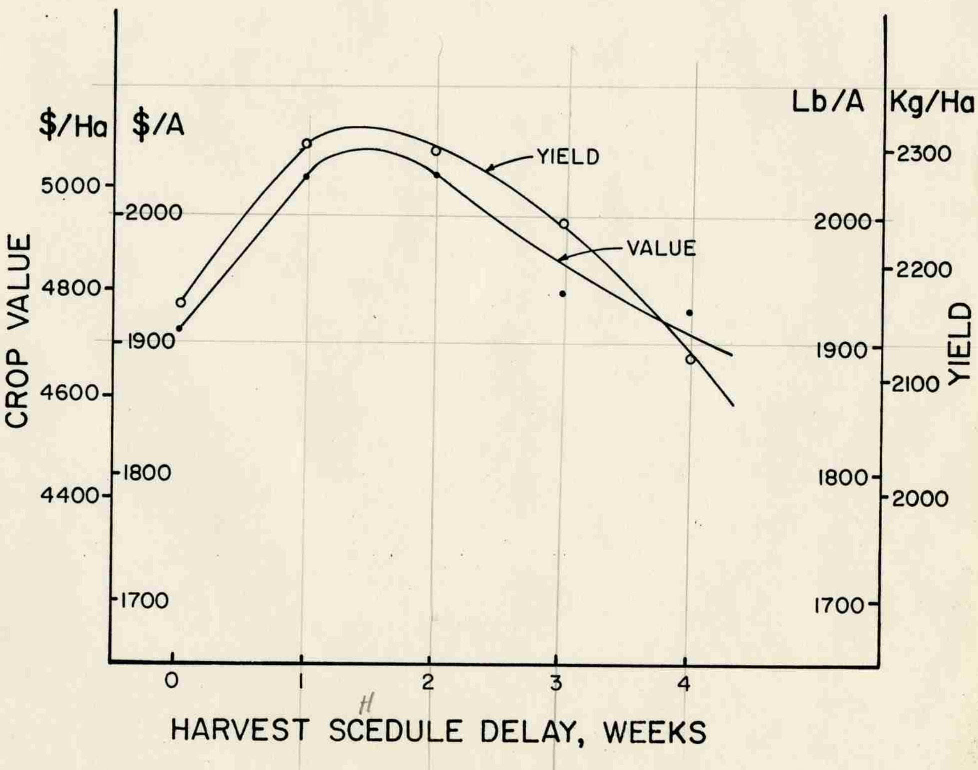
Speed	Pressure
1785	44
1640	36

Motor Drive 4" — Barn # 7 — 4" Drive

Speed	Pressure
1606	36
1448	29
1282	22
1102	17
702	6

Motor Drive 3" — BARN # 8 — 4" Drive

Speed	Pressure	½ x 48"
1352	26	- checks at 24
1178	20	- checks at ~~22~~ 16
1002	14	checks at 14 for 1050
818	~~8~~ 10	
685	6	
1048	16	



$/Ha
$/A
CROP VALUE
5000
4800
4600
4400
2000
1900
1800
1700
Lb/A
Kg/Ha
YIELD
2300
2000
2200
1900
2100
1800
2000
1700
VALUE
0
1
2
3
4
HARVEST SCEDULE DELAY, WEEKS

Barn Timeliness

1979 Tob. inf.
Average Harvest was 50 days long
~~Dr. Congleton ???~~ -
41. to 61 days See pg 28

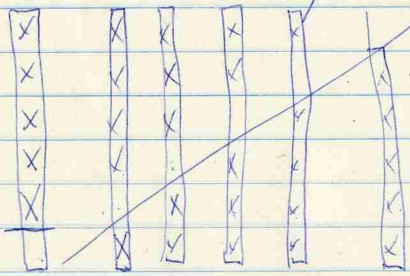
Harvest schedule - Barn Timeliness

Start 1 week green - stay ahead for best yield + value
price down ~~1.2¢ from~~ 3¢/lb but weight more than makes up for decrease.
Also ~~to~~ have ~~some~~ more leeway for delays later -

Cost of ~~having~~ not having enough barns -

15
20 boxes
3000
125
20
2500
150
7
1050
1 1/4 A/cure
5 cures
6 1/4 A

Assume 1 week/cure, Assume a 5 week harvest season
now if the crop is 20% too large for the barn one extra cure will be required - The ~~aver~~ delay ranges from 1 week for the entire stalk to no delay - The average is 1 week for 1/2 of the stalk - or 1 week for 1/2 of the crop.

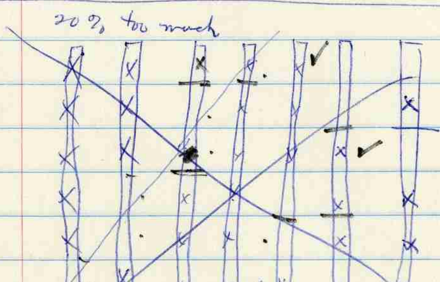


1st cure

1 week delay × 0
" × 1/5 of crop.
" × 2/5
" × 3/5
" × 4/5
1 week OR × 5/5

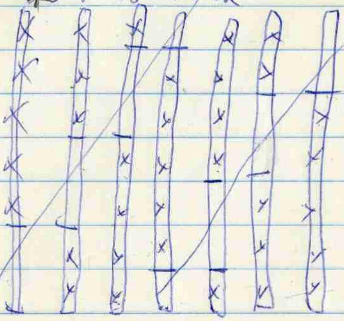
6 parts × 15/5 = 3.0/5 3/6 = 1/2 of the crop
was primed 1 week late -

20% too much



1 × 0
1 ×

40% too much



7 plots

✓ 1 × 2/5

✓ 1 × 3/5

1 × 2/5 + 2 × 1/5

1 × 3/5 + 2 × 1/5

1 × 2/5 + 2 × 2/5

1 × 3/5 × 2 × 2/5

1 × 2/5 + 2 × 3/5

17 × 20 = 340 lb = 49% delayed one week

9 × 20 = 180 lb = 26% delayed 2 weeks

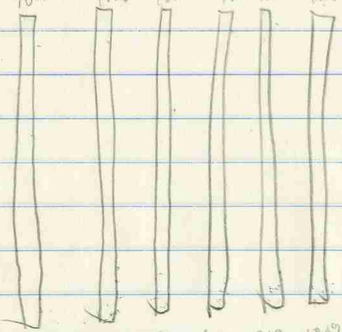
1 × 17/5 = 1 × 3 2/5 = 68%

2 × 9/5 = 2 × 1 4/5 = 36%

17/5 ÷ 35/5 = 49% delayed 1 week

9/5 ÷ 35/5 = 26% delayed 2 weeks

20% excess use light harvests



1000 1000 1000 1000 1000 1000 = 6000

5000 + 1000 = 1000 + 20%

1 week × 20% × (1/5 × 1/6) × 1 1/30

2/5 × 1/6 2/30

3/5 × 1/6 3/30

4/5 × 1/6 4/30

5/5 × 1/6 5/30

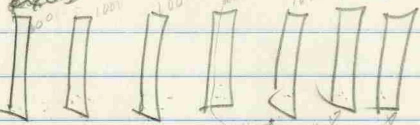
15/5 × 5/6 15/30 = 50%

3000 lb / 6000 = 50%

0 amount held over 20% 40% 60% 80% 100%

1000 1000 ... = 700 = 500 + 200 = 20% excess

40% excess



0 40 80 120 160 200

100+120 100+160 100+100

1	2	3	4	5	6	7
140	140 / 40 / 180	140 / 80 / 220	140 / 120 / 260	140 / 160 / 300	200 / 200	100 / 100
100	100	100	100	100	100	100
40	80	120	160	200	100	0

→ 700

1 w 40 80 100+ 80 40 340

2 w 20 60 100 180

220 lb = paid 1 week late

180 lb paid 2 weeks late

320/700 =

180/700

6.25A = 108%

Now a bulk barn costs about 1150 to 1258 per year to own - or assuming 6 weeks of curing 42 days. This amounts to 1200/42 = $28.57 per day -

Assume 6¼ A per barn for a 5 week harvest season - If the season is extended to six weeks then 5 barns will cure the same amount of tobacco as 6 on a 5 week season. 6 weeks × 5 cures = 30, 5 weeks × 6 cures = 30 -

20% or cost

120% = 7.5A

The loss in value is about 2032 - 1991 = $41./A for the acreage where harvest is delayed one week.

From page __ the delay would accumulate such that 50% of the tobacco would be harvested 1 week late -

The crop is 6¼ A per barn × 6 barn equivalent = 37½ A - 37½ × 41 = $768.75. This is only about ½ enough to pay for the barn.

—

40% excess

140% = 8.75A

Now assume that a 7 barn crop = 6¼ × 7 = ~~45.5~~ 43.75 A is to be cured in 5 barns (40% excess)

From page 2 - 49% of the crop would be delayed one week for harvest. This would reduce value ~~45.5~~ 43.75 × .49 × $41./A = $879

In addition 26% of the crop would be delayed 2 weeks. A two week harvest delay reduces value from $2032./A to $1927/A for a loss of $105/A.

The loss for the 26% of the crop so affected would be 43.754 × .26 × 105 = $1194 or just about enough to pay for a barn. The one week delay cost of $914. could be tolerated as it is less than the barn costs.

Calculations made on basis of 2000 lbs/A - Since value reductions are related to weight more so than to area it would be logical to substitute tons for acres in the previous analysis.

Thus a barn capacity is 12500 lb or an average of 2500 lb for each of 5 cures in a normal season. Twenty percent excess is 6 cures or 15000 lb, while 40% excess is 7 cures for 17500 lb.

Reduction in the number of primings is not expected to change the above results as the proportion of the crop which would be harvested overripe because of inadequate barn space would not be changed.

Paper Presented at 31st Tobacco Chemists' Research Conference, Greensboro, N.C.
October 5-7, 1977

Effect of Harvest Schedule on Yield, Value and Chemical Characteristics of Flue Cured Tobacco

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N.C. State University, Agricultural Experiment Station
Raleigh, N.C. 27607

ABSTRACT

Although flue cured tobacco has traditionally been harvested on approximately a weekly schedule, many growers are now harvesting at two-week intervals. In order to extend the harvest season, thereby allowing expensive equipment to be utilized more effectively, growers are also starting the harvest earlier and continuing harvesting later.

A four-year series of experiments was used to measure the effects of a reduction in the number of primings and extension of the season by priming before and after "optimum" ripeness. The extension ranged from one week immature (green) to four weeks overmature and included treatments with normal timing of the first priming followed by as much as four weeks delay before harvest of the second primings.

Per acre yield and value as well as sugar and alkaloid content were not significantly affected by harvest schedule. Yield and value ranged from 1845 to 2050 lb/A and from 1866 to 2061 $/A with the higher values generally being associated with the normal and early harvest schedules. Sugar content varied only from 15.0 to 17.2% with no trends evident. Alkaloids varied from 3.05 to 3.48% with the delayed harvest schedules tending to result in higher values.

From this work it can be concluded that harvesting can be extended several weeks without significant change in yield, value, sugar or alkaloid content. However, there was a slight trend for the normal and early schedules to give higher yields and value.

INTRODUCTION

A series of experiments extending over several years was performed to determined how much various harvesting schedules would affect crop yield, value and chemical composition. In addition to the check which was "optimally" harvested in four to five primings, Table 1, the experiment involved a series of plots with up to four weeks of harvesting delay, plots in which leaves were picked one to two weeks premature and plots with as much as four weeks between the first and second primings.

The plots were located on the Central Crops Research Station, near Clayton, N.C. All crops were grown in accordance with accepted agronomic practice. The first three years of the investigation variety N.C. 2326 was used. The last year Speights G28 was used. Leaves were hand harvested in accordance with the test schedule and cured in a bulk barn. Value was determined from plot weights, government grades and market price average for each grade.

Although some of the treatments were severe, that is, significantly earlier or later than normal harvesting, the effects on yield, value, % sugar and % total alkaloids were not appreciable, Tables 2 to 6. In fact, out of 16 comparisons only one was statistically significant. This was in 1974, Table 4, in the alkaloids. These differences were due to a low value for the three primings at two week intervals, treatment 10 and the high values for treatments 7, 8 and 9 in which the first priming was delayed 2, 3 or 4 weeks past optimum followed by "as ripe" removal of the remainder of the leaves. Even though the differences were significant the range was only from 2.75% to 3.48%.

Overall, yield and value did not display any identifiable trends with treatments 2 and 4 each being highest in two years and lowest in one year, Table 7. High and low treatments for sugar and alkaloids were also randomly distributed.

In the four year averages, Table 6, differences were relatively small with a slight advantage for the normal, the one week premature (green) and the plot in which the first priming was removed at the optimum time followed by a four week delay before removal of the second priming. Except for low sugar and alkaloid values for the plots which were harvested two weeks green there do not appear to be appreciable differences in leaf chemistry.

From this work it appears that significant changes in harvest schedule can be tolerated without appreciable changes in yield, value of sugar and alkaloids content. The better utilization of curing barns and harvesting equipment which are associated with such changes in harvest schedule can make production of flue-cured tobacco more efficient.

TABLE 1. TREATMENT DESCRIPTION FOR HARVEST SCHEDULE EXPERIMENT

TREATMENT NUMBER	1ST PRIMING	OTHER PRIMINGS	NUMBER OF PRIMINGS
1	2 WEEKS IMMATURE	IMMATURE	4-5
2	1 WEEK IMMATURE	IMMATURE	4-5
3	OPTIMUM	OPTIMUM	4-5
4	1 WEEK OVER-RIPE	1 WEEK OVER-RIPE	4-5
5	2 WEEKS OVER-RIPE	2 WEEKS OVER-RIPE	4-5
6	3 WEEKS OVER-RIPE	3 WEEKS OVER-RIPE	4-5
7	2 WEEKS OVER-RIPE (LATE START)	AS RIPE	4
8	3 WEEKS OVER-RIPE (LATE START)	AS RIPE	4
9	4 WEEKS OVER-RIPE (LATE START)	AS RIPE	3
10	OPTIMUM	2 WEEK INTERVALS	3
11	OPTIMUM	2ND PRIMING 4 WEEKS LATER	3

TABLE 2.

EFFECT OF HARVEST SCHEDULE ON YIELD, VALUE AND CHEMICAL CHARACTERISTICS OF FLUE CURED TOBACCO. 1976 RESULTS.

TREATMENT TIMING	# PRIMINGS	YIELD LB/A	VALUE $/A	SUGAR %	ALKALOIDS %
2 WEEKS GREEN	4-5	1740	1935 1.11	11.7	2.95
1 WEEK GREEN	4-5	1876	2058 1.10	12.1	2.95
OPTIMUM	4-5	1910	2159 1.13	8.9	3.03
1 WEEK OVER-RIPE	4-5	1963	2296	10.3	3.45
2 WEEKS OVER-RIPE	4-5	1919	2195	10.0	3.44
3 WEEKS OVER-RIPE	4-5	1706	1990	8.8	3.50
2 WEEKS LATE START	AS RIPE	1793	1991	8.7	3.58
3 WEEKS LATE START	AS RIPE	1744	2018	9.2	3.81
4 WEEKS LATE START	AS RIPE	1751	2044	10.7	3.41
NORMAL START	3	1640	1835	7.9	3.35
1ST PRIMING NORMAL 2ND PRIMING 4 WEEKS LATER	3	1964	2302	9.5	3.27
MEAN		1819	2075	9.8	3.34
SIGNIFICANCE OF TREATMENT		NS $1.17/lb	NS	NS	NS

Table 3.

Effect of Harvest Schedule on Yield, Value and Chemical Characteristics of Flue Cured Tobacco. 1975 Results.

Treatment: Timing	Treatment: # Primings	Yield lb/A	Value $/A	Sugar %	Alkaloids %
2 weeks green	4-5	1859	1949 1.05	17.4	2.70
1 week green	4-5	1983	2029 1.02	13.4	3.40
Optimum	4-5	1825	1970 1.08	16.5	3.17
1 week over-ripe	4-5	1525	1630	13.1	3.85
2 weeks over-ripe	4-5	1414	1528	13.4	3.57
3 weeks over-ripe	4-5	1665	1808	14.0	3.74
2 weeks late start	As Ripe	1550	1687	12.0	3.54
3 weeks late start	As Ripe	1438	1579	17.0	3.37
4 weeks late start	As Ripe	1419	1519	15.8	3.57
Normal start	3	1643	1756	13.8	3.54
~~1st priming normal~~ 2 week interval 2nd priming 4 weeks later	3	1712	1856	14.5	3.36
Mean		1639	1756	14.6	3.44
Significance of treatment		NS	NS	NS	NS

Table 4.

Effect of Harvest Schedule on Yield, Value and Chemical Characteristics of Flue Cured Tobacco. 1974 Results.

Treatment: Timing	Treatment: # Primings	Yield Lb/A	Value $/A	$/lb	Sugar %	Alkaloids %
2 weeks green	4-5	-	-		-	-
1 week green	4-5	2537	2455	96.8	20.8	3.00
Optimum	4-5	2382	2347	98.5	22.0	3.01
1 week over-ripe	4-5	2149	2061	95.9	20.8	2.93
2 weeks over-ripe	4-5	2387	2351	98.5	20.8	2.96
3 weeks over-ripe	4-5	2311	2285		20.1	3.15
2 weeks late start	As Ripe	2183	2149		22.6	3.20
3 weeks late start	As Ripe	2424	2397		21.0	3.41
4 weeks late start	As Ripe	2339	2324		21.2	3.48
Normal start	3	2368	2297		20.6	2.75
1st priming normal 2nd priming 4 weeks later	3	2397	2374		19.4	3.20
	Mean	2348	2304		20.9	3.11
Significance of Treatments		NS	NS		NS	1% level

Table 5.

Effect of harvest schedule on yield, value and chemical characteristics of flue cured tobacco. 1973 Data.

Treatment: Timing	# Primings	Yield Lb/A	Value $/A	Sugar %	Alkaloids %
2 weeks green	4-5	-	-	-	-
1 week green	4-5	1828	1587	18.2	3.16
Optimum	4-5	1884	1652 87.7	18.1	2.98
1 week over-ripe	4-5	2339	1978	20.0	3.15
2 weeks over-ripe	4-5	1841	1632	17.1	3.63
3 weeks over-ripe	4-5	1851	1638	18.5	3.48
2 weeks late start	As Ripe	1854	1634	20.6	3.25
3 weeks late start	As Ripe	1889	1674	21.7	3.34
4 weeks late start	As Ripe	1929	1711	18.1	3.31
Normal start	3	1908	1676	17.8	3.45
1st priming 4 weeks later 2nd priming 4 weeks later	3	1950	1713	19.0	2.91
	Mean	1927 $89/A	1690	18.9	3.27
Significance of Treatments		NS	NS	NS	NS

Table 6.

Effect of Harvest Schedule on Yield, Value and Chemical Characteristics of Flue Cured Tobacco. Four Years Data, 1973-76.

Treatment Timing	# Primings	Yield LB/A	Value $/A	Sugar %	Alkaloids %
2 weeks green	4-5	1800	1942	14.6	2.82
1 week green	4-5	2056	2032	16.2	3.13
Optimum	4-5	2000	2032	16.4	3.05
1 week over-ripe	4-5	1994	1991	16.0	3.34
2 weeks over-ripe	4-5	1890	1927	15.3	3.40
3 weeks over-ripe	4-5	1883	1930	15.4	3.47
2 weeks late start	As Ripe	1845	1886	16.0	3.39
3 weeks late start	As Ripe	1874	1917	17.1	3.48
4 weeks late start	As Ripe	1860	1900	16.4	3.44
Normal start	3	1890	1893	15.0	3.27
1st priming normal 2nd priming 4 weeks later	3	2006	2061	15.6	3.18
Mean		1918	1956	15.8	3.27

add 25% to get 1978 values

add 37% to get 1978 values

WK	LB/A	$/A
-2	1800	1942
-1	2056	2032
0	2000	2032
+1	1994	1991
+2	1890	1927
+3	1883	1930

Yield is	1975	1976	Av
-2	1859	1740	1800
op	1825	1910	1868

68 lb less than check or 1932 lb.

Note - the 2 weeks green treatment was not included in the first two years of the exp. Prices increased throughout the exp. Therefore, it is better to look at price as a percentage of the check - this was 97.6% - Then the properly weighted price is $.996/lb and The Value/A is ~~$1792~~.

Value is	1975	1976	Av.
-2	1935	1949	1942
op	2159	1978	2064

$122. less than check $1910

TABLE 7

TREATMENT NUMBERS FOR HIGH AND LOW YIELD, VALUE, SUGAR AND ALKALOID RESPONSE.

VARIABLE	1973		1974		1975		1976	
	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
YIELD	4	2	2	4,7	2	5,9,8	11,4	10
VALUE	4	2	2	4	2	9,5,8	4,11	10
SUGAR	8	5	7	11	1	7	2	10
ALKALOIDS	5	11	9	10	4,6	1	8	1,2

1 week 2032 - 1491 = 41

2 week - 2032 - 1950 = 82

3 week - 2032 - 1900 = 132

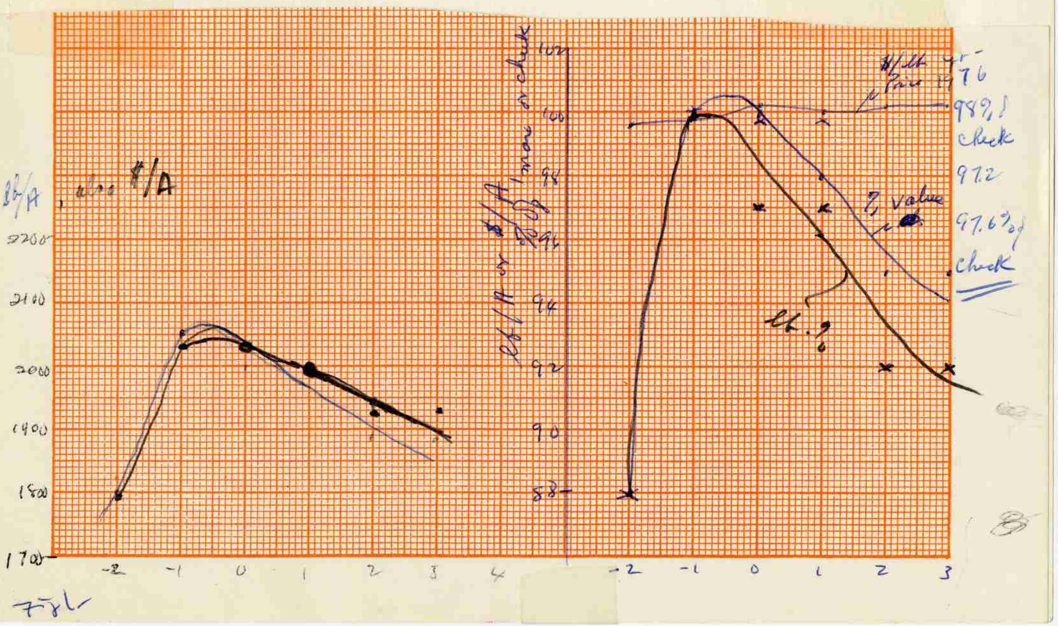


Table 6

Backup - Optimum Barn Capacity

Assume that crop ripens over a period of 5 weeks

Cropsize / Barn capacity %	Harvest Delayed 1 week %	Harvest Delayed 2 weeks %	Harvest Delayed 3 weeks	Value Loss $/barn/cure	Number of cures	Total Value loss $/barn/Priming	Annual Additional Cost of Sufficient barn space $
110	25	0	0	13	5.5	71.5	120
120	50	0	0	26	6	156	240
130	55	11	0	28.19+11.28	6.5	183+73=256	240+120
140	49	26	0	25.11+26.65	7	176+187=363	240+240
150	40	33	7	20.50+33.82+11.55	7.5	154+254+87=495	240+240+120
160	32	32	18	16.40+32.80+29.93	8	131+262+240 633	240+240+240
	51.25/3500 lb	102.50/2500 lb	165/2500 lb				

131.25/2500

238,875 need 240

	1	2	3	4	5	6	7
1	X	X	X	X		X	
2	X	X	X		X	X	
3	X	X	X		X	X	
4	X	X	X		X	X	
5	X	X		X	X	X	
6	X	X		X	X	X	
7	X	X		X	X	X	
8	X		X	X	X	X	
9	X		X	X	X		X
10	X		X	X	X		X
11		X	X	X	X		X
12		X	X	X		X	X
13		X	X	X		X	X

13/3

36

65

7

Backup: Optimum Barn Capacity

Crop Size Kg	Crop Size / Barn Capacity %	Number of cures	Amount of Delayed Harvest and Reduction in Crop Value 1 Week	2 weeks	3 weeks	Annual Costs for Barns to Eliminate Harvest Delay $	$ 1978 data	$
5670	100	5	0	0	0			
6337	110	5.5	25% 117 105	0	0	120		
6804	120	6	50% 255 230	0	0	240		
7371	130	6.5	55% 304 274	11% 120 108	0			
7938	140	7	49% 292 263	26% 306 276	0			
8505	150	7.5	40% 255 230	33% 416 374	7% 132 119			
9072	160	8	32% 218 196	32% 430 387	18% 363 327			
			85	168	252			

1973, 74, 75, 76 - 78 data

100					
110	85.25 78				
120	186 169				
130	222 202	91 52 83			
140	213 194	233 212			2750
150	185 168	317 288	129 117		
160	159 145	328 298	353 321		
	62	128	245		

Table 6

Backup – Optimum Barn Capacity

1973, 74, 75-76 data

1.19 A/barn
1134 kg/barn
2500 lb/barn

Crop size Kg	Crop size / Barn Capacity %	Number of Acres for 1 Barn	Amount and Cost* of Delayed Harvest 1 week	2 weeks	3 weeks	Annual Barn Costs to Eliminate Harvest Delay 1 week $	2 weeks $	3 weeks $
5670	100	5	0	0	0	0	0	0
6337	110	5.5	25% $72	0	0	120	0	0
6804	120	6	50% $156	0	0	240	0	0
7371	130	6.5	55% $183	11% $73	0	240	120	0
7938	140	7	49% $176	26% $187	0	240	240	0
8505	150	7.5	40% $154	33% $254 ✓	7% $87	240	240	120
9072	160	8	32% $131	32% $262 ✓	18% $240	240	240	240
			$ 5125/A	10250	165			

$/barn?

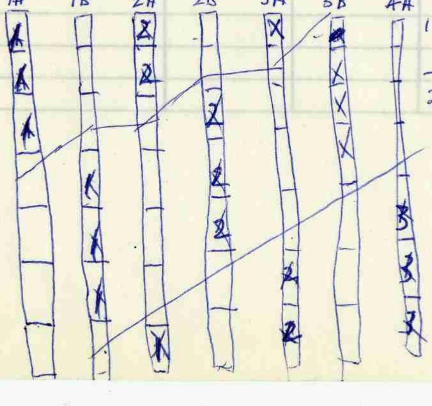
	N	1B	2B	10R	20R	30R
	1	2	3	4	5	6
A	95	150	193	35	0	0
B	72	81	95	65	43	0
C	75	68	27	54	53	44

			0	40	28
D	0	40	55	26	45
E	23				
F	112		55	104	67
G			41	90	100
H					54

$20 \times \frac{1}{5}$ — 4
$20 \times \frac{2}{5}$ — 8
$20 \times \frac{3}{5}$ — 12
$20 \times \frac{4}{5}$ — 16
$20 \times \frac{5}{5}$ — 20

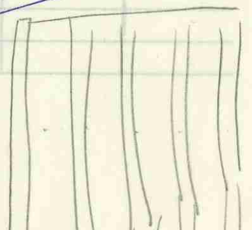
5 primings — 6 ~~weeks~~ intervals × 8 days/interval = 48 day season.

Assume 5 primings, 8 days per acre & 8 days/priming interval



15
6
21

6/21 one week late



2 $10 \times \frac{1}{5}$
4 $10 \times \frac{2}{5}$
6 $10 \times \frac{3}{5}$
8 $10 \times \frac{4}{5}$
10 $10 \times \frac{5}{5}$

	1	2	3	4	5	6	7	8
1	x	x		x	x		x	
2	x	x		x	x		x	
3	x	x		x	x		x	
4	x	x		x	x		x	
5	x	x		x	x		x	
6	x		x	x		x	x	
7	x		x	x		x	x	
8	x		x	x		x	x	
9	x		x	x		x	x	
10	x		x	x		x	x	
11		x	x		x	x		x
12		x	x		x	x		x
13		x	x		x	x		x
14		x	x		x	x		x
15		x	x		x	x		x
16								
17								

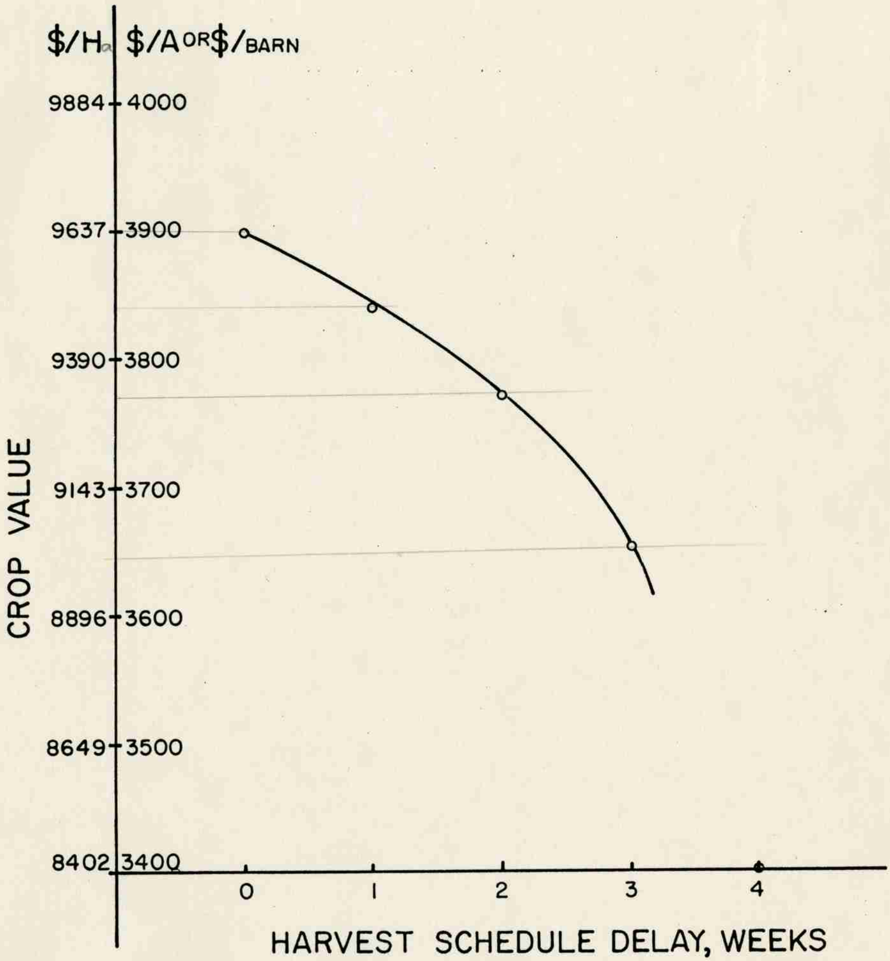
13 30 25 85 5

	1	2	3	4	5	6	7	8
1	x	x		x	x		x	
2	x	x		x	x		x	
3	x	x		x		x	x	
4	x	x		x		x	x	
5	x		x	x		x	x	
6	x		x	x		x	x	
7	x		x	x		x		x
8	x		x	x		x		x
9	x		x		x	x		x
10	x		x		x	x		x
11		x	x		x	x		x
12		x	x		x	x		x
13		x	x		x		x	x
14		x	x		x		x	x
15		x		x	x		x	x
16		x		x	x		x	x

14 26 26 14

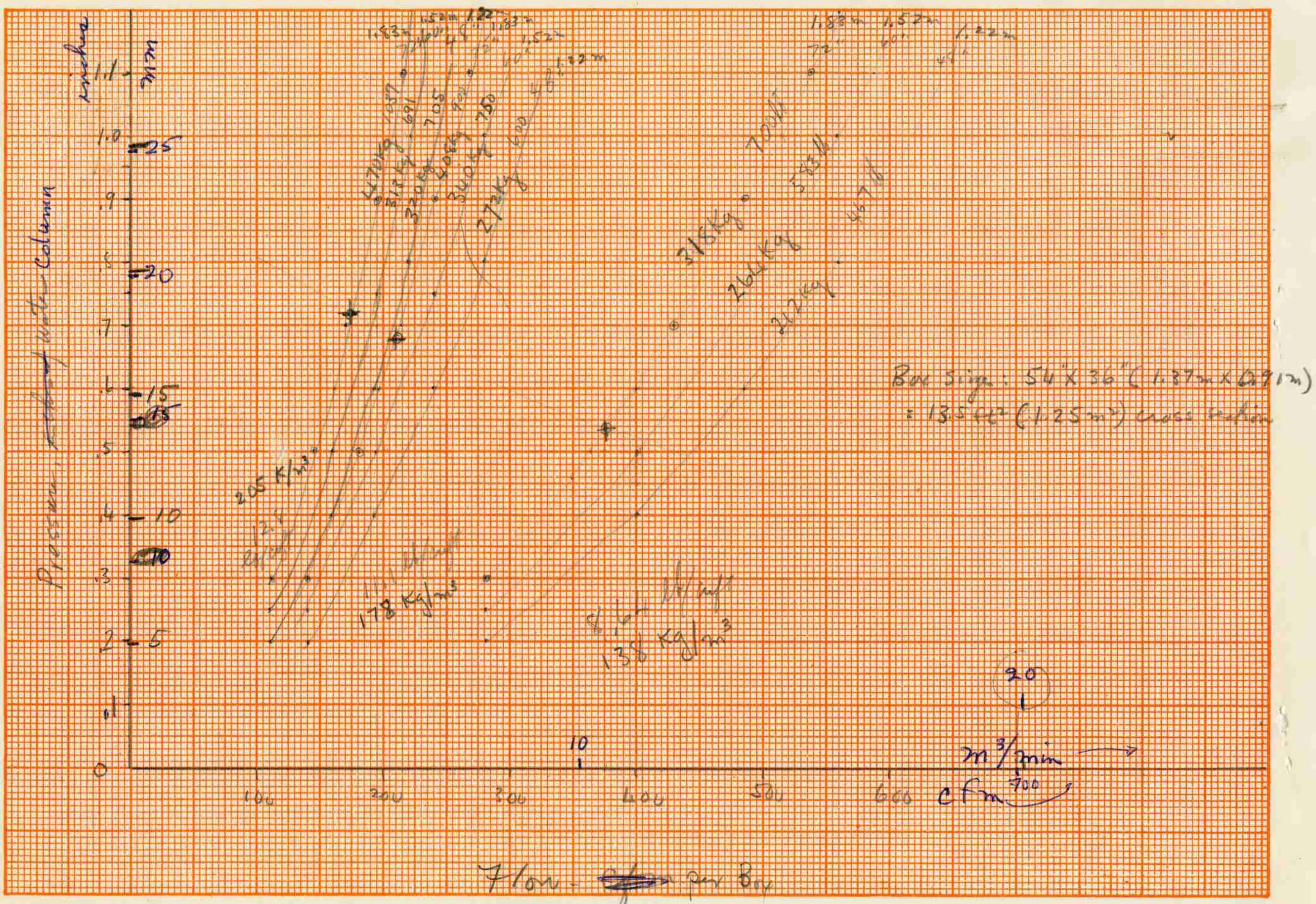
16
8
80

2500 lb



$/Ha $/A OR $/BARN
9884 4000
9637 3900
9390 3800
9143 3700
8896 3600
8649 3500
8402 3400
CROP VALUE
0
1
2
3
4
HARVEST SCHEDULE DELAY, WEEKS

78 data



Effect of Load Density and Box Height on Air Flow.

cul 1978.

Box Load Vs Equivalent Orifice Area -

	equivalent orifice Actual in2	$O = K/L$ Load^{1} 1	$O = \frac{K}{L^2}$ Load^{2} 2	Load$^{2.2}$ 3	Load$^{2.35}$	Load$^{2.5}$ 4	Load$^{2.75}$	Load$^{2.75}$ Ref. O_2	Load$^{2.5}$ Ref. O_2	Load^{3} Ref. O_2
O_1	30	30	30	30	29.1	30	30	29.94	28.116	31.89
O_2	15	23	18.15	17.26	16.13	16.00	15.03	15	15	15
O_3	12	~~19.867~~ 20.25	13.15	12.6	11.56	11.23	10.18	10.14	10.52	9.8

1. $O_1 = \frac{K}{L_1}$, $K_1 = O_1 L_1 = 30 \times 700 = 21000$, $O_2 = \frac{2100}{900} = 23.3$ ck.

2. $O_1 = \frac{K_1}{L_1^2}$, $K_1 = O_1 L_1^2 = 30 \times 700^2 = 14700000$, $O_2 = \frac{14700000}{(900)^2} = 18.148$

2. $O_1 = \frac{K_1}{L_1^{2.2}}$, $K_1 = O L^{2.2} = 30 \times 700^{2.2} = 54492526$, $O_2 = 17.26$

3. $O_1 = \frac{K}{L^{2.5}}$, $K_1 = 30 \times 700^{2.5}$, ~~1296418~~ 388925442, $O_2 =$

4 $O_1 = \frac{K}{L_1^{2.75}}$, $K_1 = 30 \times 700^{2.75}$, $= 700051663 6$, $O_2 = 15.03$

5 $O_2 = \frac{K}{L^{2.75}}$ $K_1 = 15 \times 900^{2.75}$ $= 1996445722$, $O_1 = 29.94$, $O_3 = 10.16$

6 $O_2 = \frac{K}{L^{2.5}}$, $K =$ $= 364500000$, $O_3 = 10.52$ $O_1 = 28.116$

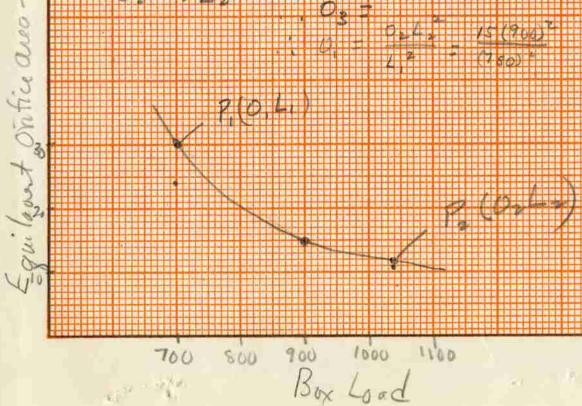
7 $O_2 = \frac{K}{L^3}$, $K = O_2 L^3$, $O_1 = 31.89$, $O_3 = 9.8$

$$\frac{O_1 = K/L_1^2}{O_2 = K/L_2^2} \quad \therefore O_2 = \frac{O_1 L_1^2}{L_2^2} = \frac{30(700)^2}{(1057)^2} = 13.15 \text{ Close}$$

$$= 15 \text{ [illegible]}$$

$$\therefore O_3 =$$

$$\therefore O_1 = \frac{O_2 L_2^2}{L_1^2} = \frac{15(900)^2}{(780)^2} = 24 \text{ - low}$$



$O = K/L^n$ $\qquad \log O = \log K - n \log L$

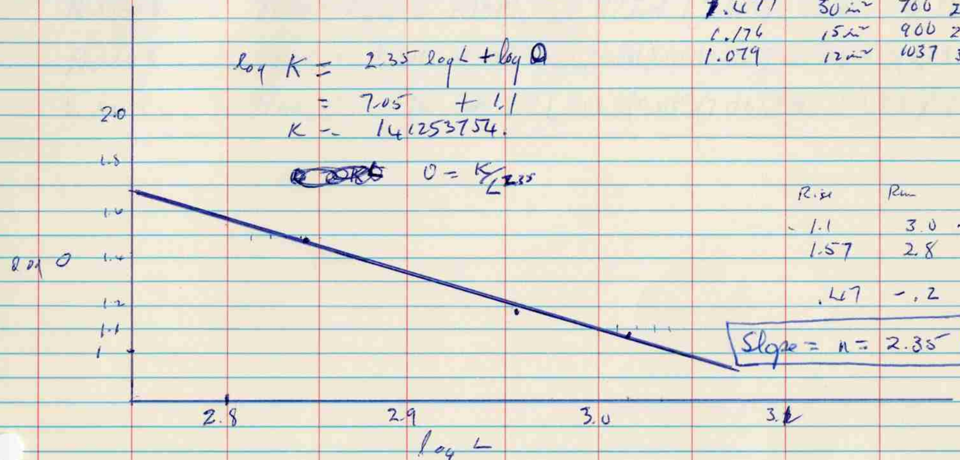
log O	O (Points)	L	log L
1.477	30 in²	700	2.845
1.176	15 in²	900	2.954
1.079	12 in²	1037	3.0158

$\log K = 2.35 \log L + \log O$

$= 7.05 + 1.1$

$K = 141253754.$

$O = K / L^{2.35}$



Rise	Run
1.1	3.0
1.57	2.8
.47	-.2

Slope = n = 2.35

Now substitute equivalent orifice area into flow equation

$\text{Flow} = 1096.5\,(.6)\,A\sqrt{\frac{\Delta P}{S}} = 1096.5\,(.6)\,\frac{K}{L^{2.35}}\sqrt{\frac{\Delta P}{S}}$

For constant pressure double the area - doubles the flow -

For constant ~~flow~~ double the area - Quadruples the flow -

Flow Calculations - Nov 7 - 78 - CWS

Flow = 1096.5(.6)A $\sqrt{\frac{\Delta P}{\delta}}$ assume 70°F, δ = .0714285

5/8 x 48 Flow = 2461.6 A$\sqrt{\Delta P}$ $_{A=.208,}$ = (375 P=.535) (.7, 429) (.3, 281) (.9, 486) (1.1, 538)

5/16 x 48 Flow = (.211, at .677 in) (.3, 140) (.5, 181) (.7, 214) (.9, 242) (1.1, 268) (1.3, 292)

1/4 x 48 Flow = 174 at .717 (.3, 112) (.5, 145) (.7, 172) (.9, 195) (1.1, 215) (1.3, 234)

~~PM 58 – Ag. Eq Automation~~

Now if we increase the height of a box ~~with constant~~ and hold density constant the resistance will increase and the pressure will increase for the same flow. For example, if a 4' high box passes 500 cfm at 1" static pressure, ~~then~~ then a static pressure of $5/4' \times 1'' = 1.25''$ will be required to cause 500 cfm to pass through a 5' box. See Glover. *

$E = IR$, Flow = I

$I = \frac{E}{R}$ for air flow = (Constants) × $A \cdot \sqrt{\text{Pressure}}$

note that area is analogous to $1/R$, ~~and~~ that $\sqrt{P}$ is analogous to voltage and constants are required involving air density, flow coefficient etc to give values in cfm, etc.

~~Now define a new quantity potential $\Theta = \sqrt{\text{Pressure}}$~~
~~If we add to the height the resistance increases in proportion – say 4' to 5' the resistance increases in the ratio of 5 to 4, effective area conductance decreases inversely, to 80%.~~

1/5 : 1/4
20 : 25

Green tob. density – 14 lb/cuft

* depth	CFM/ft²	Pressure from Graph	Pressure calculated	equivalent area in²/box	Rcdx
4	40	.6625	.6625 reference	~~37~~ 40.95	—
5	40	.82~~5~~8	.828	35.55	36.63
6	40	1.00	.994	~~40.55~~ 31.7	33.43

800 — 1500 RPM

Flow = 1096.5 (C) A $\sqrt{\frac{\Delta P}{S}}$

density at 90°F = 14 cuft/lb = .0714×2.85 lb/cuft

oct 26 - clayton Bara 11

2461.64 A $\sqrt{\Delta P}$ = 205.135 $\sqrt{\Delta P}$

A = .0833

90°F -

1/4" × 48" opening, A = 12/144 = .0833 ft²

	RPM	Pressure	in	Flow cuft/min
	~~1374~~ 1585	~~25~~ mm 33.5	1.32	236
+2	~~1585~~ 1374	27 mm	1.063	218
-4	1158	18 mm	.71	173
.2	~~960~~ 935	~~11.5~~ 12 mm	.4724	141

1/2 × 48" opening in

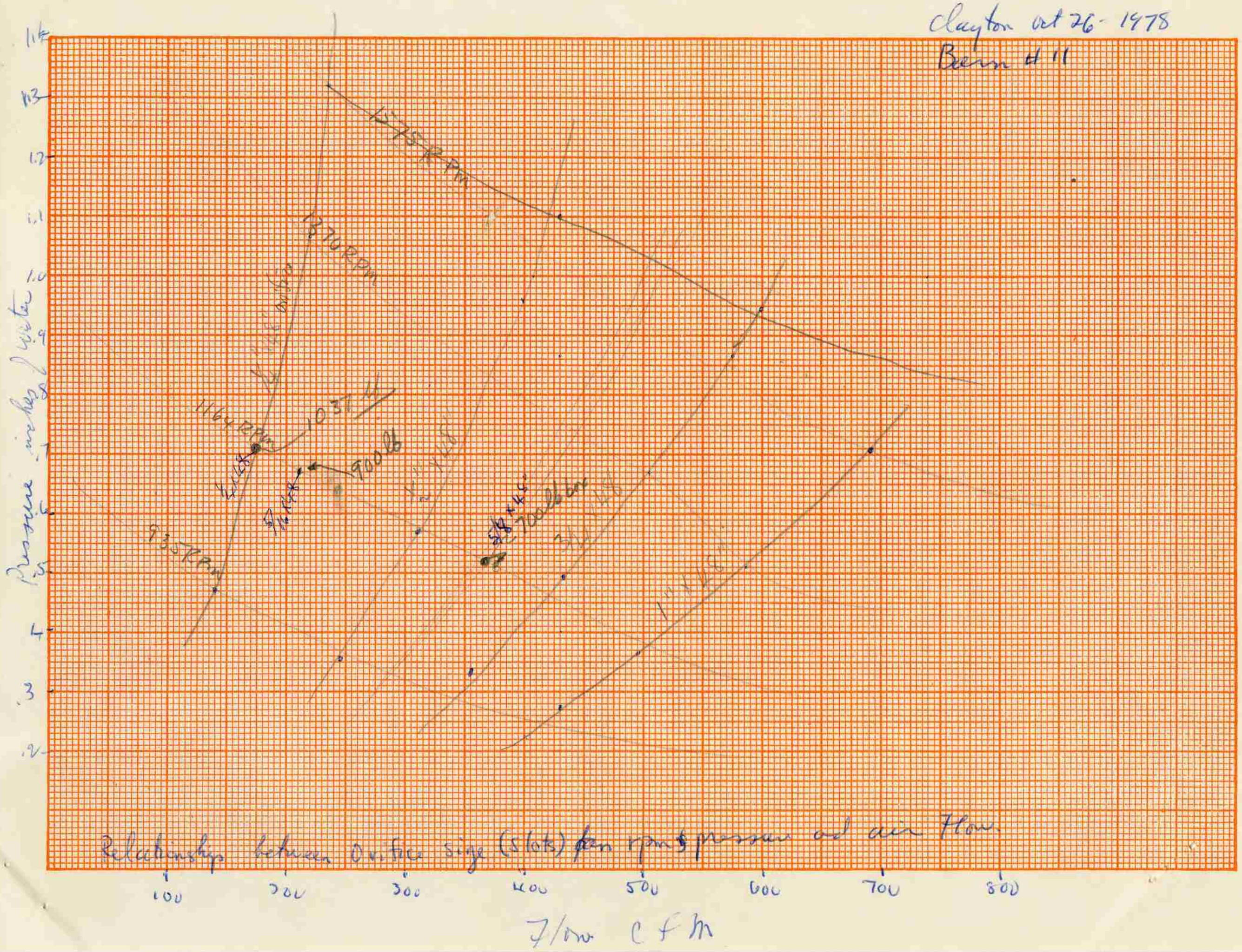
RPM	Pressure	in	Flow
934	9 mm	.354	244
1159	~~12.5~~ 14.5	.571	310
1370	~~17~~ 22	.866	382
~~1578~~ 1583	~~20~~ 28	1.10	430

3/4 X 48" opening

RPM	Pr mm	Pressure in	cfm
1578	24 mm	.94488	598
1370	22 / 17	.866 / .669	573 / 503
~~1170~~ 1164	12½	.492	432
935	8½	.3346	356

1 X 48" opening = .333 ft²

1585 -	18	.7087	691
1367	13	.5118	587
1158	9¼	.364	495
932	7	.276	431



Clayton oct 26- 1978
Bern #11
Pressure inches of water
Flow CFM
100
200
300
400
500
600
700
800
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
1275 RPM
1370 RPM
1164 RPM
1037
900 lb
935 RPM
700 lb
Relationships between Orifice size (slots) fan rpm & pressure and air Flow.

$$\text{Flow, Cfm} = .1096.5\ (.6)\ A\sqrt{\frac{\Delta P}{\delta}}$$
$$= 800.77\ \sqrt{\Delta P}$$

A = area in sq ft. , ΔP is pressure in inches of water and δ is the density of air = .070 lb/cuft at 100°F
.075 lb/cuft at – °F

Now plot ~~Fan~~ curve for #11 barn. etc.

A = 2 – ½ x 48" slots = 48 sq in = ⅓ sq ft.

#11

	RPM	Pressure, in	Flow, cfm
	1569	.88	751
→	1365	.69	665
	1156	.48	555
	925	.30	439
	792	.235	388
#10	1475	.78	707
	1268	.60	620
	1051	.40	506
	805	.23	384
	1576	.90	760
#9	1553	.80	716
	1348	.60	620
	965	.30	439
	803	.21	367
	1159	.40	506

Note – A = area is inversely related to resistance. Thus A could be thought of as conductance or conductivity which has units of square feet or other area dimensions

Box Height - density vs pressure

~~August~~ July 24

Barn #1 std box. ~~12~~ 52"

500 lb. 1st primings, pale yellow.

500 lb+	Fan RPM	Pressure expected for 800 lb load	Pressure observed
20.6 mm @ 1300 RPM, 4 Turn	1059	15 mm	14.5
	906	12 MM	10.5
	1352	24 MM	22.0
930 cfm 940	593	5 (at 570)	6.0
720 lb.	568	5	5.0
21.5 mm @ 1300 RPM, 2 Turn	905	12	11.0
	1095	16	15.0
910 cfm, 3½	1352	24	~~21.5~~ 23 - after tightening against back
990 lb.	1352	24	25
235 @ 1300 RPM, 4 turns	1060	15	17
860 cfm, 2 turns	906	12	12
1 turn	578	5-	6

Barn left running at 1070 RPM - 16 mm H_2O.

Barn #8 - July 26 - 1978

Air pressure measurements

62" Box with 450 lb tob

~~Fan RPM~~ no heat added - outside temp - 85°F

	Fan RPM	Expected Pressure for "800 lb" box	measured pressure	
450 lb, 2 turns	1048	16	15 mm	
	868	11	10 mm	
5 turns	1303	24	21 ~~23~~ mm	- 870 cfm. 925
720 lbs	1304	24	23 ~~25~~ mm	- 825 cfm
	1049	16	16 mm	870
	864	11	10 mm	
1050 lbs	863	11	11 mm	
	1050	16	17 mm	
	1304	24 26	[illegible] mm 24	- - ~~800~~ cfm. 850

$\frac{1}{25.4}$

~~4~~ July 31, 1978
Central Crops CWS

~~6~~ 72" Box – 1st primings
Hand loaded & weighed on Toledo dial scales

~~700 lb~~ Barn #11 rear – front boarded up.
also boarded up along front of box

8.64 lb/cuft. 900 lb

Equivalent slot – 48" long –
Slope not quite same as tobacco – Match up 1159 RPM –
1/2" too small 3/4" to large – 5/8" about right

	RPM	Pressure, MM
2 turns	1263	16
17 mm @ 1300 RPM	1046	11
2 turns	~~0~~ 799	6
1000 cfm 6 turns	1462	22

.2083 ft² 30 in²

RPM	Tobacco Pressure	1/2"	3/4"	1"
934	8.8 mm	9	8.5	7
1159	(13.6)	14.5	12.5	9.25
1370	19.2	22	17	13

Slits – Pressure from curve

Ref pressure 13.6 @ 1159 RPM

Ref. flow $A = \frac{30 in^2}{144}$, $P = \frac{13.6 mm}{25.4} = .535 in$ **375 cfm**

11.1 lb/cuft 900 lb –

	RPM	Pressure, MM
21.3 mm @ 1300 RPM	1464	26
	1254	20
930	1045	14
	814	9

1/4" too small 1/2" too large but nearer to 1/4 than 1/2
5/16" about right
.104 ft² 15 in²

RPM	Tob Pressure from curve	1/4	1/2
934	11.6 mm	12	9
1159	(17.2)	18	14.5
1370	23.2	27	22

Ref. pressure 17.2 @ 1159 RPM

Ref. flow: $A = \frac{15 in^2}{144}$, $P = \frac{17.2 m}{25.4} = .677 in$ **211 cfm**

12.8 lb/cuft 1037 lb.

	RPM	Pressure, MM
22.5 mm @ 1300 RPM	815	10
890 cfm	1046	~~14~~ 15
	1256	21
	1470	28

1/4" about right.
12 in²
.0833 ft²
= .717 in

RPM	Tob Pressure from curve	1/4	1/2
934	12.6	12	9
1159	(18.2)	18	14.5
1370	24.7	27	22

Ref. press. 18.2 @ 1159 RPM

Ref flow $A = \frac{12}{144}$, $P = \frac{18.2}{25.4}$ = **173.6 cfm**

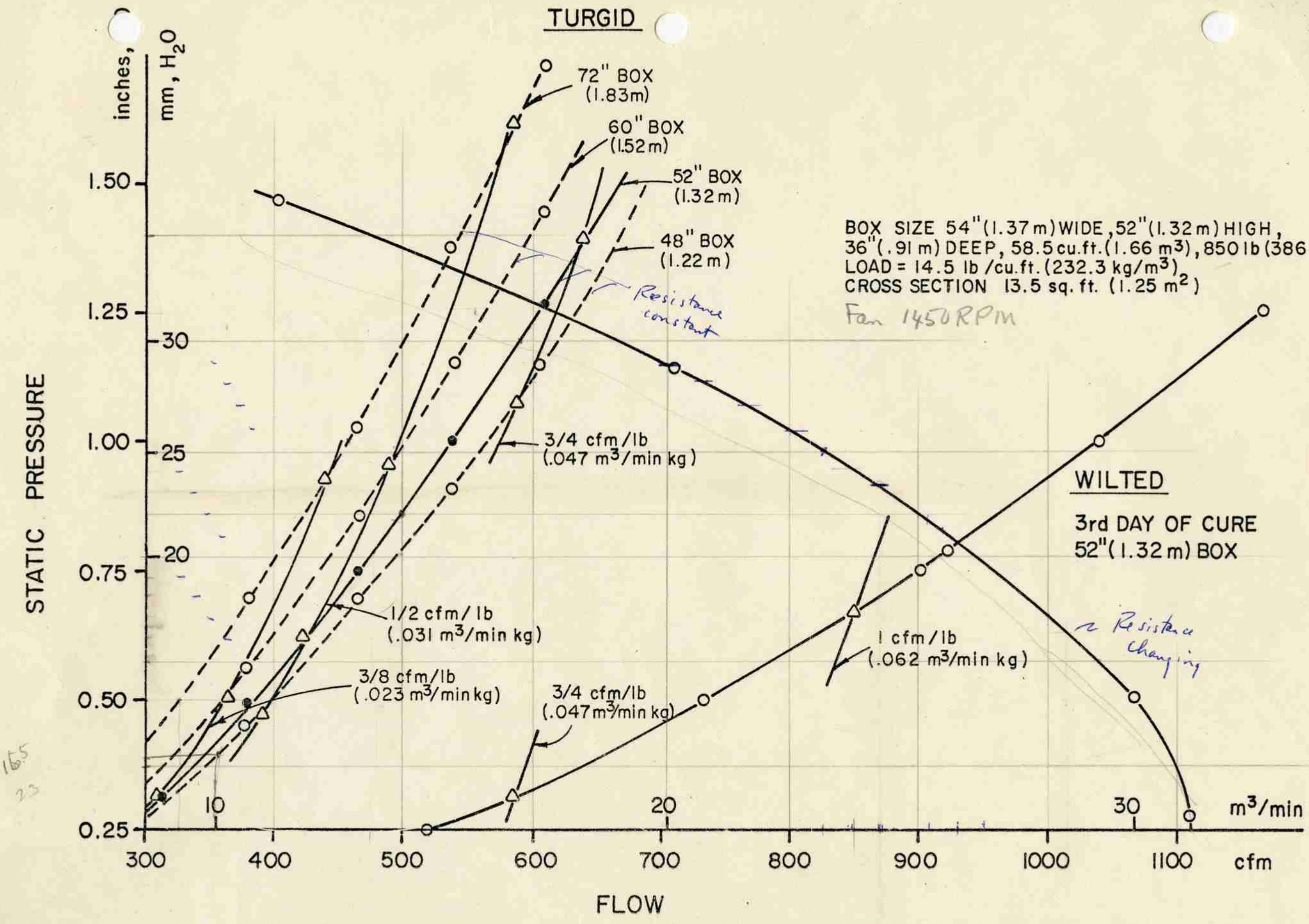


Fig. 11. Air flow characteristics of fan-curing barn system (curve running from upper left to lower right) and various sizes of curing boxes.

~~[illegible]~~	Pr. Bdh	Ethrel	Crushed	Eth + Cru	Check	Ethrel	Crushed	Eth + Cru	Check
		Cubic feet gas/lb water				curing time			
	3&4	1.02	~~1.53~~	~~1.82~~		130	140	~~135~~ 135	
			1.17				~~165~~		
✓		~~1.52~~	~~0.59~~	1.20		140	~~145~~	140	
			~~1.75~~	1.03			165	120	
		1.45	1.33	1.17		125	~~185~~ barn 9	110	
			1.12				~~190~~ - barn 10		
		1.40	1.09		1.27	140	~~190~~ barn 11		140
					1.42				150
					1.06				150
					~~1.57~~				170
Σ		5.39	7.99	5.22	5.32	535	1180	505	610
x̄		1.35	1.33	1.305	1.33	133.8	168.6	126	152.5
							144		
			8.58						
			1.226						
							305/2		
						133.8	152.5	126	152.5
		3.87	4.71	3.4	3.75				
		1.29	1.18	1.13	1.25				

		Ethrel	Crush	Eth + Cru	Check	Ethrel	Crush	Eth + Cru	Check
		cubic feet gas / lb tob				Drying Time			
		4.46	7.12	9.40		55	90	80	
			~~5.98~~				~~95~~		
		5.73	~~2.97~~	5.48		65	~~95~~	70	
			~~7.75~~	4.46			50	70	
		5.57	~~4.79~~	4.43		80	~~110~~	45	
			~~3.60~~				~~100~~		
		4.92	4.62		4.73	60	~~100~~		65
					5.56				55
					3.28				60
					5.37				65
	Σ	20.68	36.83	23.77	18.94	260	640	265	245
	x̄	5.17	5.26	5.94	4.74	65	91.4	66.3	61.2
							140/2		
						65	70	66.3	61.2

Compare CS 53 uncrushed with 54 crushed
(CS 53 in barn 4 & CS 54 in barn 2.
Fuel 809 vs 600, weight in 750 vs 750
weight out 161½ vs 183 time 170 vs 150
Drying time 75 vs 60 grade - B4 DK vs B5 ...
fuel ft³/lb water 1.37 vs. 1.06
fuel ft³/lb dry wt 5.01 vs 3.28