TABLE 1

TOBACCO, FLUE-CURED CLOSE-GROWN: LABOR AND MACHINE
Requirements per acre (Large Farm - 40 or more acres)
[Assume Plant Population of 30,000/acre]

Operation	Month	Machinery or equipment used	Labor	Machine
Plant Bed (350 sq. yd.):				
Plowing	Jan.	4-bottom plow	0.55	0.50
Discing	Jan.	20' disk	0.55	0.50
Fumigating	Jan.	custom	——	——
Fertilize, raking, seeding	Feb.	Pick-up	10.75	0.50
Top-dressing, pest control	Mar.	Pick-up, sprayer	17.50	1.25
Land Preparation:				
Plowing, 2X	Mar.	13' Chisel plow	0.24	0.22
Discing	Apr.	20' disk	0.11	0.10
Harrowing	Apr.	Section Harrow	0.15	0.14
Apply Chemicals	May	Sprayer or Spreader	0.60	0.54
Bedding and fertilizing	May	Tilrovator - distributor	.40	0.35
Transplanting:				
Pulling Plants	May	Hand	35.00	——
Hauling Plants	May	Pick-up	5.50	5.00
Hauling Water	May	2-ton truck with tank	5.50	5.00
Transplanting	May	4-row transplanter	35.00	7.00
Growing:				
Cultivating, side dressing 2X	May-June	4-row w. applicator	.50	.30
Applying pesticides 3X	June	3-bed topper sprayer	.80	.75
		2 ton truck w water tank	.50	.50
Topping, sucker control	June-July	3-bed, topper sprayer	.80	.75
		pick-up	.45	.40
HARVESTING, Curing Marketing:				
Mechanical harvesting	July-Aug	Modified forage harvester (2 row, 3 mph), 30% down time	1.60	1.22
Hauling to barn	"	Forage wagon, 4 ton	1.50	1.40
Mech. filling of modules	"	Mechan. elevator distributor @ 600/1b/min, 15% down time	2.00	.65
Loading barn	"	Fork lift	1.00	1.00
Curing Supervision	"	Pick-up	2.40	2.00
Load-out	"	Fork lift, hopper-filler	2.00	1.00
Marketing	"	Large box handling (400 lb/box) 2-ton truck	1.00	1.00
Post-harvest:				
Root destruction	Sept.	20' disc	.10	.09
Seeding cover crop	Sept.	Grain drill	.24	.22
Total Labor per Acre			126.74	

TABLE 2

COSTS AND RETURNS per Acre of CGT

Large Farm (40 or more acres)*

Category	Units	Price	Quan.	Value	
Production:					
Tobacco CGT	6000	.504	6000	$3024.10	
Total Receipts				$3024.10	
Operating Inputs:					
Tobacco Seed	oz	20.00	.500	10.00	
Custom Fumigate	SQ VD	0.18	350.00	63.00	*
12-6-6	CWT	4.61	2.35	10.85	
16-0-0	CWT	6.52	.175	1.15	
Fungicide, P.B.	Each			28.00	
Insec., P.B.	Each			1.75	
Nematicide	Acre			24.50	
Herbicide	Acre			15.38	
6-12-18	CWT	6.93	13.00	90.09	
15-0-14	CWT	8.50	4.00	34.00	
Insecticide	Acre			13.46	
Contact Suckers	Acre			28.40	
System, Suckers	Acre			33.00	
Crop Insurance	Acre			40.00	
Wheat Seed	Bu	5.25	1.50	7.88	
Tobacco Curing	Gal	0.33	905	298.65	*
Elec.	Acre			50.00	
Building Ins.	Acre			87.50	
Warehouse Chg.	Dol.	____	____	_____	
Mkt. Org.	____	____	____	_____	
Leased Quota					
Tractor Fuel Cost	Acre			4.00	
Tractor Repair Cost	Acre			2.50	
Tractor Lube Cost	Acre			0.60	
Machinery Fuel Cost	Acre			66.45	
Machinery Lube Cost	Acre			6.65	
Machinery Repair Cost	Acre			30.00	
Equipment Repair Cost	Acre			85.50	*
Total Operating Cost				1033.31	
Returns to land, labor, capital, machinery, overhead, risk and management.				1990.79	
Capital Cost					
Annual operating capital		.09	300	27.00	
Tractor Investment		.09	40.866	3.68	
Machinery Investment		.09	150.00	13.50	
Equipment Invest.		.09	2130.00	191.70	*
Total Interest Charge				235.88	
Returns to land, labor, machinery overhead, risk and management				1754.91	

Category	Units	Price	Quan.	Value	
Ownership Cost (Deprec., Taxes, Insurance)					
Tractor	Dol.			4.96	
Machinery	Dol.			26.10	
Equipment	Dol.			276.70	*
Total Owndership Cost				307.76	
Returns to Land, Labor Overhead, Risk and Mgmt.				1447.15	
Labor Cost:					
Machinery Labor and Other	Hr.	2.300	126.74	291.50	*
Returns to Land, Overhead, Risk and Management				1155.65	

PROGRESS REPORT

on

MECHANIZATION OF CLOSE-GROWN TOBACCO

January 1 - June 30, 1974

by

William H. Johnson, Prof.
Dept. of Biological & Agricultural Engineering
N.C. State University
Raleigh, N.C. 27607

Submitted to
Carreras Rothmans Limited
Christopher Martin Road
Basildon, Essex, England

PROGRESS REPORT -- MECHANIZATION OF CLOSE-GROWN TOBACCO
JAN. 1 - JUNE 30, 1974

I. INTRODUCTION

A tentative plan of work was submitted for the above project on March 18, 1974. The present report gives a more detailed description of the research developments and observations as the work evolved. Please note that certain modifications in the experimental plans have been made, in the interest of achieving the desired objectives.

This portion of work emphasized (1) a mechanized approach to direct field seeding of pelletized seed, (2) observations of alternate mulches or covers for plant protection and (3) mechanical transplanting of close-grown tobacco. The rationale for providing emphasis in these areas is based on the premise that the production system for close-grown tobacco will be radically different from that of normally grown tobacco. Instead of plant populations of about 6000/acre, populations may likely be 40,000/acre or greater. Cultural operations, harvest and curing will likely be drastically different from normal to minimize production costs per pound of cured material while achieving desired characteristics. Consideration of the various operations readily reveals that establishment of plants in the field at the high density populations is likely to be one of the greatest bottlenecks to practical production. Already, curing of tobacco plants in a chopped form has been successfully accomplished by modular curing. The remaining obstacles are (1) development of a more efficient mechanized system of plant production and transplanting, or direct field seeding and field growing of tobacco, and (2) development of an efficient mechanical harvesting and handling system for close-grown tobacco that is compatible with modular curing. Accordingly, this phase of research has emphasized approaches which offer potential for reducing costs of establishing close-grown tobacco plants in the field.

II. A MECHANIZED APPROACH TO DIRECT FIELD SEEDING

Success in seeding and growing of plants directly in the field could potentially permit bypassing of operations currently involved in plant production and essentially eliminate transplanting labor costs. While previous attempts by researchers have been rather unsuccessful (poor germination, survival, weed and grass control, etc.), there is reason to believe that greater success can be achieved for close-grown tobacco, because of the higher plant populations required and with the opportunity of applying new approaches to the various problems previously raised. Prior to initiating the particular approach, major problems to be encountered were recognized to be: (1) proper seedbed preparation (including land preparation, admixing of fertilizers and chemicals), (2) precision drilling of either naked or pelletized seed relative to a preformed bed (3) microenvironment control of soil moisture, humidity around the germinating seed, and temperature, and (4) control of weeds, grass, insects and disease organisms. An attempt was made to take all of these factors into account in the first experiment on direct field seeding.

A. Equipment

Land preparation equipment for tillage, discing, and general spraying were available at the Oxford Tobacco Research Station. However, it was necessary to procure or develop equipment for tilrovating-bed forming-seeding as an integral operation. A Ferguson Tilrovator with bedformer was purchased to permit proper admixing of fertilizer and chemicals into the top 5 to 6 inches of soil, to permit forming of a precision bed of proper compaction and to permit direct seeding or transplanting on the preformed bed. A 5-row seeder for pelletized seed was developed to mount directly behind the bedformer. Specifications for this equipment were supplied previously.

A special plastic dispensing unit was also procured to permit mechanical covering of the seeded bed with polyethylene. The unit required extensive modification to work properly with respect to the preformed bed.

A Farmall Model 840 tractor was borrowed from the Agricultural Engineering Dept. for use with the above equipment.

B. <u>Procedure</u>

Three seedings were originally planned for March 25, April 10 and April 20; however, due to weather or equipment problems the actual seedings were made on April 4, April 12 and April 22. These trials are identified as:

DFS 1. Direct field seeding, G-28 (pelletized), 0.12 acre, April 4 seeding date

DFS 2. Direct field seeding, G-28 (pelletized), 0.12 acre, April 12 seeding date

DFS 3. Direct field seeding, G-28 (pelletized), 0.12 acre, April 22 seeding date.

Approximately 0.6 acres of land was allocated for the close-grown tobacco project at the Oxford Tobacco Research Station. Unfortunately, the land is situated near the crest of a hill, is quite variable in soil type, and not well suited for bed layout, since the beds must run with the slope rather than on the contour. The field is rectangular 90' X 280'. An irrigation system was installed with three lateral lines running lengthwise the field, one on each side and one down the center.

The general procedure for the direct seeding trials was as follows. In early March the soil was turned and later disced for smoothing and breaking up soil clumps. Fertilizer was broadcast by hand at the rate of 750 lb/acre, 8-16-24, to provide per acre equivalents of 60 lb N, 120 lb P, and 180 lb K. A combination tank mix of ENIDE (8.0 lb/acre), MOCAP (6.0 lb/acre) and Dysyston (4.0 lb/acre) was applied with power sprayer for control of grass and weeds, nematodes and wireworms, flea beatles and aphids, respectively. Fertilizer and/or chemicals were disced in lightly immediately following their application. At the time of direct field seeding, the tilrovator - bed former was used on the first pass without seeding, such that equipment adjustments could be made and to assure proper bed forming. Three beds of 280 ft length were prepared for each of the three seeding. For the second pass, G-28 pelletized seed (Austria) were placed into the seed hoppers. Two seeds were dropped per hill at 8-9 inch spacing in each of five rows, one foot apart on the bed. For the third seeding, ENIDE was sprayed on following seeding rather than before, since problems in weed and grass control were evident at that time in the first two seedings. In this case, irrigation was applied for 2 hours immediately after seeding and before covering with plastic. Covering the beds was accomplished with a plastic dispensing unit, as a separate operation from seeding. The plastic was perforated with 3/8" holes on 3" centers and when applied to the bed, it snugly covered the bed surface and sidewalls. An irrigation program was established such that in the event of no rain, irrigation for 20-40 minutes per day was applied. Dates for various operations involved with the three seedings are given in Table 1.

Table 1. Dates for Operations Performed in the Direct Field Seeding Trials, Oxford, 1974

	DATES		
Operation	DFS 1	DFS 2	DFS 3
Turn Soil	3/1/74	3/1/74	3/1/74
Disc	3/15/74	3/15/74	3/15/74
Broadcast Fertilizer	3/29/74	4/11/74	4/19/74
Disc in Fertilizer	3/29/74	4/11/74	4/19/74
Spray ENIDE, MOCAP & DYSYSTON	3/29/74	3/29/74	4/22/74*
Disc in Chemicals	3/29/74	3/29/74	4/22/74
Tilrovate - DFS	4/4/74	4/12/74	4/22/74
Cover with perforated plastic	4/4/74	4/12/74	4/22/74
Remove plastic	5/1/74	5/9/74	5/17/74

*~~MOCAP~~ ENIDE SPRAYED ON AFTER SEEDING

seeding, wind displacement during dropping (careful observation of seed dropping showed that wind gusts could carry seed several inches), or displacement of seeds by water which may have flowed down the channels in certain locations due to irrigation or rain. It was noted that in certain areas of the bed, more plants were growing than could be explained by the apparent calculated seed drop. This raised questions as to whether some of the seed from the 1st pass seeding operation had germinated after re-tilrovating and seeding again, or whether it may be possible for seed from a prior crop year to germinate when supplied with favorable conditions.

The method of spraying on ENIDE prior to bed forming and seeding did not work as well as expected. This could be due to one or more of several factors. Rainfall between Mar. 29 and Apr. 4 (1.32") could have leached a portion of the chemical prior to seeding. Daily irrigation could also have leached ENIDE, particularly in select portions of the beds where water apparently percolated more easily through the plastic and entered the preformed channels. When the plastic was removed on May 1, this was more evident with grass and weeds growing better in certain portions of the channels or bed which were at a higher soil moisture during most of the test (see photographs). A third possible factor may be that the concentration of ENIDE was too low due to the tilrovating action, which vigorously tilled the soil for a depth of 4 to 6 inches.

An observation relative to maintaining soil moisture within the beds was unexpected. Although irrigation was applied essentially daily, the beds became progressively dryer. It was observed that water did not move easily through the perforations, with the majority running off the beds. It was estimated that less than 10% of the applied water actually penetrated into the beds. The layout of the beds did not help matters since most beds were on a slight slope. However, it is believed that even with level ground, this will continue to be a problem. It should be noted that there were certain areas near the low side of the field where the beds became too moist, where apparently good penetration was achieved with higher water flow on the plastic surface. Drying of the soil beneath the plastic can be explained as follows. With increasing outside temperature and solar radiation during April, the absolute humidity beneath the plastic probably increased rapidly. Evaporative loss of water could then exceed the moisture gain through the plastic, gradually reducing soil moisture content. Certain areas of the bed, therefore, became moisture limiting and reduced germination and livability. It was of interest to note that the moisture content of soil at the bottom of the preformed channels appeared higher than between channel areas. This was probably due to the soil temperature at the channel bottoms being lower than at the bed surface. Also, drip-back of condensed water into the channels may have tended to maintain a higher channel moisture content.

Temperatures beneath the plastic during the month of April were measured with three maximum-minimum thermometers. A minimum temperature of 40°F was observed with a maximum of about 120°F occurring on April 30 when outside temperature reached 88°F. I have some doubt as to the accuracy of the thermometers since solar radiation effects may not have been completely eliminated. The plants for the first seeding showed no adverse effect due to temperature.

No problems were noted in regards to diseases or insects prior to removal of the plastic on May 1.

2. Direct Field Seeding No. 2. On April 12, three beds, representing the second trial, were seeded. No changes had been made at this time to the tilrovator-seeding unit, since we were awaiting parts. The plastic dispensing unit was improved by raising the feed roller and relocating supports for the rear disc

coulters. Side shifting of the unit still remained a problem, with occasional damage to one of the side rows on the bed.

On April 19, one could not identify any germinating seeds. By April 26 (2 weeks after seeding) tobacco plants could be distinguished, again with noted variability in germination uniformity. During this period of time from seeding, the beds were becoming progressively dryer with an increase in outside temperature and incident solar radiation. In the more moist regions of the beds, tobacco seed along with grass and weeds germinated. Some locations of the beds were extremely dry and only a few tobacco seeds had germinated and survivied. Indications were that the April 12 seeding date was too late to permit proper environmental control during germination and early growth.

Since ENIDE was applied on March 29 (the same time as for the beds for the first seeding), a very similar problem in lack of weed and grass control was evidenced.

It should be noted that the perforated plastic remained on the beds for the second seeding until May 9. Unusually high outside temperatures and clear skies during the latter part of April and early May did not appear to thermally damage the small plants, although temperatures beneath the plastic were observed to be as high as 120°F. Also as in the first seeding, no problems were noted in regards to diseases or insects prior to removal of the plastic.

3. <u>Direct Field Seeding No. 3</u>. On April 22, three beds, representing the third trial, were seeded. At this time, two changes had been made to improve the seeder operation. The seeding unit was driven by a rear mounted drive wheel which "floated" to maintain positive traction with the soil. Secondly, the rear press wheels were mounted on a common shaft chain linked on the ends such that the press wheels were always in contact with the soil in the bottom of the

preformed channels. The five press wheels simply tracked the channels and applied press action solely by their weight. Seed drop and firming action appeared superior to the previous trials. It was still noted, however, that a number of seeds were not dropped directly in the channel in which case they were not firmed into the soil.

As pointed out earlier, ENIDE was applied after seeding, then irrigation was applied for 2 hours. The purpose in this procedure was to assure that the chemical was within the top 2 inches of soil with the prospect for improved grass and weed control. Following irrigation, the beds were covered with perforated plastic. It was later observed that this procedure did not work well, with many grass and weed seeds still germinating. It is possible that the irrigation moved the ENIDE below the level of near surface seeds which subsequently germinated.

On April 29 (at the time of high outside temperatures), no germinated tobacco seedlings could be identified. On May 6, some tobacco had germinated with size at this time of about 1/8-inch diameter. The number of seed which had germinated appeared much less than in the previous trials. This was very likely due to the high temperatures beneath the plastic during the germination period. These beds, very moist when covered, also appeared to be drying excessively in certain areas.

D. General Discussion

Collective observations on the three direct field seedings up to the times of removal of plastic provide the following conclusions:

(1) All seedings appeared to be too late in the season to permit proper control of soil moisture within the beds. Earlier seeding, for example beginning in early March, would likely improve matters considerably.

(2) The methods of applying ENIDE as used in this study were not too effective in the control of grass and weeds. This problem needs very serious consideration in future work. Since most of the problem appeared to be due to too moist regions of the bed, earlier seeding without irrigation during the germinating period may provide improved control.

(3) Equipment developed for tilrovating-bed forming-seeding was improved to an acceptable working level; however several improvements can be made. These include a better means of firming the seed into the soil and providing greater precision of drop relative to the preformed channel. The plastic dispensing unit also needs improvement to permit more precise tracking without side shift action.

(4) Variability of seed germination and early growth was evident in all seedings, suggesting the need for further research on factors affecting rate and uniformity of seed germination.

While a number of problems were identified in this first approach, I feel that further research and development will lead to effective solutions. Encouraging notes were that many of the tobacco seed germinated and grew well during the period of observation, pre-formed channels along with the perforated plastic provided a field environment conducive to germination and early plant growth, and progress was made in the development of a mechanized system for direct field seeding.

However, due to problems encountered with regards to uniformity of germination and weed and grass control, the decision was made in early May to discontinue observations on all beds except one from the first seeding of April 4. Bed number 3 was therefore weeded by hand, with the decision to try to grow the plants on this bed to harvest.

III. ALTERNATE COVERS OR MULCHES FOR PLANT PROTECTION

The assumption was made prior to beginning the work that some means of plant protection was essential to germination and survival of pelletized seed in the field. On the basis of other researchers' experience with plant production in normal plant beds, perforated plastic was selected for use in the main field study. However, because of costs associated with plastic covering (estimated $150/acre), it was of interest to examine the use of alternate covers or mulches in comparison with perforated plastic. Consequently at the time of each direct field seeding, a 48-ft section of a seeded bed was managed to provide eight, 6-ft lengths, having the following treatments:

Treatment	Cover	Mulch or Anticrustant
1	None	Asphalt spray over channel
2	None	Watercapsules + 1/8" layer vermiculite + asphalt spray
3	None	1/8" layer vermiculite + asphalt spray
4	Nylon	1/8" layer vermiculite
5	Nylon	None
6	slitted plastic	1/8" layer vermiculite
7	slitted plastic	None
8	perforated plastic	1/8" layer vermiculite

Irrigation was applied for 20-40 minutes daily, in the event of no rain.

The observations indicated the critical importance of a covering for successful germination and survival. In treatments 1-3, no seed germinated and survived. It was observed that the soil appeared to dry rapidly near the surface, even with daily irrigation.

In treatments 4-8, seed germinated in all cases but with variability of emergence and vigor as discussed earlier for the regular field plots. Differences between treatments appeared to be slight, and additional study would be necessary to ascertain significance. The slitted plastic (treatment 7, 6" slits, 3/4" spaced) appeared to provide too much ventilation with soil tending to dry excessively beneath the slits. While some germination was noted, it was apparent by inspection that plant stand was lower. Vermiculite within the channels did not appear to enhance germination and vigor over the treatments involving covers only.

The above comments should not be taken as conclusive of what might be achieved ultimately, since the seedings were late, and the problem of soil drying beneath the covers was noted. Variability of soil moisture along ~~with~~ the 48' length of bed, and even within treatment plots of 6' length, made plant counts meaningless. Further field studies under better conditions and with several replications are suggested.

IV. MECHANICAL TRANSPLANTING OF CLOSE GROWN TOBACCO

Since it was considered impractical to continue observations on all three of the direct seeding trials (only the third bed of the first seeding retained), the decision was made to modify the experimental plan in order to achieve the following objectives:

1. To test a 4-row, modified transplanter in setting tobacco on the preformed bed.
2. To investigate the feasibility of staggered transplantings for increasing the harvesting period and consequently the utility of harvesting and curing equipment. The concept of staggered transplanting implies not only sequential transplanting, but sequential timing of cultural operations, topdressing, etc.

3. To produce two varieties in each of the transplantings (Pale Yellow and G-28) with observations on relative performance, curability, etc.
4. To introduce H-67, high nicotine breeding line, plants as subplots to one or more of the transplant trials. This will serve to indicate whether nicotine content of close grown tobacco can be increased by breeding.
5. To obtain preliminary information on the effect of various topping heights, and sucker control vs no sucker control on yield, select chemical analyses, and regrowth potential for a second crop.

A. Experimental Plan

Ten beds were now available for the transplanting research plus one retained from the direct seeding trial. These beds are numbered from 1 to 11 from left to right. The following treatments identify bed location, prior use in the direct seeding trials, and number of plants available for harvest.

Treatment	Bed No.	Variety	Date of Transplanting	Prior Use	Number of Plants
TR1-PY-A	1	Pale Yellow	5/17/64	DFS-1	1191
TR1-PY-B	4	Pale Yellow	5/17/64	DFS-2	1299
TR1-G28-A	2	G-28	5/17/64	DFS-1	1130
TR1-G28-B	5	G-28	5/17/64	DFS-2	1215
TR1-H67	4	H-67	5/17/64	DFS-2	30
DFS-1	3	G-28	Direct Seeded		800-1200
TR2-PY-A	7	Pale Yellow	5/24/74	DFS-3	1422
TR2-PY-B	10	Pale Yellow	5/24/74	———	1409
TR2-G28-A	8	G-28	5/24/74	DFS-3	1429
TR2-G28-B	11	G-28	5/24/74		1403
TR3-PY-A	6	Pale Yellow	6/5/74	DFS-2	1235
TR3-G28-A	9	G-28	6/5/74	DFS-3	1372
TR3-H67	6	H-67	6/5/74	DFS-2	70

This plan essentially involves three plantings of Pale Yellow and G-28 along with two small plantings of H-67.

A recent decision (during Martin Johnston's visit) was made to provide additional information pertinent to objective 5. For this purpose, beds 10 and 11 (transplanting 2, 1 bed each of PY and G28) will be used. Plant count and yield data for normally topped tobacco from this sub-study will be used to estimate "corrected" yields for these particular beds in the main study.

At this stage of development in the production of close grown tobacco, several questions have arisen in regards to various cultural operations to achieve maximum yield consistent with acceptable leaf composition. Of primary importance are questions of topping vs no-topping, topping height, sucker control vs no-sucker control, and regrowth potential for a second crop from the same root system. This substudy to the main transplanting evaluation will provide preliminary data to answer some of the questions as they relate to yield, select chemical composition, regrowth potential, etc.

Treatments for this substudy are as follows:

Treatment No.	Variety	Topping Treatment	Sucker Control	Crop
1A-PY	Pale Yellow	No topping	Off-Shoot T + MH	1st
1B-PY	Pale Yellow	"	"	2nd
2A-PY	Pale Yellow	18-Leaf	"	1st
2B-PY	Pale Yellow	"	"	2nd
3A-PY	Pale Yellow	14-Leaf	Off-Shoot T + MH	1st
3B-PY	Pale Yellow	"	"	2nd
4A-PY	Pale Yellow	10-Leaf	"	1st
4B-PY	Pale Yellow	"	"	2nd
5A-PY	Pale Yellow	No topping	None	1st
5B-PY	Pale Yellow	"	"	2nd
6A-PY	Pale Yellow	18-Leaf	"	1st
6B-PY	Pale Yellow	"	"	2nd
7A-PY	Pale Yellow	14-Leaf	"	1st
7B-PY	Pale Yellow	"	"	2nd
8A-PY	Pale Yellow	10-Leaf	"	1st
8B-PY	Pale Yellow	"	"	2nd
1A-G28	G-28	No topping	Off-Shoot T + MH	1st

Treatment No.	Variety	Topping Treatment	Sucker Control	Crop
1B-G28	G-28	"	"	2nd
2A-G28	G-28	18-Leaf	"	1st
2B-G28	G-28	"	"	2nd
3A-G28	G-28	14-Leaf	"	1st
3B-G28	G-28	"	"	2nd
4A-G28	G-28	10-Leaf	"	1st
4B-G28	G-28	"	"	2nd
5A-G28	G-28	No topping	None	1st
5B-G28	G-28	"	"	2nd
6A-G28	G-28	18-Leaf	None	1st
6B-G28	G-28	"	"	2nd
7A-G28	G-28	14-Leaf	"	1st
7B-G28	G-28	"	"	2nd
8A-G28	G-28	10-Leaf	"	1st
8B-G28	G-28	"	"	2nd

B. Procedure

1. Pre-transplant operations. As indicated earlier, certain of the beds previously utilized for direct field seeding were allocated for use in the transplanting project. For these beds, the tilrovator-bedformer was used to reshape the beds and to destroy existing weeds and grass. No additional fertilizer was applied in this case; however for beds 10 and 11 fertilizer was applied prior to tilrovating to bring these to the same applied fertilizer as the other beds.

2. Transplanting. A four-row mechanical transplanter was procured from Powell Mfg. Co. to permit setting of 4 rows on the pre-formed bed. Only minor changes were required in the existing planter: relocation of plant hoppers and seats, spacing of transplanters to achieve 16" row spacings, and adjustments to obtain 8-10" plant spacings.

Tobacco plants were pulled from plant beds seeded approximately Mar. 1-5, 1974, at the station. Four men were required to drop the plants, one man per transplanter.

The operation of the equipment on the pre-formed bed worked quite smoothly, with occasional adjustments required to achieve proper depth control. A couple of problems were noted which can be easily solved in subsequent operations. Occasionally, the firming wheels which drive the transplanter receiving discs failed to turn due to lack of friction, suggesting the need for an irregular rather than smooth wheel surface. Secondly the entire unit occasionally shifted slightly to the side causing one row to be improperly set. This was experienced primarily where the beds were sloping to one side as along the crest of the hill. Indications were that the bed should be slightly wider than 57" across the top for four rows; also side guides to track the bed may be helpful.

The transplanter utilized was not designed to provide water; consequently following each transplanting, the field was irrigated for up to 1.75 hr, depending upon soil moisture available. In all three transplantings, the plants wilted quickly after setting; however plant loss did not appear excessive in any case.

While no attempt was made to accurately measure rate of transplanting for the small plots, it was observed that approximately .2 acres were set within 2 hours, suggesting that about 1 acre could be set per day.

Three transplantings were made on dates of 5/17/74, 5/24/74 and 6/5/74. Plant size at time of transplanting varied from too large and leggy for transplant 1, optimal size for transplant 2, to small for transplant 3. This was due to the fact that plants were pulled successively from the same beds. It would appear that staggered seeding of plant beds would provide better uniformity in size of plants for staggered transplantings.

3. Weed and grass control. Following the first transplanting, clumps of grass tilled in were continuing to grow. Therefore, these beds were hand cultivated.

Then following transplanting 2, beds from both first and second transplanting were sprayed over with ENIDE at 8.0 lb/acre rate. Following the third transplanting, no weed control was used due to lack of suitable spray equipment. Also since these beds had inevitably been sprayed on the prior spraying, there was concern over establishing a concentration of ENIDE which might be damaging to the plants. It was of interest also to note whether the tobacco could establish a canopy quickly enough to shade grass and weeds.

4. Fertilization (initial + side dressing). Initial fertilization prior to transplanting (note beds used for DFS trials were not re-fertilized) was at the rate of 60-120-180 lb/acre of N-P-K. Observation of plant growth and early indication of nitrogen deficiency led to the decision to apply several topdressings as appeared desirable. Table 2 shows the schedule of fertilization for the three transplantings.

Table 2. Fertilization Schedule for Transplantings of Close-Grown Tobacco, Oxford, 1974

Application			
Initial			
Rate (8-16-24)	750 lb/acre	750 lb/acre	750 lb/acre
Dates	beds 1,2; 3/29/74	beds 7,8; 4/19/74	bed 6; 4/11/74
	beds 4,5; 4/11/74	beds 10,11; 4/19/74	bed 9; 4/19/74
First Topdressing			
Rate (8-0-24)	375 lb/acre	375 lb/acre	375 lb/acre
Date	5/24/74	6/5/74	6/20/74
Second Topdressing			
Rate (8-0-24)	250 lb/acre	250 lb/acre	250 lb/acre
Date	6/20/74	7/2/74	7/17/74
Third Topdressing			
Rate (8-0-24)	250 lb/acre	250 lb/acre	250 lb/acre
Date	7/17/74	est. 7/26/74	est. 8/10/74
Total N/acre	130#	130#	130#

In addition, several areas of the beds showing more severe nitrogen deficiency due to leaching were "touched up" with a light topdressing around June 15.

As can be noted from Table 2, a problem inherent in the layout was that of variable time of initial fertilization to time of transplanting. Since the DFS beds were covered with polyethylene, leaching was considered to be less in general than would have occurred otherwise; however, certain portions of the beds which remained moist during successive irrigations showed symptoms of more severe leaching.

Another factor for future consideration is that topdressing can fairly easily be washed from the bed surfaces if simply surface applied. A definite need exists for machinery for applying and incorporating top dressing. This machinery could also serve to provide at least primary cultivation.

5. Cultivation. Crusting of surface soil during June prior to complete canopy cover suggested the need for cultivation to provide improved aeration. Consequently a simple cultivator rig was set up, consisting of 8" sweeps with shanks mounted to a 3-point hitch tool bar. This was found to work quite satisfactorily in cultivation of the first and second transplantings. The third transplanting was not cultivated.

6. Topping and Sucker Control. At the time of this report, the tobacco is flowering in the first and second transplantings, but unevenly. When approximately 80% of the plants within a transplanting have flowered, the tobacco will be topped. Off-Shoot T (contact sucker control) will be applied in the early flowering stage, followed by MH-30 at topping.

7. Harvest and Curing. Plans are to sequentially harvest the tobacco plots according to the following schedule.

Harvest	Beds	Transplanting	Approx. Date
1	1,2,3(?)	1	8/5-8/10
2	3(?),4,5	1	8/10-8/17
3	10,11	2	8/17-8/24
4	7,8	2	8/24-9/1
5	6,9	3	9/1-9/7

This should provide near optimal maturation of each plot. Tobacco stalks will be cut by hand and the material fed through dual cutting action, loaded into side-loaders and cured on approximately 1-week schedule. Following curing, the tobacco will be packaged for later evaluation in England. Green and cured weights will provide estimates of yield and conversion percentage during curing.

8. Procedure for Plant Beds 10 and 11: Substudy on Topping, Sucker Control, Regrowth. Tobacco from these beds will be managed to provide the treatments outlined earlier. The eight basic treatments (1A-8A) will be assigned to a suitable uniform portion of each bed (Pale Yellow and G-28) in a manner to provide approximately 100 plants per treatment. Since it is anticipated that sucker control will be applied concurrently for treatments 1-4, hand suckering will be used as required on the early topped treatments. All treatments, by necessity, will be harvested on the same day to fill the curing chambers. Therefore, optimal results from these trials cannot be fully obtained. Following the first crop, the beds will be fertilized with approximately 100 lb N/acre and 180 lb K/acre, cultivated, and sprayed over with ENIDE at 8.0 lb/acre. Topping procedure for the second crop will be dependent upon growth.

Data to be taken include:

1. Plant count
2. Green weight
3. Cured weight

4. Recovery ratio (wt green/wt cured)
5. Yield/acre (first vs second crop)
6. Total yield/acre
7. Nicotine and sugar
8. Subjective quality assessment
9. Lamina/stalk weight ratio of cured product

V. SUGGESTED IMPROVEMENTS FOR 1975

On the basis of observations to date with direct field seeding and production of close-grown tobacco, a number of improvements in equipment or operational procedure are suggested.

A. Direct Field Seeding

1. Preliminary to bed forming, the field layout and equipment operation can be enhanced by pre-bedding with "middlebusters". This will also permit establishing higher, more uniform beds.
2. The bed former should be widened to approximately 63". This will prevent damage to side rows during plastic covering or by errors in tractor driving.
3. Initial fertilization should be integrated with tilrovating-bed forming-seeding operation for precise placement relative to the multiple-seeded rows.
4. In regards to accuracy of seed placement, there is a need to reduce wind and equipment vibration effects.
5. A better, more positive firming of seed with soil is needed.
6. The channels into which the seed are dropped should be slightly wider and deeper.
7. Timing of the operation should begin in early March and end no later than April 1.

8. Attention should be given to improved methods of weed control - perhaps ENIDE spray on after seeding.
9. The plastic covering unit should be modified to provide more accurate tracking on the bed.
10. A thinner gage plastic is suggested; along with further consideration of perforation pattern for improved moisture control.
11. Improvements in uniformity of seed germination by sizing, hardening, etc. should be introduced into the field study as soon as demonstrated in the laboratory.

B. Transplanting of Close-Grown Tobacco

1. The 4-row transplanter should be improved to provide water metering during setting of the plants.
2. Better tracking of the 4-row transplanter on a pre-formed bed is suggested.

C. Cultural Operations During the Growth Phase

1. A suitable mechanized scheme should be developed to permit accurate spraying of weed and sucker control chemicals, insecticides, etc. for close-grown tobacco.
2. Further work is suggested for suitable mechanized side-dressing and cultivation equipment.
3. Mechanical topping should be investigated when procedures are more fully established.

D. Harvesting

Depending on outcome of tests regarding usability of close-grown tobacco, tobacco harvesting equipment should be developed to permit field cutting and rapid transport into curing.

FINAL REPORT

on

MECHANIZATION OF CLOSE-GROWN TOBACCO, 1974

by

William H. Johnson, Prof.
Dept. of Biological & Agricultural Engineering
North Carolina State University
Raleigh, N.C. 27607

Date: ____________

Distribution:

Dr. F.J. Hassler
Dr. K.R. Keller
Mr. B.C. Akehurst
Dr. R.W.J. Williams

FINAL REPORT - - MECHANIZATION OF CLOSE-GROWN TOBACCO, 1974

I. Introduction

Research on mechanization of close-grown tobacco was initiated in January, 1974 at N.C. State University under support by Carreras Rothmans, Ltd. Initial phases of the work emphasized (1) a mechanized approach to direct field seeding of pelleted seed, (2) observations of alternate mulches or covers for plant protection and (3) mechanical transplanting of close-grown tobacco at plant populations of approximately 30,000 plants per acre. Details of the experimental program for the period January 1 - June 30 were submitted in July, 1974. In this final report, covering the years' research effort, further description of the test plots with tobacco grown to harvest and carried through curing will be presented. In addition, an overall assessment of progress to date, including yield data, and major problems to be resolved will be presented.

II. Pre-Harvest Operations and Observation of Test Plots

As discussed in the previous report, direct field seeding of tobacco was only partially successful, inasmuch as while progress was made in developing a system for growth of germinating seeds under perforated plastic, problems were encountered, particularly in regards to moisture control, weed and grass control, and uniformity of seedling establishment. Only one bed (No. 3) was retained from the first seeding of April 4, with the decision to try to grow the plants on this bed to harvest. This bed was hand weeded and provided with topdressing in the same manner as for transplanting #1, as described in the earlier report.

Three transplantings of close-grown tobacco were made on May 17, May 24 and June 5 with modified transplanting equipment to provide 16" row spacing at 10 to 12-inches within row spacing on preformed beds. Speight G-28 and Pale Yellow varieties along with small subplots of H-67 (High Nicotine) were transplanted. The following table identifies the specific treatments with bed location as of July 1st, 1974.

Bed No.	Variety	Date of Transplanting	Prior Use	Number of Plants
1	Pale Yellow	5/17/74	DFS-1	1191
2	G-28	5/17/74	DFS-1	1130
3	G-28 (?)	DFS	——	est. 800-1200
4	Pale Yellow	5/17/74	DFS-2	1299
5	G-28	5/17/74	DFS-2	1215
6	Pale Yellow	6/5/74	DFS-2	1235
7	Pale Yellow	5/24/74	DFS-3	1422
8	G-28	5/24/74	DFS-3	1429
9	G-28	6/5/74	DFS-3	1372
10	Pale Yellow	5/24/74	——	1409
11	G-28	5/24/74	——	1403

Small subplots of H-67 were introduced in beds 4 and 6 during the 1st and 3rd transplanting for the purpose of noting the nicotine level of this variety in the cured leaf.

At the time of Martin Johnston's visit, a decision was made to utilize beds 10 and 11 to observe the effect of various topping heights and sucker control application on yield and regrowth potential. Specific treatments for this study were outlined in the 1st 6-months report, July, 1974.

A. Procedures and Observations:

1. Pre-Transplant Operations. As indicated above, certain beds utilized previously for direct field seeding were used for transplanting. These beds were re-tilled but no additional fertilizer was applied. For beds 10 and 11 fertilizer was applied prior to tilrovating. All beds had 60 lb of N prior to transplanting.

2. Transplanting. For each of the three transplantings the same procedure was used. Plants were hand pulled and mechanically set with a 4-row

transplanter (Powell) at 16" row spacing and 8-10" within row spacing. No water was applied during transplanting; however irrigation was provided in each case immediately following transplanting. Wilting occurred rapidly in each transplanting, but plant loss did not appear excessive. This is not believed to be the expected result, in general, since severe plant injury could occur if the length of time prior to irrigating was eight hours, say in comparison with the maximum 4-hr delay for the small plot work. Transplanting 1, having long, leggy plants appeared to receive the greatest thermal injury of the three transplantings.

3. Weed and Grass Control. Following the second transplanting, both the 1st and 2nd settings were sprayed over with Enide at 8.0 lb/acre rate. No weed control was used for the third transplanting (June 5) since suitable equipment was not available, and since these particular beds 6 and 9 had previously received two applications. It was of interest to note whether a canopy could be established sufficiently rapid to shade grass and weeds. During June, the first and second transplanting were cultivated lightly with a sweep cultivator. No cultivation was given to the third transplanting.

Enide + one cultivation effectively controlled grass and weeds on the beds for transplantings 1 and 2; hoever, some grass growth developed between the beds. For the third transplanting, considerable weed and grass growth developed and it appeared at first that the tobacco would succeed in establishing a canopy. As the growing season developed, however, the grass appeared to take over and stunted the tobacco growth. Fig. 1 illustrates the severe grass problem which developed in bed 9 during July. The question still remains as to what is the most efficient method for weed control, i.e. pre-plant herbicide alone, pre-plant plus one cultivation, spray over herbicide at transplanting, spray-over plus 1 cultivation, or one or more cultivations.

4. Topdressing. Observation of plant growth during the month following transplanting indicated nitrogen deficiency in general with rather severe deficiency noted in several areas of the field. These more severe areas were "touched up" with spot application of 8-0-24. In addition three topdressings were provided at approximately 2, 5, and 8 weeks after each transplanting for a total of 130 lb/acre applied N. The complete fertilization schedule was provided in the earlier report.

5. Growth Characteristics. It appeared that there was a general delay in vigor for the first transplanting, probably due to the fact that initial fertilization was applied on March 29 and April 11 prior to direct seeding, and very likely considerable leaching had occurred prior to transplanting. Topdressing and "spot application" aided considerably, with the tobacco responding rather quickly by becoming more vigorous, having a greener color, and forming a vegetative canopy of leaves. By the middle of July, much of the irregular growth and color appeared to have disappeared, although there were differences in height of plants in different regions of the field, due likely to soil differences. It should be pointed out that the field was very non uniform from the standpoint of soil texture. Figure 2 illustrates the general appearance of tobacco around the middle of July. Note should be made of bed 3, the direct seeded plot, which at this stage had "filled out" to a large extent. Pale yellow variety appeared in all beds to be several inches taller than comparable beds of G-28 at this time, and had a yellower

cast than G-28. H-67 subplots were disappointing, in that plants grew slowly and were quite variable in size. These plants had been produced under greenhouse conditioned and "hardened" prior to setting in the beds.

Transplantings 2 and 3, which were delayed relative to the first transplanting, continued to lag behind in growth and maturation implying the possibility of extending the harvest period by the schedule of transplanting along with staggered cultural practices.

6. Floral Initiation, Topping and Sucker Control. It was observed that the direct seeded tobacco initiated flowering prior to the transplanted tobacco, although the plants were younger. Continued observation indicated that the larger plants were flowering first. About a two to three week period was necessary for all plants to flower, perhaps due to plant size variability from direct seeding. Occurrence of flowering for the transplanted tobacco also appeared to be related to plant maturity or plant size with the earlier transplanting flowering first.

Plants were topped by hand when about 80% of the plants in a particular bed had flowered, then Off-Shoot T contact sucker control was applied. Becasue of lack of available equipment, MH-30 was not applied. Suckers which were present on the plants at the time of harvest were generally removed by hand.

Figure 3 illustrated beds 10 and 11, which were allocated for the study on effect of topping height and sucker control application on yield and regrowth potential. Unfortunately, after harvest, regrowth did not occur to the degree expected so this portion of the study was dropped from consideration. It is of interest that in 1974, plant beds harvested during active growth of the plants showed substantial regrowth capability.

This raises some interesting questions as to what role physiological or environmental factors play in regards to regrowth potential.

The specific procedures for managing these beds were outlined in the earlier report.

7. Irrigation and Water Requirements. As indicated earlier, the plants were irrigated following each transplanting. Also during the growth period, two irrigations were applied on June 15 and about July 15 during periods of dry weather. Observation of the close-grown tobacco in comparison with normal spaced tobacco in nearby fields showed that the close-grown appeared to be suffering more from the dry weather. It is believed that higher transpiration losses would be associated with close-grown than with the normal spaced tobacco, thereby depleting available soil moisture at a faster rate. Oxford, N.C. does not receive as much rainfall as does eastern North Carolina; however, even there the farmers occasionally experiences one or more dry periods during the tobacco production season. Moisture availability during the major part of the growing season will likely be an important factor in achieving the potential yields of close-grown tobacco.

III. Harvest and Curing Procedures.

Decision as to when to harvest a particular bed was made by considering the overall maturity and condition of tobacco. More emphasis was given to allowing the top leaves to mature prior to harvest, since these were likely accumulating dry matter at a faster rate than bottom leaves were losing weight through senescence.

For the major study the harvest procedure was as follows. By inspection the "best portion" of the bed, having the appearance of highest yield, was staked off and the area measured. Generally this plot was 50 to 75 ft in length. Tobacco was hand cut by machetta (Fig. 4) with record taken of number of plants and green weight. This tobacco was kept separate from the "remainder" of tobacco harvested from the bed. The remainder was weighed but stalk count and area not taken. Tobacco was placed into sheets during harvest (Fig. 5) and taken to the curing facility, unloaded and fed by hand into a cross cutter, (Fig. 6). The chopped material was conveyed directly to permit filling of side-loader (module) containers, Fig. 7. Each container was packed at a density of 20 lb/ft^3 for a filled container weight of 270 lb. Three containers were stacked to provide 4.5 ft of total curing height through which the air passed during curing, Fig. 8. Approximately 50 plants of the best portion material was separated into leaf and stalk samples prior to cutting, and placed near the center of a curing container, maintaining identity by using cheesecloth to enclose the sides of the material and to prevent mixing with the other tobacco.

Harvest and handling into curing for beds 10 and 11 were similar to that of the above procedure. In this case, data for each treatment plot included plot area, no. of plants and green weight. Each treatment was kept separate by cheesecloth dividers during curing.

After a curing chamber had been filled, curing conditions were established to accomplish the typical yellowing, leaf drying and stem drying phases for flue-cured leaf. After curing, the product was conditioned to approximately 14-15% prior to unloading, collection of samples and packaging.

IV. Results and Discussion.

A. Curing times. The following table provides pertinent information on curing time requirements for the various harvested beds of close-grown tobacco.

Harvesting Dates and Curing Times for CGT, 1974

Curing No.	Chamber	Date Harvested	Tobacco From Beds	Curing Time (hr)
1	3	8/14/74	1	168[a]
2	5	8/15/74	4	168[a]
3	4	8/15/74	1,2,4	144
4	8	8/21/74	2,5	136
5	9	8/21/74	5,7,10	136
6	3	8/22/74	7,10	112
7	4	8/23/74	10[b]	136
8	3	8/28/74	8,11[b]	138
9	5	8/29/74	8,3	162[a]
10	4	8/30/74	8	114
11	3	9/ 5/74	(Belcher Farm)	91[b]

a/ These cures had longer curing times due to faulty thermostats which failed to automatically advance, or in which the furnace high limit cut off the system.

b/ This tobacco was produced normally (variety G-28) and the entire plant harvested, chopped and cured for a control.

In most cases the tobacco was completely dry by the 4th or 5th day, although some of the curing times above exceed these time periods. Actually, the presence of the stalk portion appeared to pose no problem, in fact very likely improved air permeability characteristics of the tobacco within the containers.

Note that beds 6 and 9 (third transplanting) were not harvested. Grass and weeds generally overtook these beds, and it was considered impractical to attempt harvest. No difficulty was experienced in harvesting the first and second transplantings (TR.1. May 17, TR.2 - May 24) over a period of 16 days. It is believed that transplanting over a 4-wk period along with modified fertilization would permit harvest over a 6-week period.

B. Yield-Population Data. As pointed out previously, the method of production involved planting of four rows on preformed beds, having 81" center-to-center distances. Row distances between outside rows of adjacent beds was 31-32". Since this distance could be closer with a tractor equipped with smaller tires (or if tobacco could be planted flat), the yield and population data will be presented on an effective basis defined as:

(a) $$\text{Eff. Yield/acre} = \frac{\text{average wt/plant X 43,560}}{\text{(row spacing) X (plant spacing)}}$$

(b) $$\text{Eff. Plant Population} = \frac{\text{43,560}}{\text{(row spacing) X (plant spacing)}}$$

The following table presents effective yield-plant population data for the major field trials.

Yield-Plant Population Data for The Major Test, CGT, 1974[1]

Variety	Bed Number	Transplant Date	Yield/acre (lb) Uncured (A)	Cured (A)	Cured (B)	Plant Population (A)
G-28	2	5/17/74	32,700	5530	6750	35700
	5	5/17/74	29,450	5375	6600	38200
	8	5/24/74	23,700	4570	4080	36200
Means:			28,617	5158	5810	36700
PY	1	5/17/74	34,050	5840	6000	39600
	4	5/17/74	38,400	6825	7210	36400
	7	5/24/74	31,100	5325	5140	40100
Means:			34,517	5997	6117	38700
DFS	3	———	27,750	4825	6360	49500
G-28	Belcher Farm	Approx. 5/19/74	15,100	2788	———	6534

1/ Values given in effective yields and plant populations per acre for close-grown. For G-28 from Belcher farm, effective and actual values are same. Actual values for CGT may be obtained by multiplying by the factor, 0.79.

A/ Estimate based on "best portion" plot.

B/ Estimate based on heaviest 50 plants from "best portion" plot.

This data show that yield depended on variety and transplanting date. Utilizing the same equipment and cultural management, it is of interest that PY variety exceeded G-28 in both plant population and yield. The data suggest better livability of field-set plants for PY, along with larger plant growth, which led to increased yields. Yields for both varieties were generally lower for the second transplanting, perhaps a seasonal effect. In general, the data show that CGT yields were up to 100% greater than for normally spaced tobacco (Belcher farm). Note should also be made that uncured yields are in the range of 14 to 17 tons/acre for CGT.

Yield-plant population data for the special study on beds 10 and 11 are given in the following table.

Yield-Plant Population Data for the Special Test, Beds 10 and 11, 1974[1]

Variety	Topping Height	Sucker Control	Yield/Acre Uncured	Yield/Acre Cured	Plant Population
G-28	No topping	Off-Shoot T	26,100	5340	42700
	18 leaf	"	22,800	4730	41100
	14 leaf	"	20,500	4350	40900
	10 leaf	"	20,825	3935	41600
Means:				4589	41580
	No topping	None	27,500	5550	40700
	18 leaf	"	27,500	5250	38200
	14 leaf	"	29,100	5370	40400
	10 leaf	"	25,750	4860	43700
Means:				5258	40750
PY	No topping	Off-Shoot T	28,200	5300	42000
	18 leaf	"	24,900	5020	41600
	14 leaf	"	22,100	4330	39900
	10 leaf	"	20,700	3670	41600
Means:				4580	41280

No topping	None	40,400	6630	4220
18 leaf	"	38,500	5640	4100
14 leaf	"	33,800	5150	4050
10 leaf	"	29,700	4630	3740
Means:			5510	4028

1/ Values given in effective yields and plant populations for CGT. Actual values may be obtained by multiplying by the factor, 0.79.

This data indicate that both uncured and cured yields are decreased substantially depending on the degree of topping. Furthermore, the use of a sucker control chemical further appears to depress yields in comparison to untreated plots. These facts are particularly interesting in view of the goal to achieve maximum yields. If flower head and axillary suckers could be used in the final sheet material, further economical gains could be realized. Again, it is noted that PY variety had a higher yield than G-28 for the case where no sucker control was applied, but about the same yield where Off-Shoot T was applied.

It is to be recognized that further experiments along this line should be conducted before firm conclusions can be reached, since some of the low topping treatments had likely passed their optimal stage before topping was made. The trends however, appear fairly conclusive, since the tobacco was at or near the flowering stage for most plants and there was a yield reduction in every case for the 18-leaf (normal) topping vs no topping treatments.

C. Conversion Percentage and Leaf/Stalk Ratios. At harvest, tobacco may contain a variable moisture content, depending upon prior rainfall, leaf maturity, weather conditions during harvest, etc. The conversion percentage is defined:

$$\text{Conversion Percentage} = \left(\frac{\text{wt. cured}}{\text{wt. uncured}} \times 100\right).$$

The higher the conversion percentage, the more efficient the cure, since less water must be removed.

The following table presents data on conversion percentages for the various harvests of CGT. In addition leaf/stalk ratios for uncured and cured products are provided.

Conversion Percentages and Leaf/Stalk Ratios for the Major Test CGT 1974.

Variety	Harvest Date	Bed No.	Leaf/Stalk Ratio Uncured	Leaf/Stalk Ratio Cured	Conversion % Leaf	Conversion % Stalk	Overall[1]
G-28	8/15	2	1.59	1.38	15.2	17.5	17.2
	8/21	5	1.35	1.28	19.8	20.9	18.3
	8/30	8	1.93	1.76	16.7	18.3	19.4
	Means:		1.62	1.47	17.2	18.9	18.3
PY	8/14	1	1.35	1.11	14.7	17.8	17.2
	8/15	4	1.26	1.04	13.5	16.3	17.8
	8/22	7	1.27	1.29	15.3	15.2	17.5
	Means:		1.29	1.15	14.5	16.4	17.5
DFS	8/29	3	0.90	1.11	19.9	16.3	17.4
G-28	9/5	Belcher	——	——	——	——	15.2

1/ Overall conversion percentage was determined from entire "best portion" plot; whereas leaf and stalk conversions were based on 50 plots only.

This data indicates a rather marked difference in leaf/stalk ratio by variety, with an average of 1.47 for G-28 (cured) vs 1.15 for PY. This is believed to be due to larger leaf and shorter stalk for G-28. It is also of interest that the leaf/stalk ratio increased for tobacco from the second transplanting (beds 7 and 8). The overall conversion percentage was slightly higher for G-28 (18.3) than for PY (17.5). Stalk appeared to contain less water than leaf for both varieties. Conversion values were generally within the range of 15 to 19%, which approximates rather closely with an average for flue-cured leaf at Oxford in 1972 of 17%. DFS tobacco, while having a low leaf/stalk ratio of 1.11 for cured material, had a good overall conversion percentage of 17.5. Interestingly, normally grown tobacco from the Belcher farm had a conversion percentage of 15.2%, lower than any of the CGT material.

Overall conversion percentages for the Special Test, Beds 10 and 11 were as follows:

Conversion Percentages for the Special Test, Beds 10 & 11, 1974

Variety:	PY		G-28	
Sucker Control:	Off-Shoot T	None	Off-Shoot T	None
Topping				
No topping	18.5	16.5	20.9	20.2
18 leaf	20.2	14.7	20.8	19.2
14 leaf	19.7	15.3	18.9	18.5
10 leaf	17.8	15.6	19.0	19.0
Means:	19.0	15.5	19.9	19.2

No particular pattern of response is noted due to topping height; although there appears to be a slight tendency for conversion percentage to decrease as plants are topped lower. The use of Off-Shoot T, while as noted previously decreases yield, appears to increase conversion percentage. It is postulated that sucker control chemicals would likely reduce leaf expansion but contribute to increased weight per unit area of leaf tissue.

D. Chemical Analyses. Samples from certain lots of close-grown tobacco were evaluated by the Tobacco Laboratory at NCSU for sugar and total alkaloids. These samples were hand separated into stalk, stem, and lamina portions and subdivided to provide two replicates. Results are shown in the following table.

Tobacco Analyses - CGT 1974

Treatment	Component: Stalk		Stem		Lamina	
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
% Sugar						
TR 1 - G-28	6.8	7.7	3.9	4.2	10.4	10.6
TR 2 - G-28	10.3	10.2	6.0	5.8	11.9	12.6
TR 1 - PY	6.7	8.8	8.1	7.7	10.6	11.1
TR 2 - PY	10.9	11.8	7.5	7.3	12.2	11.1
Belcher G-28	6.2	5.2	12.3	11.3	12.2	11.7
DFS - 1	9.9	7.9	5.3	5.5	12.7	12.4
% Alkaloids						
TR 1 - G-28	0.21	0.17	0.23	0.22	0.88	0.93
TR 2 - G-28	0.15	0.18	0.22	0.22	0.74	0.72
TR 1 - PY	0.26	0.34	0.30	0.30	1.02	0.97
TR 2 - PY	0.20	0.18	0.22	0.23	1.13	1.05
Belcher G-28	0.47	0.29	0.46	0.41	1.73	1.71
DFS - 1	0.19	0.24	0.31	0.32	1.45	1.39

These data show that sugars within stalk of CGT were generally higher than in stem but lower than leaf; that sugars within stalk of CGT are higher than for normal stalk with alkaloids generally lower than for normal stalk; that sugars and alkaloids in normal stem are higher than for CGT stem; that sugars in CGT lamina are within the same general level of 10-12% as the normal plant (whole plant harvested); and that alkaloids in CGT lamina are depressed in comparison with the normal plant lamina (whole plant harvested). These data appear consistent with expectations.

E. Samples Submitted for Various Evaluations

1. Carreras Rothmans. Thirty-three samples (approx. 3 lb each) representing material from all transplantings of CGT, DFS, normal grown tobacco, and the special test (beds 10 & 11) have been submitted to Carreras Rothmans for detailed examination and chemical analyses.

2. ULT Air Separation. Approximately 515 lb. of CGT, pale yellow variety, was delivered to J.P. Taylor Company, Henderson, N.C. for air separation and threshing tests by Universal Leaf Tobacco Co., Richmond, Va.

3. AMF Sheet Making. Approximately 425 lb. of CGT, G-28 variety, was consigned to AMF for conversion to sheet, via J.P. Taylor, Henderson, N.C.

4. Consolidated Cigar Sheet Making. Approximately 105 lbs of CGT, G-28 variety, was shipped to Consolidated Cigar, McAdoo, Pa. for conversion to sheet.

5. Cigarettes for Preliminary Tests by T.C. Tso. Cigarettes from the control (Belcher farm), normally grown G-28 and cigarettes made by AMF from G-28, CGT will be examined by Dr. T.C. Tso for various smoke analyses, preliminary to more comprehensive tests from 1975 CGT at Oxford, N.C.

V. Conclusions

As a result of the research on mechanization and production of close-grown tobacco at Oxford, N.C., 1974, the following conclusions are made:

A. Direct Seeding

1. Mechanized approaches for bed preparation, direct seeding, and covering for plant protection can be developed for efficient dependable operation.

2. Major problems continue to exist with regards to weed control, plant uniformity and timeliness of operation. These can likely be solved through continued research.

B. Mechanical Transplanting of CGT

1. Mechanical transplanting of CGT on specially prepared beds has been accomplished to effective stands of 35,000 to 40,000 plants/acre.
2. Further improvement with water application appears desirable.
3. Mechanical transplanting, while feasible operationally, currently requires four to six times the labor of normal transplanting at 6,500 plants/acre. Mechanized plant production with mechanical lifting of plants could reduce labor by 50% or more.

C. Cultural Practices

1. All operations of land preparation, fertilization, cultivation, topping (if required), etc. need to be mechanized for maximum efficiency.
2. Weed control with mechanical transplanting appears to be no problem, with use of readily available herbicides such as Enide and Paarlan. Cultivation can be minimized since canopy cover shades out weeds within three weeks of transplanting.
3. Additional data is needed on the effect of various cultural practices in relation to yield and leaf characteristics, e.g. fertilization, plant population, staggered transplanting, etc.
4. Irrigation is likely to be an essential input for maximizing yield for CGT, and assuring success during extended dry weather. CGT appears to require more water than normal tobacco culture.

5. Field damage due to insects and disease organisms has been less that anticipated. Disease susceptibility under close-grown conditions needs complete evaluation.
6. The effect of no topping appears to enhance yield/acre. Product evaluation of usability of cured material with flower head or sucker inclusion should be determined.

D. Harvest

1. Yield/acre appears to be increased by allowing maturation of top leaves, with less emphasis to bottom leaves.
2. Mechanized harvest with a modified forage harvester should be considered as a "first approach" to efficient harvest of CGT. If this operation can be achieved, man-hr requirements for harvest should be 2.0 or less per acre.
3. An efficient materials handling system into curing will be essential for high capacity harvest-curing systems. Live-bed feeding directly into curing modules is a possible solution.
4. Harvest should be extended as much as possible to effectively utilize harvesting and curing equipment.

E. Curing

1. Time requirements for curing appear to be from four to five days.
2. Inclusion of the stalk appears to enhance air flow and rate of drying.
3. Curing equipment cost per pound of cured leaf should be reduced if possible, to prevent increased costs/acre for this operation.
4. Modular curing of CGT in a chopped form has been successfully accomplished with complete drying in all cures.

F. <u>Post-Curing Evaluation</u>.

1. Effective yield/acre was found to be in the range of 4000 to 7200 lb/acre for the 197~~2~~4 study. With improved knowledge of fertilization, cultural practices, etc., it is anticipated that yields of 6000-7000 lb/acre can be achieved consistently in N.C.
2. Yield/acre should be up to 100% or more than conventional grown tobacco (including stalks).
3. Leaf/stalk ratios were found to be in the range of 1.04 to 1.76. This ratio appears to be varietal dependent and varies with transplanting.
4. Conversion percentages were found to be in the range of 17 to 19%, slightly higher than for normal flue-cured leaf. Stalk contains less water, generally than leaf. The effect of sucker control appears to be an increase in the conversion percentage.
5. CGT stalk appears to contain more sugar and less alkaloids than normal stalk.
6. CGT stem appears to contain less sugar and less alkaloids than normal stem.
7. CGT lamina appears to contain average levels of sugar but less alkaloids than normal lamina.
8. Complete evaluation by manufacturers for product usability, physical and chemical properties, suitability for sheet processing and smoke characteristics is urgently needed.

Fig. 1. Close-grown tobacco, beds 7-11, around mid-July. Note the grass problem which developed in bed 9 (center).

Fig. 2. Close-grown tobacco, beds 1-5, around mid-July.

Fig. 3. Close-grown tobacco, beds 10 and 11, used for the special study on topping height and sucker control.

Fig. 4. Close-grown tobacco harvested by hand with machetta.

Fig. 5. Harvested tobacco was placed on sheets, weighed and carried to the curing facility.

Fig. 6. Tobacco plants were hand fed into the tobacco cutter, for producing approx. 3" X 4 1/2" strips.

Fig. 7. Chopped material was loaded directly into side-loader, modular curing containers.

Fig. 8. Three containers gave a curing depth of 4.5 ft. Air was forced vertically for curing.

PROPOSED 1975 RESEARCH PROGRAM

ON

MECHANIZATION OF CLOSE-GROWN TOBACCO-USA

William H. Johnson, Prof.
Dept. of Biological & Agricultural Engineering
North Carolina State University
Raleigh, N.C. 27607

Date: ________

Distribution:
Dr. F.J. Hassler
Dr. K.R. Keller
Mr. B.C. Akehurst
Dr. R.W.J. Williams

I. INTRODUCTION

Research conducted in 1974 on Mechanization of close-grown tobacco placed emphasis on mechanization of direct seeding, transplanting, and production of test plots of tobacco for evaluation purposes. While considerable experience was gained and progress was made towards development of an efficient production system, it is recognized that several major problems must be solved before a practical production package could be proposed and introduced at the farm level.

For the concept of close-grown tobacco to succeed in the long run, there appears to be the necessity for success in direct seeding to establish economically the high plant populations. For the near term, more efficient plant production and transplanting techniques may still be practical, considering the fact that yield potential may be double that of current production systems. Results in 1974 in direct seeding were only partially successful, with inadequate weed control, lack of plant uniformity, and timeliness of operation identified as major problems. There is reason to believe that these problems can be solved but very likely over a period of several years, the various factors relative to plant uniformity must be established and means must be found to control these factors in field experiments. Secondly, the weed control problem must be agressively researched to seek more effective control through either or both improved herbicides or management. Because of the importance associated with more efficient plant production or direct seeding, continued effort is needed in this area.

Production of close-grown tobacco in the United States would likely involve multiple-row planting on raised beds, to provide necessary drainage and root aeration for optimal growth. The entire production system is therefore altered somewhat, in comparison with conventional production. For an efficient system, various operations such as fertilization, bedding, transplanting, cultivation, weed and insect control, top-dressing, topping and sucker control, harvesting, etc. must be mechanized. While most operations can be easily mechanized with simple modification of existing available machinery, there is a need to introduce such adaptations as early as possible into the experimental program.

Harvesting and materials handling aspects, in particular, need considerable attention at this time. All of the previous work in the U.S. has involved hand cutting of plants, and hand feeding of the cut plants through disc and rotary blade cutters at the curing shed to produce a chopped material for curing. Development of a suitable field harvester and materials handling system will be essential for practical production of close-grown tobacco. This becomes apparent when one considers expected green weight yields of up to 15 tons/acre. Mechanized harvest and handling of material in a chopped form could facilitate large operations of 100 acres or more with minimal labor requirements.

For the above reason, the 1975 research program will emphasize (1) continued research in mechanized direct seeding (2) field production and (3) mechanized harvest and processing.

II. <u>DIRECT SEEDING</u>

A. <u>Objectives</u>:

1. To improve uniformity of seed germination, emergence and early growth.
2. To improve weed control capability.

B. Background: Results of the 1974 direct seeding trials at Oxford indicated several areas where improvements in equipment or management may lead to improved uniformity of seed germination, emergence and early growth.

Prior to bed forming and seeding, fertilizer was applied by hand since equipment was not available at that time for this operation. Variability of fertilizer placement could be an important factor relating to variability in growth rate observed at different locations on the beds. Attempts should be made to provide a suitable fertilizer distributor for accurate and uniform placement prior to bed forming.

The seeding device developed for pelleted seed in 1974 worked well in providing two pellets per station with high reliability; however, certain problems were experienced in regards to placement and firming of the pellets into the top 1/8" of soil. Precision of seed placement was affected primarily by wind, although some displacement due to equipment motion was noted. Lack of proper press action appeared to be due to the use of narrow press wheels which occasionally "missed" the seed. Attention should be given to these problems to achieve more accurate placement with positive firming action.

Weed control was identified as a major problem in the 1974 study, in which the approach was to utilized a herbicide rather than fumigation since the latter is considered to be too expensive for practical use. The only herbicide currently available which will not injure the small germinating tobacco seed is ENIDE. It appeared that excessive leaching of ENIDE during the germination and early growth period resulted in poor control. In addition, the use of perforated plastic excludes the possibility of spray-over applications in the event a weed problem is noted. These factors suggest the importance of further assessment of management procedures for weed control and investigation of other plant covers which permit secondary herbicide application directly through the covering.

Evidence both in the U.S. and England indicates that variation of seedling size may arise due to factors related directly with the seed or seed pelletting process. While it is impractical to consider introducing variants of all factors into field trials, two aspects should receive immediate attention. First, seed size variability could likely influence seed or seedling performance, particularly under a range of soil and microclimatological conditions encountered in field conditions. The larger seed, having greater embryo size or food researve, may perform better than the smaller seed. Examination of field performance of two or more sizes of seed should therefore be considered. Furthermore, graded seed lots should be pelletted by two or more processes to determine the magnitude, if any, of this effect.

C. Approach: It is proposed that field trials on direct seeding of pelletted seed be carried out using a range of seed size, two or more pelletting processes, and different covering materials. Other factors such as fertilization rate, plant density, method of seeding, etc. will be held constant. The research will be aimed at providing near optimal conditions for germination, survival, and early plant growth in establishing a uniform stand, with effective weed control. The mechanized approaches utilized will serve the dual purpose of (1) mechanization of transplant production and (2) mechanization of direct seeding for field establishment.

In carrying out this phase of research, engineering development will emphasize:

1) Pre-bedding to permit establishing more uniform beds during tilrovating-bed forming.

2) Mechanized fertilizer placement prior to the tilrovating-bed forming operation.

3) Development of an improved seeder for precision placement of pelletted seed with positive forming action.

4) Improved tracking of the covering device for the seeded beds.

Experimental conditions for field trials are as follow:

Location	Tobacco Research Station, Oxford, N.C.
Trials (3)	1) Approx. March 1
	2) Approx. March 15
	3) Approx. April 1
Soil Preparation	Turn and disc - February
Pre-seeding Chemical Application	MOCAP - 6.0 lb/acre - for nematodes & wireworms
	DYSYSTON - 4.0 lb/acre - for flea beatles and aphids
Pre-bedding	This operation to be performed no later than Feb. 25
Fertilization	750 lb/acre, 8-16-24
Tilrovate-bed form-seed	Ferguson Tilrovator-bed former, with precision seeder
Variety	G-28, pelletted
Seed Sizes (3)	To include large and small graded sizes by sonic sieving plus ungraded lot.

Pelletting Methods (3)	1) Normal triple-coat, Austrian 2) Greenhouse pellet, Austrian 3) Asgro, U.S.A.
Irrigation	Approx. 1 inch following seeding; as necessary during early plant growth.
Weed Control	ENIDE sprayed over beds at 8.0 lb/acre
Covering (3)	1) Perforated plastic 2) Nylon, .40 oz/yd^2 3) Nylon, .60 oz/yd^2
Replications	3
Sample Size	Approx. 250 stations/replicate
Observations	Germination percentage, variability of plant establishment, size variability
Planted Area	Approx. 0.30 acre (based on 9 rows/bed at 6" spacing, 3" within rows).

III. FIELD PRODUCTION OF CLOSE-GROWN TOBACCO

A. Objectives:

1. To provide mechanized operations of fertilization, transplanting, cultivation, top-dressing, insect and sucker control, and harvesting which will contribute to reduced labor and higher yields.
2. To produce experimental material for evaluation by Carreras Rothmans, Ltd. and NCI.

B. Background: Production of close-grown tobacco at Oxford in 1974 was semi-mechanized, i.e. only certain operations such as land preparation, bed-forming, pre-plant chemical application, and transplanting were mechanized. Other operations such as pre-plant fertilization, top-dressing, sucker control and harvesting were by hand. There is a need to fully mechanize all operations, where possible. (Because of the importance of developing mechanized harvesting and materials handling into curing, this aspect will be presented separately in Section IV). In 1974, yield/acre (actual) on one plot was 5700 lb/acre. It is believed that with improved techniques for fertilization, cultivation and pest control, yield per acre will be further improved.

There is also a need for close-grown tobacco produced under "practical" cultural management for various evaluations, such as chemical analyses, sheet production and evaluation, and biological tests. In addition to supplying select samples for Carreras' evaluations, an effort will be made to produce experimental material for evaluation by NCI.

C. Approach: It is proposed that approximately 1.5 acres of close-grown tobacco be produced, incorporating where possible mechanized approaches which simulate a practical production system.

Details of the experimental conditions are as follow:

Location	Tobacco Research Station, Oxford, N.C.
Variety	G-28
Land Preparation	Turn and disc
Soil Treatment	To be determined after land assignment. Consideration will be given to MOCAP + DYSYSTON, or multipurpose fumigant.
Pre-bedding	Field layout prior to bed forming.
Fertilization	Mechanical application of 8-16-24, 750 lb/acre.
Tilrovate - bed form	Ferguson Tilrovator - bed former (57" top width of bed).

Transplanting	A 4-row mechanical transplanter will be further improved to provide better tracking and setting of plants. At least two transplantings will be made to extend the harvest period.
Row Spacing	16"
Plant Spacing	10 to 12"
Plant Population	25,000 to 30,000/acre
Herbicide	ENIDE Spray over at 8.0 lb/acre
Cultivation	4-row, 3 pt. hitch sweep cultivator
Top-dressing	Mechanical incorporation, possible split application
Application of insecticides and sucker control chemicals	Mechanical sprayer, Application rates to be determined.
Harvest	Modified forage harvester approach
Curing	Modular curing in compartmental chambers.
Harvest Date	Green weight and cured weight yields.

IV. MECHANIZED HARVEST AND PROCESSING

A. Objectives:

1. To investigate the possible utilization of a modified forage harvester for high capacity harvest of close-grown tobacco.

2. To develop further the materials handling system for rapid filling of the curing containers.

B. Background: To realize the potential benefits of close grown tobacco production, an efficient harvest and handling system must be available.

Harvest weight per acre is expected to be from about 12 to 18 tons, at least double that of conventionally grown leaf.

Previous work at Oxford has involved hand feeding of a cutter at the barn; however, this approach is suitable only for a low capacity or small operation. With practical production units of 50 acres or more, mechanized field harvesting is necessary. A modified forage harvester approach may offer the most feasible solution for the short-run. These machines are capable of cutting and chopping forage at capacities up to 25 tons/hr; however, it is not known what capacities may be possible with tobacco. If 10 tons/hr could be achieved, a one-row harvester operating over a 6-wk period could harvest up to 150 acres.

At this capacity of harvest, filling of curing containers may likely be accomplished more efficiently at the curing facility, with mechanical unloading of transport wagons and movement of the chopped material through distribution equipment to the containers. Both facets of harvest and materials handling need immediate investigation.

C. Approach: For harvest of single rows of tobacco on a raised bed, a side-mounted forage harvester will be necessary. A New Holland Model 707 tractor mounted harvester (or similar model) will be modified to achieve the desired cut length with reduced bruising as required for tobacco. This will likely involve reducing number of blades reducing the cutter rpm or increasing feed-in rate, modifying feed rolls, and perhaps developing a different conveying system to carry the chopped product to the transport wagon. These changes should be made and initial field testing accomplished as early as possible in the harvest season, to permit necessary refinements prior to harvest of the test tobacco.

The chopped material will be fed back to a transport wagon or trailer, equipped with live-bed unloading. Study will be given to mechanically unloading the transport units at high efficiency.

The material will be cured in compartmental units, either in side-loader containers or curing modules.

PROGRESS REPORT

on

MECHANIZATION OF CLOSE-GROWN TOBACCO
January 1 - June 30, 1974

by

William H. Johnson, Prof.
Dept. of Biological & Agricultural Engineering
N.C. State University
Raleigh, N.C. 27607

Submitted to
Carreras Rothmans Limited
Christopher Martin Road
Basildon, Essex, England

PROGRESS REPORT -- MECHANIZATION OF CLOSE-GROWN TOBACCO
JAN. 1 - JUNE 30, 1974

I. INTRODUCTION

A tentative plan of work was submitted for the above project on March 18, 1974. The present report gives a more detailed description of the research developments and observations as the work evolved. Please note that certain modifications in the experimental plans have been made, in the interest of achieving the desired objectives.

This portion of work emphasized (1) a mechanized approach to direct field seeding of pelletized seed, (2) observations of alternate mulches or covers for plant protection and (3) mechanical transplanting of close-grown tobacco. The rationale for providing emphasis in these areas is based on the premise that the production system for close-grown tobacco will be radically different from that of normally grown tobacco. Instead of plant populations of about 6000/acre, populations may likely be 40,000/acre or greater. Cultural operations, harvest and curing will likely be drastically different from normal to minimize production costs per pound of cured material while achieving desired characteristics. Consideration of the various operations readily reveals that establishment of plants in the field at the high density populations is likely to be one of the greatest bottlenecks to practical production. Already, curing of tobacco plants in a chopped form has been successfully accomplished by modular curing. The remaining obstacles are (1) development of a more efficient mechanized system of plant production and transplanting, or direct field seeding and field growing of tobacco, and (2) development of an efficient mechanical harvesting and handling system for close-grown tobacco that is compatible with modular curing. Accordingly, this phase of research has emphasized approaches which offer potential for reducing costs of establishing close-grown tobacco plants in the field.

II. A MECHANIZED APPROACH TO DIRECT FIELD SEEDING

Success in seeding and growing of plants directly in the field could potentially permit bypassing of operations currently involved in plant production and essentially eliminate transplanting labor costs. While previous attempts by researchers have been rather unsuccessful (poor germination, survival, weed and grass control, etc.), there is reason to believe that greater success can be achieved for close-grown tobacco, because of the higher plant populations required and with the opportunity of applying new approaches to the various problems previously raised. Prior to initiating the particular approach, major problems to be encountered were recognized to be: (1) proper seedbed preparation (including land preparation, admixing of fertilizers and chemicals), (2) precision drilling of either naked or pelletized seed relative to a preformed bed (3) microenvironment control of soil moisture, humidity around the germinating seed, and temperature, and (4) control of weeds, grass, insects and disease organisms. An attempt was made to take all of these factors into account in the first experiment on direct field seeding.

A. Equipment

Land preparation equipment for tillage, discing, and general spraying were available at the Oxford Tobacco Research Station. However, it was necessary to procure or develop equipment for tilrovating-bed forming-seeding as an integral operation. A Ferguson Tilrovator with bedformer was purchased to permit proper admixing of fertilizer and chemicals into the top 5 to 6 inches of soil, to permit forming of a precision bed of proper compaction and to permit direct seeding or transplanting on the preformed bed. A 5-row seeder for pelletized seed was developed to mount directly behind the bedformer. Specifications for this equipment were supplied previously.

A special plastic dispensing unit was also procured to permit mechanical covering of the seeded bed with polyethylene. The unit required extensive modification to work properly with respect to the preformed bed.

A Farmall Model 840 tractor was borrowed from the Agricultural Engineering Dept. for use with the above equipment.

B. Procedure

Three seedings were originally planned for March 25, April 10 and April 20; however, due to weather or equipment problems the actual seedings were made on April 4, April 12 and April 22. These trials are identified as:

DFS 1. Direct field seeding, G-28 (pelletized), 0.12 acre, April 4 seeding date

DFS 2. Direct field seeding, G-28 (pelletized), 0.12 acre, April 12 seeding date

DFS 3. Direct field seeding, G-28 (pelletized), 0.12 acre, April 22 seeding date.

Approximately 0.6 acres of land was allocated for the close-grown tobacco project at the Oxford Tobacco Research Station. Unfortunately, the land is situated near the crest of a hill, is quite variable in soil type, and not well suited for bed layout, since the beds must run with the slope rather than on the contour. The field is rectangular 90' X 280'. An irrigation system was installed with three lateral lines running lengthwise the field, one on each side and one down the center.

The general procedure for the direct seeding trials was as follows. In early March the soil was turned and later disced for smoothing and breaking up soil clumps. Fertilizer was broadcast by hand at the rate of 750 lb/acre, 8-16-24, to provide per acre equivalents of 60 lb N, 120 lb P, and 180 lb K. A combination tank mix of ENIDE (8.0 lb/acre), MOCAP (6.0 lb/acre) and Dysyston (4.0 lb/acre) was applied with power sprayer for control of grass and weeds, nematodes and wireworms, flea beatles and aphids, respectively. Fertilizer and/or chemicals were disced in lightly immediately following their application. At the time of direct field seeding, the tilrovator - bed former was used on the first pass without seeding, such that equipment adjustments could be made and to assure proper bed forming. Three beds of 280 ft length were prepared for each of the three seeding. For the second pass, G-28 pelletized seed (Austria) were placed into the seed hoppers. Two seeds were dropped per hill at 8-9 inch spacing in each of five rows, one foot apart on the bed. For the third seeding, ENIDE was sprayed on following seeding rather than before, since problems in weed and grass control were evident at that time in the first two seedings. In this case, irrigation was applied for 2 hours immediately after seeding and before covering with plastic. Covering the beds was accomplished with a plastic dispensing unit, as a separate operation from seeding. The plastic was perforated with 3/8" holes on 3" centers and when applied to the bed, it snugly covered the bed surface and sidewalls. An irrigation program was established such that in the event of no rain, irrigation for 20-40 minutes per day was applied. Dates for various operations involved with the three seedings are given in Table 1.

Table 1. Dates for Operations Performed in the Direct Field Seeding Trials, Oxford, 1974

	DATES		
Operation	DFS 1	DFS 2	DFS 3
Turn Soil	3/1/74	3/1/74	3/1/74
Disc	3/15/74	3/15/74	3/15/74
Broadcast Fertilizer	3/29/74	4/11/74	4/19/74
Disc in Fertilizer	3/29/74	4/11/74	4/19/74
Spray ENIDE, MOCAP & DYSYSTON	3/29/74	3/29/74	4/22/74*
Disc in Chemicals	3/29/74	3/29/74	4/22/74
Tilrovate - DFS	4/4/74	4/12/74	4/22/74
Cover with perforated plastic	4/4/74	4/12/74	4/22/74
Remove plastic	5/1/74	5/9/74	5/17/74

*~~MOCAP~~ ENIDE SPRAYED ON AFTER SEEDING

Photographs in the Appendix illustrate certain operations and equipment utilized for direct field seeding.

C. Observations

1. Direct Field Seeding No. 1. Equipment performance during this trial was excellent for the tilrovating - bedforming operation, however problems were encountered with the seeder and plastic dispensing units. The seeder, mounted directly behind the bed former, was driven by a front gage wheel of the tilrovator. Adjustments in the tilrovator - bed former during travel frequently caused the gage wheel to lift above the ground which stopped the seeder. The seeder was mounted too close to the pre-formed bed and changes in the tilt caused the drop spouts of the seeder to occasionally become clogged. After seeding the first bed, the seeder was raised about 2 inches and the bed tilrovated and seeded again. A third problem became apparent in that the press wheels were now not effectively firming the seed in the pre-formed channels. The decision was made to proceed with the first trial, nevertheless, and to modify equipment prior to the second and third seedings. Two problems were found in connection with the plastic dispensing unit. Occasionally the feed roll near the bed surface contacted the bed and filled in the channels. This problem was not immediately apparent during the actual covering operation, but noted by inspection after the beds were covered. In addition sidewise shifting of the unit due to differential drag force of the rear disc coulters caused occasional damage to one side of the bed, in cases completely closing the side row channel and covering the seed.

On April 19 (15 days after seeding) about 10% of tobacco seeded appeared to have germinated and emerged. By April 26, a large number of plants had emerged, however plant sizes were quite variable ranging from 1/8" to 1". Seed placement was noted to be very irregular, either due to side shifts of equipment during seeding, wind displacement during dropping (careful observation of seed dropping showed that wind gusts could carry seed several inches), or displacement of seeds by water which may have flowed down the channels in certain locations due to irrigation or rain. It was noted that in certain areas of the bed, more plants were growing than could be explained by the apparent calculated seed drop. This raised questions as to whether some of the seed from the 1st pass seeding operation had germinated after re-tilrovating and seeding again, or whether it may be possible for seed from a prior crop year to germinate when supplied with favorable conditions.

The method of spraying on ENIDE prior to bed forming and seeding did not work as well as expected. This could be due to one or more of several factors. Rainfall between Mar. 29 and Apr. 4 (1.32") could have leached a portion of the chemical prior to seeding. Daily irrigation could also have leached ENIDE, particularly in select portions of the beds where water apparently percolated more easily through the plastic and entered the preformed channels. When the plastic was removed on May 1, this was more evident with grass and weeds growing better in certain portions of the channels or bed which were at a higher soil moisture during most of the test (see photographs). A third possible factor may be that the concentration of ENIDE was too low due to the tilrovating action, which vigorously tilled the soil for a depth of 4 to 6 inches.

An observation relative to maintaining soil moisture within the beds was unexpected. Although irrigation was applied essentially daily, the beds became progressively dryer. It was observed that water did not move easily through the perforations, with the majority running off the beds. It was estimated that less than 10% of the applied water actually penetrated into the beds. The layout of the beds did not help matters since most beds were on a slight slope. However, it is believed that even with level ground, this will continue to be a problem. It should be noted that there <u>were</u> certain areas near the low side of the field where the beds became <u>too</u> moist, where apparently good penetration was achieved with higher water flow on the plastic surface. Drying of the soil beneath the plastic can be explained as follows. With increasing outside temperature and solar radiation during April, the absolute humidity beneath the plastic probably increased rapidly. Evaporative loss of water could then exceed the moisture gain through the plastic, gradually reducing soil moisture content. Certain areas of the bed, therefore, became moisture limiting and reduced germination and livability. It was of interest to note that the moisture content of soil at the bottom of the preformed channels appeared higher than between channel areas. This was probably due to the soil temperature at the channel bottoms being lower than at the bed surface. Also, drip-back of condensed water into the channels may have tended to maintain a higher channel moisture content.

Temperatures beneath the plastic during the month of April were measured with three maximum-minimum thermometers. A minimum temperature of 40°F was observed with a maximum of about 120°F occurring on April 30 when outside temperature reached 88°F. I have some doubt as to the accuracy of the thermometers since solar radiation effects may not have been completely eliminated. The plants for the first seeding showed no adverse effect due to temperature.

No problems were noted in regards to diseases or insects prior to removal of the plastic on May 1.

2. <u>Direct Field Seeding No. 2</u>. On April 12, three beds, representing the second trial, were seeded. No changes had been made at this time to the tilrovator-seeding unit, since we were awaiting parts. The plastic dispensing unit was improved by raising the feed roller and relocating supports for the rear disc

coulters. Side shifting of the unit still remained a problem, with occasional damage to one of the side rows on the bed.

On April 19, one could not identify any germinating seeds. By April 26 (2 weeks after seeding) tobacco plants could be distinguished, again with noted variability in germination uniformity. During this period of time from seeding, the beds were becoming progressively dryer with an increase in outside temperature and incident solar radiation. In the more moist regions of the beds, tobacco seed along with grass and weeds germinated. Some locations of the beds were extremely dry and only a few tobacco seeds had germinated and survivied. Indications were that the April 12 seeding date was too late to permit proper environmental control during germination and early growth.

Since ENIDE was applied on March 29 (the same time as for the beds for the first seeding), a very similar problem in lack of weed and grass control was evidenced.

It should be noted that the perforated plastic remained on the beds for the second seeding until May 9. Unusually high outside temperatures and clear skies during the latter part of April and early May did not appear to thermally damage the small plants, although temperatures beneath the plastic were observed to be as high as 120°F. Also as in the first seeding, no problems were noted in regards to diseases or insects prior to removal of the plastic.

3. Direct Field Seeding No. 3. On April 22, three beds, representing the third trial, were seeded. At this time, two changes had been made to improve the seeder operation. The seeding unit was driven by a rear mounted drive wheel which "floated" to maintain positive traction with the soil. Secondly, the rear press wheels were mounted on a common shaft chain linked on the ends such that the press wheels were always in contact with the soil in the bottom of the

preformed channels. The five press wheels simply tracked the channels and applied press action solely by their weight. Seed drop and firming action appeared superior to the previous trials. It was still noted, however, that a number of seeds were not dropped directly in the channel in which case they were not firmed into the soil.

As pointed out earlier, ENIDE was applied after seeding, then irrigation was applied for 2 hours. The purpose in this procedure was to assure that the chemical was within the top 2 inches of soil with the prospect for improved grass and weed control. Following irrigation, the beds were covered with perforated plastic. It was later observed that this procedure did not work well, with many grass and weed seeds still germinating. It is possible that the irrigation moved the ENIDE below the level of near surface seeds which subsequently germinated.

On April 29 (at the time of high outside temperatures), no germinated tobacco seedlings could be identified. On May 6, some tobacco had germinated with size at this time of about 1/8-inch diameter. The number of seed which had germinated appeared much less than in the previous trials. This was very likely due to the high temperatures beneath the plastic during the germination period. These beds, very moist when covered, also appeared to be drying excessively in certain areas.

D. <u>General Discussion</u>

Collective observations on the three direct field seedings up to the times of removal of plastic provide the following conclusions:

(1) All seedings appeared to be too late in the season to permit proper control of soil moisture within the beds. Earlier seeding, for example beginning in early March, would likely improve matters considerably.

(2) The methods of applying ENIDE as used in this study were not too effective in the control of grass and weeds. This problem needs very serious consideration in future work. Since most of the problem appeared to be due to too moist regions of the bed, earlier seeding without irrigation during the germinating period may provide improved control.

(3) Equipment developed for tilrovating-bed forming-seeding was improved to an acceptable working level; however several improvements can be made. These include a better means of firming the seed into the soil and providing greater precision of drop relative to the preformed channel. The plastic dispensing unit also needs improvement to permit more precise tracking without side shift action.

(4) Variability of seed germination and early growth was evident in all seedings, suggesting the need for further research on factors affecting rate and uniformity of seed germination.

While a number of problems were identified in this first approach, I feel that further research and development will lead to effective solutions. Encouraging notes were that many of the tobacco seed germinated and grew well during the period of observation, pre-formed channels along with the perforated plastic provided a field environment conducive to germination and early plant growth, and progress was made in the development of a mechanized system for direct field seeding.

However, due to problems encountered with regards to uniformity of germination and weed and grass control, the decision was made in early May to discontinue observations on all beds except one from the first seeding of April 4. Bed number 3 was therefore weeded by hand, with the decision to try to grow the plants on this bed to harvest.

III. ALTERNATE COVERS OR MULCHES FOR PLANT PROTECTION

The assumption was made prior to beginning the work that some means of plant protection was essential to germination and survival of pelletized seed in the field. On the basis of other researchers' experience with plant production in normal plant beds, perforated plastic was selected for use in the main field study. However, because of costs associated with plastic covering (estimated \$150/acre), it was of interest to examine the use of alternate covers or mulches in comparison with perforated plastic. Consequently at the time of each direct field seeding, a 48-ft section of a seeded bed was managed to provide eight, 6-ft lengths, having the following treatments:

Treatment	Cover	Mulch or Anticrustant
1	None	Asphalt spray over channel
2	None	Watercapsules + 1/8" layer vermiculite + asphalt spray
3	None	1/8" layer vermiculite + asphalt spray
4	Nylon	1/8" layer vermiculite
5	Nylon	None
6	slitted plastic	1/8" layer vermiculite
7	slitted plastic	None
8	perforated plastic	1/8" layer vermiculite

Irrigation was applied for 20-40 minutes daily, in the event of no rain.

The observations indicated the critical importance of a covering for successful germination and survival. In treatments 1-3, no seed germinated and survived. It was observed that the soil appeared to dry rapidly near the surface, even with daily irrigation.

In treatments 4-8, seed germinated in all cases but with variability of emergence and vigor as discussed earlier for the regular field plots. Differences between treatments appeared to be slight, and additional study would be necessary to ascertain significance. The slitted plastic (treatment 7, 6" slits, 3/4" spaced) appeared to provide too much ventilation with soil tending to dry excessively beneath the slits. While some germination was noted, it was apparent by inspection that plant stand was lower. Vermiculite within the channels did not appear to enhance germination and vigor over the treatments involving covers only.

The above comments should not be taken as conclusive of what might be achieved ultimately, since the seedings were late, and the problem of soil drying beneath the covers was noted. Variability of soil moisture along ~~with~~ the 48' length of bed, and even within treatment plots of 6' length, made plant counts meaningless. Further field studies under better conditions and with several replications are suggested.

IV. MECHANICAL TRANSPLANTING OF CLOSE GROWN TOBACCO

Since it was considered impractical to continue observations on all three of the direct seeding trials (only the third bed of the first seeding retained), the decision was made to modify the experimental plan in order to achieve the following objectives:

1. To test a 4-row, modified transplanter in setting tobacco on the preformed bed.
2. To investigate the feasibility of staggered transplantings for increasing the harvesting period and consequently the utility of harvesting and curing equipment. The concept of staggered transplanting implies not only sequential transplanting, but sequential timing of cultural operations, topdressing, etc.

3. To produce two varieties in each of the transplantings (Pale Yellow and G-28) with observations on relative performance, curability, etc.
4. To introduce H-67, high nicotine breeding line, plants as subplots to one or more of the transplant trials. This will serve to indicate whether nicotine content of close grown tobacco can be increased by breeding.
5. To obtain preliminary information on the effect of various topping heights, and sucker control vs no sucker control on yield, select chemical analyses, and regrowth potential for a second crop.

A. Experimental Plan

Ten beds were now available for the transplanting research plus one retained from the direct seeding trial. These beds are numbered from 1 to 11 from left to right. The following treatments identify bed location, prior use in the direct seeding trials, and number of plants available for harvest.

Treatment	Bed No.	Variety	Date of Transplanting	Prior Use	Number of Plants
TR1-PY-A	1	Pale Yellow	5/17/64	DFS-1	1191
TR1-PY-B	4	Pale Yellow	5/17/64	DFS-2	1299
TR1-G28-A	2	G-28	5/17/64	DFS-1	1130
TR1-G28-B	5	G-28	5/17/64	DFS-2	1215
TR1-H67	4	H-67	5/17/64	DFS-2	30
DFS-1	3	G-28	Direct Seeded	———	800-1200
TR2-PY-A	7	Pale Yellow	5/24/74	DFS-3	1422
TR2-PY-B	10	Pale Yellow	5/24/74	———	1409
TR2-G28-A	8	G-28	5/24/74	DFS-3	1429
TR2-G28-B	11	G-28	5/24/74	———	1403
TR3-PY-A	6	Pale Yellow	6/5/74	DFS-2	1235
TR3-G28-A	9	G-28	6/5/74	DFS-3	1372
TR3-H67	6	H-67	6/5/74	DFS-2	70

This plan essentially involves three plantings of Pale Yellow and G-28 along with two small plantings of H-67.

A recent decision (during Martin Johnston's visit) was made to provide additional information pertinent to objective 5. For this purpose, beds 10 and 11 (transplanting 2, 1 bed each of PY and G28) will be used. Plant count and yield data for normally topped tobacco from this sub-study will be used to estimate "corrected" yields for these particular beds in the main study.

At this stage of development in the production of close grown tobacco, several questions have arisen in regards to various cultural operations to achieve maximum yield consistent with acceptable leaf composition. Of primary importance are questions of topping vs no-topping, topping height, sucker control vs no-sucker control, and regrowth potential for a second crop from the same root system. This substudy to the main transplanting evaluation will provide preliminary data to answer some of the questions as they relate to yield, select chemical composition, regrowth potential, etc.

Treatments for this substudy are as follows:

Treatment No.	Variety	Topping Treatment	Sucker Control	Crop
1A-PY	Pale Yellow	No topping	Off-Shoot T + MH	1st
1B-PY	Pale Yellow	"	"	2nd
2A-PY	Pale Yellow	18-Leaf	"	1st
2B-PY	Pale Yellow	"	"	2nd
3A-PY	Pale Yellow	14-Leaf	Off-Shoot T + MH	1st
3B-PY	Pale Yellow	"	"	2nd
4A-PY	Pale Yellow	10-Leaf	"	1st
4B-PY	Pale Yellow	"	"	2nd
5A-PY	Pale Yellow	No topping	None	1st
5B-PY	Pale Yellow	"	"	2nd
6A-PY	Pale Yellow	18-Leaf	"	1st
6B-PY	Pale Yellow	"	"	2nd
7A-PY	Pale Yellow	14-Leaf	"	1st
7B-PY	Pale Yellow	"	"	2nd
8A-PY	Pale Yellow	10-Leaf	"	1st
8B-PY	Pale Yellow	"	"	2nd
1A-G28	G-28	No topping	Off-Shoot T + MH	1st

Treatment No.	Variety	Topping Treatment	Sucker Control	Crop
1B-G28	G-28	"	"	2nd
2A-G28	G-28	18-Leaf	"	1st
2B-G28	G-28	"	"	2nd
3A-G28	G-28	14-Leaf	"	1st
3B-G28	G-28	"	"	2nd
4A-G28	G-28	10-Leaf	"	1st
4B-G28	G-28	"	"	2nd
5A-G28	G-28	No topping	None	1st
5B-G28	G-28	"	"	2nd
6A-G28	G-28	18-Leaf	None	1st
6B-G28	G-28	"	"	2nd
7A-G28	G-28	14-Leaf	"	1st
7B-G28	G-28	"	"	2nd
8A-G28	G-28	10-Leaf	"	1st
8B-G28	G-28	"	"	2nd

B. Procedure

1. Pre-transplant operations. As indicated earlier, certain of the beds previously utilized for direct field seeding were allocated for use in the transplanting project. For these beds, the tilrovator-bedformer was used to reshape the beds and to destroy existing weeds and grass. No additional fertilizer was applied in this case; however for beds 10 and 11 fertilizer was applied prior to tilrovating to bring these to the same applied fertilizer as the other beds.

2. Transplanting. A four-row mechanical transplanter was procured from Powell Mfg. Co. to permit setting of 4 rows on the pre-formed bed. Only minor changes were required in the existing planter: relocation of plant hoppers and seats, spacing of transplanters to achieve 16" row spacings, and adjustments to obtain 8-10" plant spacings.

Tobacco plants were pulled from plant beds seeded approximately Mar. 1-5, 1974, at the station. Four men were required to drop the plants, one man per transplanter.

The operation of the equipment on the pre-formed bed worked quite smoothly, with occasional adjustments required to achieve proper depth control. A couple of problems were noted which can be easily solved in subsequent operations. Occasionally, the firming wheels which drive the transplanter receiving discs failed to turn due to lack of friction, suggesting the need for an irregular rather than smooth wheel surface. Secondly the entire unit occasionally shifted slightly to the side causing one row to be improperly set. This was experienced primarily where the beds were sloping to one side as along the crest of the hill. Indications were that the bed should be slightly wider than 57" across the top for four rows; also side guides to track the bed may be helpful.

The transplanter utilized was not designed to provide water; consequently following each transplanting, the field was irrigated for up to 1.75 hr, depending upon soil moisture available. In all three transplantings, the plants wilted quickly after setting; however plant loss did not appear excessive in any case.

While no attempt was made to accurately measure rate of transplanting for the small plots, it was observed that approximately .2 acres were set within 2 hours, suggesting that about 1 acre could be set per day.

Three transplantings were made on dates of 5/17/74, 5/24/74 and 6/5/74. Plant size at time of transplanting varied from too large and leggy for transplant 1, optimal size for transplant 2, to small for transplant 3. This was due to the fact that plants were pulled successively from the same beds. It would appear that staggered seeding of plant beds would provide better uniformity in size of plants for staggered transplantings.

3. Weed and grass control. Following the first transplanting, clumps of grass tilled in were continuing to grow. Therefore, these beds were hand cultivated.

Then following transplanting 2, beds from both first and second transplanting were sprayed over with ENIDE at 8.0 lb/acre rate. Following the third transplanting, no weed control was used due to lack of suitable spray equipment. Also since these beds had inevitably been sprayed on the prior spraying, there was concern over establishing a concentration of ENIDE which might be damaging to the plants. It was of interest also to note whether the tobacco could establish a canopy quickly enough to shade grass and weeds.

4. Fertilization (initial + side dressing). Initial fertilization prior to transplanting (note beds used for DFS trials were not re-fertilized) was at the rate of 60-120-180 lb/acre of N-P-K. Observation of plant growth and early indication of nitrogen deficiency led to the decision to apply several topdressings as appeared desirable. Table 2 shows the schedule of fertilization for the three transplantings.

Table 2. Fertilization Schedule for Transplantings of Close-Grown Tobacco, Oxford, 1974

Application			
Initial			
Rate (8-16-24)	750 lb/acre	750 lb/acre	750 lb/acre
Dates	beds 1,2; 3/29/74 beds 4,5; 4/11/74	beds 7,8; 4/19/74 beds 10,11; 4/19/74	bed 6; 4/11/74 bed 9; 4/19/74
First Topdressing			
Rate (8-0-24)	375 lb/acre	375 lb/acre	375 lb/acre
Date	5/24/74	6/5/74	6/20/74
Second Topdressing			
Rate (8-0-24)	250 lb/acre	250 lb/acre	250 lb/acre
Date	6/20/74	7/2/74	7/17/74
Third Topdressing			
Rate (8-0-24)	250 lb/acre	250 lb/acre	250 lb/acre
Date	7/17/74	est. 7/26/74	est. 8/10/74
Total N/acre	130#	130#	130#

In addition, several areas of the beds showing more severe nitrogen deficiency due to leaching were "touched up" with a light topdressing around June 15.

As can be noted from Table 2, a problem inherent in the layout was that of variable time of initial fertilization to time of transplanting. Since the DFS beds were covered with polyethylene, leaching was considered to be less in general than would have occurred otherwise; however, certain portions of the beds which remained moist during successive irrigations showed symptoms of more severe leaching.

Another factor for future consideration is that topdressing can fairly easily be washed from the bed surfaces if simply surface applied. A definite need exists for machinery for applying and incorporating top dressing. This machinery could also serve to provide at least primary cultivation.

5. Cultivation. Crusting of surface soil during June prior to complete canopy cover suggested the need for cultivation to provide improved aeration. Consequently a simple cultivator rig was set up, consisting of 8" sweeps with shanks mounted to a 3-point hitch tool bar. This was found to work quite satisfactorily in cultivation of the first and second transplantings. The third transplanting was not cultivated.

6. Topping and Sucker Control. At the time of this report, the tobacco is flowering in the first and second transplantings, but unevenly. When approximately 80% of the plants within a transplanting have flowered, the tobacco will be topped. Off-Shoot T (contact sucker control) will be applied in the early flowering stage, followed by MH-30 at topping.

7. Harvest and Curing. Plans are to sequentially harvest the tobacco plots according to the following schedule.

Harvest	Beds	Transplanting	Approx. Date
1	1,2,3(?)	1	8/5-8/10
2	3(?),4,5	1	8/10-8/17
3	10,11	2	8/17-8/24
4	7,8	2	8/24-9/1
5	6,9	3	9/1-9/7

This should provide near optimal maturation of each plot. Tobacco stalks will be cut by hand and the material fed through dual cutting action, loaded into side-loaders and cured on approximately 1-week schedule. Following curing, the tobacco will be packaged for later evaluation in England. Green and cured weights will provide estimates of yield and conversion percentage during curing.

8. Procedure for Plant Beds 10 and 11: Substudy on Topping, Sucker Control, Regrowth. Tobacco from these beds will be managed to provide the treatments outlined earlier. The eight basic treatments (1A-8A) will be assigned to a suitable uniform portion of each bed (Pale Yellow and G-28) in a manner to provide approximately 100 plants per treatment. Since it is anticipated that sucker control will be applied concurrently for treatments 1-4, hand suckering will be used as required on the early topped treatments. All treatments, by necessity, will be harvested on the same day to fill the curing chambers. Therefore, optimal results from these trials cannot be fully obtained. Following the first crop, the beds will be fertilized with approximately 100 lb N/acre and 180 lb K/acre, cultivated, and sprayed over with ENIDE at 8.0 lb/acre. Topping procedure for the second crop will be dependent upon growth.

Data to be taken include:

1. Plant count
2. Green weight
3. Cured weight

4. Recovery ratio (wt green/wt cured)

5. Yield/acre (first vs second crop)

6. Total yield/acre

7. Nicotine and sugar

8. Subjective quality assessment

9. Lamina/stalk weight ratio of cured product

V. SUGGESTED IMPROVEMENTS FOR 1975

On the basis of observations to date with direct field seeding and production of close-grown tobacco, a number of improvements in equipment or operational procedure are suggested.

A. Direct Field Seeding

1. Preliminary to bed forming, the field layout and equipment operation can be enhanced by pre-bedding with "middlebusters". This will also permit establishing higher, more uniform beds.

2. The bed former should be widened to approximately 63". This will prevent damage to side rows during plastic covering or by errors in tractor driving.

3. Initial fertilization should be integrated with tilrovating-bed form-ming-seeding operation for precise placement relative to the multiple-seeded rows.

4. In regards to accuracy of seed placement, there is a need to reduce wind and equipment vibration effects.

5. A better, more positive firming of seed with soil is needed.

6. The channels into which the seed are dropped should be slightly wider and deeper.

7. Timing of the operation should begin in early March and end no later than April 1.

8. Attention should be given to improved methods of weed control - perhaps ENIDE spray on after seeding.
9. The plastic covering unit should be modified to provide more accurate tracking on the bed.
10. A thinner gage plastic is suggested; along with further consideration of perforation pattern for improved moisture control.
11. Improvements in uniformity of seed germination by sizing, hardening, etc. should be introduced into the field study as soon as demonstrated in the laboratory.

B. <u>Transplanting of Close-Grown Tobacco</u>

1. The 4-row transplanter should be improved to provide water metering during setting of the plants.
2. Better tracking of the 4-row transplanter on a pre-formed bed is suggested.

C. <u>Cultural Operations During the Growth Phase</u>

1. A suitable mechanized scheme should be developed to permit accurate spraying of weed and sucker control chemicals, insecticides, etc. for close-grown tobacco.
2. Further work is suggested for suitable mechanized side-dressing and cultivation equipment.
3. Mechanical topping should be investigated when procedures are more fully established.

D. <u>Harvesting</u>

Depending on outcome of tests regarding usability of close-grown tobacco, tobacco harvesting equipment should be developed to permit field cutting and rapid transport into curing.

Figure 1. Applying combination tank mix of ENIDE, MOCAP and DYSYSTON prior to seeding.

Figure 2. Discing in fertilizer and pree-plant chemicals.

Figure 3. Tilrovator-bed former-seeder, prior to modifying seeder drive and press wheels.

Figure 4. Close-up of seeder unit.

Figure 5. Tilrovator-bed former-seeder, after modifying seeder frive and press wheels.

Figure 6. Seeding at approximately 3 mph.

Figure 7. A bed having 5 rows of direct field seeded tobacco.

Figure 8. Covering the seeding bed with perforated plastic.

Figure 9. Field layout after first and second seedings.

Figure 10. Condensation can be noted over the row channels.

Figure 11. The problem of weeds and grass noted in wet portions of the bed.

Figure 12. The weed problem in DFS 3, beds 7, 8, 9 (May 22).

Figure 13. First transplanting of May 17 (beds 1, 2, 4, 5) and DFS bed 3 (photo May 22).

Figure 14. 4-row mechanical transplanter.

Figure 15. Transplanting 4 rows on the pre-formed bed.

Figure 16. Third transplanting on June 5, shown planting bed 6.

Figure 17. Transplanting operation shown from a distance (June 5).

Figure 18. Beds 1, 2, and 3 on June 5. Note DFS on bed 3 with larger plants.

Figure 19. Beds 3, 4, and 5 on June 5.

Figure 20. Beds 7 and 8 of second transplanting shown surviving well on June 5.

Figure 21. Bed 9 freshly tilled prior to transplanting on June 5; also beds 10 and 11 of second transplanting to right.

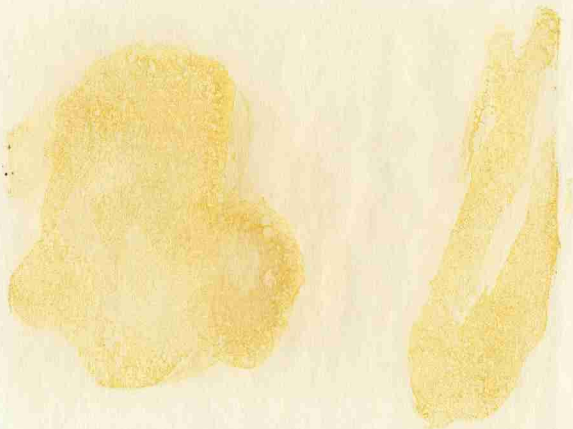

Figure 22. Beds 1 and 2, June 14.

Figure 23. Beds 3, 4 and 5, June 14.

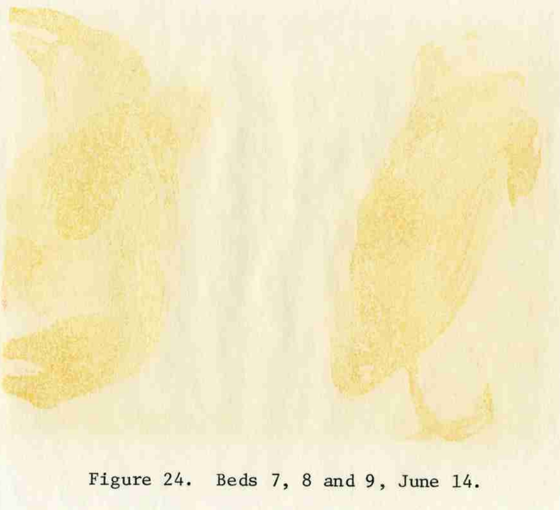

Figure 24. Beds 7, 8 and 9, June 14.

Figure 25. Beds 9, 10 and 11, June 14.

Figure 26. Beds 1, 2, and 3, July 5. Note flowering of DFS, bed 3.

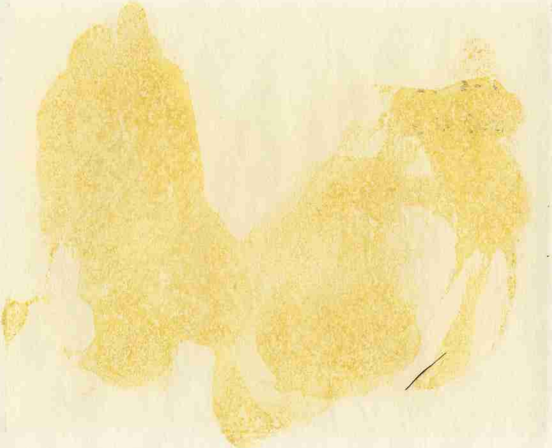

Figure 27. Beds 4, 5, and 6, July 5.

Figure 28. Beds 7, 8, and 9, July 5.

Figure 29. Beds 10 and 11, July 5.


JOHNSON

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2

6 3 1 8 2 4 1 D

3

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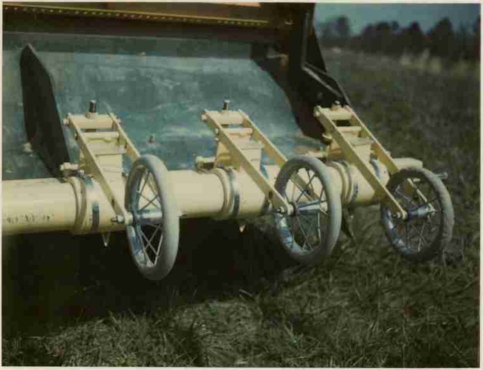

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G 3 1 8 2 4 1 C

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6 3 1 8 2 4 1 D

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7 6

COLOR 2 TYPE 108

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May 22, 1974

C 2 1 8 2 4 1 D

POLACOLOR ® TYPE 108

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May 22, 1974

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4 POLACOLOR ® TYPE 108

14

~~15~~

G 3 1 8 2 4 1 0

6/5/74

15 Transplanting last 2 beds

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POLACOLOR ® TYPE 108

16 6/5/74

Bed 6- Transplanting 4 rows

PY

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4 POLACOLOR ® TYPE 108

P7 6/5/74

Bed 6 - Transplanting operation
4 rows/bed

G 3 1 8 2 4 1 0

1 2 3

2 18

POLACOLOR ® TYPE 108

6/5/74

bed 1 - PY 1st Transplant

bed 2 - 628 1st Transplant

bed 3 - DFS

G31 8241 0

NO POLACOLOR ® TYPE 108

19 6/5/74

bed 3 - DFS

bed 4 - PY

bed 5 - 628

G 3 1 8 2 4 1 C

6 7

20 6/5/74

bed 7 - PY - 2nd Transplant

bed 8 - 628 - "

Note Fresh tilled beds

6, 9 for 3rd Transplanting

21

6/5/74

bed 9 fresh tilled

10 PY - 2nd Transplant.

11 628 - 2nd Transplanting

63182410

22

June 14, 74

Bed No. 1 & 2

A 4 0 9 4 7 1 D

6-14-74

23

Bed No. 3 & 4 & 5

A 4 0 9 4 7 1 D

10

9

7

8

24

6-14-74

Bed No. 8 & 7

A409471 D

0

10 11

POLACOLOR ® TYPE 108

June 14 25

Bed NO. 10 & 11

6318241 D

26

7-5-74

Bed NO. 1, 2, 3

G31.8241 D

6

5

POLACOLOR ® TYPE 108

27

7-5-74

Bed 4,5,6

G 3 1 8 2 4 1 D

10 POLACOLOR ® TYPE 108

28

7-5-74

Bed No. 6, 7, 8, 9

G318241D

12

11

POLACOLOR ® TYPE 108

29

7-5-74

Bed No. 10, 11

G 3 1 8 2 4 1 0