A SUMMARY OF THE
EXPERIMENTS WITH FLUE CURED
TOBACCO 1952-56.

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SUMMARY

The report has been divided into two parts. The first section gives an outline of the experimental work carried out at the College since 1952. This is a complete account, stage by stage, of the methods employed at the College for the production of flue cured tobacco.

Part two contains a description of the experiments attempted this year, by which it was intended to finalise the work on seedbeds and to cost the production of one acre of tobacco.

Due to the failure of the experiments this could not be done. The possible reasons for failure are discussed.
The writer wishes to take this opportunity to thank his supervisor, Mr. J.S. Campbell, most sincerely for his help, so freely given, and the kind consideration shown throughout the year. I also wish to record my appreciation of the efficient manner in which the farm staff have carried out my wishes.
PART I - ACCOUNT OF TOBACCO EXPERIMENTS AT THE
COLLEGE SINCE 1951.

1. INTRODUCTION.

Up to 1951 air cured tobacco had been grown at the College old farm continually since 1923, the leaf being sold locally. In 1951-52 it was decided to investigate the possibility of producing flue cured tobacco in Trinidad. If successful, a considerable saving on tobacco imported for manufacture into cigarettes would be possible.

During the intervening years ten post-graduate students have studied the possibilities of flue cured tobacco in great detail and at the beginning of this year it was felt that most of the problems had been solved. The major part of this report has therefore been devoted to a summary of this work.

Most of the experiments have been carried out on the Market garden area of the New Farm, so that the results are applicable to this soil type. Chenery (1952) defines it as a River Estate loam and a typical soil analysis is included in Appendix 1.

For convenience and clarity the report has been arranged so that problems are discussed in the order in which they occur when tobacco is grown.

2. VARIETIES.

Preliminary work in 1951-52 compared two locally selected varieties with four imported ones: Bonanza, Gold dollar, Delcrest and Yellow Mammoth. Yields of Gold dollar were lower than those of other varieties but when judged on an air-cured sample, Gold dollar and Delcrest gave the better quality. Dunbar in 1952-53 again found Gold dollar to be low yielding, but of good quality, when compared with Bonanza, Kentucky one Sucker, Yellow Mammoth.
and Harrisons Special. Following these trials Gold dollar was selected as the standard variety.

Successively poor results in the ensuing years led to further trials by Orpin in 1956-57, who compared Gold dollar, Dixie Bright, Cokers 139 and Virginia 45. Dixie Bright gave the best yields and higher quality of leaf and was slightly superior to Cokers 139. It had also been grown with success in Tobago and Trinidad and was therefore recommended for use in future experiments at the College.

3. **SEEDBEDS.**

(a) **PREPARATION.**

Seedbed size has been constant at 30 ft. by 4 feet, with paths 2 feet wide between beds. From a practical point of view a width of 3 feet, as recommended by McGregor (1937) and Collins (1955), would make it possible to reach all the bed from one side, but this is not essential.

The beds are formed by throwing soil from the pathways, so raising the bed about 3 inches above ground level. The edges are then lined with split bamboo canes, to retain the soil, and bamboo soil is added to give a final height of 4 to 6 inches.

The term bamboo soil refers to topsoil of high organic matter content, obtained from a nearby plantation. A typical analysis of the soil is given in Appendix 1.

Experiments by Hanger (1955-56) showed that the River Estate loam soil gave better results when it was topped with about 2 inches of this bamboo soil.

(b) **STERILISATION.**

Preliminary experiments in 1951 had shown that loss of seedlings, due to damping off, was likely to occur, so in 1952-53 Wytttenbach carried out detailed experiments on chemical methods of control. A series of box experiments were laid down to determine the suitability of several chemicals. Various rates of

\[\text{Formalin} \ldots\]
Formalin, Shell D.D., Chloropicrin and Cheshunt compound were compared with steam sterilisation.

Complete control up to five weeks was obtained with 80 mls. of a 2 per cent. formalin solution per cu. ft. of soil, saturation with formalin and by fumigation in a closed container for 48 hours with chloropicrin. Smaller amounts of formalin, as well as 4 or 6 mls. D.D. per cu. ft. of soil gave only incomplete control.

Seed could be safely sown after 4 to 6 days in all cases. Formalin, and to a lesser extent steam were found to stimulate plant growth. A point of major interest is that unless stringent precautions were taken seed box re-infection by damping off organisms (Pythium spp.) occurred, and the benefits of sterilisation were lost.

Dunbar, working under field conditions in the same year, also found re-infection occurring. Seedlings could only be saved by pricking out. It was noticed that dense seedling populations and excessive moisture induced damping off and later workers have found optimum seed rates to be much lower than those previously used. As a result of the use of lower seed rates and regular seedbed sterilisation damping off has now been eliminated. When sterilisation cannot be carried out spraying with 1 oz. Perenox in 2 gallons water, per seedbed, at weekly intervals, will give adequate control.

Hand weeding of tobacco seedbeds can be a time-consuming job and it may also retard seedling development. A study of seedbed sterilisation, as a means of controlling weed growth, was therefore undertaken. Seed box experiments carried out by Morkel (1954-55) showed that saturation with 2 per cent. formalin, or treatment with Chloro-Bromo-propane (C.B.P.) will control most weeds. Seed could be safely sown 2 days after C.B.P. and 4 days after formalin treatment.

Unfortunately ...
Unfortunately, these substances do not kill Nut grass (Cyperus rotundus) which is a serious weed of the New Farm. Hanger (1955-56) tested out Methyl bromide, a volatile, poisonous gas, which controlled the growth of all weeds, including Nut grass for at least a month after treatment. The procedure was to form a tent over the seedbed with a polythene cover and seal down the edges with soil. The gas was then allowed to pass from the container along a tube and under the cover. The polythene can be removed after 72 hours and seed successfully sown 48 hours later.

A serious disadvantage in this experiment was that the Methyl Bromide was in a large container and it was impossible to regulate the amount of gas applied to each bed. This year (1957-58) Methyl Bromide has been obtained in 1 lb. canisters, containing sufficient gas to sterilise one seedbed, and there is now no reason why this substance cannot be used on a commercial scale. It was found that Methyl Bromide gave absolute weed control up to one month after application; thus verifying Hanger's findings.

In 1956-57 Thompson tried out a new substance, Vapam, which can be mixed with water at the rate of 2 quarts to 2 gallons, and can be watered onto the bed. With pilot seed box experiments it was found that seed could be safely sown 8 days after treatment. Field experiments did not however confirm this: seed sown at eight days did not germinate. In the current year experiments have been laid down to compare Vapam and Methyl Bromide and to determine how soon after treatment it was possible to sow seed. Due to failure of the seed to germinate the only result obtained was that Vapam is not so efficient as Methyl Bromide because it will not kill Nut grass.
Prior to 1955 it was not thought necessary to use fertilisers as analysis of the bamboo soil suggested that sufficient nutrients were present. In 1955 an arbitrary amount of 1 lb. per seedbed of a 6.10.15 fertiliser was used in an attempt to improve the quality of the seedlings.

The following year, 1955-56, Hanger found that a dressing of 1 lb. per square yard of 4.10.15 fertiliser gave better seedlings than when no fertilisers were used. The rate of germination was however slightly lower on the fertilised beds.

The production of good seedlings is dependent on good soil, a suitable seed rate and the presence of sufficient nutrients; any one of which may be a limiting factor. Hanger therefore undertook to test out various seed and fertiliser rates on beds with and without the bamboo topsoil. The optimum seed rate was found to be 0.7 gms. per seedbed of 120 square feet whilst bamboo soil was the best medium for germination. Under these conditions a 2.5.10 fertiliser mixture at the rate of 9 ozs. per square yard produced the best seedlings. If the fertiliser was raked into the topsoil it was found to be quite safe to sow the seed two days later.

Analysis of leaves from plants in two of the experiments showed that Nitrogen and Potassium were limiting growth. In the field Phosphate was also necessary.

Orpin (1956-57) verified these findings of Hanger. A combination of 0.7 gms. seed per seedbed and 8 ozs. per square yard of a 4.10.15 fertiliser gave excellent seedlings.

When compared with fertiliser requirements in other parts of the world, summarised by Thompson (1956-57, page 7), this dressing is low. It is however the amount of available nutrients that is important, and without a knowledge of the inherent fertility of other soils a legitimate comparison cannot be made.
(d) SEED RATES.

In early experiments the seed rates used were those recommended by other workers and varied from 0.7 to 1.5 gms. per seedbed. Since fertilisers were not applied either, the result was that seedlings were spindly, susceptible to damping off and difficult to establish in the field. Hanger (1955-56) therefore set out to determine the best method of producing seedlings.

Seed rates varying from 0.3 to 1.5 gms. per seedbed were tried out. It was found that with a bamboo topsoil, and the recommended rate of fertiliser, that 0.6 to 0.8 gms. were optimum. When bamboo soil is not available the rate should be increased to 0.9 gms. of seed. The result should be a plant density of 312 plants per square yard so that to plant an acre of tobacco at 3 feet by 2 feet spacing, seedlings from three seedbeds will be required.

Stinson (1953a) and Ogden and Fulton (1953), also found that seed rates above 0.9 gms. per seedbed gave spindly, unsuitable seedlings.

The method of sowing the seed will vary with the aims of the experimenter. In precise experiments, where it is desirable to sow the exact amount of seed on all beds, it is advisable to use a sand or wood ash filler. The seed can then be sown from a small tin which has holes in the lid. On a commercial scale such accuracy is unnecessary and the seed can be mixed with water and applied from a watering can.

(e) COVERS.

Because tobacco seeds are very small, soil conditions must be optimum for germination and early plant development. The most important factors affecting early growth are soil compaction, due to heavy rain, and excessive evaporation drying out the soil. In all tobacco growing areas efforts are therefore made...
made to shield young plants from the full effects of sun and rain.

In accordance with established practices in other parts of the world (Purseglove 1951) shade was first provided by bamboo frames, supported about 5 feet above the bed, and lightly covered with palm leaves. Shading was found to be satisfactory but rain washing through the bamboo leaves caused soil compaction. An improvement used by Greening, was to shade the plants with alternate strips of re-inforced plastic and corrugated iron, which reduced light intensity by half.

Finally, in 1954, at the suggestion of the representative of a Jamaican tobacco firm, an entirely new technique was adopted. Bamboo hoops placed across the bed at 4 feet intervals support a finely woven cloth cover which is held in position by nylon threads, threaded along both edges of the cloth and fastened to pegs in the ground.

Experiments were carried out by Morkel (1954-55) comparing cloths of four different weaves with bamboo leaves and straw. It was proved conclusively that the cloth covers provided better production and the cloth with a 26x28 weave gave the most uniform and vigorous seedlings. Palm leaves proved to be satisfactory in the dry season but with heavy rains soil compaction occurred. The leaves also harboured insect pests. The useful life of the cloth is from 3 to 4 years, providing they have been chemically treated by the manufacturers to prevent bleaching and rotting.

Plants growing under cover develop in an artificial climate, which means that they must be introduced to the full effects of sun and rain very gradually. Hardening off is accomplished by removing the covers for increasing periods of time from the third week of life to planting out time. In practice the length of exposure will depend on the weather and condition of the plant. Following Morkel's recommendations the
time-table should be roughly as follows:

- **0 - 3 weeks** covers on continuously,
- **3 - 4½ weeks** covers removed 3 hours daily,
- **4½ - 6 weeks** covers removed 6 hours daily,
- **after 6 weeks** covers removed completely.

(f) **WATERING.**

Tobacco seedlings will not thrive under waterlogged conditions and the aim in watering should be to maintain the soil in a damp condition. The amount of water required will depend on the rainfall.

Where overhead irrigation is available the covers need not be removed to water. When however watering is by hand the covers must be removed and then replaced immediately. A good guide is to water when the edges of the bed begin to dry out, which in Trinidad in the dry season means at least twice a day.

4. **TRANSPLANTING.**

The primary factors affecting yield of tobacco from a given area of land are the number, size, and uniformity of the plants remaining at harvest. If unsuitable seedlings or incorrect transplanting techniques are used the final stand of plants will not be a good one. Experiments have been carried out to study this aspect of production.

(a) **TYPE OF SEEDLING.**

Hanger (1955-56) compared the stand of plants resulting from the use of rosette and tall, spindly type seedlings, produced by seed rates of 0.7 and 1.2 gms. per bed respectively. The rosette seedlings required fewer supplies but both types gave similar yields of green leaf at harvest. Seed at the rate of 0.7 gms., together with a dressing of compound fertiliser gave the best seedling.

Orpin (1956-57) also obtained similar results.
Morkel (1954-55) found no difference in rates of establishment between planting out before 10.00 a.m. or after 2.00 p.m. Further experience has shown that seedlings planted in the evening do rather better, presumably because of moisture condensation during the night. Watering the beds before removing the seedlings will reduce root damage, but there was no advantage in adding Goodrich latex spray to the water. In the field watering each plant with 1/2 pint of water immediately after planting aided establishment. Addition of Transplantone, (a synthetic hormone) to this water did not improve the rate of establishment.

Where irrigation is available, it is advisable to plant out tobacco at the end of the rainy season and irrigate the crop whenever necessary. Plants are then transplanted into damp soil, the amount of water can be controlled and waterlogging avoided, and the crop will be ready to harvest before the onset of the rains.

(c) SPACING.

In all work at the College tobacco has been planted in rows 3 feet apart with 2 feet between the plants. At the New farm where the fields are in 24 feet cambered beds it has been found that planting rows across, instead of along the beds reduces loss from waterlogging in the wet season. Picking is also made easier because leaves can be piled in the ditches, until they can be removed.

5. FIELD MANAGEMENT.

(a) FERTILISERS.

The use of fertilisers on tobacco plants has two conflicting results. As well as increasing yields the additional nutrients, especially nitrogen, make the texture of the leaf coarser and less suitable for curing. In Trinidad work has been mainly concerned with the effect of fertilisers on yield because leaf quality is very difficult to assess. Many other factors,
such as climate, soil type and system of curing will also affect quality.

Greening (1953-54), working at both Old and New farms compared plots with and without pen manure. He also had treatments of two levels each of Sulphate of Ammonia, Superphosphate and Potassium sulphate. Pen manure did raise yields slightly, but its applications could not be justified economically. There was little difference between dressings equivalent to 50 and 100 lbs. per acre of $P_2O_5$, 60 and 100 lbs. per acre of $K_2O$. 20 lbs. of $N_2$ gave increased yields over a dressing of 10 lbs. per acre. A compound fertiliser consisting of 20 lbs. $N_2$ as Sulphate of Ammonia; 115 lbs. $P_2O_5$ as Double superphosphate and 132 lbs. $K_2O$ as a mixture of Sulphate and Muriate of Potash gave satisfactory growth.

Mackay (1955-56) increased the amount of $N_2$ to 40 lbs. and reduced the Phosphate and potash dressings to 90 and 100 lbs. respectively.

Orpin (1956-57) retained these levels of Phosphate and Potash and compared 20 and 40 lbs. per acre of $N_2$. Although 40 lbs. gave maximum yields the leaves were too fleshy for successful curing and 30 lbs. would appear to be optimum.

Apart from 1954-55 when Mackay split the applications, all fertilisers have been given at one time; placed in circles around the plants 2 to 3 weeks after transplanting. The method is laborious but ensures maximum utilisation of the fertilisers. Split applications did not increase yields and tended to give a coarser leaf.

(b) IRRIGATION AND WEEDING.

Due to the limited time available for student projects it has been the practice to transplant about Christmas and grow the crop in the dry season. Irrigation has always been necessary;
water usually being applied once a week. Overhead sprinklers are used and one inch of water is given at a time.

Weeding is carried out by hand at least twice in the growing season.

(c) PRIMING.

Priming is the removal of all leaves on the plant below 6 to 9 inches to prevent the spread of Frog eye spot (Cercospora nicotiana), and to concentrate the plant's food reserves in the upper leaves. Direct loss in the field from the disease is not great but secondary infection, which gives rise to barn spotting, reduces leaf quality considerably. The spread of spores is facilitated by leaving old leaves on the plant.

Until 1954-55 priming was done every year. Greening found in one experiment that plants primed late were attacked by Cercospora, although in a second experiment unprimed tobacco was untouched.

Corbett (1954-55) tested Perenox (a copper compound) and Zineb (Zinc ethylene) as a means of control. Spraying plants with 14 gms. Perenox per gallon water or with a 0.1 per cent solution of Zineb did not give better control than on hand primed plots.

(d) TOPPING AND SUCKERING.

Removal of flower heads, just before opening, is carried out to prevent accumulated food stores being removed from the leaves, so reducing quality. As this permits axillary bud development the suckers produced must also be removed.

Topping and suckering is a tedious job by hand and in 1954-55 Wallis tested several chemicals to see if they would control sucker growth after the plants had been topped. The substances used were the methyl ester of naphthalene acetric acid, Maleic hydrazide, Risella oil and Citspray, both oil emulsions,
and Amizol 981, a herbicide. Maleic hydrazide was sprayed onto the plants and the other chemicals were pipetted onto the cut surface left after topping. Citspray and Risella oil were found to give the best sucker control along with least leaf scorch and plant distortion.

Mackay (1955-56) again tested these two oils, this time against coconut oil and Maleic hydrazide, and also found them to be the best method of control. Of the two, Citspray was preferred because the white colour of the oil showed whether sufficient oil had been applied.

Orpin 1956-57, testing a range of Citspray concentrations, found that 2.4 ml of a 25 per cent solution gave maximum sucker control with least damage to the plant. Application was with an "oil-rite" topper; a pair of secateurs which apply the appropriate amount of liquid as the plant is topped. By topping Gold dollar at weekly intervals all the plants can be treated at the correct stage of growth, which is when the flowers are beginning to show colour. For other varieties the best time to top will vary slightly.

6. CURING.

In 1951-52 tobacco was air cured but in subsequent years it has been cured in a specially built flue barn. The tobacco is placed on sticks in the barn and cured by the heat from sixteen oil burners, placed on the floor. Ventilators around the barn at ground level and one large one in the roof ensure complete control of the humidity inside the barn.

Briefly, the procedure in curing is as follows. Maximum humidity and a temperature of 90°F. are maintained until the leaves begin to go yellow at the edges. By raising the temperature gradually to 115°F. a uniform yellow colour is obtained. Fixation of the colour, which is the next step, is then ...
then achieved by keeping the temperature at 120°F. and reducing the humidity. As the leaf dries the temperature is then raised to 140°F, and maintained there until the lamina is completely dry. Finally, the mid rib must be dried by opening the ventilators fully and bringing the temperature to 160°F. The time taken to carry out a cure depends upon the rate at which these changes occur.

Cures in the first year were unsuccessful because of the lack of experience of the curing process. From his experiences Greening recommended that the barn should be completely filled in one day and handling and bruising of the leaf should be reduced to a minimum. Otherwise ripening will be uneven and poor quality tobacco will be produced. In one cure Greening found/exposing the leaves to acetylene for 36 hours before curing, as recommended by Purseglove (1951), also gave an evenly cured leaf.

In 1954-55 Wallis also modified the cure by starting it at 100°F. (Stinson, 1953b). Cercospora spores do not germinate below this temperature and so cannot damage the leaf. Mackay (1955-56) obtained better cures than in previous years but sponging of some of the leaves did occur, due to dry leaves reabsorbing moisture. This was prevented by Orpin (1956-57), who reduced the moisture content of the barn in the later stages of yellowing, and all cures were successful.

In conclusion it can be said that well cured tobacco should be produced at the College, if the modified procedure outlined above is strictly adhered to.

7. PESTS AND DISEASES.

(a) OF SEEDBEDS.

Damping off disease (Pythium spp.) was prevalent in all early experiments, but has now been controlled by regular seedbed sterilisation. Bachac ants and mole crickets have caused some damage to seedlings and can be controlled with D.D.T.. Aldrin ...
Aldrin is not advised on young tobacco plants.

(b) IN THE FIELD.

Cercospora nicotiana, which results in direct losses, due to leaf damage, and causes barn spotting, has been the most serious disease in the field. Corbett (1954-55) found that Copper or Zinc sprays would give control, but were not economical.

Root knot eelworm (Heterodera marioni) is present at the New farm, but so far no method of control has been attempted. Plants must be provided with optimum growing conditions in order to reduce losses to a minimum.

Black shank (Phytophthora parasitica var. nicotiana) and Tobacco mosaic have occurred from time to time and infected plants have been removed and destroyed.

Damage by insect pests has been quite insignificant. The most persistent pests have been the tobacco flea beetle (Epitrix parvula), tobacco hornworm (Protoparce secta) and mole crickets (Scrapeteriscus vicinus Scudd.). Flea beetle can be controlled by dusting with D.D.T., hornworm by dusting with lead arsenate and mole crickets with 1 gallon per acre of 5 per cent aldrin solution.

8. ECONOMICS OF PRODUCTION.

During the years 1954-55 and 1955-56 detailed costings were kept of the production of 1 acre of tobacco. The cost of production was found to be between $500 and $550 per acre which could be covered by a yield of 800 lbs. cured tobacco sold at 75c per lb. In these two years yields did not reach this high level and the losses were $556 and $710. The heavy loss incurred in 1954-55 was due to the fact that only 60 lbs. of the estimated 700 lb. yield were saleable.

With the improved methods of production, already outlined it might be possible to increase yields, but it is extremely doubtful...
doubtful whether the profit under Trinidad conditions would be sufficient to justify commercial tobacco production.

This year (1957-58), it had been hoped to cost an acre of tobacco, using the improved methods of production already evolved. Unfortunately this has not been possible, due to failure of the seed to germinate.

Every experiment has been a failure, which is most disappointing, and at the time of writing attempts are still being made to determine the reason.

EXPERIMENT A. PRELIMINARY INVESTIGATIONS WITH VAPAM.

AIMS OF THE EXPERIMENT.

To determine the efficiency of Vapam as a soil sterilant for seedbeds.

To decide how soon seed can be safely sown after treatment.

The seedbeds were situated on Field 16 of the Old Farm. Previous cropping of the area is included in Appendix I.

DESIGN:

A randomized block with split plots replicated four times.

TREATMENTS:

Main plot: A. 1 quart Vapam/2 galls. water per 150 sq. ft.  
B. 1 pint Vapam/2 galls. water per 150 sq. ft.

Sub-plot:  
(a) Control. No Vapam treatment.  
(b) Vapam applied 4 days before seed sown.  
(c) Vapam applied 9 days before seed sown.  
(d) Vapam applied 14 days before seed sown.  
(e) Vapam applied 21 days before seed sown.
PART II - EXPERIMENTAL WORK.

INTRODUCTION.

In all experiments the methods and techniques evolved during the past six years have been strictly adhered to. Details of practical procedure have therefore only been given when it differs from the methods outlined in the first part of the report.

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Sub-plot.  
(a) Control. No Vapam treatment. 
(b) Vapam applied 4 days before seed sown. 
(c) Vapam applied 9 days before seed sown. 
(d) Vapam applied 14 days before seed sown. 
(e) Vapam applied 19 days before seed sown. 

/ Each ...
Each main plot occupied one full seedbed and a total of 8 beds were used. Each bed was divided by wires into 5 sub-plots. A plan of the layout is included in Appendix 1. The area of each sub-plot was 5 ft. 9 ins. by 3 ft. 9 ins., which allowed a discard of 6 ins. at the side of each plot and 12 ins. between plots.

It was decided to sow seed on all sub-plots at the same time and Vapam was applied the requisite number of days previously. By this means all tobacco was growing at the same time and differences due to climatic effects were avoided.

**PRACTICAL PROCEDURE.**

Eight seedbeds were made up on the 25th of October and the first Vapam treatment was applied on the 28th; nineteen days before the seed was sown. The sub-plots were first watered lightly to dampen the soil, then the Vapam was watered evenly over the plots. The soil surface was then sealed with a further 4 gallons of water per plot. The appropriate sub-plots were treated in exactly the same way at 5 day intervals. On beds which had been undisturbed for several days it was necessary to loosen the soil with a rake and pull out the larger weeds.

Fertiliser was applied to the beds 4 days before the seed was sown, at the rate of:

- 3 ozs. Sulphate of Ammonia
- 3 ozs. Triple superphosphate
- 4 ozs. Sulphate of Potash

At the same time soil on the control plots was replaced because the weeds had become too dense for the seed to be sown. It was already apparent that compared with the control plots Vapam was preventing weed growth.

Gold dollar seed of 84 per cent germination was sown at the rate of 0.5 gms. per sub-plot (0.75 gms. per seedbed). The 

$\frac{1}{2}$ seed ...
seed was mixed with a small amount of sand and broadcast, using a small tin with holes in the lid. Immediately afterwards the cloth covers were placed over the beds.

Watering by hand was carried out whenever there was insufficient rain to keep the soil moist.

After 7 days seedlings were visible on some of the beds.

On December 3rd, 17 days after the seed was sown a plant count was done to determine the numbers of tobacco and weed seedlings present. It was impossible to count the whole sub-plot and 1/10th of the area was taken as a sample. A quadrant 9 ins. by 5 ins. was constructed and plant counts were done at four predetermined places within the plot.

The germination over the whole experiment was very uneven and bore no relation to the treatments. There was complete failure on two of the beds and they had to be discarded immediately.

By December 18th, it was apparent that the numbers of plants on all but two of the seedbeds were insufficient for the experiment to be continued. As a matter of interest a second plant count was carried out, but the results have no meaning.

RESULTS.

At both treatment levels Vapam controlled all weeds except Bahama grass (Cynodon dactylon) and Nut grass (Cyperus rotundus).

Where there was several days delay in treating prepared beds, it was necessary to weed before applying the Vapam.

The plant counts were insignificant because insufficient seed germinated.
INVESTIGATION OF THE FAILURE.

The following possible causes of failure were investigated:

(a) SEED.

Germination in the laboratory was 84 per cent.

The variety could not have been the cause as Dixie bright seed (Experiment 2) also failed to germinate.

(b) VAPAM TREATMENT.

The control plots also failed.

(c) FERTILISERS.

It was possible that too much fertiliser had been used, resulting in too strong a concentration of soluble ions in the soil. However, Dixie bright seed was used to re-sow several seedbeds in experiment 2 without success. This was fifteen days after the fertilisers had been applied, during which time a considerable amount of rain had fallen. It was concluded that the amount of fertiliser could not have been the cause of failure.

(d) SOIL.

A test for acidity showed a pH of 5.5 which Garner (1951) considers quite suitable for tobacco. To verify this, two seed boxes were made up with the same type of bamboo soil and to one was added a small amount of lime. Dixie bright seed was found to germinate in 8 days and there was no difference between the two boxes.

Having exhausted all the plausible reasons for failure it had to be concluded that soil conditions had not been suitable for germination, due to heavy rainfall. It was realised that this was not an absolutely satisfactory conclusion.
EXPERIMENT 2. TO GROW AND COST ONE ACRE OF TOBACCO.

Five seedbeds were made up on the 25th. of October and treated with Vapam three days later. Fertilisers were applied on the 11th of November and 0.7 gms. of Dixie bright seed (80% germination) was sown on the 16th by watering on from a watering can.

Following absolute failure of the seed to germinate the beds were re-sown on the 27th of November, again without success.

Five new seedbeds were laid down adjacent to the old ones and no fertilisers were applied. Although the seed did germinate it died off, in spite of top dressings with very dilute solutions of Potassium nitrate and Ammonium phosphate.

In an attempt to obtain some idea of the cost of production of tobacco, it was decided to salvage some of the Gold dollar seedlings from experiment 1, and plant them out.

Transplanting began on the 6th of January and was completed on the following day. There were sufficient seedlings for just over ½ of an acre. Immediately after planting out, 1 pint of water, containing aldrin, was given to each plant to prevent damage by Bachac ants (Atta cephalotes). Because of the dry weather, watering at weekly intervals was necessary.

The field was supplied on the 21st of January, 9.4 per cent of the plants having died. Four days later fertilisers were applied in a ring around the plants at the rate of 1 oz. per plant. This is equivalent to -

\[
\begin{align*}
30 \text{ lbs. N}_2 \\
90 \text{ lbs. P}_2\text{O}_5 \\
100 \text{ lbs. K}_2\text{O}
\end{align*}
\]

per acre.

On February 7th, it was decided to surface irrigate the tobacco; all plants being quite healthy and well established.

/ The
The results were however disastrous. Too much water was applied and stood in low places on the field. Subsequently, 75 per cent of the plants died or made very poor growth and yet another experiment had to be abandoned.

EXPERIMENT 3 - TO COMPARE METHYL BROMIDE AND VAPAM AS SEEDBED STERILANTS.

On a trial bed at Old farm Methyl bromide was applied, using the polythene cover method, in order to try out the method of application. The trial was successful and complete control of Bahama and Nut grass was obtained. No tobacco was sown on this bed.

AIMS OF THE EXPERIMENT.

(a) To determine whether Methyl bromide will control weeds better than Vapam.

(b) To find out how soon after treatment seed can be safely sown.

SITE.

The market garden area of the New farm, the soil of which is defined by Chenery as a River estate loam. A typical analysis is included in Appendix 1.

DESIGN AND LAYOUT.

A randomised block with split plots, replicated three times. Since this experiment was also a failure, and the layout was basically the same as in Experiment 1, a plan has not been included.

TREATMENTS.

Main plot. (a) 1 quart Vapam per 120 ft. of seedbed.

(b) 1 lb. Methyl Bromide per 120 ft. of seedbed.

(c) Control. No treatment.

Sub-plot ...
Sub-plot. (a) Seed sown 5 days after treatment.
(b) Seed sown 10 days after treatment.
(c) Seed sown 15 days after treatment.

REPLICATION.

Each replicate was started 5 days after the previous one, in order to allow any variances due to climatic effects to be removed in the Analysis of Variance.

PRACTICAL PROCEDURE.

Commencing on January 3rd. three seedbeds were made up and fertilisers applied at 5 day intervals until January 18th.

The rate of fertilisers was:

3 ozs. Sulphate of Ammonia
3 ozs. Triple Superphosphate
4 ozs. Sulphate of Potash

per seedbed.

Five days after the seedbeds were made up the main plot treatments were applied, as described in the main section of the report. The sub-plots were then sown with 0.25 gms. of Dixie Bright of 55 per cent germination at 5 day intervals.

RESULTS.

Once again the seed failed to germinate. This result showed that the previous failure could not have been due to conditions at the Old farm. The reason could have been either poor seed, or the use of excessive fertiliser rates.

Therefore on February 13th, a new trial was carried out simply to see if tobacco could be grown.

Three seedbeds were made up as before and the following treatments were applied:

Main plot: 1. Full fertiliser rate.
2. Half fertiliser rate.
3. Control. No fertiliser.

Sub-plot ...
Sub-plot: (a) Dixie bright seed. 
(b) Gold dollar seed.

<table>
<thead>
<tr>
<th>Fertilisers</th>
<th>Full rate</th>
<th>Half rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate of Ammonia</td>
<td>28 ozs.</td>
<td>14 ozs.</td>
</tr>
<tr>
<td>Triple Superphosphate</td>
<td>28 ozs.</td>
<td>14 ozs.</td>
</tr>
<tr>
<td>Sulphate of Potash</td>
<td>52 ozs.</td>
<td>26 ozs.</td>
</tr>
</tbody>
</table>

The seed was sown on January 19th, allowance being made for the differing rates of germination. Aldrin was added when the seed was watered onto the beds, because of the presence of ants. Within 8 days seedlings were visible on the control and half fertiliser rate beds, and appeared on the other bed 2 days later. One week later it was apparent that the stand of Dixie Bright was poor on all beds. The full rate of fertiliser appeared to have had an adverse effect on the germination of both varieties. The stand of Gold dollar on the control and half rate plots was good.

On the strength of these encouraging results a further detailed experiment was undertaken.

**CONCLUSION**

One month after sowing there was an even stand of seedlings on the half rate plot. The seedlings were better, but fewer, on the full rate plot. The germination of Dixie Bright was poor on all beds.
REPEAT OF EXPERIMENT 3. TO COMPARE METHYL BROMIDE AND VAPAM AS SEEDBED STERILANTS.

The layout and treatments were exactly the same as in Experiment 3. All the main treatments were however applied to all the beds at the same time. The fertilisers applied were the same as the half rate in the previous trial.

The results were also a repetition of Experiment 3, because the Dixie Bright seed did not germinate.

Of the treatments, it can be said that Methyl Bromide controlled weeds completely on two out of three beds for one month. On the third bed a few shoots of Nut grass were visible.

Vapam controlled all the weeds except Nut grass for a similar length of time.

CONCLUSIONS

The experiments this year have been a complete failure, and at the time of writing the reason has not been determined. The only conclusion that can therefore be arrived at is that Methyl Bromide is a more effective soil sterilant for tobacco seedbeds than Vapam.
A survey of the experiments has revealed that the only successful seedbeds were those where the seed was watered onto the bed and aldrin was added to the water (Page 23). It was therefore decided to determine whether aldrin had in some way affected these results.

On April 10th one seedbed was made up and fertilisers were added at the normal rate, in the usual manner. The bed was then divided into two and the seed watered onto each half. Gold dollar seed was used and aldrin was added to one lot of water, but not to the other. As ants were present on and around the bed they had to be eliminated by watering the paths with a strong solution of aldrin.

RESULTS.

After 2½ weeks there was an even stand of plants on the aldrin treated area whilst on the other there were only about 2 dozen plants.

It was also noticeable that nut grass was very prominent on the aldrin treated area whilst there were few weeds on the second half. This is very surprising because apart from the use of aldrin the two areas had been identically treated. No seed bed sterilisation was carried out.

DISCUSSION.

It would appear that the aldrin was responsible for these results, but it is not known how, or why. Following the treatment of the paths, ants did not go onto the beds, to the knowledge of the writer. It is also highly improbable that ants removed every single seed from the 18 seed beds in Experiment 3.
There would therefore seem to be some unknown factor at work.

Of all the previous experimenters only Wallis (1955) did not use aldrin, but he did not encounter any difficulties. For future workers it is therefore possible only to emphasise this apparent connection between the use of aldrin and success, in order that their experiments will not meet with the same fate as the current ones.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Market garden wall</td>
<td>2.50</td>
<td>3.2</td>
<td>4.5</td>
<td>6.11</td>
<td>8.9</td>
<td>18</td>
</tr>
<tr>
<td>Beach wall</td>
<td>5.67</td>
<td>3.0</td>
<td>4.4</td>
<td>6.04</td>
<td>11.6</td>
<td>19.7</td>
</tr>
</tbody>
</table>

Crop grown up field 12, 12a 1956:

- 1956: Egg plant,
- 1957: Broccoli, Spinach, Lettuce.
### Appendix I.

**Analysis of Typical Soil Samples.**

<table>
<thead>
<tr>
<th>Soil type</th>
<th>C. M. F.</th>
<th>I.T.</th>
<th>pH</th>
<th>O.M. %</th>
<th>Total N %</th>
<th>Ratio C/N</th>
<th>K$_2$O p.p.m.</th>
<th>P$_2$O$_5$ p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market garden soil</td>
<td>2 50</td>
<td>22</td>
<td>5.3</td>
<td>1.6</td>
<td>0.11</td>
<td>8.3</td>
<td>82</td>
<td>44</td>
</tr>
<tr>
<td>Bamboo soil</td>
<td>3 57</td>
<td>32</td>
<td>4.8</td>
<td>4.4</td>
<td>0.23</td>
<td>11.3</td>
<td>197</td>
<td>97</td>
</tr>
</tbody>
</table>

*Crops grown on Field 16, Old farm.*

- **1956:** Egg plant.
- **1957:** Bodi beans.

Lettuce.
**EXPERIMENT 1.**

**PLAN OF LAYOUT.**

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 C 9 4 19</td>
<td>C 19 14 4 9</td>
<td>4 9 14 19 C</td>
<td>C 4 9 14 19</td>
</tr>
<tr>
<td>Full rate</td>
<td>Half rate</td>
<td>Full rate</td>
<td>Half rate</td>
</tr>
</tbody>
</table>

Full rate: 1 quart Vapam/seedbed.

Half rate: 1 pint Vapam/seedbed.

C  Control. No Vapam.

4  Vapam 4 days before seed sown.

9  Vapam 9 days before seed sown.

14 Vapam 14 days before seed sown.

19 Vapam 19 days before seed sown.
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