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PRELIMINARY INVESTIGATION INTO THE SOLAR DRYING OF GREEN BANANAS

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ABSTRACT

This preliminary presentation looks into the utilization of plastic solar box collectors for drying green bananas which would then be milled into a flour for storage. Because of the conditions under which this study was done the results show an injustice to what would be found in an actual tropical setting.

It is also shown that better results would be gotten out of a solar box of a trapezoidal shape. However, there is the need for further studies for more concrete deductions.

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INTRODUCTION

Banana drying has been around a long time and is all part of the cultural tradition of many developing and/or undeveloped rural areas of tropical and some subtropical countries or regions.

This traditional method which is that used also for most other crops is the open air method where the fruit is simply left out in the open during the day to be sundried.

This method however, apart from having the great disadvantage of being exposed to the elements i.e. rain, dust, animals and insects, could be more efficiently carried out by very simple and locally made solar boxes.

Stated very simply, the solar box method is one of utilizing, in a very efficient manner, radiation energy from the sun. This is done by making use of a closed box painted inside with a selective coating and covered over with a plastic transparent material. This set up will act as a trap for the incoming radiation thus increasing the temperature of the box which eventually can be used for the drying process.

It is also well established that south facing collectors are much more exposed to direct sunlight than when placed flat; so that everything else being equal, such a collector would be more efficient. This would thus lead to a reduction in the drying time. There will thus be a better preservation of flavour and will also be a plus factor in time maximization in an agro-industrial setting.

SCOPE OF THE INVESTIGATION

Basically the investigation sets out to examine the following:

(1) The use of plastic solar collectors in the banana drying process,

(2) The most efficient method of utilizing the collector,

(3) The most efficient method of preparing the banana for drying.

Being a crop that is grown extensively in the tropics, the countries of which are in the main considered as developing and the remainder undeveloped, the study has as its main aim the following:

(a) A very cheap and easy method of set up,

(b) The utilization of intensive labour that will be cheap.

APPARATUS AND PROCEDURE

SOLAR BOX

Two boxes with similar dimensions were constructed (see appendix). Box A consists of a removable plywood piece which is painted on both sides and contains the stainless steel pins which stick out through soft wire gauze which is laid on the plywood so as to prevent direct contact with the bananas. Box B consists of a wire gauze stand as shown.

BANANA PREPARATION

For the drying process the fruit was simply peeled off its skin and either given one longitudinal slice down its middle or cut across into thin slices approximately three to four millimetres thick. The longitudinally cut banana could then either be stuck onto the pins in the solar box or laid flat for drying. The sliced fruit, on the other hand, was spread evenly one layer thick on the wire gauze stand in the box which was then placed on the ground at a very small angle of inclination, say 10°.

MEASUREMENT OF DRYING PARAMETERS

After plaicng in the sun regular data were taken of the following:

(a) weight of box with drying fruit,

(b) wet and dry bulb temperature,

(c) outlet temperature of solar box.

NATURAL MOISTURE CONTENT MEASUREMENT

For this the fresh banana was peeled and sliced and then put into an ordinary kitchen oven set to 230°F. The bone dry product was then weighted and the moisture loss expressed as a percentage of the wet or total weight. The theoretical formula used here was:

$$\text{moisture content} = \frac{100 \times \text{weight of moisture}}{\text{wt. of moisture} + \text{wt. of dry}}$$

$$\text{or} \qquad \frac{100 \times \text{wt. moisture}}{\text{wt. total}} \ \%$$

For all the tests done it was observed that this was seventy five per cent on an average.

RESULTS OF OPEN AIR DRYING OF BANANAS

Date: 18 September 1981

Weather: 0.0 chance of rain
clear sky
barometer at 7:00 am was 30.22

Time	9 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
Weight (g)	1360	1262	1165	1078	999	938	891	854	835
M.C. Loss (g)	0	98	97	87	79	61	47	37	19
M.C. (Wet) (%)	75	73.1	70.3	68.5	66	63.8	61.8	60.2	59.3
Dry Bulb (°F)	69	83	85	88	87	87	86	83	83
R.H. (%)	90	68	65	55	60	60	60	64	68
Insolation Btu/hr/ft^2	55	175	260	275	270	225	175	100	40

Remark: Here the bananas are longitudinally sliced by one cut down the middle.

RESULTS OF SOLAR BOX DRYING OF BANANAS

Date: 22 October 1981 Weather: Cloudy and windy

Time	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm
Weight (g)	1674	1670	1647	1582	1499	1406	1346	1297
M.C. Loss (g)	0	4	23	65	83	93	60	49
M.C. (Wet) (%)	75	75	74.6	73.6	72.1	70.2	68.9	67.8
Dry Bulb (°F)	72	76	81	85	85	85	86	83
R.H. (%)	77	78	65	60	60	55	60	52
Outlet Temp. (°F)	71	80	89	98	109	106	102	96
Insolation Btu/hr/ft^2	45	130	270	240	270	70	80	90

Remark: (1) The insolation values taken were those when the sun came from under a cloud.

(2) Here also the box was tested by placing in the horizontal position.

(3) Bananas were cut longitudinally down the middle here.

RESULTS OF SOLAR BOX FACING SUN - BANANA WITH ONE LONGITUDINAL SLICE

Date: 12 and 13 November 1981

Weather: 12 November - space shuttle launch - fine day

13 November - fine also, though cold

Time	12 Nov 11 am	13 Nov 9 am	13 Nov 11 am	13 Nov 2 pm
Weight (g)	1786	1324	1228	924
M.C. Loss (g)	0	462	96	304
M.C. (Wet) (%)	75	66.3	63.7	51.7

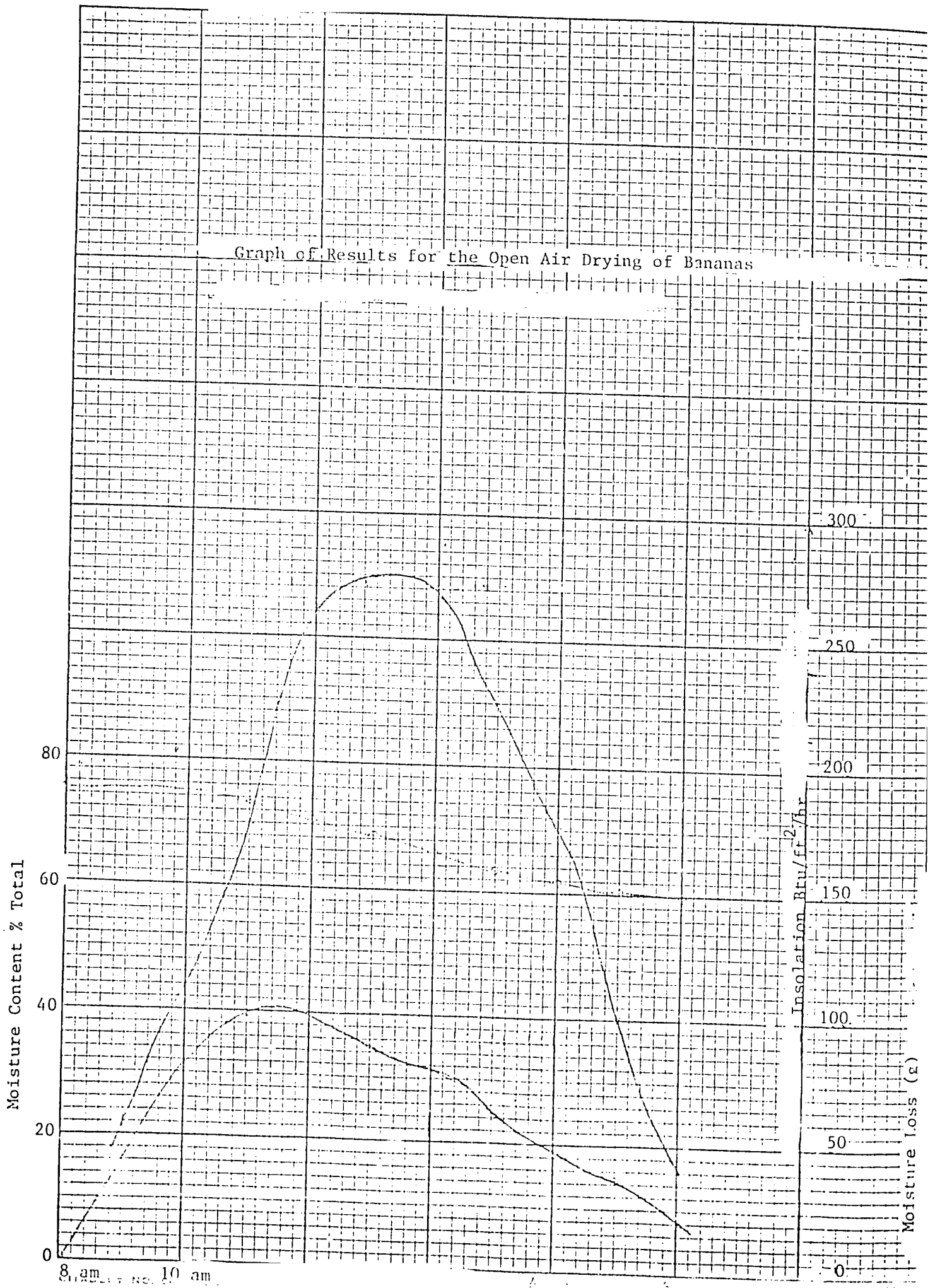
RESULTS OF SOLAR BOX HORIZONTAL - BANANAS CUT INTO THIN SLICES - APPROX 3 mm. THICK

Date: 12 and 13 November 1981

Time	12 Nov 11 am	13 Nov 9 am	13 Nov 11 am	13 Nov 2 pm
Weight (g)	1492	1185	1082	797
M.C. Loss (g)	0	307	103	285
M.C. (Wet) (%)	75	68.5	65.5	53.2
Insolation Btu/hr/ft^2	210	141	227	160

Results: Water condensed on plastic.

Graph of Results for the Open Air Drying of Bananas



DISCUSSION AND CONCLUSION

Firstly, it can be noticed quite clearly that much further work will have to be carried out in order to paint a much better picture of the banana drying process. However, from the amount of information gathered, though minimal, concludes most significantly that at this time of year the high humidity and low and infrequent levels of insolation in Gainesville's environment was not adequate for the methodology adopted. Such would not be the case in a tropical environment, which on the average, would witness at least seven hours of bright sunshine per day.

The results of the open air drying showed a faster moisture loss than the solar box drying placed horizontally. However, this was due to the fact that (a) the plastic covering was too close to the fruit thus causing condensation and thus the retardation of expulsion of moisture, (b) though the solar box temperature increased by as much as 20°F, air flow control was very poor and this was further amplified by very frequent dips of the sun as can be seen by the insolation print out. It was realized also that the whole arrangement left very little of the selective surface exposed to the sun's rays.

A close study of the comparative tests involving the solar box with bananas facing the sun and that lying horizontally it can be seen that when put to face the sun there is a greater moisture loss with time. Also, there was no condensation on the plastic of the box facing the sun whereas a high percentage of moisture remained on the plastic of the box placed flat for the greater portion of the morning.

However such a method of placing the solar box with pins to face the sun would not easily be taken up by the individual rural farmer or house-

holder.

Arising out of the above discussion it can be clearly seen therefore that a solar box of a trapezoidal design would be of much greater effect than the rectangular boxes used in this experiment. A still more effective design would be the cabinet drier set up where the collector is separate from the fruit containers. From the tests however, the protection aspect of the collector stood out as the fruit could be left out for long weekends to the elements with no apparent damage.

Finally, it could be concluded that if the final product which is the flour, is to be marketed, it would be of very great advantage to have everything from the peeling to the milling process to be carried out under controlled conditions in an agro-industrial set up.

FUTURE WORK PROPOSAL

Any future work on the solar drying of green bananas should involve the following:

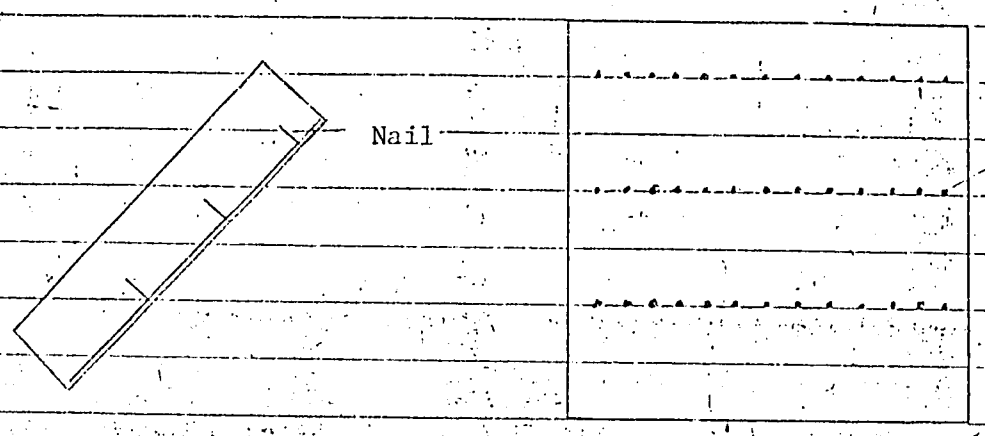
(1) Utilization of a trapezoidal box design or simple cabinet set up. In the trapezoidal box design the plastic covering would be sloping towards the sun. This is expected to lead to much better convection currents and thus less condensing of water on the plastic.

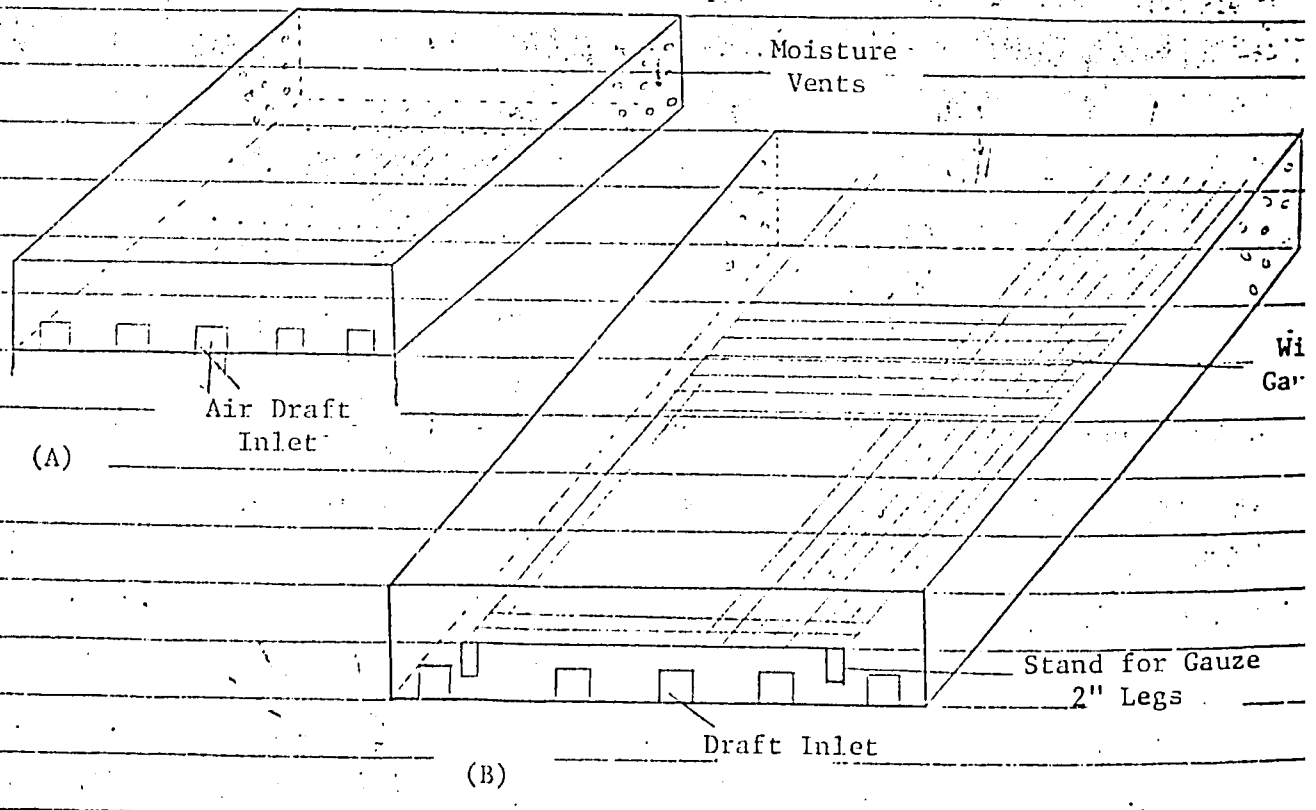
(2) A more in depth study of air flow. This can be achieved by variations of adjustments in the sizes of the inlet and outlet ports. Much better air currents perhaps could also be achieved by placing holes in the bottom of the box.

(3) Studies into the finding of the maximum drying temperature to be achieved that will not damage the quality of the dried product.

Best Available Document

APPENDIX





Collector Sketches

see above

SPECIFICATIONS

(1) Two (2) boxes to be constructed:
   (a) one with nails
   (b) one without nails but to make use of wire gauze stand.

(2) Box dimensions: 2' X 2' X 10" plywood

(3) Nails - to project approx. 3/4 to 1"

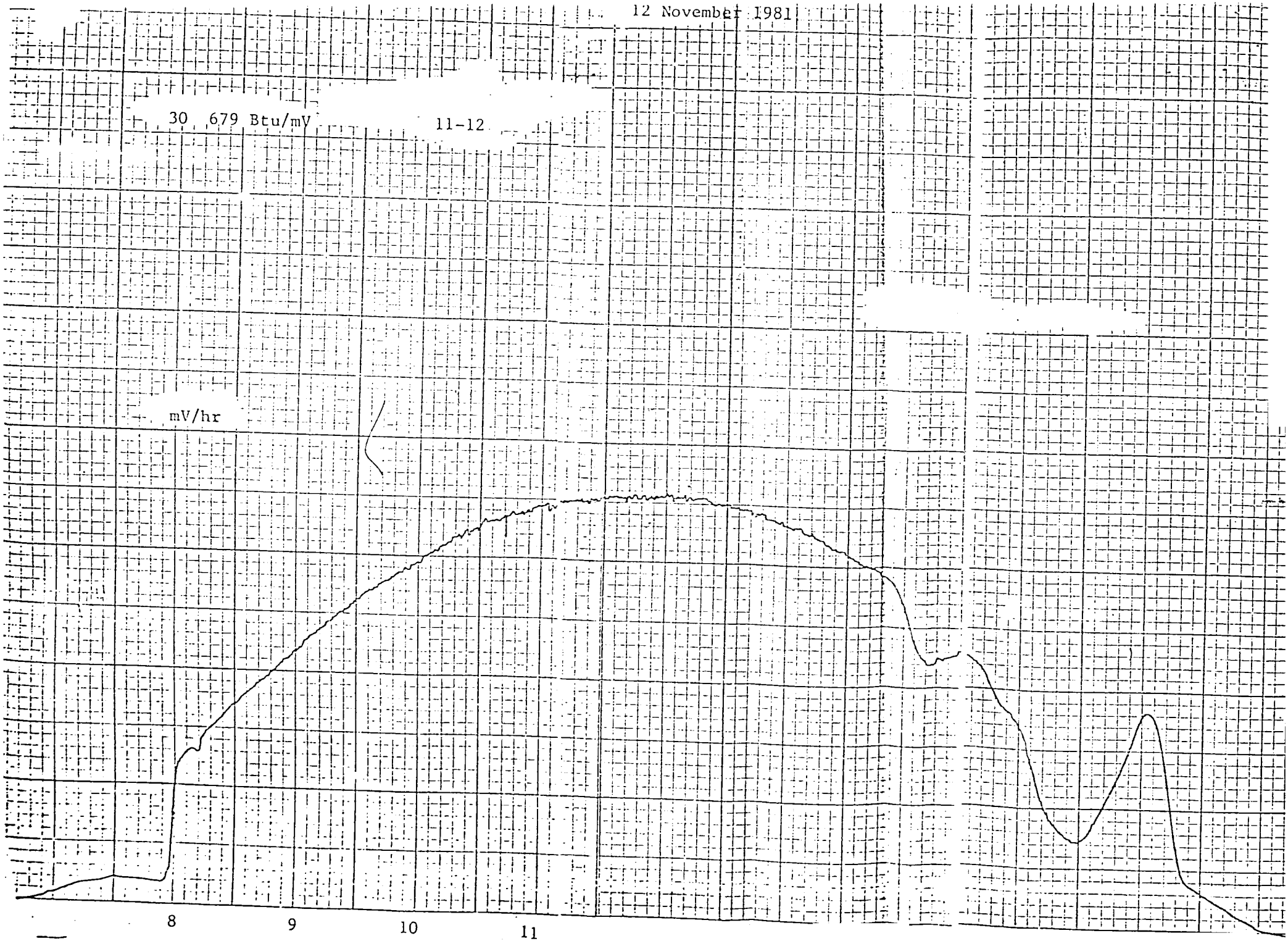
(4) Plastic covering - to be arranged so that easy reach could be made at the drying specimens.

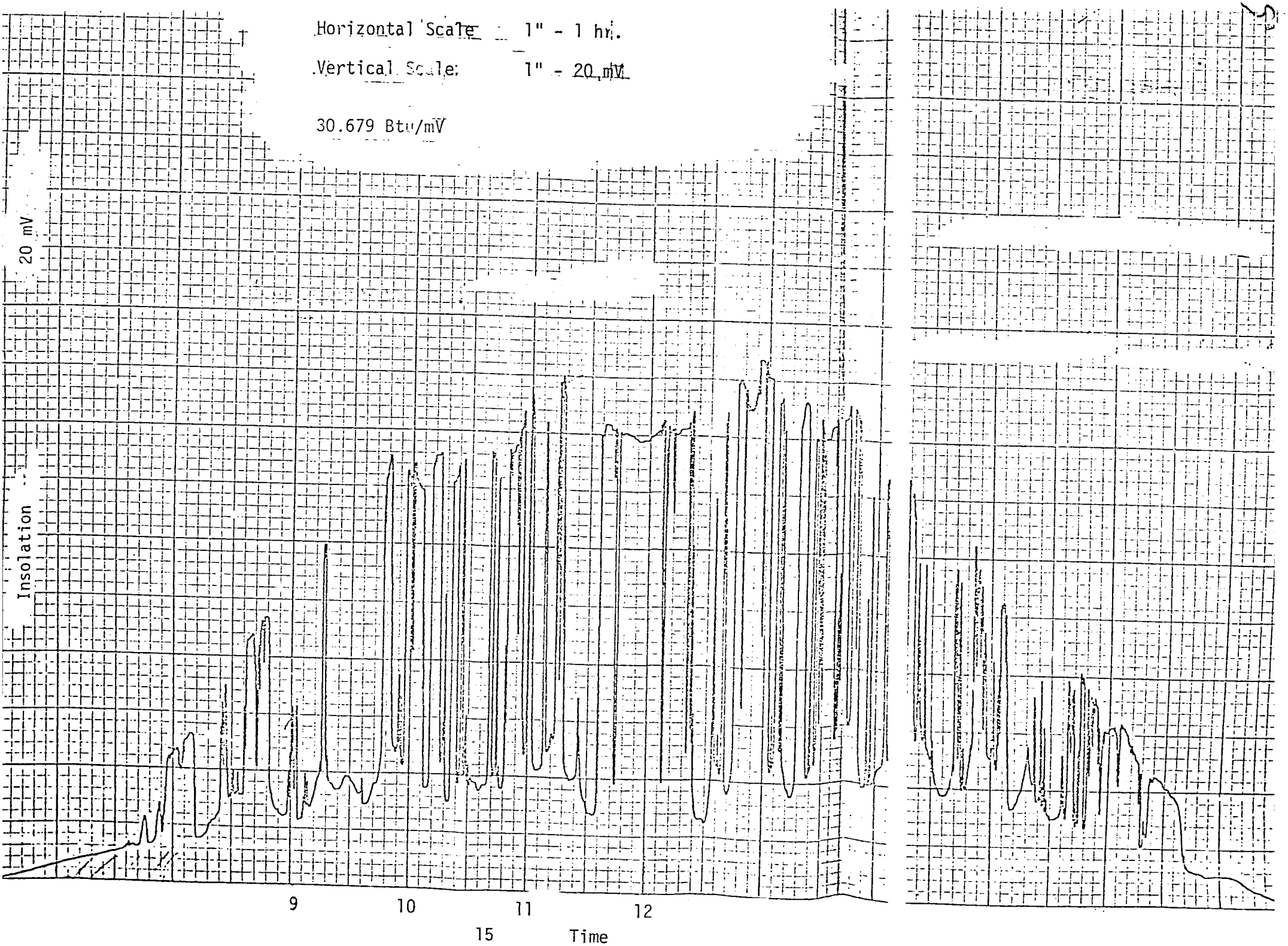
(5) Interior of box painted black.

(6) Nail spacings: vertically 7" centers
   horizontally 2" centers

(7) Nail type: the nails must be of a quality that will not discolor the bananas.

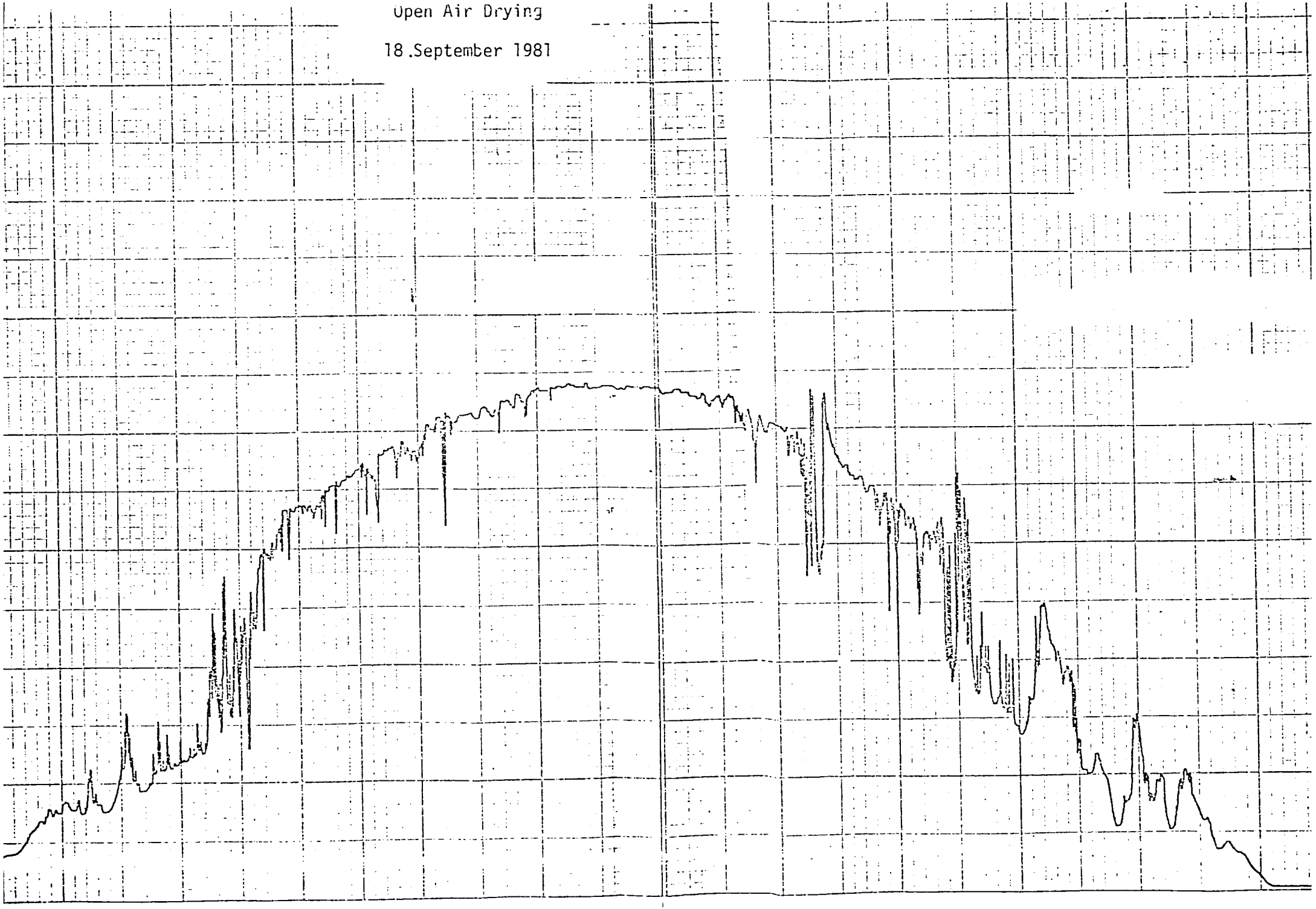
(8) Plastic cover to fit very snugly on the box.

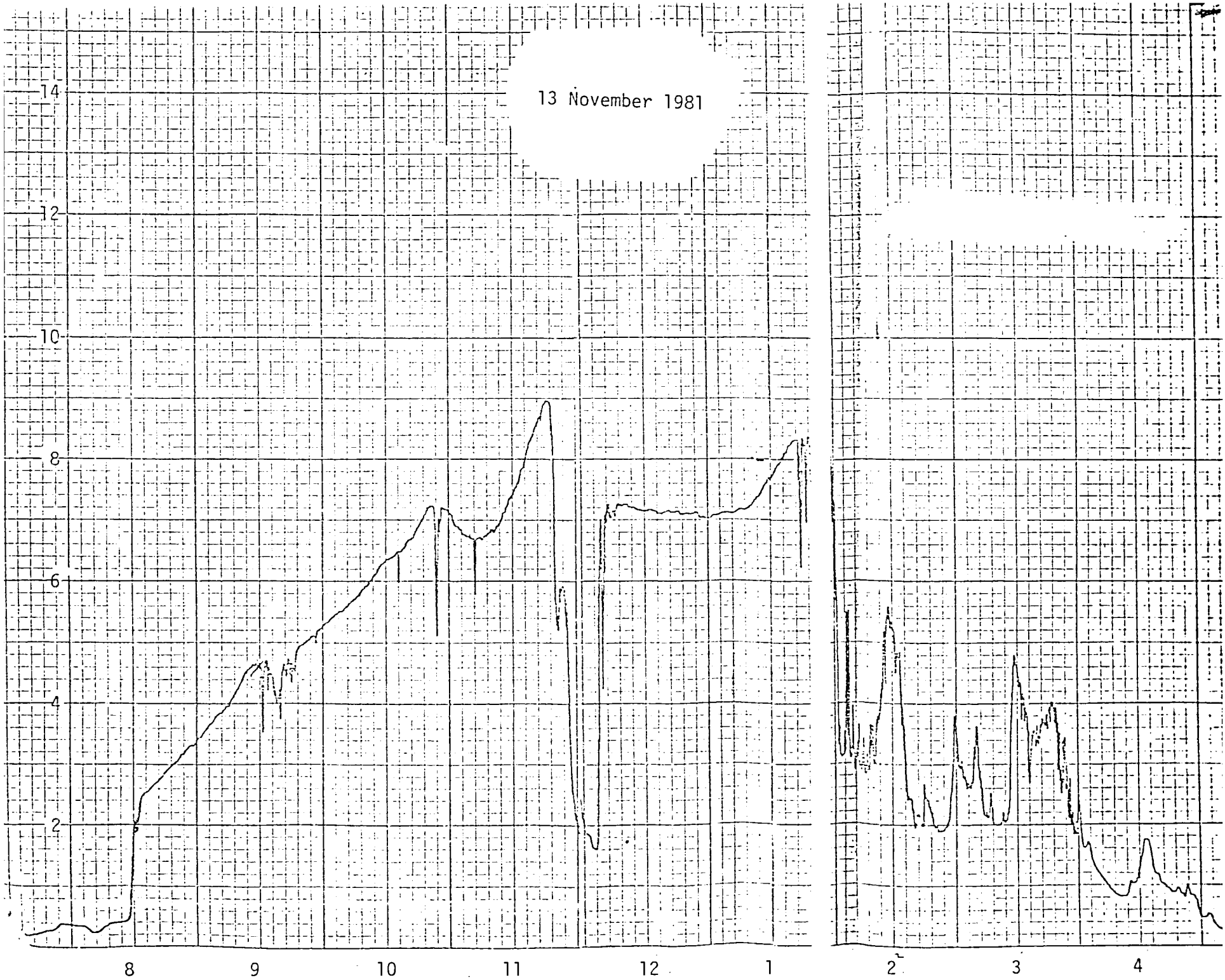

12 November 1981
30 679 Btu/mV
11-12
mV/hr
8
9
10
11


Horizontal Scale 1" - 1 hr.
Vertical Scale: 1" - 20 mV
30.679 Btu/mV
20 mV
Insolation
9
10
11
12
15
Time

Open Air Drying

18 September 1981




13 November 1981
14
12
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