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MARKETING No. 1

A METHODOLOGY FOR THE EVALUATION
OF POST-HARVEST LOSSES
THE CASE OF BLACK-EYE PEAS

GEORGETOWN, OCTOBER 25, 1977
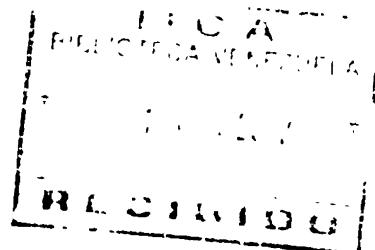
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INTER – AMERICAN INSTITUTE OF AGRICULTURAL SCIENCIES – OAS

MARKETING No. 1

A METHODOLOGY FOR THE EVALUATION
OF POST-HARVEST LOSSES
THE CASE OF BLACK-EYE PEAS

By
GEORGE MANSFIELD

GEORGETOWN, OCTOBER 25, 1977

P R E S E N T A T I O N.

During the month of October, 1977 a case study was
developed with a team composed of, W. Smith, Agricultural Economist
from the Ministry of Agriculture, Yut'se Thomas, Food Technologist
from Guyana Marketing Corporation, N. McAndrew, Agronomist from
Ministry of Agriculture, and H. Barreyro, Agricultural Economist from
Inter-American Institute of Agricultural Sciences (IICA).

As part of this case study, IICA hired, on a consulting
basis, Mr. George Mansfield to provide advise on the proper
methodology to study losses that occur after production of the crop.
Mr. George Mansfield, from the Dominican Republic, is an Industrial
Engineer, specialized in food technology.

This document is part of the results of Mr, Mansfield's
visit to Guyana, and the first of a series of documents relating to
this case study.
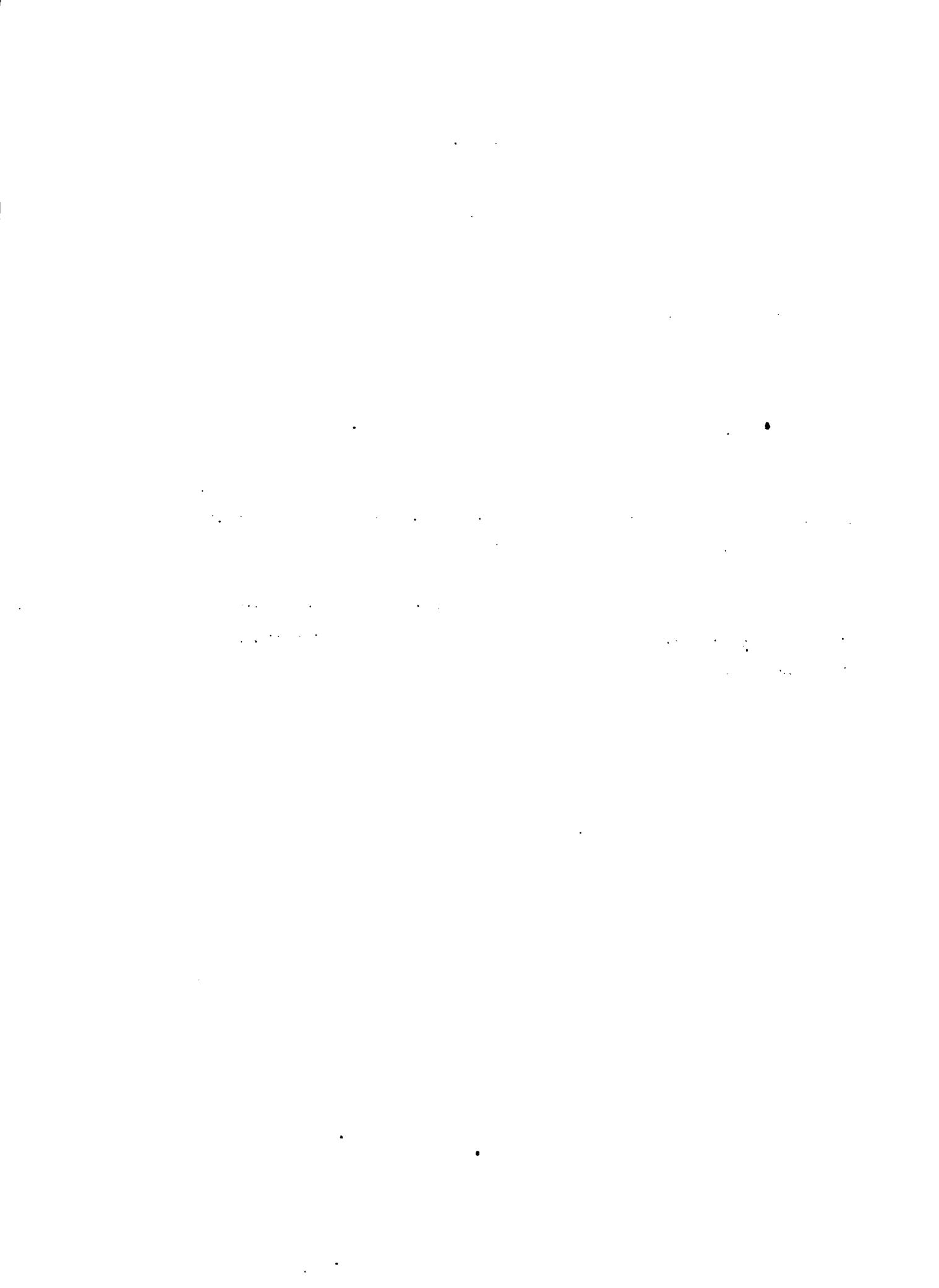
I N D E X

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PAGE

INTRODUCTION

Post-Harvest losses evaluation starts
when the marketing channels have been identi-
fied and a general agreement has been reached
about what channels are more important and
what percentage of the total volume they handle.

It is in the channels handling the
highest percentage of the total volume that
evaluation of losses should be carried out.

The following discussion will present
a systematic approach to post-harvest losses
evaluation, that we have used in the Dominican
Republic with good results.

The first step in post-harvest losses
evaluation is a flow analysis. At the earlier
stages of the study when few information is
available about the flow, no attempt should
be made to gather data to quantify losses.

/We know ....

We know that pressure to show early results to justify the study mounts up, especially from the people who are financing the research; but, in our experience, data gathering at this stage, without a flow analysis, is often erratic and uses up intellectual energy that should be concentrated in analysing the flow conditions.

As a flow analysis technique we have used, with very good results, the flow charting methods used by industries to improve their manufacturing flow conditions, in order to make them more efficient and less costly.

The principles of this technique are very simple and can be found in any industrial engineering manual at your libraries.

The objective of the flow analysis is to produce a flow with least amount of activities by combining or eliminating unnecessary ones. Each activity should be examined individually and as a part of the flow.

/In general........
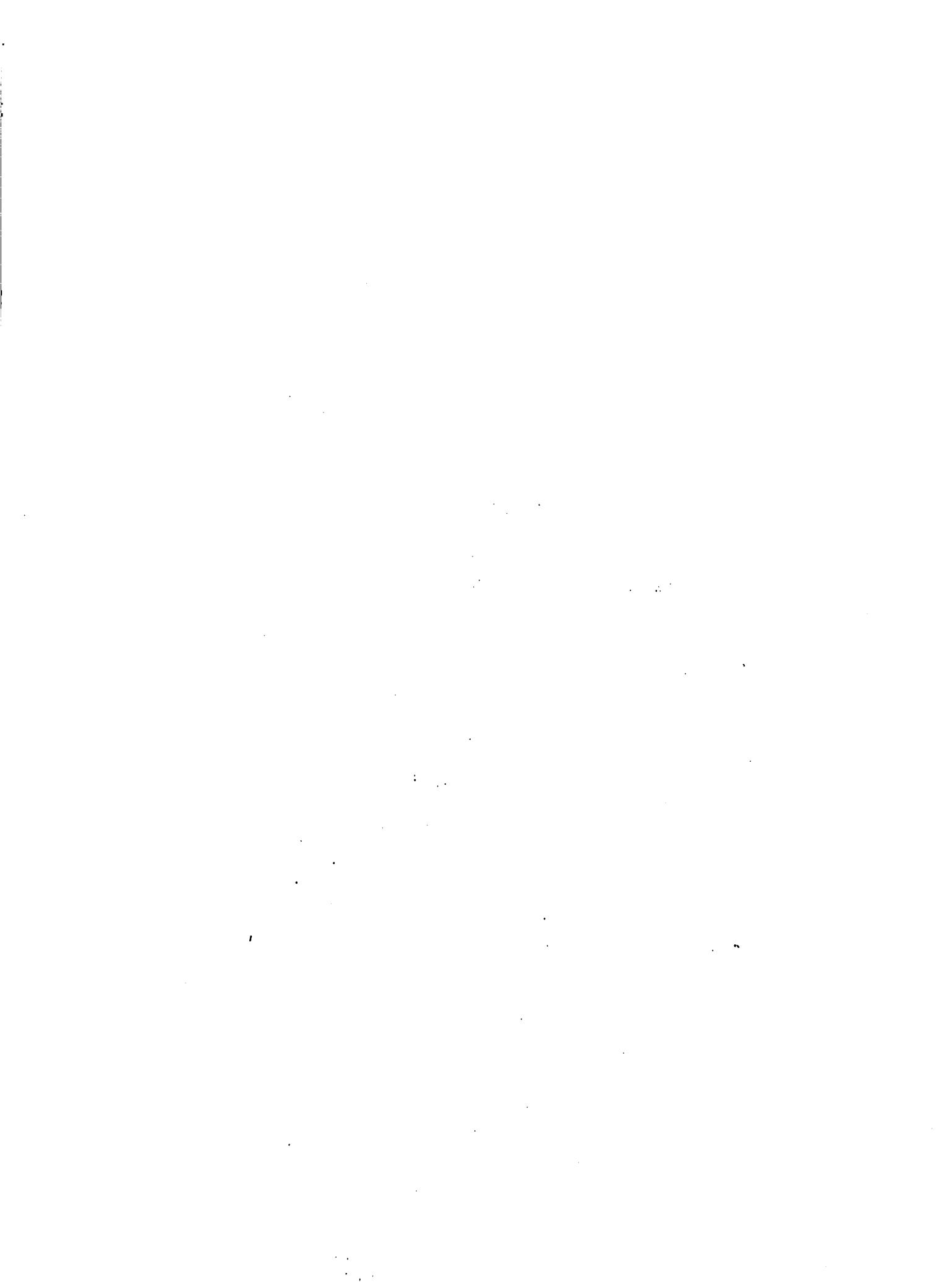
In general terms the technique con-
sists of classifying all the activities of
a flow into the following categories or a com-
bination of them:

⬡ Operation.

▭ Inspection or grading.

▷ Transportation.

▽ Storage.

◗ Delay.

I will not explain what is meant by
each one of these categories of activities,
but to illustrate their uses, we will go over
a flow of blackeye peas that corresponds to
one of the channels identified in the work
prepared by A.V. Downer, W.C. Smith and Y.
Thomas, entitled "POST-HARVEST LOSSES IN
GUYANA", that was presented at the seminar
in Santo Domingo.

Diagram No. 1 ....
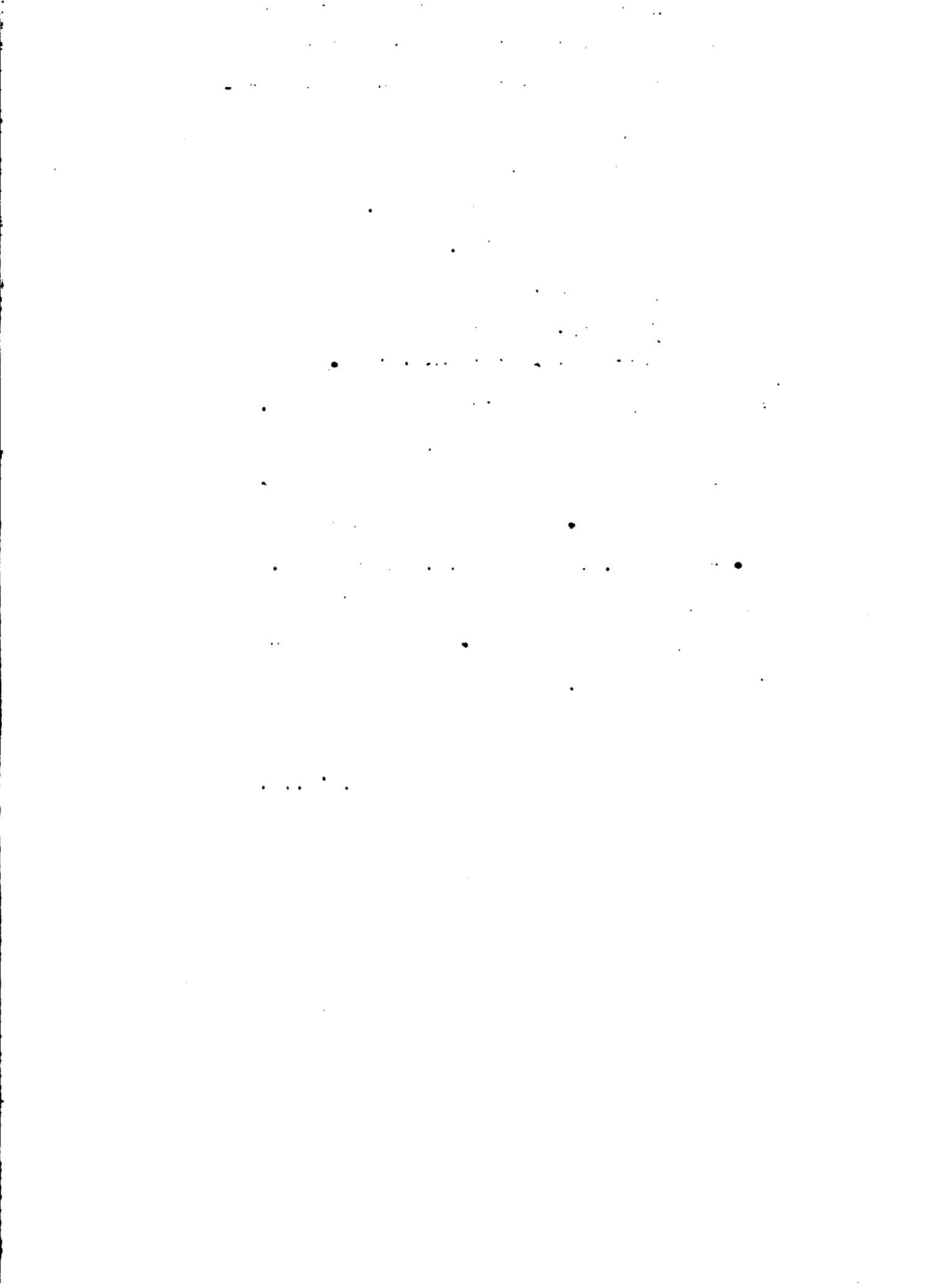
DIAGRAM NO. 1

BLACKEYE PEAS, MARKETING CHANNEL FOR

THE POMEROON AREA

```
        ┌─────────────────┐
        │  Farmer in the  │
        │  Pomeroon Area  │
        └────────┬────────┘
                 │
                 ▼
        ┌─────────────────┐
        │  G.M.C. Rural   │
        │  Buying Centre  │
        └────────┬────────┘
                 ┊
                 ▼
        ┌─────────────────┐
        │  G.M.C. Storage │
        │  In Georgetown  │
        └───┬─────────┬───┘
            │         │
            ▼         │
  ┌──────────────┐    │
  │ Wholesalers  │    │
  └───────┬──────┘    │
          │           │
          ▼           ▼
        ┌─────────────────┐
        │   Retailers     │
        └────────┬────────┘
                 ┊
                 ▼
        ┌─────────────────┐
        │   Consumer      │
        └─────────────────┘
```
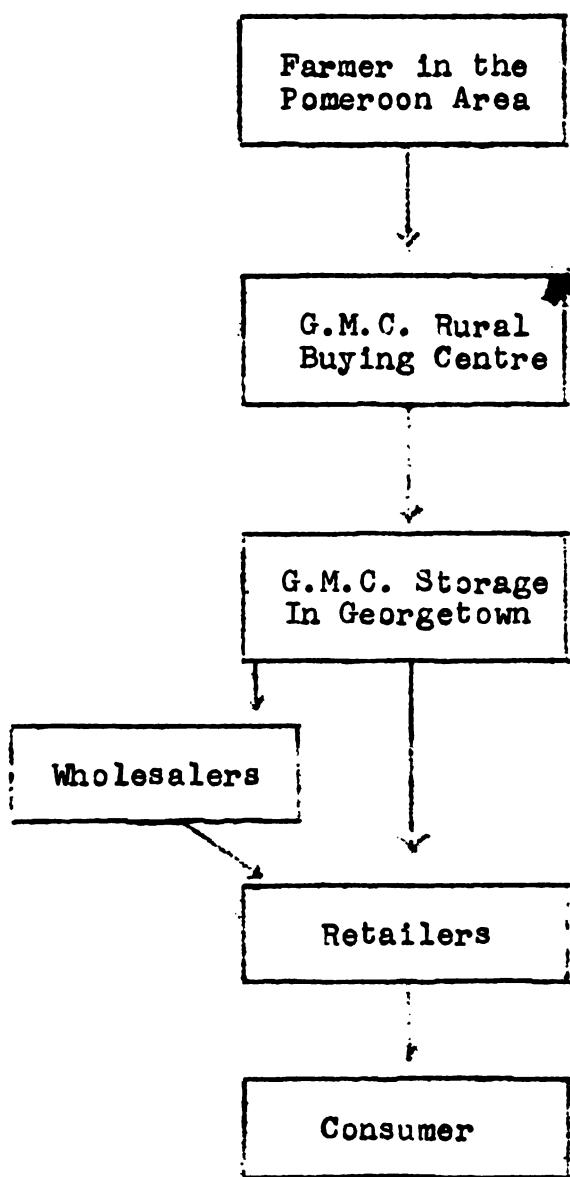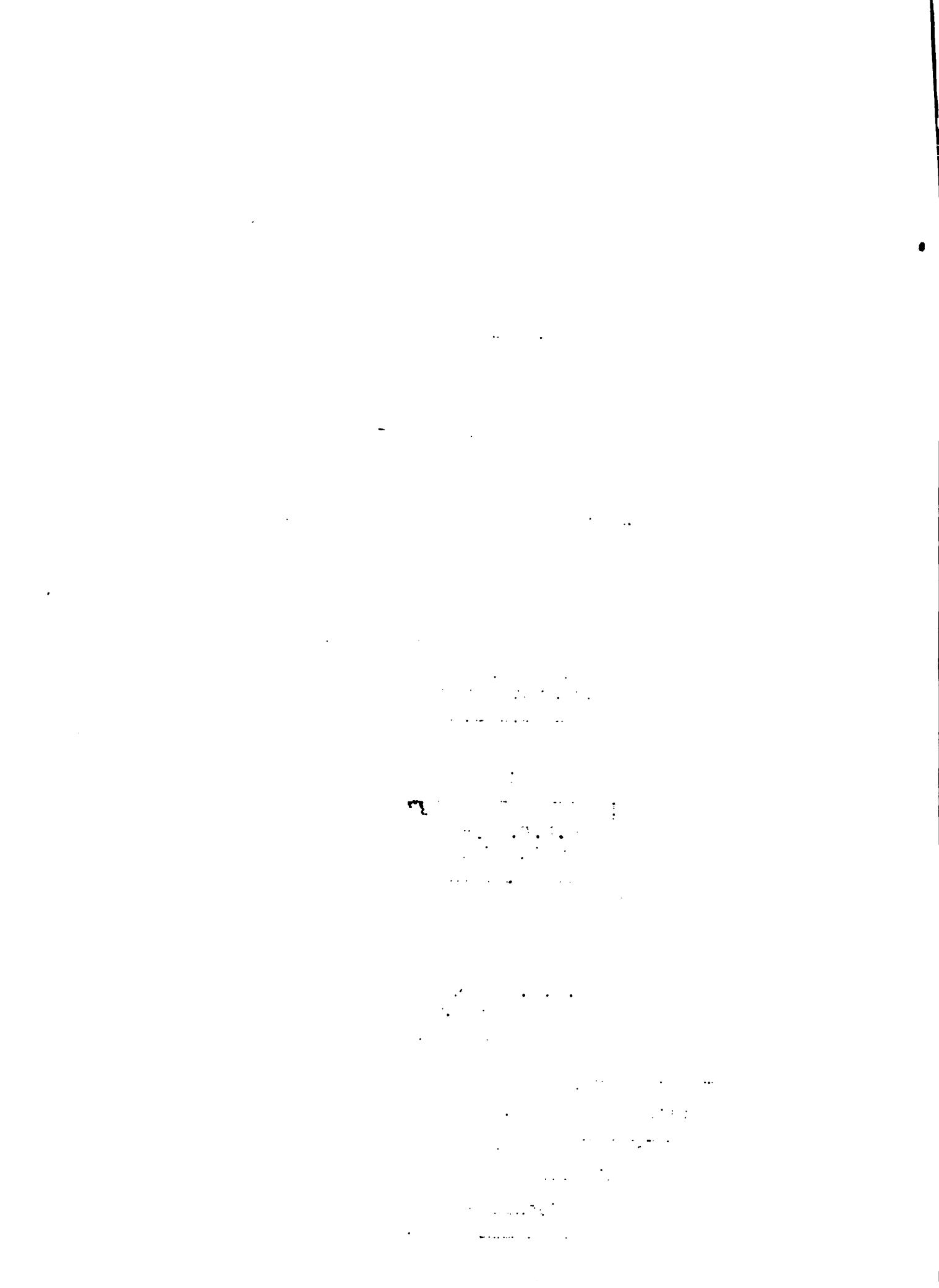
In our visit to the Pomeroon Area
and other points along the Channel, includ-
ing visits to Guyana Marketing Corporation
storage facilities, Wholesalers and Retail-
ers in the Bourda and Stabroek Markets, we
were able to gather information about that
marketing channel to be able to present the
flow with all the activities classified as
mentioned before.

Flow analysis requires that all ac-
tivities, no matter how insignificant, be
included in the flow, this is even more
important when dealing with fresh products,
where apparently insignificant handling
procedures may cause bruises and cuts that
will serve as entrance to contaminating
micro-organism. In the case of legumes
where a percentage of the activities at the
farm level is done with the bean within the
pod, having thus a natural cushioning pro-
tection against mechanical damage, the first

/activities......
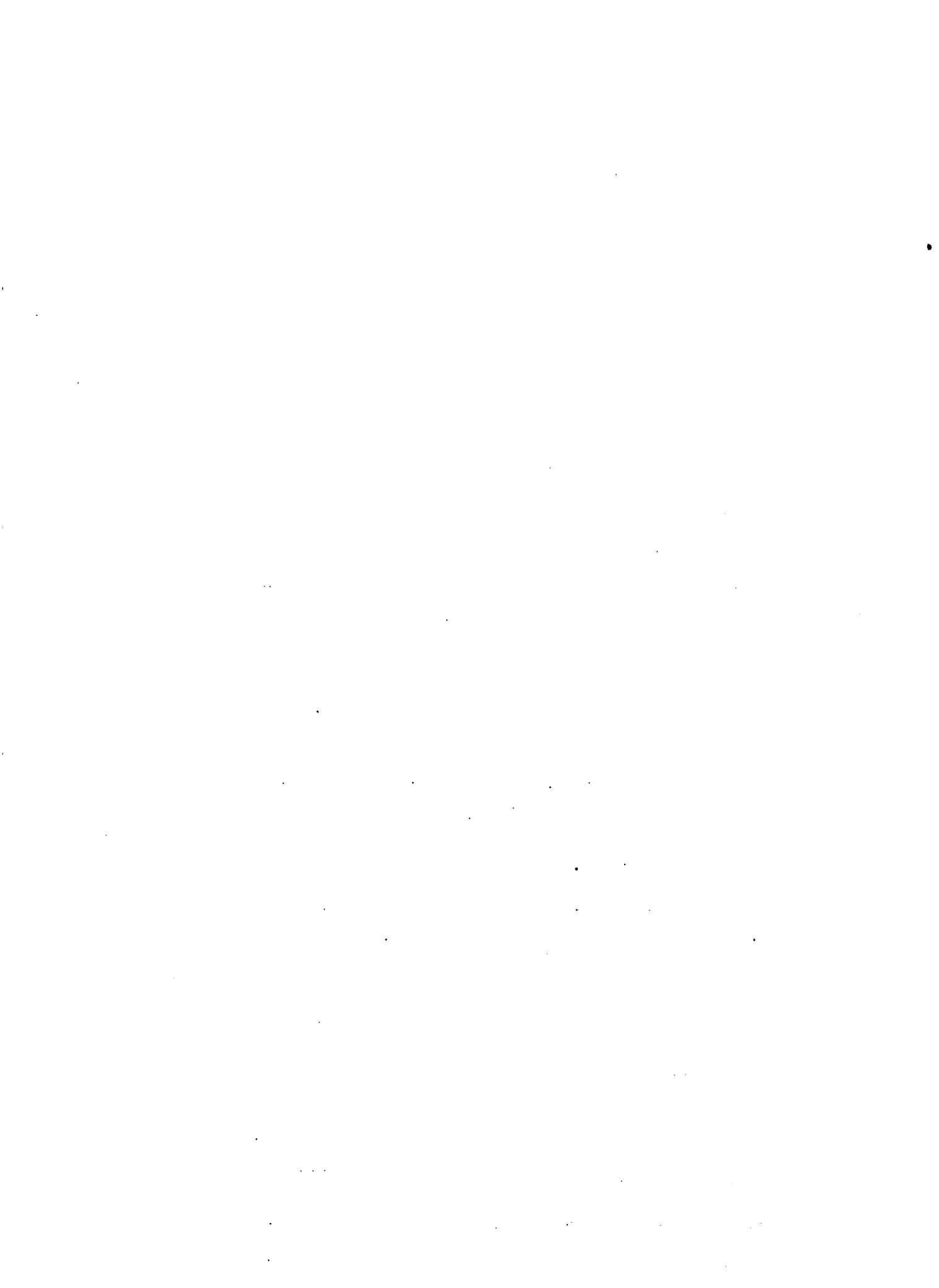
activities of the following flow might not
be required, but nevertheless recommend any-
one doing post-harvest flow analysis to be
as detailed as possible in this part of the
study.

/Table 1 (overleaf)......
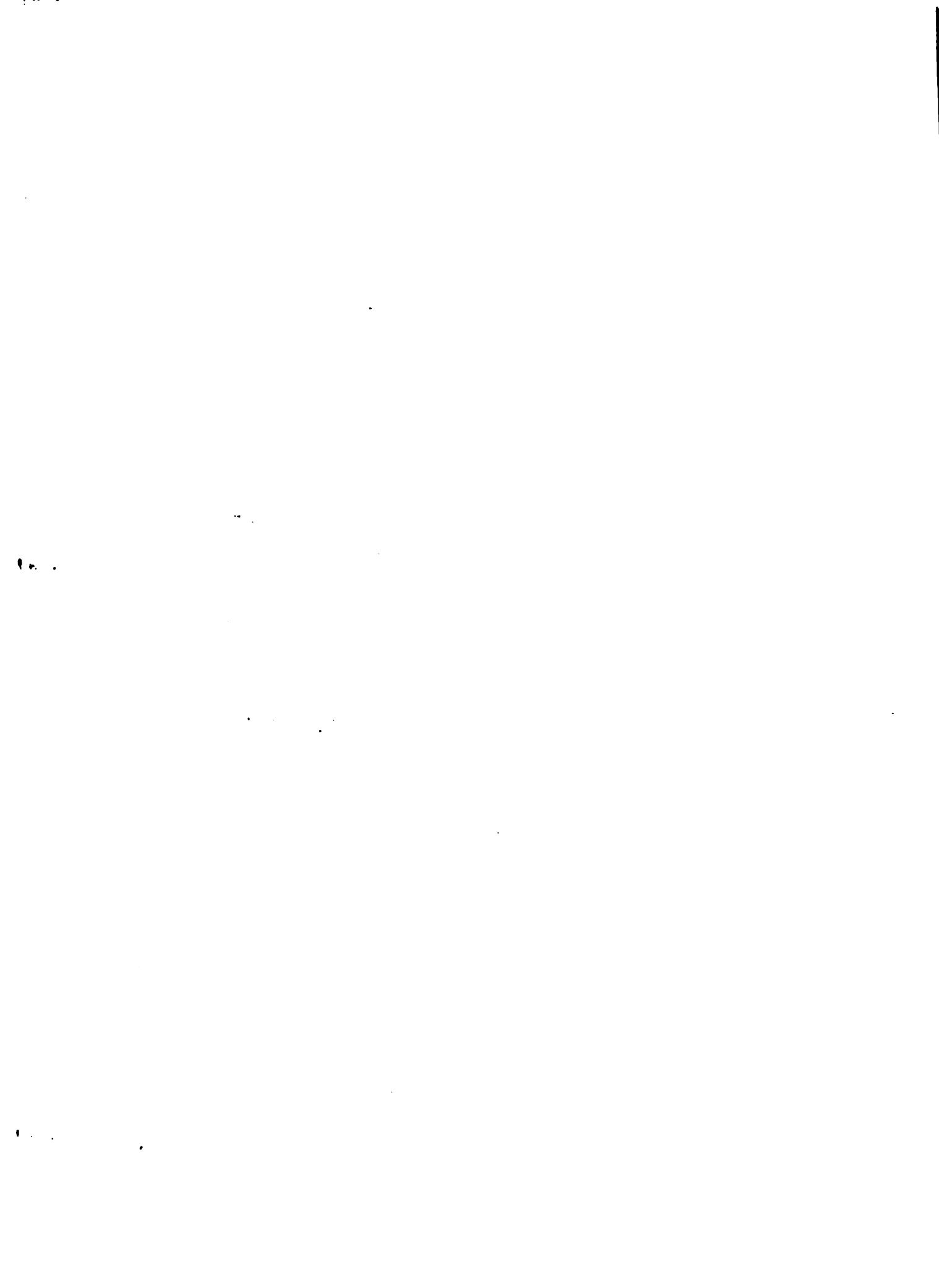
T A B L E - 1

FLOW OF BLACKEYE PEAS FROM FARMER TO CONSUMER.

POMEROON AREA.

Act No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or end (E) of activity	Type of loss to be measured
1	Harvesting - (Manual)	◯	Conditions of harvesting contains physical and sanitary selection of items for harvesting	- Can container cause mechanical damage? - Can container contaminate product? - Is product harvested under optimum condition?
2	Moving product from harvesting container to carrying basket	⬖	General handling procedure: Type of conditions of carrying basket	- To find if spillage occurs? - If mechanical damage is promoted? - If basket contaminates product?

/Act No. 3............
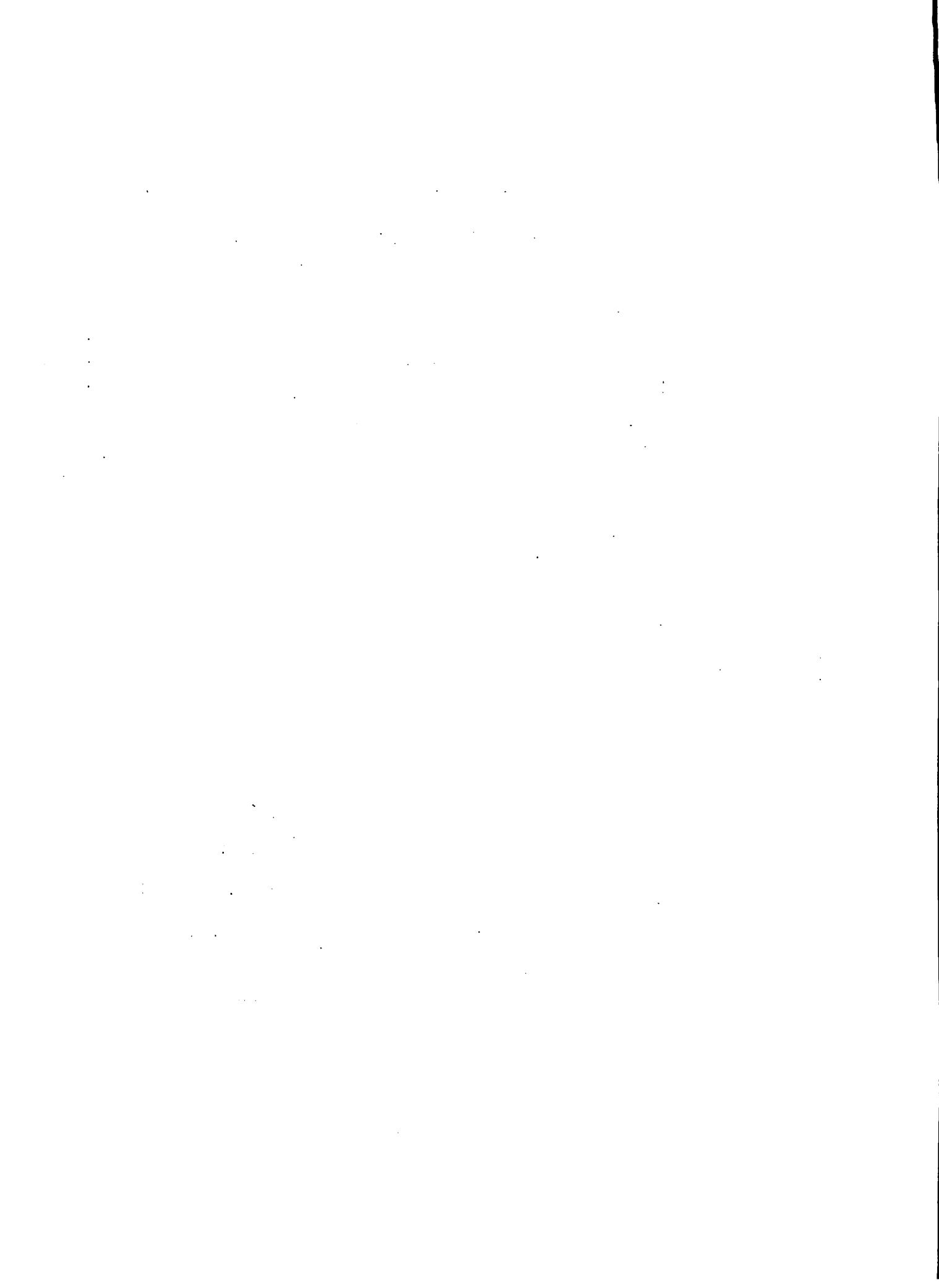
- 8 -

| Act No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or End (E) of activity	Type of loss to be measured
3	Delay in carrying basket before moving to drying place	D	Check for typical delay time	- Long delays may require same study as those activities considered storage
4	Moving to the drying facilities	△	Check for typical distance Vibrating conditions	
5	Unloading carrying basket into drying facilities	○	General procedure	- With present knowledge or solar drying, can they be improved? Check made on the subject

Act No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or End (E) of activity	Type of loss to be measured
6	Sun drying and moving pods to increase drying rate	(D)	Check for drying time E.% moisture level, % discolouration, % insect infested beans	- To determine if initial moisture level is at a safe level. - To use data as initial condition of beans and to measure deterioration with respect to those conditions
7	Loading into bags	( )		
8	Moving bags to shelling areas	△		
9	Shelling by pounding the bags	O		

/Act No. 10 ....
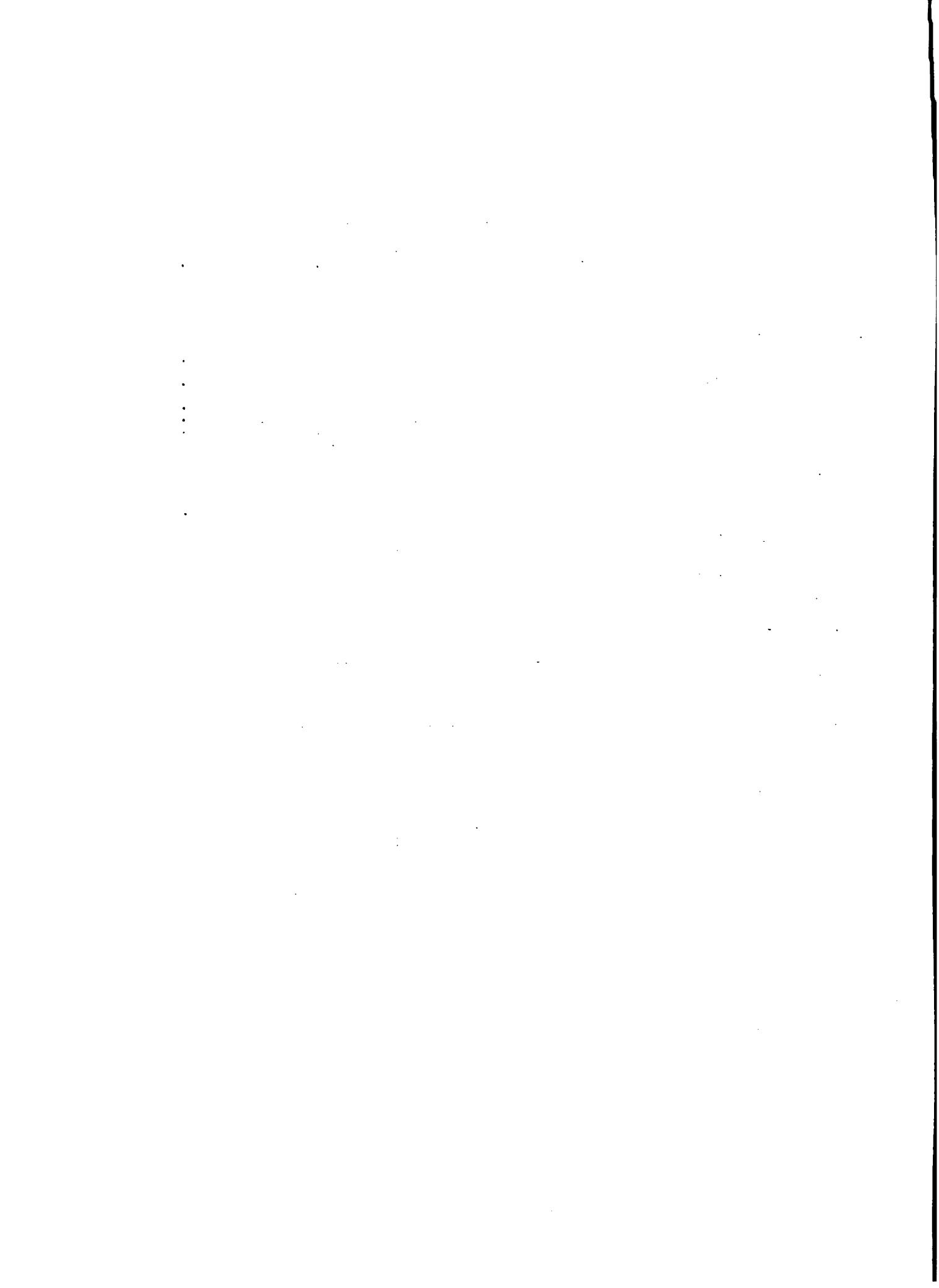
| Act No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or End (E) of activity	Type of loss to be measured
10	Air Sifting	⊡	(E) % of broken and discarded beans.	- To determine effect of shelling operation on bean condition
11	Loading of peas into bags and closing them	◯	General sanitary and physical condition of bag	- Possible source of contamination - Spillage problems?
12	Moving bags to farmer Storage	△		
13	Storage Stage before moving from the buying centre	▷	Check for typical delay time E (1-3 hrs. before loading into boat) % discolouration, % insect infested, % splits, level of rodent attack, wt. of bags.	- To determine degree of infestation by insects and microorganisms level of farm storage. As a base in which to measure handling conditions by % increase in ...

Act No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or End (E) of activity	Type of loss to be measured
			A.H. of storage facilities	- in split beans - To be able to determine spillage at end of flow and measure rodent attack
14	Loading the boat to transport to G.M.C. centre	⊘	As Act No. 2 (Spillage...)	-- To find if spillage occurs? - If mechanical damage is proved?
15	Transportation to G.M.C. buying centre	△	Check for typical time Stocking procedures	- Can stacking procedures be improved to use space better? - Is vibration promoted by stacking method?
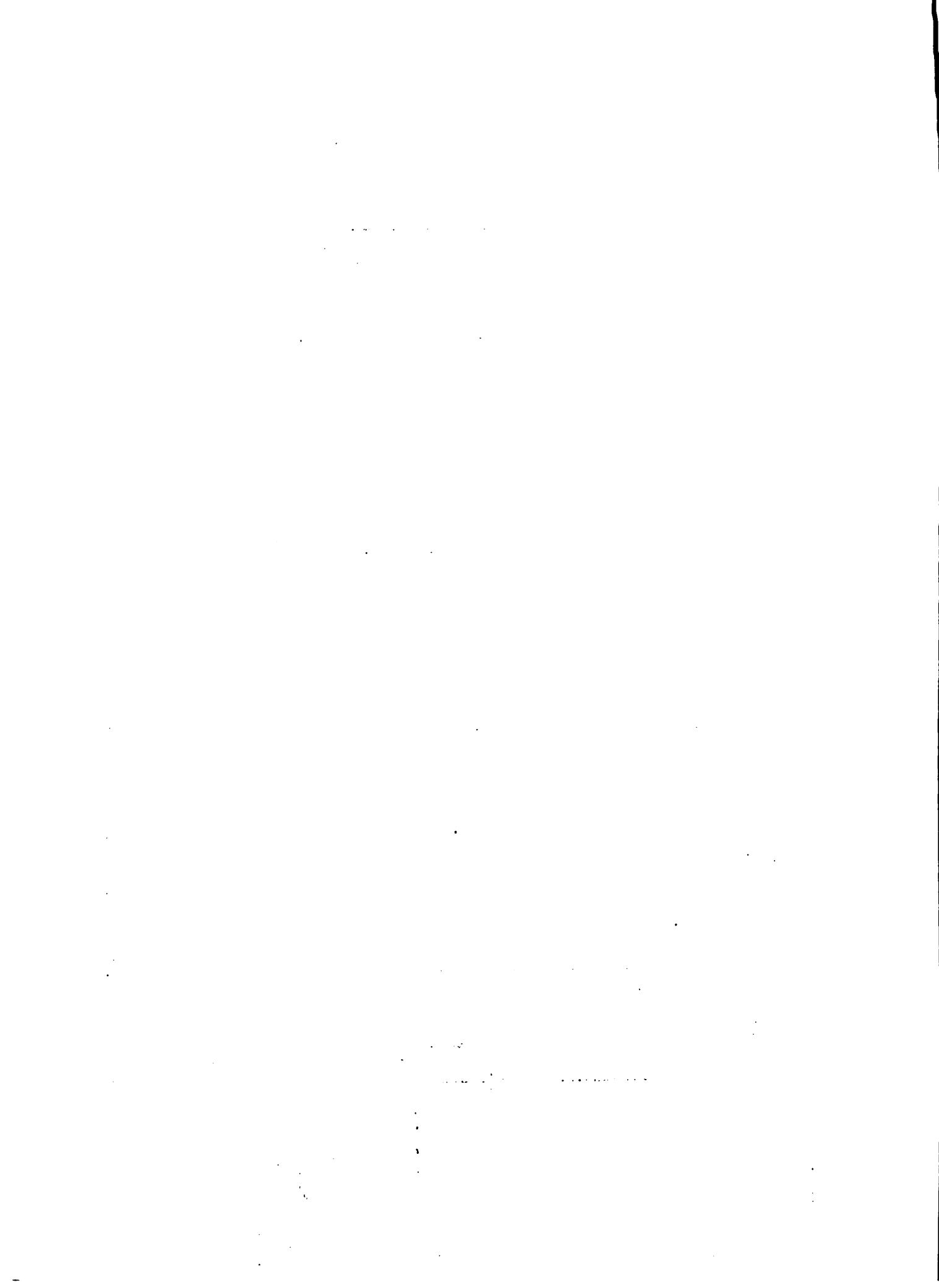
| Act. No.	Description of Activity	Symbol	Measurements or observations required at beginning (B) or End (E) of activity	Type of loss to be measured
16	Unloading at G.M.C. centre		As Act No. 2	As Act No. 14
17	Storage at G.M.C. rural buying centre		As Act No. 13 (weight of bags not required)	- To determine degree of infestation by insects or micro-organism at level of G.M.C. buying point; and amount of splits caused by handling up to this point.
18	Loading the boat to Georgetown		As Act No. 2	As Act No. 14

/Act No. 19..........
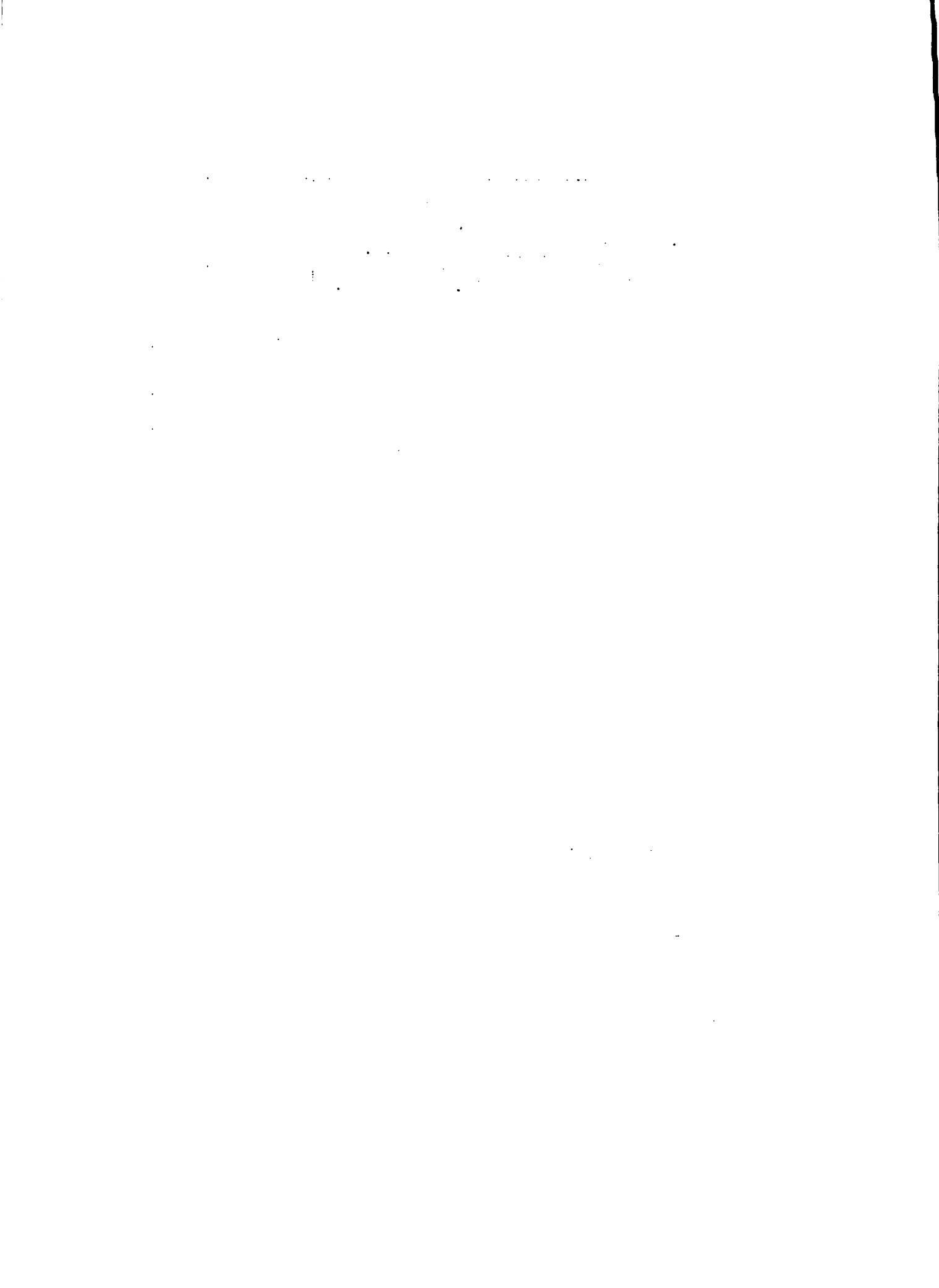
| Act. No.	Description of Activity	Symbol	Measurements or observations required at Beginning (B) or End (E) of activity	Type of loss to be measured
19	Transportation to Georgetown	△	As Act No. 15	- As Act No. 15
20	Unloading the boat nae	⊿ (circled)	As Act No. 2	- As Act No. 14
21	Delay before loading into transport vehicle	D	Check for typical delay time. Check for stacking made	- As Act No. 3 - Can stacking procedure improve space used?
22	Loading bags into transport vehicle	⊿ (circled)	As Act No. 2	- As No. 14.
23	Transportation to G.M.C. storage	△	Check for typical time - Stacking procedure -	- As Act No. 15

/Act No. 24...........

| Act No.	Description of Activity	Symbol	Measurements or observations required at Beginning (B) or End (E) of activity	Type of loss to be measured
24	Unloading at G.M.C. Storage in Georgetown		As in Act No. 2	- As in Act No. 14
25	Storage at G.M.C. facilities		B: % Badly discoloured, % insect infested, % splits, % moisture content, level of rat attack. E: As at B of this activity	- To determine level of infestation, by insects and micro-organism during transportation from rural area to G.M.C. - To determine amount of splits produced during transportation - To find out when moisture level reaches a critical level. - To determine level of infestation by insects and mic-

/organism.........

Act No.	Description of Activity	Symbol	Measurements or observations required at Beginning (B) or End (E) of activity	Type of loss to be measured
				- ro-organism during storage at G.M.C. storage - To find out when moisture level reaches a critical level
26	Inspection of product by wholesaler before buying	▢	- Criteria used for inspection - General inspection procedure	- With some products, inspection procedures by buyers create problems?
27	Loading into wholesaler's truck	⬭	As in Act No. 2	- As in Act No. 14
28	Transportation to wholesaler storage	△	As in Act No. 15	- As in Act No. 15

Act No	Description of Activity	Symbol	Measurements or observations required at Beginning (B) or End (E) of activity	Type of loss to be measured
29	Unloading at wholesaler storage		As in Act No. 2	- As in Act No. 14
30	Storage at wholesaler		E: As in Act No. 25 - Weight of bags - Extraction of rat infested beans as explained in the following exercise *	- As in Act No. 25 - To determine amount of spillage * To determine amount of rat infested beans
31	Loading whole- saler truck		As in Act No. 2	- As in Act No. 14

/Act No. 32..........
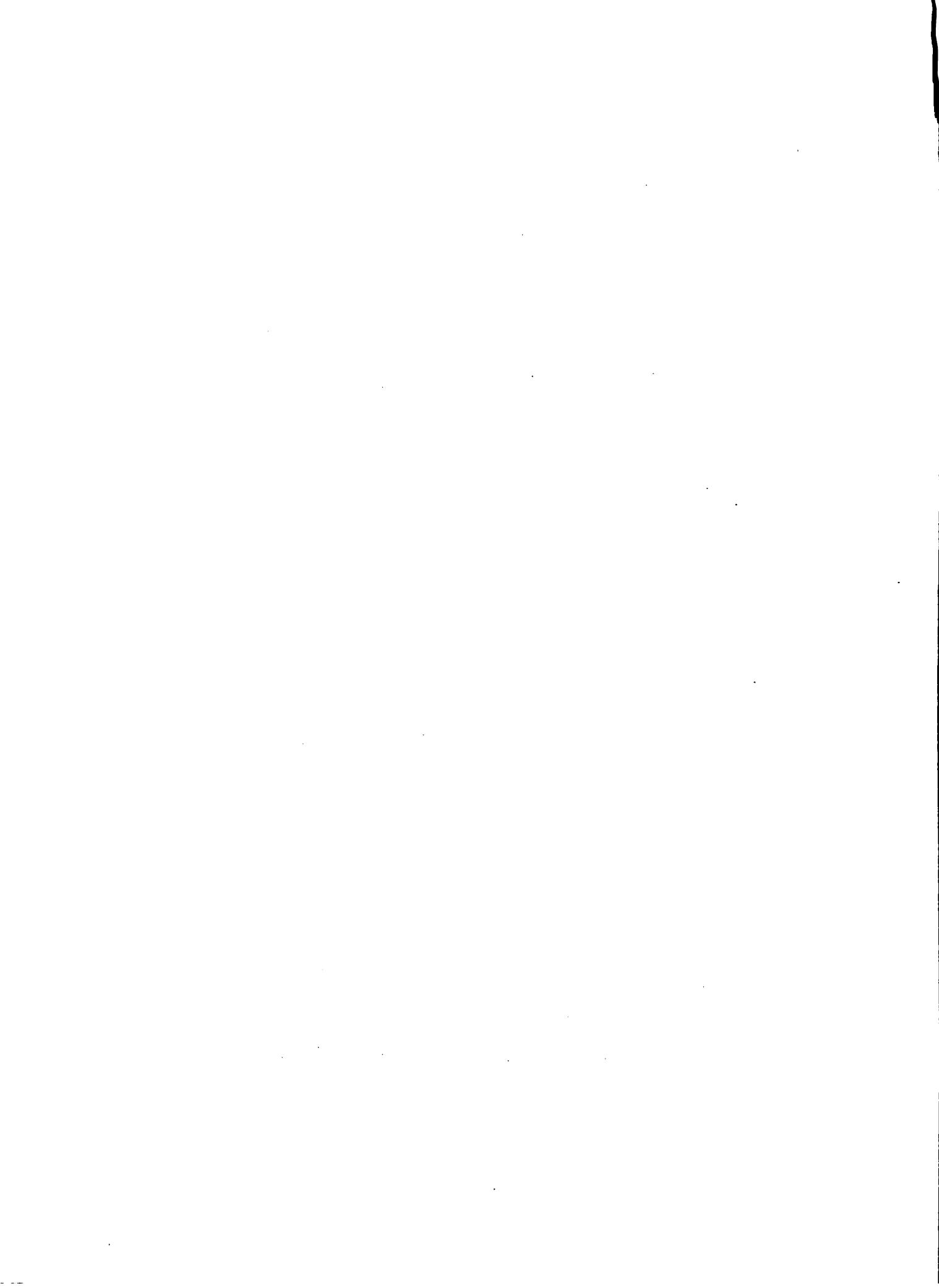
Act No.	Description of Activity	Symbol	Measurements or observations required at Beginning (B) or End (E) of activity	Type of loss to be measured
32	Transportation to retailers	△	As in Act No. 15	- As in Act No. 15
33	Unloading at retailers in Bourda Market place	(triangle in circle)		
34	Delay at re- tailers be- fore consumer buying	D		
35	Inspection of product by consumers	□		
36	Weighed and placed in bags for the con- sumer	○		

/Act No. 37........

Act No.	Description of Activity	Sym-bol	Measurements or observations re-quired at Begin-ning (B) or End (E) of activity	Type of loss to be measured
37	To consumer homes	△		

/Exercise..........
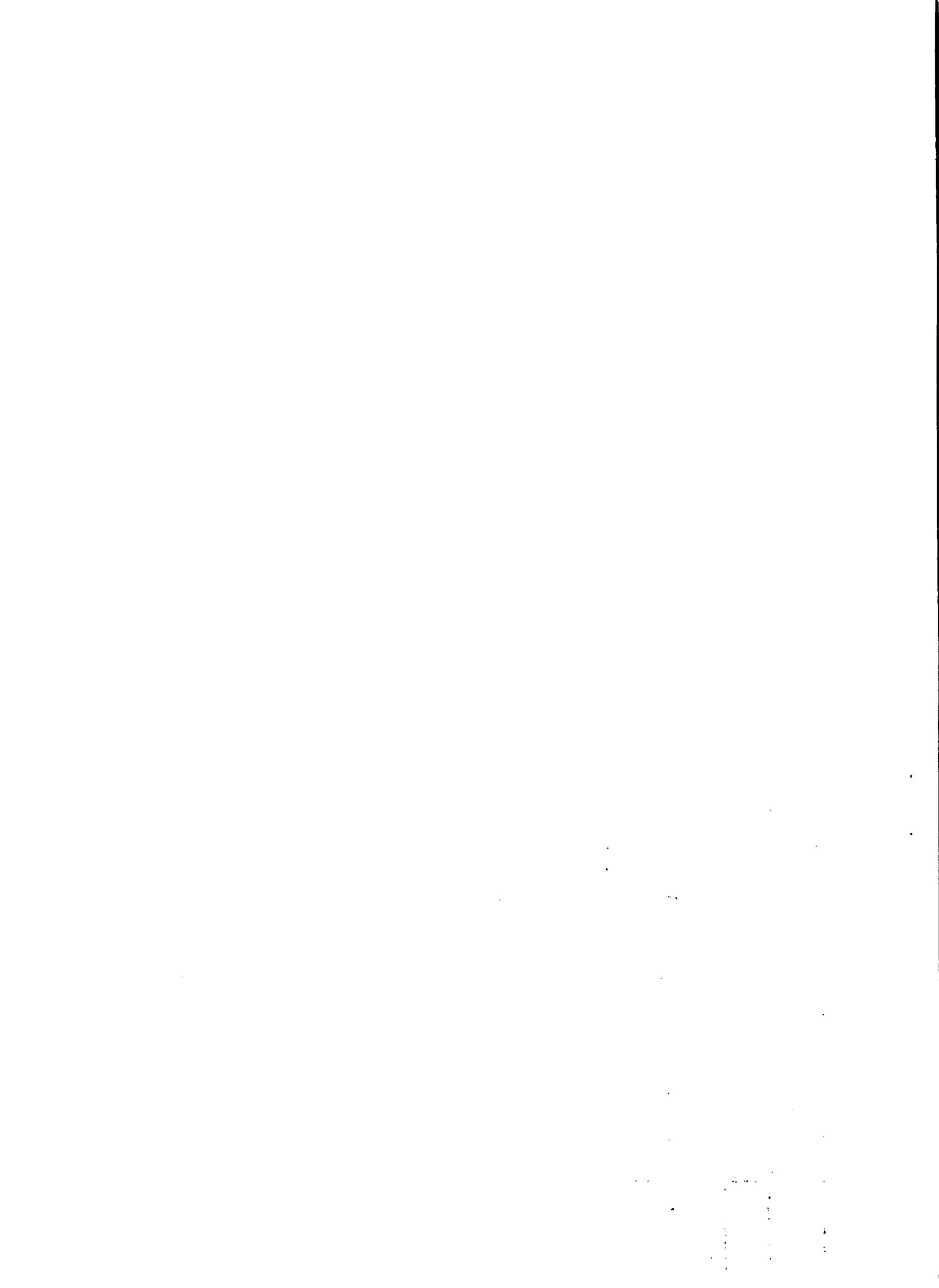
Exercise to illustrate the way in which losses can be quantified and presented according to the procedure recommended. No claim is made that this is the only way to do it.[1].

Assumptions made:

1. Harvesting is done at the optimum stage of maturity.

2. The condition at which a bean should be discarded because it is unfit for human consumption, has been determined by a seed analyst and a grading system to that effect has been developed that defines as a loss the following:-

(a) All badly discoloured beans.

(b) All splits.

(c) All insect infested beans.

(d) All beans within a 3 inch radius of a rat hole.

3. Differences found among samples are statistically significant at the 15% level.

General Considerations:

/After ....

After a careful examination of the
flow conditions, it was concluded by the team
that the losses were going to be quantified
from the farmer to the wholesaler, because it
is in that part of the flow that changes can
be brought about with less resistance to re-
duce losses and, therefore, it is in that part
of the flow where losses quantification is
specially important in order to obtain cost -
figures that can justify projects to reduce
them.

      1.   All data in this exercise has
          been made up for illustration
          purpose and does not corres-
          ponds to actual data.

Information of data collected at dif-
ferent levels:

Losses at farm level -

Farm level is concluded from Activity
No. 1 to No. 14.

/TABLE 2 ....

T A B L E _ 2

INFORMATION COLLECTED AFTER DRYING PRO-

CEDURE:

CLASSIFICATION	Wt. 0.3	%	% Moisture level :10
Badly discoloured	-	-	* Not considered a loss but an inevitable natural phenomena *
Splits	-	-	
Insect infested	-	-	
Very small (*) de-formed beans	0.5	3	
Other	15.5	97	

T A B L E _ 3

Information collected after two days (2 *) at the farmer storage preferable within 1 to 3 hours before sending product to G.M.C. buying points:

/Chart overleaf........

CLASSIFICATION	Wt. 0.3	%	% Moisture level :10
Badly discoloured	0.5	3	
Splits	0.3	2	
Insect infested	-	-	
Other	15	94	

(2 *) According to information gathered, it is the longest time it will stay in farmers hands.

T A B L E _ 4

Information collected to determine the amount of split beans produced during the shelling operation:

/Chart - overleaf...........
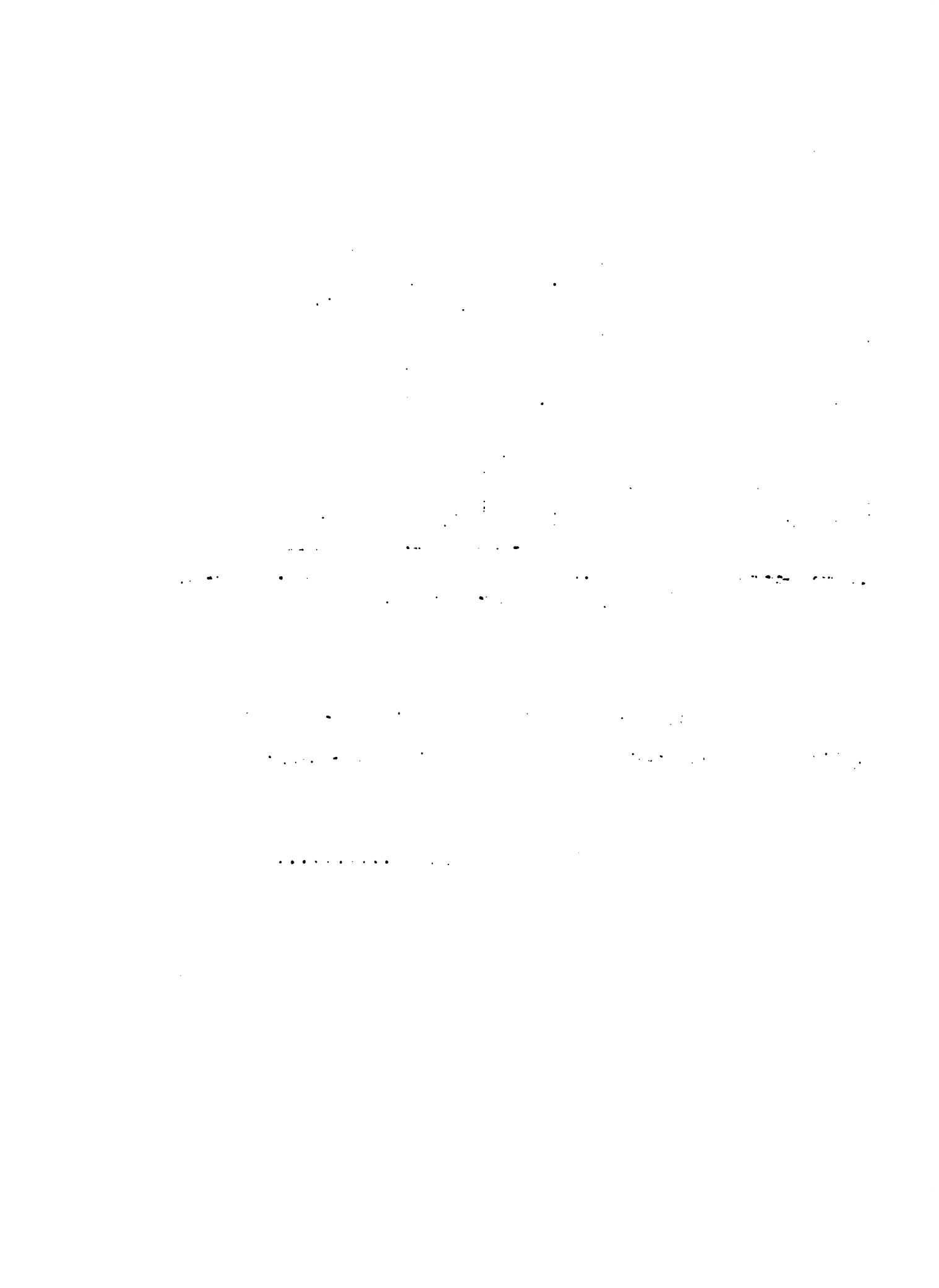
No.	Other (lbs)	Splits & dis-carded (lbs.)	% Splits & discarded	
1	30	1	3	
2	28	$\frac{3}{4}$	3	
3	30	1	3	
4	29	$\frac{1}{2}$	2	
5	30	1	3	

Average % of splits and discarded: 2.8

T A B L E _ 5

SUMMARY OF FARM LEVEL LOSSES

CAUSE	%
Badly dis-coloured	3
Splits	2.8
Total	5.8

/Losses......
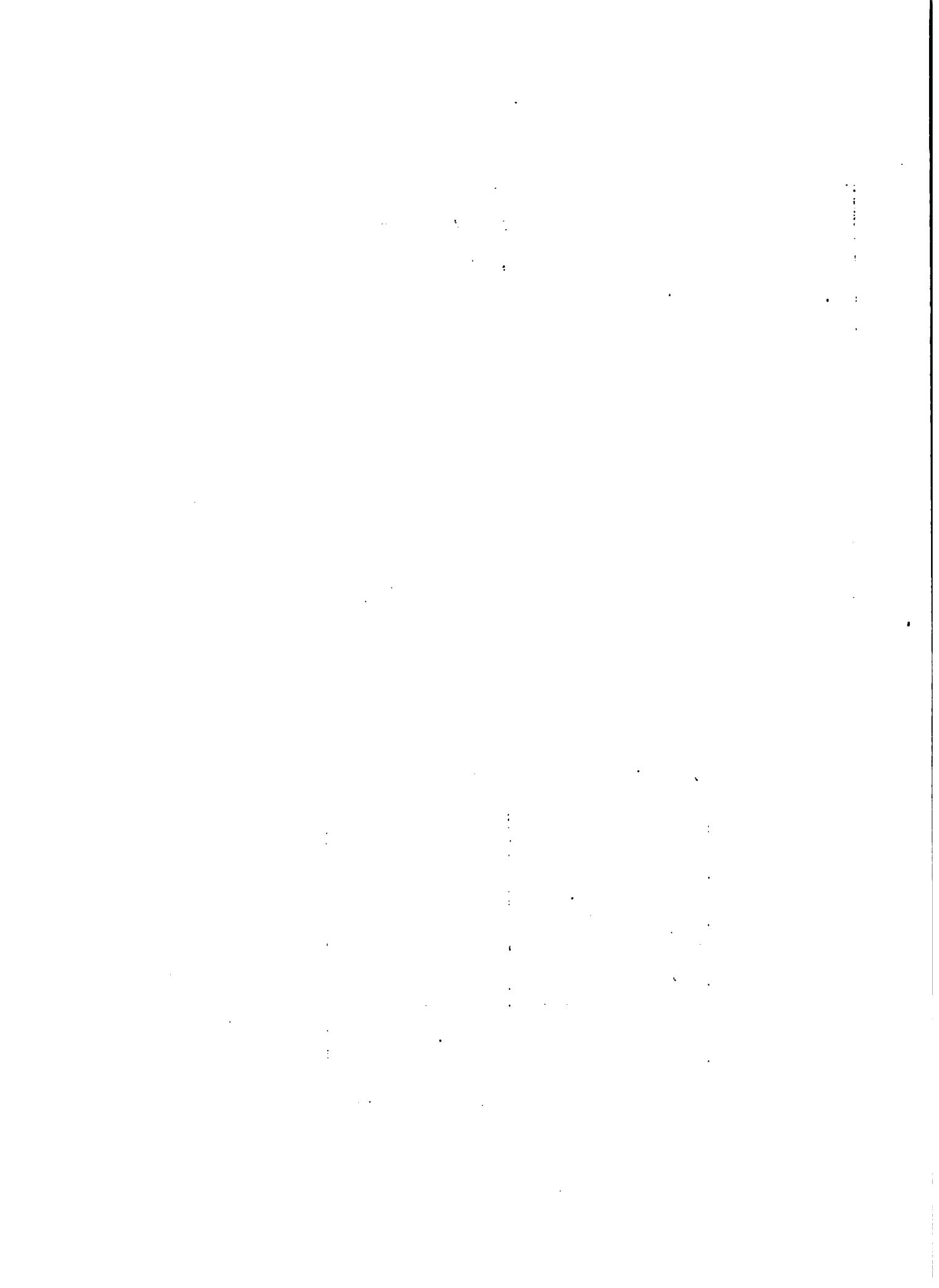
Losses at G.M.C. buying point,
from Act No. 15 to No. 18, since we have
information on the condition just before
it left the farmers hands; assuming that
in the short trip from farmer to G.M.C.
buying point condition of beans remains
the same, it is enough to determine con-
dition of the beans just before they
leave G.M.C. buying point.

T A B L E _ 6

CLASSIFICATION	Weight 0.3	%	% Moisture level: 14
Badly discoloured	0.6	3.8	
Splits	0.7	4.0	
In Insect infested	0.2	1.3	
Other	14.5	90.9	

Sometimes at the storage places, the location of

a bag or a package may affect the degree of deterioration,

for example it is possible that bags stored in the bottom,

on the bare floor, will get infested by insects much

faster than those at the top.

In those cases, information must be obtained on

the conditions of produce at different location in storage.

This information may recommend a change in stacking proce-

dure.

/TABLE 7.........
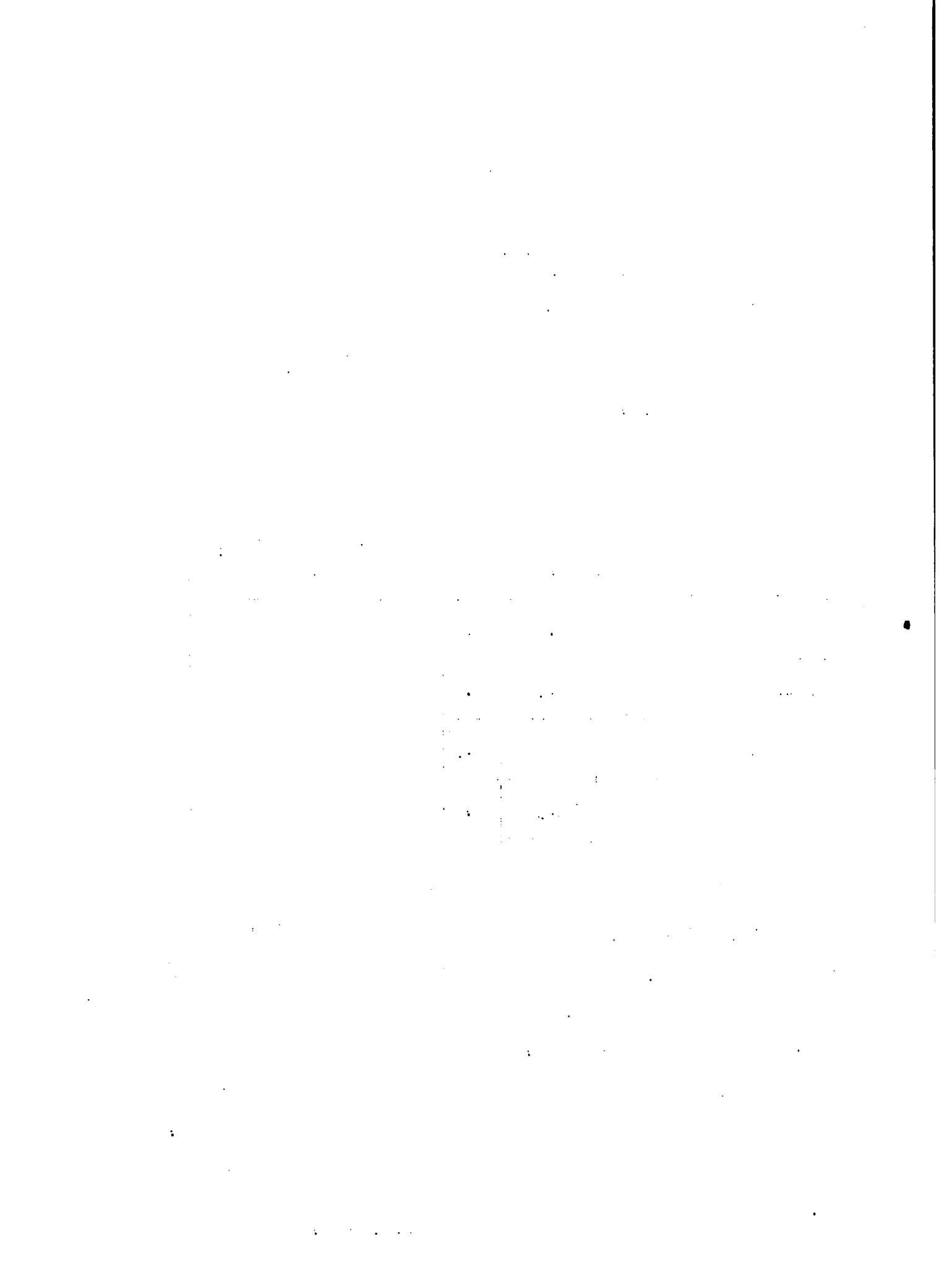
T A B L E _ 7

Level of Rodent Attack

BAG No.	No. of holes in bag
1	1
2	-
3	-
4	2
5	-

T A B L E _ 8

Summary of Losses at G.M.C. Buying Points

CAUSE	%
Badly discoloured	0.8
Splits	0.8
Insects	1.3
Total	2.90
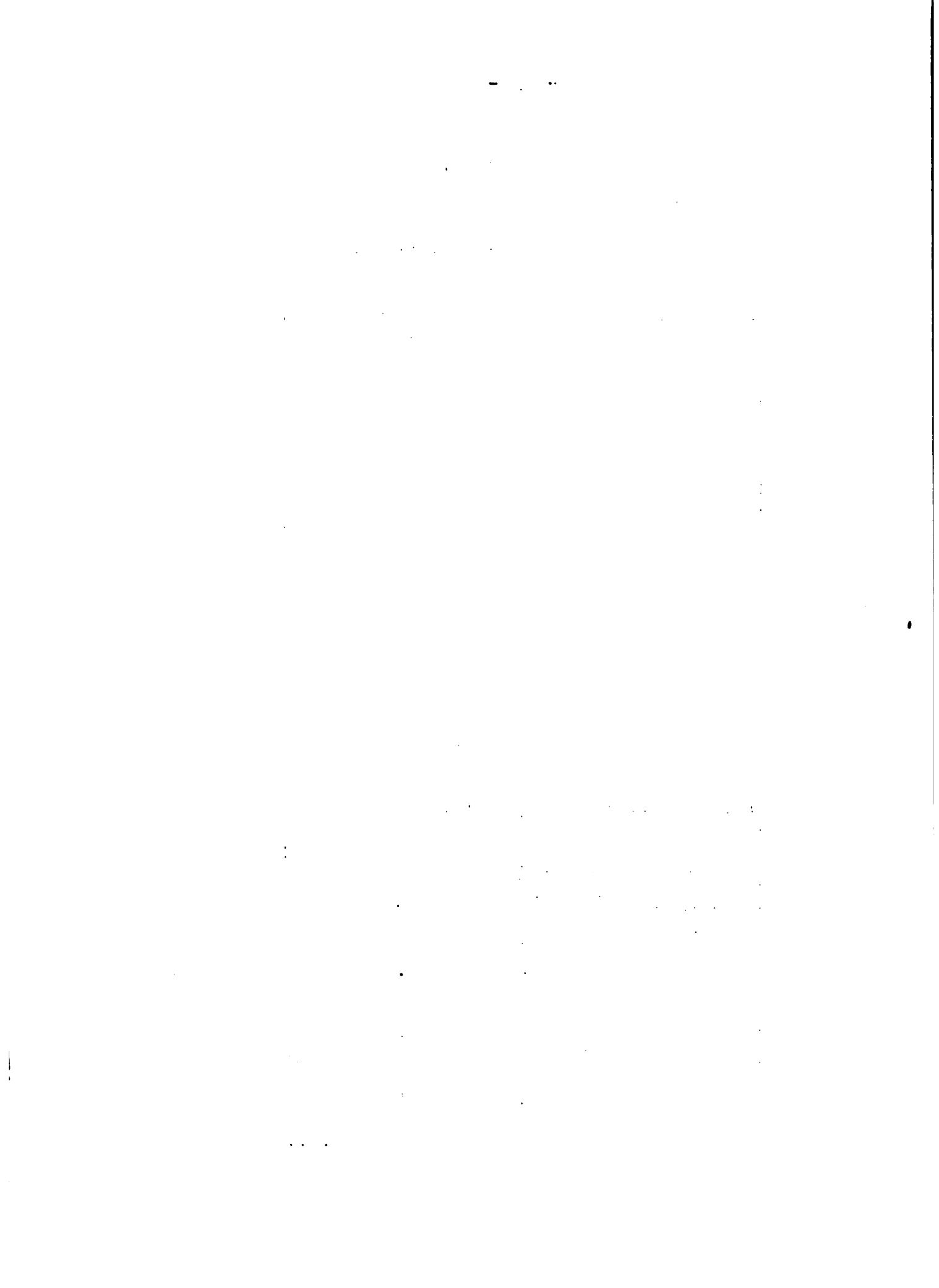
Information collected to determine

losses during transportation from G.M.C.

buying centre to Georgetown. From Act

No. 19 to No. 24.

T A B L E _ 9

CLASSIFICATION	Weight . 0 7	. %	% Moisture level: 14
Badly discoloured	0.7	4.3	* Information collected within 1-3 hours of reaching the G.M.C. storage at Georgetown.
Splits	0.7	4.8	
Insect infested	0.3	1.5	
Other	14.4	39.9	

T A B L E   10

Level of Rodent Attack:

Bag No.	No. of holes in bag
1	1
2	-
3	-
4	2
5	-

T A B L E _ 11

Summary of Transportation Losses

CAUSE	%
Badly discoloured	0.5
Splits	-
Insects	0.4
Total	0.9

Information collected to measure

losses at G.M.C. storage facilities in

Georgetown.*   From Act No. 24 to No.....

T A B L E   12

CLASSIFICATION	Weight . (03)	% .	% Moisture Content: 16
Badly discoloured	0.8	7	* After 2 weeks storage at G.M.C. facil-ities, the typical stor-age period for those beans at this storage.
Splits	0.6	4.8	
Insect infested	0.5	3	
Other	14.1	86.2	
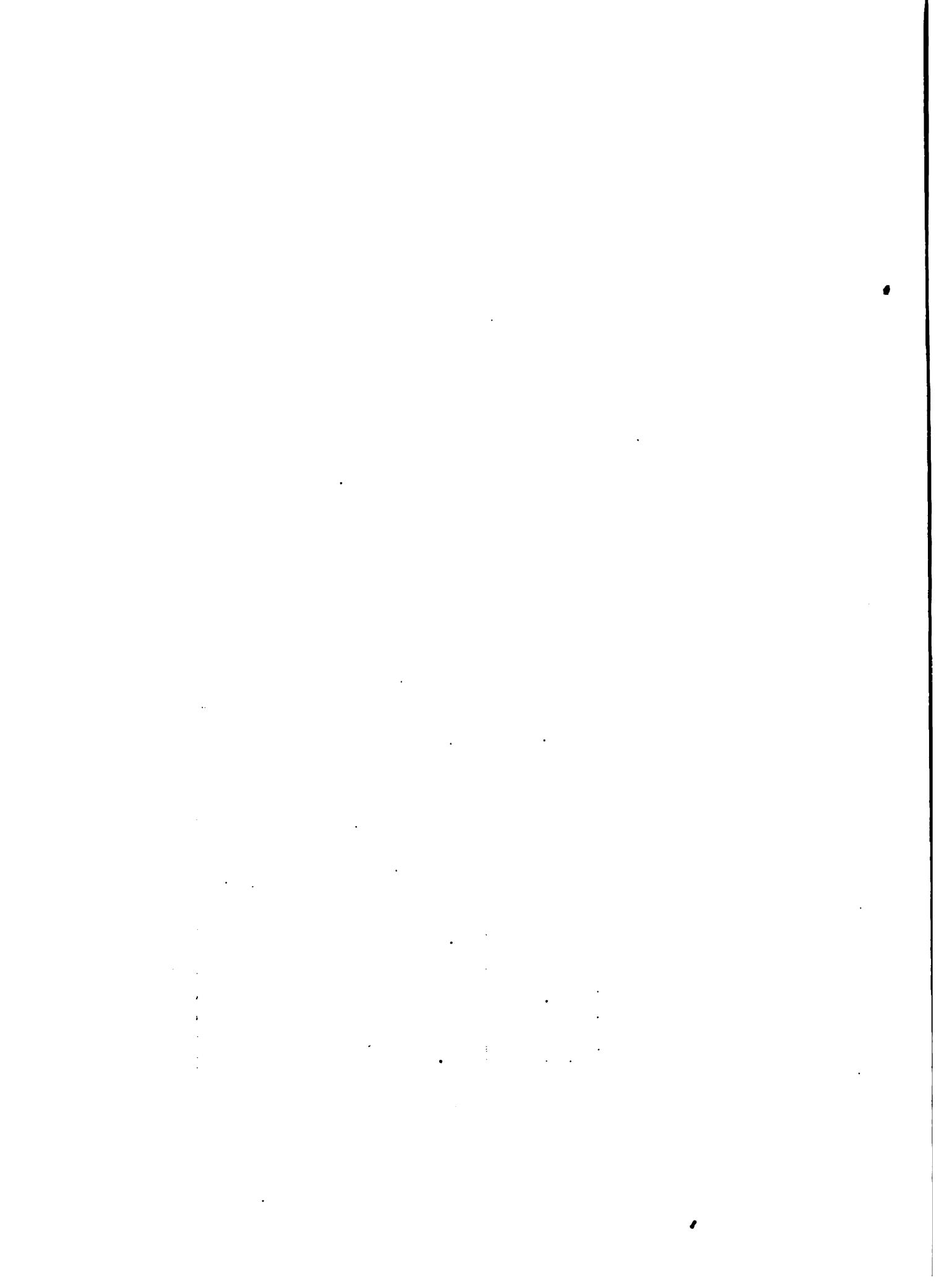
T A B L E   13

Level of Rodent Attack

Bag No.	No. of holes in bag
1	1
2	1
3	2
4	3
5	1

T A B L E   14

CAUSE	%
Badly discoloured	2.70
Insects	1.50
Total	4.20
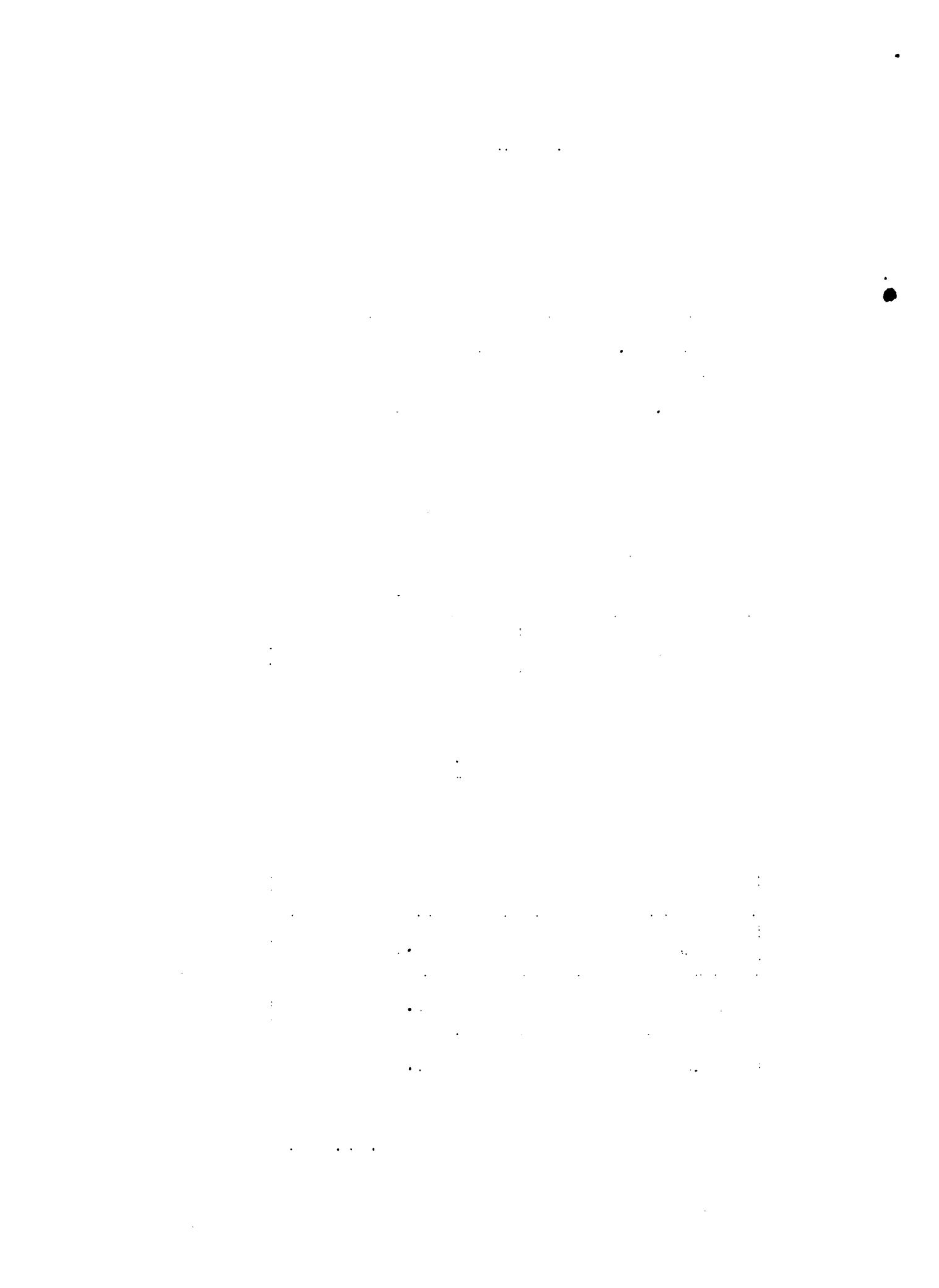
Information collected to measure

losses at Wholesaler storage level.

From Act No. 26 to No. 30.

For this exercise, it is assumed

that the conditions of the beans before

storage is the same found two weeks after

G.M.C. storage.

T A B L E 15

CLASSIFICATION	Weight (0.6)	%	% Moisture level 18
Badly discoloured	1.6	10	* Information collected 10 days after wholesaler storage, a typical storage time at this level.
Splits	0.6	5	
Insect infested	0.5	5	
Other	13.3	83	

/TABLE   16......
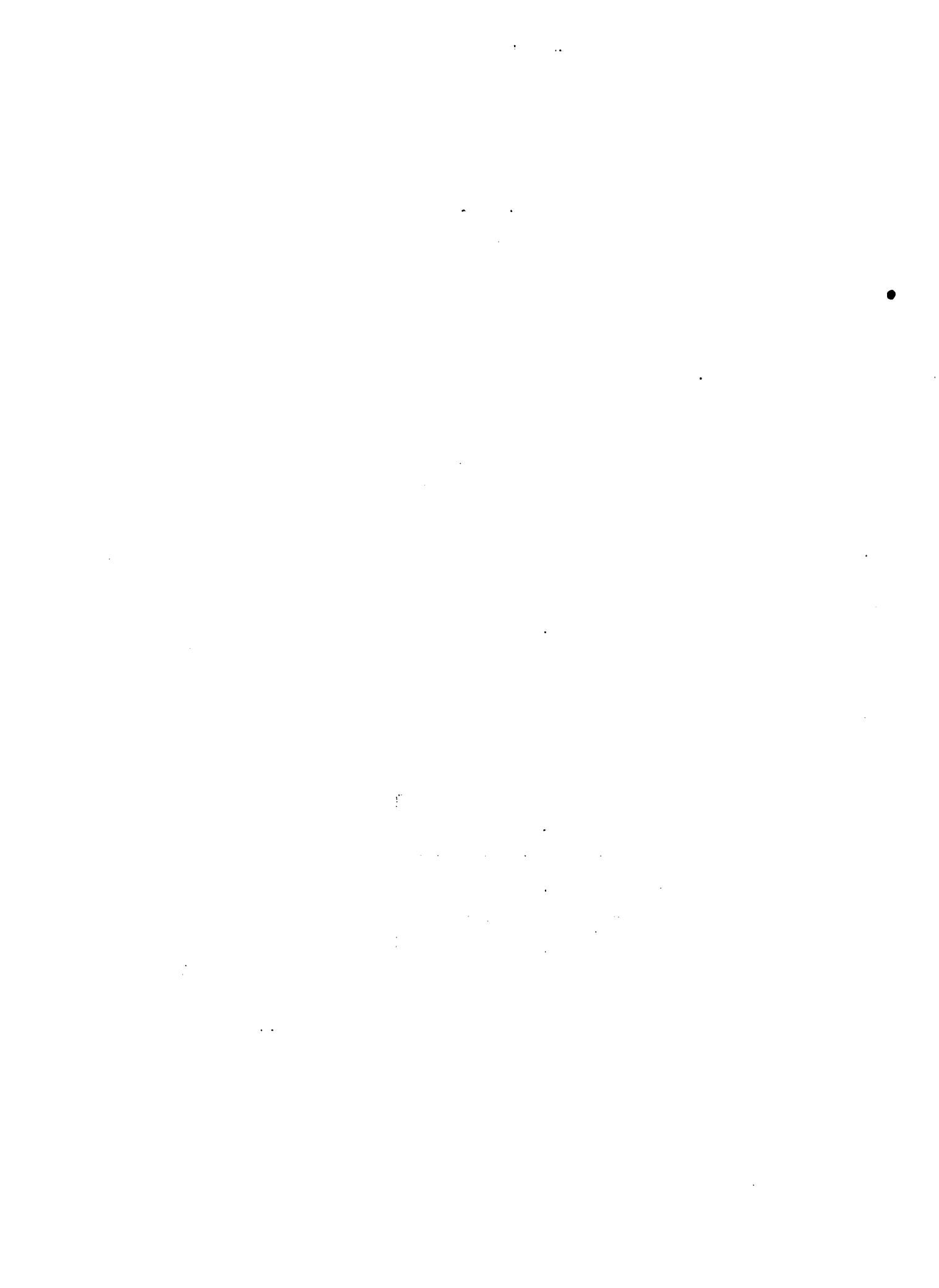
T A B L E 16

Level of Rodent Attack

Bag No.	No. of Holes in bag
1	1
2	2
3	2
4	3
5	1

T A B L E 17

Summary of Losses at wholesaler storage

CAUSE	%
Badly disco᠌ ᵊd	3
Splits	0.2 *
Total	3.2

/*Mechanical.......

* Mechanical damage to the beans
in the transportation between G.M.C. and
wholesaler.

Information collected to determine
spillage losses and losses due to rodent
attack. From Act No. 13 to No. 30

To determine spillage and rodent
attack losses, tagged bag will be weighed
at the farm level (End of Act No. 13) and
then at the moment it leaves the wholesaler
storage.

After weighing, the bags to deter-
mine spillage losses at end of Act No. 30,
an inspection of the bags follows to deter-
mine number of rat holes per bag, and to
remove all beans within a 3 inch radius
of the rat hole or discard heavily attacked
bags.

/TABLE 18.........

T A B L E 18

At farmers level: % Moisture

level: 10 - Weight of the bags: 1 (lb.)

Bag No.	Wt. of bags (lbs.)	Wt. of dry beans(lbs.)
1	69	61.20
2	70	62.10
3	71	63.00
4	69	61 20
5	70	62.10
Total		309.6

Table 19........

T A B L E   19

At Wholesaler level: % Moisture: 18.

Weight of bag - 116 *

Bag No.	Weight of bag - lbs.	Weight of dry beans - lbs.
1	68	54.94
2	70	56.58
3	69	55.76
4	69	55.76
5	68	54.94

* Assumed that the bag has not absorbed

any humidity

To determine rodent attack losses
a cot is made in the bag at each rat hole,
to remove all beans within a 3 inch radius
of the hole. Provisions are taken to close
the holes after the experiment; or beans

/must.........
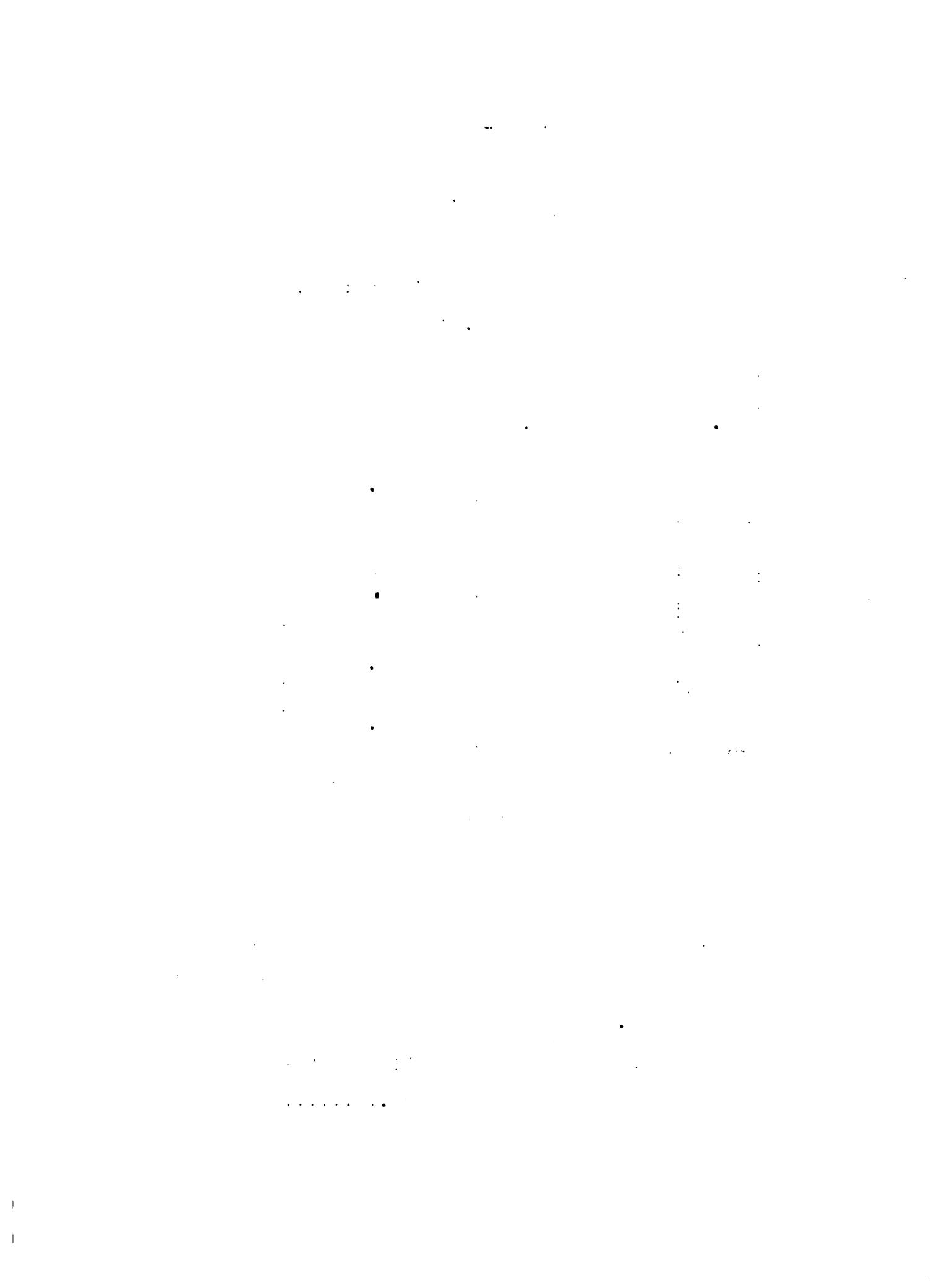
must be placed in a new bag. Following
this procedure 10 lbs. of beans were re-
moved - considered infested by rodents.

T A B L E 20

Losses due to spillage and Rodent attack:

Bag No.	Loss (lbs.)
1	4.90
2	4.12
3	5.84
4	3.08
5	5.76
Total	23.70

Average weight loss per bag = 4.7
lbs.

Of the 10 lbs. collected as losses
due to rodent attack, about 17% would have
been considered a loss anyway, due to dis-

/colouration......
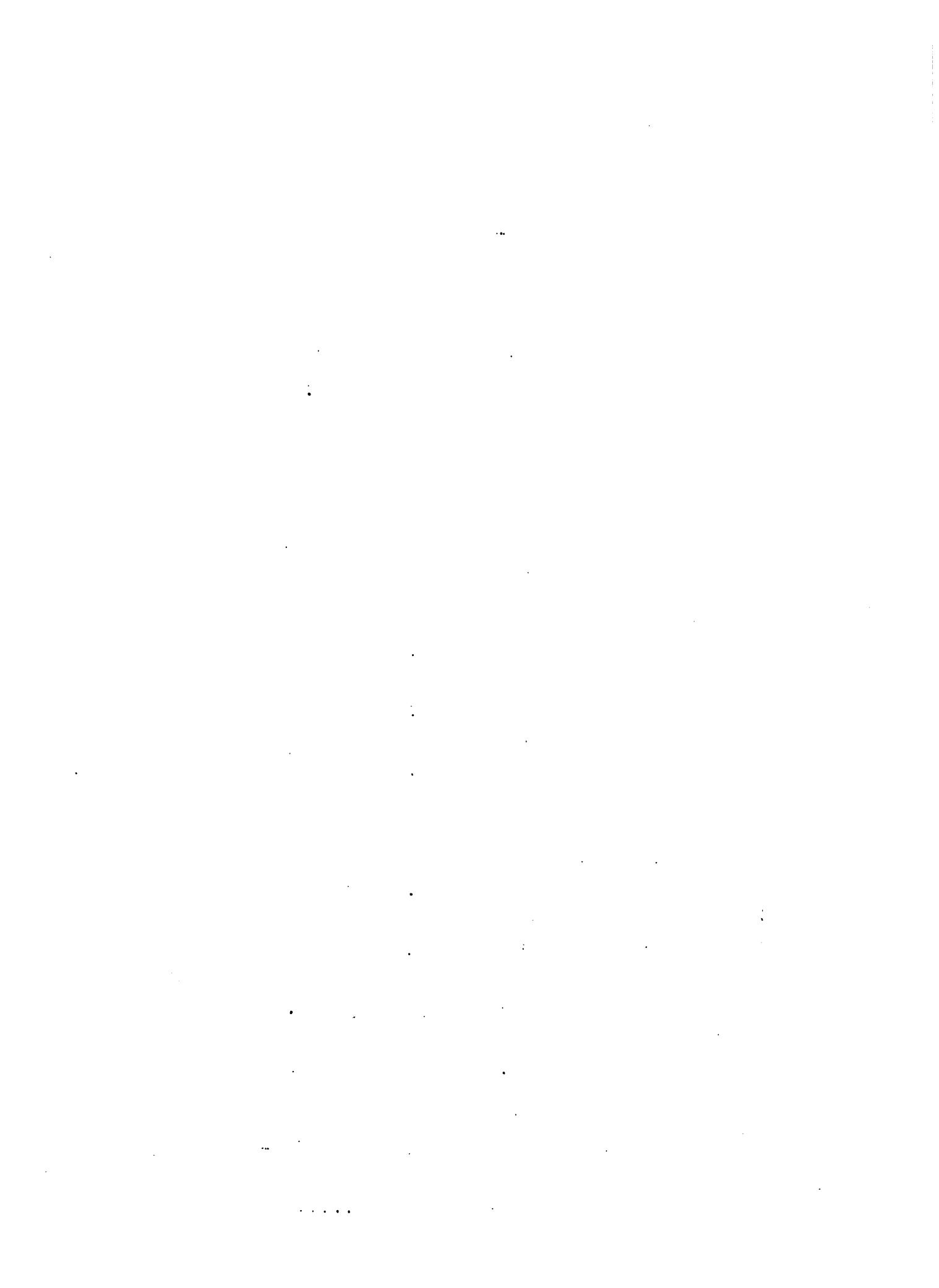
coloration, insect infestation or splits,

therefore, the real loss due to rodents

as defined here is 8.30 lbs. The same is

true to the 23.70 lbs. loss as spillage.

Therefore % losses due to spillage

and rodent attack are quantified as follows:

$$\frac{8.30 - 8.30\ (0.10) + 23.70 - 23.70\ (0.17)}{309.6} =$$

$$\frac{27.14}{309.6} = 0.09 = 9\%$$

/TABLE 21 (overleaf)........

T A B L E 21

SUMMARY OF LOSSES

LEVEL CONSIDERED	FROM ACT. NO.	TO ACT. NO.	BADLY DISCOVERED	SPLITS	INSECTS	RODENT AND SPILLAGE	TOTAL
Farmer			3	2	-		5
Rural handling and storage at G.M.C. buying point			0.8	0.8	1.3		2.90
Transportation to Georgetown			0.5	-	0.4		0.9
G.M.C. Storage			2.70	-	1.50		1.20
Handing to wholesaler			3	-	-		3
Wholesaler storage				0.2			0.2
Farmer to wholesaler						9	0
Total			10	3	3.20	9	25.20
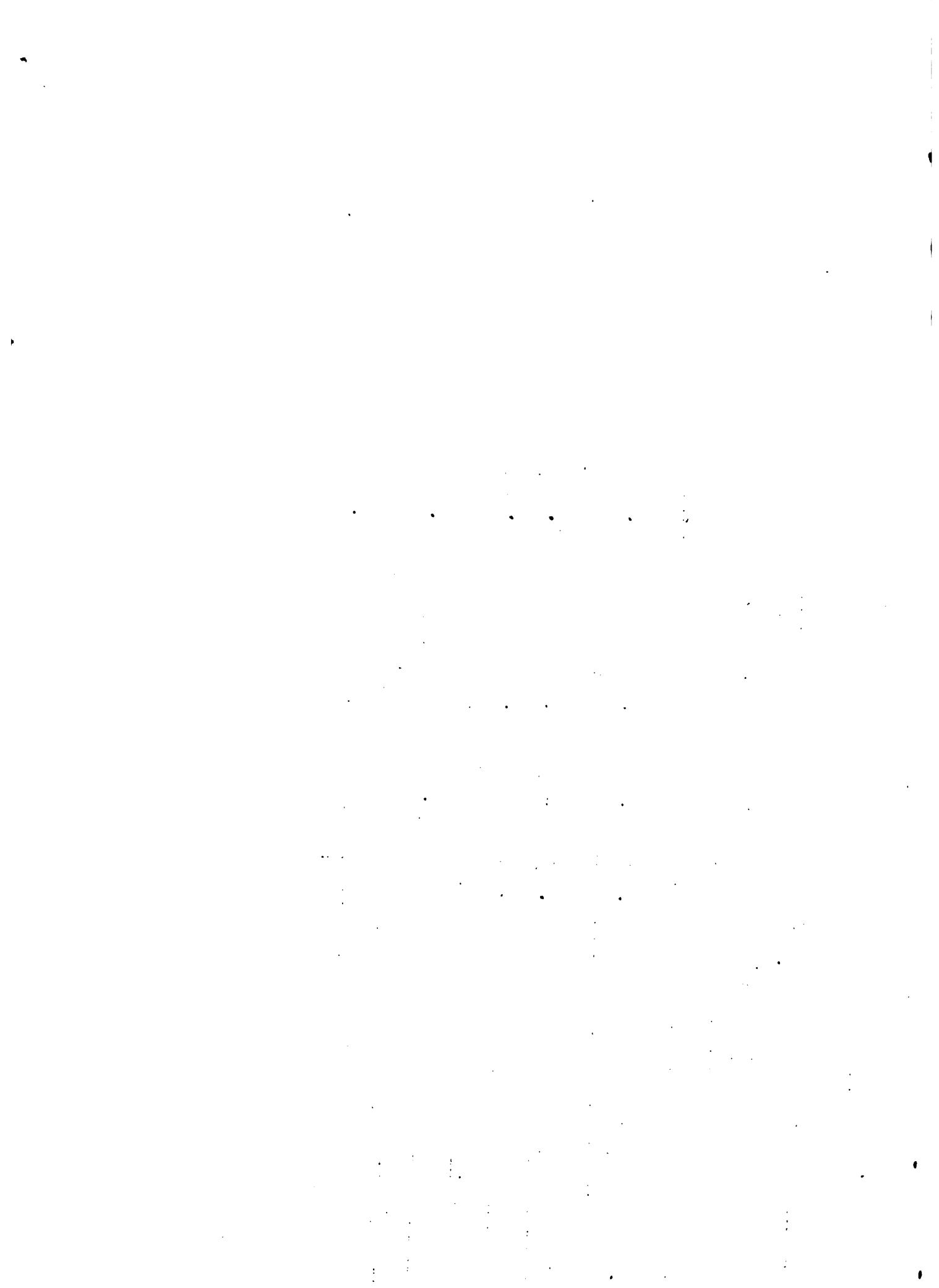
G R A P H No. 1
## COMPARISON OF LOSSES AT DIFFERENT POINTS
IN THE FLOW
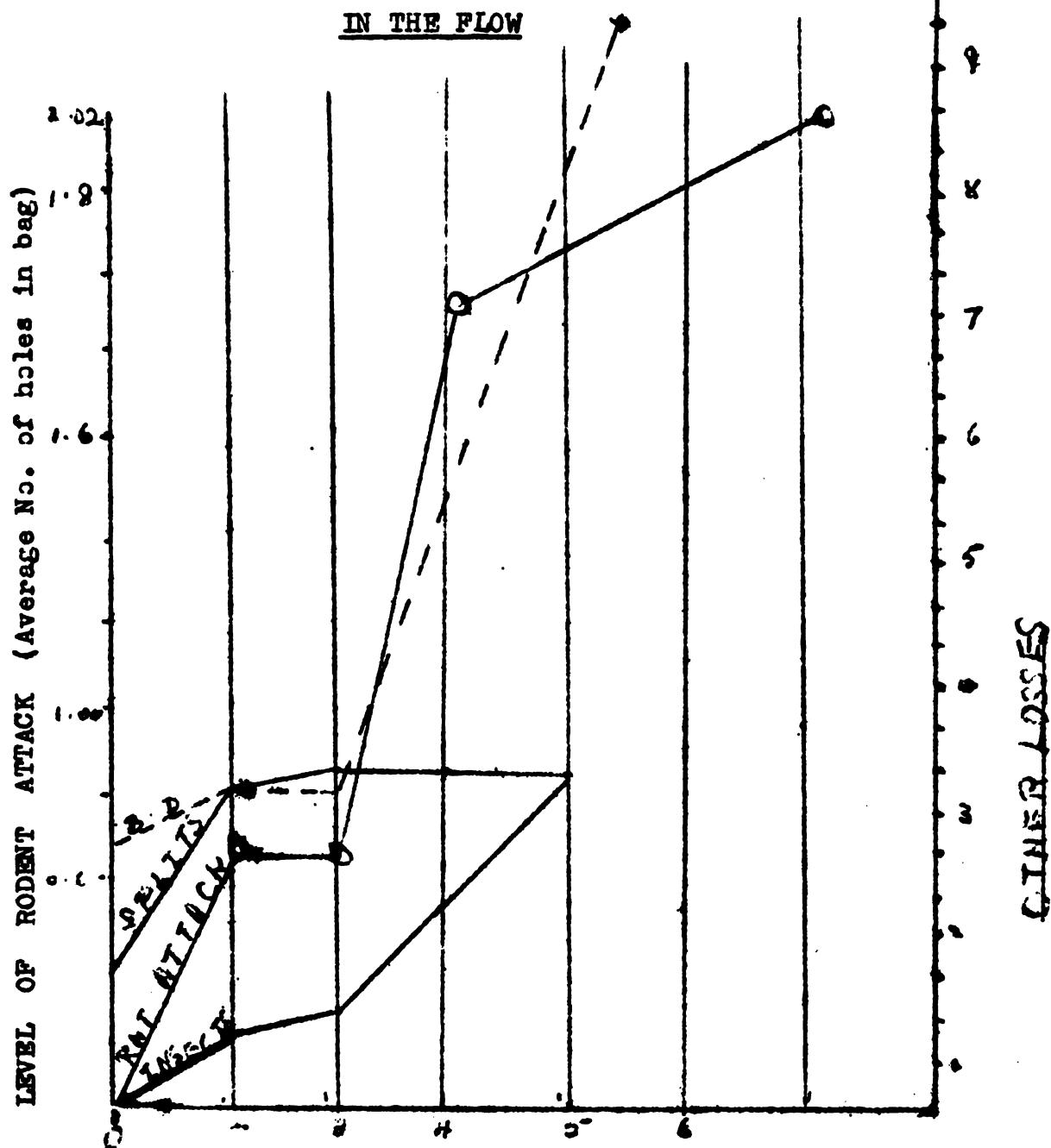
1 - Before leaving the farm

2 - Before leaving to Georgetown

3 - At arrival in Georgetown

4 - After storage at G.M.C. in Georgetown

5 - After storage at wholesaler