OLIVE RIVER RUN-OFF PLOTS
DESCRIPTION OF THE EXPERIMENT

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by

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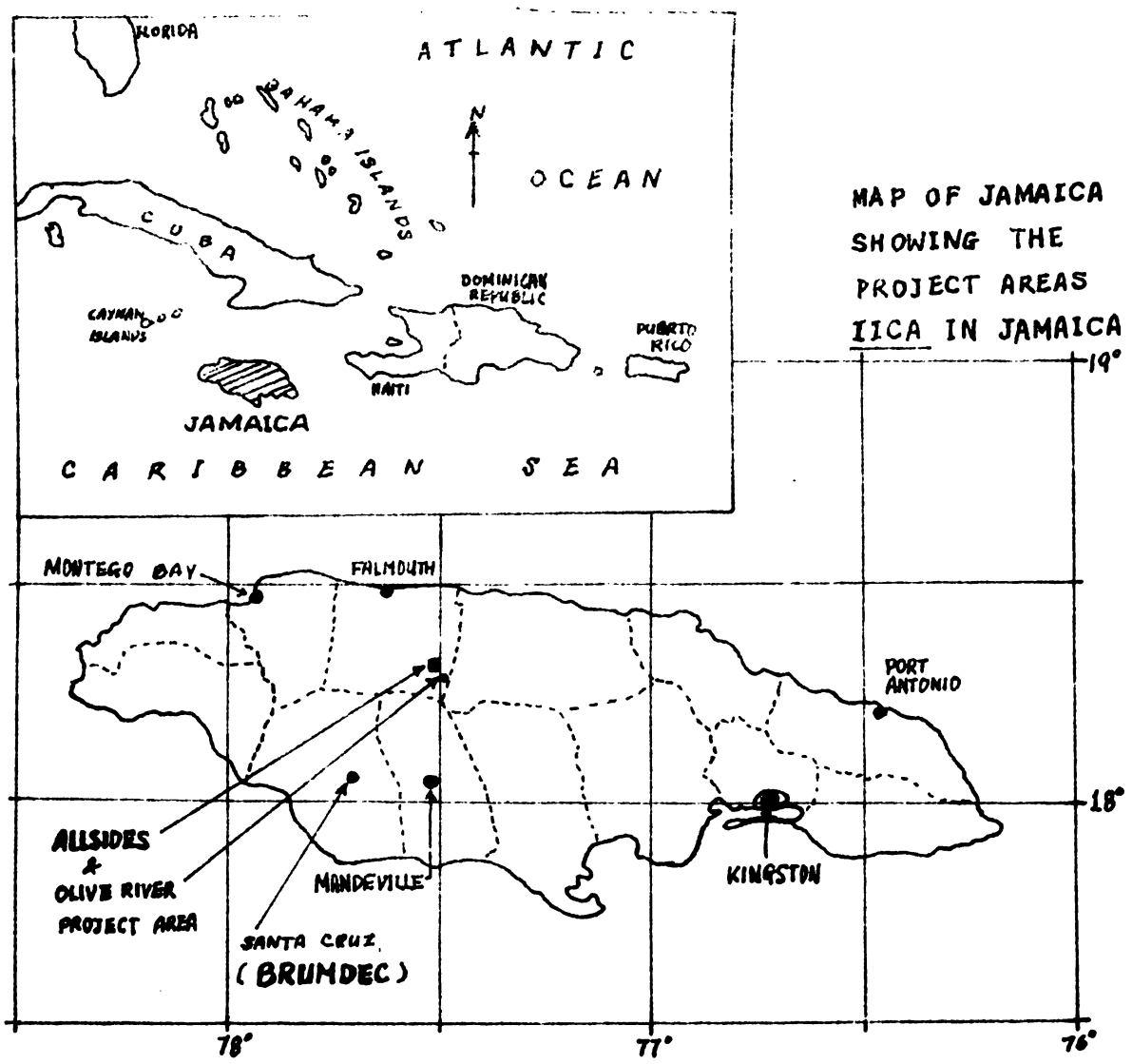
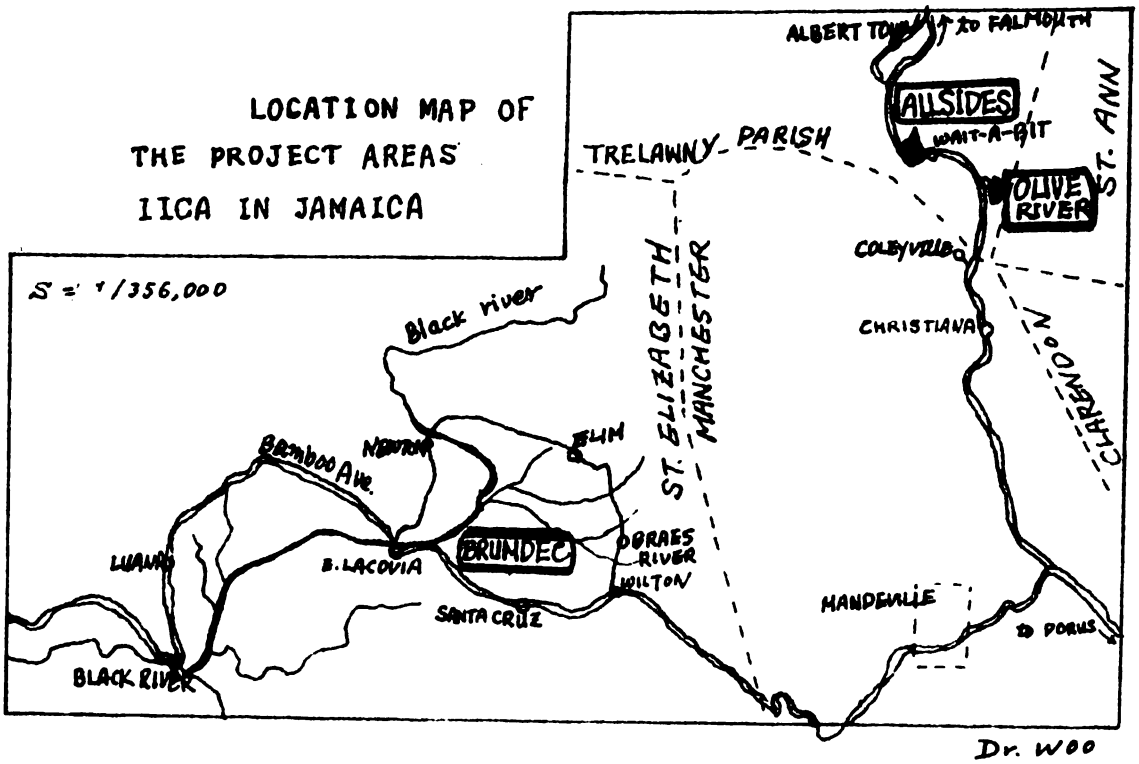


MAP OF JAMAICA SHOWING THE PROJECT AREAS IICA IN JAMAICA



Dr. WOO

FOREWORD

As a result of conversations initiated by the IICA Office Director with the Ambassador of Korea, Dr. Woonsong Choi, a tripartite agreement between the Government of Jamaica, the Government of Korea and IICA was signed in August of 1979.

Based on the above agreement, Dr. Bo Myeong-Woo was brought to work with IICA, and he was asked by IICA to monitor the Olive River/Jamaica Experimental Station.

Dr. Woo is Professor of Forestry and Soil Conservation at the Seoul National University. He finishes his contract with IICA in February 1982 and returns to teaching.

Dr. Woo has demonstrated ability, capacity and resilience in dealing with the day to day problems. All the staff of IICA/Jamaica have great personal and professional regard for him.

IICA/Jamaica welcomes this paper to the IICA/Jamaica collection "Agriculture in Jamaica", and wishes Dr. Woo continued success in his work in Korea.

Percy Aitken-Soux
Director

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I. BACKGROUND - SOIL CONSERVATION

Soil erosion and sedimentation are the most important factors affecting the production of food crops in the hillsides of Jamaica.

Technology for the control of erosion and sedimentation has been underway for many years in the developed countries. Originally, the research efforts focused primarily on agricultural land.

The first scientific investigation of soil erosion was carried out by the German, Wollay (1877-1895). Small plots were used to measure a wide range of effects such as:

- vegetation and surface mulches on the interception of rainfall;
- deterioration of soil structures;
- effects of soil type;
- slope on run-off plot; and
- erosion.

Since then, the bulk of activities relating to soil erosion research has been centered mainly in the United States of America. The first quantitative experiments were laid down by the Forest Service in 1915 in Utah. They were followed by those of Miller in Missouri in 1917. As a result of long-term research work, the main features of the erosion process were identified and mathematically enumerated. The former initiated today's quantitative scientific investigation.

In the West Indies, some experiments on rates of soil erosion have been conducted in Puerto Rico and Trinidad and Tobago, by the University of the West Indies in 1973 and in Barbados by the IICA Office in 1978.

In Jamaica, a soil loss experiment on the Wait-A-Bit Clay loam (Map No. 95) was conducted by Mitchel, USAID soil adviser, at James Hill, Central Clarendon. This experiment indicated that a bare escarpment lost an average of 1.4 inches annually in a three-year period (1962-1965). The method involved the placement of metal spikes in the ground.

In cultivated watersheds (Yallahs), the rate of erosion was measured by Champion (1966). Estimated soil loss from the Upper Yallahs Valley was 40 tons per acre per year, or 14 acre-feet per square mile per year.

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Run-off experiment plot studies have been conducted at the Smithfield Demonstration Centre in Hanover since 1969 by the UNDP/FAO JAM 505 Project. A site with a slope of 17^{o} was selected and subjected to four treatments, using yam as the sole crop. The average soil loss from the check plot was 54 tons of oven dry soil per acre per year. The bench terraced plots' loss was 7 tons per acre per year. For other types of soil conservation treatments, soil losses varied from 7 to 16 tons per acre per year. No significant difference was found in annual run-off water among all the plots. The run-off water percentage was approximately one-third of the annual rainfall received by the plot in a cropping year.

In 1977, the Government of Jamaica requested IICA's assistance in developing viable systems of production for newly terraced lands. After the experiments were completed, and recognizing the high cost required to build bench terraces, IICA began in 1980 to test the viability of farming systems using systems of soil conservation other than terraces.

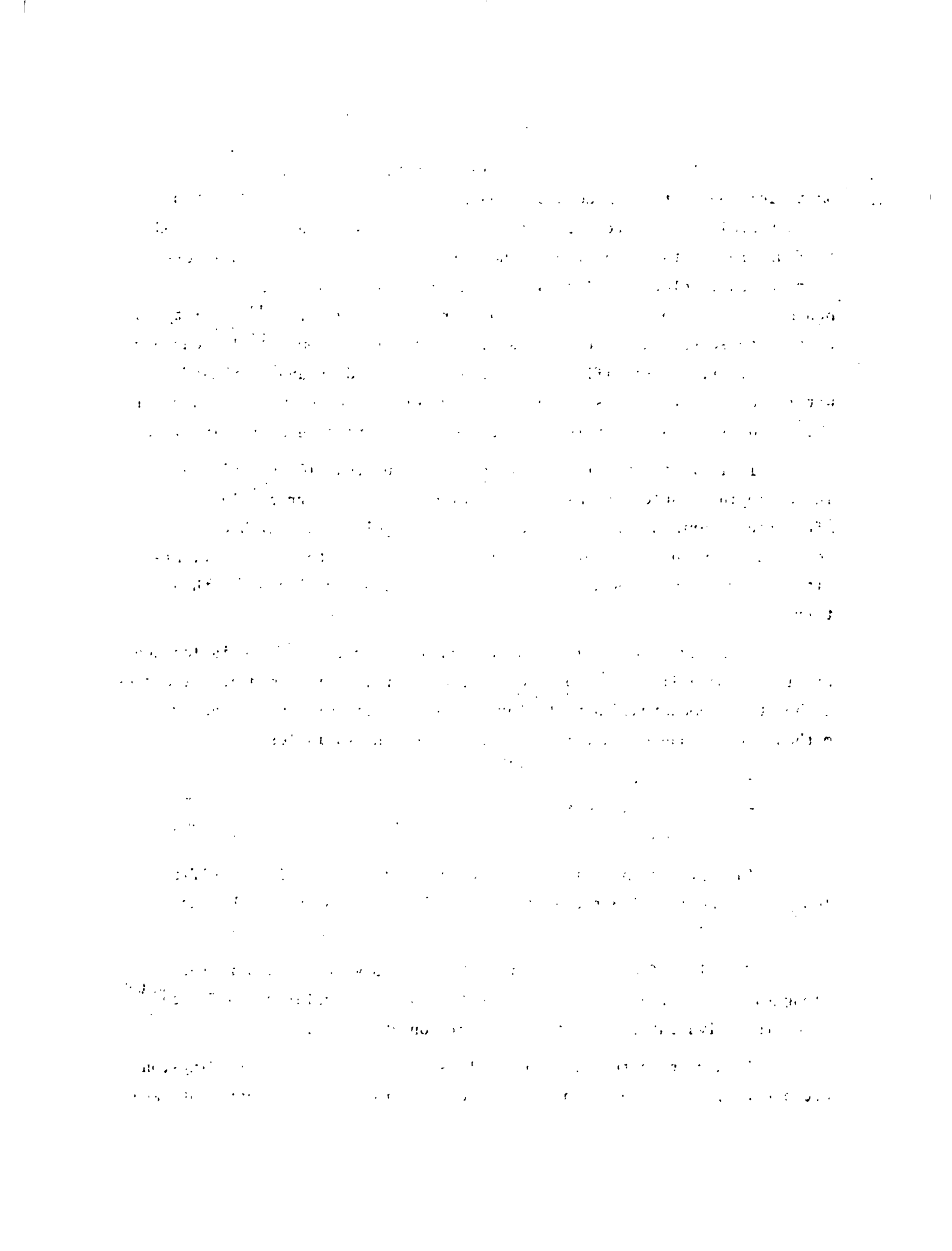
The Olive River Soil Conservation Demonstration Centre is located within the Lowe River area of Trelawny. The Project is aimed at the establishment of demonstration plots for farming systems with soil conservation methods other than bench terracing, observing the variables of:

- productivity
- cost of soil conservation
- soil loss

The soil at the Olive River Demonstration Centre is classified locally as the Wait-A-Bit clay (Map No. 95) and the slope of the run-off plots is 20^{o}.

The size of a run-off plot is 2.7 metres wide by 15.8 metres along the slope producing 40 square metres of rectangular run-off area, which is equivalent to 1/100th of an acre on 20^{o} slope.

Inquiries in the field as well as at the IICA Office in Kingston are often received concerning procedures for initiating run-off plots and



criteria for the design of the plots. This publication is a follow-up to the IICA/Jamaica publication "Crop Production on Hillsides using Non-Bench Terracing Alternative Measures for Soil Conservation." This publication will present step-by-step procedures for establishing run-off plots. It will follow the installation and construction methods used at the Olive River Soil Conservation Demonstration Centre.

II. CONSIDERATIONS AND DETERMINATIONS FOR THE RUN-OFF PLOT CONSTRUCTION

The main components of a run-off experiment plot are: (1) site selection (2) size of plot (3) slope (4) boundary walls (5) earth wall (6) side-pavement (7) collection trough and conveyance pipe (8) storage tanks and outlet pipes, and (9) rain gauge installation.

The principal considerations for determining the appropriate specifications of each component of the run-off plot design are described. Additionally, the main procedures and reasons for adoption of the specifications are given.

1. Site Selection for the Construction of the Run-off Plot

In general, the most suitable site for installation of the run-off plot is where the slope is sufficient to place the tanks close to the low border of the run-off plot, and to use side ditches to drain away run-off water. The slope topography will dictate the excavation required for the installation of equipment.

The extreme situation can be reached where the slope flattens out below the plots. In this situation, it is necessary that the tank site be dry, and drainage ditches must be used to ensure this. In allocating the plots, the run-off experimental plots should be laid out in blocks so that plots are separated only by the boundary walls. Also, enough space should be provided for appropriate replications of the treatments, at the same site.

2. Size of Plots

The ideal size plot for measuring surface run-off and soil sediment should be a miniature of the natural watershed. Size of a plot affects significantly the process of soil erosion and carrying of run-off materials from the plot.

In general, the run-off experimental plot could be built in a square or rectangular shape. Square plots have the advantage that the ratio of plot border to plot area is less than for rectangular plots. The main advantage of a rectangular plot is that a larger slope is provided for a given area.

The run-off experiment facilities consist of eight (8) sets of run-off plots and receiving tanks. Under the consideration of the maximum utilization of the given topography in the site where the land surface slope is nearly 20° within the land of the Olive River Centre, the size of one plot was determined as 2.7 metres (8.9 ft) wide by 15.8 metres (52.5 ft) long, along the slope (14.8 metres horizontally) making 40 square metres (435 ft^2) of run-off producing area which is 1/100th of an acre and/or 1/250th of a hectare on 20° degree sloping land.

The relationship between the slope and horizontal area are shown in Figure 1.

3. Boundary Walls

In general, various devices such as (a) shallow drains (b) earth mounds (c) metal sheet strips, and (d) wooden planks, have been used on the run-off experimental plots elsewhere to isolate the actual plot from its border area.

The following disadvantages, among others, are generally recognized in relation to the following types of boundary walls:

(a) drain boundaries: plot run-off water may be diverted into them;

(b) earth mound boundaries: heaping up the earth leaves a channel which concentrates run-off

and tanks to scour, or alternatively to avoid forming the channel, extra soil may be carted onto the plots, but this is a laborious process when several cultivations are required during the season.

(c) metal sheet boundaries: it is sometimes expensive and dangerous to the operators of the run-off plots; and

(d) wooden plank boundaries: wood is very susceptible to termite infestation and damage.

At Olive River a set of eight (8) contiguous run-off plots (as shown in Figure 2) was originally designed and constructed along the slope to accomodate four soil conservation and cropping system treatments. Each plot was delineated by concrete block boundary walls. The height of the boundary wall is 35 cm from the soil surface and the width, including the cement mortar lining work is 15 cm.

At the lower end of the plot boundary, the concrete block (lower end wall) is keyed into the collection trough (a metal sheet tongue) and a small heap of earth packed round to prevent leaks.

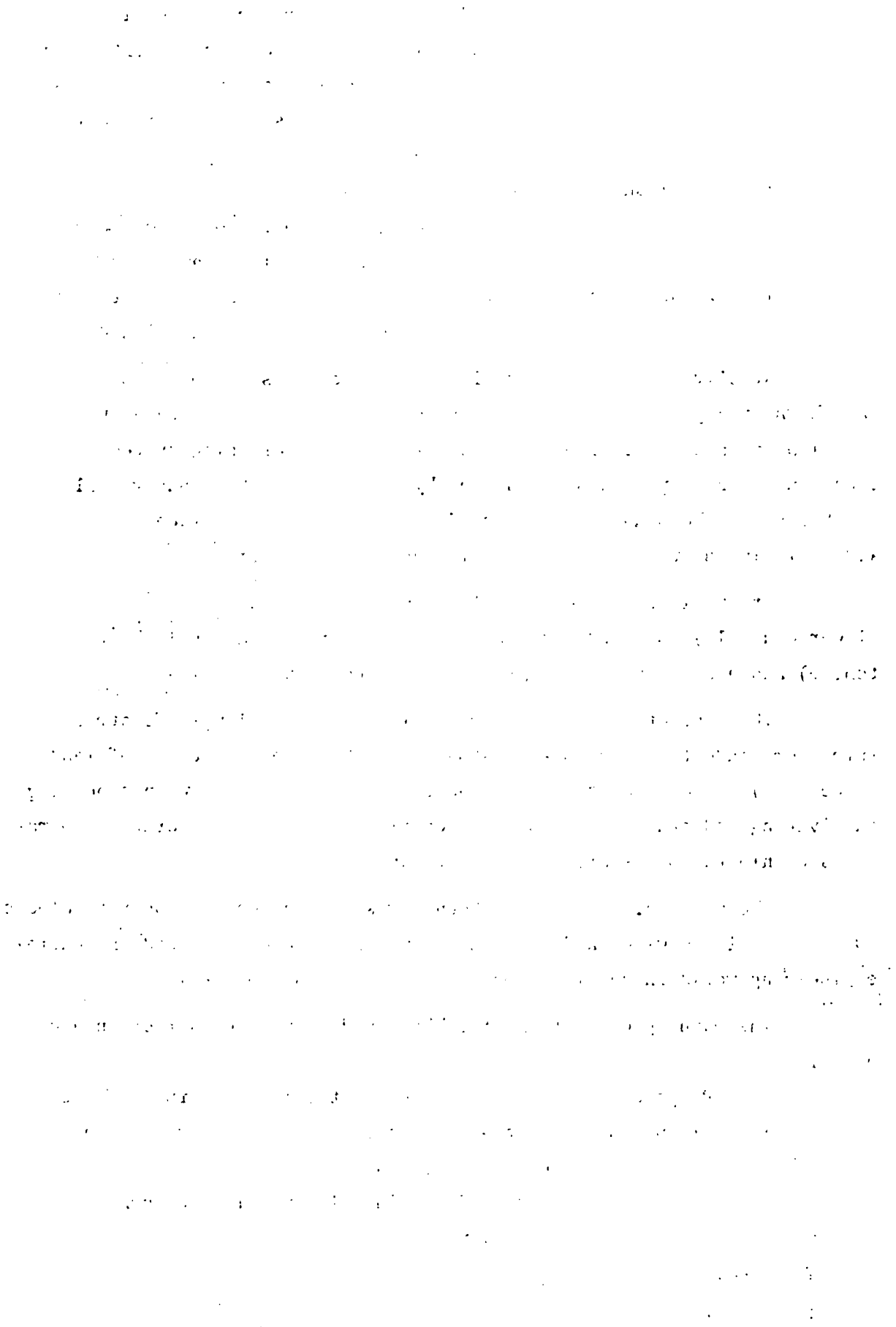
The concrete block boundary walls are rather long-life structures for conducting the run-off studies in the same conditions of land slope (20^{o}). These walls are permanent and also immovable when ploughing, cultivating and other operations are carried out. Land preparation operations within the plots are carried out manually.

The material used in the boundary walls was hollow concrete blocks 40 cm long, 14 cm wide, and 18 cm high, which are commonly used in general engineering works in Jamaica (locally called 5½ inch blocks).

The main specifications for the boundary wall construction are as follows:

(a) Purpose: for separating and protecting each run-off plot;

(b) Dimension: Height - 35 cm above the ground surface, and 5 cm under ground..
Width - 15 cm wide (14 cm + 1 cm of cement mortar lining).



(c) Shape of top crest: U-shaped cross section which serves to drain the rainfall water from the crest of the up-and-down wall.

(d) Materials: concrete block (5½ inch block)

(e) Masonry method: stand on-end method.

(f) Lining works: After the masonry work with the concrete blocks, lining with cement mortar on the portion above the ground is completed. Thickness of the lining is about 0.5 cm at each side of the wall.

4. Earth Wall

In addition to the concrete boundary wall, a one-foot wide earth embankment wall along the perimeter outside of the boundary wall (both side-walls and top wall) was constructed to support the boundary wall, and to protect again against seepage. After the embankment construction, carpet grass (Axonopus compressus) was transplanted to protect the earth s surface. A cross section of an earth wall is shown as "ew" in Figure 3.1.

The purpose and specifications of the earth wall are as follows:

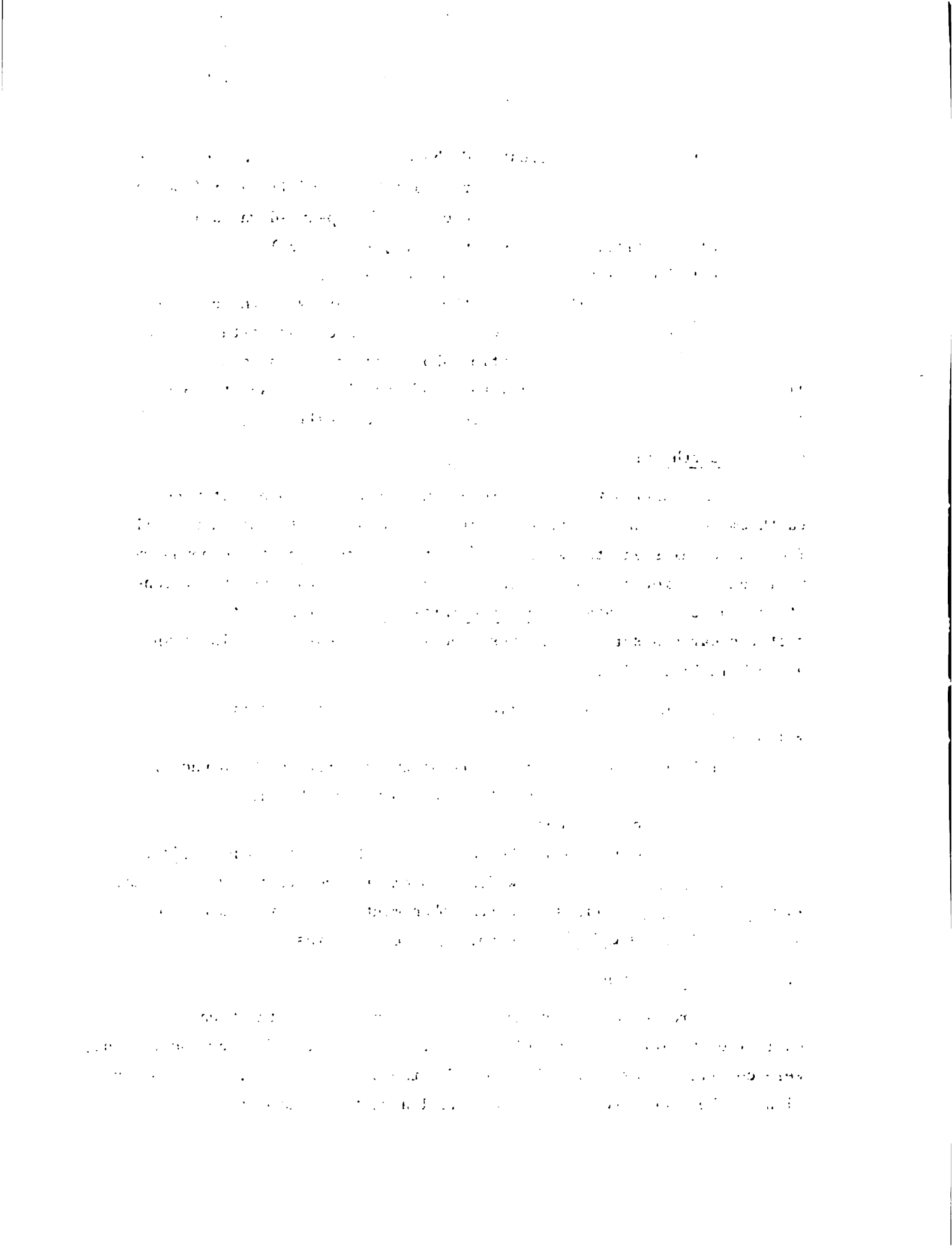
(a) Purpose: for supporting the concrete block boundary wall of the perimeter of the plot.

(b) Specifications:

- dimensions: height - 30 cm above the ground surface; width - 30 cm attached to the wall.
- materials: earth embankment, and protected by planting of carpet grass.

5. Side Pavement

Narrow concrete pavements at only one side of the boundary wall of each plot having a width of 20 cm and a depth of 11 cm underground, were constructed as foundation work for the boundary walls. The construction of the side pavements has practical advantages such as:



(a) for retaining the plot boundary wall;

(b) for preventing scouring erosion along the boundary wall;

(c) for use as a cultivating operation path, and

(d) for separating the neighbouring plots.

A cross-section of a side pavement is shown in Figure 3.2.

The purpose and specifications of the side pavement are as follows:

(a) Purpose: for preventing scouring erosion along the boundary wall.

(b) Specifications:

- dimensions: thickness - 11 cm under surface of ground.
  width - 20 cm on only one side of the boundary side wall.
- materials: concrete, mixed at the field.

6. Run-Off Collection Trough and Conveyance Pipe

The collection trough for run-off materials serves as a collection area across the bottom of the plot, and as a conduit for run-off material to the storing and sampling unit tanks.

The galvanized sheet has a distinct advantage of being malleable. This makes it possible to adjust its height to the level of the lower-end boundary of the plot as soil subsides during erosion.

The collection trough acts, therefore, as a leading channel for the run-off materials. This trough was designed to reach across the entire width of the plot, and the major elements of this design are depth, width and bottom slope.

Design slope can be determined in two ways, depending on whether a measuring flume is used or whether run-off is conducted directly to the sediment tank. If a flume is used, depth of the trough is controlled by the size of the approach channel required by the flume. The design is, therefore, started by choosing the type and size of the flume necessary to handle maximum run-off. This would be the depth of the

flume plus about 10 per cent free board. When a conveyance pipe alone is used (no rate measurement), the depth of the collection trough is based on the size of the outlet pipe needed to carry the run-off load.

After the depth of the collection trough is calculated as discussed above, a free board of approximately 5 to 10 cm is added to the collection trough depth. This free board is needed primarily to form a notch across the plot and may be changed to suit local design requirements. (width of trough, within limits, is largely a matter of preference). It should be narrow enough to form an efficient channel, but wide enough to allow a worker to clean it easily, about 20 or 30 cm or about equal to the depth of the flume.

Bottom slope is usually pre-determined by the over all length of the trough and the required depth. However, a good figure to use is a 5% minimum slope. Screens on the outlet conveyance mouth of the trough could be used to keep trash out of the outlet system. A screen of about 2 cm mesh works well and can be attached to the trough wall towards the outlet pipe. Under these considerations, the collection trough designed has dimensions of 270 cm in length, 30 cm in width, and 25 cm in depth, with a rectangular shaped box made of the galvanized sheets.

A collection trough set consists of the main body of the trough and attachments such as an outlet conveyance pipe, supporting bars, insertion tongue and cover. For preventing the undesirable entry of rainfall water and debris into the collection trough, an adequate cover (271 cm in length, 31 cm in width) made of galvanized sheet was provided for each trough.

Each collection trough set has five (5) supporting iron bars (about 1.5 cm in width and 30 cm in length) across the width of the trough so as to maintain the strength of the trough and also to protect it from damage.

The upper edge of the trough is extended to make an insertion tongue, about 30 cm wide, so as to insert it into the compacted soil of the lower end of the plot. The insertion tongue blocks off the plot and furnishes a stable attachment for the collection trough. The insertion tongue of the trough therefore assists in leading away run-off materials as well as in the protection of the lower end of the plot boundary from leakages and from seepage.

Each collection trough set also has an outlet conveyance pipe for the run-off materials, running from the collection trough body to the sediment tank (A). This outlet pipe is made of the same material (galvanized sheet) as the collection trough body and has a rectangular shape. The dimensions of the outlet conveyance pipe is 100 cm long, 20 cm wide, and 15 cm high. The edge of the upper end is welded to the middle part of the trough.

The eight (8) sets of collection troughs and their attachments were all painted for protection from rust. The front and top view of a collection trough is shown in Figures 4-1 and 4-2.

The purpose and specifications of the collection trough and outlet conveyance pipe are as follows:

(a) Purpose: for collection and conveyance of the run-off materials from the plot above to the tanks below.

(b) Specifications:

- dimensions: length - 270 cm
  width - 30 cm
  height - 25 cm
- shape: rectangular, box-like
- cover for the trough: for preventing the entry of excessive rainfall and other residue into the trough.
- dimensions of the cover: slightly bigger than the trough, so as to fit over the trough.
- materials: galvanized sheet for trough and cover.

- attachments: supporting bars, 5 flat iron bars per trough, having 1.5 cm width and 30 cm length. Insertion tongue, for inserting into the plot soil portion, actually an extended portion of the trough into the plot above, with a width of 20 cm.
- conveyance pipe: located between the collection trough and Tank A, and having the following dimensions---length 100 cm, shape rectangular, width 20 cm, height 15 cm, material galvanized sheet, and attached to the trough by welding.

7. Run-Off Soil and Water Storage Tanks

Two 55 gallon (220 litres) capacity metal drums of 85 cm height and 57.5 cm diameter were installed for each run-off plot for the collection of run-off soil-water material. These tanks designated A and B are referred to as sediment tank (A) and suspension tank (B).

The sediment tank unit (A) has two major functions: (1) to retain all the heavy soil material and pass only a suspended sediment mixture to the next tank unit (B), and (2) to store sediment which will make up the bulk of the soil loss from the run-off plot.

Turbulence in the sediment tank (A) due to high entrance velocities from the run-off plot is reduced by placing appropriate wood sticks along the flow direction, or screens across the flow through the sediment tank. In case of screens, the screens also keep trash from clogging up the tank. Over-flow material from tank (A) is conveyed to the suspension tank (B) by means of metal outlet pipes. Two metal pipes of 60 cm length (one is a 2" pipe of 5 cm inner diameter, the other a 4" pipe of 10 cm inner diameter) were welded to the upper end of the tank (A). These pipes are supported by means of the iron bars welded to the bottom side of tank (A). Each tank has a short drain pipe with plug cap of 20 cm length and 5 cm inner diameter for using the final drain from the bottom of the tank after appropriate measurements were recorded.

In the case of suspension tank (B), it has only one outlet metal pipe (2" pipe) of 60 cm length at the top level of the tank for safe drainage of the excess run-off water from tank (B) to the outside drain, and also supported with iron bars like tank (A). Tank (B) also has a final drain pipe of 20 cm length which is welded on as in tank (A).

To service the eight (8) run-off plots, a total of 16 tanks (Tank A - 8 and B - 8) were installed, each resting on a concrete base having a thickness of 10 cm. The drums may either be disconnected and overturned or emptied with small sized rubber hoses.

To facilitate the sampling of soil run-off measurements from the collection troughs, a continuous 80 cm wide concrete pavement was constructed across the lower end (around the trough area) of the eight plots. This pavement also serves to reinforce the plots against possible slippage down-hill.

Sometimes, the multislot division could be adopted for the proper conveyance of over-flow run-off from sediment tank (A) to suspension tank (B). In the experiment at the Olive River Centre, however, the experiment was principally to get the soil losses rather than the run-off water. The run-off collecting system in this experiment was, therefore, not considered in the multislot division system. The side and top view of both the sediment and suspension tanks are shown in Figures 5-1 and 5-2.

The purpose and specifications of the tanks and outlet pipes are as follows:

(a) Purpose: for storage of run-off soil and water transported from the collection trough above, through the conveyance pipe.

(b) Specifications:

- material: metal drum (commonly used drum, 55 gallon size)
- dimensions: height - 85 cm
  diameter - 57.5 cm
  capacity - 220 litres (approx. 55 gallons)

- outlet pipe (b): for conveying the excess overflow water from tank (A) to tank (B). There are two round steel pipes per each tank (A), of 60 cm length and 5 cm inner diameter. They are attached to tank (A) by welding, are also supported by two bars welded to tank (A), and are made of steel.
- outlet pipe (c): for conveying the excess overflow from tank (B) to the drainage ditch outside. There are two outlet pipes per tank (B), of the same length and shape as those for outlet pipe (b). They are attached to tank (B) by welding and are also supported by two bars.

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- outlet pipes (d) and (e): outlet pipe (d) is for the final drainage from the bottom of tank (A) to the outside. Outlet pipe (e) is for the final drainage from the bottom of tank (B) to the outside. Outlet pipes (d) and (e) are attached to tank (A) and (B) respectively, by welding to the bottom of the tanks.

8. Rain Gauge

A standard rain gauge was installed on the concrete-made platform at the front side of the middle part of the receiving tank area. Daily rainfall is measured at 8:00 a.m. in the morning.

The Clear VU rain gauge in the metric system (mm) is constructed of tough, clear tenite butyrate plastic, and is virtually unbreakable and will not crack or become brittle with age. Graduations are

raised and darkened for easy reading. The gauge stands 35 cm (14 inches) high, and 10.6 cm (4 inches) in diameter, and is designed with a rust-proof mounting bracket for attachment to post or stake. By the metric system, the gauge measures each 0.2 mm to a maximum of 279 mm. No measuring stick is required.

III. IMPORTANT POINTS IN CONSTRUCTION PRACTICES FOR THE RUN-OFF PLOTS

The essential features of a run-off plot installation include those necessary for acquiring accurate data, and those for accomodating the operations which are to be performed.

The following are important points which were considered in the installation and construction of the run-off plots at the Olive River Demonstration Centre.

1. In Construction of the Boundary Walls

The boundary walls, as described earlier, consisted of the top-wall, lower-end wall, and the side-walls which run up and down the run-off plot, and these walls form eight rectangular plots at the same site.

These walls were constructed with concrete blocks. During the construction period, attention had been given particularly to the small drainage way of the V-shaped section on the top crest of the side walls. This V-shaped drain serves to remove the rainfall safely from the crest of the side walls to the top of the plot below. Careful attention was paid to the concrete base and the side-pavement (20 cm wide) attached to the concrete block side-wall, and also to the lining of the walls, using cement mortar to prevent cracks and leakages in the future.

To ensure against leakage or seepage resulting from burrowing by animals such as rodents, it is imperative that periodic checks be conducted on all the boundary walls.

2. In Construction of the Collection Trough

The eight (8) sets of collection troughs were made of galvanized steel (gauge No. 30, 3 feet wide by 8 feet long), forming a rectangular box-like trough by welding. Carefull attention was given particularly to the welding works for preventing damage due to cracking. Care was exercised in the installation of the insertion tongue for providing a satisfactory run-off channel for water through the portion of the lower-end wall. Asphalt-cement mortar was used to seal any seams when nailing it to the lower-end wall.

A concrete base for the troughs was provided for their safe and proper installation.

Finally, a retaining wall was constructed with concrete blocks to protect the cut-slope from excavating between the collection troughs and the receiving tanks. The retaining wall was constructed to a height of 90 cm above ground and 20 cm underground, respectively. This wall was reinforced with steel bars and a lining with cement mortar.

3. Construction of the Run-Off Storage Tanks

Operating the run-off plots is always a wet and muddy job, since it occurs after rainfall. The tanks should therefore be placed on a platform to facilitate the sampling of run-off soil, and the cleaning of the equipment without wading around in mud. A concrete platform (80 cm x 80 cm) was thus provided for each tank and a mettle-ballasted pavement was provided to prevent mud from collecting around the tank area.

Careful attention was paid particularly to the welding works between the drum (thin metal sheet) and the outlet pipes (heavy steel pipe). The outlet pipes were adequately supported by small-sized steel bars attached to the lower part of the drum.

4. Construction of the Lateral Facilities

The run-off experiment plots at the Olive River Demonstration Centre were laid out in blocks so that plots were separated only by the side-boundary walls. Hence, excavation for the sediment receiving tanks

(A & B) and drains could be in the form of one large ditch-like platform to accomodate the drums for all the plots. A service road was built to run along the line of sediment receiving tanks (A & B).

A drain ditch was constructed with the pre-fabricated concrete blocks (60 cm x 90 cm with parabolic cross section) along the end line of the outlet pipes of the suspension tank (B). A diversion ditch planted with carpet grass was also constructed at the upper boundary wall of the experiment plots for safe disposal of excess run-off water from the up-slope land above the plots.

Finally, for protecting the experiment plot, the entire perimeter of the plot was closed with barbed-wire fencing.

IV. SOIL CONSERVATION TREATMENTS AND CROPPING SYSTEMS

1. Soil Conservation Treatment

In designing the treatments for the system or systems to be recommended, much importance was given to simplicity and ease of adoption by the farmer. These considerations also took into account the cropping systems which the farmer is traditionally accustomed to, and possible ways of enhancing farm productivity with a modicum of technological change.

Viewed in toto, the soil conservation treatments were evaluated together with cropping patterns that are relevant to the area and the farming community.

Consequently, the following four basic soil conservation treatments and cropping systems were selected for evaluation during the first cropping cycle (March 1980 to February 1981). Arrangement of the soil conservation treatments and cropping systems is shown in Figure 6.

In cases where individual hills were constructed, (Treatment I & II) they were spaced at a distance of 1.5 m along the contour horizontally and 1.4 m along the slope (1.3 m horizontally). The height of hills from the soil surface was approximately 60 cm.

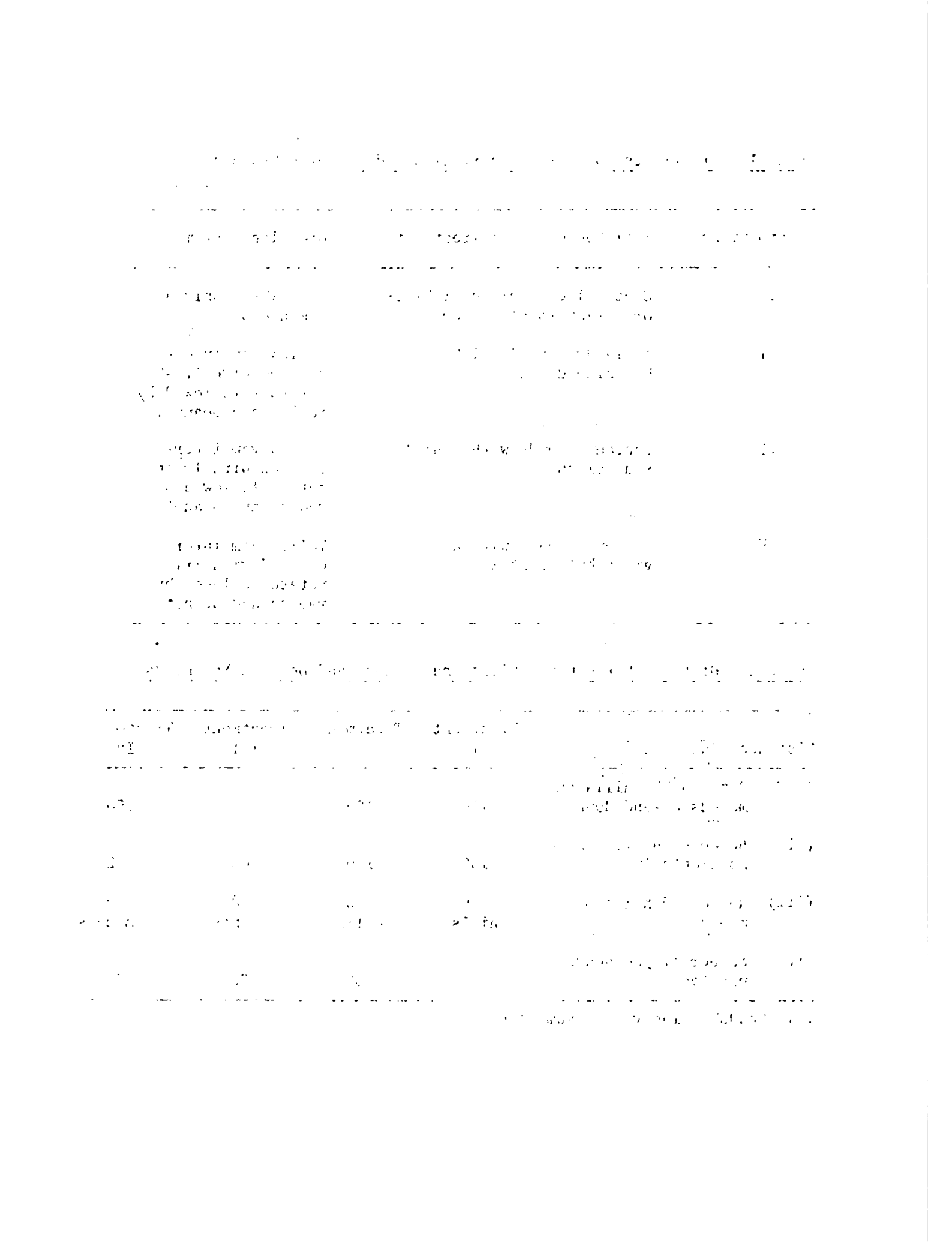
Table 1 Treatments for Soil Conservation and Cropping Systems

Treatment No.	Soil Conservation Treatment	Cropping System
I	Check, i.e. individual hills or "traditional system"	Yellow yam only as a monocrop
II	Individual hills with a hillside ditch	Yellow yam intercropped with Irish potatoes followed by radish and peanut.
III	Contour mounds with a hillside ditch	Yellow yam intercropped with Irish potato followed by radish and peanut
IV	Contour mounds with a grass buffer strip	Yellow yam intercropped with Irish potato followed by radish and peanut

Table 2 Distance between the Hills and Mounds, and between Yam Heads

Distances (unit: cm)		Treatment I	Treatment II	Treatment III	Treatment IV
(i)	Between the hills and mounds up-and-down	150	150	150	150
(ii)	Between the yam "heads" horizontally	130	130	62	62
(iii)	Number of hills or mounds	20 hills	16 hills	8 mounds	9 mounds
(iv)	Number of yam heads planted	32	32	32	32

Yam "heads" = individual yam plants



The contour mounds (Treatment III & IV) extended across the plots and were spaced 1.5 m apart with a height of 45 cm.

A hillside ditch having a width of 2.0 m (2.5 m along the slope) was constructed approximately midway down the plots (7.6 m and 8.0 m along the slope from the top-wall, and 4.9 m and/or 5.3 m along the slope from the lower wall) for Treatments II and III. This is a triangular type of hillside ditch which is effective to keep the run-off materials from the above slope-land and also is used for the farm path. Napier grass (Pennisetum purpureum) was transplanted for stabilization. A cross-section of the hillside ditch is shown in Figure 7.

Specifications for the hillside ditch on the 20^{o} land slope are as follows:

(i) total width: 2.3 metres
(ii) reverse slope: 10%
(iii) riser slope:
(iv) height of riser: 57 cm
(v) reverse height: 18 cm

A grass buffer strip having a width of 1.3 m was established about mid-way down the plot (7.6 m and/or 8.0 m along the slope from the top-wall) and 5.9 m and/or 6.4 m along the slope from the lower-wall for Treatment IV only, by planting Napier grass at a spacing of 30 cm. A plane view of the grass buffer strip is shown in Figure 8. Napier grass is one of the most promising species of grass for the hillsides of Jamaica. It establishes with relative ease and serves as a good source of fodder for cattle.

2. Cropping Systems

Since the amount of run-off sediment for a given slope is also related closely to crop cover, it was decided to introduce the concept of intercropping whereby more than one crop is grown simultaneously on the same plot of land, i.e. multicropping.

This system is ideally suited to small farm operations on hillsides in Jamaica, in terms of (i) employment generation; (ii) increased farm income; (iii) increased productivity per unit area; and (iv) enhancing nutritional profiles of farm families. An ideal cropping pattern for rainfed agriculture is one which makes maximum use of rainfall water, available soil moisture, and crop nutrients, plot space and incoming solar radiation energy.

Based on these considerations and on experiences gained from the "Allsides Hillside Farming Development Project", yam was intercropped in sequence with Irish potatoes, radish and peanut as shown in Figure 6.

Irrespective of soil conservation treatments and cropping systems, each plot received the same number of yam heads (plants), 32, to produce an expected population of 8,000 yam plants per hectare, equivalent to 3,200 per acre.

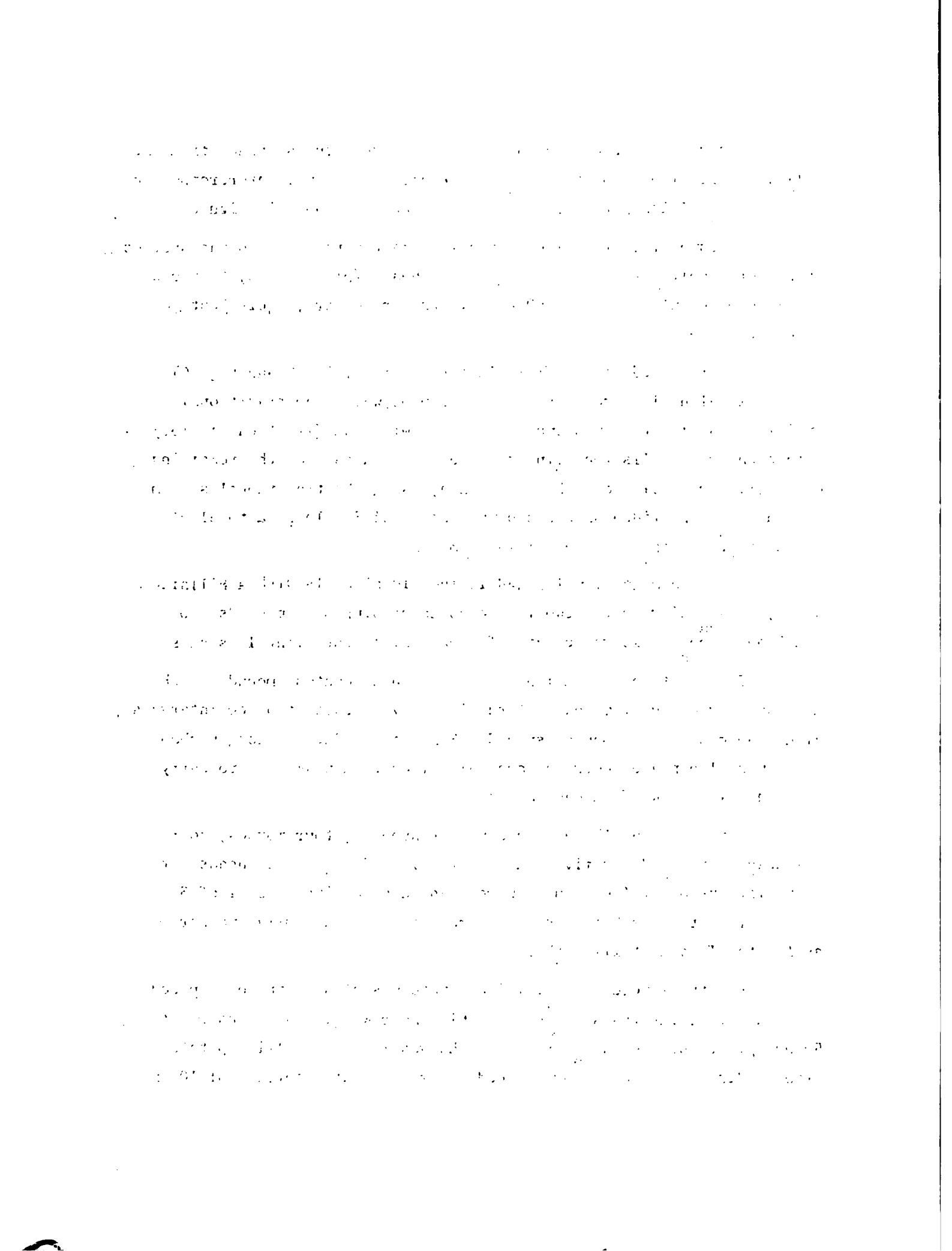
As presented in the field layout diagram (Fig. 2 and Fig. 6) 20 individual hills were constructed per plot where the traditional individual hill method was employed for growing yam (Treatment I plot) with each of 12 hills receiving two "heads", and each of the remaining eight hills receiving one "head". Again, using the traditional system each hill was provided with one bamboo stake of 5 m long, a total of 20 stakes to accomodate the twining yam vine.

For Treatment II which had 16 individual hills with a hillside ditch, each hill received two yam heads comprising 32 yam heads. One 5 m long bamboo stake was erected for each hill, totalling 16 stakes.

For Treatment III which had 8 continuous contour mounds, each mound received four yam heads, totalling 32 yam heads at 62 cm intervals along the mound, with mounds spaced 1.5 m apart. One 5 m long bamboo stake was also placed between each pair of contiguous mounds to carry four yam vines, two from each mound.

For Treatment IV which had 9 continuous contour mounds, four yam heads per mound for five mounds were planted, and three heads per mound for the other four mounds were planted so making a total of 32 heads per plot. The bamboo stakes were erected in a similar manner as for the Treatment III method.

For the intercropping, Irish potato was planted in rows spaced 40 cm apart at intervals of 30 cm within the row, giving a density of 50,000 plants per hectare. Following harvesting of the Irish potato crop, radish was sown in rows spaced 30 cm apart at intervals of 10 cm



within the row. This resulted in a plant population of approximately 125,000 per hectare. After the harvesting of the radish crop, peanuts were sown in rows spaced 40 cm apart, and at an interval of 20 cm within the row. This gave an expected density of approximately 63,000 plants per hectare.

V. PROCEDURES FOR MEASURING & CALCULATING SOIL LOSS FROM THE RUN-OFF EXPERIMENT PLOT

1. Measurement of Rainfall

The amount of daily rainfall is measured using a standard rain guage located next to the run-off plots. At 8:00 a.m. measurements were taken and recorded on the "Rainfall Recording File."

2. Measurement of Soil-Loss

2.1 Duration for Measuring and Sampling Soil-Loss Determination

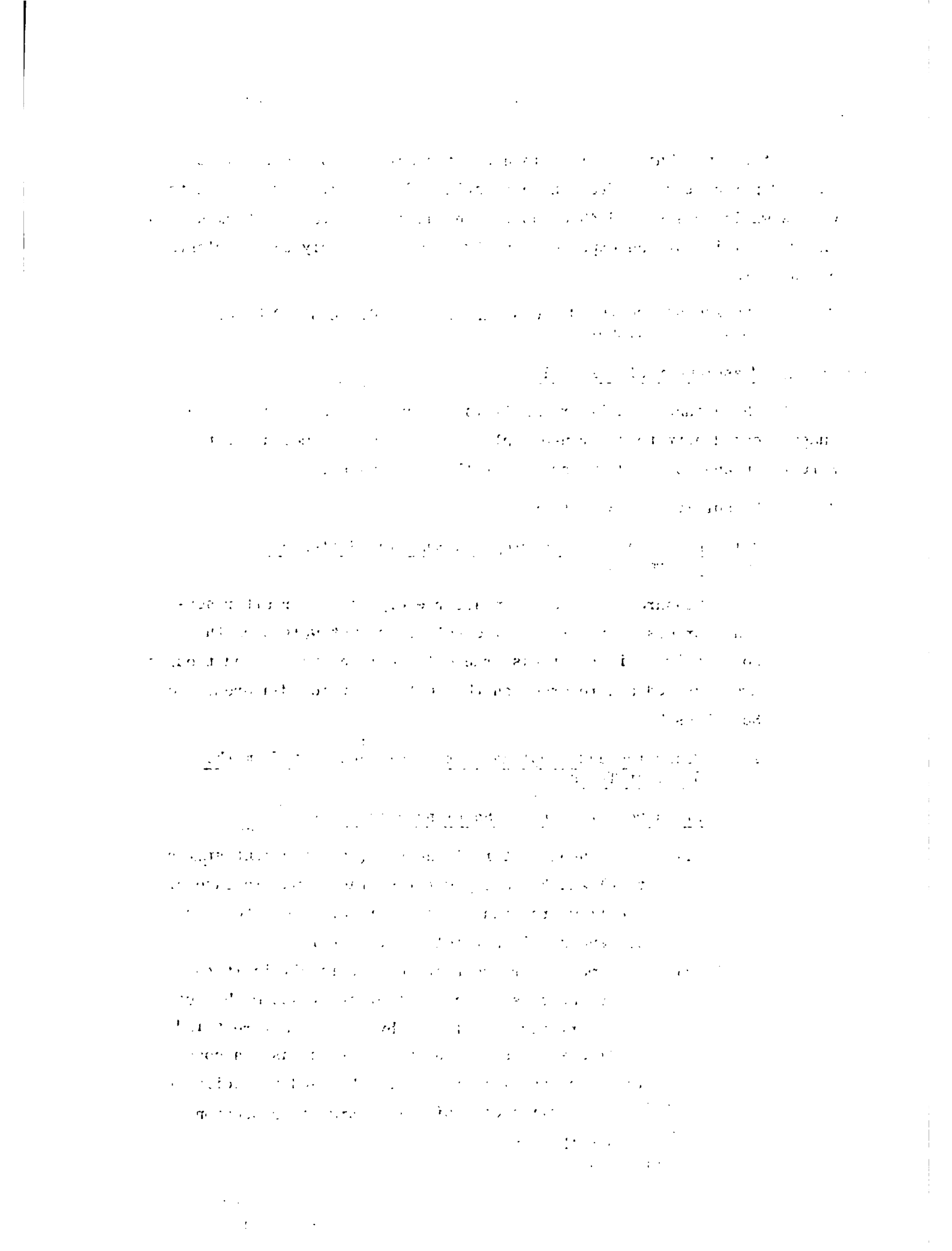
Measurements are taken after every storm, or after several periods of rainfall. The volume and wet weight of the soil sediment in the tanks (run-off receiving tanks) and troughs are measured and recorded on the "Data Sheet for Measurement of Soil-loss."

2.2 Measuring and Sampling of the Soil Sediment from the Sediment Tanks

A. Field Measurement and Sampling Procedures

(1) The run-off water of tanks A (main sediment storage tank) and B (mostly water storage tank, in case of overflow from tank A above, is drained after the suspended soil-particles have settled.

(2) At times of frequent storms, it is difficult to carry out this exercise after every storm, because one storm may be followed by another before solid materials can settle down. In this case, a coagulant such as alum or lime can be used to facilitate quick settling down of soil-sediment suspension within the tanks.



(3) Drainage of the run-off water is then achieved by siphoning, with a plastic hose of about 10-15 mm in diameter, and about 2-2.5 m in length. The hose for siphoning should reach a depth of about half the height of the water in each tank. This operation is begun by sucking the hose with the mouth. In case there is a need to drain some more from a tank, due to the settling of sediment, the mouth of the hose should be made to reach carefully down to the estimated level. This draining operation should be continued carefully until the soil sediments have the minimum content of free water, and each tank has approximately the same water content.

(4) Total net amounts of wet sediment in volume as well as in weight are then measured simultaneously by using the graduated buckets (or bottles) in litres (or cc) units for volume and in kg (or gm) units for weight. Each measurement is recorded in the appropriate column of Form 1 (net wet-sediment in row "a", and net wet-weight in row "b". The plastic buckets (or bottles) should be precisely graduated by using the graduated glass cylinder. The weight of the buckets is also measured.

(5) If the total volume of sediment in tank A is more than one bucket, it is necessary to use two or more buckets so as to put the entire amount of sediment into the buckets at the same time. In this case, each bucket should be filled with the same amount of sediment, and the volume and weight measured and recorded as above. Then one bucket should be selected out of them for further sampling.

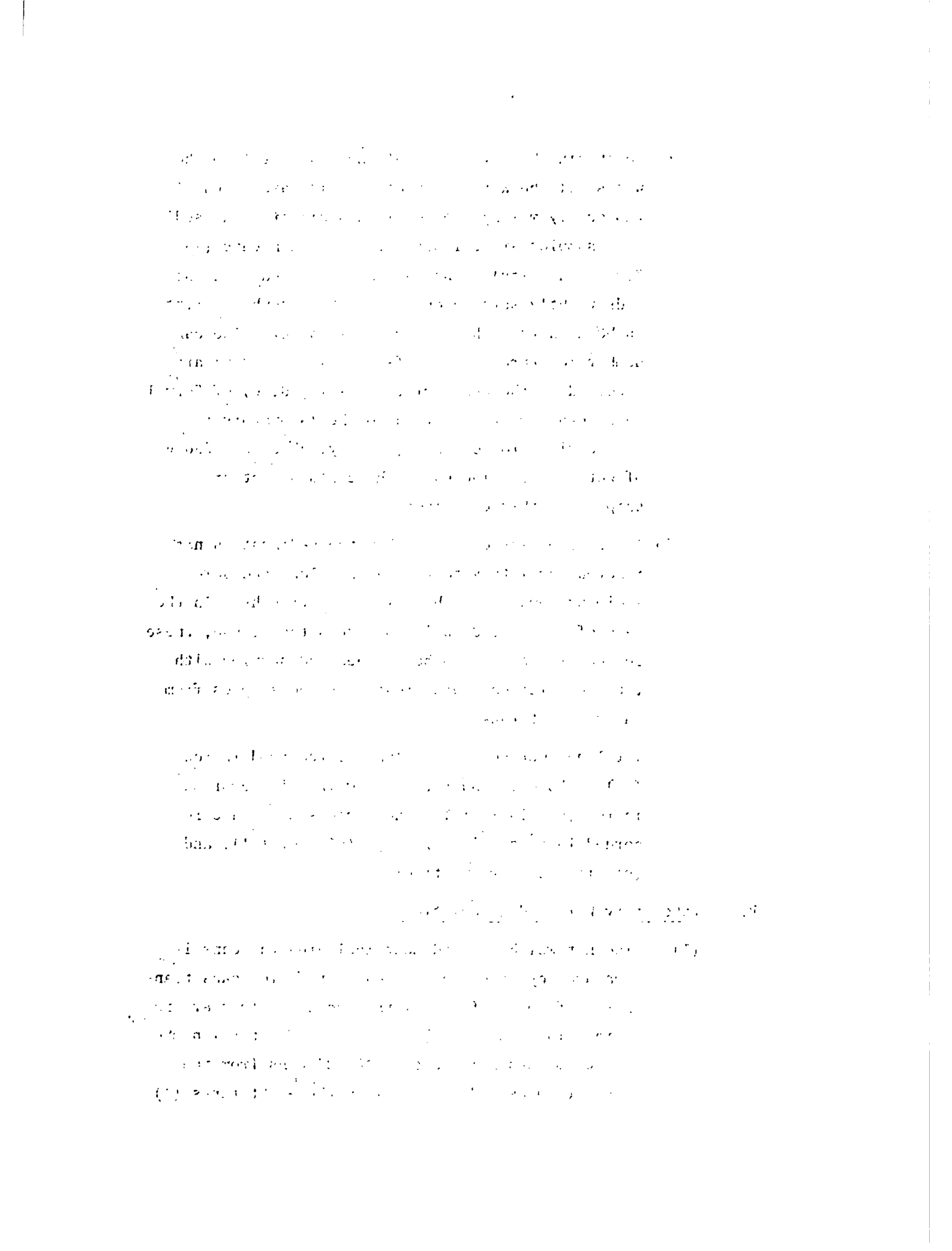
(6) To obtain the dry-weight of the sediment from the wet-sample bucket, three can-samples are taken after thoroughly mixing the bed-load sediment. The sediment samples are collected in aluminium cans (250 - 300 cc capacity). The cans are numbered with the lids tightly screwed on and matching numbers written on both parts with a water-proof marker. The can number for three samples (sample x, y, and z) are recorded in the appropriate rows (c, d, e) of Form 1. These cans are transported to the laboratory for oven-drying procedures. (Usually, about 200-250 gm of wet-sediment including the can's weight are sampled in this experiment).

(7) It is sometimes observed that the sediment is not removed completely to the tanks below, and some sediment remains in the collection troughs. In the case of sediment deposition within the trough, these sediments are also to be weighed and sampled with the aluminium cans and treated as the samples from the sediment tanks.

Total net wet-sediment volume is recorded in row (a') in Form 1, and total net weight is recorded in row (b') in Form 1. The three samples are recorded in rows (c') for (x'), (d') for (y'), and (e') for (z'), respectively.

B. Laboratory Work and Calculation

(1) The net weight of sediment including the cans is measured by weighing the sediment-filled cans transported from the field plots, and the values are recorded in column (Wwt) of Form 2. The total number of sediment-sample cans is 48: 24 cans from the eight troughs and 24 cans from the eight tanks (A).



(2) The weight of the cans including lids should always be measured prior to the sediment sampling works, and recorded in column (Cwt) of Form 2.

(3) Drying of the wet-samples is carried out by placing them in an oven until constant weight is obtained. Drying times are also dependent on the capacity of the oven and quantity of samples. (It has been fixed for 72 hours oven-drying at 105°C in the experiment).

(4) After 72 hours oven-drying, the sediment-filled cans are weighed to get the oven-dried weight of sediment samples including the can weight (Dwt), and recorded in column (Dwt) of Form 2.

(5) The net weight of wet-sediment samples (WSwt) is obtained by subtracting the can weight (Cwt) from the wet-weight of sediment.

(6) To get the net weight of oven-dried sediment samples (DSwt), it is necessary to subtract the can weight from the corresponding (Dwt).

(7) The rate of dry to wet-weight of the sediment samples is obtained by dividing the net dry-weight of the sample by the net wet-weight of the corresponding samples. The total dry-sediment weight of the tanks and/or troughs could then be computed by multiplying the total net-weight of sediment within the tanks and/or troughs by the average rate of dry to wet-weight. In this computation, however, the "per cent moisture" method was adopted by Dr. Wahab.

(8) The per cent moisture is then obtained by the formula:

$$\% \text{ moisture} = \frac{\text{wet weight (WSwt)-dry weight (DSwt)}}{\text{dry weight (DSwt)}} \times 100\ (\%)$$

The % moisture calculated by the formula is recorded in column (%M) of Form 2. By this step, Form 2 is completely filled up.

(9) The values of % moisture are transferred to the corresponding column (%c, %d, %e, %c', %d', and %e' respectively) of Form 1.

(10) The mean % moisture (M%) is computed by averaging the % moisture of three sediment samples (%c, %d, and %e, or %c', %d', and %e'). The total dry-sediment weight of a tank (SWta) is then obtained by multiplying the total net wet-weight of sediment of a tank (b) by the mean % moisture (M%) of its corresponding sample cans. The total dry-sediment weight of a trough (SWtr) is also obtained as for the tank A (namely (b') x M'% trough).

(11) Finally, the total dry-sediment weight (TDS) of a run-off plot is computed by adding the total dry-sediment weight of the tank (SWta) and its corresponding trough (SWtr).

(12) The soil-loss per run-off plot in dry-weight is then estimated as the total dry-sediment (TDS') weight.

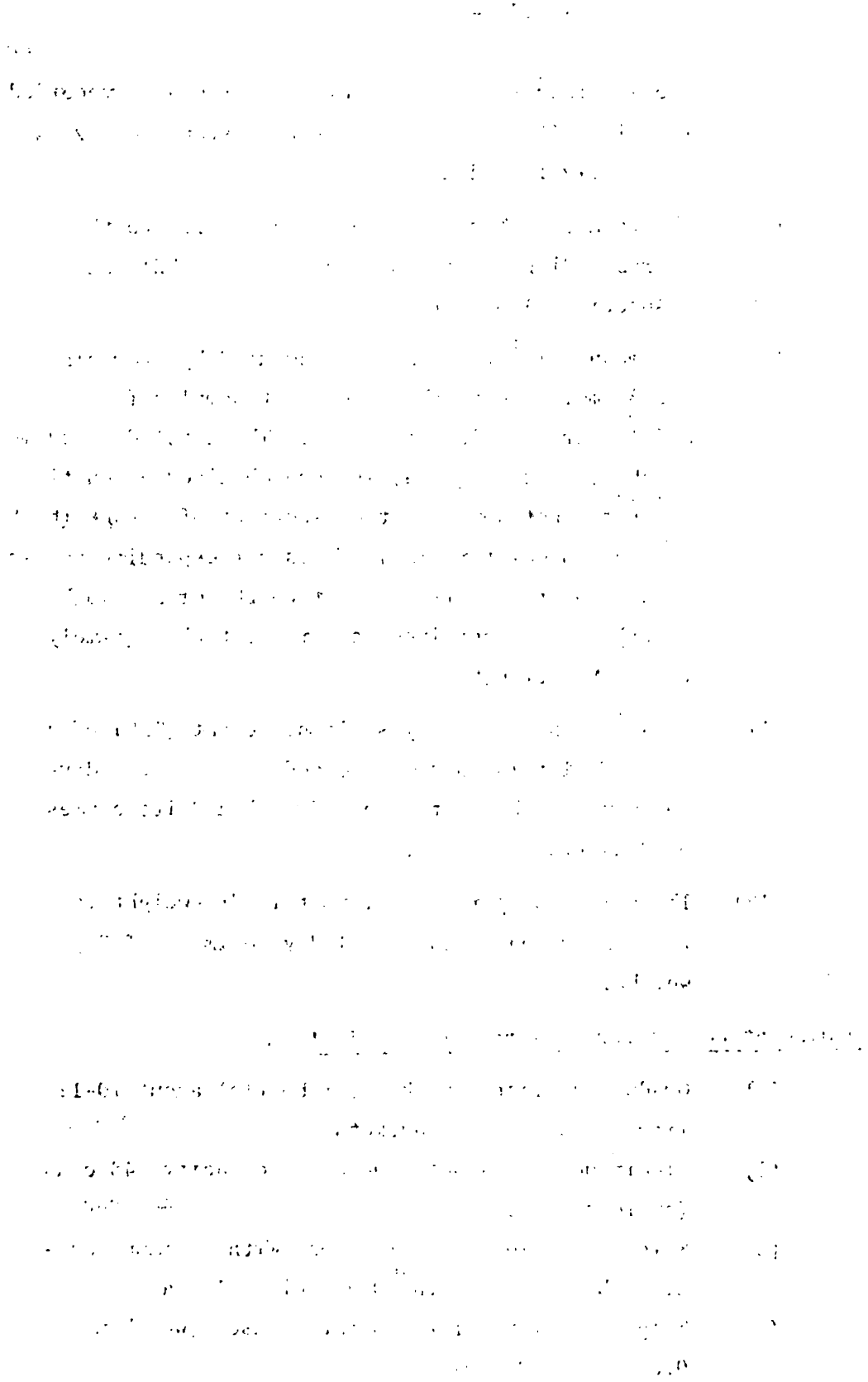
3. Equipment needed for Measurement of Soil Loss

(1) Graduated plastic bucket (or bottle) about 10-12 litres capacity: 5 buckets

(2) Aluminium cans about 200-300 cc capacity: 48 cans (at least as one set).

(3) Weighing scale for field uses with maximum capacity about 25 kg with 50 gm unit: 1 scale

(4) Weighing balance for laboratory uses (weighing 0.01 gm to 500 gm)



(5) Electric oven: one

(6) Draining hoses about 10 mm in diameter, and 2.5 metres in length: 2 hoses

(7) Plastic basin for field use about 4,000 cc capacity: 4 basins

(8) Graduated metric steel tape in mm unit: 1 ruler

(9) Trestle for laboratory use: 1 trestle

(10) Rain gauge: one

VI. COMPUTATIONS OF THE MATERIALS REQUIRED FOR CONSTRUCTION OF A RUN-OFF PLOT

1.	Concrete blocks (6" blocks)	2,000 blocks
2.	Drums (55 gallon) and caps:	16 drums
3.	Collection troughs and caps:	8 troughs
4.	Mixed concrete (volume):	6.41 m^3
5.	Cement mortar (volume)	1.40 m^3
6.	Steel bars (for retaining wall)	25 bars
7.	Mettles for ballasted pavement:	9 m^3
8.	Fence:	
	(i) barbed-wire	440 m
	(ii) fence posts	60 posts
	(iii) entrance gate	2 gates
	(iv) nails (2 inch)	330 nails
9.	Other:	
	(i) nylon-made strings	300 metres
	(ii) surveying pegs (wood stake)	100 stakes

LIST OF FIGURES

LIST OF FORMS

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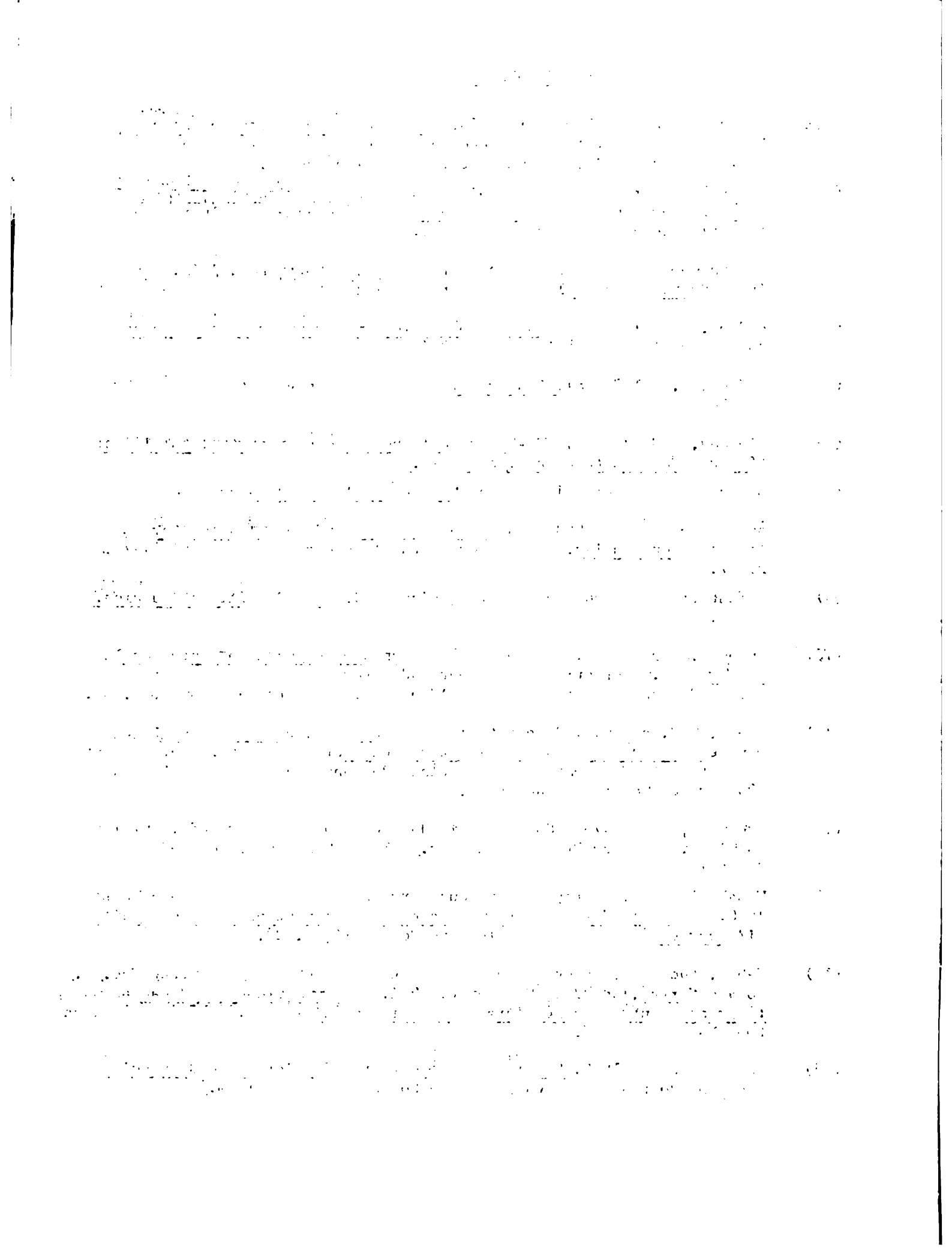


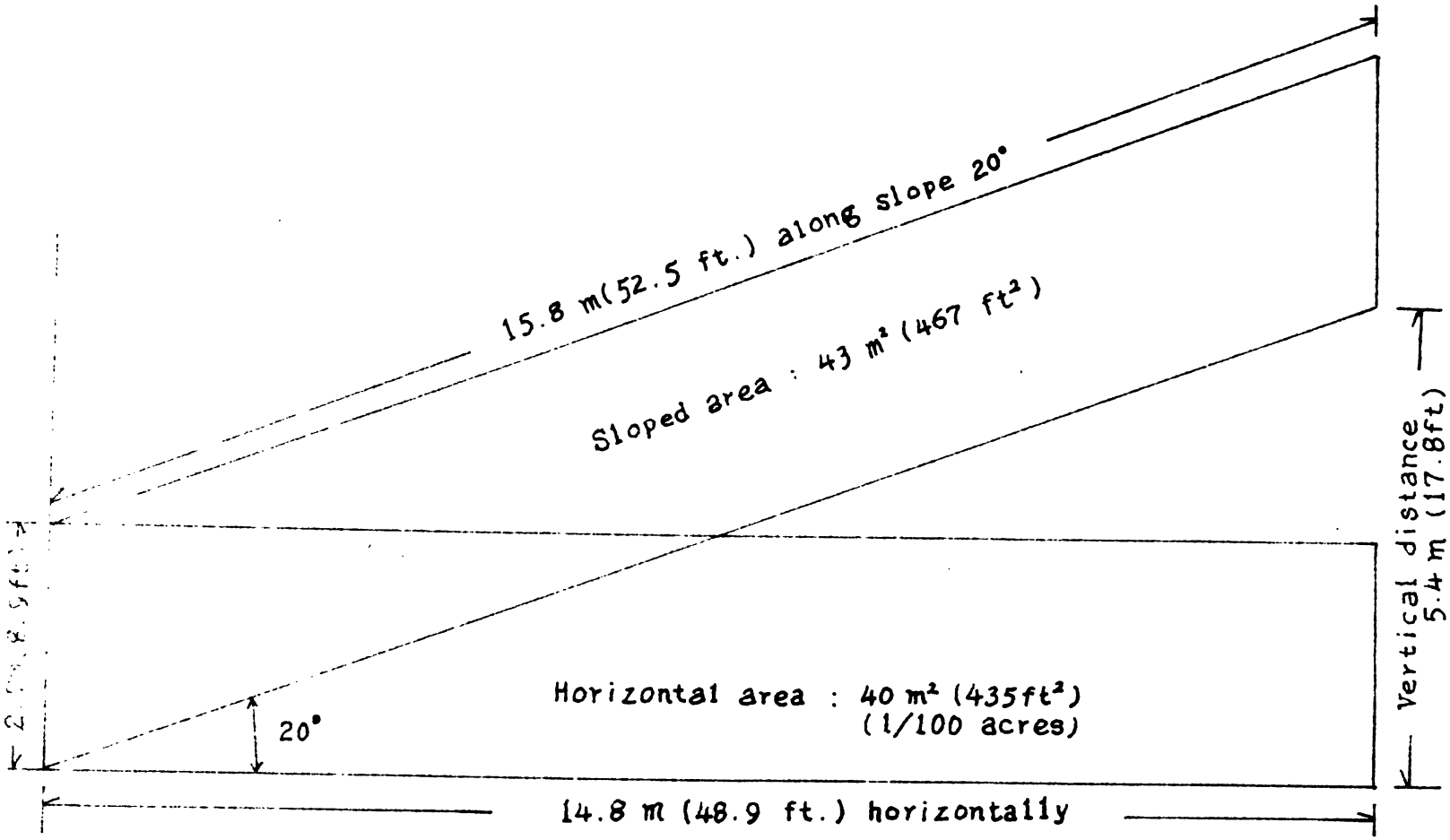


Fig.1 Relationship between the slope area and horizontal area of the experimental plots

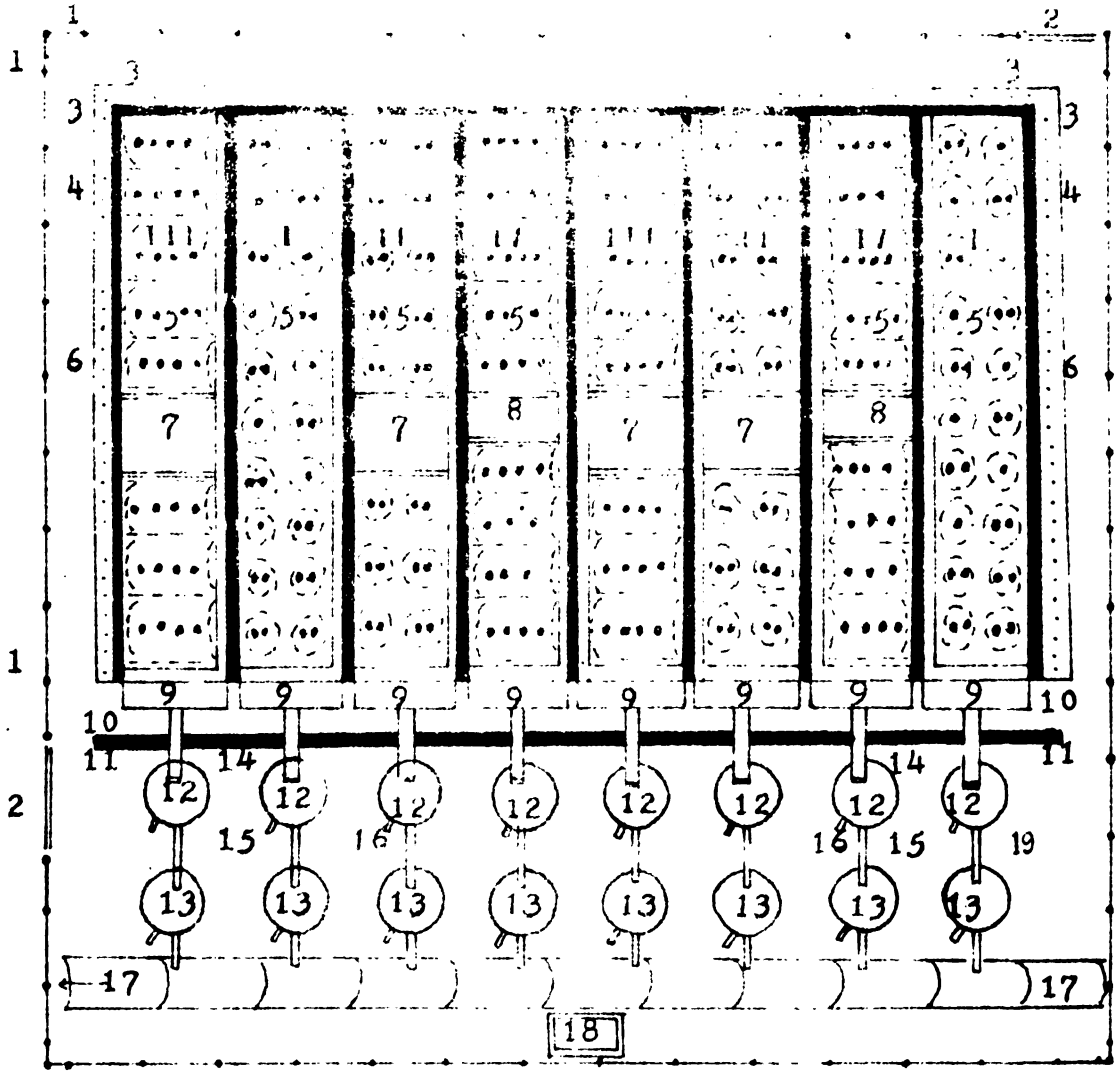


Fig. 2 Top-view of layout of the run-off experiment plots

Legends

1 Barb-wire fence
2 Entrance gate
3 Earth wall
4 Plot boundary wall
5 Plot area
6 Plot pavement
7 Hillside ditch
8 Grass buffer strip
9 Collection trough
10 Concrete base
11 Retaining wall
12 Storage tank (A)
13 Storage tank (B)
14 Outlet pipe (a)
15 Outlet pipe (b)
16 Drainage pipe
17 Drainage way
18 Rain gauge
19 Mettle pavement

I, II, III, IV : Treatment No.

Yams on individual hill

Yams on contour mound

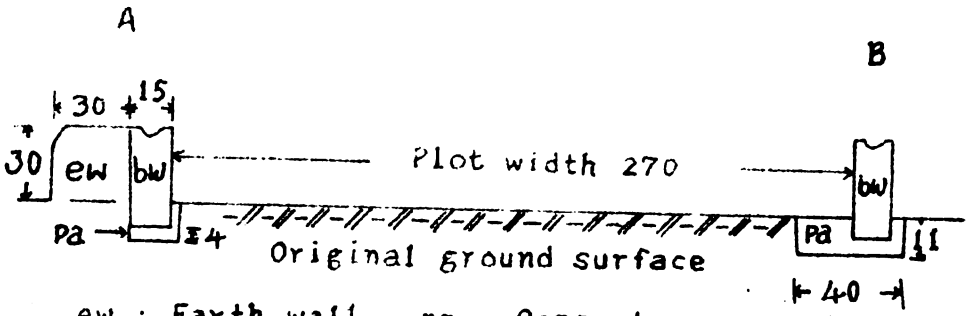


Fig.3-1 Cross section of a plot and boundaries (unit : cm)

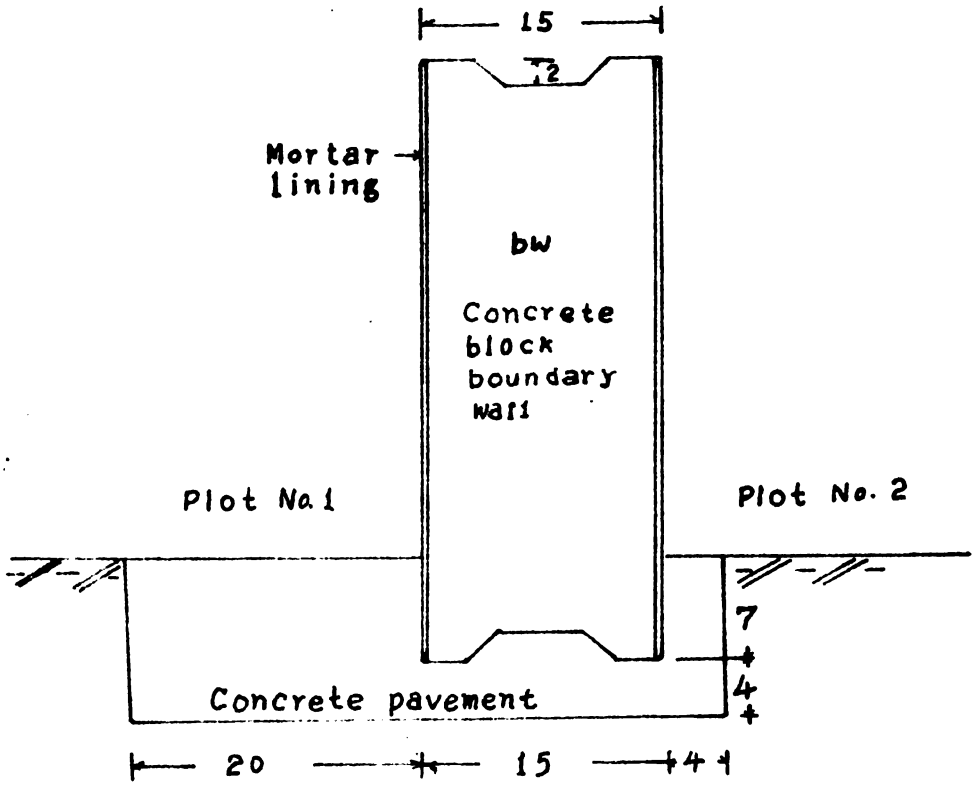


Fig.3-2 Cross section of boundary wall and pavement (unit : cm)

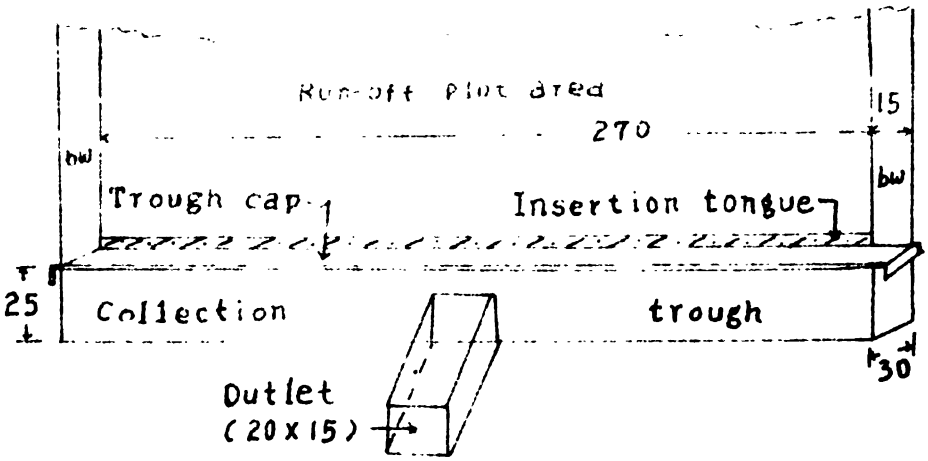


Fig.4-1 Front view of collection trough (unit:cm)

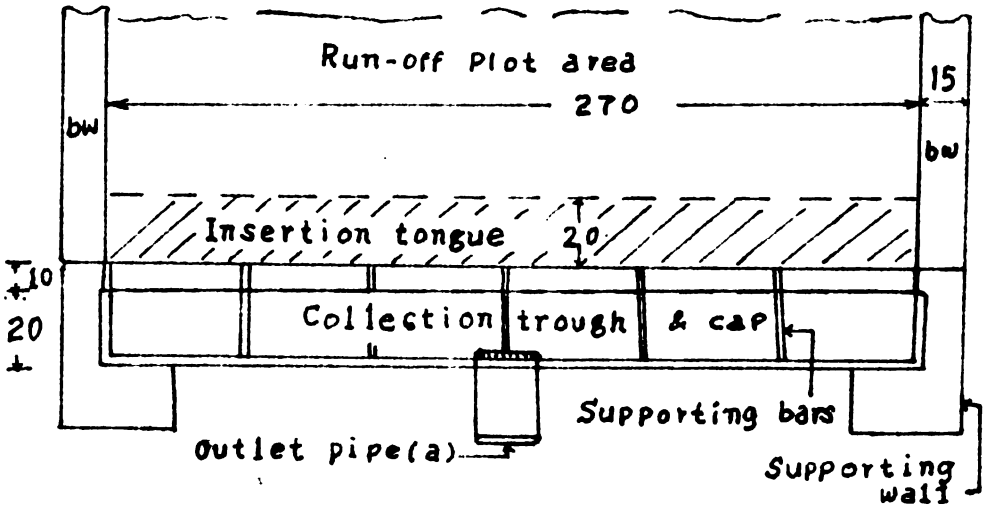


Fig.4-2 Top view of collection trough (unit: cm)

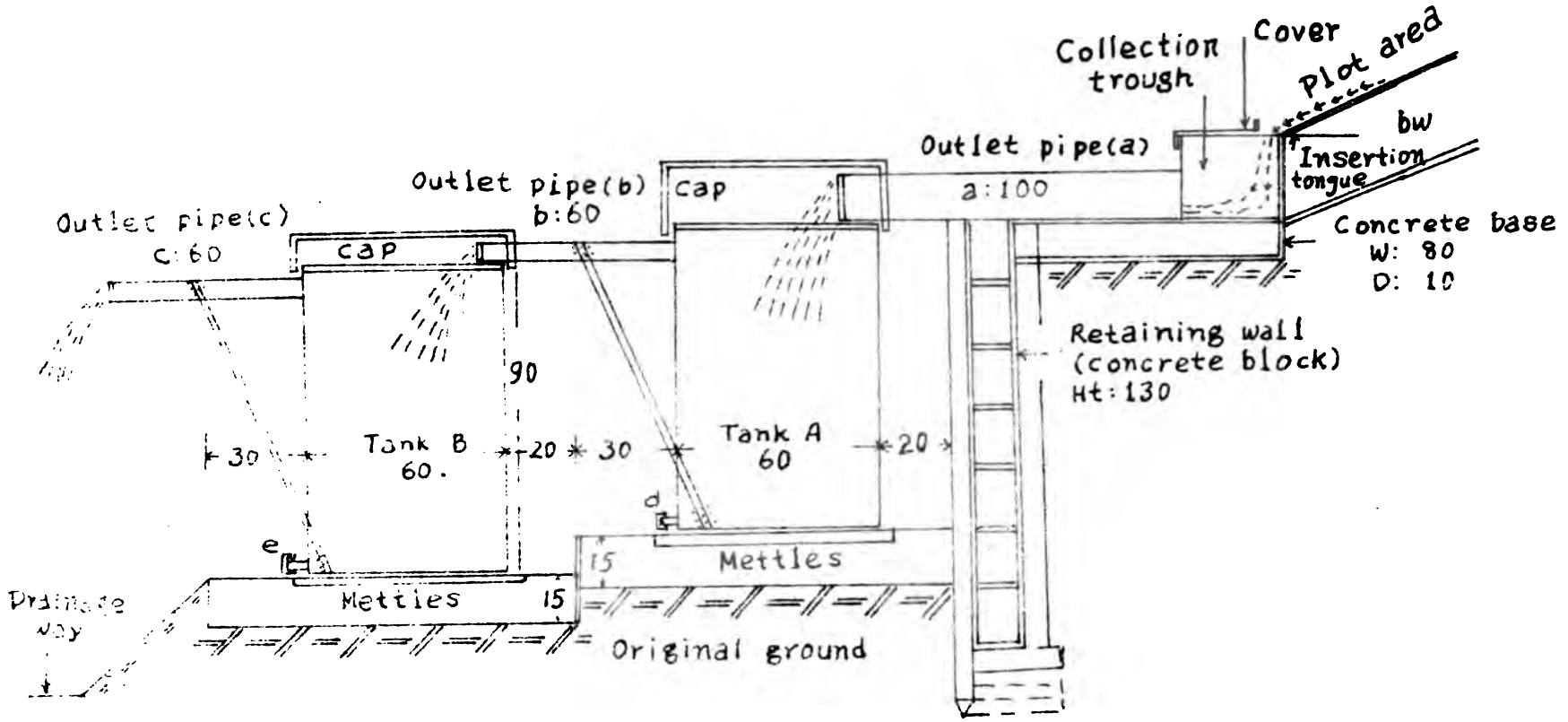


Fig.5-1 Side view of tank A & B, outlet pipe a, b, c, d, e, trough, retaining wall, and concrete base (Unit : cm)

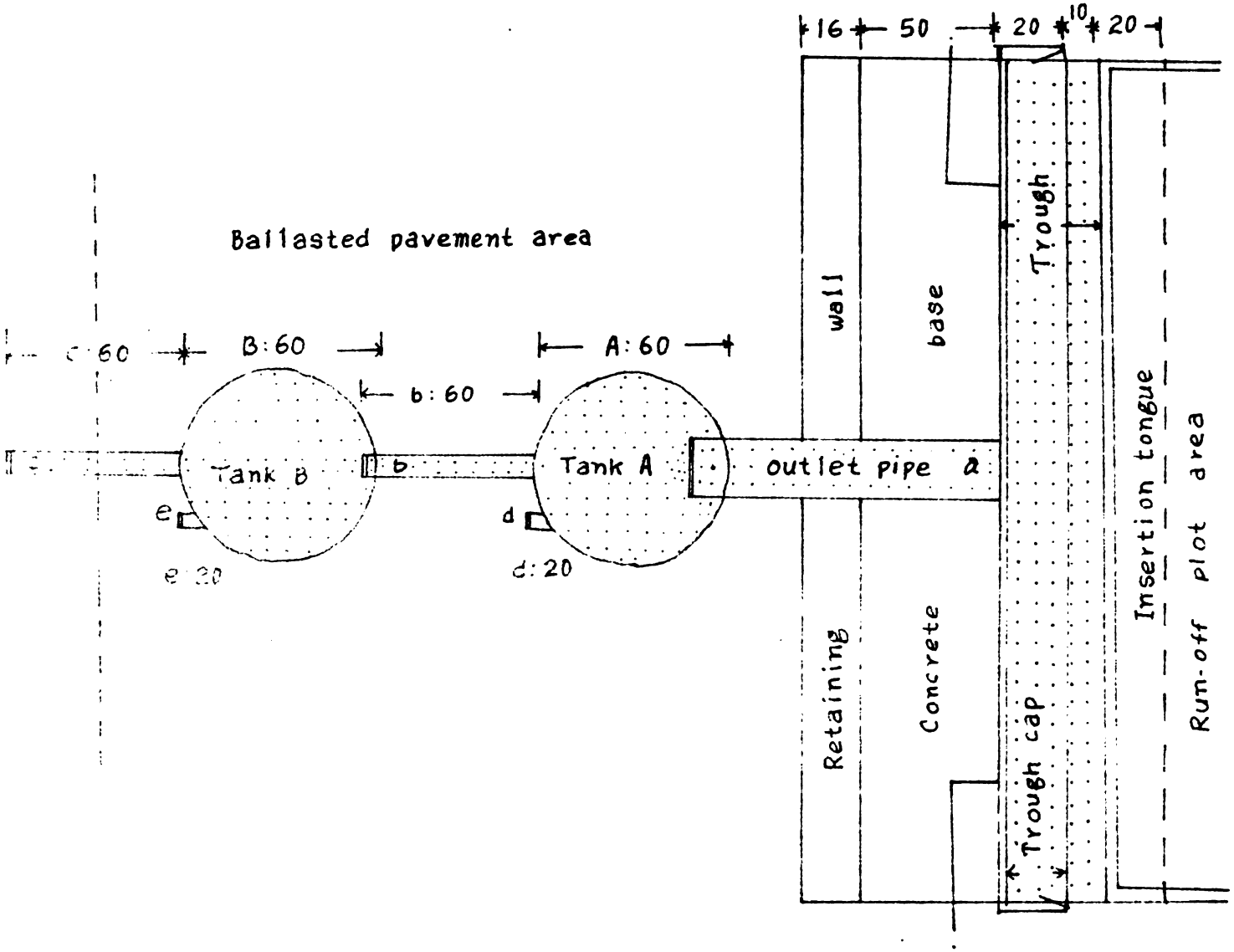
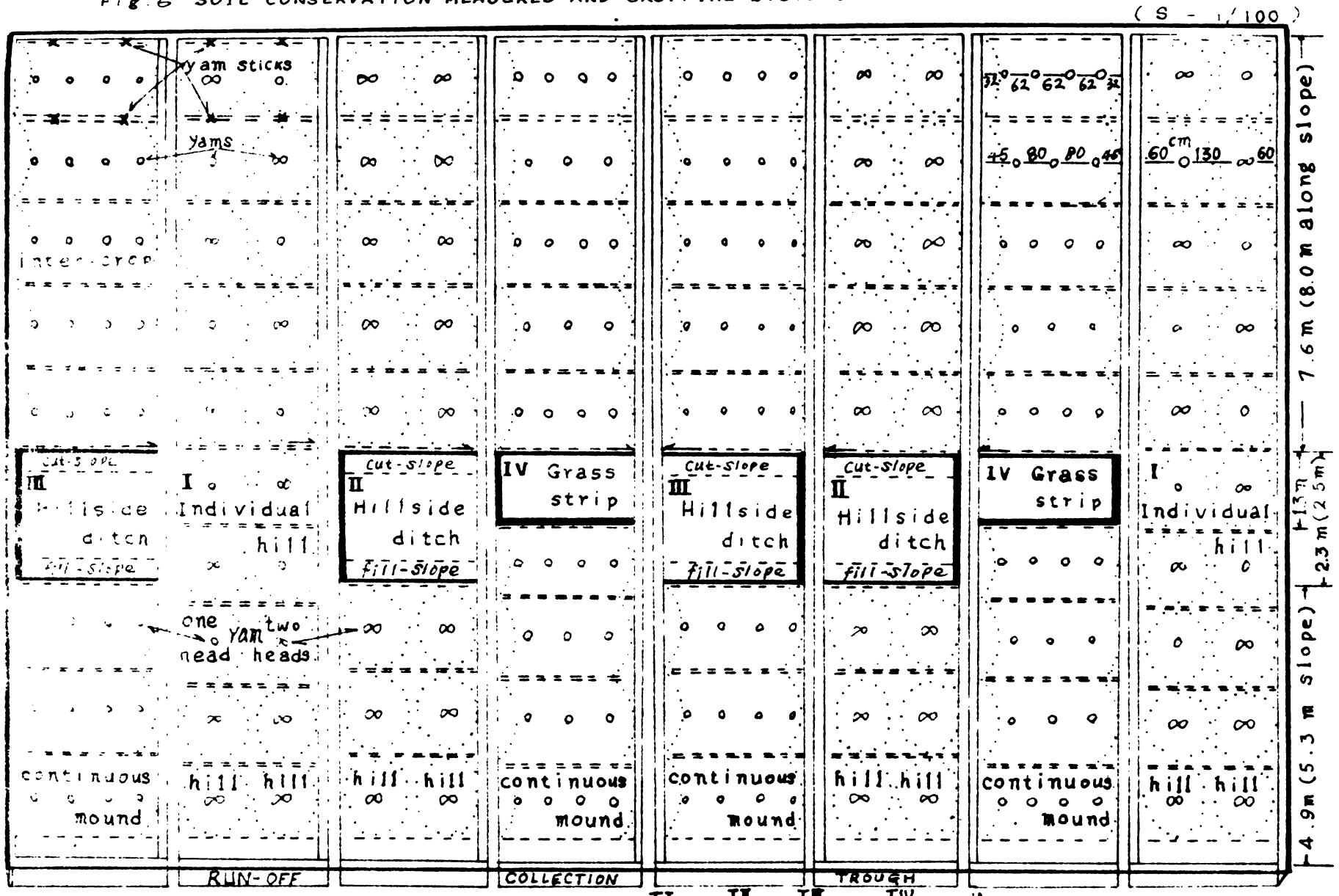


Fig.5-2 Top-view of tank A & B, outlet a, b. c, d, e. trough, retaining wall and concrete base (unit : cm)

Fig. 6 SOIL CONSERVATION MEASURES AND CROPPING SYSTEMS IN THE RUN-OFF PLOTS



	TI	TII	TIII	TIV
Distance between mounds & hills up & down :	150	150	150	150
Distance between yam heads horizontally (cm):	130	130	62	62; 80

32 yam-heads planted per Plot.

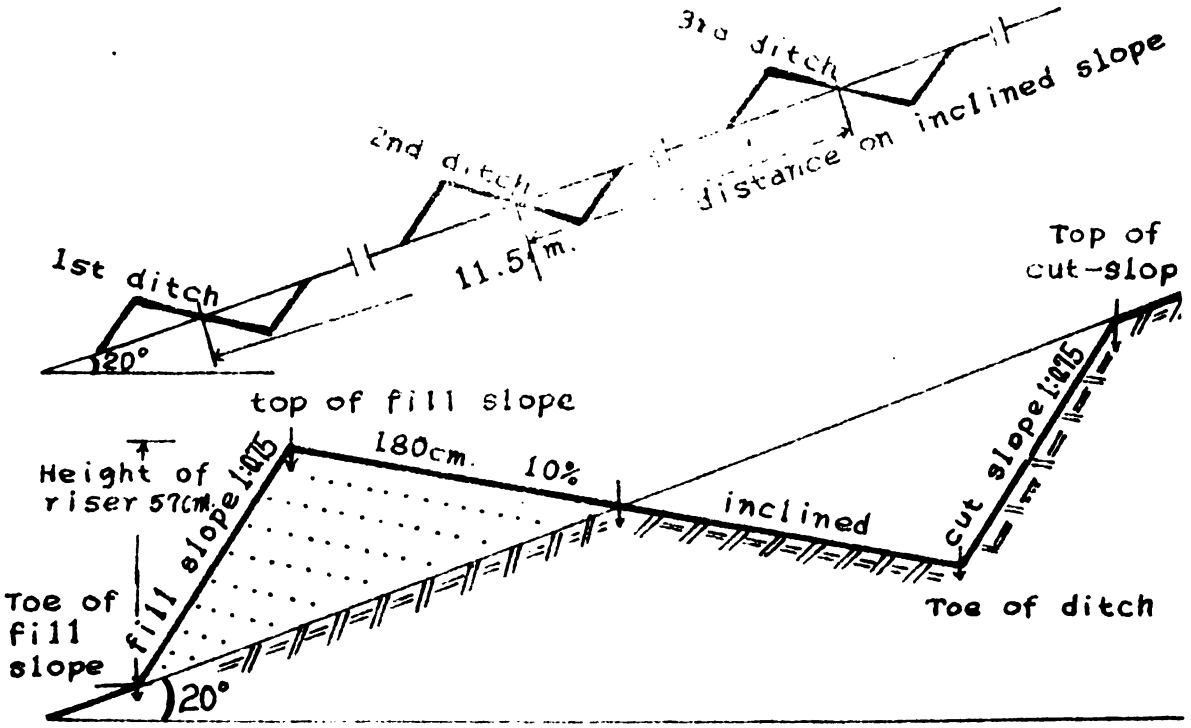


Fig. 7 Cross Section of Hillside Ditch

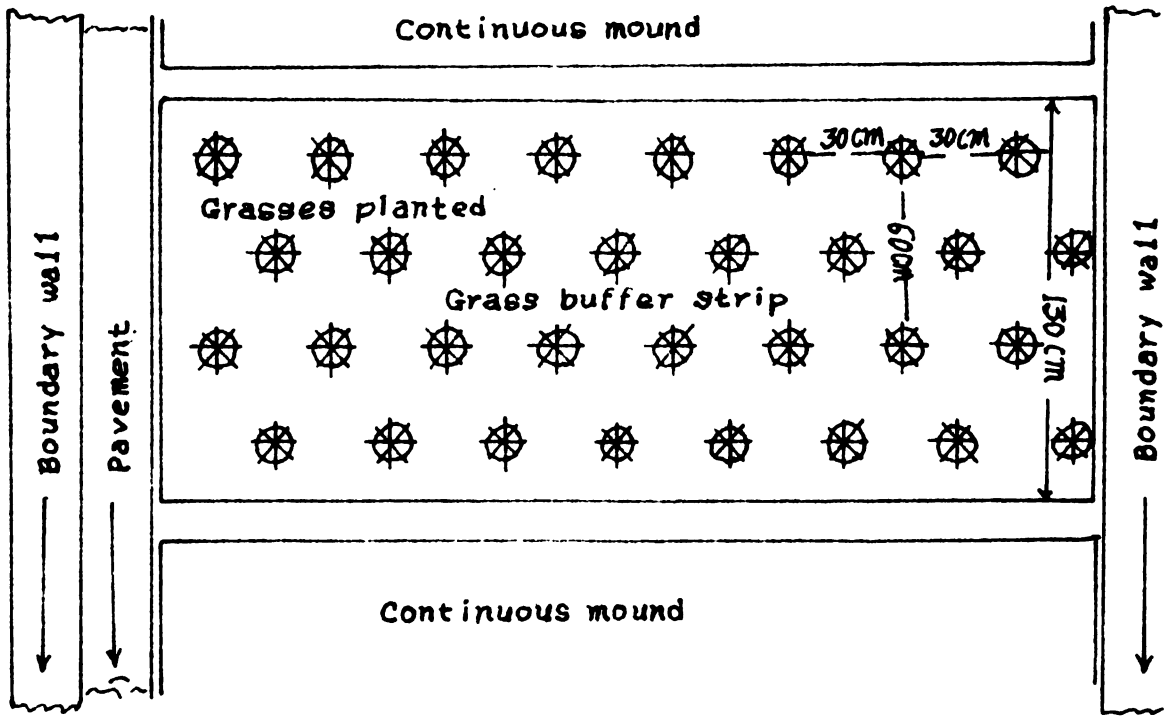


Fig. 8 Plane View of Grass Buffer Strip

FORM 1 DATA SHEET FOR MEASUREMENT OF SOIL-LOSS

Duration of rainfall received: _____

Date of field sample measurement: _____ Field measurement by: _____

Total rainfall for the period: _____ (mm) Lab. and calculation by: _____

	Sediment sample No.	Plot No. ——→	1	2	3	4	5	6	7	8	Remarks
		Treatment No. ——→	T10	T4	T11	T12	T9	T5	T6	T1	
TROUGH	Net wet sediment volume of trough (litres): (a')										
	Total net wet-weight of sediment of trough (kg)(b'):										
	Sediment sample (x')	Can No. (c')									
		% moisture (%c')									
	Sediment sample (y')	Can No. (d')									
		% moisture (%d')									
	Sediment sample (z')	Can No. (e')									
		% Moisture (% e')									
	Mean % moisture (M%)										
	Dry-sediment weight of trough (kg): (SWtr)										
TANK (A)	Net wet sediment volume of tank (A) Litres: (a)										
	Total net wet weight of sediment of tank (Kg) (A)										
	Sediment sample (x)	Can No. (c)									
		%moisture (%c)									
	Sediment sample (y)	Can No. (d)									
		%moisture (%d)									
	Sediment sample (z)	Can No. (e)									
		% moisture (%e)									
	Mean % moisture (M%)										
	Dry-sediment weight of tank (A) (Kg): (SWta)										
	Total dry-sediment weight of Plot (kg): (TDS)										

Form ..: SOIL MOISTURE DATA SHEET

IICA/GOJ Olive River Soil Run-off Studies

Sample No. _____ Sampled Date: _____

Sampled By : _____

Can No.	Wt. of Can + Lid (gram) : (C wt)	Wt. of Can + Lid + Wet Soil Sample (W wt)	Wt. of Can + Lid + Dry Soil Sample (D wt)	Wt. of Wet Sample : (W wt)	Wt. of Dry Sample : (D wt)	% Moisture :(% M)
1.	49.3					
2.	49.1					
3.	49.1					
4.	50.0					
5.	49.6					
6.	49.3					
7.	49.1					
8.	49.3					
9.	49.8					
10.	49.0					
11.	49.3					
12.	49.2					
13.	49.4					
14.	49.8					
15.	48.8					
16.	49.1					
17.	49.7					
18.	49.2					
19.	49.4					
20.	48.8					
21.	49.5					
22.	49.5					
23.	49.0					
24.	49.6					

FORM 2: SOIL [illegible] DATA SHEET

LIDAR/SOIL OLIVE TRAIL SOIL RUN-OFF STUDIES

Sample No. _____ Sampled Date: _____

Sampled by: _____

Can No.	wt. of Can + Lid (gram) :(Cwt)	wt. of Can + Lid + Wet Soil sample :(Wwt)	wt. of can + Lid + Dry Soil sample: (Dwt)	wt. of wet sample: (WSwt)	wt of Dry Sample :DSwt)	% Moisture: (%M)
25.	49.8					
26.	49.0					
27.	49.6					
28.	49.0					
29.	49.2					
30.	49.1					
31.	49.7					
32.	49.0					
33.	49.3					
34.	48.9					
35.	48.9					
36.	49.6					
37.	49.7					
38.	49.4					
39.	49.2					
40.	49.6					
41.	49.8					
42.	49.5					
43.	49.2					
44.	49.4					
45.	49.0					
46.	49.5					
47.	49.5					
48.	49.6					

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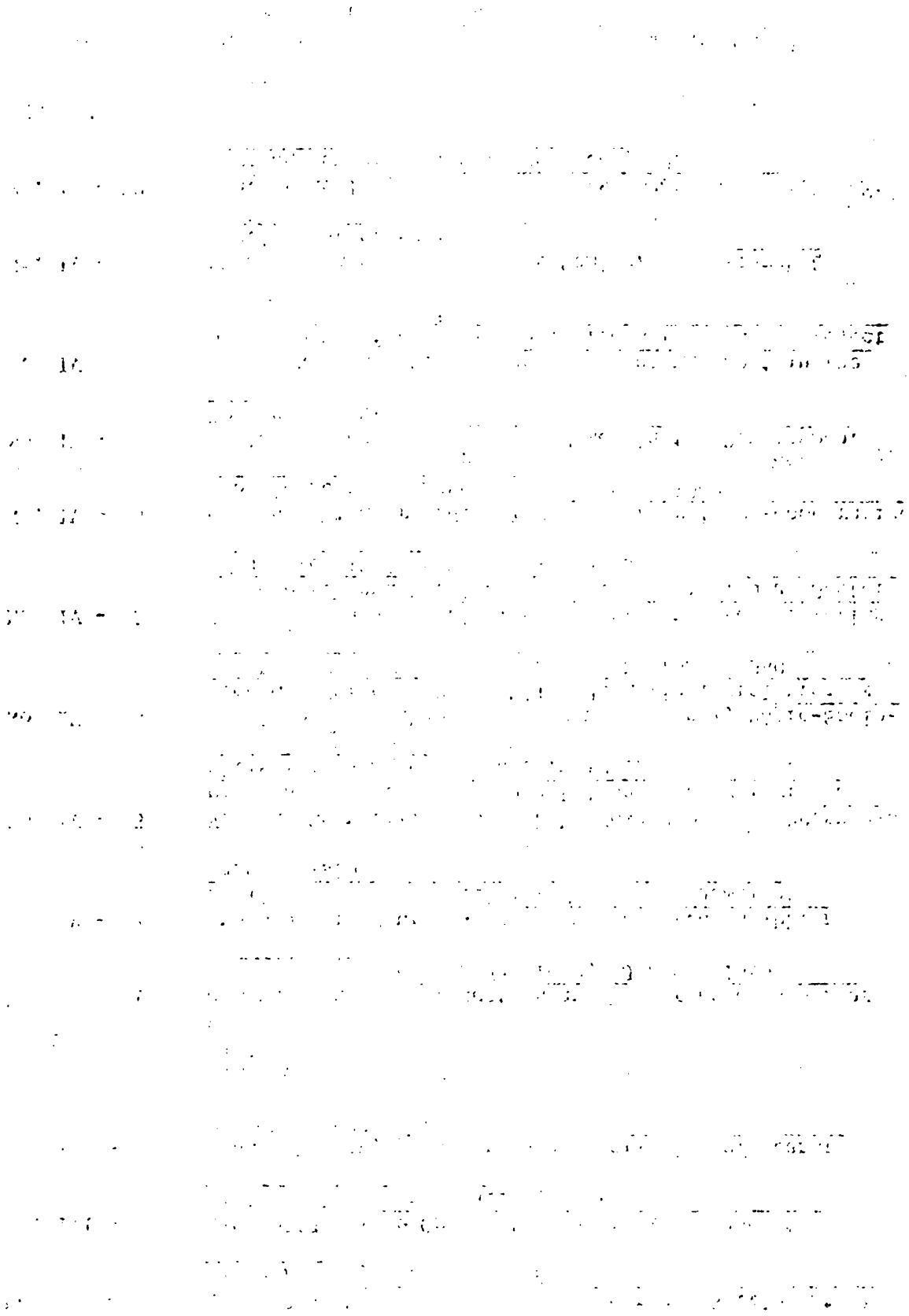

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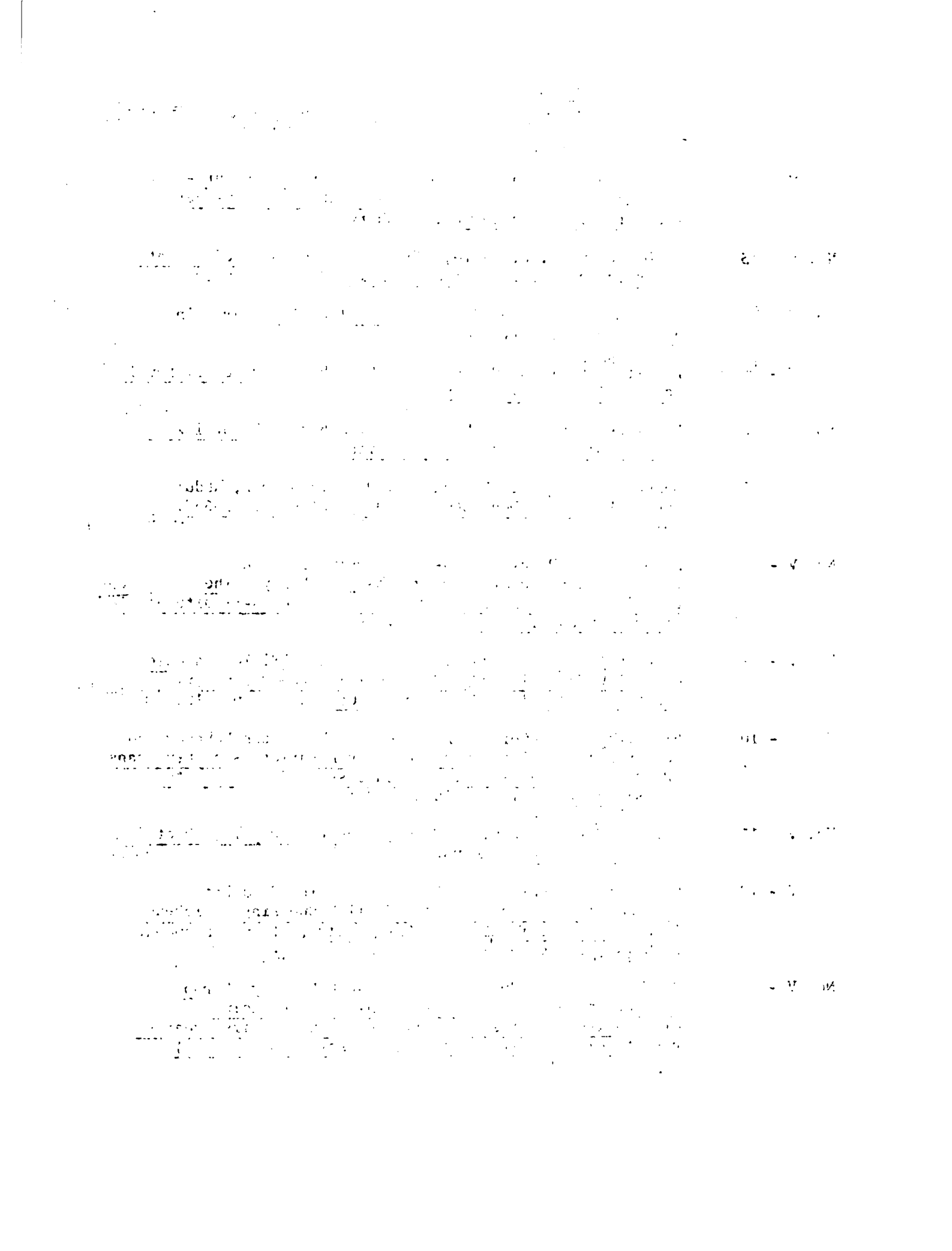

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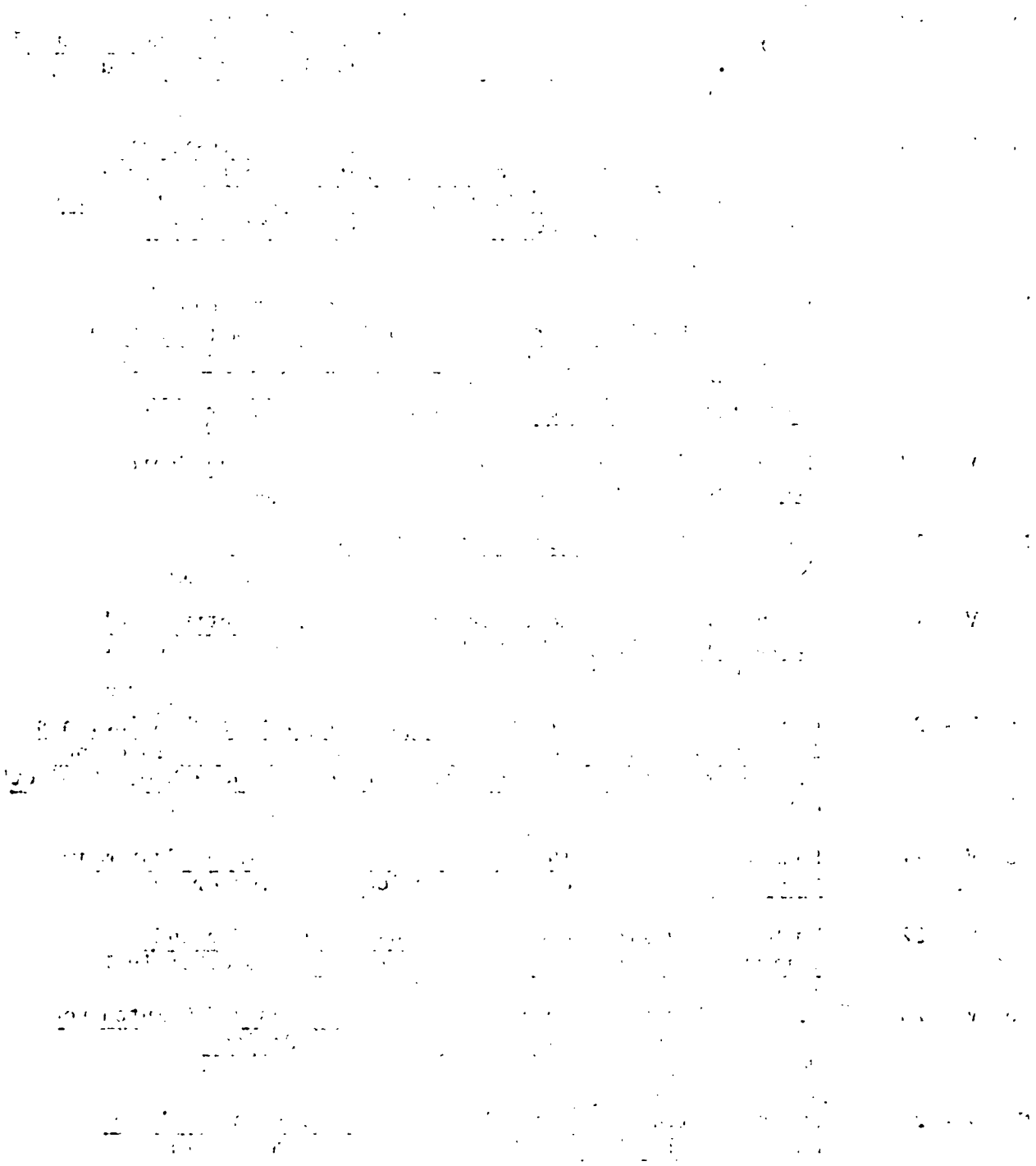

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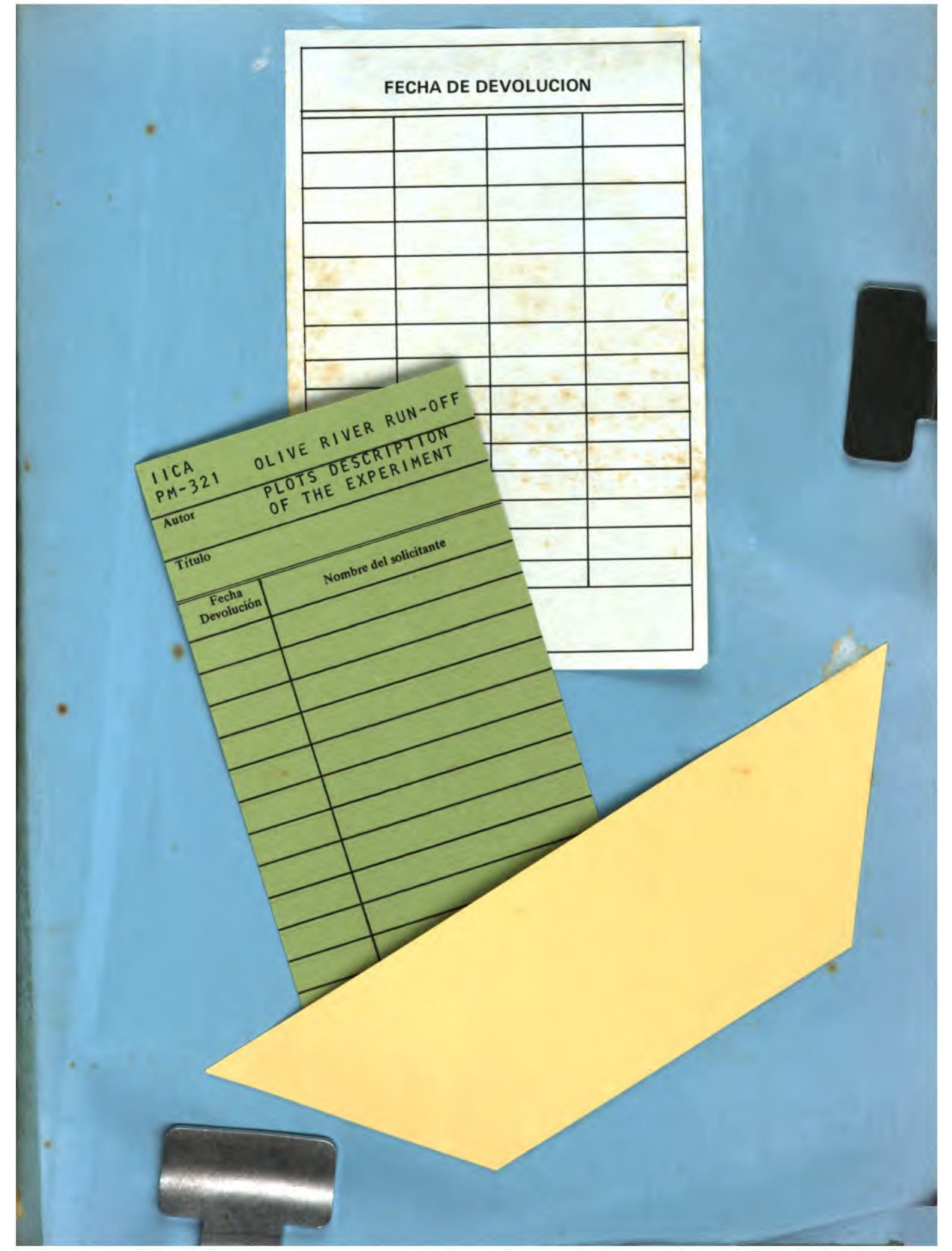
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IICA
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OLIVE RIVER RUN-OFF
Autor
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OF THE EXPERIMENT
Título
Fecha Devolución
Nombre del solicitante