# PROGRAMME OF WORK FOR THE SHORT-TERM ADAPTIVE PRODUCTION ORIENTED RESEARCH ON RICE IN THE BRUMDEC PROJECT

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# PROGRAMME OF WORK FOR THE SHORT-TERM ADAPTIVE PRODUCTION ORIENTED RESEARCH ON RICE IN THE BRUMDEC PROJECT

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## 1. INTRODUCTION

A review of the current state of technology in rice production and adaptive research on rice in the BRUMDEC Project area has been completed.[1]

On the basis of that review this short-term programme for adaptive production-oriented research on rice in the BRUMDEC Project is proposed.

This programme aims at correcting deficiencies by the transfer of technology and by generating information to enable the formulation of improved norms in the management of the rice crop.

## 2. OBJECTIVES

This programme of work has as its objectives:

2.1. Establishing the use of appropriate technologies that will correct observed imbalances in the rice production system on the BRUMDEC farm within the next two seasons.

2.2. Establishing fertilizer recommendations for rice grown on the Clay soils in the Project area.

2.3. Developing a complete technological package for rice production on the Morass Peat soil.

2.4. Evaluating the economics of rice production on each of the major rice soils in the Project area.

2.5. Training of National Technicians consistent with the overall agronomy of rice production.

2.6. Accumulating information that will provide the basis for planning of a longer-term programme of adaptive production-oriented research on rice and validation of the results and achievements attained.

## 3. STRATEGY

The strategy will be as follows:

3.1. In order that the programme produces immediate benefits, the identifiable deficiencies in the rice production system which can be corrected by applying appropriate methods will be given high priority for attention. The methods to be adopted have been dealt with in some detail in the review paper.(1)

Attention will be given to improving the quality of seed of the variety CICA 9, and any other variety needing such attention, up to internationally recognised quality standards.

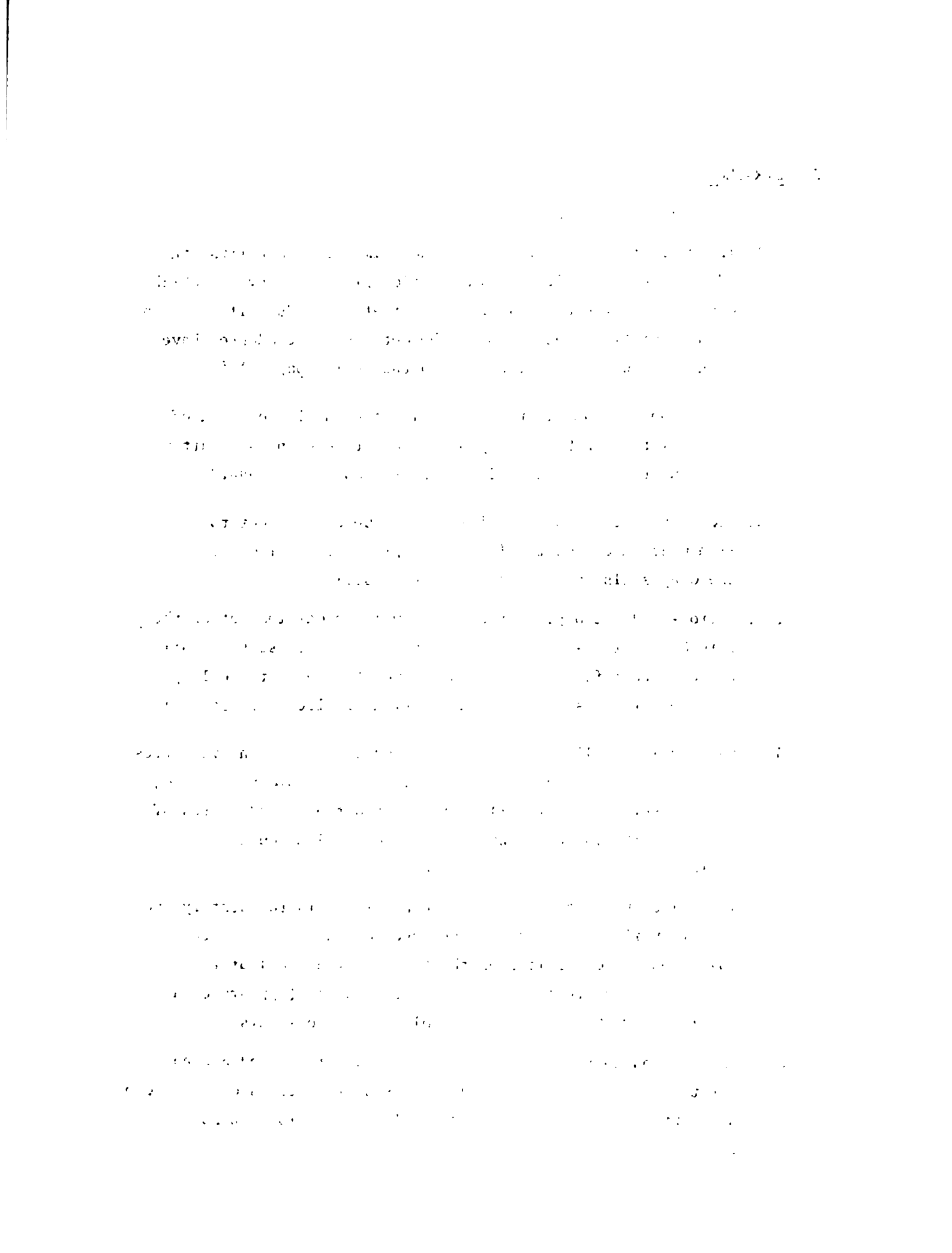
3.2. Micro-and macro-plot experiments will be carried out to establish what should be the fertilizer practice for rice grown on the Clay soils and on the Morass Peat soil.

3.3. Micro - and macro-plot experiments will be carried out on the main Clay soil -- Cashew Clay -- and on the Morass Peat soil to generate information for the formulation of a technology package for the successful cultivation of rice on those soils.

3.4. Variety x fertilizer trials will be carried out using varieties of rice developed in Colombia (CIAT-ICA), Dominican Republic, Guyana, Philippines (IRRI), Suriname and the United States of America. The varieties will be tested simultaneously at different levels of fertilization.

The objective of this part of the programme is to identify one or more varieties having a high level of adaptation to the environmental conditions of the Project area. All of the varieties to be tested will have rice quality (appearance and cooking characteristics) acceptable to the consumers.

3.5. In addition to the field studies planned for 3.2 and 3.3 above, pot trials will be carried out to assess the status of the micronutrient requirements of the rice plant when grown on soils of the Project area:



- on Clay soils from fields which have not been cultivated with rice;
- on similar soils from fields which have been cultivated with rice for several seasons,
- on the Morass Peat soil which will be tested with rice for the first time.

3.6. Two training programmes will be conducted, one at the end of each season, for National technicians and farmers. The training programmes will embrace all important aspects of the agronomy of rice production.

## 4. METHODOLOGY FOR EXPERIMENTS, PRODUCTION STUDY, SEED PURIFICATION, AND TRAINING

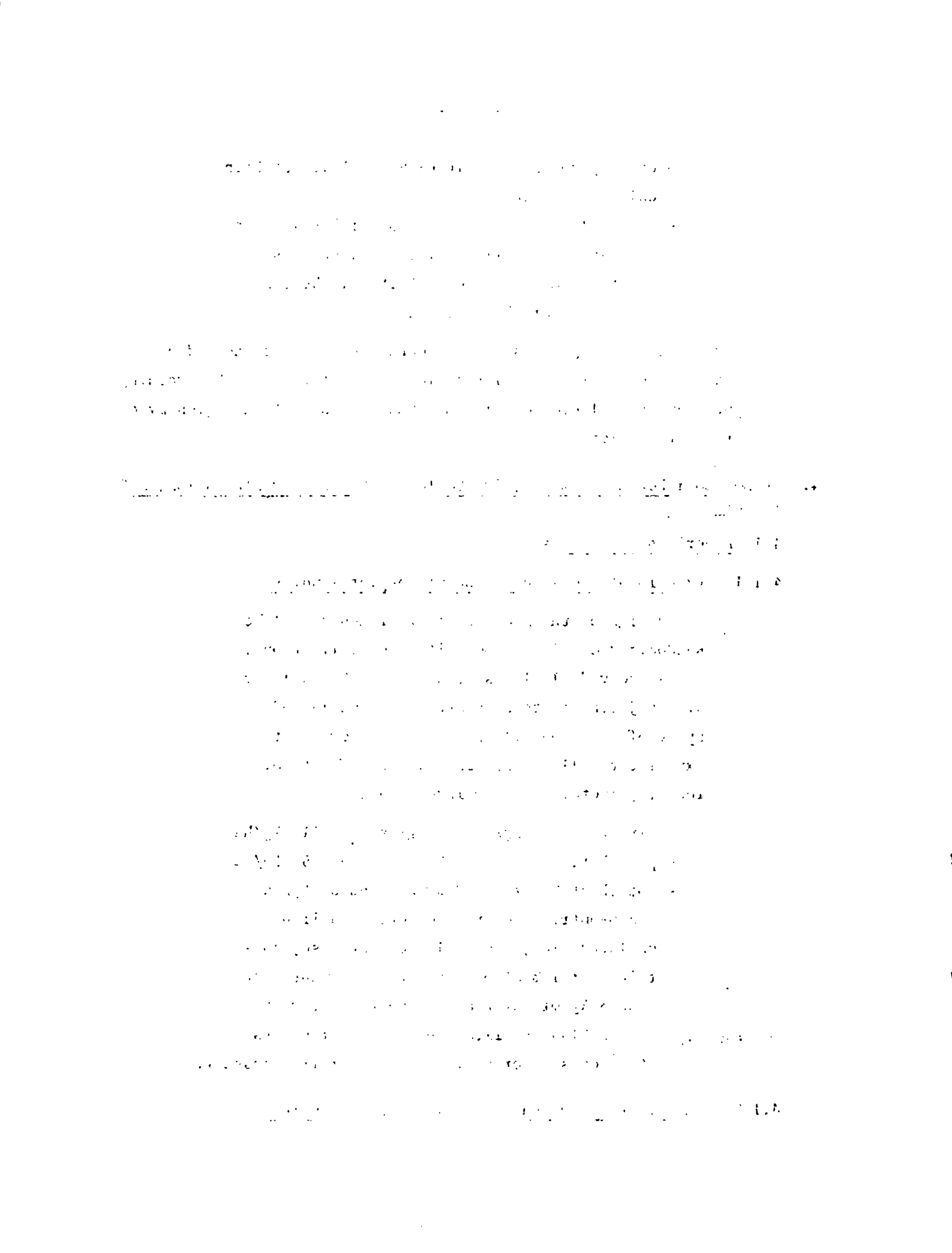
### 4.1. Experimental Methods

#### 4.1.1. Experimental design of the micro-plot studies

The design of the micro-plot experiments will be a Randomized Complete Block with two replications. Gross individual plot size will be 2.0 m x 1.0 m, with adjacent plots separated by an unplanted space of 0.5 m on all sides. Each micro-plot experiment will occupy 399 $m^2$. The effects of four (4) factors will be investigated:

- nitrogen at 0 kg/ha, 56 kg/ha, and 112 kg/ha.
- phosphate at 0 kg/ha, 28 kg/ha, and 56 kg/ha.
- potash at 0 kg/ha, 30 kg/ha; and 60 kg/ha.
- micro-nutrient mixture of chelated iron, chelated zinc, and chelated manganese, containing 3.12% of each of those elements, at 4.0053 kg mixture/ha, 8.0106 kg mixture/ha, and 12.0159 kg mixture/ha as foliar sprays at 35 days after sowing or earlier if necessary.

#### 4.1.2. Experimental design of the macro-plot studies



4.1.2.1. Studies of NPK requirements of rice on soils of the BRUMDEC Project

The design of these studies on all soil types will be a 3 x 3 x 3 NPK factorial with partial confounding of the NPK interaction, with two replicates having three blocks of nine plots each per replicate.

In these experiments the basal rate of application of micro-nutrients as foliar sprays will be:

- on the Clays: zinc at 0.25 kg/ha iron at 0.25 kg/ha, and manganese at 0.25 kg/ha.
- on the Morass Peat: zinc at 0.375 kg/ha; iron at 0.375 kg/ha, manganese at 0.375 kg/ha, and copper at 0.6 kg/ha.

The gross individual plot size will be 12 m x 7 m and the net plot size (harvested plot size) 10 m x 5 m (1/200th hectare). A border of 30 cm width contiguous to the net plot will be maintained intact. Also to be maintained intact is the outermost 30 cm wide border of the gross plot. The space (40 cm width) between the inner and outer border will be the sampling space for soil and plant samples to be taken during the course of the studies.

The treatment levels for the three factors will be:

- on the Clays: N at 0, 56 and 112 kg/ha.
  $P_2O_5$ at 0, 28, and 56 kg/ha.
  $K_2O$ at 0, 30, and 60 kg/ha.

The rate and timing of fertilizer will be:

- nitrogen: 1/3 at 21 DAS*; 1/3 at panicle differentiation, and 1/3 at first heading.
- phosphate: ½ at sowing, and ½ at panicle differentiation
- potash: ½ at 21 DAS; and ½ at panicle differentiation

* DAS = Days after sowing of germinated seed

- on the Morass Peat:

N at 0, 20 and 40 kg/ha.
$P_2O_5$ at 0, 30, and 60 kg/ha.
$K_2O$ at 0, 30 and 60 kg/ha.

The fertilizer application will be split in the same proportions as indicated for the treatments on the Clay soils.

These experiments will be repeated in the second season starting from October - November 1981.

4.1.2.2. Studies on the managment of tillage, irrigation water, and fertilizers in rice on the Cashew Clay soil and the Morass Peat soil

The design of this study on each soil type will be a Randomized Complete Block Split-Split-Plot Design with two (2) replicates.

Main plots: Tillage management
Sub-plots: Water management
Sub-sub-plots: Fertilizer management

Factor definition:

- Tillage management 1 (T1): Dry tillage to produce a fine tilth, and levelling under dry conditions;
- Tillage management 2 (T2): Dry tillage initially to reduce the size of largest aggregates to approximately 7.5 cm diameter, flooding to an average depth of 10 cm, puddling, under-water-levelling;
- Tillage management 3 (T3): Flooding to an average depth of 10 cm, rototilling, and under-water-levelling.
- Water management. When tillage operations are completed under dry conditions all plots are to be submerged. All tillage on dry-tillage treated plots must

therefore be completed before flooding. Wet tillage operations will begin immediately after flooding and all plots will be kept submerged until two (2) days after all wet-tillage operations are completed.

At two (2) days after the completion of wet-tillage operations the following water management treatments will begin:

- Water management treatment 1 (W1):
  - Retain average depth of 7.5 cm flood;
  - Seal all levees; allow seedlings to emerge through flood;
  - Irrigate to renew 7.5 cm average depth of flood when average depth of flood reduces to 2.5 cm;
  - When plants are approximately 14 cm tall, increase depth of flood to 10 cm and renew to this depth when flood depth reduces to 2.5 cm.
  - Drain plot completely at 15 days after 50% heading.
- Water management treatment 2 (W2)
  - Retain average depth of 7.5 cm flood (by draining off excess water if necessary).
  - Sow seed
  - Seal all levees, do not irrigate (if rainfall increases flood depth, drain off water to maintain 7.5 cm depth of flood)
  - Grow seedlings through this depth of flood and maintain daily records of depth of flood in each plot.
  - Irrigate to renew 7.5 cm average depth of flood when the soil surface becomes exposed to the atmosphere.

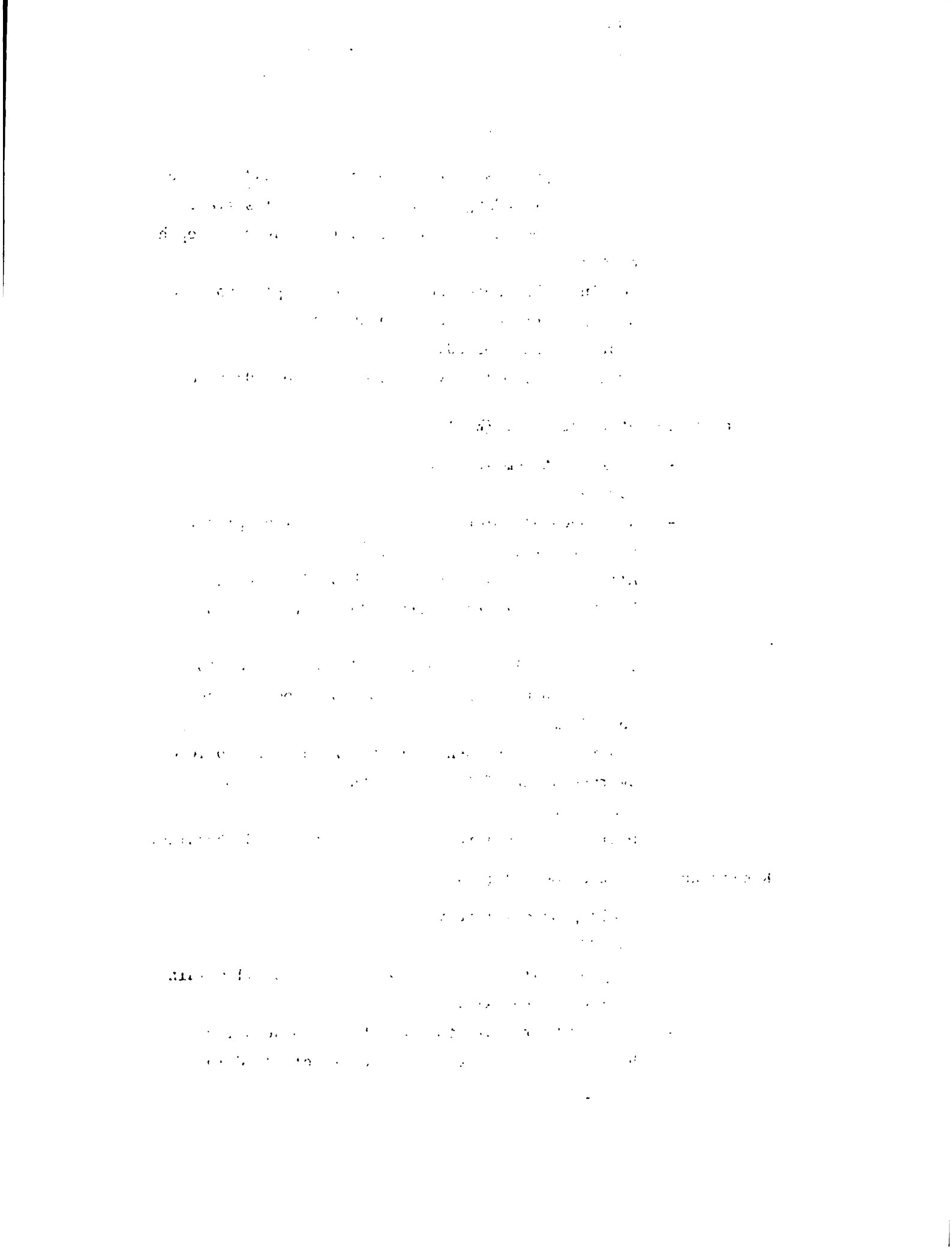
- Allow evapotranspiration, percolation and seepage to reduce flooding depth until the soil surface is just exposed, then irrigate to 10 cm average depth of flood.
- Continue this sequence of topping up plot to 10 cm average depth of flood when the soil surface of plot is just exposed.
- Drain plot completely at 15 days after 50% heading.

- Water management treatment 3 (W 3)

  - Drain plot completely.
  - Sow Seed
  - Keep open all plot-drainage outlets from plot to allow rainfall water to exit.
  - All 10 DAS irrigate to a depth of 75% seedling height. Record the average depth of flood in each plot.
  - Irrigate to increase average depth of flood to 10 cm. When the average depth of flood reduces to 2.5 cm.
  - Continue this sequence of topping up plot to 10 cm average depth of flood when the average depth reduces to 2.5 cm.
  - Drain plot completely at 15 days after 50% heading.

- Water management treatment 4 (W 4)

  - Drain plot completely
  - Sow Seed
  - Keep open all plot drainage outlets to allow rainfall water to exit.
  - At 10 DAS irrigate to a depth of 75% seedlings height. Record the average depth of flood in each plot.



- Allow evapotranspiration percolations and seepage to reduce flood depth until the soil surface of the plot is just exposed then irrigate to 10 cm average depth when the soil surface of the plot is just exposed.
- Drain plot completely at 15 days after 50% heading.

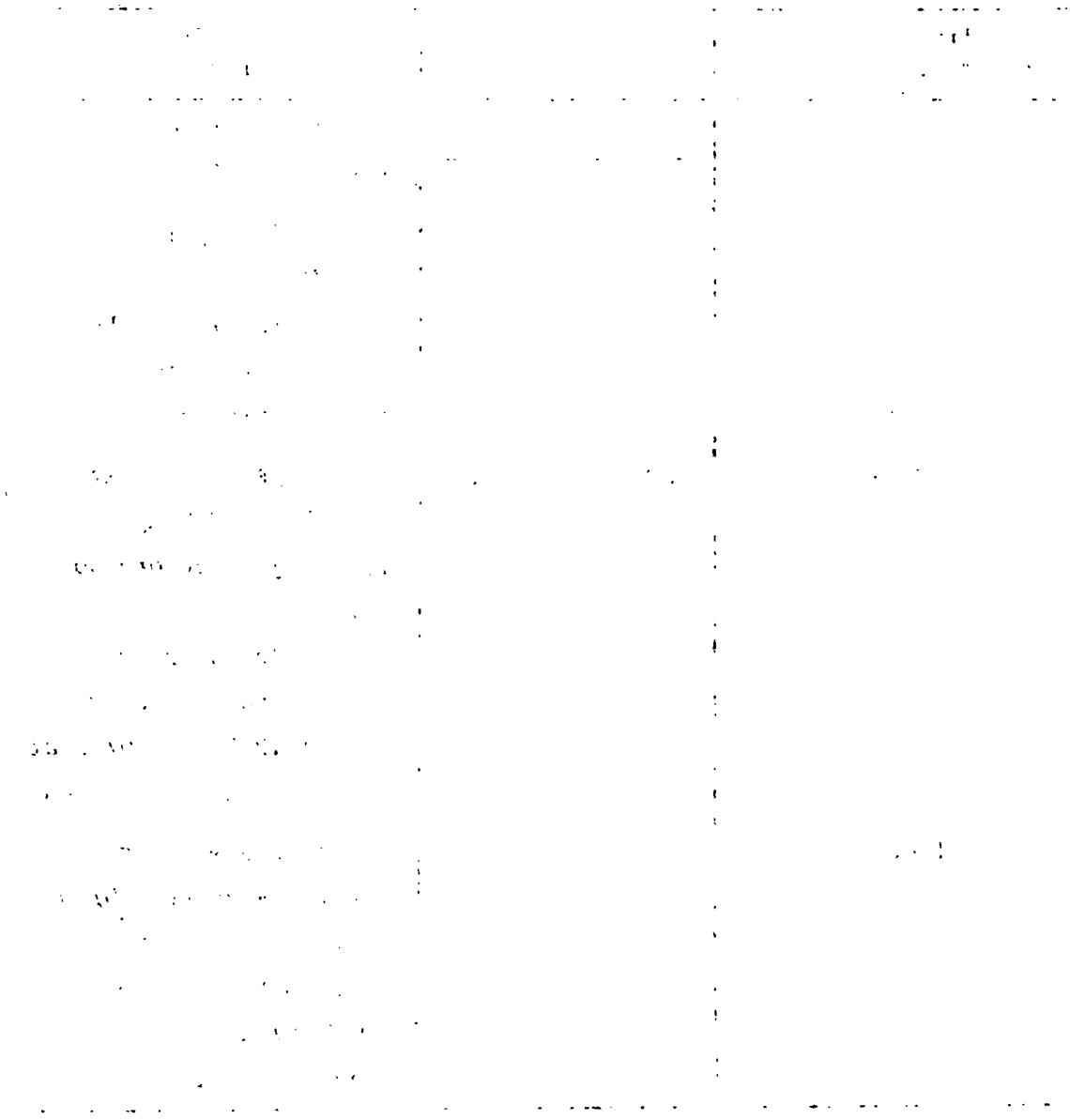
4.1.3. Fertilizer Management Treatments

There will be seven (7) fertilizer management treatments:

4.1.3.1. On Cashew Clay Soil

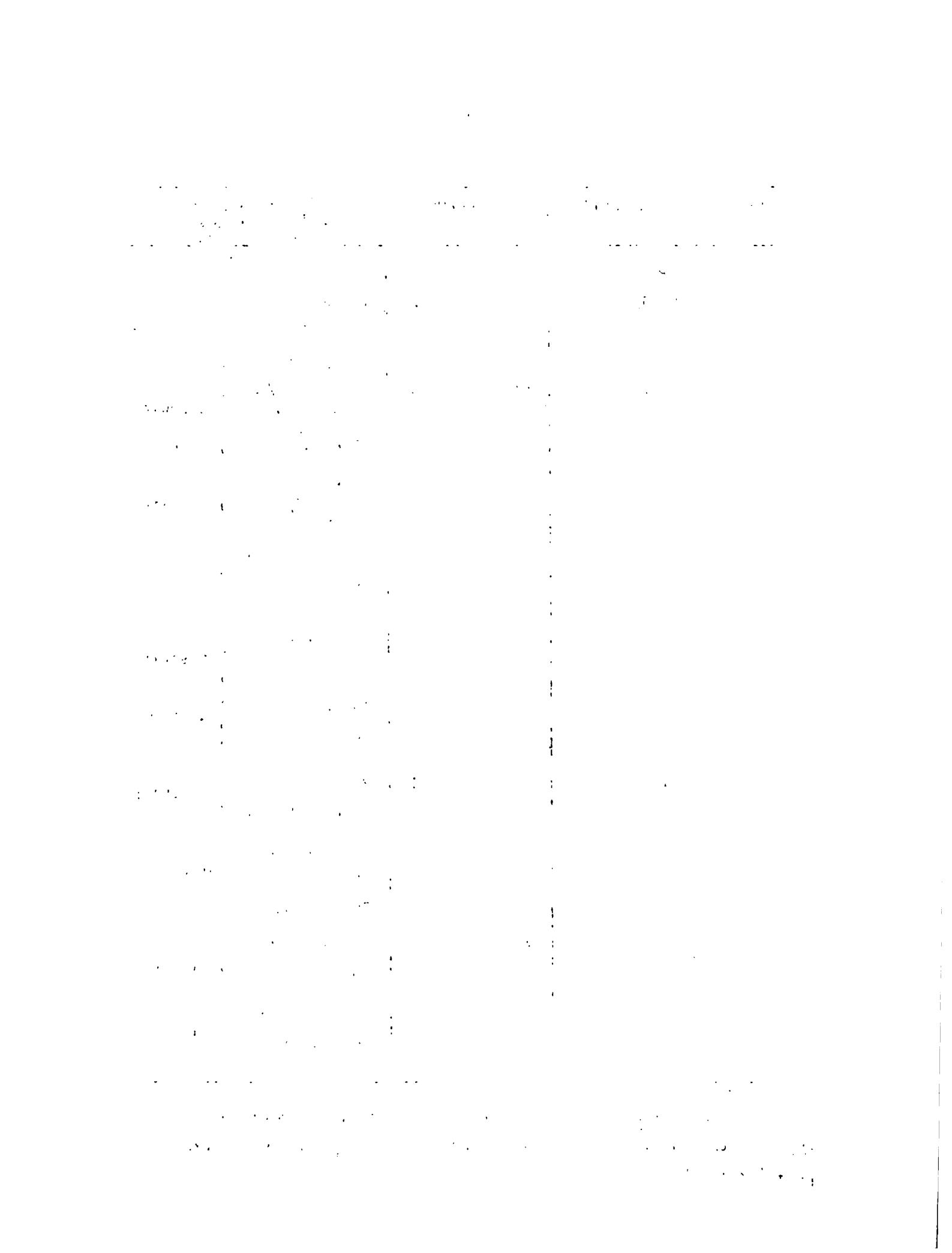
| Fertilizer Management Treatment | Kg/Ha | | | Rate of Timing of Fertilizer |
|---|---|---|---|---|
| | N | $P_2O_2$ | $K_2O$ | |
| FMCCO | 0 | 0 | 0 | None |
| FMCC1 | 64.4 | 28.8 | 36.6 | 28.4 Kg N/ha + 28.8 $P_2O_5$/ha + 33.6 Kg $K_2O$/ha just prior to sowing<br>12 Kg N/ha at 21 DAS<br>24 Kg N/ha at panicle differentiation |
| FMCC2 | 64.4 | 28.8 | 33.6 | 12 Kg N/ha + 28.8 Kg $P_2O_5$/ha + 33.6 Kg $K_2O$/ha just prior to sowing<br>28.4 Kg N/Ha at 21 DAS<br>24 Kg N/ha at panicle differentiation |
| FMCC3 | 64.4 | 28.8 | 33.6 | 12 Kg N/ha + 14.4 Kg $P_2O_5$/ha + 16.8 Kg $K_2O$/ha just prior to sowing<br>12 Kg N/ha at 21 DAS<br>24 Kg N/ha + 14.4. Kg $P_2O_5$ + 16.8 Kg $K_2O$/ha at panicle differentiation |

| Fertilizer Management Treatment | Kg/Ha | | | Rate and Timing of Fertilizer |
|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | |
| FMCC4 | 64.4 | 28.8 | 33.6 | 12 Kg N/ha + 14.4 kg $P_2O_5$/ha + 16.8 kg $K_2O$/ha just prior 28.4 Kg N/ha at 21 DAS 24 Kg N/ha + 14.4 Kg $P_2O_5$/ha at panicle differentiation |
| FMCC5 | 50 | 25 | 25 | 10 Kg N/ha + 12.5 Kg $P_2O_5$/ha + 12.5 Kg $K_2O$/ha just before sowing. 20 Kg N/ha at 21 DAS 20 Kg N/ha + 12.5 Kg $P_2O_5$ + 12.5 Kg $K_2O$/ha at panicle differentiation. |
| FMCC6 | 50 | 25 | 25 | 10 Kg N/ha + 25 Kg $P_2O_5$/ha + 25 Kg $K_2O$/ha just before sowing. 20 Kg N/ha at 21 DAS 20 Kg N/ha at panicle differentiation. |



| On Morass Peat Soil | Kg/Ha | | | Rate and Timing of Fertilizations |
|---|---|---|---|---|
| FMMP 0 | 0 | 0 | 0 | None |
| FMMP 1 | 10 | 10 | 20 | 10 Kg $P_2O_5$/ha )<br>20 Kg $K_2O$/ha )at sowing<br>10 Kg N/ha ) |
| FMMP 2 | 10 | 10 | 20 | 10 Kg $P_2O_5$/ha )<br>20 Kg $K_2O$/ha )at sowing<br>10 Kg N/ha ) at P.D. |
| FMMP 3 | 20 | 20 | 30 | 10 Kg $P_2O_5$/ha )<br>20 Kg $K_2O$/ha )at sowing<br>10 Kg $P_2O_5$/ha )<br>10 Kg $K_2O$/ha ) at P.D.<br>20 Kg N/ha ) |
| FMMP 4 | 20 | 20 | 30 | 20 Kg $P_2O_5$/ha )<br>20 Kg $K_2O$/ha )at sowing<br>10 Kg $K_2O$/ha )<br>20 Kg N/ha ) at P.D. |
| FMMP 5 | 30 | 30 | 40 | 20 Kg $K_2O$/ha )<br>20 Kg $P_2O_5$/ha )at sowing<br>20 Kg $K_2O$/ha )<br>10 Kg $P_2O_5$/ha )at P.D.<br>30 Kg N/ha ) |
| FMMP 6 | 30 | 30 | 30 | 40 Kg $K_2O$/ha )<br>20 Kg $P_2O_5$/ha ) at sowing<br>10 Kg $P_2O_5$/ha )<br>30 Kg N/ha ) at P.D. |

In these rice crop management experiments basal micro-nutrient fertilization will be at the rates indicated for the Clays and Morass Peat in 4.1.2.1. above.



These experiments will be repeated in the second season beginning October - November 1981.

4.1.2.3 Variety Trials

In this season's work only four varieties will be included in the variety trials. The varieties will be CICA 8, CICA 9, Variety "N" and Rustic. The first three named varieties are long-grained. Rustic has an extra long grain.

On the matter of consumer acceptance the Jamaican public has been supplied with rice of variety "N" and Rustic in rice shipments imported from Guyana.

In the second season's work it is planned to include in addition to the four varieties named above, one variety from the Dominican Republic (JUMA 57), two varieties from Suriname (ELONI and Diwani) another variety from Guyana (Champion), and three varieties from the U.S.A. (Bluebelle, Starbonnett, Lebonnet).

The design of the first season's variety trial has been changed to permit the testing of the four varieties at different levels of fertilization. The design will be a Latin Square Split Plot with varieties occupying the main plots and fertilizer levels occupying sub-plots. This study will be done on Cashew Clay and Morass Peat Soil.

The sub-plot treatments will be as follows:

| Fertilizer Level | Kg/Ha N | P | K | Rate and Timing of Fertilization |
|---|---|---|---|---|
| CCF 0 | 0 | 0 | 0 | None |
| CCF 1 | 56 | 20 | 25 | 10 Kg $P_2O_5$/ha )<br>15 Kg $K_2O$/ha )at sowing |
| | | | | 28 Kg N/ha at 21 DAS at panicle |
| | | | | 28 Kg N/ha )<br>)differentiation |
| | | | | 10 Kg $P_2O_5$/ha )<br>10 Kg $K_2O$/ha ) |
| CCF 2 | 64 | 29 | 34 | 29 Kg $P_2O_5$/ha )<br>34 Kg $K_2O$/ha )at sowing |
| | | | | 28 Kg N/ha at 21 DAS |
| | | | | 12 Kg N/ha at 42 DAS |
| | | | | 24 Kg N/ha at panicle differentiation |

| On Morass Peat Soil | Kg/Ha N | P | K | Rate and Timing of Fertilization |
|---|---|---|---|---|
| MPF 0 | 0 | 0 | 0 | None |
| MPF 1 | 10 | 10 | 20 | 10 Kg $P_2O_5$/ha )at sowing<br>20 Kg $K_2O$/ha )<br>10 Kg N/ha at panicle differentiation |
| MPF 2 | 20 | 20 | 30 | 10 Kg $P_2O_5$/ha )<br>20 Kg $K_2O$/ha )at sowing<br>10 Kg $P_2O_5$/ha )at panicle<br>10 Kg $K_2O$/ha )differentia-<br>20 Kg N/ha )tion |

For the variety X fertilizer trials the micro-nutrient fertilization levels on the Clay soil and on the Morass Peat soil will be as indicated in 4.1.2.1. above.

4.1.2.4. Pot Trials

The pot trials for the first season's work will test the response of the rice plant to foliar applications of selected micro-nutrients. The ph ranges of the Clays and the Morass Peat [4] suggest that minor element nutrition should be investigated.

The minor elements to be used are:-

On Clay Soils:

- Iron, manganese and zinc

On the Morass Peat Soil:

- Iron, manganese, zinc and copper

The design of the experiments will be:

- on the Cashew Clay and Wallen's Clay $2^3$ factorial in a completely Randomized Design with two replicates.

- on the Morass Peat Soil: $2^4$ factorial in a completely Randomized Design with two replicates.

Basal NPK fertilization will be applied as follows:

| | |
|---|---|
| - on the Clay soils: | 60 Kg N/ha |
| | 30 Kg $P_2O_5$/ha |
| | 30 Kg $K_2O$/ha |
| - on the Morass Peat Soil | 30 Kg N/ha |
| | 30 Kg $P_2O_5$/ha |
| | 40 Kg $K_2O$/ha |

4.1.2.5. Rice Production Study

On the Cashew Clay Soil type a state of the art production plot of ten (10) hectares (24.71 acres) will be managed as per a prorated budget for 10 hectares. A budget for 405 hectares has been presented earlier.(1) Actual costs and returns will be recorded.

4.1.2.6. Seed Purification

Seed purification plots of all varieties entered in the variety/fertilizer trial will be grown in the first season. The entire area for seed purification work will not exceed one (1) hectare (2.471 acres). Separate nurseries will be prepared for each variety. Each variety will occupy approximately 0.25 hectare (0.618 acres) in the field after transplanting. Spacing will be 30 cm x 15 cm at one (1) seedling per hill.

We expect to obtain approximately 800 kg. (1,763 lbs) of bulked seed and 100 single-plant selections of each variety after purification in the field is completed.

4.1.2.7. Training Programme

On the Cashew clay and Morass Peat soil types, demonstration plots of size 0.4 hectare (approximately 1 acre) will be sown with variety CICA 9 at 14 day intervals. There will be ten (10) sowing dates on each soil type.

The training programme of each season will be planned to begin on DAY 119 and to end on DAY 126.

Participants will be exposed to the rice crop at all important stages of its development from land preparation through to harvesting.

Field work will occupy one-half of each training day and class room lectures will be conducted for not more than 1 hour each day. Some time will be allocated each day for participants to familiarise themselves with the different types of agricultural chemicals used in rice production.

4.1.3. Data Collection

4.1.3.1. Soil Analysis

To monitor nutrient status of the soil prior to each fertilizer application and at maturity.

Sampling at: prior to 1st tillage; 21 DAS, 63 DAS, 126 DAS

| Sampling Date | Type Sample | To be analysed for |
|---|---|---|
| Prior to 1st tillage | Soil Sample | % Clay, % silt, % sand<br>% organic carbon<br>$P_2O_5$ - ppm (Truog)<br>K - m.e./100g soil<br>Na - m.e./100g soil<br>Mg - m.e./100g soil<br>Ca - m.e./100g soil<br>$SO^s$ - m.e./100g soil; non Sulphare - S<br>$Cl^4$ - me./100g soil<br>Mn - ppm<br>Zn - ppm<br>Fe - ppm<br>B - ppm<br>Mo - ppm<br>Cu - ppm |
| AT 21 DAS, 63 DAS | Soil Sample | % organic carbon<br>$P_2O_5$ - (ppm) (Truog)<br>K - m.e./100g soil<br>Na -m.e./100g soil;<br>Mg - m.e./100g soil<br>$SO^s$-m.e./100g soil; non Sulphare - S<br>$Cl^4$ - m.e./100g soil<br>Mn - ppm, Fe - ppm, B- ppm, Zn - ppm; Mo - ppm |

4.1.3.2. Plant tissue analysis

At 21 DAS, 42 DAS 63, DAS, Plant Dry weight/100 $cm^2$ plot area, 84 DAS, 105 DAS, 126 DAS. Sample content of N,P,K, Ca, Na, Mg, $SO_4$, Cl, Mn, Zn, Fe, and B in plant tissue.

4.1.3.3. Grain (at 12% moisture) (g) / Straw (Dry weight) (g) ratio at maturity (126 DAS).

- From two (2) 10 cm x 10 cm. Sub-samples in micro plot studies
- From four (4) 30 cm x 30 cm. Sub-samples in macro-plot studies.

4.1.3.4. Grain yield will be recorded only from macro-plot studies on the basis of kg/ha of clean grain at 12.5% moisture.

4.1.3.5. Data on number of tillers per unit area will be recorded at the same time when plants and soil are sampled for chemical analyses.

4.1.3.6. Plant height of 10 randomly selected plants/plot at maturity will be recorded to the nearest centimetre. Plant height will be measured from the soil surface to the tip of the panicle of the tallest tiller each randomly selected plant (excluding awns if present).

4.1.3.7. The following ancillary data will be recorded from the samples taken at 4.1.3.3. above.

- Number of grains/panicle
- Weight of 100 grains (g)

4.1.3.8. From the grain harvested to provide yield data in the micro-plot studies, two 500g samples of clean dried grain at a moisture content of 12.5% for each plot will be dehulled using a laboratory shelter and milled in a laboratory mill for 30 seconds. The data to be collected will be:

- weight of dehulled sample (g) and by difference find weight of hulls (g) and calculate % by weight of hulls.
- weight of milled rice, and calculate % total recovery.

- weight of head rice (g) and weight of brokens (g) separately, and calculate % recovery of head rice and % recovery of brokens.
- by difference between weight of dehulled sample (g) and weight of milled rice (g) find weight of bran and calculate % recovery of bran.
- Percentage by weight of chalky grains in the hulled rice sample. A chalky grain for the purpose of this assessment is defined as a rice grain exhibiting one or more of the following blemishes:
  - (a) white belly
  - (b) white centre
  - (c) white back

A random sub-sample of the chalky grains will be assessed for the extent of chalkiness using an internationally accepted scale.[3]

Table I: Scale for Opacity of the Rice Endosperm[3]

| Scale | Chalkiness (expressed as % Surface Area) |
|---|---|
| 0 | None (0%) |
| 1 | Low (less than 10%) |
| 5 | Medium (10% to 20%) |
| 9 | High (more than 20%) |

4.1.3.9. Condition of Crop

Specific notes will be made of the condition of the crop in the field from sowing through harvesting with reference to lodging of the crop, the occurrence of pests, weeds, and diseases, the type of control measures used and the effect of such control measures.

4.1.3.10. Meteorological Data

It is desirable that during the cause of the experiments we should be able to obtain daily records of the following meteorological data:

- rainfall (mm)
- maximum and minimum temperatures (°C)
- relative humidity at 0900 hours and at 1400 hours
- Solar radiation ( ) or if such data are not available, number of hours of sunshine per day
- open pan evaporation rate.

4.1.3.11 Quality of Irrigation Water

Routine sampling of irrigation water entering experimental blocks will be done at each irrigation time-run. Samples will be sent to a laboratory to be analysed for:

- electrical conductivity
- bicarbonate content
- pH

4.1.3.12. Soil Moisture Prior to Dry Tillage Operations

Routine tests will be done to obtain data.

ADDITIONAL STUDIES IN SECOND SEASON OF WORK

All main studies done in the first season will be repeated in the second season to test the repeatability of the results. From the results of the first season's work the best treatment or best treatment-combination will be used as the median level and will be bracketed by lower and higher treatment levels.

All factors of which a treatment level has been adjudged to be significantly better than the other levels tested will be included in a separate study to be done on the Cashew Clay soil and the Morass Peat. This additional study will provide in greater detail, information on the response surface.

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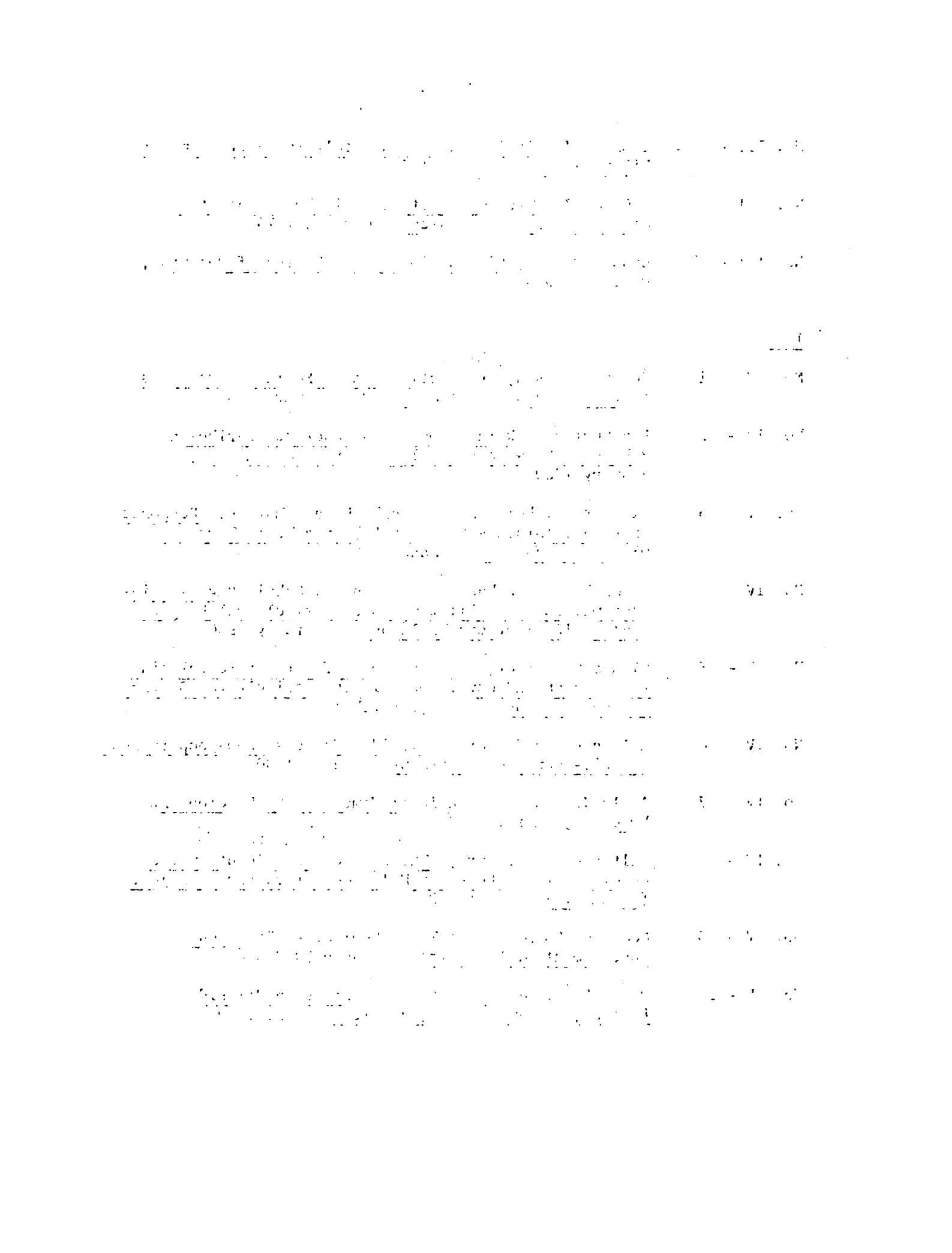

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