RICE-PASTURES PROJECT

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1. Introduction

One of CIAT's present goals is to develop sustainable agricultural systems. A combined project between the Rice and the Pastures Programs is being implemented in order to carry out works in the mentioned direction. The project attempts to associate and/or to rotate rice and pastures aiming to obtain a more sustainable system than that of rice monoculture or pastures systems alone.

Given the extensive cattle production and the suitable pastures technology together with the advanced upland rice varieties adapted to yield economically in acid soils, it is a reasonable strategy to start working with rice-pastures systems in the Colombian Llanos Orientales.

2. Background

There are several known factors that can be taken as a base point to start researching from.

To begin with, we know that,there species of both pastures and rice that perform well in conditions of low pH and poor fertility when grown alone. Pastures planting after rice crops and even in association is already an existing practice in some areas of Brazil. There, and in the Colombian Llanos Piedmont scientists of CIAT's Rice Program have observed that Brachiaria decumbens tends to choke the rice when it is allowed to regrow in association with the rice crop. It is a fact that rice and pastures will compete. On the other hand, fertilization and legume based pastures face adoption problems by pastures (cattle) producers. The rice crop needs fertilization and in the Llanos it has responded with economically increased yields to applications of N and P. No response has been observed to other nutrients at least in the first 1-2 years of rice production. Soluble fertilizers are expensive and are inefficiently utilized by the plants under the tropical conditions of high rainfall, high temperatures and high P fixing capacity of the savanna soils. The potential N supply by legumes associated to grasses and to rice in the same field, as well as the use of native sources of low nutrient solubility such as rock phosphate are attractive possibilities to investigate. Further depletion or imbalance of nutrients other than N and P is to be taken into account at a later stage, perhaps in the same fields where N and P work was taking place. It is suspected that residual fertility of the rice crop will be available for the establishment or the reestablishment of pastures. Establishment if they are being sown with or soon after the rice or reestablishment if they are being allowed to grow back after a rice crop, in the same field where they were previously grown. It has been shown that increasing the number of plants in the field will increase competition. The intensity of this competition will depend on the species involved in the associations. It will be necessary to investigate the response of rice-pastures associations in this respect.

Land preparation methods for upland rice in the savanna are already reasonably acceptable. It would seem likely that the rice crop will need a deeper plough than that needed for pastures establishment. Methods such as early ploughing could prove very useful in helping weeds control, promoting mineralization and microbial activity and producing less pressure on the soil at one single time thus reducing erosion. The availability of machinery in the area might mean a constraint on land preparation other than that needed for pastures establishment.

The region from Villavicencio to Carimagua offers a range of contrasting savanna soils with changing climatic conditions in which to carry out both on farm and on station research.

3. Experiments planning

Based on the above background we can conclude that to make this project efficient and to obtain effective results as soon as possible, we have to begin by looking at basic agronomy (competition, location, spacing, different soils) of rice-pasture systems. As this knowledge is obtained further aspects can be studied such as fertilization and plant nutrition, land preparation, plant competition, other agronomic practices, etc.

Experiments can be planned for the first year, with continuation of some evaluations in subsequent years. Planning of new experiments should be partly based on the results of the first set of experiments, so that we can evolve finding constraints and sorting them out as research goes on. At present we do not know more than some major points that we should use as a framework to start investigating rice-pastures systems as a whole.

The set of planned experiments concentrate mainly on the aspects of agronomy of rice-pastures systems mentioned above, seeking to answer basic questions such as: will rice and pastures establish and produce when grown together? will such systems work in different locations?, which pastures will associate better with rice?, what are the best relative planting dates for rice and pastures? what systems, seed rates and row distances are the best for associated rice with pastures?....... Once these basic questions are answered, having used acceptable land preparation and fertilization practices, then we can concentrate on "tuning" the system by actually concentrating on land preparation and fertilization experiments. Simultaneously of afterwards research on basic competition studies, integrated pest management, diverse crop rotation, use of new pastures, extrapolation to other countries/ecosystems, etc could be a potential sequence of the project. (see table 1). Table 2 shows the components of the Rice-Pastures Project and the way the planned experiments fit into them, for the period 1989-1990.

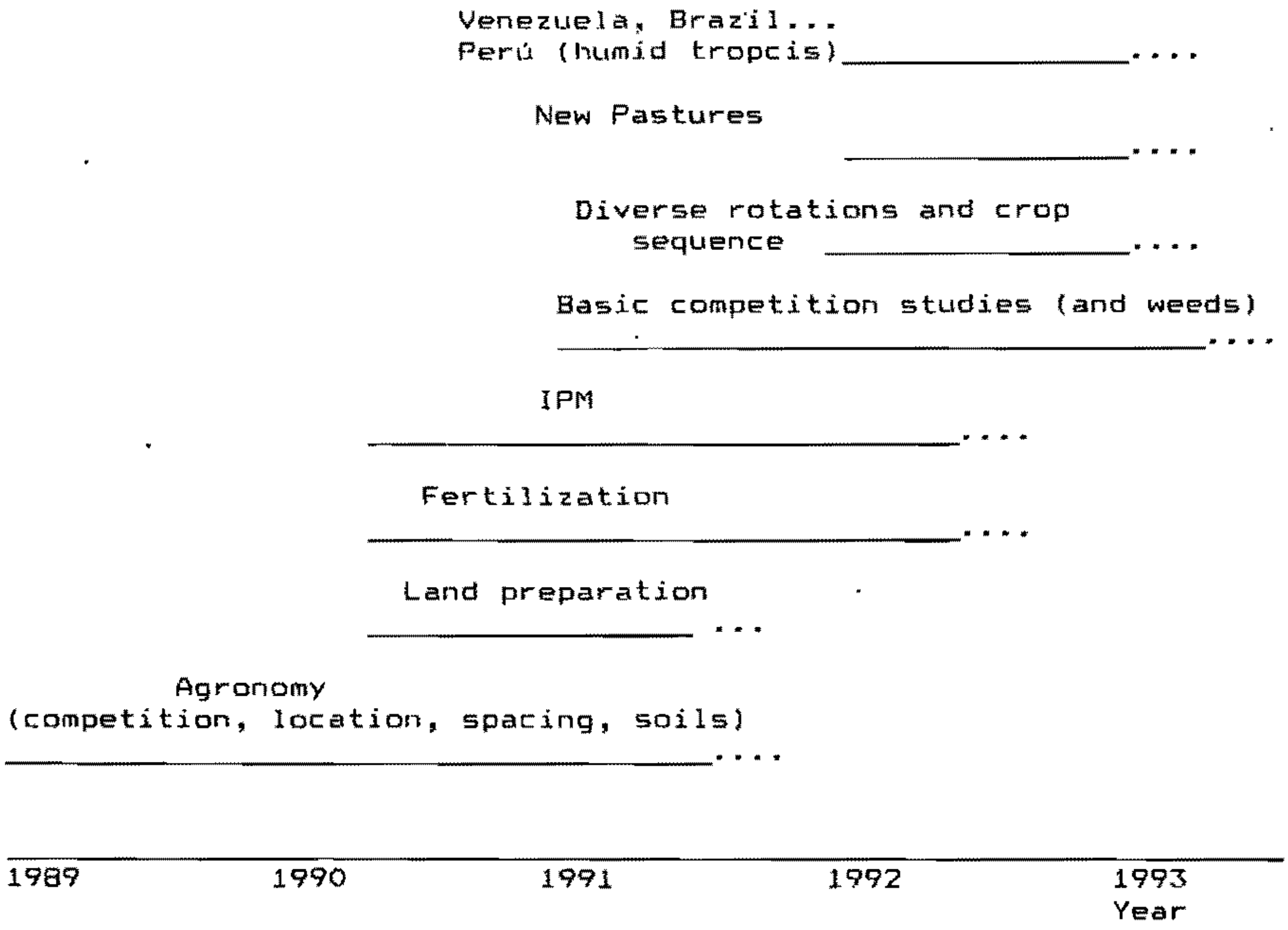

Table 1. Components of the Rice-Pastures Project and their subsequence in time.

Table 2. Components of the Rice-Pastures Project, and the way the planned experiments fit into them. (1989-1990).

	RICE-PASTURES						
	Competition Rice VS Pastures				Sites		
	Different pastures systems and rice monoculture vs rice-pastures systems	Broadcast vs grain drill rice	Relative dates of planting	Space and density rice	Cari-magua	Puerto López 1	Puerto López 2
Carimagua 1:[1] Types of land preparation and rice planting systems in rice-pastures associations	X	X			X		
Puerto López 1: The establishment of rice-pastures systems considering different sowing dates for pastures	X		X			X	X
Puerto Lopez 2:[2] The effect fo row spacings and rice seed rates on the establishment of rice-pasture systems	X			X		X	X
Puerto López 3: The comparison of rice vs rice-pastures systems	X					X	X

[1] Includes early ploughing vs late ploughing treatments.

[2] Includes plouging (for rice vs. for pastures) and fertilization (for rice vs. for pastures) treatments

Cont. Table 2.

	Pastures - Rice		
	Competion Rice vs pastures		
	Different pastures systems and Rice monoculture vs. Rice-Pastures syst.	Broadcast vs grain drill rice	Fertilization
Carimagua 2: The establishment of rice on degrading pastures in constrast with native savanna and pastures recuperation after the rice crop	X	X	N and legume (*P. phaseoloides*) as well as P.

4. The Experiments

4.1 Rice-Pastures

4.1.1. Carimagua 1. (Hato Yopare)

Types of land preparation and rice planting systems in different rice-pastures associations.

Design and treatments:

Split plot design with a factorial arrangement

- Main plots : ploughing

2
1 = Early (December/88) Shallow disk
2 = Late (April/89) Plough for rice

X

- Subplots : Cultures X Rice planting systems

Cultures :

1. Rice alone
2. Rice + Pasture 1 (*B. dictytoneura* + *C. acutifolium*)
4 3. Rice + Pasture 2 (*A. gayanus* + *S. capitata*)
4. a. Pasture 1 alone
   b. Pasture 2 alone

X

Rice planting systems:

B. Broadcast (80 kg seed ha^{-1})
2 D. Drill (60 kg seed ha^{-1} and 30 cm between rows)
3 - Reps : 3

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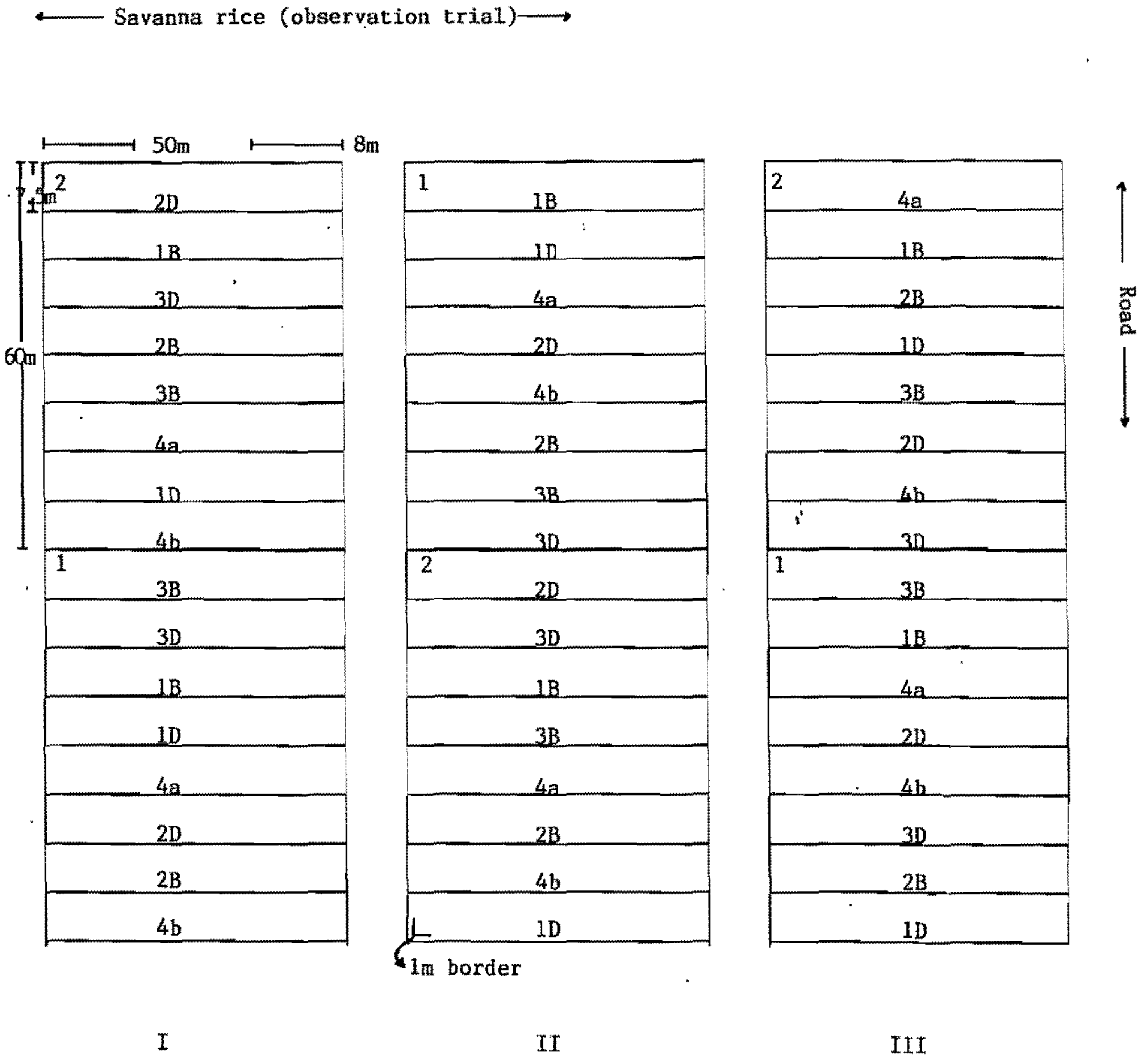
48 Subplots of 375 m^2 each


Savanna rice (observation trial)
50m
8m
7.5m
1
60m
2
2D
1B
3D
2B
3B
4a
1D
4b
1
3B
3D
1B
1D
4a
2D
2B
4b
1
1B
1D
4a
2D
4b
2B
3B
3D
2
2D
3D
1B
3B
4a
2B
4b
1D
1m border
2
4a
1B
2B
1D
3B
2D
4b
3D
1
3B
1B
4a
2D
4b
3D
2B
1D
Road
I
II
III

Note : Harvest borders first, then plots (for rice)

<u>Observations:</u>

- Basic fertilization

80 kg N ha^{-1} (Urea)	30 kg N at 30 days (rice) 50 kg N at 60 days
50 kg P ha^{-1}	25 kg P as Huila Rock Phosphate 25 kg P as Triple Super Phosphate (Broadcast with late ploughing for broadcast rice and drill at sowing time for grain drill rice)
80 kg K ha^{-1} (KCl)	30 kg at 0 days (with P) 50 kg at 30 days (with 1st N)

300 kg dolomitic lime ha^{-1} (with late plough)

- Pastures mixtures broadcast 30 days after rice, together with 1st application of N and 2nd of K
- 1 pluviometer and 1 thermometer (max.min.) for daily reading

4.1.2 Puerto López 1

The establishment of rice-pastures systems considering different sowing dates for pastures

Design and treatments

Split plot design (for each farm)

- Main plots: Sowing dates for pastures

  1: Simultaneously with rice

  2: 30 days after rice

  3: 60 days after rice

  4: After rice harvest (approx. 120 days) with light disk

  5: Pastures alone, simultaneous with pastures in 4, light disk, and fertilizer for pastures

5

X

- Subplots: Associations

2 a. Rice + Pasture 1 (<u>B. dictyoneura</u> + <u>C. acutifolium</u>)

b. Rice + Pasture 2 (<u>A. gayanus</u> + <u>S. capitata</u>)

X

3 - Reps : 3

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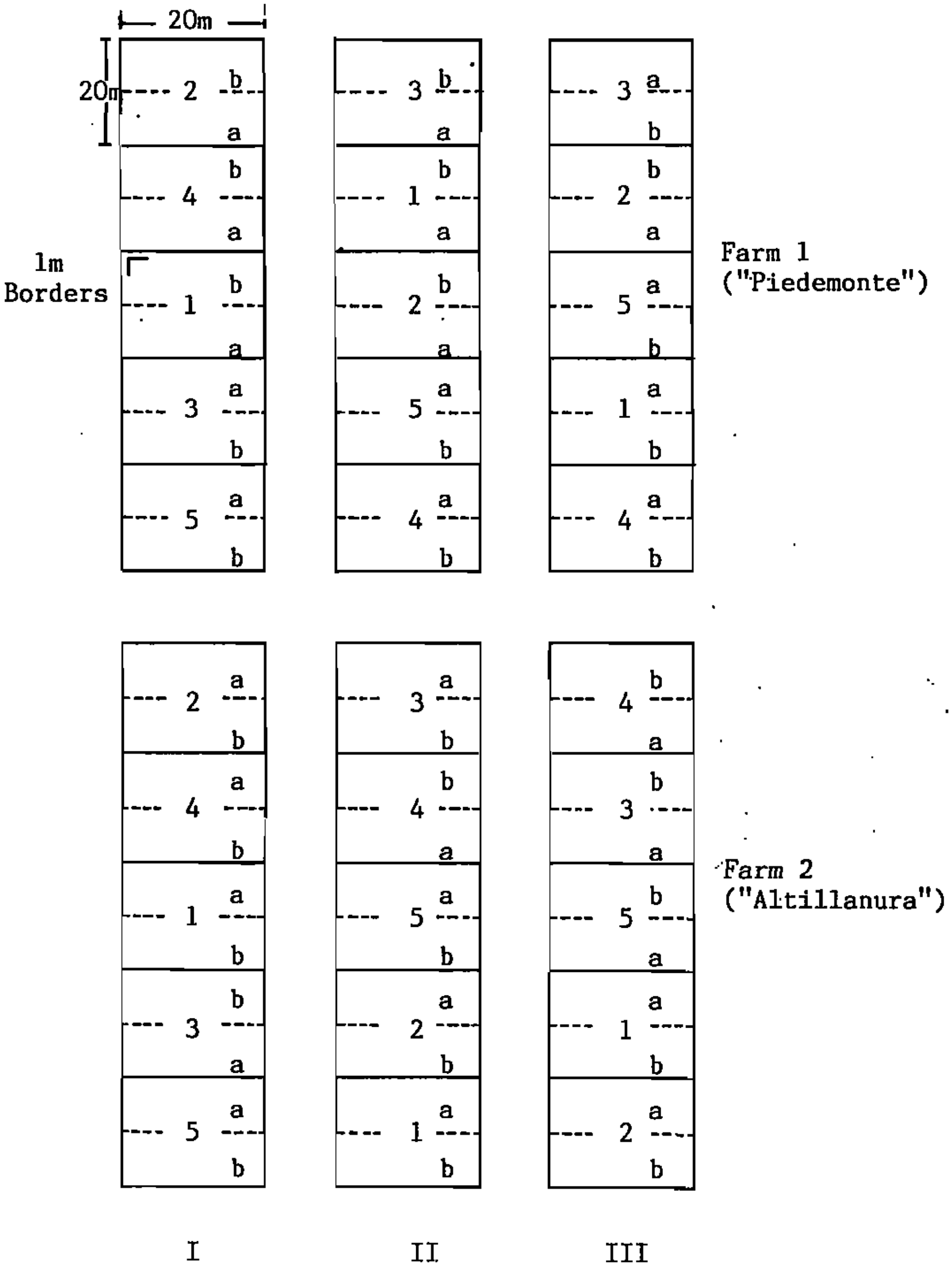
30 subplots of 200 m^2 each per farm

<u>Observations</u>

- Pastures broadcast, and rice drill (60 kg seed ha^{-1} and 30 cm between rows).
- Basic fertilization: As in Carimagua 1 For main plots 1 to 4. For main plot 5 broadcast: 20 kg P ha^{-1} as huila rock phosphate, 20 kg KCl-K ha^{-1}, and 200 kg dolomitic lime ha^{-1}
- 1 pluviometer, 1 thermometer (max-min) for daily reading per farm.


20m
20m
1m Borders
Farm 1
("Piedemonte")
Farm 2
("Altillanura")
2 b a
4 b a
1 b a
3 a b
5 a b
3 b a
1 b a
2 b a
5 a b
4 a b
3 a b
2 b a
5 a b
1 a b
4 a b
2 a b
4 a b
1 a b
3 b a
5 a b
3 a b
4 b a
5 a b
2 a b
1 a b
4 b a
3 b a
5 b a
1 a b
2 a b
I
II
III

4.1.3 Puerto López 2

The effect of row sapcing and rice seed rate on the establishment of rice-pasture systems

Design and treatments:

Split plot design (for each farm)

(with a randomized block design within subplots of main plot 3)

- Main plots: Cultures
  1. Rice alone
  2. Rice + Pasture (*A. gayanus* + *S. capitata*)
     a. With fertilizer for rice
        (control for main plots 1 and 2)
     b. With fertilizer for rice but
        without Nitrogen
  3 3. Pasture alone
     c. With fertilizer for pastures
     d. Nil

X

- Subplots : Row spacing(s) X Seed rate (R) (Rice)

  S30 R60 : 30 cm X 60 kg ha^{-1}

  S30 R90 : 30 cm X 90 kg ha^{-1}

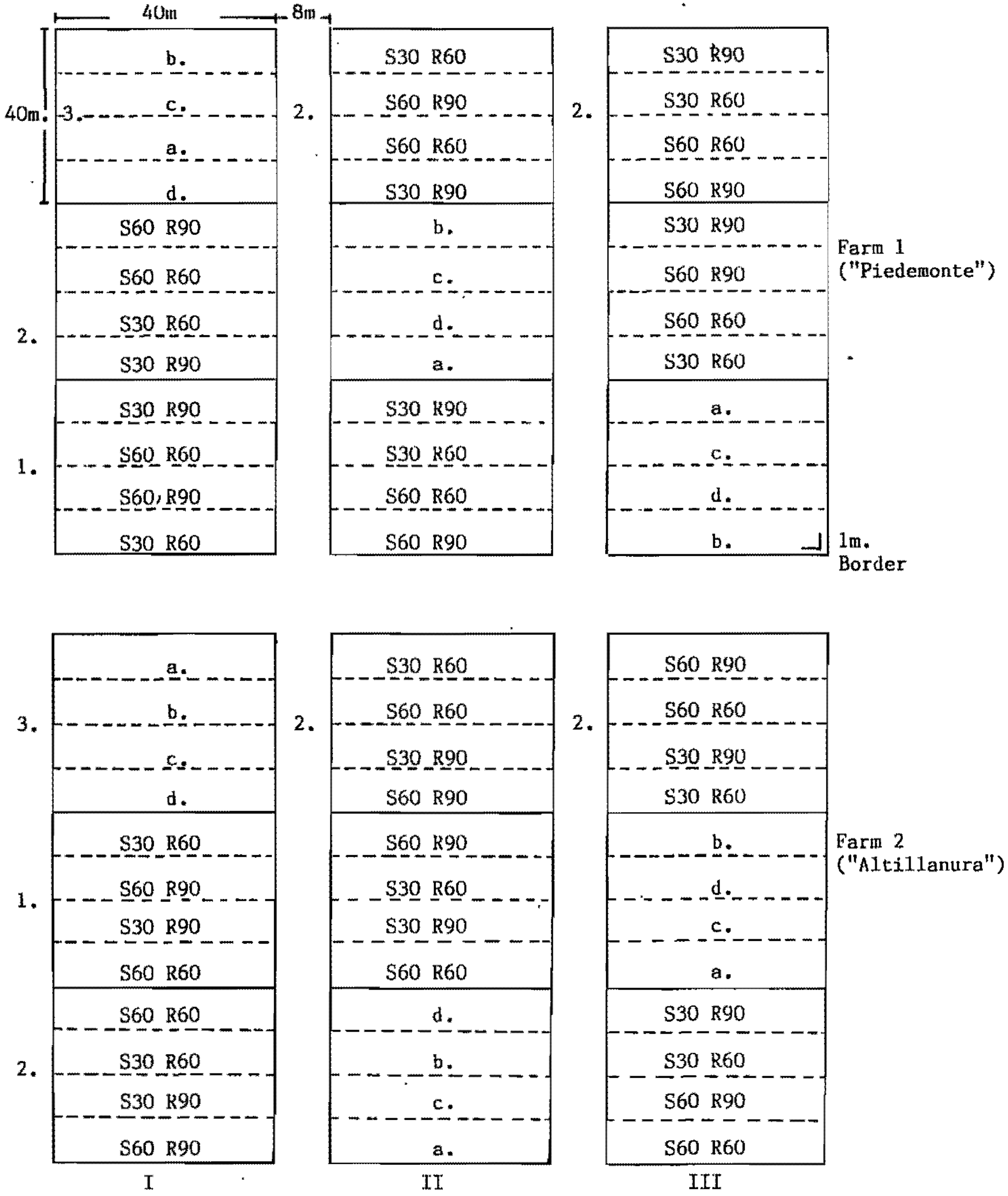
  S60 R60 : 60 cm X 60 kg ha^{-1}

  S60 R90 : 60 cm X 90 kg ha^{-1}

  X

  3 – Reps : 3

  36 subplots of 400 m^2 each per farm



40m
8m
40m.
3.
b.
c.
a.
d.
S60 R90
S60 R60
2.
S30 R60
S30 R90
1.
S30 R90
S60 R60
S60/R90
S30 R60
2.
S30 R60
S60 R90
S60 R60
S30 R90
b.
c.
d.
a.
S30 R90
S30 R60
S60 R60
S60 R90
2.
S30 R90
S30 R60
S60 R60
S60 R90
S30 R90
S60 R90
S60 R60
S30 R60
a.
c.
d.
b.
Farm 1
("Piedemonte")
1m.
Border
3.
a.
b.
c.
d.
1.
S30 R60
S60 R90
S30 R90
S60 R60
2.
S60 R60
S30 R60
S30 R90
S60 R90
2.
S30 R60
S60 R60
S30 R90
S60 R90
S60 R90
S30 R60
S30 R90
S60 R60
d.
b.
c.
a.
2.
S60 R90
S60 R60
S30 R90
S30 R60
b.
d.
c.
a.
S30 R90
S30 R60
S60 R90
S60 R60
Farm 2
("Altillanura")
I
II
III

Observations

- Pasture broadcast 30 days after rice, together with 1st application of N and 2nd of K.
- Basic fertilization: As in Carimagua 1 (grain drill rice) for main plots 1 and 2 and for subplot a; also drill for subplot b but without N; for subplot c: 20 kg P ha^{-1} as huila rock phosphate, 20 kg KCl-K ha^{-1} and 200 kg dolomitic lime ha^{-1} (broadcast); for subplot d nil.
- 1 pluviometer, 1 thermometer (max.min.) for daily reading per farm.

4.1.4 Puerto López 3. (Best bets)

The comparison of rice vs. rice-pastures systems.

Design and treatments

Randomized block design (for each site).

Treatments :

1. Rice alone (60 kg ha^{-1} drill, at 18 cm)

3 2. Rice (at 30 cm) + Pasture 1 (*B. dictyoneura* + *C. acutifolium*)

3. Rice (at 30 cm) + Pasture 2 (*A. gayanus* + *S. capitata*)

x

3 - Reps. 3

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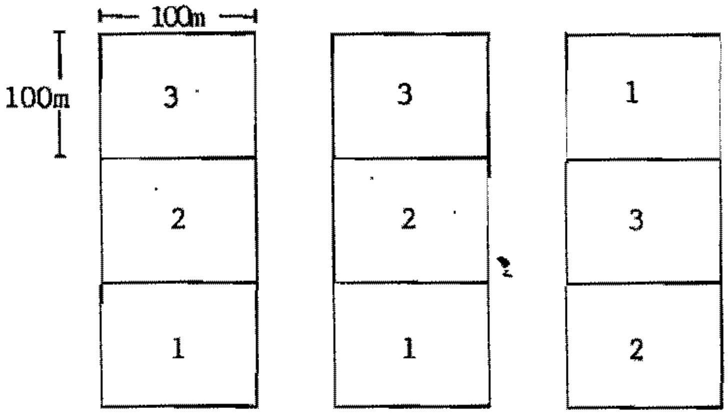
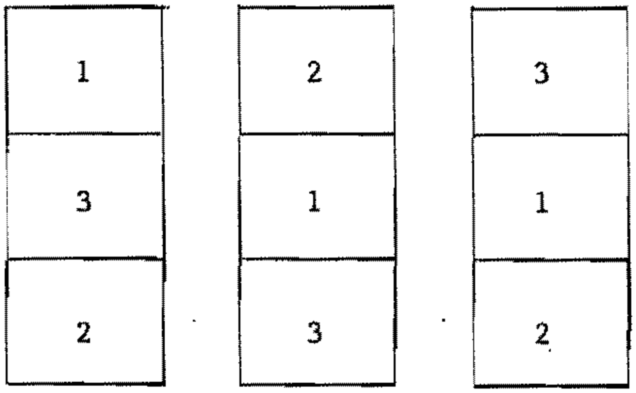
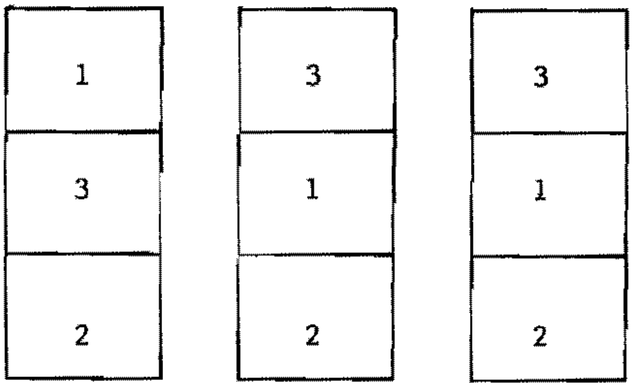
9 plots of 1 ha each per site



Farm 1 (site 1)
("Piedemonte")



Farm 1 (site 2)
("Piedemonte")



Farm 2
("Altillanura")

Observations

- Basic fertilization: As in Carimagua 1 (drill rice treatments)
- Plant broadcast pastures followed immediately bu grain drill rice
- 1 pluviometer, 1 thermometer (max. min.) for daily reading per farm
- Farm 1 site 1 and Farm 2 with the same rice line used in all other experiments i.e. CT 6196-33-11-1-3. Farm 1 site 2 with another rice line i.e. CT 6196-33-10-4-15.

4.2 Pastures-Rice

4.2.1. Carimagua 2

The effect of ten years of previous pastures growth on rice establishment and production.

Design and treatments

Randomized block design with a factorial arrangement (for each site)

- Each site with a preceding pasture system: (burnt with Paraquat)

Site 1 : Bd + Pp   _B._ _decumbens_ + _P._ _phaseoloides_

Site 2 : Bd   _B._ _decumbens_

Site 3 : n.s.   native savanna

Treatments

P-levels (50% Triple Super Phosphate + 50% Huila Rock Phosphate)

25 P : 25 kg P ha^{-1}

2 50 P : 50 kg P ha-1

X

Urea N-levels

0N : 0 kg N ha^{-1}

40N : 40 kg N ha^{-1} 15 kg N at 30 days
25 kg N at 60 days

3

30 kg N at 30 days

80N : 80 kg N ha-1

50 kg N at 60 days

X

3 Reps.

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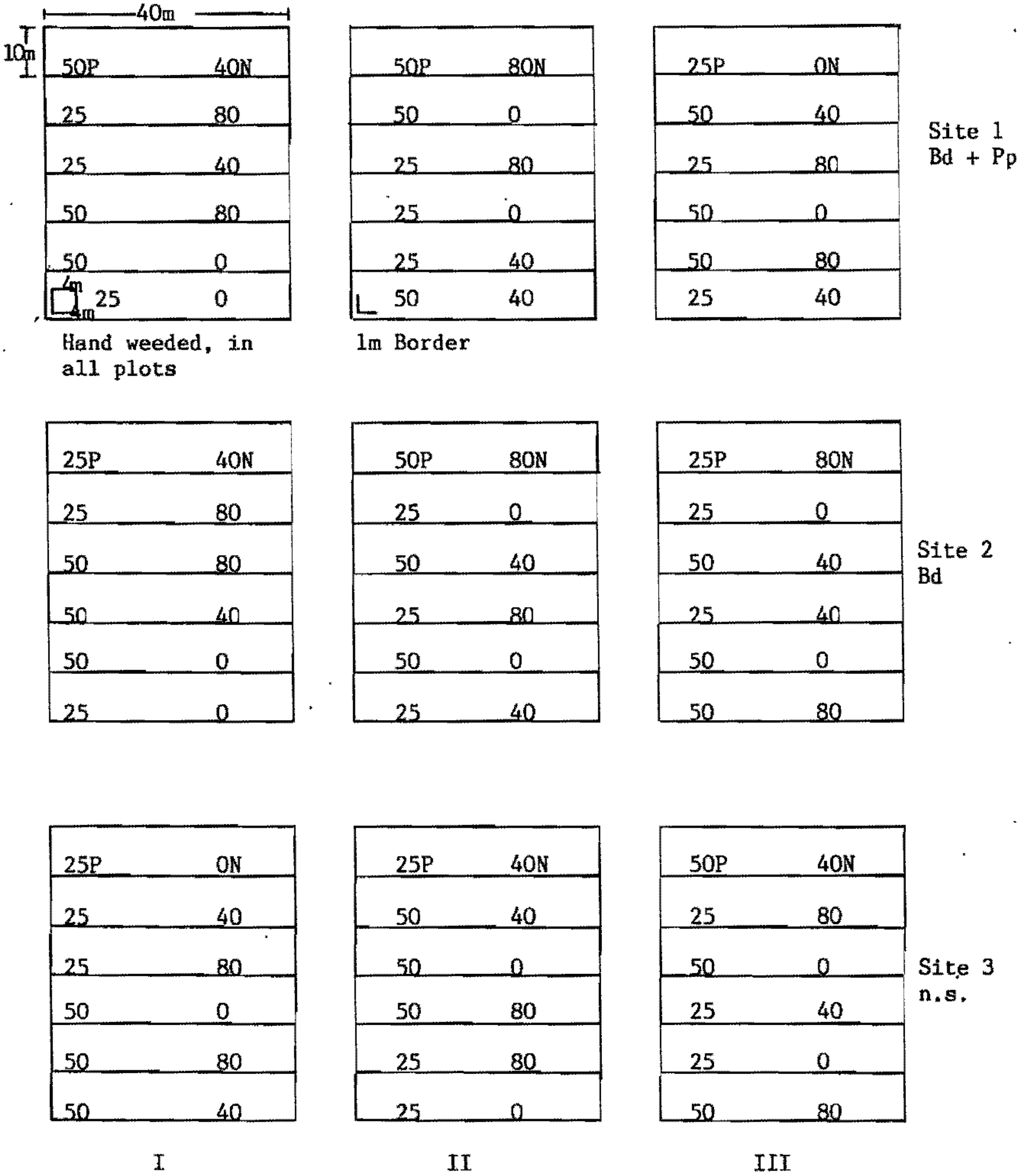
18 Plots of 400 m^2 each per site



Site 1
Bd + Pp

50P	40N	50P	80N	25P	0N
25	80	50	0	50	40
25	40	25	80	25	80
50	80	25	0	50	0
50	0	25	40	50	80
25	0	50	40	25	40

Site 2
Bd

25P	40N	50P	80N	25P	80N
25	80	25	0	25	0
50	80	50	40	50	40
50	40	25	80	25	40
50	0	50	0	50	0
25	0	25	40	50	80

Site 3
n.s.

25P	0N	25P	40N	50P	40N
25	40	50	40	25	80
25	80	50	0	50	0
50	0	50	80	25	40
50	80	25	80	25	0
50	40	25	0	50	80

I II III

Observations

- Rice graindrill 60 kg ha^{-1} at 18 cm between rows
- Basic fertilization : As in Carimagua 1 except for N and P levels (see treatments)
- 1 Pluviometer, 1 thremometer (max. min.) for daily reading
- In each plot there will be a 4 X 4 m plot to be hand weeded in order to have rice alone without pasture competition in all treatments.

5. Variables to measure:

- Soil analysis before planting (before ploughing 0-5 cm and 5-20 cm and after ploughing 0-20 cm) (Full chemical analysis plus OM and texture by Boyoucos).
- Soil analysis at rice harvest as above (0-20 cm).

Rice

- Rice coverage at the same times as for pastures (number of plants per row when drill and same as for pastures when broadcast; see pasture below).
- Leaf sample 30 days after planting (Full analysis).
- 40 days leaf blast.
- 40 days dead heart.
- 60-70 days leaf scald and leaf brown spot.
- After flowering to maturity:
    - Leaf sample (as above)
    - Neck blast
    - Leaf brown spot
    - Dirty grain
    - 50% flowering
    - Panicles per m^2
    - Height
    - Lodging
    - Yield

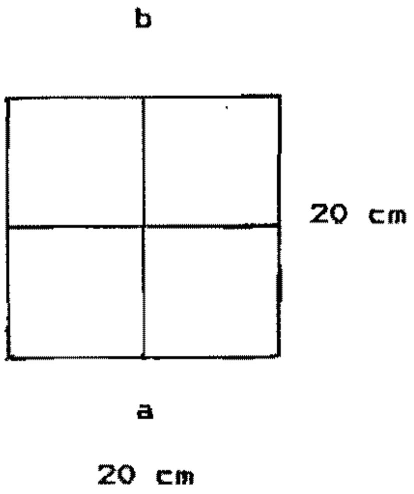
Pastures

- Carimagua 1

    - Germination:

      Counts at 10 and at 30 days after planting pastures (Number of plants per quadrat, 20 per plot) each quadrat of 20 cm x 20 cm.

    - Coverage:



      Using quadrats (and by previous eye calibration).

      20 per plot at 30, 60, 120 and 180 days for both pastures and rice. For drill rice the row goes along the a-b line of the quadrat (number of plants per row).

    - Dry matter yield and plant tissue analyses for both pasture (gramineae and legume) and rice stuble at rice harvest time, at the end of the rainy season, and with a previous standardization cut, at the beginning of the next rainy season. (Harvest same quadrats above).

Carimagua 2:

As in Carimagua 1, but "Germination" at 20 and 40 days after planting rice, trying to separate seedlings and vegetative growth if possible.

P. López 1:

As in Carimagua 1, but "Germination" at 10 and 30 days for each pasture sowing date.

P. López 2:

As in Carimagua 1.

P. López 3: (Best bets):

Botanal 60 days after rice harvest and around June 1990.

Others:

- Daily rainfall
- Daily maximum minimum temperature.

Note : Land preparation practices have not been included in this project as a fixed treatment because they may vary from site to site. They will be the minimum necessary to achieve acceptable rice seed bed.