SOCIAL RELATIONS OF LAND AND FERTILIZER USE AND FRONTIER INTEGRATION: UPLAND RICE IN THE LLANOS ORIENTALES OF COLOMBIA.

Report to IFDC
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I. Abstract

Research among upland rice farmers in the Meta Piedmont showed that upland rice production was fully integrated to national commercial agricultural institutions including agricultural research and technology delivery systems. Nonetheless, within the domain of commercial agriculture, class differences--as indicated by area of rice planted--exist in access to appropriate upland rice soils, tenure relations and soil management practices.

Three distinct patterns of fertilizer use were identified, principally distinguished by the source of phosphorus that farmers used. Thirty eight point three percent (38.3%) of farmers sampled used no phosphorus. Twenty one point three percent (21.3%) used compound fertilizers, and 40.4% used Diammonium Phosphate (DAP) and slow release sources like Basic Slag and Rock Phosphorus. The use of DAP and slow release sources predominates among farmers planting over 100 hectares of rice, and among ranchers who use rice to prepare the land for establishing or renewing pastures. The no-phosphorus pattern predominates among farmers who plant fewer than 50 hectares of rice.

CIAT has estimated that the significant increases in Latin American rice production before the end of the century will tak place in frontier regions. The theoretical orientation of the reports shows that only when land tenure is stable is fertilizer of interest to farmers. Cattle and rice are Latin America's frontier crops. The Meta case study shows that in order to do on-farm evaluations of PR fertilizer technology on the alluvial soils presently planted in upland rice, two distinct trial designs are called for to reflect the major land management practices of frontier regions that have been integrated to national commer-

cial agriculture. Trials should be designed to reflect continuous cropping patterns, as well as the use of upland rice to prepare land for pasture.

II. Introduction and Theoretical Orientation[1]

The development of technology for frontier crops and crop rotations has been advocated as part of an over-all strategy to improve food production in tropical developing countries (CIAT, 1981:1-2; 17). Since Phosphorus has been repeatedly identified as a limiting factor for agriculture in the acid and infertile soils of much of Latin America, low cost phosphorus fertilizer technology is an essential component of such a strategy (Fenster and Leon, 1979). The IFDC/CIAT Phosphorus Project identified rice, under rainfed--or upland--as well as irrigated conditions as one of the most promising crops for fertilization with indigenous phosphorus rocks (PR) on the Oxisols of the Eastern Plains of Colombia (IFDC/CIAT, 1981:48-50).

This paper reports on the land management and fertilizer practices of upland rice farmers in the Meta Piedmont of the Llanos Orientales. The research was designed in order to extend the promising results of the IFDC/CIAT phosphorus rock research with rice to the stage of on-farm evaluation of the technology. Anthropological research on land tenure, land use patterns and the institutional infrastructure affecting the selection and use of fertilizer was undertaken in order to discover whether differences in soil management and fertilizer use existed among different socio-economic groups of farmers. A description of the strategies and circumstances that affect fertilizer use among farmers serves to indicate factors which may be taken into account in the design and testing of fertilizer technology.

Rice farming in Meta is land extensive and intensive in its use of capital

and technology. It falls within the domain of what has been described as commercial, capitalist agriculture, in contrast to production by peasants, or small farmers. Within these bounds, the research shows that four different types of farmers grow rice in Meta. At different socio-economic levels the goals of each type of farmer entail three distinct land use patterns. In order to adequately evaluate the performance of Rock Phosphorus fertilizers under farm conditions, the research shows the need for two different designs for on-farm trials.

Sections III and IV of the report describe the field site and research methods. Section V gives a brief social history of rice farming in Meta, so as to place in context the data on farmer types, land management and fertilizer use, which is set forth in Section VI. Section VII closes the report with a discussion of the implications of the research findings for future phosphorus fertilizer research on upland rice.

The balance of this introductory section is given to a discussion of the importance of rice as a crop in Latin America, and of the social dynamic by which frontier lands are integrated to commercial agricultural production. This is done in order to contribute towards the development of a broad social framework for research on rice and phosphorus fertilizers in Latin America and the discussion is used as base from which to set forth the specific objectives of the research in Meta.

In the past 15 years rice has become a widely cultivated crop in Latin America. Moreover the importance of rice grown under rain fed, upland conditions has received increased recognition. In spite of the spread of the high yield, irrigated varieties developed for Latin America in the 1970's,

just over half of the rice produced in Latin America is grown by the upland sector on an estimated 6.2 million hectares. Irrigated rice, in contrast, covers, 1.9 million hectares. The area under upland rice is growing faster than that under irrigation, and it has been estimated that the area under upland rice will increase by 50% by the year 2000, largely as a result of a shift in cultivation to cheaper lands, as in Meta, Colombia, or the edges of the Amazon Basin, as in Peru and Brazil, or the Yucatan in Mexico (CIAT, 1982, 1983).

Unfortunately, beyond a general recognition that upland rice is grown in a wide range of environments and cropping systems, ranging from frontier slash and burn subsistence systems to highly mechanized and capital intensive ones, there is little information on the social aspects of Latin American rice farming (Laing, et al, 1982; Seguy, 1982; Martinez, 1982). The mapping of the distribution of upland rice farming systems in Latin America that is currently underway at CIAT emphasises the agroecological factors that will favor or constrain the extension of upland rice. For example, the distinction between "favored" and "unfavored" upland rice systems is based on edaphic and climatic data. It identifies the areas where upland rice is grown, or where it can potentially be grown, but it does not yield information on sociological factors that will favor or limit the extension of the crop or the adoption of new technology in producing it (Jones, 1983).

Who plants upland rice, how and why in any given location is important information for the development of a fertilizer technology that farmers will use. Since it is known that rice is planted in a variety of farming systems, it is

important to identify their characteristics and to understand the dynamic that leads to the replacement of one by another.

For example, during this century, the Meta Piedmont has seen two distinct systems of rice farming. The first, unmechanized upland rice farming (arroz de secano a chuzo), was characteristic of pioneer frontiers. Rice was a "civilizing crop": tropical forests in the Meta Piedmont were cut, and burned. Corn was planted and when yields began to decline after a few harvests of corn, rice or yucca were interplanted with pasture. (Leurquin, 1967). The pastures were used to fatten cattle that were extensively raised on the natural grassland of Eastern Meta and Casanare. The second system, mechanized upland rice farming, has been termed an "opportunistic spin-off" from research developed for irrigated rice, and has a relatively short history (Jennings, et al, 1981).

Because rice has been, and will continue to be a frontier crop, and because as recently as twenty years ago parts of the Meta Piedmont were in what is commonly recognized as "frontier conditions"--that is, characterized by "empty" and "free" land--it has been assumed that the lack of infrastructure and other social factors related to frontier expansion would limit the adoption and use of fertilizers (IFDC/CIAT, 1981; IFDC, 1980). Indeed, this has been the case on the pioneer frontiers surrounding the tropical forests of the Amazon basin and Central America, and in the less favored ecologies where upland rice planted, often in order to prepare the land for pasture.[2] In the Meta Piedmont of the Llanos Orientales such frontier conditions do not apply to mechanized upland rice farming. They are long past and they are not the determinants of fertilizer use in rice farming.

The production of rice in Meta is highly technified and based on the agrochemical inputs required by high yield variety seeds. Rice is, after all, Colombia's Green Revolution crop (Scobie and Posada, 1976), and Meta is the second most important producing region of the country. Meta's production is thoroughly integrated into Colombian commercial agriculture. In 1980 transportation costs, which are a notorious problem for frontier agriculture, were among the lowest of all rice farming areas in Colombia (OPSA, 1981). Appendix I summarizes representative management practices for upland rice farming in the region.

These considerations made it important to think about frontiers and commercial agricultural in order to account for the relatively high level of technification in Meta. It was useful to place the data generated by field research on land use and fertilization practices in the broad context of three issues that are central to discussions of the modernization of Latin American farming.

1. The process of integration of frontier areas into national and commercial agricultural structures.
2. The hypothesized tendency of small farmers to disappear as commodity producers in the face of competition from agricultural production systems which are capital intensive and based on new technology; and
3. What has been termed the "odious competition between man an animal for agriculturally fertile lands (Feder, 1980), or the strategy of using land for grazing cattle rather than for cereal production.

Taken together, these issues are important for fertilizer research in Latin America, because as they translate into local conditions they provide the parameters which define who produces a given commodity, and with what land

use patterns and agronomic practices. I want to expand on these issues briefly in order to demonstrate their importance to fertilizer research.

It has been shown that agriculture on frontier lands has been responsible for much of the growth in food crop production in Latin America (de Janvry, 1981:70-71; Foweraker, 1981:60-63. It is important to know why this is so.

The clearest general theory of frontier expansion in Latin American countries was developed by J. Foweraker (1981) as a result of field research on Brazilian frontier expansion. Foweraker shows that import substitution industrialization (ISI) entails changed relationship with frontier lands because the very processes of industrialization generate 1) concentrated populations in cities; 2) increased demand for staples; and 3) an "excessive surplus of labor" which is "available to move to the frontier to meet this demand"(1981:60). The process of integrating new lands to the national economy is shown to pass through three stages with distinct land use patterns as well as extractive, productive, and populational characteristics.

At the beginning of frontier integration the land is isolated and economic activities are fundamentally extractive, nomadic and sporadic. Such as they are, they are organized by outside traders or entrepreneurs responding to demand for commodities like rubber, lumber or mate. Where labor is needed, it is brought in under coercive, servile, or debt-peopnage conditions. When demand for the commodity at issue subsides, the economic activity ceases--but often left behind is a small subsistence group of pioneers using land in an extensive and equally nomadic fashion. During this period, which Foweraker calls the non-Capitalist stage, land has no value whatsoever.

During the second phase of integration, labled the Pre-Capitalist Stage

extractive activities become more intense and land begins to be bought and sold. But the price represents the value of what is on the land and not the value of land itself. Land leases are granted by governments to extractive enterprises and conflict frequently develops between a growing subsistence and petty commodity sector and the extractive enterprises.

The final and third stage of integration, the capitalist stage, is characterized by intense in-migration, and an increase in land values, that with more or less social violence, results in the concentration of land tenure. This is when steady agricultural production begins to replace extraction as a main economic activity. The third stage always involves the emergence of a landless labor force and the development of a free labor market. Agriculture itself tends to become capitalized and this transformation often results in the replacement of the subsistence farmers who market their surplus production, by large capitalized farmers or ranchers (1981:37-57).

It is in this connection that the expansion of capitalized ranching as an instance of frontier integration in the third stage has been very heavily criticized. Many writers have argued that meat production in Latin America for luxury consumption at home or abroad is directly responsible for the destruction of natural resources; the concentration of land; the creation of a landless labor force and the diversion of crop lands to feed animals rather than people (Feder, 1981; Nations and Komer, 1982; Shane, 1980; de Walt et al, 1982; de Walt, 1983; Myers, 1981).

Less attention perhaps, has been given to the needs of the subsistence pioneer whose aim is precisely to work within market terms, but finds it easier to produce and sell a product that can walk to market rather than

to produce and sell large quantities of perishable food crops. It is matter for research whether such aims are the motive force behind the use of rice as a "civilizing crop" to turn forest lands into pasture. Many accounts of Brazilian and Andean frontier expansions towards the Amazon Basin suggest that it is (Turchi, 1981; Esteban, 1978; Roman, 1974; Valverde and Bandy, 1982; Navas, 1982; Smith, 1982; Schurman, 1980; Bromley, 1980; Ortiz, 1980). I will return to the livestock/cereal issue below.

Foweraker's general theory or model of the dynamic of frontier integration to national ISI economies shows some of the mechanisms by which frontier integration reproduces on the frontier the split between "capitalist" and "peasant" agriculture that characterises so many Latin American countries. Because it shows the new relation of ISI to frontier lands it complements the model developed by Alain de Janvry, who also sees ISI as ultimately responsible for the growing separation between capitalist and peasant agriculture.

The essential distinction between the two forms of production according to de Janvry, lies is the state support provided to the capitalist sector for the agricultural production of export commodities to generate the foreign exchange necessary to finance ISI; for the production of industrial crops to supply industry; and for the production wage goods, or cheap food, so that industrial wages can be kept low. Rice in Colombia has been a diagnostic crop in this regard.

Essentially, modernization of rice farming in Colombia consisted of replacing the unmechanized upland system, planted principally by small farmers using family labor, by a mechanized and irrigated system of production, planted by large, commercial farmers using hired labor. Colombia's post war ISI policy

favored the agricultural production of industrial inputs, like cotton, and sesame, and rice, the latter as a wage good. Irrigation and mechanization were introduced to Tolima and Huila in the 1940's and to Meta in the 1950's. In the early 1970's, CIAT developed the first high yield varieties for Latin America.

Spectacular increases in rice production were due to a sui generis collaborative agreement between the Insituto Colombiano Agropecuario (ICA), the Rice Grower's Federation (Fedearroz) and CIAT (Centro Internacional de Agricultura Tropical) to produce high yield seed varieties and to develop training programs in appropriate cultivation practices (IICA, 1981: IV:54; III:12). The Ley 5a. of 1973 was passed in order to develop the institutional framework necessary to ensure the effective delivery of the new technology by linking technical standards of production to agricultural credit from the Fondo Financiero Agropecuario (FFAP-the Colombian Agricultural Credit Fund).

In their analysis of the introduction of High Yield Varieties to Colombia, Scobie and Posada were able to state that "the benefits of technological change all accrued to consumers, "with the lowest income households receiving the largest gain, absolutely and relatively" (1977:78). This was consonant with the country's industrialization policy; they concluded that as a wage good, rice "represented a dampening effect on the rise of industrial wages" (1977:32).

In contrast--and in response--to competition from capital intensive and technified agricultural production systems, the food producing small farm sector in Colombia began to disappear. The small farms that produced 50% of the country's rice under upland conditions in 1966 were displaced within the decade

by the price declines which followed the increased production and economies of scale brought about by public irrigation works, mechanization, and later, high yield varieties (Scobie and Posada 1977; IICA 1981, I;17, de Leal, 1981). Thus the small farm sector tends to become a transitory and disappearing category: as small farmers are thrown off land they held in non capitalist forms of tenure or come to derive over half their income from off farm labor, in cities or in the countryside. In this way the modernization of agriculture generates the "excess surplus labor", which as long as frontier lands are available, can also move away to begin the cycle of frontier integrations (de Janvry, 1981; Foweraker, 1981).

Although stunted in its brevity, the foregoing discussion on the political economy of frontier integration to a national industrializing economy provides a critical perspective from which to view agricultural modernization and from which to determine research objectives.

It makes it difficult to use the term "frontier" loosely with regard to frontier rice production and fertilizer research because it shows why, independently of any particular frontier with its given agroecological characteristics, each stage of frontier integration implies different groups of farmers, different intensities of land use and widely different probabilities of adoption of fertilizer technology. It also begins to suggest why--in ways that will become clearer in section V--why Meta, which passed from frontier rice farming, as a "civilizing crop" to prepare land for pasture, to highly commercial and capitalized rice farming, is such an appropriate and interesting place in which to undertake fertilizer research.

For Meta, these considerations on the relation between ISI agricultural

modernization and frontier integration translated into three specific questions that organized my research.

1. How did the process of frontier integration work itself out as affects the determination of who the rice farmers are, how they manage land, and how they use fertilizers?
2. Do small farmers disappear from the commercial production of rice? If they do not, do their land management and fertilizer practices differ from those of more capitalized farmers?
3. What role, if any, do cattle play on rice farms, and how does the presence of cattle affect soil management.

These are important questions for fertilizer research because the essential characteristic of PR fertilizer technology is its slow release of phosphorus to the plant. Over four years, the residual effect of PR fertilizers has been shown to equal that of soluble sources on some Llanos soils (CIAT, 1980:165). Social factors affecting tenure and soil management are critical to the disposition and evaluation of residual benefits. On farm trials of the agronomic effectiveness of PR fertilizer technology on rice, will for example need to be designed differently for farmers who plant the same field year after year in crops, and those who use upland rice to prepare pastures.

III The Field Research Site

The Department of Meta is in the Southeast of Colombia (Figure 1). The Piedmont area was in a finger of moist tropical forest extending up from the Amazon Basin. The forest has been cut and the Piedmont is now one of Colombia's most important rice producing regions.

Rice is grown at 400-450 masl. When the crop is planted under irrigation, it is planted on high terrace soils that are acid, infertile and low in phosphorus. It is grown on such infertile soils around Villavicencio, Puerto Lopez, Cumaral and Restrepo, and fed by gravity irrigation by the Guatiquia, Ocoa, Upia and Humea rivers. Villavicencio and Puerto Lopez are the oldest irrigated rice regions of the Piedmont and were responsible formaking Meta one of Colombia's main rice regions as early as 1967. South of Villavicencio, irrigated rice is grown on high terraces in Acacias, S. Carlos Guaroa and Castilla and Guamal. Where the volume of water in the rivers permits a second crop, rice is planted continuously. Otherwise the land is rotated with sorghum or cattle.

Mechanized upland rice is agroecologically favored in Meta (Martínez, 1982). It is grown on the alluvial, vega, soils along the rivers that cross the Piedmont. Figure 2 shows the distribution of alluvial soils in the Meta Piedmont. These soils are of variable quality but considerably more fertile than the acid high terrace soils used for irrigated rice. Phosphorus is the most variable element, with quantities oscillating between 15 ppm to 92 ppm (Martinez, 1982:3; Sanchez and Leal, nd). However, since the advent of mechanization, many fields have been continuously cropped and Bray II analyses by the Phosphorus Project have shown quantities of phosphorus well below 10 ppm, suggesting a process of soil degradation over time.

Upland rice production is heaviest in the Ariari Basin, around Granada, along the Rio Negro in the Villavicencio region, and along the Guatiquia and Humea rivers, north of Villavicencio. Only one crop of rice a year is possible because the crop is rain-fed. Planting begins in March and by May most farmers have finished planting. For the second semester the land is rotated with a crop of cotton, or sorghum, or cattle are grazed on the stubble.

Rainfall in the Meta Piedmont averages 2789mm (Figure 3). The rainy season begins in March and the dry months are December, January and February. The average temperature is 25C, ranging between an average of 31C in the hottest months of February and March and 21C in the coldest months of July and August. The relative humidity is highest in June (85%) and lowest in February (65%) (Sanchez and Owen, 1979:6-7; Martínez, 1982:3-4).

The high relative humidity and occasional drought stress during the planting season upland rice especially vulnerable to fungus diseases such as Pyricularia oryzae, Helminthosporium oryzae and Rhynchosporium oryzae. Although some types of fungus--related grain discolorations are independent of Piedmont soil conditions others are associated with acid soils, hoja blanca virus, and in the case of pyricularia, excessive nitrogen fertilization (Laing et al, 1982:19-20; Castaño, 1983:2, 17, 21).

In 1982 the average sized plot for irrigated rice was 75 hectares; for upland rice, 35 hectares. Although there is a shortage of drying capacity, there are 46 mills in the Piedmont, including a plant for processing parboiled rice for export and domestic consumption (Caja de Crédito Agrario, 1982: I, iii:17; II,i:1; Fedearroz, 1981:11). Seventy percent of the rice produced in Meta is shipped out of the department for distribution throughout the country. Overall, this farming system exemplifies the commercial and tech-

nified facet of Colombian agriculture, in marked contrast to the small farmer cropping systems the Phosphorus Project works with in the Cauca Valley (Ashby, 1981).

IV Methodology

In Villavicencio discussions with key informants (farmers, agricultural extension agents, private agronomists, fertilizer and agrochemical salesmen) provided basic information on irrigated and upland rice, and small farmer crops. A decision was taken to limit research to upland rice farmers on the assumption that the lower costs of production of upland rice relative to irrigated rice made it accessible to a greater socio-economic range of farmers.

In order to identify different groups of farmers and variations in fertilizer practices an interview schedule was written that emphasized personal history, land tenure, fallows and crop rotations, and fertilizer use. A haphazard sample of 33 informants developed as an extension of the original network of key informants; that is, the farmers interviewed were friends clients, neighbors or acquaintances of the original informants in Villavicencio.

Data from these interviews were used to select farms for one semester on-farm fertilizer trials in 1983 and to design farmer chechks for the trials.

In 1983 survey work concentrated on three subregions in the Piedmont: Villavicencio where rice has longest growing tradition; Granada, which has the richest soils in the region and was a pioneer frontier twenty years ago; and Cumaral/Paratebueno, where land has traditionally been used to fatten cattle. A 45 minute to one hour interview was administered to 47 farmers in order to test hypotheses about the intensity of cropping and the relationship between cattle and rice production that had been raised in 1983.

V. Frontier Integration: The Transition from Unmechanized Upland Rice Farming to Mechanized Upland Rice Farming in the Meta Piedmont.

The theory of frontier integration states that each stage of integration is accompanied by different kinds of farmers, in different forms of land tenure. I want to use this section to discuss the ways Meta's integration to the national economy and the emmergence of commercial rice farming defined who planted upland rice, how farmers managed their soils, and ultimately, how they currently fertilize their rice crop. In the Meta Piedmont the transition between the two rice farming systems took place in two stages. In the first stage, farmers who planted unmechanized upland rice, "arroz de secano a chuzo" on fertile alluvial soils were replaced by farmers who planted mechanized irrigated rice on acid and infertile high terrace soils. The second stage returned upland rice to alluvial soils, but it brought new groups of farmers to plant it, and brought the crop into the institutional domain of commercial farming.

At the turn of the century the Meta Piedmont began to develop a regional specialization in fattening cattle that were extensively raised on the natural pastures of eastern Meta and Casanare. Upland rice was planted as a "civilizing crop" by migrants from the Andes, beginning at the turn of the century, and then more intensively as migrations to the Piedmont increased in the 1930's and 1950's. After the forest was cleared and burned, rice, or corn or yucca were rotated for two or three years. Varieties with names like Monolaya, Fortuna, Salvatucasa and Rexora were planted with digging sticks and harvested by hand. The final rotation was interplanted with pasture and the process began again on a new piece of forest.

In the Mid 1950's Meta and all the Llanos Orientales was the most extensive cattle raising region of all Colombia, with the lowest density of animals in the country (Hertford, 1980). The Piedmont region produced only 5% of the country's rice. But the modernization of rice farming in other areas of Colombia was underway, and the Meta Piedmont was rapidly connected to this modernization.

In Meta, the transition from the unmechanized upland rice system parallelled that of the rest of the country, but with a slightly different twist. In the 1950's two strong migratory currents increased Meta's potential as a national rice producer: peasants and workers running away from the social conflict known as La Violencia came to Meta as pioneers; and wealthy irrigated rice farmers came from Tolima and Huila in search of cheaper land and lower costs of production (IICA:II:4).

This resulted in an interesting and unusual distribution of land, in which both the poverty and the politics of the runaway workers and peasants limited many of them to the best and most fertile lands of the Piedmont. The immigrant rice farming bourgeoisie bought or rented large expanses of land on acid, infertile, low phosphorus high terrace soils that had been used for extensive cattle raising. It was possible to move from the fertile soils of Tolima and Huila to the cheap but infertile soils of Meta because the anaerobic conditions created by irrigation raises the pH of the soil, increases the level of available phosphorus to the plant, and lowers the amount of toxic aluminum in the soil solution (Leon, 1981:14ff).

The runaway peasants and workers could not acquire large expanses of land. They bought, but more often squatted on small parcels of land by the rivers and planted subsistence crops, rice,corn and platano on the far more fertile alluvial

or vega soils. Hence, they were known as vegueros. Moreover, La Violencia had had an independent presence in the Llanos: as part of the settlement of what was known as La Guerra de los Llanos (The War of the Llanos) a land distribution program for the guerrillas and other pioneers was established in the Ariari Basin, about 100 km south of Villavicencio (Molano 1981).

Although it has the richest soils of the Piedmont, the Ariari basin around Granada has the region's shortest agricultural history. In the 1950's it was virgin forest practically devoid of human population. With World Bank support, INCORA (Instituto Colombiano de Reforma Agraria, the Colombian Land Reform Agency) founded a colony around Granada in 1964. In terms of the frontier scheme presented earlier, while the Piedmont areas around Villavicencio and Restrepo were in transition from the second to the third stage of frontier integration, the Ariari basin catapulted from stage I to stage III of frontier integration, and was subject to intense immigration, titling of land in 50 ha parcels, and impressive agricultural production.

These historically particular circumstances meant that while upland rice was in decline in the rest of the country, it underwent a brief apogee in Granada. For the years between 1965 and 1973, ICA estimated that a stable 20.000 hectares a year were planted in arroz de secano a chuzo, most of it on the alluvial soils of the Ariari basin (Leal et al 1974; Molano, 1981; Giraldo and Ladron de Guevara, 1980).

The best account of the failure of the Granada colony is to be found in Molano (1981). In spite of the roads that were built, and the bridge over Ariari River, insuficient credit and infrastructure--accompanying the shift in national policy away from land reform--and later, competition from mechanized agriculture, led most pioneer farmers to bankrupcy. Those who remained to see

and collect the excellent harvest of 1974 were ruined by the disastrous landslide at Quebrada Blanca which closed the road from Villavicencio to Bogotá for six months. Prices plumetted because the crops couldn't be moved out of Villavicencio. In a pattern that has been repeated on other Latin American frontiers, most of the founding fathers sold their holdings to second comers like themselves, immigrant peasants or workers, or to professionals from Bogota or capitalized farmers from Tolima. The pioneers moved south to open new lands in a spontaneous colonization.

But these historically particular circumstances also explain why frontier integration in a latifundist and extensive cattle raising region, colonized by a commercial and technified agricultural sector, left much of the best land in the hands of relatively small pioneers or second comers.

Ultimately, as in the rest of Colombia, irrigated rice became the dominant from of rice production. Pioneer farmers, or second comers with holdings on vega land grew corn or cotton, and ranchers began to use corn as a civilizing crop to prepare pastures, because neither vegueros nor ranchers could compete with the production of mechanized, irrigated upland rice farming.

By 1978, the Meta Piedmont was fully integrated to the national economy: the infrastructural limitations and social tensions associated with pioneer frontiers had become as insignificant as the production of arroz de secano a chuzo, statistics for which were no longer collected by the regional ICA office (Instituto Colombiano Agropecuario- the National Agricultural Research Institute). Interviews with peasant leaders in 1981 indicated that the invasions and conflicts over land had essentially subsided by the mid 1970's (Zamosc , 1981). Ownership of land was largely titled and highly concentrated. The 1970 census showed that 70.6% of the establishments in Meta were legally

titled. Sixty six point seven percent of the farms were below 50 hectares, on 3.8% of the land; 26.5% of the farms were between 50 and 500 hectares, on 16.1% of the land, and 6.8% of the farms were over 500 hectares, on 80.1% of the land. Although there has been no census since then, legal title ownership to land appears to be virtually complete in the Piedmont (Dane 1973; Caja de Crédito Agrario, 1982:33).

Those who owned the mechanizeable land, however, were not often the major rice planters. In 1981, Fedearroz estimated that 75% of the land planted in rice in the Piedmont was rented (1981a: 15). Farmers thus brought land into production as renters, in an oscillating pattern that responded to marketing difficulties and varietal resistance. Figure 4 shows the oscillation in hectareage planted in upland rice in the Piedmont since 1965.

The second stage in the transition between two upland rice farming systems began in 1979, as an "opportunistic spin-off" of research developed for commercial, irrigated rice farming. (Jennings, et al, 1981). The release of the variety, CICA-8, was responsible for the large increase in hectareage planted in upland rice that is shown in Table 1. Between 1978 and 1982, the hectares in upland rice increased from 6.267 to 38.825.

Although CICA-8 was developed for irrigated conditions, it could also be planted under rainfed conditions on fertile alluvial soils at lower costs and equal--sometimes higher--yields. (Jennings, et al, 1981 ; Martínez, 1982). Costs were lower because the labor for preparing the fields for irrigation, overseeing the supply of water, and maintaining the irrigation ridges was eliminated.

Contributing to the increased hectareage put in upland rice in the Meta

Piedmont was the decline in markets for corn and cotton which had previously been planted on alluvial, vega, soils. Corn prices had been dealt a blow by imports in 1980, but regional yields were decreasing, and corn fields were plagued by disease (ICA, 1982a). Cotton farmers couldn't sell their product because the Colombian textile industry was buying more cheaply on the international market.[3]

The re-emergence of an upland sector as a result of the development of CICA-8 thus allowed others besides irrigated rice farmers to plant rice. While irrigated farmers diversified their holdings with plots of upland rice, and ranchers began to use rice again to prepare or renew pastures on vega soils, professionals,like agronomists, airplane pilots, doctors, veterinarians and accountants, invested in rice. They rented land to plant it, as did rural wage workers, like tractors divers, farm overseers, and combine drivers. Finally relatively small farmers, who had been excluded by the costs of the crop under irrigation, or who had previously planted corn or cotton began also to plant rice.

That the introduction of CICA-8 allowed relatively small farmers to plant rice should not lead us to conclude that this technological development began to blur the distinction between commercial and small farm crop production. The poorest farmers of the Meta Piedmont do not plant rice. According to the 1973 census 40% of the farms in the Piedmont are below 20 hectares and there is localized evidence of increased minifundization during the course of the decade (DNP, 1980; CECORA, 1980; ICA, 1982). Rice and its rotation crops of sorghum or cotton are notably absent from the Integrated Rural Development programs that address the small farmer of the Piedmont. Most of these cluster

on the unmechanizeable foothills of the Andes. Around Villavicencio they are for the most part double purpose meat and milk production systems based on Criollo Cebu herds with some crossing of Brown Swiss, Brachiaria decumbens pastures, and family labor (Kleeman et al, 1982). In the Ariari basin, 77% of the farms surveyed by DRI were below 5 hectares. Crops on these farms are platano, cacao, coffee, corn, yucca, citrus fruit and papaya, in that order of importance (ICA, 1982). The land requirements and the costs of producing rice even under upland conditions are still too high to permit the poorest groups of farmers to plant it (see Appendix II).

The relatively small farmers who do plant rice are in a vulnearable position. When, as in 1982, the demise of a variety (CICA-8) coincides with high costs, national overproduction and low prices, delays in payment and mounting interest rates, the credit system rapidly reasserts the difference between small farmers and capitalized commercial farmers. The instability at the fringes of commercial farming becomes apparent, as banks foreclose on loans and refuse to lend to renters or farmers without sufficient land or additional capital to cover their eventual losses. The division between commercial farming and small farm production is accentuated by these shakeouts.

Upland rice was a "new crop" for some farmers but the Ley 5a. requirement that all crops planted with credit from the Fondo Financiero Agropecuario--the Colombian Agricultural Credit Fund--must be supervised by professional technical assistance made the absence of prior experience with the crop unimportant for many of these farmer/investors.

When a farmer applies for credit, he must have a receipt for the purchase of certified seed and a signed contract with an agronomist. The contract

specifies that the agronomist is responsible for "a prior visit to the lot... and the prescription, application and control of the appropriate technology", as the later is defined by ICA's research (Arroz, 1980:13).

Because the Ley 5a. requires that all farmers who plant with credit from the FFAP pay for technical assistance from an independent professional agronomist, the agronomist's recommendations are the pivotal point on which rests all the infrastructural weight of the Ley 5a's linkage of credit with technology. Agronomists must be university graduates and licenced by ICA. ICA, in turn is responsible for providing the courses which keep agronomists abreast of ICA's latest research and production technologies, and for monitoring the performance of agronomists.

In terms of fertilizer use, the implicaticns of the contract are clear. Farmers do not decide on fertilizer use alone. Their agronomists prescribe the sources and quantities of fertilizer they should use in accordance with ICA's research. Fundamental to ICA's fertilizer recommendations is the use of soil analyses. The emphasis on soil analyses is an appropriate one for a farming system based on such a high percentage of rental land. In 1980 Sanchez and Owen found that the soils of the Piedmont were extremely variable reflecting the different treatments accorded them by rental farmers (Sanchez and Owen, nd.).

For upland rice in Meta, ICA's regional office recommends the application of NKP compound fertilizer as a source of P, applied at planting or before, with the doses determined by the results of soil analyses. Also, before planting and depending on the results of soil analyses, is recommended the application of 1.5 tons of lime for every meq of exchangeable acidity (Al+H)

per 100 g of soil. Up to 60 kg of Nitrogen are recommended, split into three applications at 30, 50 and 70 days after germination (DAG). Potassium applications are to be applied half at planting, and half at 30 DAG, with the doses again determined by the use of soil analyses (Sanchez and Owen, nd(a)).

The resurgence of upland rice farming in the domain of commercial agriculture did, as in the rest of Colombia, exclude the smallest farmers from rice production. It brought old and new farmers into production and gave them access to an elaborate structure that links national agricultural research, the training of middle income professionals and technology delivery to the farm level by the requirement that farmers using credit pay for professional services. This structure exists in order to keep farmers abreast of new agricultural research, and to ensure uniform agricultural practices and high yields.

VI Land Tenure. Soil Management and Fertilizer Use

The previous section has argued that the resurgence of upland rice took place in a situation of full integration to the national economy. Although the second stage of transition to mechanized upland rice production broadened the spectrum of farmers planting rice, it maintained the fundamental split between small farm and commercial producers. In its new form, upland rice is a capital intensive crop predominantly planted by urban farmers with access to capital and technology, as specificied by Ley 5a.

These processes may suggest that this is not a likely place for PR fertilizer research. The alluvial soils on which upland rice is planted are not as low in P as those previously worked on by the Phosphorus Project (Leon and Fenster, 1979). The large amount of land planted in rental suggests difficulty in evaluating residual effects, and the agricultural research and delivery system under which rice is planted argues for a high degree of technification and uniformity in land use and fertilizer practice.

Here I want to show that in spite of the high proportion of land planted in rentals, there is a stability of tenure of land, but there are important differences in soil management. With variations in intensity introduced by rentals, these reduce to two patterns: continuous cropping, and the use of crops to prepare or renew pasture. Within the cropping pattern there are different intensities of soil use. Moreover, even within the domain of commercial farming, there are class differences among farmers that entail different patterns of fertilizer use and imply different access to technology delivery. There are three patterns of fertilization of upland rice in the Meta Piedmont,

commercial farming in a low hectareage year. The farmers in the sample were largely an experienced, urban and literate group. The average age of the farmers is 42 years. Eighty five percent have been in the Piedmont region for over 10 years and 51.5% for over 20 years. Among those owning farms, 77.4% acquired them before 1980; 12.9% before 1970 and 64.5% during the decade of the seventies. This is probably an older group with more experience in the region than would be turned up by a survey during a peak year. Almost 60% (59.6%) of the sample had planted rice under upland conditions before the advent of CICA-8 in 1978 but only 20% had planted a chuzo, with digging sticks. Thus, a full 80% of the sample began their rice farming careers with mechanized and commercial rice farming.

Accordingly, although only the largest farmers owned one or two combines (N=9, 19.2%), 78.7% owned one or more tractors and 25.5% owned three or more tractors. The average number of hectares worked by this machinery was 111.1: Sixty seven point one percent of the farmers planted over 50 hectares rice. Sixty eight percent owned farms with an average size of 98.6 hectares. The smallest farm was 8 ha--the only one below 20 hectares. The largest was 750 hectares.

Even in an off-peak year rentals were important to farmers in the sample. Fifty three point one percent of the hectares covered by the survey were rented.

Further evidence of their integration into commercial farming is that 85% planted with FFAP credit, during a year that banks limited their loans; 93% planted with an agronomist, and 72.3% are affiliated with one or more of the major rice institutions like Fedearroz, Coagrometa or Union de Arroceros, as well as other institutions, like the Cotton Growers Association and the Ranchers Committee.

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Integration to commercial agricultural structures is attended by life style characteristics: this is a largely urban and well educated group. Sixty eight point one percent of the sample have permanent employees to oversee their farms. Seventy two point three percent live in cities: Villavicencio, Granada and even Bogotá, and visit their plots between once and four times a week. Seventy four point five percent have heavy duty vehicles: jeeps or pick up trucks, with which to do so. It is a literate group. Six point four percent (N=3) have never attended school. Forty two point five percent had some primary education, 25.5% some secondary education, and 25.5% had attended university.

In this sample, the farmer who earns his living by rice alone is exceptional. Ninety five point eight percent have economic activities in addition to planting rice: 61.7% plant other crops; 63.8% raise or fatten cattle, 23.4% are professionals, 27.7% do commerce, 40.2% rent machinery. Only 8.5% (N=4) earn their living with wage work.

In sum then, the farmers in the sample are characterized by their experience in the region, and the overall wealth which distinguishes commercial from peasant agriculture.

Nonetheless, the sample is not homogeneous. Subregionally farmers in Villavicencio, Cumaral/Paratebueno and Granada differ in important ways, as shown in Table 2. Farmers in Villavicencio have a larger average farm size, a greater proportion of permanent employees, automobiles and urban residence than those in Cumaral/Paratebueno, or Granada. Cumaral/Paratebueno is distinguished by the high average number of cattle per farmer, a greater proportion owning at least one tractor, and the lowest proportion of urban residents. Granada farmers are distinguished by a smaller average farm size and the lowest average number

of cattle per farmer.

Nor is the sample homogeneous with respect to social class. For the purposes of this report, the fundamental indicator of class is the number of hectares planted. The number of hectares a farmer plants depends on the amount of land he owns--or the resources he can command to rent land--and the kind of collateral he can present at the bank. Farmers are responsive to the market for rice, and to previous year losses or gains, and so the hectareage they plant may vary from year to year. A farmer who planted 80 rented hectares in 1982 and had to be refinanced, was not, for example approved for credit in 1983. He reduced the area planted to 20 hectares in 1983, and paid the production costs with profits from a successful cotton rotation. In spite of this built in annual variation, the number of hectares planted is usually a pragmatic indicator of social class. Among ranchers, who plant small lots of upland rice, it needs to be supplemented with number of cattle and farm size.

In this sample, the number of hectares planted coincided with two life style characteristics: urban residence, and automobile ownership. Eighty three point three percent of farmers who plant fewer than fifty hectares of rice live on their farms, or in a nearby hamlet (caserío). Only 20% of farmers who plant between 50 and 99 hectares live in the countryside. Eighty-five point seven percent of farmers planting over 100 hectares of rice lived in Villavicencio, Granada or Bogotá.

With regard to ownership of automobiles, 100% of farmers planting over 100 hectares own them, 80% of farmers planting between 50 and 99 hectares have cars. The proportion decreases to 50% among farmers planting fewer than 50 hectares.

Subregional and class differences that appear in land use and fertilizer use are discussed below.

i. Size Category and Farmer Types

Farmers in the sample include renters and ranchers as well as investors and mixed farmers. They farm quantities of rice land ranging from 2 hectares to 400 hectares. In order to organize fertilizer and land use data, the farmers were classified by size category, farmer type, tenure and subregion. Farmers in size category I plant between 1 and 49 hectares. In size category II, they plant between 50-and 99 hectares, and those in size category III plant over 100 hectares of rice.

Because land use patterns among ranchers are distinctly different to those of agriculturalists, it became useful to classify farmers according to their overall entrepreneurial goals, their tenure and other economic activities in addition to growing rice. Three criteria were used to develop four farmer types: ownership of cattle, proportion of owned farm land in rice, and principal economic activity. The farmer types are shown in Table 3.

Pure rice farmers are distinguished from other farmer types because they own no cattle. Growing rice is their principal economic activity and the landowners among them are distinguished from other landowners in the sample by the high proportion of owned farm land in rice, 92.9%. Pure rice farmers comprise 17.2% of the sample (N=8) and plant 32% of the hectares covered by the survey. The average size farm among the landowners is 133.2 hectares.

Mixed farmers are so characterized because in contrast to Pure farmers, cattle are an integral part of their enterprises. The average number of

animals owned by a Mixed farmer is 123 head. The proportion of owned farm land planted in rice is 68.1 hectares. Mixed farmers are the largest group in the sample, 46.8% (N=22) and they plant 45.5% of the hectares covered by the survey. The average size farm among the landowners is 117.9% hectares.

Ranchers produce rice as a secondary or supplementary activity to their main business, which is raising and fattening cattle. Accordingly, Ranchers own the largest average number of animals in the sample, 410 head, and they have the lowest proportion of owned farm land in rice, 20.8%. In contrast to the landowning Pure and Mixed farmers, where only 25% have another farm, 75% of the Ranchers have a "feeder" ranch where they raise cattle for subsequent fattening on the farms where they plant upland rice.

Like Pure rice farmers, Ranchers comprise 17.02% of the sample, but they farm only 8.1% of the hectares covered by the sample. Their average farm size is 208 hectares. Ranchers plant rice in order to prepare land for pastures, and in this sample most planted fields of 50 hectares or less, reflecting the size of the pasture they are preparing.

Investors and Income Supplementers grow rice to supplement their incomes from other activities. They include tractor drivers, and wage laborers, like farm overseers, as well as urban professionals and businessmen. No investor owns any rice land at all. One hundred percent of their crop is planted on rented land. In this sample the group is characterized by an absence of cattle although two urban investors own an average of 161 animals between them. These animals are kept on lands other than, and distant from those they rent for rice. Investors comprise 19.4% of the sample and plant 14.0% of the hectares covered by the survey.

A confirmation of the validity of the typology and the diagnostic utility of cattle is the farmer's response to the question, "Have you ever planted a semester crop in order to prepare the land for a pasture?". Among Pure farmers, only 1 farmer in size category II had done so, and this in order to be able to rent the pasture out. Eighty six point four percent of Mixed farmers had done so, in all size categories. One hundred percent of the Ranchers had, and among the Investors, only one had done so in the past, as a pioneer on his facher's farm in Granada.

The four farmer types are present in the three subregions of Villavicencio Cumaral/Paratebueno and Granada, as shown in Table 4, and they are distributed across the three size categories, as shown in Table 5.

Table 4 shows that the highest percentages of Mixed farmers are found in Granada and Villavicencio. Ranchers predominate in Cumaral/Paratebueno, whereas the Investors in the sample are evenly distributed across the regions.

Table 5 shows that Pure Rice farmers tend to plant in the large size categories. Mixed Farmers comprise about half of the farmers in each size category. Most of the Ranchers plant lots of 50 hectares or less. In this sample, most Investors are tractor drivers, laborers, or urban investors, like agronomists, and they plant below 50 hectares of rice.

Discrimination of farmers by size, type and subregion allows a more precise pin pointing of upland rice farmers. For example, Table 6 shows the effect of size category on the proportion of hectares that farmer types plant in upland, rather than irrigated rice. As all farmer types control more land, they plant less upland rice. The decline is most notable among Pure Rice Farmers, who emphasize production of irrigated rice on large expanses.

In this sample, they do not plant fewer than 50 hectares.

Upland rice is most important for ranchers where it has reassumed its traditional function of preparing land for pasture. It follows in importance among Investors and Mixed farmers, especially in size category I. These discriminations will allow an assessment of the relative effects of size, or class, and entrepreneurial strategy on tenure, land management and current use of fertilizers.

ii. Land Tenure

The importance of rental land to 72.4% of the sample is shown in Table 7. By definition, the Investors rent most land. They are followed by Pure Farmers, Mixed Farmers and Ranchers. Except for four farmers in the sample, farmers said they had stable relations to the land they planted on.

An examination of who the landlords of rented parcels are accounts for some of the stability reported. Table 8 shows the landlords of 40 rented parcels of land, by Farmer Type. "Small Farmers too poor to plant rice" ("un pequeño agricultor sin medios para sembrar") and "Small Ranchers" ("un pequeño ganadero") provide 37.5% of the parcels. Relatives provides 25% of the parcels, and between them, Rentier landlords and Ranchers ("uno que tiene la tierra ahí para eso" literally, "a man who has the land there for that", and "Un ganadero") provide 30% of the parcels.

Considered together with Table 7, the distribution of parcels by Farmer type in Table 11 shows that the control over land is virtually complete among Ranchers and Mixed Farmers who rent from family members: fathers, fathers-in-

law, and a brother. Mixed Farmers rent 60% of the parcels owned by relatives Although these farmers declare themselves to be planting on rented land, and would appear as renters in the inscriptions for credit, in terms of ongoing access to the land, they determine its disposition.

Rentier landlords and Ranchers provided 12.5% and 17.5% of the parcels respectively. Rentiers may live in Villavicencio, Bogota or Cali and may or may not have other sources of income. A Mixed Farmer renting 200 hectares from a Rentier refers to him as "un parasito : Ese ahi arrienda y vende para comer" ("A parasite: that one rents and sells his land in order to eat "). Others are liberal professionals or businessmen who acquired the land cheaply in the 1960's, and who hold it as an investment, or like Ranchers, plan eventually to put it in pastures.

Company land belongs to the company and not to the individual partners who may own different proportions of the company shares. Companies vary in their degree of organizational sophistication. For example, the investor who plants on company land, plants over 200 hectares of rice for a company that is active in rice farming, breeding pure strains of cattle and selling semen, pasture seed production, and farm vehicle distribution. This farmer's main activity is administering the business but he has also invested in company shares. He is an agronomist and is directly responsible for the company's rice production. The rancher who plants on company land, owns his own fattening ranch, but in addition he has a 1/3 interest in a ranching company composed by himself--a veterinarian--and three liberal professionals who live in Bogotá. The third farmer who plants on company land has the simplest arrangement: he and a Bogota lawyer split the cost of buying a farm,

he farms it personally, and the costs and profits are shared between the two partners.

We can get a clearer sense of the distribution of rental land, and of the role played by the "small farmers to poor too plant rice", and "Small Ranchers," if we redistribute the parcels of land that each type of landlord rents out according to the size category of the tenant. Table 9 shows that farmers planting in size categories II and III rent most (73.3%) of the parcels provided by Small Farmers or Ranchers. Such large farmers also rent most of the parcels made available by Rentiers and Ranchers. Since we know that Pure Farmers, Mixed Farmers and Investors all decrease their holdings in upland rice as they plant more hectares, Table 9 suggests that the rentals from Rentiers and Ranchers are large parcels on savannah land planted in irrigated rice, and the parcels rented from small farmers and ranchers are small parcels of alluvial vega soils planted in upland rice. In fact, the 11 parcels rented by farmers in size categories II and III from "pequeños agricultores" and "pequeños ganaderos" have an average size of 36 hectares, and 8 of them were planted in upland rice, three in irrigated. The nine parcels rented from Rentiers and Ranchers have an average size of 123 hectares. Four of them were planted in upland rice, and five in irrigated.

In addition to showing that farmers who plant large quantities of rice rent from landlords too poor to plant rice, Table 9 also shows that the family rentals are concentrated among Mixed farmers in size categories I and II. These are predominantly the Mixed farmers of Granada and Villavicencio. Eighty percent of the parcels are rented by farmers who plant less than 100 hectares, and most (33.3%) are planted by farmers who plant between 50 and 99 hectares.

Among the farmers in straight rental situations, 57.9% have one semester contracts, 31.6% have three year contracts and 10.6% have an annual contract. Although the proportion of three year contracts is low, 81.5% of the farmers with semester contracts said they had stable relations to the land they rented. A presence of three or more years planting on the same hectares was taken as an indication of stability.

The four farmers who had unstable land relations were small farmers in size category I. Three were Investors, and one a Mixed farmer owning a 37 hectare farm, who rented additional land. The reason they gave for their instability on rented land was that the landlords (a rancher and three small farmers) were constantly raising the rent or promising the land to another farmer who could pay in advance. These reasons suggest that the instability of tenure implied by renting land in a semester contract is limited to small farmers: there is a market for land that is suitable for upland rice, and farmers who cannot afford to plant rice provide the commodity and look for the best buyers. Another reason that does not appear in the survey, is that when they can, "pequeños agricultores" plant rice themselves, and take the land off the market.

For landlords who are Ranchers and Small Ranchers, there is an additional benefit beyond the rental received, which accounts for stability of rental relations. They receive the benefit of free mechanization that prepares the land for seeding or reseeding pastures. In past years rental contracts specified the delivery of land seeded in pasture. In this sample, only one farmer, an investor with a three year contract for 10 hectares had as a condition of rental the obligation to "destroncar", or to pull out the three stumps from the field

he was planting. This and the concomitant mechanization then allows the landlord to renew his pasture, at the end of the contrat.

The analysis of who farmers rent from, and how rented parcels are distributed among farmers of different types and size categories shows that in this sample, planting on land that is not individually owned does not always mean a tenuous or unstable relation to land. This is clearest in the case of farmers who plant on family land or in compañia land. For the Ranchers and Mixed Farmers these two types of tenure make their control of land virtually complete. For renters, the availability of unused land, be it from small farmers or ranchers, and the benefits that the landlords derive from mechanization make it possible for them to renew their contracts easily.

iii. Soil Management:Fallows, Rotations and Pastures.

Here I want to discuss long range and short range soil management practices among farmers in the sample. The discussion of Farmer Types has shown clearly that there are two basic long range soil management practices among upland rice farmers in the sample. Land is used for crops by landowning Pure and Mixed Farmers, but Ranchers use crops to prepare land for pasture. Before discussing the long range direction of soil management, I want to look at the short range intensity of soil use.

Farmers say they do not plan fallow periods for the land they plant in upland rice. The practice of fallowing crop land for 2-4 years was discontinued with the advent of mechanization. Mixed Farmers who plant in size categories I and II say that the land is not allowed to rest, "even for 10 minutes:" that it is constantly under the steel of the plough.

But if we measure the intensity of cropping by how farmers plan to treat their upland soils during the second semester of 1983, it becomes apparent that only about half of the hectares covered by the survey will be planted in crops. Tables 10 and 11 shows the rotations that farmers planned for 1983 B. Table 10 shows rotations planned for owned land, and Table 11 shows those planned for rented land.

Fifty seven percent of the owned upland soils shown in Table 10 were to be planted in crops. The land in "stubble", "nothing" and "other"--37.1%-- was to have an effective fallow period of six months. Only 7.0% of the hectares were to be completely idle, however: cattle would be grazed on 27.2% of the hectares, and 2.9% were to mechanized for weed control for the following harvest.

The ranchers in the sample are represented by the 5.2% of hectares to be planted in pasture. Two ranchers grazed cattle on stubble, and three planted crops.

The distribution of soil uses across size categories, however, shows that farmers in size categories I and II, regardless of Farmer type are cropping their soils much more intensely than do farmers in size category III. Whereas the large farmers in size category III planned to crop only 43.7% of their hectares, farmers in size categories I and II planned to put 74.5% and 81.9% of their hectares in cotton or sorghum. Only 10.5% of the hectares planted by farmers in size category I were to be left in stubble for six months. None of the farmers in size category II planned that use for their soils but over 40% of the hectares planted by farmers in size category III were to be left in stubble.

A similar situation is shown in Table 11 on the rotations planned for rented soils. The overall proportion of hectares to be cropped decreases to 43.1%, with 52.7% in effective fallow in "stubble", "nothing", or other. Cattle would be grazed on 40.2% of the hectares. Two farmers in size category I planned to put 4 and 6 hectares in cacao and pasture respectively.

Just as on the owned soil, the distribution of rotations planned across size categories shows a much greater intensity of cropping in size categories I and II. Only 27.8% of the hectares planted by farmers in size category III were to be planted in crops. In size category II, 86.5% was to be cropped. Again, the proportion of land left for cattle is greatest among the largest farmers.

The distribution of rotations on rented upland soils during the second

semester suggest that the Mixed farmers of size categories I and II, with stable rental relations with family or others, are using their land more intensely than do the farmers in size category III, who either let the land lie fallow, or turn it over to cattle belonging to Rancher landlords.

If the short range intensity of cropping is greatest among the smaller farmers of the sample (those planting fewer than 100 hectares), the long range direction of soil use for much of the land is into pasture. This is apparent in the case of the Ranchers, who plant two or three crops of upland rice, and then establish or renew pastures. For instance, in order to establish pasture on land that was characterized by gully erosion (Zuralles), a rancher in the sample planted 100 hectares of rice rotated with sorghum for two years. The mechanization leveled the land so that cattle can now be grazed on stubble. In March of 1984, he will plant pastures of puntero (Hyperania ruffa) and Brachiaria decumbens. A second rancher in the sample, routinely renews his pastures every 12 years, in the past, with a crop of corn, and at present with a crop of upland rice.

In accordance with the Ranchers' use of their Piedmont ranches as fattening stations, Ranchers plant yaragua (Melinis minutiflora), puntero (Hyperania ruffa), guinea (Panicum maximum) and kudzu (Pueraria phaseoloides), in addition to Brachiaria decumbens. Only one Rancher use Brachiaria decumbens exclusively. Twenty five percent of the ranchers used no fertilizer to establish their pasture. Fifty percent said the pastures were fertilized by the fertilizer left over from the cropping stage ("lo del cultivo"), and 25% (N=2) applied additional fertilizers, like Urea, 15-15-15, and Basic Slag.

But virtually all the Mixed farmers have also used crops to prepare

pasture (84.4%). Those who have not, bought their farms with pastures already established on them. For Mixed farmers, cattle and pasture are an integral part of their enterprises. The sale of cattle provides financial back up to cover eventual losses from crops, and an important alternative to agriculture. Thus of the 19 Mixed farmers who had used crops to prepare pasture, 57.9% said they did it because they needed the pasture, 5.3% used rice as a "civilizing crop" after chopping the forest, and 36.8% had planted pastures on land that was "tired" ("la tierra ya está cansada"), or overun with weeds, or otherwise unsuitable for farming. For example, a Mixed farmer who rents land for rice from his father-in-law, has turned his own farm over to 130 head of cattle to graze on stubble and regrowth (rastrojo). The cattle were bought at the end of the 1983 harvest. His own 105 hectare farm had been "under steel" for 15 years.

There is less variety of pasture grasses chosen by Mixed farmers. Forty five point five percent (N=10) of them plant Brachiaria decumbens, and half of these are farmers in size category III. Fields of Brachiaria and puntero were planted by 27.3% and 13.6% planted puntero or yaragua. Pastures were not fertilized at all by 47.4% of the farmers. Twenty six point three percent ~~continued~~ counted on the fertilizer left over from the crop to fertilize the pasture, and 26.3% applied additional fertilizer.

Farmers who planted below 100 hectares of rice pointed out that the future of the land depended on the selection of pasture grasses. Because Brachiaria decumbens is so hardy and invasive, smaller farmers expressed concern about its spread. When a large farmer who planned to put 200 hectares of vega soil in Brachiaria was asked about this problem, he replied that if he ever wished

to return his land to crops, he had the facilities for irrigation. Excessive moisture will destroy Brachiaria.

If mechanization halted the expressed practice of fallowing, mechanization also made it possible to bring pasture land--except that under Brachiaria--back into crops. This was pointed out by a farmer in Granada. Ninety three point six percent of the farmers had never planted a pasture and returned it to crops. Most reacted with horror or derision at the thought. ("Sembrar y volver a arrancar? No Señora!" "Put in pasture and then pull it out? No, Mam"). But two Mixed farmers in Granada had done so, not as a distinct practice, as it is among Ranchers, but because their lots had lost fertility or were overun with weeds, and their pastures had finished. The crop lands were put in pasture, and the pastures in cotton or rice.

Especially during bad harvests, Mixed farmers say they will abandon agriculture for ranching. It is not as lucrative, they say, but more secure than cropping. In this sample, 20% of the Mixed farmers said they would put all their land in pasture for those reasons. They has said it before in previous bad years. But no farmer in this sample had actually done so. Next year is always the last crop of rice.

Response to the question "Do you know farmers who lost money in 1982 and put their fields in Brachiaria?" suggest some of the reasons why relatively small upland rice farmers remain Mixed farmers. Since almost everyone lost some money in 1982, all said they knew farmers who had lost money, but only 19.2% were able to name farmers who had put land in Brachiaria or any other pasture. When they did, the names were always of large Mixed farmers who farmed over 100 hectares of rice. Farmers who planted between 30 and 60

hectares, it was explained, and lost money in 1982, hadn't the money left for pasture seed and additional fencing. Some sold cattle to pay their debts, others sold the farm, others left the land fallow, and others put their land up for rent if they could find a tenant.

Thus, although Mixed farmers have the option to turn their vega soils entirely over to pastures, and talk about it, farmers in the sample suggest it is not a rapid or automatic transition for those who plant fewer than 100 hectares. Until the transition is made, if it is, they continue cropping at the intensities indicated by Tables 10 and 11.

iv. Fertilizer Use

Farmers in the sample used three patterns of fertilization on their upland rice yields. The principal distinguishing criterion was source of phosphorus. Timing of application, quantity of phosphorus and quantity and source of Nitrogen also varied with the patterns set by source of P, but not as markedly.

i) No-P Farmers apply no phosphorus at all. Twenty to thirty days after germination they apply Urea or Nitron as a source of Nitrogen, and sometimes KCl, as a source of potassium. A second fertilization with Urea, and sometimes KCl follows between 50 and 60 days after germination.

ii) Compound Users follow essentially the same pattern of 2 applications, except that a compound fertilizer is used as source of phosphorus. 10-30-10 or more usually, 15-15-15 is applied together with the Nitrogen and Potassium at the time of the first fertilization.

c) The High-Tech pattern is characterized by the use of two sources of phosphorus, Diammonium Phosphate (DAP) and slow release sources of phosphorus like Basic Slag or Huila Rock Phosphate. Slow release sources of phosphorus are always applied before planting or at planting. DAP may be applied before planting, but more usually it is applied at the time of the first Nitrogen and Potassium fertilization, between 20 and 30 days after germination.

Fourteen point nine percent of the sample applied three fertilizations, but the average number of fertilizer applications was 2.2.

Which pattern a farmer uses depends on his class status, as indicated mainly by the number of hectares he farms, but also by the number of cattle owned. Land tenure does not affect the selection of the source of P or the timing of application. The quantities of N and P applied decrease on rented land, but the analysis of land tenure shows that this is probably a reflection of the class of the farmer and the small number of hectares planted.

a) Source of Phosphorus

Table 12 shows the distribution of Phosphorus source by the subregions, Villavicencio, Granada and Cumaral/Paratebueno. Thirty eight point three percent of the farmers in the total sample used no phosphorus. About three quarters (72.2%) of the farmers using the first pattern of fertilization grow rice in Granada, and 65% of the farmers sampled in Granada used no phosphorus source. The second pattern, the use of compound fertilizers, was used by 21.3% of the total sample. The proportion of farmers who used compound sources of phosphorus was more or less evenly distributed by region. Farmers who use the sources that characterize the third pattern, DAP and slow release sources, predominate in Villavicencio and Cumaral/Paratebueno, but DAP users comprise only 25.5% of the sample, and slow release users dwindle to 14.9% of the sample. Only one farmer sampled in Granada (5%) used a slow release source of phosphorus.

It is worth noting that Granada differs considerably from Villavicencio and Cumaral/Paratebueno in all fertilizer practices. Table 13 shows that fewer

have ever had a soil analysis done; that fewer had ever applied any pre-plant product like lime or slag. Forty percent of Granada farmers used two fertilizations, in contrast to 75% of farmers in each of the other subregions. Fifteen percent of Granada farmers applied fertilizer only once: in Villavicencio and Cumaral/Paratebueno, only 6.6% and 8.3% respectively did so. But the greatest proportion of farmers used three fertilizations in Granada: 45% as opposed to 40% in Villavicencio and 16% in Cumaral/Paratebueno.

Table 13 shows that Cumaral/Paratebueno farmers also have peculiarities: a very high use of KCl is most notable, but so is the low proportion of farmers applying the third nitrogen fertilization. These data suggest the hypothesis that regional differences reflect the different proportions of Farmer Types in Granada and Cumaral/Paratebueno: Sixty percent of farmers in Granada are Mixed farmers: they raise cattle, but on their rice fields they are committed to high yields. The greatest number of farmers samples in Cumaral/Paratebueno, traditionally a cattle raising region, are Ranchers, and in this sample they appear to have a greater committment to the soil rather than to the crop. We will return to this question below.

Tables 14a and b show the distribution of P sources by size category of farmer, and by farmer type in the entire sample. The effect of size category on the distribution of phosphorus source is strong. The proportion of <u>No-P</u> users decreases from 50% in size category I to 21.4% in Size Category III. All three of the farmers in size category III who use no phosphorus are from Granada. The same is the case among <u>compound users</u>. As farmers plant more hectares of rice, they do not use compound sources of phosphorus. Thirty three percent of farmers in size category I use compounds; the proportion

decreases to 7.1% among farmers in size category III.

With regard to the use of DAP, the progression is reversed: as the area of rice planted increases, the proportion of farmers using this source increases. In size category I, 11.1% of farmers use DAP; in II, 33.3%; and in size category III, 35.7. The same is the case among users of slow release sources. The proportions increase with size category from 5.6% to 6.7% to 35.7%. If we consider DAP and slow release sources together as a package that is selectively used by farmers in different size categories, in Size category I, only 16% of the farmers are high-tech farmers; in size category II, the proportion increases to 40% and in size category III, 71.4% of the farmers use DAP or slow release sources.

Table 14b shows the phosphorus source used by different farmer types. Seventy five percent of Pure Rice Farmers used the third pattern of fertilization. Among Mixed Farmers 40.9% are No-P farmers and 31.8% use the high tech pattern. The lowest proportion of farmers using the third pattern is to be found among the Investors.

Our earlier discussions account for these differences within farmer type, and show why size of hectareage planted is such a determining force. Among the investors, for example, 55.6% were No-P farmers and 55.5% of them planted in size category I, that is, they planted less than 50 hectares of rice. We have also seen that Pure farmers plant only in the two large size categories. Among Mixed farmers, who plant in all size categories, the use of high tech increases among those who plant over 100 hectares of rice. This is the case, even among Granada farmers, where 65% of the farmers from that subregion use no phosphorus. The Mixed farmers of Granada who use DAP or slow release sources

of phosphorus (16.7%) are all in size category III (N=2).

We have seen why the number of hectares planted by Ranchers is not always a reliable indicator. Among farmers of this type, 50% of them, with the largest farms, and greatest number of animals, used the third pattern of fertilization. Clearly, the class status of ranchers gives them access to the same fertilizer options available to Pure rice farmers or Mixed farmers in size category III.

It may be noted that farmers in size category III, regardless of type, may use both DAP and slow release forms. They may do so on different lots, or they may do so on the same lot. Moreover, an application of DAP in 1983, may well be following an application of basic slag or rock phosphorus in 1982.

b) Timing of Application of Phosphorus Fertilizer

Among Compound Users and High-Tech farmers who use a phosphorus source, the timing of application is only mildly responsive to the size category of the farmer. Tables 15a and b show the timing of application among phosphorus users in the sample, by size category and farmer type.

These tables show a strong post plant emphasis among all the phosphorus users in the sample. Almost 60% of the farmers apply phosphorus after planting, together with their regular nitrogen and potassium applications at 20 to 20 DAG. The "Other" option indicated in the tables (3.5% of the sample), indicates a size category III farmer--from Granada--who applied basic slag and rock phosphorus before planting, and then applied DAP at 25 days.

The distribution of preplanting phosphorus applications across size

categories shows that this practice increases steadily with the size category. In part, this is a reflection of the use of slow release sources of phosphorus, for these are always applied before planting. Nonetheless, a slightly higher proportion of DAP users apply their DAP before planting --33.3%--than is the case among Compound users, among whom only 20% apply before planting.

Table 15 on the timing of application by Farmer Type repeats the post-plant emphasis noted. Again, as the area of rice planted within farmer types increases, the high tech pattern is adopted. The generally smaller proportions of farmers in with each type who apply their phosphorus before planting are either Ranchers, or farmers in size category III.

c) Related Practices

If the identification of three fertilizer practices and its association with farmer types in different size categories is correct,the distribution of other fertilizer practices should parallell the distribution of phosphorus source.

Table 16 shows that this is generally the case with regard to soil analyses and soil amendments. This table shows the proportions of farmers using each fertilizer pattern who had ever had soil samples taken for analysis the proportion of those and who had ever applied lime and/or basic slag to their rice fields. The proportions increase as we would expect them to between No-P users, Compound users and High-Tech farmers. Two factors account for the apparently high proportion of soil analyses among farmers using no phosphorus source. Among these farmers, who cluster in size category I, are

farmers whose soils were sampled by IFDC. More important, several had planted cotton before the decline of cotton prices. The Cotton Growers' Association required soil analyses during the peak cotton years of 1977-78. Thus in size categories I and II the No-P and Compound users who had had soil-analyses taken, had had this done before 1980.

With regard to the quantities of P + N applied the picture is more complex. Table 17 shows a remarkable increase in quantities of P applied by size category. This needs to be interpreted with caution. These kg averages include kgs of slow release sources, as well as kgs of soluble sources, like DAP and compounds. In this sample slow release sources were applied in quantities ranging from 400 kg/ha to 1000 kg/ha. Therefore, the remarkable average kg/ha of P shown for the Ranchers in Table 17b does not mean that Ranchers are applying over 200 kg source of P. Rather it reflects the fact that in the sample of 8 Ranchers, one applied 1000 kg Rock Phosphorus. A more reliable indication of the quantity of P implied by each fertilization pattern can be gained by considering only the average kgs of Compound and DAP applied by farmers using each pattern.

Table 18 shows the average kgs applied by Compound users and DAP users distributed by size category. Compound users apply an average of 100 kg and DAP users an average of 61.5 kg. The Compound fertilizer used most frequently is 15-15-15. Using 15-15-15 as a base for calculation the Compound users are applying an average dose of about 15 kg of P_2O_5. The DAP users, in contrast, are appying an average dose of 28.3 kg P_2O_5.

Table 18 shows that the quantities of P applied decrease in size category III among Compound users as well as among DAP users. I think this reflects the technology available to farmers of size category III, and not a variation from

the trend presented here that the class of farmers in size category III means quantity, in terms of amount of land planted as well as fertilizer applied. I think it reflects the sensitivity of these farmers to the characteristics of the rice variety, METICA-1, they planted in 1983. METICA-1 is extremely susceptible to piricularia in the leaf as early as 8 DAG and Nitrogen increases the plant's vulnerability to the disease.

Table 18 shows that the average quantities of N applied in kg/ha are not too different across size categories, but that, as we would expect, there is a slight increase in kg/ha with size category. The decrease in P dosages among large farmers may reflect their awareness of the extra N in 15-15-15, and 18-46-0. In support of this hypothesis is the case of the 200 hectare and Investor who said he switched from DAP in 1982 to 15-15-15 in 1983 because of the higher percentage of N in DAP. I think its useful to view the low quantities of N applied by Ranchers shown in Table 18 from a perspective that recognizes this sensitivity among the ranchers who use high-tech P fertilizer sources. Moreover, they are preparing pastures or renewing pastures on vega parcels that have either not been cropped for 10-12 years, or that have been infrequently cropped, and so feel they can economize on N.

d) The Effects of Tenure on Fertilization

In this sample, the effect of land tenure on the selection of a P source is not strong. As shown in Section ii this is because farmers who declare themselves as "renters" are planting on land owned by family members, or have long term contracts, or relations with landlords that are too poor to plant

rice, such that most of the renting farmers in the sample had stable relations to the land they planted.

Two farmers in the sample, however, did indicate different P fertilizer use on owned and rented land. They are indicative of what might be the case in a year in which more land was rented for rice. The first was a Mixed Farmer in size category I, who applied 50 kg/15-15-15 on his own land, but no P source on the rented land. He said he had not done so because he wanted to "make an experiment", and to "economize on fertilizer". The second, was also a Mixed Farmer, but in size category III. On his own 300 hectares he applied Rock Phosphorus and Basic Slag in different lots. On the 150 rented hectares, he applied DAP. When I asked why he applied DAP on rented land, he explained that it was the last year of this three year contract, and he wasn't sure if the Rock Phosphorus he had applied three years ago when he began planting on the land was still effective. These differences are entirely consonant with the compound-user pattern and the high tech patterns of fertilizer use, within each farmer's size category.

v. Discussion

This analysis shows that far from the regularity of fertilizer practice implied by the technology delivery system developed by Ley 5a there are three distinct patterns of fertilizer use among Piedmont farmers, and that most apply their fertilizer after planting. Although ICA recommendations and their linkage to credit and professional technical assistance imply the use of soil analyses, these are in fact rarely used. There are institutional reasons for this. Only in 1982 did Fedearroz offer a soil analysis service in Villavicencio, and even there, farmers complain about the length of time it takes to get the results returned. Most frequently farmers say they have not used them because "the agronomist didn't recommend one."

We have seen that the agronomists role is pivotal to the working of Ley 5a's technology delivery system: the analysis of fertilizer use suggests that they deliver their services differently to farmers of different social classes. Three factors account for the recommendations made by agronomists. First, the de facto post plant emphasis of their work; second, the differences in fertilizer recommendations made by ICA and those made by fertilizer sales people; and finally, the position of agronomists in the professional status hierarchy in the Piedmont, as it intersects with the class standing of the farmers they serve.

The credit regulations and limitations contribute to the post-plant emphasis of agronomists's work. There is, for example, no credit line for fertilizer. An application for credit must be accompanied by a receipt for the purchase of certified seed, and a signed contract with an agronomist

licenced by ICA. Before applying for credit, then, the farmer has already invested in certified seed, and he may planted his rice by the time he signs the contract with the agronomist for the credit application. The first of two credit payments is usually made after a visit from a bank functionary to the field to ascertain that the rice has been planted. This is the time at which the agronomist is paid, at a variable rate per hectare. The first credit payment is used to buy the fertilizer, herbicide and insecticide applications recommended by the agronomist at that time.

This sequence contributes to an understanding of why most agronomists efforts are dedicated to monitoring the incidence of weeds, insects, disease and fungus in the field and not to developing a preplanting fertilization plan, based on soil analyses. Agronomists thus tend to prescribe fertilizers on the basis of their experience and their connections to the sources of new technology.

Second, although the Ley 5a credit regulations specify that ICA is the source that farmers and agronomists must use for technological recommendations, commercial interests often make other recommendations. The source of Phosphorus is a case in point.

For example, ICA recommends the use of compound soluble sources of P for upland rice, applied at planting, and until 1981, Fedearroz, which is a major supplier of agricultural inputs, supported ICA in its recommendations. In 1981, however, Fedearroz announced a rice fertilization plan based on replacing compound fertilizers with simple ones, and recommended the use of Diammonium Phosphate (DAP) as a source of phosphorus (Gómez, 1981). Since only the large farmers and the agronomists who serve them were aware of these changes, the smaller upland rice farmers, or the more distant farmers who hire the less

experienced agronomists continue buying the fertilizers produced in Colombia.

There is another hypothesis that is put forth by Villavicencio agronomists, farmers and ranchers that has to do with the difficulties these professionals have in making a living. There is a high degree of unemployment and under-employment among agronomists in the Meta Piedmont. In 1983 it was estimated that one of every 6 such professionals in Colombia was unemployed (El Tiempo, June 4. 8A), and in Meta the market for their services has been glutted for some years. For example, during the first semester of 1981, 48.497 hectares of rice were inscribed for credit. At that time there were 97 agronomists registered with ICA, each permitted to assist no more than 900 hectares. If the hectares were shared evenly--which they are not--each agronomist would have about 500 hectares to work. During the second semester, 29,120 hectares were inscribed, providing even less employment (ICA, 1981. 4). Agronomists then have to supplement their incomes from other sources, like commercial intermediation. It is generally difficulty for a university graduate to find employment or to get enough hectareage to work. He needs palanca (connections) in order to get a desk job at ICA, a field job with one of the agrochemical firms, or sufficient hectareage to oversee.

Because so many agronomists are unemployed, or underemployed, farmers and ranchers who are using rice credit to prepare land for pasture can obtain their signatures for bank credit at well below the rates paid to the top agronomists working for large farmers. It is believed that many Meta agronomists are "signature agronomists," or "firmones", who never visit the fields, but earn their livings by signing many contracts cheaply, and most frequently after the rice has been planted.

A rancher in the Villavicencio area who rehabilitates his pastures every 10 years with two seasonal harvests raised the hypothesis that firmones are specifically sought out by ranchers using rice credit to prepare pasture, rather than by "serious" rice farmers.

For agronomists who are not firmones, the strategy is different. Here money is made from maximum hectareage and minimum farmers: large farmers who pay a higher rate per hectare, or occasionally, settle on a percentage of yield per hectare. Being a firmon for large farmers may provide an entry--and farmers of all kinds say they have used firmones at some point--but it is an unreliable one. Generally an agronomist must show results, high productivity, greener rice, deader bugs and so forth. Because the contract frequently begins after planting, again the emphasis is on the agrochemical protection of the crop and post plant Urea and KCl fertilizations.

Underlying these popular charicatures of the highly technical and often physically gruelling work that agronomists perform, is an expressed uncertainty that agronomists have about the best way to fertilize upland rice with phosphorus, in spite of the annual courses provided by ICA. This is partly because upland rice is a "new crop" and the variety's needs seem to change from year to year. CICA-8 needed little fertilization in the first years-- it was planted on new vega lands or the Class I soils previously used for cotton. By the fourth year, when its vulnerability to piricularia had increased, some agronomists began to be concerned about the number of fertilizations with Urea and the quantities of Nitrogen in Diammonium Phosphate.

Because of these uncertainties, and because agronomists can so easily be replaced, agronomos de gaillada, the popular term for the "gang" of agronomists working for the largest farmers, can be peculiarly sensitive to fashion in

agronomic practice. In the case of DAP, the fashion developed in the agricultural supply houses, and it is sometimes responded to by agronomists in ways that are not always economically or agronomically sound. For example, an agronomist explained that he was recommending an application of DAP at 60 days after germination to all of his six farmers (total hectares assisted, 700). They liked it, he said, because it made the rice "nice and green". ("Eso da un arrocito verde, verde"). The visible response was most likely to the Nitrogen in DAP because the immobility of Phosphorus in the soil makes it likely that the 60 day old roots of the plant would be unable to absorb it. A similar effect of greenness might be achieved more cheaply with a moderate application of Urea.

The number of hectares a farmer plants, however, does seem to affect the delivery of agronomists services. All farmers complain that their technical assistant don't visit the fields regularly, but the complaints are loudest among farmers in size categories I and II. In Granada and Cumaral/Paratebueno, agronomists are referred to as "ladronomos" (a play on the word for 'thief'), either because they must be paid for in order to obtain credit, or because they do not visit the fields in time. Such relatively small farmers must seek out agronomists. For the credit contract they can be initially chosen on the recommendation of a neighbor or even a bank functionary. Afterwards, they are sought out with leaf samples of diseased rice in hand, in order to get the appropriate pesticide prescription. A size category I farmers who has nothing but praise for his technical assistant, says "He has always attended me whenever I've gone to look for him in Granada". But another lost his 25 hectare field to piricularia because he couldn't find him for four weeks in Villavicencio, although

he saw the agronomist's car go by weekly to a large farmer's fields down the road. Farmers in size categories I and II report difficulties in finding agronomists when they need them.

Because they are paid by the hectare, agronomists seek out the large rice farmers. If they get a contract, they seek them out in the evenings to discuss the weekly visits, the harvest, and, if the two get on well, possibly a joint farming venture (a compañia on rented land) for the following year. If they don't get a contract, they start their careers with the small farmers first, and simultaneously try to develop contacts with those who control more hectares.

In addition to the number of hectares planted, the associated life style characteristics of urban residence and automobile ownership also play a role in farmers' access to technology. Except for very transient rental investors, who are not represented in this sample, farmers are not entirely dependent on agronomists for farming technology. They have their own experience to drawn on. But large farmers who live in Villavicencio and own automobiles share many of the same sources for new technology used by agronomists. They attend conferences, sales talks and field days given at ICA's La Libertad Experiment Station. Rural farmers do not. Farmers without cars and who live in the countryside are thus especially vulnerable to technological neglect.

Hence, although the Ley 5a technology delivery system is meant to be uniform for all farmers within the area of commercial farming, it is not so. As it is filtered through agronomists, it contributes to reinforcing the stratification that exists among commercial upland rice farmers.

VII Summary and Implications for Phosphorus Fertilizer Research

A case study of how farmers manage their land and fertilize upland rice in the Meta Piedmont shows social factors that make on farm phosphorus fertilizer research relevant to other recently integrated frontier areas where upland rice is planted. The integration of Meta to the national Colombian economy has conditioned who plants upland rice and how. First, small upland rice farmers planting on alluvial soils were displaced by large farmers who planted irrigated rice on acid high terrace soils. The economies of scale achieved with irrigation, mechanization, and later, high yield varieties made it unprofitable for rice to be planted in unmechanized upland conditions. Second, a technological development in research for commercial irrigated rice farming, the development of CICA-8, led to a resurgence of upland rice farming. New groups of farmers, including ranchers and relatively small farmers, were able to plant rice on vega soils and under the institutional and financial umbrella of Ley 5a's agricultural research and technology delivery system.

The smallest farmers in Meta to do not farm rice. At the unstable fringes of commercial rice farming are small farmers who own mechanizeable alluvial soils. When they have not the means to plant rice themselves, they rent their land to larger farmers.

The research showed that there are four types of rice growers in the Meta Piedmont. Pure rice farmers, Mixed farmers, Ranchers and Investors. The land these farmers plant is managed in two basic patterns. In the first, the land is cropped in order to prepare pasture, and in the second the land is continuously cropped. Ranchers plant a field in rice for one or two seasons and then

plant it in pastures. The field may be rotated with sorghum, or it may be left to cattle to graze on the stubble between seasons. In addition to the land put in pastures by Ranchers, all the alluvial soils that agriculturalists, be they Pure, Mixed, or Investors, rent from ranchers is also being prepared for pasture.

Landowing Pure rice farmers and Mixed farmers rotate the land they plant with sorghum or cotton and repeat the cycle the following year. The intensity of cropping among these farmers is related to the number of hectares they plant. Farmers who plant less than 100 hectares use their own land and rented land more intensely than do farmers who plant over 100 hectares. An intermediary pattern is that land belonging to large farmers, or Rancher or Rentier landlords, will be planted in upland rice for a season, and followed for six months with cattle grazing on the stubble. The field may or may not be planted in rice the following year, depending on whether it is rented, and the market for rice that year.

Of the four farmer types only Investors owned no rice land at all. Nonetheless the survey showed that 72.4% of the farmers planted on some rented land. Fifty three point one percent of the hectares covered by the survey were rented. These rental figures on an offpeak year indicate the importance of rental land for rice farming in Meta.

Some rental contracts were for three years, but most were annual contracts. The landlords of the greatest number of parceles were "small farmers too poor to plant rice" or Small Ranchers. The second greatest group of parcels were provided by family members. Regardless of form of tenure, tenure relations were reported as stable among 81.5% of the farmers. Only Investors who planted under

50 hectares of rice reported unstable tenure relations. Thus, the high proportion of rentals in upland rice farming in Meta is not a limitation for the evaluation of residual effects of Phosphorus Rock fertilizer technology.

In spite of the technology delivery system developed by Ley 5a, which implies a certain regularity of fertilizer practice, the survey showed that there were three distinct patterns of fertilization essentially distinguished by the source of phosphorus used. No-P farmers used no phosphorus; Compound users used compound sources of phosphorus like 15-15-15; and High Tech farmers used DAP or slow release sources like Basic Slag or Rock Phosphate.

The analysis showed that what source a farmer used was determined by his class, as indicated by the number of hectares planted. Thus all four farmer types, when they planted over 100 hectares tended to use the high sources. The research accounted for the differences in source selection by the differential way in which professional agronomists deliver their services to farmers of different social classes and the independent access that large farmers have to the sources of technology. The distribution of P sources among farmers of different socio-economic status shows that the Ley 5a delivery system is not such that the same technology reaches all farmers equally. While the wealthier farmers have access to ongoing fertilizer research and marketing, small farmers do not, and many use no P at all.

Just as fertilizer use is related to the class of the farmer, so is the intensity and direction of land use. After one or two harvests, large ranchers put their fields in pasture. Regardless of type or tenure, farmers who plant over 100 hectares in rice, tend to use their land less intensively. On the other hand, Mixed farmers who plant below 100 hectares keep their land "under steel", until it must be put in pasture for low fertility or weed problems.

This means that those who plant under 100 hectares of rice are using their land most, and fertilizing it least. This is the case especially among farmers who plant under 50 hectares of rice, and have stable tenure relations. It is not the case among the unstable small investors. This implies soil degradation over time among small upland rice farmers. Initially high rates of P in the soil are thus reduced in time. For such relatively small upland rice farmers, soil degradation makes phosphorus research especially important.

An assumption underlaying socio-economic investigations of farming systems for fertilizer research, is that on-farm trials should reflect the major land use patterns regionally in use. Descriptions of the ways farmers use their land and select and apply fertilizers provides information which can contribute to the design of on-farm fertilizer trials. In Meta, the research show that in order to evaluate PR fertilizer technology in on-farm trials, the experimental design should reflect the two major land use patterns used by upland rice farmers in the region. The design should also incorporate the different intensities of land use shown by the different social classes of farmers.

This implies the use of two distinct trial designs for 1) continuous cropping of upland rice, rotated with sorghum or cotton, and 2) the use of upland rice in order to prepare the land for pasture.

Because the residual effects of PR fertilizers can appear as late as three years after application, and in some Llanos soils have been shown to equal those of soluble sources of P, the time allowed for on farm evaluation of PR fertilizer technology is also important. One semester trials on upland rice are not likely to allow for an adequate evaluation of PR fertilizer technology; nor is it probably that one semester renters are likely to adopt the technology.

An evaluation of the on-farm performance of PR technology in any of the trial designs suggested above, should therefore be scheduled for monitoring for at least three years. Tenure conditions in the Piedmont permit this scheduling.

Moreover, both the time frame and the inclusion of an animal component in the overall experimental design argues for a size of experimental plot that is consonant with the commercial upland rice farming and ranching that characterises the Piedmont region. Besides the difficulty of evaluation the residual effects of P on 5x5 m experimental plots, under any of the three trial designs proposed above, farmer management practices for upland rice, including fertilizer use, cannot be adequately evaluated with the use of 5x5 m plots. Because the average upland rice plot is 35 hectares, experiments based on small plots automatically require a different treatment than that accorded by the farmer to the rest of his field. Three farmers in the sample described experiments that they had planted to evaluate different fertilizer practices, and none of them used plot sizes of less than 1 hectare.

The results of this research and the implications for on farm evaluations of PR fertilizers, have applications that go beyond the Meta Piedmont. If the estimates made by CIAT on the future importance of upland rice in Latin America are correct, upland rice will spread to frontier or little utilized lands. The discussion of the stages of frontier integration shows when farmers are likely to need and to use phosphorus fertilizer technology. During the first and second stages of integration, farming is small scale, nomadic, disperced and based on family labor. It is only during the third stage of integration that farmers have enough stability of tenure, access to capital and technology to be able to need or to use P fertilizers. The Meta case study is in acord with the expectations raised by the model of frontier integration.

But the Meta study also suggests that in Latin American countries where the split between commercial/small farmer cropping is accentuated, technology delivery within the commercial sector may reveal a class bias similar to that shown for fertilizer use among upland rice farmers in the Piedmont.

This means that if the farmers who can most benefit from phosphorus fertilizer technology are not to slip between the interstices of research and delivery systems developed for peasant agriculture and capitalized agriculture a decision must be taken to recognize the farmer at the unstable fringes of commercial agriculture as a special type of farmer, whose needs for technology and technology delivery are distinct from those of commercial farmers or peasants.

VIII. Notes

[1] This research was funded by a Rockefeller Foundation Post Doctoral Grant to work with the International Fertilizer Development Center's Phosphorus Project at the Centro Internacional de Agricultura Tropical in Colombia. I acknowledge the support of the three institutions with gratitude. I also acknowledge the collaboration received from scientists working at ICA's Regional 8 offices in Villavicencio, La Libertad, Restrepo, Acacias, Guamal and Granada. The support and participation of farmers, agronomists and ranchers in the Piedmont made the research possible. I most greatfully acknowledge the intellectual challenge and encouragement of Drs. Alfredo Leon and Jacqueline Ashby of the IFDC/CIAT Phosphorus Project.

[2] See for example, Turchi, 1981; Esteban, 1974; Roman, 1974; Bromely, 1980.

[3] A third factor which is locally cited as contributing to the increased hectareage in upland rice, was the need to launder moneys obtained in the production and marketing of cocaine. Cocaine is planted on the pioneer frontiers in Southern Meta on the borders between Caqueta and Vaupes.

Figure 1. Colombia and Meta

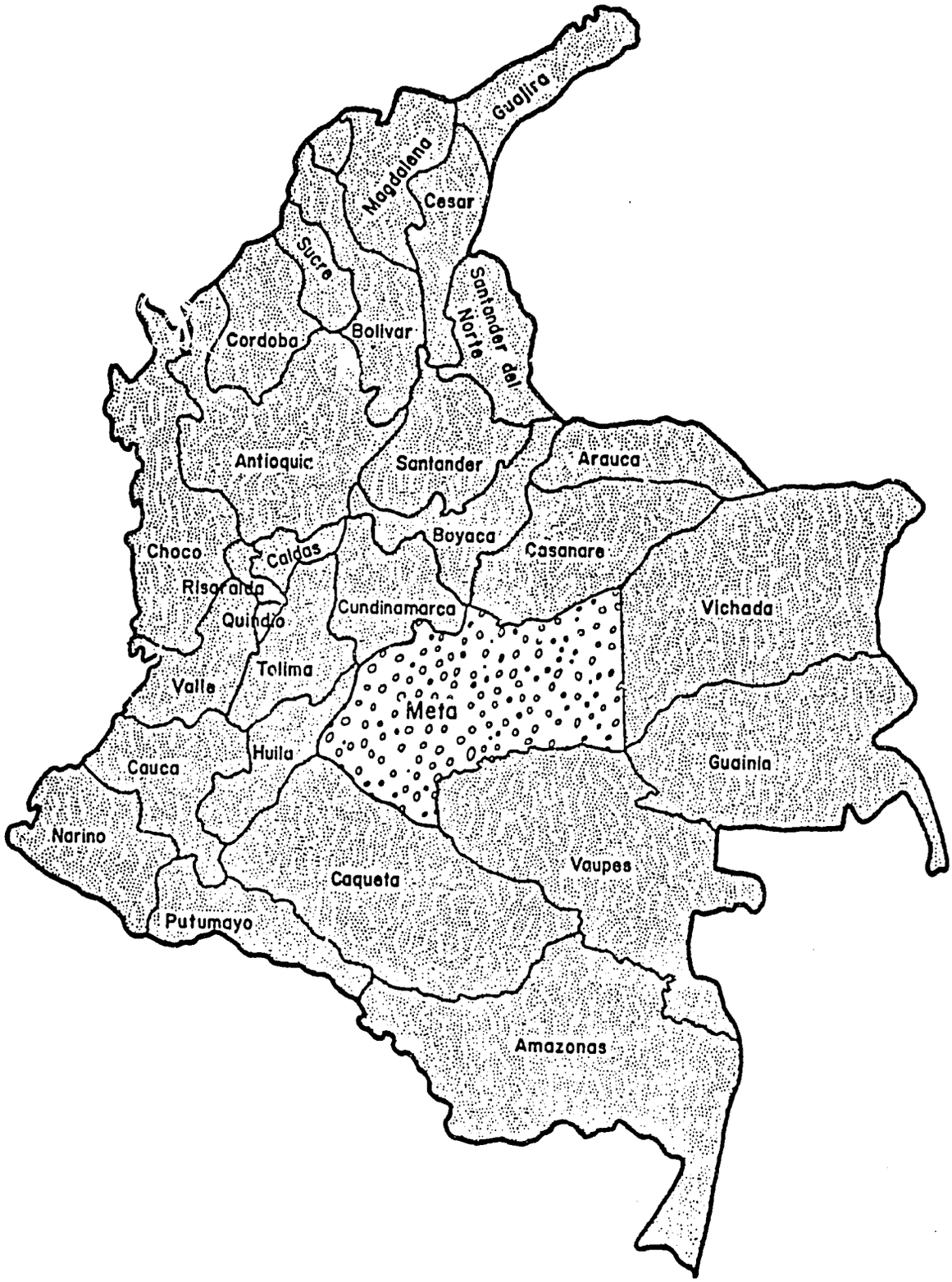


Figure 2. The soils of Meta

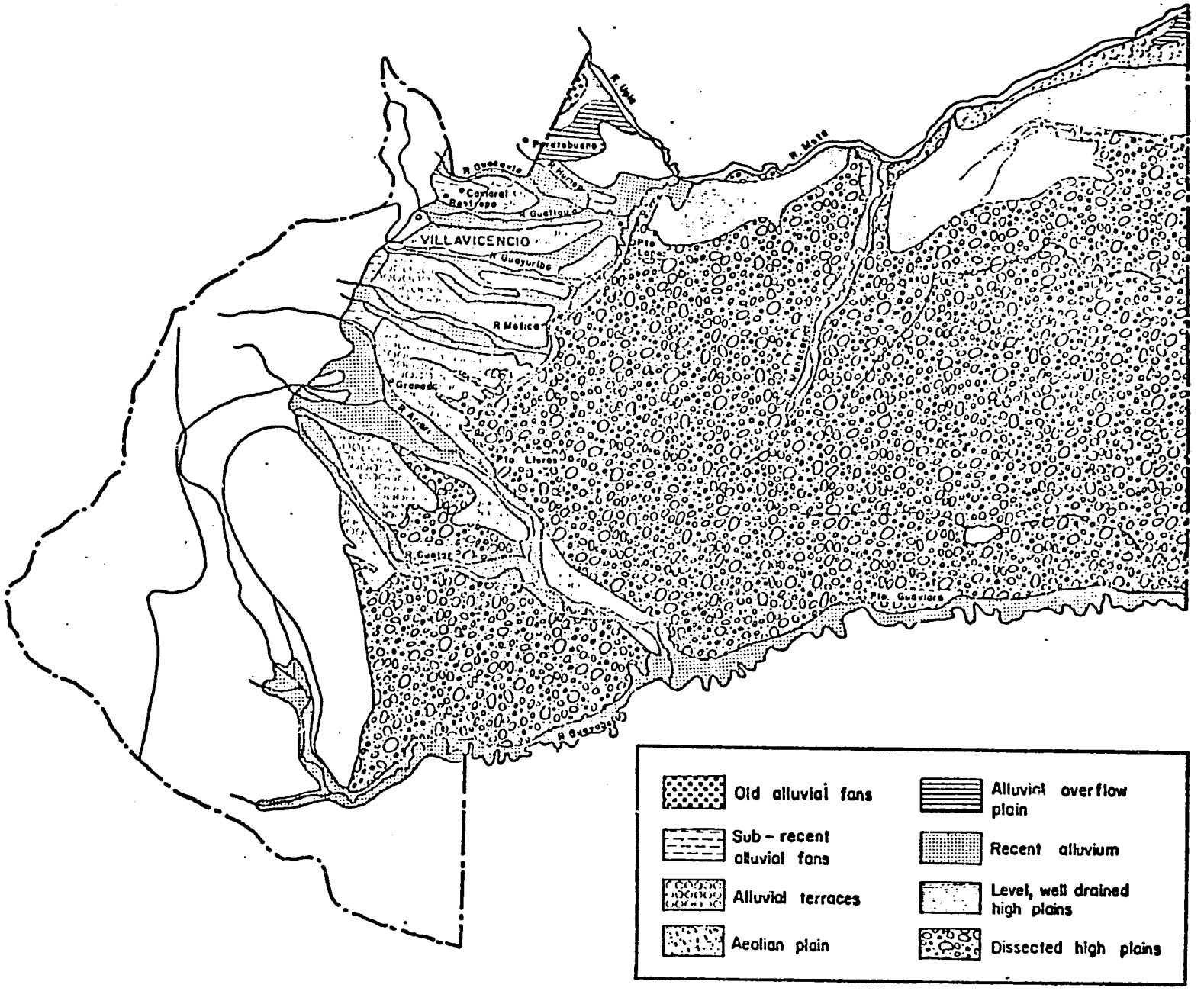
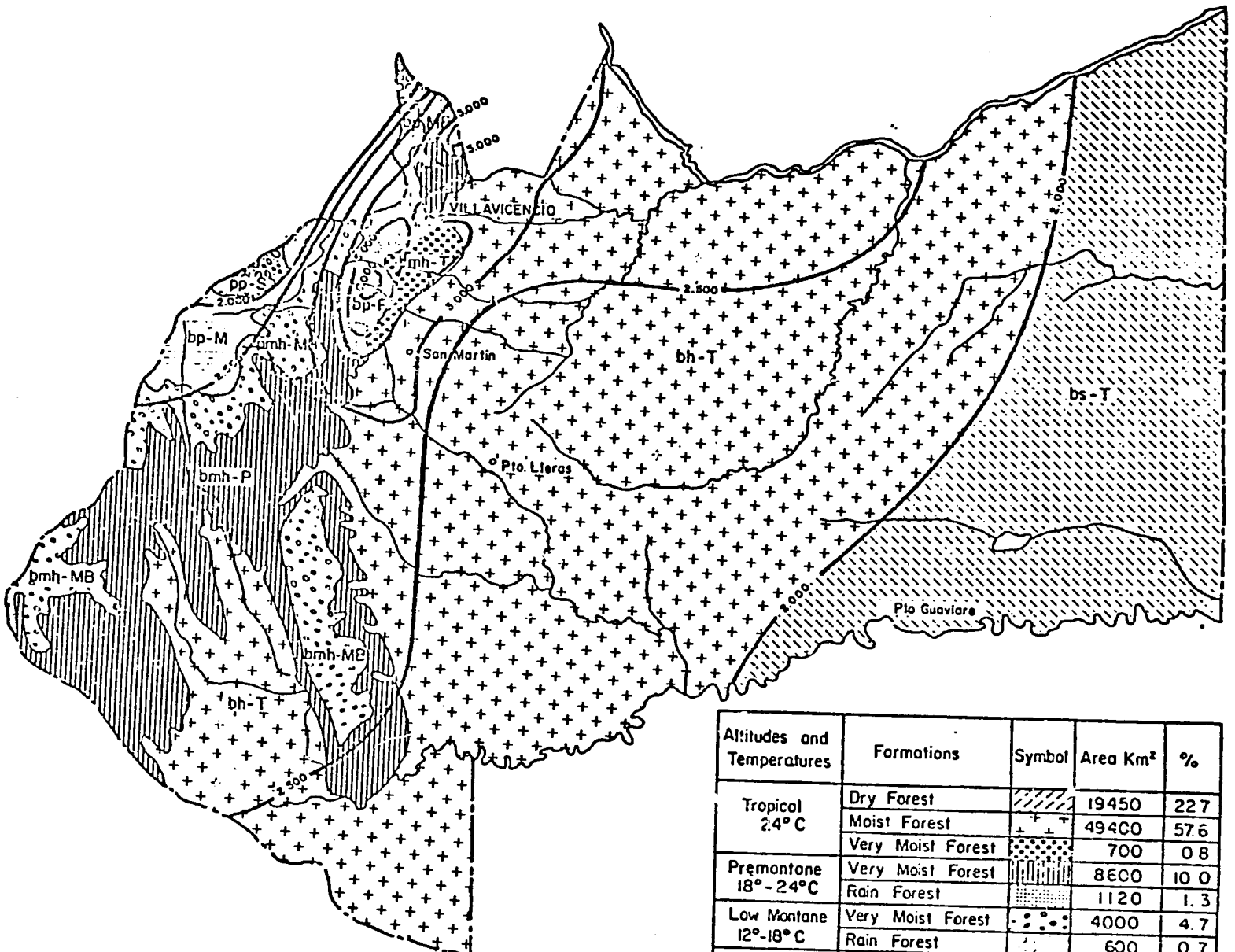
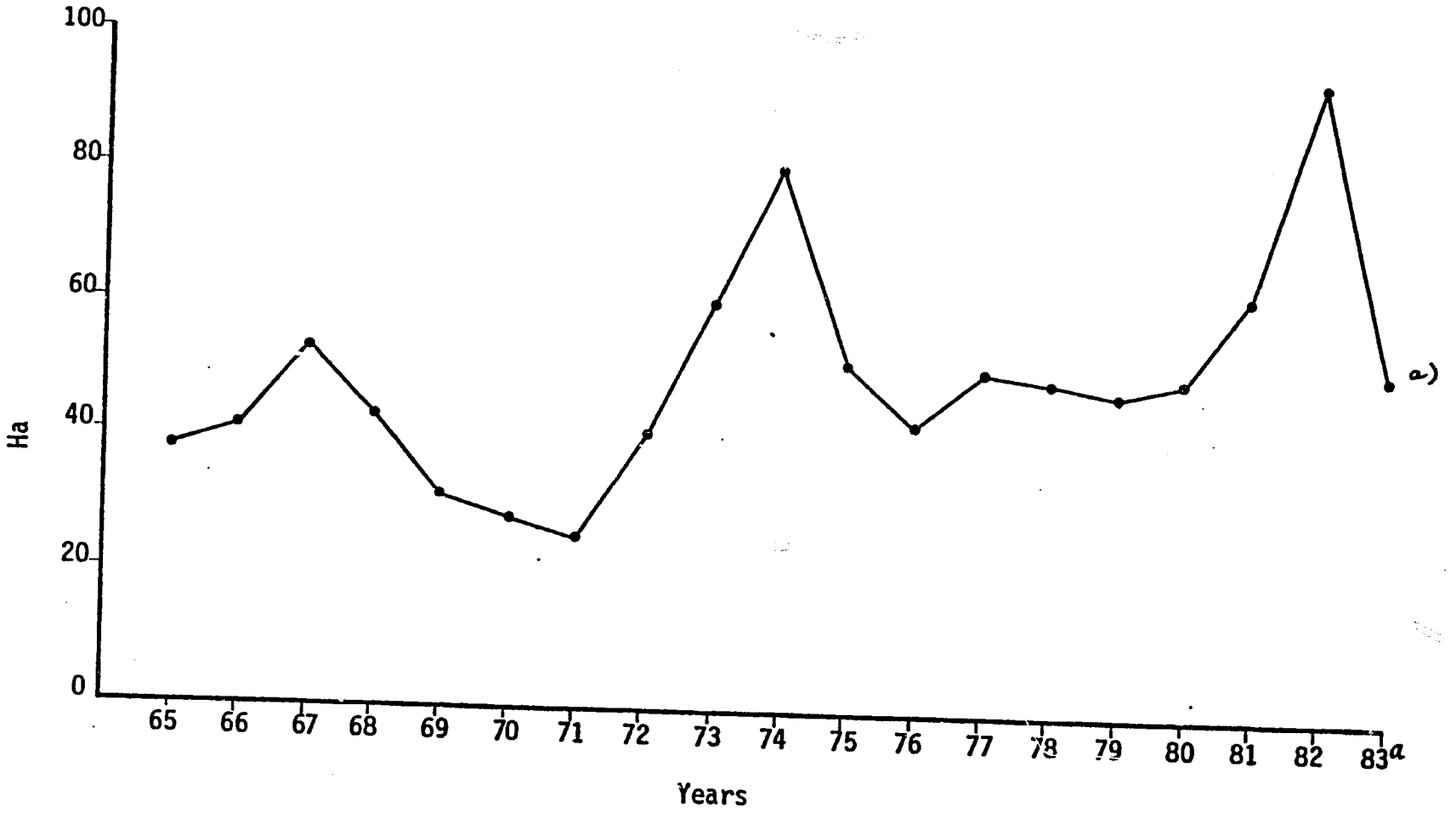


Figure 3. Natural zones and rainfal, Meta



Altitudes and Temperatures	Formations	Symbol	Area Km²	%
Tropical 24° C	Dry Forest		19450	22.7
	Moist Forest		49400	57.6
	Very Moist Forest		700	0.8
Premontane 18°-24°C	Very Moist Forest		8600	10.0
	Rain Forest		1120	1.3
Low Montane 12°-18° C	Very Moist Forest		4000	4.7
	Rain Forest		600	0.7
Montane 6°-12° C	Very Moist Forest		260	0.3
	Rain Forest		1310	1.5
Subalpine	Paramo Pluvial		330	1.4



[a] 1983 A only
Sources: ICA 1982b, 1982c, 1983.

Figure 4. Hectareage planted in rice, Meta Piedmont, 1965-1983

Table 1. Hectareage in irrigated rice, upland rice, corn, cotton and sorghum, Meta 1978-1982[1]

	Irrigated Rice	Upland Rice	Corn	Cottom	Sorghum
1978					
A	32.540	6.247	9.946	--	--
B	10.136	--	--	16.884	4.918
1979					
A	25.480	9.284	4.244	--	--
B	11.766	--	--	12.957	9.525
1980					
A	24.218	14.278	5.589	--	--
B	10.995	--	--	6.665	9.987
1981					
A	27.942	17.689	2.178	--	--
B	17.022	307	31	1.621	10.170
1982					
A	41.079	38.825	2.322	--	--
B	13.998	252	343	3.275	16.259
1983					
A	27.701	23.006	2.068	--	--

[1] A and B refer to the semesters, from January to July (A) and from August to December (B).

Sources: ICA, 1982b, 1982c, 1983.

Table 2. Subregional differences among Meta farmers.

	Villavicencio	Cumaral/ Paratebueno	Granada
Av. Farm Size*	173.6 ha	129.3 ha	84.8 ha
Av. # Cattle*	271.4	363	99.9
% with one or more tractors	73.4	91.7	75.0
% with employees	80.0	50.0	70.0
Urban Res.	73.3	33.3	60.0
% with cars	86.7	75.0	75.0
Professionals	33.0	16.0	20.0
Affiliations	80.0	42.0	85.0
Credit	73.3	83.3	95.0
Agronomist	93.3	91.7	95.0

* Only landowners and cattle owners including in calculating average holdings.

Table 3 . Farmer types, discriminated by cattle ownership and percent of owned farm land in rice.

	Average Number Cattle	Percent owned farmland in rice	% hectares covered by the sample	N	%
Pure	0	92.9	32	8	17.02
Mixed	123	68.1	45	22	46.8
Ranchers	410	20.8	8.1	8	17.01
Investors	161	0	14.9	9	19.4
			100.0	47	100.0

Table 4. Four types of upland rice farmers, by subregions.

Subregion	Pure Rice		Mixed Farmers		Ranchers		Investment/ Supplement		Total	
	N	%	N	%	N	%	N	%	N	%
Villavicencio	3	20	7	46.7	2	13.3	3	20.0	15	100
Cumaral/Paratebueno	2	16.6	3	25.0	4	33.3	3	25.0	12	100
Granada	3	15	12	60.0	2	10.0	3	15.0	20	100
Totals	8	17.02	22	46.8	8	17.02	9	19.2	47	100

Table 5. Farmer types by size category

Size	Category	Pure Rice		Mixed Farmers		Ranchers		Investment/ Supplement		Totals	
		N	%	N	%	N	%	N	%	N	%
I	1-49	0	0	8	44.4	5	27.7	5	27.8	18	100
II	50-99	3	20.0	8	53.3	1	6.7	3	20.0	15	100
III	100	5	35.7	6	42.8	2	14.3	1	7.2	14	100
Totals		8	17.02	22	46.8	8	17.02	9	19.2	47	

Table 6. Percent hectares in upland rice, by farmer type and size category.

	% hectares planted by farmers in size categories			
Farmer Type	I	II	III	Total
Pure	-	53.9	46.1	45.2
Mixed	83.7	67.5	58.1	62.9
Ranchers	100.0	100.0	61.0	80.5
Investors	88.8	67.4	62.9	70.6
Totals:% in upland rice	89.8	65.8	52.7	59.7

Table 7 . Land tenure and size categories, Meta 1983.

Size Categories		Owned only		Rented only		Owned and rented		Totals	
		N	%	N	%	N	%	N	%
I	1-49	9	50.0	7	38.9	2	11.1	18	100
II	50-99	2	13.3	7	46.7	6	40.0	15	100
III	100+	2	14.3	3	21.4	9	64.3	14	100
Totals		13	27.3	17	36.2	17	36.2	47	100

Table 8 . Landlords of rented parcels by farmer type

Type Farmer	Small Farmer or Rancher		Family		Rancher		Renter		Company		Total Parcels	
	N	%	N	%	N	%	N	%	N	%	N	%
Pure	4	26.6	1	10.0	2	28.6	1	20.0	1	33.3	9	22.5
Mixed	8	53.4	6	60.0	3	42.8	1	20.0	0	0	18	45.0
Rancher	0	0	2	20.0	0	0	0	0	1	33.3	3	7.5
Investor	3	20.0	1	10.0	2	28.6	3	60.0	1	33.3	10	25.0
Totals	15	100.0	10	100.0	7	100.0	5	100.0	3	100.0	40	100.0

Table 9. Landlords of rented parcels by size category

Size Category		Small farmer or Rancher		Family		Rancher		Renter		Company		Totals	
		N	%	N	%	N	%	N	%	N	%	N	%
I	1-49	4	26.6	3	30	2	28.6	1	20	0	0	10	25
II	50-99	5	33.3	5	50	2	28.6	2	40	1	33.3	15	37.5
II	100+	6	40.0	2	20	3	42.8	2	40	2	66.7	15	37.5
Totals		15	100.0	10	100.0	7	100.0	5	100.0	3	100.0	40	100.0

Table 10. Rotations by on owned secano soils by hectares

Size Categories		Crop		Stubble		Nothing		Pasture		Other		No Ans.		Totals	
		Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
I	1-49	228	74.5	32	10.5	-	-	46	15.0	-				306	100
II	50-99	213	81.9	-	-	7	2.7	-	-	40	15.4	-	-	260	100
III	100+	355	43.7	343	42.2	90	11.1	25	3.0	-		-	-	813	100
Totals		796	57.7	325	27.2	97	7.0	71	5.2	40	2.9	-	-	1379	100

Table 11. Rotations on rented *secano* soils by hectares

Size Categories	Crop		Stubble		Nothing		Pasture		Other		No Ans.		Total hectares	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
I 1-49	69	38.1	55	30.4	10	5.5	4	2.2	6	3.3	37	20.5	181	100
II 50-99	302	86.5	20	5.7	27	7.8	0	0	0	0	0	0	349	100
III 100+	259	27.8	512	55.0	140	15.0	0	0	0	0	20	2.2	931	100
Total	630	43.1	587	40.2	177	12.1	4	0.3	6	.4	57	3.9	1461	100

Table 12. Source of P by subregion

Subregion	0		Compound		DAP		Slow Release		Total	
	N	%	N	%	N	%	N	%	N	%
Villavicencio	3	20.0	4	26.7	5	33.3	3	20.0	15	100
Cumaral/ Paratebueno	2	16.7	2	16.7	5	41.7	3	25.0	12	100
Granada	13	65.0	4	20.0	2	10.0	1	5.0	20	100
Totals	18	38.3	10	21.3	12	25.5	7	14.9	47	100

Table 13. Subregional differences in fertilization practices.

Practices	Granada %	Villavicencio %	Cumaral/ Paratebueno %
Use of KCl in 1st fertil.	60.6	66.7	83.3
Use of KCl in 2nd fertil.	10.0	20.0	75.0
Use of Soil analysis	55.0	86.7	75.0
Use of a preplant product	10.0	66.7	41.7
1 fertilization	15.0	6.6	8.3
2 fertilizations	40.0	75.0	75.0
3 fertilizations	45.0	40.0	16.0

Table 14.

a. Source of P by size category.

Size	0		Compound		DAP		PR/Slag		Total	
	N	%	N	%	N	%	N	%	N	%
I	9	50	6	33.3	2	11.1	1	5.5	18	100
II	6	40	3	20.0	5	33.3	1	6.7	15	100
III	3	21.4	1	7.1	5	35.7	5	35.7	14	100
Totals	18	38.3	10	21.3	12	25.5	7	14.9	47	100

b. Source of P by farmer type

Type	0		Compound		DAP		PR/Slag		Total	
	N	%	N	%	N	%	N	%	N	%
Pure	2	25.0	0	0	5	62.5	1	12.5	8	100
Mixed	9	40.9	6	27.3	4	18.2	3	13.6	22	100
Ranchers	2	25.0	2	25.0	2	25.0	2	25.0	8	100
Investors	5	55.6	2	22.2	1	11.1	1	11.1	9	100
Totals	18	38.3	10	21.3	12	25.5	7	14.9	47	100

Table 15. Timing of application among phosphorus users.

a. by size category

Size Category	Pre-plant N	Pre-plant %	Post-plant N	Post-plant %	Other N	Other %	Total N	Total %
I	2	22.3	7	77.3	0	0	9	100
II	3	33.3	6	66.7	0	0	9	100
III	6	54.6	4	36.4	1	9.0	11	100
Totals	11	37.9	17	58.7	1	3.4	29	100

b. by farmer type

Farmer Type	Pre-plant N	Pre-plant %	Post-plant N	Post-plant %	Other N	Other %	Total N	Total %
Pure	3	50.0	3	50.0	0	0	6	100
Mixed	4	30.8	8	61.5	1	7.7	13	100
Ranchers	2	33.3	4	66.7	0	0	6	100
Investors	2	50.0	2	50.0	0	0	4	100
Totals	11	37.9	17	58.7	1	3.4	29	100

Table 16. Related practices: Use of soil analyses and soil amendments by farmers using three sources of phosphorus.

Phophorus Sources	Soil Analyses %	Soil Amendments %
Pattern I, No P	61.1	55.5
Pattern II, Compounds	60.0	70.0
Pattern III, DAP/Slow Release	84.2	84.2

Table 17. Average quantities of P from all P sources applied in kg/ha.

a. by size

Size	Average kg/ha P source
I	59.9
II	80.0
III	242.8

b. by farmer type

Size	Average kg/ha P source
Pure	100
Mixed	100
Rancher	228
Investor	94.9

Table 18. Average quantities of DAP or compound fertilizer applied, by size category.

Size Category	Compound (15-15-15) $\bar{X}$ kg/ha	DAP (18-46-0) $\bar{X}$ kg/ha
I	80	62.5
II	133	66.6
III	100	61.5
Total average	100	61.5

Table 19. Average quantities of Urea in kg/ha applied

a. by size

Size	kg/ha
I	134.7
II	137.3
III	143.9

b. by farmer type

Type	kg/ha
Pure	162.9
Mixed	159.1
Rancher	60.6
Investor	152.8

Appendix I

Summary of representative management

Upland rice, Meta, Piedmont

Planting Date	March 20-April 30
Site Selection	Mechanized alluvial soil plot.
Av. Size Lot	35 ha
Preparation	With the rains of February, or after sorghum harvest in December and January 3-4 harrowings, two to three weeks between each. 5-7 diskings.
Soil Amendments	No
Seed Varieties	Metica-I all certified seed.
Method of Seeding	Tractor drawn broadcaster, 150 kg/ha.
Insect Pests	A. Sogatodes oryzicola, Eutheola sp. and Hydrellia sp.
Insect Control	Products and dosage:

Depending on insect, one or mixtures of:

Granulated Furadan	20-25 kg/ha lt.
Lorban	½ - 1 lt.
Metil Paration	1 lt/ha
Dipterex	1 lt/ha
Toxafeno DDT 40-20	1 gl/ha
Basudin	1 lt/ha
Dimecrón	1 lt/ha
Sevin 80	1 kg/ha
Sistemin-Diostop	1 lt/ha

Method: Usually by airplane but up to 50 days after germination (DAG) tractor drawn spayers may be used.

No. of Applications: Variable, depending on pest intensity and agronomist recommendation.

Time: Beginning at germination, may be weekly against sogata and cucarrón. Later applications may be mixed with fungicides.

Weed Control

According to farmer and agronomists recommendations:

Products and dose:

Propanil 500	2-2½ gal/ha
Saturno Plus	8-10 lt/ha
Propanex	2-2½ lt/ha
Stam M-4	2-2½ lt/ha
Stam-100	10-12 lt/ha
Machete	5 lt/ha
Avirosan	4-4½ lt/ha
Tordon	150-500 cm/ha
Prowl	5 lt/ha + Stam.

Method: Airplane, or tractor drawn sprayer

No. of Applications: 1-3 according to farmer, plot and agronomist recommendations.

Timing: From germination to 30 DAP, especially between 8-25 DAG. Caution with phytoxicity of propanil herbicides (eg. Saturno plus Propanex, Stan, Machete, etc) with phosphorated insecticides (eg. Furadán, Dipterex, Lorban, Metil Paration. Keep an 8 day spread between applications of propanil and phosphorated products.

Fertilization

Nitrogen and Potassium

Source: Urea and KCl

Quantity: 125 kg Urea, 50 kg KCl

Timing: In 2 applications

i) 8 days after herbicide application (15-25 DAG)
ii) At the beginning of peduncle formation (50-75 DAG)

Method: By hand, tractor drawn broadcaster, or airplane (after 50 DAG), depending on farmer.

Phosphorus, Farmer Check

1½ 50 kg bags DAP, post-plant with 1st fertilization.
1½ 50 kg bags compound fertilizer (15-15-15) post-plant with 1st fertilization.

Fungus disease control

A. Piricularia

Products and dose:

Hinosan	1 lt/ha
Kasumin	1½ lt/ha
Blas	1-2 lt/ha
Kitazin	1½ lt/ha

Method: Airplane except for varieties that are susceptible before 50 DAG when tractor drawn sprayers may be used.

No. of Applications: Depends on variety, farmer and agronomist recommendations.
a) C-8: 2 routine preventitive applications

i) at 20% tillering (80 DAG)
ii) at 80% tillering (90 DAG)

(1982 saw some farmers do 8 applications).

B. Rynchosporium oryzae

Products and dose:

Ditane M-45	5-6 lb/ha
Antracol	2 kg/ha
Duter	2 kg/ha
Benlate	0.3 kg/ha

Method: Airplane with piricularia products

No. of Applications: 2

Harvest

105-125 DAG depending on variety, farmer, and availability of hired combines.

Expected yields

4-5 T/ha.

Appendix II.

Costs, yields and prices: major crops of the Meta Piedmont, 1982

	A Costs/ha in $ *a*	B Yields T/ha	C Price S/T	D $/ha (BxC)	D Profit/ha (D-A)	Number Semesters
Irrigated rice	959.95	4.8	229.92	1.103.62	143.67	1
Upland rice	849.16	4.0	229.92	919.68	70.52	1
Cotton	853.95	1.2	847.82	1.017.39	163.44	1
Corn (mechanized)	551.80	2.0	316.14	632.27	80.47	1
Corn (unmechanized)	281.90	1.5	316.14	474.21	192.31	1
Sorghum	514.53	2.5	251.47	628.68	114.15	1
Yucca	648.02	11.0	76.39	839.19	191.17	3
b)	216.01				63.72	
Plantain	1.885.73	1.875 rac.	@ 1.80 rac.	367.94	1.482.20	6
b)	314.28	314			247.04	

a 69.59 pesos = $U.S. 1.00, 1982
b Calculated by dividing establishment and maintenance costs by semesters

Sources: Banco de la República, preliminary figures, 1982, for irrigated rice, upland rice cotton, mechanized corn and sorghum.
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