

**Economic Analysis of a Small Farm  
In La Cordillera Department  
Paraguay**

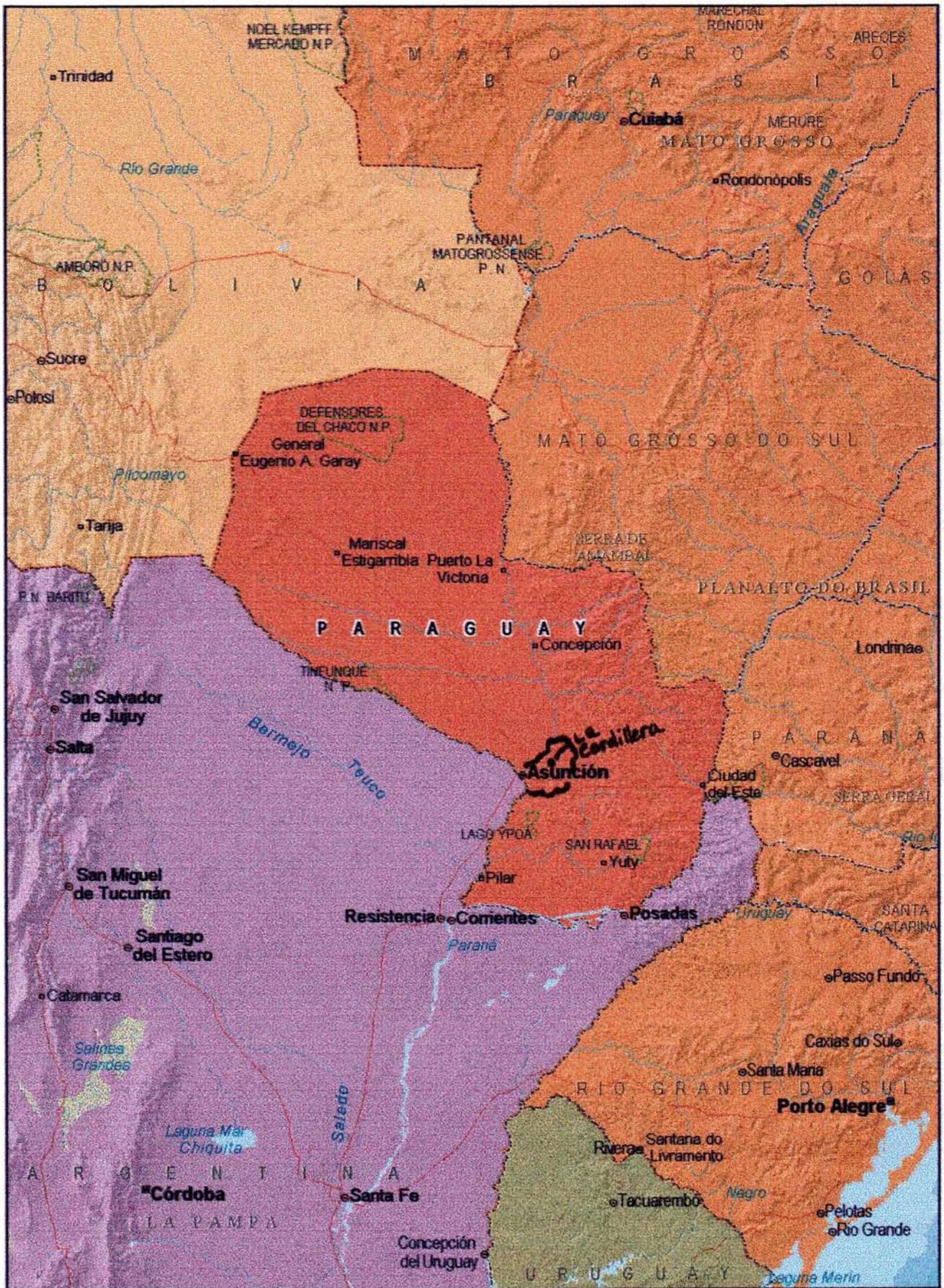
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**AEB 5167, Economic Analysis of Small Farms**

**And Livelihood Systems**

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**THE FINCA OF MERARDO FRANCO, DEPARTMENT  
OF LA CORDILLERA – PARAGUAY**

The “finca” or “chacra” (both words mean small farm) we will be looking at is located only about 40 miles from the capital city of Asunción. It is situated in the Department (administrative region) of La Cordillera- Literally “the Mountain Range” but more realistically “The Hills.” The owner of the land is Mr. Merardo Franco. Mr. Franco is married and has five children: An older(18) daughter who works in Asunción as a domestic servant, sends home around half of her monthly wage of 300.000Gs. to help her family; two boys in their young teens (14 and 12); and two smaller girls, ages 9 and 7, help their mother around the house. Only the two boys attend school and in order to do so they need money for uniforms, school supplies and shoes. The greater part of this money is needed in late February, just before the start of the school year, which runs from March through early December. The fact that these young boys attend school, and have to walk there in the morning, and back home under the hot noonday sun, limits the time they can spend helping their father in the fields on a daily basis, although they may skip school during the intense planting and harvesting seasons. This accounts for the fact that neither one of them has passed the 6<sup>th</sup> grade yet and both brothers have repeated grades several times. The boys do, however complete their daily chores in the afternoons including chopping grass or cane for the oxen and helping their mother draw water from the well, as well as odd jobs and errands.

“La Cordillera” is one of the earliest colonized regions of Paraguay and most soils are exhausted from over 400 years of continuous use. This prolonged utilization, along with the hilly topography of the region explain in great measure the state of extreme deterioration of all natural resources today, which has been compounded by several decades of solecropping. Another contributing factor to the poor overall situation has been the fact that La Cordillera is and has always been a traditional provider of firewood, lumber and charcoal for the capital city of Asunción. This region is almost completely deforested, with only around 1.7% of the total area covered with native continuous forest in 1991. What little is left today is seriously deteriorated as is the brush and secondary growth woody vegetation that covers a large portion of the department.

One of the unique features of this area is that, in some lowlying areas of grazing land, and in almost all farm plots, there is a medium to high population of the Paraguayan coconut palm (*Acrocomia totai*), whose small round nuts (about the size of a ping pong ball) are collected from the ground and sold to local industries where they are transformed into soap and cattle feed, as well as cooking oil. The demand for these coconuts has been declining in recent years even though it is a recognized fact that the soap made from its pulp is among the finest and most natural available anywhere. Most farms also have several other species of trees native to the zone and managed in a traditional way by the farmer.

La Cordillera is blessed - as is most of the Eastern Region of Paraguay - with a great abundance of streams, rivers, springs etc., which are underutilized and poorly taken care of (if at all) at present. Many springs and water courses are drying up due to heavy deforestation and the accompanying erosion. Some basins are silting up, depriving the

local residents of formerly crystal clear cool and clean water. Irrigation is a very rare practice and with the exception of two or three very experimental farmers one can say that it is nonexistent.

Another characteristic of this region is its division into very small plots or “minifundios,” a great number of which are less than one hectare in size, and have poor to very poor soil. This situation provoked massive migration away from the area either to new forested regions to the North and East, or to the ever increasing poverty belts around Asunción, and in many cases Buenos Aires, Argentina, where people have migrated in search of a better livelihood.

The population of La Cordillera department is 206,097 according to the 1992 census (1982 census: 194,011) The population has remained relatively stable due to the high rates of migration. There are also some 237,974 head of cattle, although these are not necessarily in the hands of the “campesinos” or small farmers, who may own a few milking cows and a pair of oxen for draught work. Most large herds belong to medium to large ranchers who usually reside in Asunción as absentee “patrones.” In the population breakdown one can see that the great majority of the population is made up of the elderly, women and children, as young men of working age have mostly migrated elsewhere.

According to the 1992 Agrarian Census, there are 22,362 fincas or farms in La cordillera (1981:20.842), of which 60 % are less than 5 ha in size. The process of “Minifundización” or the breaking up into smaller and smaller farms, has many contributing factors among which are the growth of larger ranching units, the expansion of suburban Asunción towards the farming areas for recreation or week-end farms, and the slow growth of the population. There are also more complex background historical causes for this process which are quite

complex and are not the object of this report to discuss.

On the positive side, the proximity of La Cordillera to the main consumer market, that is, the city of Asunción, has turned it into one of the largest, and most natural, providers of food and produce to the Capital. It is also, and has always been, the principal provider of building materials (bricks, roofing tiles etc.) and firewood. This last item has led the SFN (Servicio Forestal Nacional) to calculate that more than 900 ha of forests are needed annually just to provide Asunción and the building materials industry with enough firewood yearly. This represents a great advantage for this region if and when it can begin to produce firewood sustainably. Another advantage for the region is the fact of its proximity to the capital for providing fresh produce with a relatively low cost for trucking. Whether the incorporation of modern irrigation equipment to the farming systems would be profitable remains to be studied; however, it is safe to assume that for most produce crops, as well as fruit and flowers, irrigation would provide a “guarantee of production” as well as year round income, and higher prices obtainable from early or late season production.

Soils in La Cordillera Department are sandy or sandy loam resulting from the decomposition of the hilly area’s bedrock which is sandstone. These sandy soils are the most common in the higher areas and on hillsides. The lower areas, used almost exclusively as grazing, are sandy to a depth of about 50 cm, with an underlying stratum of black impermeable clay. It is this clay that is used as raw material for the many brick and tile factories in the area. Land that is devoted exclusively to agricultural use has suffered most since traditional cultivation methods exclude trees and other cover vegetation leaving the soil bare and exposed to the elements for a period of several months a year. The common practice of burning stubble after the harvest compounds this situation.

A trend towards the implantation of more perennial crops has been noticed in recent years which allow better soil conservation, especially on slopes. This change in attitude has been heavily influenced by the “Centro de Promoción de Campesinos de la Cordillera”- CCCP (Center for the Promotion of Small Farmers of the Cordillera), whose basic objective is to reintegrate trees onto the farm and avoid the total disappearance of what little natural forest remains. Merardo Franco is a founding member of this NGO.

To this end, The Paraguayan Ministry of Agriculture implemented the “Program of Land Utilization,” through the auspices of GTZ (International Development Agency of Germany), and the General Office of Planning. This project began in 1984 and from 1989 through 1992, several sites in La Cordillera Department were added to the project through the coordination of the CPCC, an organization which, aside from land use, was aiming at a holistic approach to improving the lives and livelihoods of small farmers in the region. The project had different rates of success in different areas, with the community projects having obtained the poorest results. The aspect of reforestation and diversification of crops, however, proved to be ground-breaking and an awakening to other small farmers on the all important issue of erosion control through intelligent land utilization. The small farm of Merardo Franco, was part of the above mentioned project, and is the object of this study.

Agricultural production in the region involves a range of traditional crops along with some recently introduced ones. Some of the principal crops grown in the area are:

**Maize:** white flint and yellow flint as well as yellow dent are grown mostly for family consumption and to feed the poultry and pigs on the farm. In the nearby town of Valenzuela there is a farm which produces certified maize hybrid seed. Maize is planted in small parcels, generally intercropped with beans (cowpea) and/or mandioca (cassava).

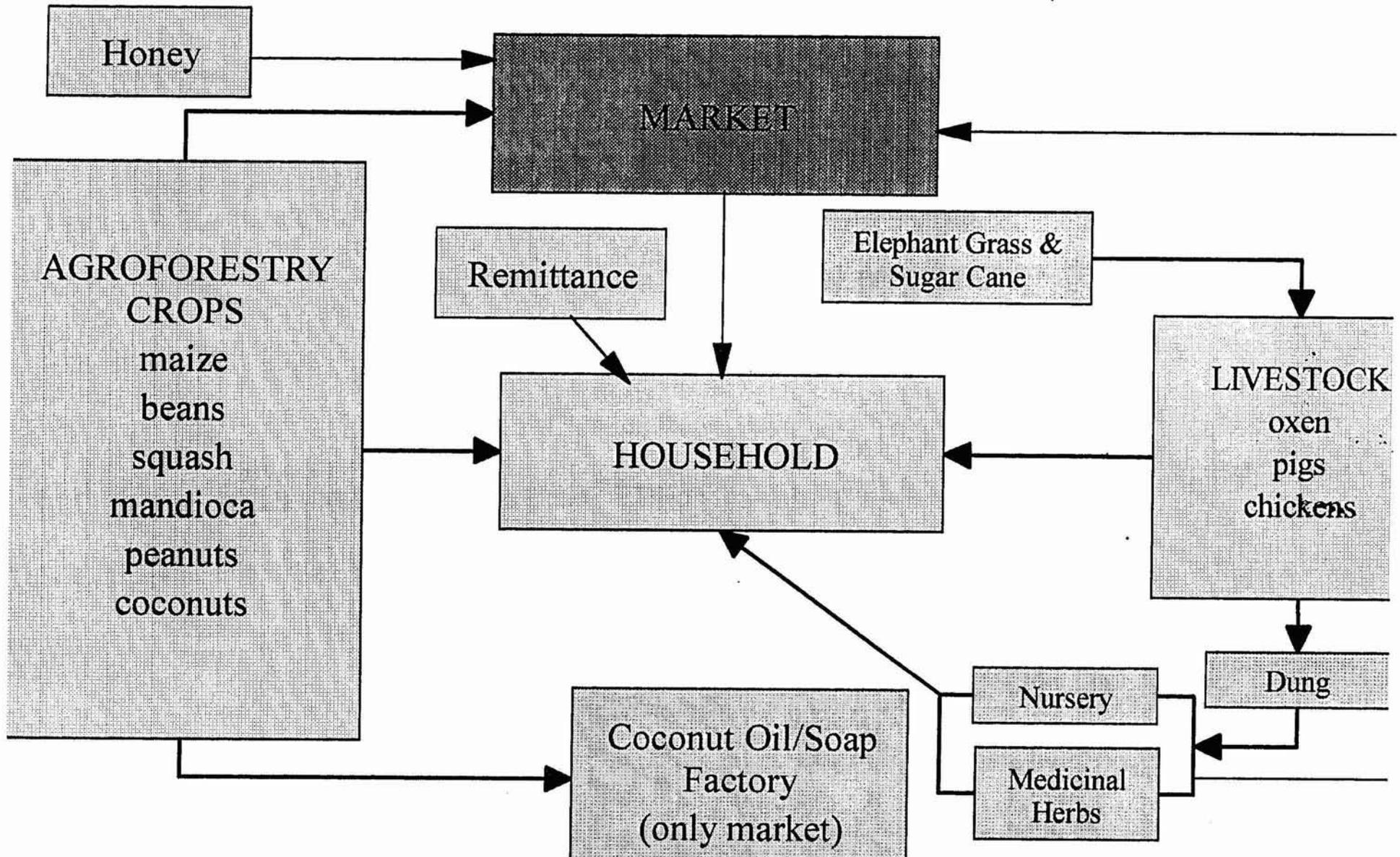
**Beans:** cowpeas (*Vigna unguiculata*) and some fava beans are generally grown for self consumption. Many times they are associated with maize where they are useful for ground cover.

**Mandioca (cassava):** as in the rest of the country, mandioca is the traditional product for family consumption. It is in fact the daily bread. Whatever is not consumed by the family is sold at the market as fresh mandioca. Industrialization to transform cassava into starch is insignificant, even though in the department of La Cordillera there are many “Chipa (Paraguayan scone) factories” which consume large amounts of cassava starch. As much as 176 tons are needed each year according to a market study undertaken by a firm interested in installing a starch factory in the area. The average yield of cassava is low, averaging 13 tons/ha, except in a very few newly cultivated areas. Since this crop is so traditional, many ancestral methods of cultivation and varieties are used. The cassava growers developed their own science which was enriched over the centuries. Due to this, most small farmers handle from 3 to 5 varieties at the same time, enabling them to provide the “daily bread” almost all year round. There are more than 200 varieties and ecotypes known in the country which differ in taste, size, time to maturity and resistance to disease and pests.

**Peanuts:** Traditionally, peanuts are for family consumption; however, recently they are becoming more of a cash crop. As with mandioca, a large number of varieties and ecotypes are handled.

**Sugar Cane:** Most farmers have at least a small plot for cattle fodder during the winter months. In and around the city of Piribebuy there are several molasses factories which consume large amounts of sugar cane. The price however, has become unattractive to farmers recently and they have been replacing it with other crops. Many farmers have gone

# Schematic Representation of the Farming System (Phase III)



bankrupt in the past due to the ruinous prices paid by the sugar mills.

**Coconuts:** These are the best example of silvopastoral and agroforestry systems in the region. All small farmers keep and take care of these trees as they provide cash income around Christmas time, and the leaves and other subproducts are used for animal fodder.

Some experts predict the end of the coconut industry with the coming of MERCOSUR.

**Squash** (and also melons and watermelons): are traditional summer crops and useful as groundcover while intercropping.

**Medicinal herbs:** most small farmers have a small garden for family consumption which saves on formal medical treatment. Due to the large population in Asunción, some plants have become limited cash crops.

**Livestock:** livestock is considered a sort of savings account as well as providers of traction on the farm. Management is done in small paddocks, in silvopastoral (with coconut) and on the stubble of harvested crop. The area utilized is generally small and overgrazed. In the past, common grazing areas were very much in use. At present, farmers tend to grow cut and carry forrage such as elephant grass (*pennisetum purpureum*) and sugar cane. The Franco family owns two oxen.

**Pigs and Poultry** are raised mostly for consumption and rarely sold in cases of extreme need or when surplus is available. The family owns two mother sows and twelve piglets of different sizes.

#### **Details and Constraints:**

Mr. Franco's plot is divided up into the following categories:

1) Windbreaks of shrubs and small trees.....0.4 Ha

2)Agroforestry: Coconut palms, citrus and crops.....	1.44 Ha
3)Bamboo Patch (where beehives are located).....	0.12 Ha
4) Bananas.....	0.04 Ha
5)Family Tree Nursery.....	0.06 Ha
6)Enriched and managed Forest (with Yerba Mate)....	0.72 Ha
7) Elephant Grass/S Cane f/ cut and carry fodder.....	0.16 Ha
8) Natural Grass (paddock).....	0.17 Ha
9) Grass with Fruit Trees.....	0.10 Ha
10) Medicinal herb garden.....	0.10
11) House and Yard.....	0.52 Ha
Total.....	4.00 Ha

The objective of this analysis is to simulate reality as closely as possible without getting bogged down by very small or insignificant details. As will be discussed below, some activities were at first included in the model and later dropped as they seemed to have little or no effect on the system. An example of this was the handling of small animals (piglets and chickens). Some apparently important figures, such as the amount of beginning cash required to start the crops in each semester, when tested, turned out to have little impact on the over-all result, aside from slightly diminishing the total end cash.

### **Inclusions for Matrix**

We will only be considering the crops that are actually being harvested at this time since this will not be a multi-year matrix. The crops harvested to either be sold or consumed are: beans (*vigna unguiculata*), maize, peanuts, squash, coconuts, cassava,

medicinal herbs, honey, sugar cane and elephant grass. The livestock that will be considered are: the two oxen that are used for draft work. Two activities besides raising crops will be built-in. These are a selling activity for each sellable crop product, and a grocery buying activity which goes on monthly. Items that are bought in the local stores include first and foremost meat, along with “galleta,” a kind of hard-tack bisquit, rice, noodles, tomato paste, powdered milk, cooking oil, propane gas, matches and cigarettes. An additional input to the system will be remittances sent by the 18 year old daughter.

**Labor:** As on many other small farms in Paraguay, most of the actual field work is done by the father. That is, plowing, harrowing (Mr. Franco owns an ox-drawn disc harrow but does not wish to invest in any further equipment as this would “only lead to more poverty”), weeding, raising ridges, spraying etc. The single most important tool on the farm is the hoe, followed by the ever present machete. The number of days required for labor on each crop can be seen in Table 1.

**Mrs. Franco** does much work that is difficult to account for. Luckily, she lives close enough to Asunción so that she can use bottled natural gas for cooking, and although this is not the general rule for all of rural Paraguay, it does save quite a bit of time on not having to gather firewood on a daily basis. The negative side of this, of course, is that each 10 kg tank of gas sells for Gs 16000, and it is difficult to use less than two tanks per month. Mrs. Franco spends some time each day drawing water from the well. This water is taken to the house in plastic buckets about 15 liters at a time. Water is also hauled to the oxen, pigs and chickens. Additionally, Mrs.F. carries several bucketfuls per day to her medicinal herb garden, and 1 or 2 buckets to the family nursery. A good portion of the day is consumed by household chores, especially sweeping, washing clothes and dishes and caring for the two

# The Franco Family

## WOMEN

- Housework
- Feeding chickens and pigs
- Planting
- Harvesting
- Herb garden
- Shucking
- Shelling

## GIRLS

- Gathering coconuts
- Housework

- Mr. Merardo Franco
- Mrs. Franco
- 18 year old daughter
- 14 year old son
- 12 year old son
- 9 year old daughter
- 7 year old daughter

## MEN

- Plowing
- Harrowing
- Planting
- Weeding
- Harvesting

## BOYS

- Chopping fodder for oxen
- Gathering coconuts
- Planting
- Harvesting

little girls, whom, although no longer babies, still require looking after. All this leaves the mother with limited time for field work, although she always participates at planting and harvesting time, and when Mr. Franco may need a hand, such as hauling water to him when he is fumigating, or when there is an extra strong weed infestation that requires urgent taking care of. The actual 7 hour days that Mrs. Franco has left over for working in the fields is 40 days per year.

**The two teen-aged boys**, work on average only about one hour per day doing mostly chores and especially chopping elephant grass (in summer), and sugar cane (in winter) for the family's pair of oxen. On average, each brother is only able to contribute 20 seven hour workdays per year including extra time put in during harvest, and collecting coconuts from the ground.

**The two younger daughters**, help the mother feeding the chickens and cleaning up around the house but otherwise contribute nothing as to field labor except for helping gather coconuts from the ground. For practical purposes, as these two girls take away more time and work than anything noteworthy that they could contribute at this time, they are not considered in the breakdown of labor.

**The 18 year old daughter** who works as a domestic servant in Asunción contributes nothing of labor, but does send around Gs. 1.800.000 or \$643 annually, on a monthly basis. (Exchange rate: 1 USD = 2800 Gs., November, 1998).

**Summary of Labor Available per year:**

Merardo Franco: 240 days

Mrs. Franco: 40 days

Teen-aged Boy 1: 20 days

Teen-aged boy 2: 20 days

Others : 0 days

**Total workdays: 320 days**

### **WORKDAYS REQUIRED PER CROP - Table 1**

	<b>Maize</b>	<b>Cassav</b>	<b>Peanut</b>	<b>Squa</b>	<b>Honey</b>	<b>Cocon</b>	<b>Grass</b>	<b>Nurser</b>	<b>Herbs</b>
<b>Adult</b>									
<b>Male</b>	<b>30</b>	<b>29</b>	<b>27</b>	<b>30</b>	<b>12</b>	<b>5</b>	<b>12</b>	<b>24</b>	<b>6</b>
<b>Adult</b>									
<b>Fem.</b>	<b>4</b>	<b>10</b>	<b>8</b>	<b>4</b>	<b>0</b>	<b>12</b>	<b>0</b>	<b>12</b>	<b>24</b>
<b>Teen</b>									
<b>Boys</b>	<b>4</b>	<b>14</b>	<b>8</b>	<b>10</b>	<b>0</b>	<b>24</b>	<b>26</b>	<b>6</b>	<b>6</b>
<b>Total</b>	<b>38</b>	<b>53</b>	<b>43</b>	<b>44</b>	<b>12</b>	<b>39</b>	<b>38</b>	<b>42</b>	<b>36</b>

The total number of workdays required is: 345.

The total number of workdays available is: 320

Conclusion: While total labor is not constraining using these data, when broken up into gender it is clear that adult female labor is constraining (a deficit of 20 workdays), as well as adolescent male labor (a deficit of 27 days).

### **The Intercrop Numbers**

The tables and man-hours listed above correspond to each crop cultivated separately.

Upon deeper inquiry, it was found that most of the crops in this area are intercropped in fields that are sparsely populated by the Paraguayan coconut palm. Maize is the principal crop, planted about one meter apart – sometimes more – allowing for the intermediate rows of cassava, cowpeas, squash or peanuts. The labor required for this variable mix was obtained from colleagues (agronomists) who knew the area and this type of work. The following Table was set up for this intercrop:

**Workdays Required for the Intercrop – Table 2**

	<b>Coco,maize, peanut squash,beans</b>	<b>Elephant Grass and Sugar cane</b>	<b>Honey</b>	<b>Medicinal herbs</b>	<b>Tree Nursery</b>
<b>Adult Male</b>	<b>24</b>	<b>4</b>	<b>12</b>	<b>-</b>	<b>14</b>
<b>Adult Fem.</b>	<b>8</b>	<b>-</b>	<b>-</b>	<b>22</b>	<b>4</b>
<b>Teen Boys</b>	<b>4</b>	<b>20</b>	<b>-</b>	<b>8</b>	<b>4</b>
<b>Total</b>	<b>36</b>	<b>24</b>	<b>12</b>	<b>30</b>	<b>22</b>

The number of days required for cropwork has been drastically reduced, not by half, but by three quarters. Although this information appeared dubious at first, it was later confirmed from separate sources. Intercropping then, is much more than an environmentally better way of growing things that small farmers use seeking the benefits of pest control, improved fertility and crop complementarity, **it is actually a fantastic labor-saving device** known and passed down for countless generations. If during one walk to the same field a farmer can perform several separate operations such as planting one crop, thinning another

and weeding still another, the total amount of time saved – although the total work may be the same – is enormous.

**Recommendations:**

**A) Labor:** The structure of labor input needs to be looked at and some work has to be re-allocated to the teen-aged boys (as the mother is physically unable to), or hiring of off-farm help should be considered.

**B) Cash:** Although a substantial amount of cash is needed on a monthly basis, for meat, cooking gas and other groceries; as well as in a greater amount for the beginning of the schoolyear, the amount received for the sale of such low value items as cassava, maize and squash barely covers the bill. Honey, and remittances from the daughter, as well as cash from coconut collection fill in a substantial portion of the gap. Bee keeping should be carefully studied as a simple, on-farm alternative for producing a substantial amount of cash through the sale of honey. A more long term approach would be to embark upon the production of higher value added crops such as vegetables, flowers, strawberries and certain medicinal herbs, as well as increasing the number of beehives if possible. Before making definite recommendations however, market studies conducted by professional, reliable technicians must be undertaken in order to assure or at least confer a higher probability of success on any "wonder" crops (strawberry, flowers. "kaá heé" or others), which have proved a let down to small farmers in the past. Truckloads of luscious fruit and vegetables have literally been dumped to rot in the past due to lack of market or weak prices, leaving farmers out in the cold and skeptical as to any future recommendations that technicians could make to them regarding how to obtain higher incomes. **Farming is back-breaking work**, and any studies of how to improve livelihoods should be conducted

with the highest degree of seriousness and focus on reality. Unfortunattely, this has not always been the case in the past. The setting up of a forest tree/fruit tree nursery should be encouraged as an interesting side occupation, although it cannot be expected to add large amounts of cash to the system. Dairy cattle for fresh milk and cheese are also a feasible, small-scale but permanent source for cash. Perennial crops such as citrus, mangoes and “yerba mate” or paraguayan tea could also prove valuable.

c) **Infrastructure:** In order for any of the improvements mentioned above to be possible, both on-farm and off-farm infrastructure must be improved. On-farm irrigation could be an excellent project to look into. It would, however, require a substantial leap in technological level from the present situation and if forced upon this particular farmer or his community through a project, it would not be rare to see it fail. Off-farm refers mostly to the improving of local roads so as to make them usable year round on a daily basis. Price supports are an unlikely scenario in a country that is bankrupt at the moment. Education and healthcare are other off-farm inputs that merit study. They are obviously lacking as in most developing countries. A way of including these external factors into a matrix for analysis is something that needs to be looked into but is unfortunattely too brøad a subject to be adressed in this term paper.

### **ECONOMIC ANALYSIS USING LINEAR PROGRAMMING**

The goal of the paper was to see if a complex small farm could be replicated to a high degree so that it could later be manipulated to test different alternatives for obtaining higher levels of discretionary cash for family use. In order to analyze the many variables, attempt to simulate the existing farm as closely as possible and to test various alternate schemes for

improving the livelihoods of the Franco family, linear programming was used as a tool which turned out – once mastered to a certain degree – to be an effective means of achieving the stated goals. The specific methodology involved the use of Quattro Pro 6.0 spreadsheet. Activities were put into columns. These included crops raised for consumption and sale, forage crops, the production of honey (in some models), a tree nursery, a medicinal herb garden, selling activities, remittances (in some models), a grocery buying activity (including meat) and cash transfers. Rows were filled with constraints on the system and these included: land, labor, consumption of various crops, accounting rows and beginning cash for each quarter of the year. The term “beginning cash, with a row for each quarter, refers to the cash needed to start off the cultivation of that particular crop. Since the Franco farm has been exposed to certain technologies which lessen the need for money to purchase insecticides, herbicides and in most cases, seed, these amounts are low. The objective function was, in all cases, the maximization of end-year cash since the area where the Franco farm is located is one where a cash economy has replaced the purely subsistence one quite some time ago. The term “End Year Cash” is different from “Total Income.” The latter term describes the gross total of all in-coming money from sales and other sources, while the former refers exclusively to the amount of money left over, after expenses are paid, for discretionary spending, or the purchase of “luxury” items. That is, things which are not strictly indispensable for survival. The year was divided into four quarters for closer simulation and these were as follows: First quarter January, February, March – a somewhat “relaxed” time as far as field work is concerned, as most crops are in a vegetative stage and maize has already grown too high for weeding. This quarter, however, is important because near its end there is an important cash

requirement for the purchase of school supplies and uniforms. Second quarter: April, May. June is harvest time. It is here that labor is constrained. The third quarter: July, August and September in which soil preparation is the main activity, and the fourth quarter: October, November and December where planting and weeding are the main activities and the grocery bill goes up due to the Christmas holidays.

### **SCENARIOS TESTED**

- 1. The basic farm without honey or remittances, in which total end cash amounts to Gs. 1,312,722.**
- 2. The farm without remittances but with honey, in which total end cash amounts to Gs. 2,333,605.**
- 3. The farm without honey but with remittances, in which total end cash amounts to Gs. 3,740,267.**
- 4. The farm with remittances and honey, in which total end cash amounts to Gs. 4,725,767.**

1 US\$ = 2,800 Gs. (End Cash varies from 469 to 1,688 US\$).

The results of these situations can be seen below as LP 1, LP2, LP 3 and LP 4.

When honey and remittances did not come into the equation, the program adjusted by having the farmers use more land for the intercrop. This figure rose from 0.88 ha to 1.82 ha.

### **Results**

**In all four cases the program was able to run and give a feasible solution. The variation that occurred as remittances and/or honey were blocked out in the optimizer was an increase in area cultivated in the intercrop (see Graph 1). In the program,**

**very low yields were used for each of the crops, as these numbers more closely simulated the real farm. Also, the government standards for consumption of staples were raised nearly 20 % in order to put the issue of food security to the test. It proved to be a surprising result when, even with low yields and normal to low prices, the family met their objective of feeding themselves while obtaining some left-over cash for discretionary spending at the end of the year.**

### **Limits Built Into the Optimizer**

Land for medicinal herbs and the tree nursery was limited to one tenth of an ha each.

This was done so that the model would be as real as possible. When this constraint was removed, the result was the planting of two ha of medicinal herbs. This is an unlikely situation as the market for herbs is precarious at best and if several “campesinos” decided to plant three ha each, the already low price for each “mazo” of herbs would very quickly drop to zero.

### **Conclusions**

The major constraining factor on the system is labor and the time of year when this affects the farm’s production most notably is during the harvest quarter. The choice of the Franco family was apparently a fortunate one. With two young adolescent boys, soon to be able-bodied young adults, and two small girls who are no longer toddlers and will soon be old enough to contribute to the family work pool, this family is probably on the “edge.” That is, they are past the extremely labor stressing time of rearing small children, and they have not yet arrived at the relatively wealthy status that occurs when young males can contribute more significantly to total income or go away to earn cash that will be sent

home, and when girls cease to be all consuming on the mother's time. For this reason, alternate family compositions were not tested. An interesting "shock" to the system that should be tested, is what happens when the eldest boy reaches 16 years of age and has to go away for 18 months to complete his military service.

An interesting conclusion arrived at by using trial and error for crop yields, was that the matrix only began looking like the real farm when government statistic for average yields were halved and then halved again. This served to substantiate the notion that small farmers tend to expect a lot less from their fields than most government researchers take into account. An additional explanation for low yields is that in an intercrop on terraced land, swaths from 3-5 meters wide are plowed in alternate strips, with much loss of land to ridges, coconut trees, termite hills and other obstacles. In other words, a small Paraguayan farmer who usually plants Only 12,000-15,000 maize plants per ha ( recommended: 45,000-55,000) usually winds up with only half or less, as he is not really using the entire hectare.

As far as cash is concerned, it is not a constraint on the system. This is proved by the fact that the program continues to be feasible even without remittances from the daughter or cash income from the sale of honey. In these cases, end cash is reduced but does not disappear. As greater awareness of the consumer economy exposes the family to new "necessities" such as electronics, appliances, nicer clothes and tennis shoes, etc., a greater strain on the cash flow can be expected and will surely become a constraining factor before land does.

**The small family owned farm studied in this paper – although far from being wealthy by developed nation standards – produces enough food to feed the family and**

**different levels of discretionary cash at year's end. When compared to small farms in other areas of Paraguay, or situations in Latin America and Africa it is relatively well off, even when heavy stresses on extra income are tested on it.**

### **STRENGTHS AND WEAKNESSES**

Like most studies, this one possesses inherent strengths and weaknesses. By identifying the issues involved in replicating a small farm as closely as possible, others who use linear programming may have the benefit of referring to works which could both save time and increase effectiveness, especially in differentiating the details that truly affect systems.

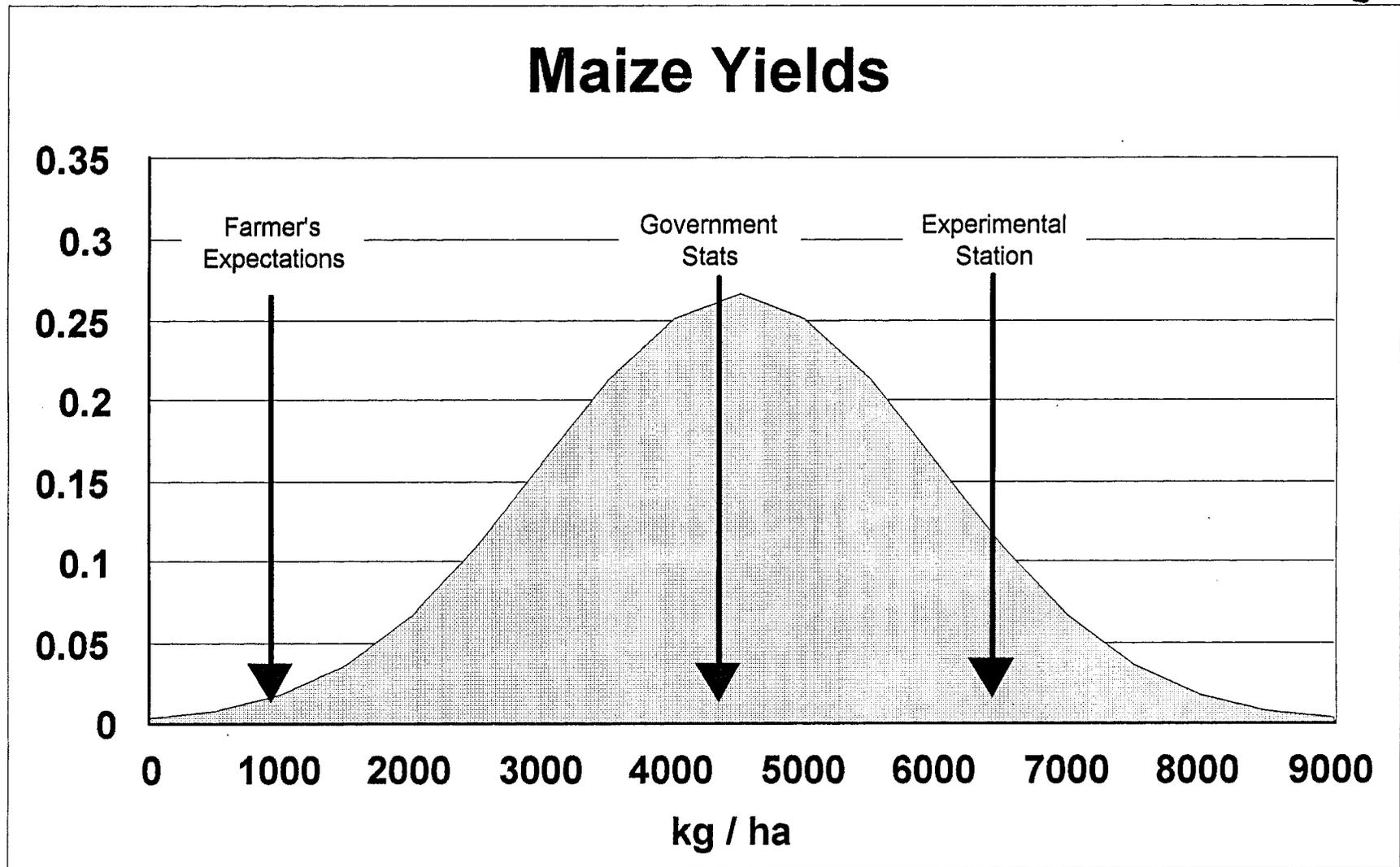
This study was done using real data. There were three separate sources for these: Publications from government and non-government sources in Paraguay, data sent from colleagues who were asked specific questions by post or electronic mail, and personal knowledge from having worked the better part of the decade in the Paraguayan countryside. This experience allowed me to screen out information that seemed off target, and sometimes even preposterous. As in any algebraic equation, in order to identify the unknown variable "x," all other variables have to be known. Thus, if enough precise data are available, linear programming may be used for induction as well as deduction. That is, with end results known, one can look back within the matrix and learn which data are wrong. This may prove especially useful for seeing through government statistics and getting to the real numbers that the small farmers use and rely upon.

An objective critique shows more weaknesses than strengths. Principle among these was the fact that the model only accounted for one year. Just as a look at a snapshot only shows one instantaneous picture, a static model does not account for changes that occur from year to year. Some of this can be compensated by the use of input tables for variables such as

prices and yields, however, a snapshot is not as good as a film - that is - no matter how closely a one year model tries to simulate reality, it can never be as close as a dynamic, multi-year approach. Defining who handles cash in the household proved most difficult. Most persons interviewed seemed to think that this was exclusively the man's domain. There were, however, conflicting answers, and the truth or at least the greatest tendency may only be discovered by living with this particular family over a period of time. The description of the Franco family as being on the dividing line between stressed and unstressed families, comes from past studies that identified types of families as tending to be either stressed or unstressed. This study did not approach family composition and is thus confined to this specific family during one specific year, and can therefore never represent any sort of mean, average or trend in the study area or anywhere else.

# WHAT IS THE RANGE FOR YIELDS ?

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cassava transfr	Nursery tree transfer	Squash Transfer	Peanut Transfer	Grass & Sugar Cane Transfer	remit- tances from daughter	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	cash transfer 1st quar- 2nd quar	Cash transfer 2nd quar- 3rd quar	cash transfer 3rd quar- 4th quar	cash transfer 4th quar- end year	RHS	Resource
260	0	50	80	29.2	0	0	0	0	0	0	744500.6	484622.9	2333605		
															<b>Use</b>
														<=	2.8 2.4766505 Intercrop Land
														<=	1 0 Forest Land
														<=	0.1 1.613E-06 MedHerbs Land
														<=	0.1 0.1 Tree Nursery Land
														<=	60 66.399146 MLabor 1st quar
														<=	60 64.058921 MLabor 2nd quar
														<=	60 30.270982 MLabor 3rd quar
														<=	60 27.715497 MLabor 4th quar
														<=	10 1.0001355 FLabor 1st quar
														<=	10 8.3111498 FLabor 2nd quar
														<=	10 4.6556588 F Labor 3rd quar
														<=	10 4.6556588 F Labor 4th quar
					1									<=	1 0 daughter Rem
														<=	16 6.1722384 MTeenLabor1stQ
														<=	8 8 MTeenLabor2ndQ
														<=	8 4.3444767 MTeenLabor-rdQ
														<=	8 6.1722384 MTeenLabor4thQ
														<=	1 0 Forest Use
														<=	-280 -280 Maize Consump
														<=	0 -3.86E-13 Maize acctg
-1														<=	-260 -260 Cassava connsm
1														<=	0 -6.81E-13 Cassava acctg
				-1										<=	-80 -80 Peanut Consum
				1										<=	0 2.152E-13 Peanut Account
			-1											<=	-50 -50 Squash consum
			1											<=	0 -1.51E-12 Squash Actoun
														<=	0 -3.63E-13 coconut acctg
														<=	0 0 Honey acctg
														<=	0 -4.44E-14 NursTree acctg
														<=	0 -1.63E-17 MedHerbsacctg
					-1									<=	-29.2 -29.2 Grass/cane con
					1									<=	0 1.11E-15 Grass/cane acctg
														<=	0 0 Forest Use
						-450000	150000				1			<=	1 1 Beg Cash 1st Q
						-450000		200000			-1			<=	1 1 Beg Cash 2ndQ
						-450000			150000			-1		<=	1 1 Beg Cash 3rd Q
						-450000				200000			-1	<=	1 1 Beg Cash 4thQ
														<=	1 1 Beg Cash 4thQ
														>=	0 2333605 Tot Cash end year

The Farm of Merardo Franco  
 Area '= 4 ha  
 Department of La Cordillera, Paraguay

LP3 THE FARM WITH REMITTANCES BUT WITHOUT HONEY

Variables>>	Mze+Cas bean+pnt squash coconuts	Honey Honey	Fruit and Forest Nursery Trees	Medicinal Herbs	Forest	Elephant Grass & Sugar Cane	Feed pair of Oxen	Sell Medicinal Herbs	Sell Forest and Nursery Trees	Sell Squash	Sell Peanuts	sell maize	sell coconuts	Sell Cassava	Sell Honey	maize transfer
	0.888889	0	1	0.850694	0	0.684167	0	204.1667	10	1350	125.3333	0	373.3333	206.6667	0	280
Intercrop Land ha	1	0	0			1		0	0	0	0	0	0	0	0	
Forest Land ha						1										
MedHerb Land ha				0.1												
TreeNursery Land ha			0.1													
MLabor 1st quar days	4	2	3				1	2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
MLabor 2nd quar days	6	2	4				1	2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
MLabor 3rd quar days	8	4	3	0			1	0	0	0	0	0	0	0	0	
MLabor 4th quar days	6	4	4				1	2	0.01	0.01						
FLabor 1st quar days	0		1	6					0.01	0						
FLabor 2nd quar days	4		1	4					0.01	0						
FLabor 3rd quar days	2		1	6					0.01	0						
FLabor 4th quar days	2		1	6					0.01	0						
daughter Rem days	0		0													
MTeenLabor1stQ days	1		1	2			5	2		0.01						
MTeenLabor2ndQ days	2		1	2			5	2		0.01						
MTeenLabor-rdQ days	0		1	2			5	2		0.01						
MTeenLabor4thQ days	1		1	2			5	2		0.01						
Forest Use ha						1										
Maize Consump kg																-1
Maize acctg Gs.	-315												1			1
Cassava consum kg															1	
Cassava acctg Gs.	-525															
Peanut Consum kg												1				
Peanut Account Gs.	-231															
Squash consum kg																
Squash Acctoun Gs.	-1575										1					
coconut acctg Gs.	-420													1		
Honey acctg Gs.		-45														1
NursTree acctg saplings			-1000						100	100						
MedHerbsacctg mazos				-24000					100							
Grass/cane con kg																
Grass/cane acctg Gs.																
Forest Use ha						1										
Beg Cash 1st Q Gs.				62000												
Beg Cash 2ndQ Gs.		54000	48000													
Beg Cash 3rd Q Gs.	220000						-10000		-75000	-70						
Beg Cash 4thQ Gs.							0	-5000			-260	-180				
totCashEndYea													-850	-70	-8500	

cassava transfr	Nursery tree transfer	Squash Transfer	Peanut Transfer	Grass & Sugar Cane Transfer	remit- tances from daughter	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	cash transfer 1st quar- 2nd quar	Cash transfer 2nd quar- 3rd quar	cash transfer 3rd quar- 4th quar	cash transfer 4th quar- end year	RHS	Resource
260	0	50	80	29.2	1	0	0	0	0	0	397257.9	1650601	2958466	3740267	
															Use
															2.8 1.5730556 Intercrop Land
															1 0 Forest Land
															0.1 0.0850694 MedHerbs Land
															0.1 0.1 Tree Nursery Land
															60 29.934722 MLabor 1st quar
															60 32.7125 MLabor 2nd quar
															60 10.795278 MLabor 3rd quar
															60 12.159167 MLabor 4th quar
															10 8.1458333 FLabor 1st quar
															10 10 FLabor 2nd quar
															10 9.9236111 F Labor 3rd quar
															10 9.9236111 F Labor 4th quar
															1 1 daughter Rem
															16 7.1111111 MTeenLabor1stQ
															8 8 MTeenLabor2ndQ
															8 6.2222222 MTeenLabor-rdQ
															8 7.1111111 MTeenLabor4thQ
															1 0 Forest Use
															-280 -280 Maize Consump
															0 -5.79E-13 Maize acctg
															-260 -260 Cassava connsn
															0 -7.19E-13 Cassava acctg
															-80 -80 Peanut Consum
															0 -5.57E-13 Peanut Account
															-50 -50 Squash consum
															0 -1.52E-12 Squash Acctoun
															0 -2.79E-13 coconut acctg
															0 0 Honey acctg
															0 0 NursTree acctg
															0 -3.73E-12 MedHerbsacctg
															-29.2 -29.2 Grass/cane con
															0 -1.5875 Grass/cane acctg
															0 0 Forest Use
															1 1 Beg Cash 1st Q
															-450000 150000 1 -1 1 Beg Cash 2ndQ
															-450000 200000 1 1 Beg Cash 3rd Q
															-450000 150000 1 -1 1 Beg Cash 4thQ
															-450000 200000 1 -1 1 Beg Cash 4thQ
															1 >= 0 3740267.1 Tot Cash end year



cassava transfr	Nursery tree transfer	Squash Transfer	Peanut Transfer	Grass & Sugar Cane Transfer	remit- tances from daughter	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	Buy Meat and Groceries	cash transfer 1st quar- 2nd quar	Cash transfer 2nd quar- 3rd quar	cash transfer 3rd quar- 4th quar	cash transfer 4th quar- end year
260	0	50	80	29.2	1	0	0	0	0	397257.9	1488601	2796466	4725767

RHS Resource

														Use			
														<=	2.8	1.5730556	Intercrop Land
														<=	1	0	Forest Land
														<=	0.1	0.0850694	MedHerbs Land
														<=	0.1	0.1	Tree Nursery Land
														<=	60	35.934722	MLabor 1st quar
														<=	60	38.7125	MLabor 2nd quar
														<=	60	22.795278	MLabor 3rd quar
														<=	60	24.159167	MLabor 4th quar
														<=	10	8.1458333	FLabor 1st quar
														<=	10	10	FLabor 2nd quar
														<=	10	9.9236111	F Labor 3rd quar
														<=	10	9.9236111	F Labor 4th quar
					1									<=	1	1	daughter Rem
														<=	16	7.1111111	MTeenLabor1stQ
														<=	8	8	MTeenLabor2ndQ
														<=	8	6.2222222	MTeenLabor-rdQ
														<=	8	7.1111111	MTeenLabor4thQ
														<=	1	0	Forest Use
														<=	-280	-280	Maize Consump
														<=	0	1.994E-13	Maize acctg
-1														<=	-260	-260	Cassava connsm
1														<=	0	1.807E-13	Cassava acctg
				-1										<=	-80	-80	Peanut Consum
				1										<=	0	2.722E-13	Peanut Account
			-1											<=	-50	-50	Squash consum
			1											<=	0	-1.11E-13	Squash Acctoun
														<=	0	9.29E-13	coconut acctg
														<=	0	0	Honey acctg
														<=	0	-1.78E-13	NursTree acctg
														<=	0	-1.07E-12	MedHerbsacctg
					-1									<=	-29.2	-29.2	Grass/cane con
					1									<=	0	-1.5875	Grass/cane acctg
														<=	0	0	Forest Use
						-450000	150000				1			<=	1	1	Beg Cash 1st Q
						-450000		200000		-1		1		<=	1	1	Beg Cash 2nd Q
						-450000			150000		-1	1		<=	1	1	Beg Cash 3rd Q
						-450000				200000		-1	1	<=	1	1	Beg Cash 4thQ
													1	>=	0	4725767.1	Tot Cash end year

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