ECONOMICS AND EVOLUTION OF SMALLHOLDINGS CONSERVATION AGRICULTURE IN PARAGUAY

Mid-Term Experiences

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2005
Inappropriate agricultural cultivation systems are one of the main reasons for the poverty and food insecurity faced by smallholders in most parts of the rural regions in developing countries. Unsustainable agricultural practices lead to an exhaustion of forest and soil resources, which results in reduced productivity, an increase in the area suffering from desertification and a reduction of the biodiversity, along with well known negative impacts at a national and global level.

Conservation Agriculture (CA) is addressing these problems by introducing cultivation systems and techniques that increase agricultural production, improve natural resource management, and contribute towards a more sustainable rural development. The use of agricultural conservation practices in many parts of the world has proven to minimize soil erosion, enhance the biodiversity and reduce the emissions of CO$_2$, which contribute to climate change mitigation. Moreover, smallholder families have attained a more secure livelihood and improved their income through higher yields achieved by practising CA. Therefore, CA contributes towards reaching the «Millennium Development Goals».

Today, CA is practised on almost 90 million hectares worldwide; however, most of this area is covered by mechanized medium and large farms. Countries such as Paraguay indicate the appropriateness and increasing importance of CA for smallholdings. Paraguay is the world leader in terms of the percentage of total area under CA. Medium and large farms as well as thousands of smallholders practice this technique that results in improved incomes and labour savings being reinvested in an intensification and diversification of their production systems.

The purpose of this study is to characterize the practical mid-term experiences with CA at the smallholder level in Paraguay, while at the same time showing the potential of this agricultural technique for reducing rural poverty. The data for the study were attained from selected families for the second time, five years after information was first collected on CA. During this period, living conditions of the smallholder families underwent an impressive improvement. The study shows that CA contributed substantially to the increase in income and economic stability of smallholder families. In addition to describing the implementation and expansion of CA in Paraguay, the study shows the importance of cooperation and partnership between international and national organizations and institutions in achieving poverty reduction.

The study was carried out under the joint cooperation between the Food and Agriculture Organization of the United Nations (FAO) and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), the later on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ), Germany, and with the support of the Paraguayan Ministry of Agriculture and Livestock as well as other national institutions.

We would like to invite all readers to adopt and practice «Conservation Agriculture». If you have any questions, please feel free to contact us at the addresses of FAO, GTZ or the Paraguayan partners indicated. We wish you a pleasant and enlightening reading through this study.

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Director General
Asia, Pacific, Latinamerica and Caribbean Department
GTZ

Doyle Baker
Chief, Agricultural Management,
Marketing and Finance Service
Agricultural Support Systems Division
FAO
### ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASDTA</td>
<td>Asociación de Siembra Directa Tracción Animal, Paraguay</td>
</tr>
<tr>
<td>BMZ</td>
<td>Federal Ministry for Economic Cooperation and Development, Germany</td>
</tr>
<tr>
<td>BNF</td>
<td>Banco Nacional de Fomento, Paraguay</td>
</tr>
<tr>
<td>CA</td>
<td>Conservation Agriculture</td>
</tr>
<tr>
<td>CAH</td>
<td>Creditos Agricola de Habilitacion, Paraguay</td>
</tr>
<tr>
<td>CC</td>
<td>Conventional Cultivation</td>
</tr>
<tr>
<td>DEAg</td>
<td>Agricultural Extension Directorate, Paraguay</td>
</tr>
<tr>
<td>DGEEC</td>
<td>Dirección General de Estadísticas, Encuestas y Seno, Paraguay</td>
</tr>
<tr>
<td>DIA</td>
<td>Agricultural Research Directorate, Paraguay</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<tr>
<td>FEPASIDA</td>
<td>Paraguayan Federation of Conservation Agriculture for Sustainable Agriculture</td>
</tr>
<tr>
<td>Gmcc</td>
<td>Green manure cover crop</td>
</tr>
<tr>
<td>G</td>
<td>Guaraníes (Paraguayan currency)</td>
</tr>
<tr>
<td>GTZ</td>
<td>Gesellschaft für Technische Zusammenarbeit, Germany</td>
</tr>
<tr>
<td>IAPAR</td>
<td>Parana State Agricultural Research Institute, Brazil</td>
</tr>
<tr>
<td>IDB</td>
<td>Interamerican Development Bank</td>
</tr>
<tr>
<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
</tr>
<tr>
<td>JICA</td>
<td>Japan International Cooperation Agency</td>
</tr>
<tr>
<td>KfW</td>
<td>Kreditanstalt für Wiederaufbau, Germany</td>
</tr>
<tr>
<td>MAG</td>
<td>Ministry of Agriculture and Livestock, Paraguay</td>
</tr>
<tr>
<td>TG</td>
<td>Thousand Guaraníes</td>
</tr>
<tr>
<td>NPK</td>
<td>Nitrogen, phosphorus and potassium</td>
</tr>
<tr>
<td>PNMCRS</td>
<td>Programa Nacional de Manejo, Conservación y Recuperación de Suelo, Paraguay</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>USS</td>
<td>United States of America Dollar</td>
</tr>
<tr>
<td>WB</td>
<td>World Bank</td>
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</tbody>
</table>
SUMMARY AND CONCLUSION

This report presents the results of an economics study of Conservation Agriculture (CA). A case study approach was used to compare the performance of CA to conventional cultivation (CC) on smallholder farms in Paraguay. Additionally, the change in performance of CA over the five-year period 1998-2003 is assessed by comparing the results with those obtained from a previous study. The investigation for this report was carried out during September and October 2003 and was funded by FAO and GTZ.

It is estimated that 1.2 million people live on small farms in Paraguay, 41% of whom live in poverty. Small farm families have been suffering from declining incomes and deteriorating levels of nutrition and health, and consequently urban drift has been escalating. One cause of poverty is soil erosion, which is severe and threatens the viability of agriculture in Paraguay and other parts of Latin America. Facing declining productivity and incomes due to soil erosion and soil degradation, farmers in many parts of Latin America have switched to CA, i.e., they eliminated tillage, introduced direct seeding, crop rotations and green manure cover crops (gmcc); and managed crop residues to ensure soil cover for as long as possible—which is becoming recognised as a technological revolution.

The experience in Paraguay and elsewhere in the world suggests that CA is a cost-effective method of production and soil conservation. In 1990 CA was introduced on mechanised medium and large farms in Paraguay. By 2002 some 1.4 million ha, 60% of the total cultivated area in Paraguay, was cultivated using CA. The economic benefits from this rapid adoption of CA are estimated at US$ 941 million in savings, arising from reduced erosion and savings in fuel, fertiliser and labour. Taking into consideration the impressive rate at which CA has spread on mechanised farms, little CA is found on small farms. Out of about 268,000 small farmers with a total of 1.7 million ha of land, approximately 2,000 of these farmers manage only 6,500 ha of CA (human and animal traction).

Selected field areas

This report is based on case studies of farms in two regions of the country with the longest experience of CA on smallholdings--Edelira (Itapúa Department) and San Pedro (Capital of San Pedro Department). The farms were selected as being representative of smallholder farms and varied in size from 4.25-20 ha. The performance of these farms was appraised at three points: before the adoption of CA, in 1998 after the adoption of CA, and five years later in 2003. By 2003 the Edelira farmers had 10 or 11 years of experience with CA and those in San Pedro had 7 years experience. Two farms that had not adopted CA, one in each region, were also analysed. During the last period (1998-2003) one of the non-adopters in Edelira had adopted CA on 50% of his farm area.

The previous study in 1998 had confirmed that yields of the majority of the crops including cotton, soybeans, tobacco and maize (important cash crops for smallholders) had been falling rapidly under CC systems. This study showed that crop yields improved after the adoption of CA. Yields increase as soil fertility and organic matter levels rise rapidly when CA is introduced. Furthermore, soil erosion was evident on the CC case study farms but not on land under CA. Strikingly, the Edelira smallholder who adopted CA on 50% of his cultivated area had visible erosion on the conventionally cultivated land.

Edelira

The farms in Edelira lie amidst the main soybean production area of Paraguay where farming is dominated by large and medium size mechanized CA farms. The case study smallholdings represent four different smallholder farm types, which are typical for the region; three of the four use animal traction and one farm is worked manually with a jab-planter and hand-hoe. The financial performance, for two scenarios, and its development from the conventional cultivation system towards CA in 1998 and in 2003 can be found in Table A.

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1 Sorrenson William; Duarte, César; López Portillo, Justo. (1998): Economics of No-till Compared to Conventional Systems on Small Farmers, Policy and Investment Implications, San Lorenzo (Paraguay).

2 Sorrenson et al. 1998.

3 For the report, two price scenarios were elaborated for all case study farmers in the two field areas. The first scenario calculates with the present market and product prices, input costs and exchange rate (Guaranies– US dollar). Whereas, the second scenario uses the same market and product prices, input costs and exchange rate...
for each crop on a one-hectare base. This was then adjusted to the area used of each crop in order to obtain their net farm income.

Notes: Half the CC1 farm was converted to CA during the period 1998-2003 and so no longer could be considered as an entire conventional farm and not be used for a comparison with CA.

### Table A. Comparison of Production Systems on Smallholder Farms in Edelira

<table>
<thead>
<tr>
<th>Unit</th>
<th>Smallholder</th>
<th>Rodríguez CC1</th>
<th>Mendoza AC1</th>
<th>Ozuna AC2</th>
<th>Ramírez AC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-Experience</td>
<td>Years</td>
<td>4</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Farm area</td>
<td>Ha</td>
<td>20.5</td>
<td>9.2</td>
<td>18</td>
<td>17.5</td>
</tr>
<tr>
<td><strong>pre-1998 (CC only)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour (person-days)</td>
<td>days</td>
<td>363</td>
<td>177</td>
<td>300</td>
<td>379</td>
</tr>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>1,520 (543)</td>
<td>5,460 (1,950)</td>
<td>7,963 (2,844)</td>
<td>7,986 (2,852)</td>
</tr>
<tr>
<td>Return per day</td>
<td>G/day (US$)</td>
<td>4,172 (1.49)</td>
<td>30,828 (11.01)</td>
<td>26,516 (9.47)</td>
<td>21,506 (7.52)</td>
</tr>
<tr>
<td><strong>CA 1998</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour (person-days)</td>
<td>days</td>
<td>na</td>
<td>143</td>
<td>239</td>
<td>350</td>
</tr>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>8,884 (3,173)</td>
<td>10,788 (3,853)</td>
<td>16,030 (5,725)</td>
</tr>
<tr>
<td>Return per day</td>
<td>G/day (US$)</td>
<td>na</td>
<td>61,964 (22.13)</td>
<td>45,192 (16.14)</td>
<td>45,836 (16.37)</td>
</tr>
<tr>
<td>Increase in net farm income: CC to CA1998</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>3,424 (1,223)</td>
<td>2,825 (1,009)</td>
<td>8,044 (2,873)</td>
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<tr>
<td>%</td>
<td>na</td>
<td>63</td>
<td>35</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td><strong>2003 (1st Scenario)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour (person-days)</td>
<td>days</td>
<td>199</td>
<td>180</td>
<td>242</td>
<td>195</td>
</tr>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>24,372 (3,931)</td>
<td>13,119 (2,116)</td>
<td>37,740 (6,087)</td>
<td>53,673 (8,657)</td>
</tr>
<tr>
<td>Return per day</td>
<td>G/day (US$)</td>
<td>122,450 (19.75)</td>
<td>72,912 (11.76)</td>
<td>155,744 (25.12)</td>
<td>275,962 (44.51)</td>
</tr>
<tr>
<td>Increase in Net farm income: CA1998 to CA2003</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>4,235 (-1,057)</td>
<td>26,951 (2,234)</td>
<td>37,643 (2,932)</td>
</tr>
<tr>
<td>%</td>
<td>na</td>
<td>48</td>
<td>250</td>
<td>235</td>
<td></td>
</tr>
<tr>
<td>Overall increase in net farm income: CC to CA2003</td>
<td>TG/year (US$)</td>
<td>22,852 (3,388)</td>
<td>7,659 (166)</td>
<td>29,777 (3,243)</td>
<td>45,688 (5,805)</td>
</tr>
<tr>
<td>%</td>
<td>1,503</td>
<td>140</td>
<td>374</td>
<td>572</td>
<td></td>
</tr>
<tr>
<td><strong>2003 (2nd Scenario)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>8,882 (3,172)</td>
<td>9,430 (3,368)</td>
<td>18,908 (6,753)</td>
<td>34,490 (12,318)</td>
</tr>
<tr>
<td>Return per day</td>
<td>G/day (US$)</td>
<td>44,632 (15.94)</td>
<td>52,360 (18.70)</td>
<td>78,036 (27.87)</td>
<td>177,324 (63.33)</td>
</tr>
<tr>
<td>Increase in net farm income: CA1998 to CA2003</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>546 (195)</td>
<td>8,120 (2,900)</td>
<td>18,460 (6,593)</td>
</tr>
<tr>
<td>%</td>
<td>na</td>
<td>6</td>
<td>75</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Overall increase in net farm income: CC to CA2003</td>
<td>TG/year (US$)</td>
<td>7,361 (2,629)</td>
<td>3,970 (1,418)</td>
<td>10,945 (3,909)</td>
<td>26,505 (9,466)</td>
</tr>
<tr>
<td>%</td>
<td>484</td>
<td>73</td>
<td>137</td>
<td>332</td>
<td></td>
</tr>
</tbody>
</table>

from 1998. This was done to find out if the financial developments are market driven or if they can also be related to the conditions of the cultivation system. Both scenarios are based on financial analyses, for which crop budgets were elaborated. The crop budgets include the income and input costs such as seeds, fertilizer, labour,
The financial performance in Edelira under the first scenario shows a remarkable net farm income growth for all farmers within the last 5 years. The increase ranges between 48% (CA1) and 250% (CA3). For the CA2 and CA3 farmers, this is even more than they achieved by changing the cultivation systems. However, the highest increase of net farm income was achieved by the CC1 farmer, as a result of the adoption of CA on 50% of his farm area (which also led to a reduction of labour-days from 363 to 199). The overall comparison between the net farm incomes prior to the introduction of CA and the situation in 2003, shows that all CA farmers have increased their revenue. The most impressive increase was achieved by the CA5 farmer, who experienced an increase of more than 570% after 11 years of CA. The other two CA farmers achieved returns of 140% (CA1) and 372% (CA2).

The financial performance under the second scenario confirms the results of the first scenario. Although the increases in net farm income and return to labour are not as high, it is clear that the good performance continued five years more into the CA system (or by the adoption of CA by the CC1 farmer) and that the development is not only market driven, but also must be related to CA.

**San Pedro**

The results document the financial farming performance of three smallholdings in San Pedro, which are located in a region mostly comprised of smallholder farmers. The three case study smallholdings are representative for the different farms types of the region; one farm is cultivated under CC, one farm is hand worked under CA (CA4) and one farm is worked with animals (working oxen) under CA (CA5). The financial performance, for both scenarios, and its development from CC towards CA in 1998 and in 2003 can be found in Table B.

The financial performance in San Pedro under the first scenario shows a net farm income growth for all farmers compared to 5 years ago. This increase ranges from 104% (C4) to 249% (CC2). For the CA5 farmer, the increase of 220% is even more than he achieved by changing cultivation systems. The overall comparison of the net farm incomes before the introduction of CA and the situation in 2003, shows that all CA farmers have increased their revenue. The most impressive increase was achieved by the CA4 farmer, who experienced an increase of more than 630% after 7 years of CA. The other CA farmer achieved 462%. The financial performance under the second scenario confirms the good performance of the CA farmers and that this is not only market driven, but also must be related to the CA system. This is confirmed by the performance of CC2 farmer who suffered a decrease in net farm income and return to labour under the second scenario.

**Conclusion**

This study clearly shows that the mid-term effects of CA, in financial terms, are much better than those under CC systems. Nevertheless, the difference between the two scenarios indicates that the higher income achieved by the farmers is mainly derived from the improved commodity prices and cost reduction. When looking at the results of the second scenario, it is clear that a further improvement of farming conditions such as increased soil fertility, resulting in higher yields, are based on the CA system. By analysing the crop budgets it is visible that the CA farmers have intensified their production and that this intensification is the main reason for the improved financial performance. The later was achieved by the consequent use of the elements of the CA system (direct seeding, crop rotation, gmcc and permanent soil cover). Diversification of the crop production is another reason for the increased financial performance, but it is not related exclusively to CA. However, as the CA farmers search for an enhanced crop rotation, this is more likely to happen on CA farms. Consequently, all CA farmers introduced new crops, but the contribution to the total net-farm income reaches only 20% in one case.

A further diversification of production of the CA farming systems is more important due to the introduction of alternative sources of income. These other diversified sources are reforestation, bee-keeping, fish-breeding, increased fruit and vegetable production, and an increased breeding of small animals. These sources are also not limited to the CA system, but show that the management style of the CA farmers changed by amplifying their production and, more important, that the CA farmers have resources for further investment. Examples for this are the cases of CA4 and CA5 who do not receive any credit. The enhanced management skills of the CA farmers can be related to the good technical assistance they received from the extension agents and from the high level of participation in workshops and congresses over the years. A further observation is that all CA farmers have developed their own system of CA (in terms of crop rotations, gmcc used and area size), based on their personal preferences. Nevertheless, this is not always positive in economic terms, since it hinders some farmers in taking «objective» and market orientated management decisions.
**TABLE B. Comparison of Production Systems on Smallholder Farms in San Pedro**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Aquino CC2</th>
<th>Ledezma CA4</th>
<th>Oporto CA5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-Experience</td>
<td>Years</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Farm area</td>
<td>Ha</td>
<td>8.5</td>
<td>4.25</td>
</tr>
</tbody>
</table>

**pre-1998 (CC only)**

<table>
<thead>
<tr>
<th>Labour (person-days)</th>
<th>Days</th>
<th>183</th>
<th>164</th>
<th>163</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>3,542 (1,265)</td>
<td>1,596 (570)</td>
<td>4,043 (1,444)</td>
</tr>
<tr>
<td>Return per labour-day</td>
<td>G/day (US$)</td>
<td>19,348 (6.91)</td>
<td>9,772 (3.49)</td>
<td>24,808 (8.86)</td>
</tr>
</tbody>
</table>

**CA1998**

<table>
<thead>
<tr>
<th>Labour (person-days)</th>
<th>Days</th>
<th>na</th>
<th>156</th>
<th>203</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>5,776 (2,063)</td>
<td>7,098 (2,535)</td>
</tr>
<tr>
<td>Return per labour-day</td>
<td>G/day (US$)</td>
<td>na</td>
<td>36,904 (13.18)</td>
<td>34,916 (12.47)</td>
</tr>
<tr>
<td>Increase in net farm income: CC to CA1998</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>4,180 (1,493)</td>
<td>3,054 (1,091)</td>
</tr>
<tr>
<td>%</td>
<td>na</td>
<td>262</td>
<td>76</td>
<td></td>
</tr>
</tbody>
</table>

**2003 (1st Scenario)**

<table>
<thead>
<tr>
<th>Labour (person-days)</th>
<th>Days</th>
<th>225</th>
<th>129</th>
<th>202</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net farm income</td>
<td>TG/year (US$)</td>
<td>12,357 (1,993)</td>
<td>11,774 (1,899)</td>
<td>22,711 (3,663)</td>
</tr>
<tr>
<td>Return per labour-day</td>
<td>G/day (US$)</td>
<td>54,932 (8.86)</td>
<td>91,264 (14.72)</td>
<td>112,592 (18.16)</td>
</tr>
<tr>
<td>Increase in Net farm income: CA1998 to CA2003</td>
<td>TG/year (US$)</td>
<td>na</td>
<td>5,997 (-164)</td>
<td>15,613 (1,128)</td>
</tr>
<tr>
<td>%</td>
<td>na</td>
<td>104</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Overall increase in net farm income: CC to CA2003</td>
<td>TG/year (US$)</td>
<td>8,815 (728)</td>
<td>10,178 (1,329)</td>
<td>18,667 (2,219)</td>
</tr>
<tr>
<td>%</td>
<td>249</td>
<td>638</td>
<td>462</td>
<td></td>
</tr>
</tbody>
</table>

**2003 (2nd Scenario)**

| Net farm income      | G/year (US$) | 3,086 (1,102) | 7,605 (2,716) | 13,558 (4,842) |
| Return per labour-day| G/day (US$)   | 13,720 (4.90) | 58,940 (21.05) | 67,200 (24.00) |
| Increase in net farm income: CA1998 to CA2003 | TG/year (US$) | na | 1,828 (653) | 6,460 (2,307) |
| %                    | na    | 32  | 91  |     |
| Overall increase in net farm income: CC to CA2003 | G/year (US$) | -457 (-163) | 6,009 (2,146) | 9,514 (3,398) |
| %                    | -13   | 376 | 235 |     |
A strong indicator of the better performance of the CA farmers, and at the same time another mid-term effect of CA in socioeconomic terms, is the improved living conditions. Two out of the four farmers in Edelira built new houses and replaced their old wooden houses with stone houses. The CC1 farmer even bought a second house in the village of Edelira. Additionally, the farmers bought household goods like TVs, motorcycles, fridges, freezers or a horse and cart, as in the case of CA4. The sons of CA3 and CC1 started to study agriculture at university. The school-aged children attend school on a regular basis and will continue to do so, because their work is no longer needed on the farm (through less labour requirement for crop production) and their parents can afford to pay school costs. None of the CA farmers or their sons have to leave in order to work off-farm, which is another indicator of the good farming performance. At the same time, the sons of the CA farmers remaining on the farm, grow up with the CA system, preparing the next generation for continuing the work of their parents or use it on their own farm in the future. In one particular case, the son of a farmer even returned from Argentina to work on his family’s farm.

**Recommendations**

The report indicates an impressive increase in the financial performance of all CA smallholders. In addition, improved living conditions of smallholders have been shown. Therefore, it can be recommended that CA should be introduced, adopted and expanded on smallholdings throughout Paraguay and other countries. The ever-threatening problems of soil erosion and soil nutrient loss have disappeared from CA farms. The whole development process seems to be irreversible and therefore, sustainable; hunger and poverty are not associated with CA farms in Paraguay.

One lesson learnt is that a consistent application of the four elements of CA will enhance farm performance. Furthermore, each farmer has to be encouraged to develop his own CA system, rooted in personal preferences and market orientation, and achieved by an openness to experiment with crop rotations and gmcc. Further diversification of crops and sources of income will further reduce risk stemming from market and climatic conditions. The production of gmcc seeds amongst smallholders should be encouraged, not only as form of income diversification, but also to minimise dependence on the market. All farmers interviewed acknowledged the need for continuous technical assistance, which, therefore, plays a key-role.

The introduction of CA is linked to necessary investments in machinery and other inputs such as fertilizer and gmcc seeds. The results of this study show that smallholders practising CA benefit from a rapid increase in income and therefore, are able to pay back loans within only a few years. Additionally, investments in new machinery can be avoided through modifications of existing machinery; this has already been proved by other studies⁵. The smallholders can purchase more sophisticated implements later, once they have experienced the economic benefits of CA. At the same, consideration should be given to designing a credit line for smallholder farmers in order to facilitate investments in CA inputs, such as fertilizers, gmcc seeds and, only where absolutely necessary, herbicides.

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⁵ For example, Lange and Meza (2004), Florentin et al. (2001).
1. INTRODUCTION

1.1 BACKGROUND

1.1.1 Socioeconomic Context of Small Farms

Small farms account for a significant proportion of the Paraguayan agriculture. According to the most recent data, there are 268,000 small farms of less than 20 ha; these occupy a total of 1.7 million ha, which represent approximately 14% of the total agricultural area of Paraguay. The breakdown of small farms by farm size is shown in Table 1.

Small farms of less than one hectare are relatively insignificant in terms of number and the total area they occupy. Many of these farmers, as well as those between 1-5 has, are receptive of other sources of income for their livelihoods. Therefore, smallholdings of 5-20 has, which total about 159,000 (59% of the total number of all smallholdings) and occupy 1,463,190 has (86% of the total area of all smallholdings), are the most receptive of their farms for their livelihoods; as a result, these smallholders, i.e. with areas of 5-20 has, are the most receptive of new ideas and the introduction of new technologies on their farms.

Smallholder farmers make a considerable contribution to the Paraguayan economy. The entire agricultural sector generates 26% of the economy’s Gross Domestic Product, provides 37% of all jobs, and 90% of all exports. Despite the comparatively small area occupied by smallholdings, they generate over a third (35%) of the total value of agricultural production\(^6\). Most of the actively employed people in agriculture are smallholders. They are also the main producers of a host of products, both food and export crops as shown in Table 2.

Table 1. Number and Area of Small Farms by Farm Size

<table>
<thead>
<tr>
<th>Farm Size</th>
<th>Number of Small Farms (% of total in parentheses)</th>
<th>Area of Small Farms (ha) (% of total in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 ha</td>
<td>109,109 (41%)</td>
<td>241,415 (14%)</td>
</tr>
<tr>
<td>5 - 10 ha</td>
<td>79,114 (29%)</td>
<td>507,558 (30%)</td>
</tr>
<tr>
<td>10 - 20 ha</td>
<td>80,111 (30%)</td>
<td>955,632 (56%)</td>
</tr>
<tr>
<td>Total</td>
<td>268,334 (100%)</td>
<td>1,704,605 (100%)</td>
</tr>
</tbody>
</table>

Source: National Agrarian Survey 2003

By analyzing the demographics of the last three censuses (see Table 3), it is quite evident that there has been an increasing urban drift. While the total population has increased by 25\% between 1992 and 2002, the increase rate of the urban population has been much greater than that of the rural population. In 1972, the urban population was 37\% of the total for the country, while in 1982, 1992, and 2002, this had increased to 43\%, 50\%, and 57\% respectively.

Table 2. Smallholder Farmers Contribution in Paraguayan Agricultural Production

<table>
<thead>
<tr>
<th>Products</th>
<th>National Production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>71</td>
</tr>
<tr>
<td>Cassava</td>
<td>76</td>
</tr>
<tr>
<td>Maize</td>
<td>53</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>51</td>
</tr>
<tr>
<td>Cowpea</td>
<td>86</td>
</tr>
<tr>
<td>Tobacco</td>
<td>83</td>
</tr>
<tr>
<td>Peanuts</td>
<td>33</td>
</tr>
<tr>
<td>Soybean</td>
<td>10</td>
</tr>
<tr>
<td>Garden bean</td>
<td>68</td>
</tr>
</tbody>
</table>

Source: Dietze, 1997 based on Censo Agropecuario Nacional de 1991

Increasing urbanization is due mainly to declining rural incomes, particularly those of small farms, of which many exist below the poverty line. Terms of trade have been moving against small farms, i.e. input costs have been increasing at a faster rate than product prices, with the latter characteristically oscillating up and down over time. However, there is another underlying cause to the demise of the small farming sector--declining crop

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\(^6\) Dietze, 1997.
yields. Decreasing productivity is due mainly to falling levels of soil fertility. Smallholder farmers have been using inappropriate conventional cultivation systems with very little, if any adoption of soil conservation methods; generally fertilizer or other yield-enhancing inputs, in labour-intensive production systems are not used. Additionally, serious water-borne erosion has been depleting the fertility of soils and degrading their structure.

Consequently, a United Nations Development Programme (UNDP) report indicates that 41% of the smallholding families live in poverty, and as a result, increasing numbers of small farm families suffer from health, education and nutritional deficiencies. Faced with declining incomes and increasing poverty, many rural families have been selling their farms and moving to town in an attempt to break-away from their ever-decreasing standards of living. Sadly and ironically, many find themselves confronted with even worse levels of poverty in the urban centres. Families quickly find their income from selling their farms dwindle, jobs are difficult to find, and their costs of living soar with the need to purchase all of their food requirements.

1.1.2 Conservation Agriculture on Small Farms in Paraguay

The National Programme for Soil Management, Conservation and Recuperation (PNMCRS) of the Ministry of Agriculture and Livestock (MAG) estimates that there are 6,500 hectares of land under CA on small farms in Paraguay, mostly using azadas (hand-hoe) and matracas (jab-planters). This represents less than 1% of the total cultivated area in the country. However, CA is not practised permanently on all of this area. It has been difficult for the study team to try and piece together the extent to which CA has spread on small farms in Paraguay, because there is considerable uncertainty about the area and number of small farmers using CA in Paraguay. The Agricultural Extension Service (Dirección de Extension Agraria–DEAg) estimates that there are around 2,000 smallholder families permanently practising CA, using green manure cover crops (gmcc), crop rotation, direct seeding and a permanent soil cover. A further 2,500 smallholders only occasionally practise CA. In the Alto Paraná and Itapúa Departments, around 700 smallholders are estimated to be permanently practising CA, with a further 1,100 occasionally practising CA. In the San Pedro and Concepción Departments, 20 permanent CA smallholders and 100 occasional CA smallholders were observed; while in other regions (principally Caaguazú, Caazapá, and Paraguarí Departments), 200 permanent CA smallholders and 400 occasional CA smallholders were observed. These numbers are only estimates since the last Agrarian Census dates back to the year 1991, before the introduction of CA on small farms.

From 1993 to 2001, a MAG-GTZ Project, Conservación del Suelo, has been active in promoting CA on small farms in five pilot regions of Paraguay. Support has been provided to extension agents of the DEAg and through the provision of CA machinery. Edelira, a rural town located within the Itapúa Department, has been the area where most activities have been concentrated. In this region, some 150 smallholders are now permanently practising CA while another 700 occasionally practice it. In San Pedro, the other main focal area of this study, it is estimated that some 20 smallholders are also permanently practising CA. A second area, which developed into another CA-Centre, is Caaguazú. Here, small committees were formed to enhance the adoption of CA. The extension service providing high quality assistance and financial support came from Kreditanstalt für Wiederaufbau (KfW). A region, which is starting to develop into a third CA-Centre, is the Caazapá Department. In this Department, a joint project between the local government and the GTZ introduced CA in 2002. To begin with, efforts focused on educating the extension service of the DEAg, which was then transferred to the small farms. Today, 50% of the smallholders belonging to the beneficiary group of this project are using gmcc and direct seeding. A fourth CA area has begun to develop in Quyuquyo, Paraguarí. Although socioeconomic and soil conditions are different to the other regions previously mentioned, CA starts to gain importance.

The GTZ, in association with the MAG, have also been introducing gmcc on small farms in other regions in Paraguay since 1990. For example, support has been provided for trials on gmcc and crop rotations in Chore (Campo Experimental de Chore – DIA/MAG), San Pedro Department. Considerable efforts have been directed at introducing gmcc to smallholders although, once again the number of farmers benefiting is not known.

7 UNDP 2003.
8 K. Moriya pers. comm.
9 F. Cespedes, pers. comm.
In 1997, the MAG-GTZ project initiated a programme of recuperating soil fertility by introducing CA in Paraguay. This programme involved 11 small farms directly. Through these efforts, the GTZ had supplied seeds, fertiliser and CA equipment. The results of this initiative were well documented by Florentin et al. in 2001. After visiting these smallholders during another study, it can be confirmed that they have extended the CA area and managed to recover their soils, resulting in an increased production.

Despite the good examples found, it is clear from many interviews and field observations, that the spread of CA amongst smallholders in Paraguay is still slow. The reasons for this are diverse. Firstly, it is due to the fact that CA is still unknown to most of the smallholders. Therefore, CA has only been adopted in areas where there has been extensive and high quality technical assistance. Another important factor to take note of is that CA has only been practised where the gmcc seeds and CA equipment have been supplied free of charge to smallholders through these projects (e.g. by GTZ, JICA, KfW, IDB) and/or where CA had been included in an international cooperation project (EU, WB, IICA). These efforts have been worthwhile and interesting in proving that, technically, CA can be successfully implemented on small farms. However, a series of sustainable development initiatives and supportive policies will need to be put in place before a significant number of smallholders will be able to benefit from the technique of CA.

1.1.3 Soil Erosion and the Economic Impact of Soil Conservation

The declining farm productivity resulting from ever-increasing soil erosion and soil degradation under conventional cultivation cropping systems has reached catastrophic proportions. Farmers, in the face of declining incomes and unsustainable farming systems, inevitably have to abandon their farms. In response to this, sustainable CA systems have been developing rapidly in South America, as indeed in other parts of the world13. Farmers have quickly reaped the advantages of CA cropping, which has proven to be not only profitable to them, but also a cost-effective method of soil conservation. However, the areas where CA has rapidly expanded have been almost exclusively on medium and large mechanized farms. CA has yet to reach small farms on a wider extension, not only in Paraguay, but in other parts of the world too13.

The area under CA in Paraguay on mechanized farms has been increasing rapidly since it was first introduced in 1980s. In 2003, the total CA area cultivated mechanically was around 1,500,000 hectares (80% of the total cultivated area). However, the cost of soil erosion is still not widely known, nor are the substantial benefits of CA appreciated. In 1997, Paraguay lost almost 10.6 million tones of soil through conventional cultivation on medium to large-sized mechanized farms12, while the areas under CA only lost around 254,000 t of soil as a result of erosion. The cost of the nutrients lost under the conventionally cultivated area of almost 460,000 ha in 1997 has been estimated at US$424 million19 or about US$920/ha. At the same time, medium and large farmers who have adopted CA practices have almost completely eliminated soil nutrient losses, thus providing a net saving in lost nutrients of US$433 million.

Besides this saving in lost nutrients, which farmers do not perceive directly, incomes from higher crop yields are being obtained, while concomitantly reduced fertilizer, herbicide and fuel inputs have significantly reduced crop production costs16. The total value of these reduced costs on the 480,000 hectares of land under CA was already estimated at US$84 million in 1997, or US$175/ha17. Therefore, the costs of soil erosion in 1997 and the savings from having implemented CA in the same year totalled an impressive US$941 million.

These estimates highlight the high costs of soil erosion still incurring and the extent of the economic benefits CA has already provided in Paraguay. If the adoption rate of CA on small farms were to be increased, the additional economic gains that Paraguay could receive are enormous. This approach will also bring about important environmental benefits through reduced water and air pollution. Other social benefits include significantly reduced rural and urban poverty through increased agricultural production and farm incomes, as well as reducing the exodus of small farm families to the cities.

1.1.4 Economics of Conservation Agriculture - the Previous Studies

The economics of CA systems on mechanized farms compared to conventional cultivation systems were first evaluated in detail in Brazil by Sorrenson and Montoya

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12 Derpsch, 1998b.
At that time, over six years of research and development into CA by GTZ and Instituto Agro- nômico do Paraná (IAPAR) had been completed and a small number of farmers were beginning to introduce CA on their properties. The results of this study indicated that there were substantial benefits perceived by smallholders and society at large when farmers replaced conventional cultivation systems with CA cultivation systems. The rest is history. CA has spread rapidly throughout Brazil, Argentina and Paraguay.

MAG-GTZ initiated work on CA systems on mechanized farms in Paraguay during 1993. The economics of CA compared to conventional cultivation systems on medium and large mechanized farms in Paraguay were studied in detail by Sorrenson et al (1997a). This study showed that the adoption of CA was highly profitable, provided farmers changed their cropping systems by introducing crop rotations and successfully mastered the technique of CA. The most important benefits arising from the introduction of CA were:

- Increased cropping intensities possible under CA compared to conventional cultivation (normally 3.5 crops per year, e.g. soybean, maize, sunflower and wheat, as opposed to only 2, e.g. soybean and wheat);
- Increased yields (from 5% to 20% depending on the crop and soil type/climate); and
- Reduced costs per crop due to savings in fertilizer (up to 50%), herbicide (up to 30%), reduced tractor hours, and labour requirements.

In general, the economics of CA on small farms has not been widely documented. Nevertheless, a study on the short term benefits by Sorrenson et al. (1998) exists for Paraguay. This study clearly shows that the financial performance of conventional cultivation systems was poor and that, by contrast, CA would offer an almost instant and considerable improvement. Not only did crop incomes rise, but also crop production costs were significantly reduced. Conventional systems were calculated as being marginally economic only when all factors of production, including family labour, are considered at market rates; farming systems where CA had been introduced, on the other hand, have shown a dramatic improvement, not only in terms of income and yields but also in terms of the reduced problems with soil erosion and water pollution.

Nevertheless, as these advantages were based on short term experiences (up to 6 years) with CA, it seemed necessary to have another study documenting the medium term effects (e.g. production, socioeconomics) of CA on small farms, which is the purpose of this study. The concept was to use the first report (1998) as a base for an updated study on the development of the same farms and use this to find out which are the medium term effects of CA and if CA could be an entrance point for a solution to the problems faced by rural populations.

1.2 OBJECTIVE AND METHODOLOGY

1.2.1 Objective

Two objectives were defined for the research documented in this study. The first objective (1st Objective) was to analyze the economics of CA compared to conventional cultivation on small farms in two very different areas of East-Paraguay during the year 2003. The second objective (2nd Objective) was to compare the results obtained with the results of the first study carried out in 1998, in order to attain a case study for the medium term effects of CA at a smallholder farmer level.

1.2.2 Methodology

The methodologies employed were similar to those used in the 1998 William Sorrenson et al. study; consequently, the results are broadly comparable. Therefore, an in-depth case study analysis of the very same farmers surveyed 5 years ago was used. In addition, a comparative static analysis was used in relation to the second objective. The approach used was to visit the farm together with the local extension agents in the two study areas; San Pedro and Edelira. In the case of San Pedro, Fabiano Cespedes, the same as in 1998, was engaged. Here the Agro-economists Ezequiel Gill and Cesar Duarte accompanied the interviews; the latter being co-author of the first study in 1998. In Edelira the local extension agent, Magín Meza accompanied the interviews carried out during this study. His presence provided a valuable contribution, since he introduced CA at a small farmer level in Edelira. Both extension agents were also chosen to assist as translators for the local language, Guaraní.

Using the data provided by the smallholders interviewed, crop budgets were prepared for all the main activities carried out on the farms, which were con-
Considered relevant for a comparison of the two different cultivation systems (1st Objective). During these activities, all production was valued at farm gate prices and all direct costs were calculated. These included both, the fixed and variable costs directly attributed to each activity, valued at their market opportunity costs. For example, all labour used on the farm was valued at the market labour rate, irrespective of whether family labour or contracted labour was used. In the case of land preparation activities, these were valued at the market rate for animal traction, irrespective of whether the farmer had his own working oxen or had to hire them. In the case of farm production consumed on the farm, where possible, this was also valued at the current farm gate prices. Full details of the costs by crop are given in the Appendices. For each of the operations involved in the growing of the crops, the tables itemize the physical and technical inputs, and their costs. In addition, full crop budget information is given on the crop yields, product prices, total labour used, and daily returns to labour. All of these details can be gleaned from these tables.

The analysis used is a partial one; this means that all of the fixed costs are valued in the budget. Those that remain unaltered with or without CA have been ignored; for example, the value of the land and the fixed costs for the farm buildings and machinery, since these make no difference under the two cultivation systems. However, all farm costs, both fixed and variable, which differ between the two systems, are taken into account.

For comparison between the years 1998 and 2003 (2nd Objective) the methodology used is based on a comparative static analysis. In a first scenario, the 2003 prices for all products and labour requirements were obtained for the two regions, for 1998 the results of the first study were used. However, when these were not available for certain products in one of the regions, MAG would provide them on a country average base. The study was carried out during 2 ½ months of field work in East-Paraguay related to two other CA studies with smallholders. As a result of this, a verification of prices and labour days was possible, because they could be compared with the results obtained for the other studies and the information provided by the MAG.

As opposed to the first study, the values for the revenues in the local currency Guaraní (G) are used for the financial analysis. In May 1998 one US dollar was the equivalent of G 2,800. In October 2003 the exchange rate changed to G 6,200. This reflects an increase of more than 125%. At the same time the real prices and costs did not increase that much. For example, the daily wage rate in the case study region San Pedro went up only by 50% from G 10,000 to G 15,000. Therefore, the daily wage in 1998 had a value of US$3.57 (G 10,000), while in 2003 the value was around US$2.42 (G15,000). Consequently, the use of the US dollar would have provided a false comparison of the financial results and, therefore, it was necessary to change to G.

Due to the increased exchange rate, input costs and product prices, a second financial scenario was calculated, using the 1998 exchange rate, input costs and product prices for the 2003 results of the farming systems. The purpose of this is to be able to compare whether the farming performance is market driven or if it is due to the farming conditions, such as yields, labour reduction, etc. resulting from CA.
2. FINANCIAL ANALYSIS OF SMALLHOLDER FARMING SYSTEMS IN EDELIRA

2.1 BACKGROUND

2.1.1 The Study Area

The Edelira district is located in the Itapúa Department of south-eastern Paraguay, about 90 km north-east of Encarnación, the third largest city in Paraguay. The soils, which are amongst the most fertile in the country, are predominantly clay (*latossolos rojos*). This district covers a total area of 74,900 ha. There are a total of almost 2,900 small farms of less than 20 ha. Within the group of small farms, the percentages of farms of less than 5 ha, between 5 and 10 ha, and between 10 and 20 ha are approximately the same at 37%, 32% and 31%, respectively\textsuperscript{19}.

The first colonies of small farms were established in the district of Edelira during the mid 1970s. Farms were mostly 18 or 20 ha each. Families migrated from several parts of the country, although most came from colonies further south in Itapúa. People ventured in search of more fertile virgin soils, abandoning lands they had previously occupied as crop yields had rapidly declined due to severe soil erosion and degradation. Smallholdings average 11 ha in size within the Edelira District and the average family size is of about seven members\textsuperscript{20}.

Soybean is the main crop grown in the district. Although soybean is grown mostly on the medium and large mechanised CA farms, it is nevertheless an important crop for many smallholder farmers who have to hire tractors and machinery from medium or large farmers for cultivation, sowing and harvesting. Cotton, yerba mate, tung, cassava and maize are also important sources of income for smallholders.

Production systems are highly diversified. In addition to the cash crops mentioned above, maize, cowpea, peanuts and cassava are the most important food crops. Any production surplus to family food requirements is sold providing additional income. A variety of other food crops such as potatoes, rice and other vegetables, are also grown for home consumption, as well as fruits and domestic animals such as cattle, pigs, ducks and chicken, which also represent supplementary farm income. In the Edelira region, gmcc have become an integral part of the farming systems and are commonly used on around 700 smallholder farms, which probably make up a quarter of the total number of these farms\textsuperscript{21}.

Crop yields on small farms in Edelira are generally high by Paraguayan standards. Yields average about 1,800 kg/ha for soybean, 1,700 kg/ha for cotton, 15 t/ha for cassava and 2,000 kg/ha for maize, however, these yields have been declining. This is due to the loss of soil nutrients through soil erosion under conventional cultivation. Soil conservation is either inadequate, or more commonly, not practised at all. Crop residues are mostly burned, monoculture cropping practices are the most prevalent and fertilisers are not used by smallholder farmers, who remain unconvinced about their importance and/or lack the economic conditions to purchase them.

Edelira has been the pioneering region in Paraguay for the development of CA. In 1989 gmcc were first introduced by DEAg on demonstration plots. Several crop species were experimented, for example vetches, black oats, white oats, blue lupine, white lupine, Italian ryegrass and velvetbean. The system of CA was first introduced on smallholder farms in Edelira in 1992. Since 1995, Edelira has developed into the CA centre at the smallholder level, being home to the *Asociación de Siembra Directa a Tracción Animal* (ASDTA). A very small number of leading smallholder farmers (about 60) have accumulated up to eleven years of experience with CA and up to 13 years experience growing gmcc.

While the MAG-GTZ project «Conservación de Suelos» has been most effective in promoting this development during the mid-1990s and early 2000, the main force behind the motivation of this initiative has been the excellent technical support provided by the extension agents from the DEAg\textsuperscript{22}.

\textsuperscript{19} MAG, *Dirección de Censos y Estadísticas Agropecuarias*.
\textsuperscript{20} Statistical data for Edelira obtained from E. Lopez de Meza, pers. comm.
\textsuperscript{21} M. Meza, pers. comm.
\textsuperscript{22} Magín Meza, extension agent of DEAg and Elba Lopez de Meza, also extension agent of DEAg, have developed an excellent and effective partnership with the smallholders. Their work is based on trust with the farmers who have been directly involved in all activities since the beginning. This created an ownership for the results achieved by changing the cultivation systems.
2.1.2 The Farming Systems Analysed

The same four case study farms from 1998 were analysed in detail as part of the study, which includes one CC and three CA systems. The conventional farm of Bruno Rodríguez was typical of smallholder farms in the Edelira district where CC techniques are widely used and soybean is the main crop. By contrast to the 1998 study, Bruno Rodríguez has started with CA on about 50% of his farm area, which makes up his total soybean area; this farm type is described below in section 2.2. The other three systems studied are representative of different types of CA farms found within the district of Edelira; these farm types are described below in section 2.3. The CA farms analysed were those of Teófilo Mendoza, Florencio Ozuna and Victor Ramírez.

2.2 CONVENTIONAL CULTIVATION SYSTEMS IN 2003

2.2.1 Introduction

Many smallholder farmers in the Edelira District practice conventional tillage with animal traction. Steel mouldboard ploughs, wooden ploughs ("tatu" type), and disc ploughs are used to till the soil. In areas recently cleared of forest cover, the land is ploughed two or three times prior to planting, but after two or three years the number of ploughings is reduced to only one or two. Often, ploughing is followed by one disc harrowing prior to sowing. Before tilling the soil, the burning of crop residues is often, but not always, practised as part of the cleaning operation. Horses or oxen are used for weeding during crop cycles, usually two to four times, depending on the crop grown, and for the most part combined at the same time with hand-weeding. All tree stumps are eventually removed following a number of years of cropping soybeans with oxen. It then becomes possible for farmers to hire tractors to plough the soil and sow the crops since this offers a cheaper option for them than hiring oxen.

Additionally, mechanical harvesters are hired on these "clean" areas, resulting in considerable savings over manual harvesting and threshing operations. Smallholder farmers usually plant soybeans in the same plot every year because this facilitates the use of machinery. Similarly, land used for growing cotton may also be tilled by tractor in the same plot every year.

2.2.2 Case Study I: Bruno Rodríguez Peives General

The conventional farming system of Bruno Rodríguez studied in 1998 was considered typical of conventionally cultivating smallholder farms in Edelira. By contrast to 1998, he is now a typical example of a smallholder in transition to CA, because he is currently in the process of converting his cultivation system from a 100% CC to a CA system; almost 50% of his farm area is currently under CA.

The 20.5 ha farm of Bruno Rodríguez is located one kilometre from the main asphalt road, and situated in a valley where the sloping land is cultivated. He stopped burning on his farm in the year 2000, rotating his crops as much as possible, with the exception of the area under soybean. Due to capital increase and labour reduction in the last years, it was possible for Rodríguez to expand his cultivated area by using a former fallow area. About two hectares of forest remain on the steepest part of the farm. Altogether, the Rodríguez’s family cultivate 13.5 ha of their property, which represents an increase by three hectares since 1998.

PHOTO 1. The house of Bruno Rodríguez

Dirk Lange

Bruno Rodríguez is married to Valeriana Vera; they have eight children, of which six live on the farm. Their eldest son, Freddy (23), studies Agriculture in Hohenau, Itapúa and their eldest daughter, Nancy Beatrice (25), lives in Uruguay. The other children have important daily roles on the farm. While their two sons, Alcides (26) and Edgar René (19), work the entire day on the farm, the others, Ángel Dario (16), Maria Nelly (14), Maria Rosanna (10) and Maria Fatima (7) work only...
half day on the property, since they attend school during the other half. Thanks to the help of the children, Bruno Rodríguez only needs to contract labour for harvest and during an emergency (e.g. heavy weed or pest infestation). The family is dependent on income and food produced on the farm for their subsistence.

This farmer receives credit from a local private company due to not being a member of the Colonias Unidas Cooperative, although it is the most important in the region. Unlike in 1998, an agreement exists with this cooperative for purchasing inputs (e.g. seed) and selling products. This agreement was established through the Ka’aguy Poty Cooperative, of which Rodríguez is a member. He is also a member of ASDTA through which he has access to CA implements, technical assistance and the possibility of exchanging information with other CA farmers.

Bruno Rodríguez started farming his property in 1976; at this time it was completely covered by native forest. He grew soybeans for the first time the following year (0.75 ha), which has remained as his main income crop to this very day. The soybean area planted under the CC system was gradually increased about half a hectare per year, peaking at 7 ha in 1990, and then falling back to 5 ha on average throughout the late 1990s. With the introduction of CA, in 1999, he began to increase the soybean area, first to 7 ha again and is currently working 9 ha. He stopped rotating the area under soybean, but seeds directly using gmcc (black oats and Italian ryegrass) and a permanent soil cover. The first hectare of tung, a high value tree from which oil is extracted from the blossoms, was planted in 1993, and then expanded to 2 ha, and as predicted in the 1998 study, it developed into the second most important source of income. Cassava, peanuts, maize, cowpea and other vegetables are grown mainly for family consumption. Pigs, piglets, chickens, ducks, eggs, milk, as well as surplus vegetable, fruits (few), maize, cowpea, garden pea, garden bean and cassava supplement income from soybeans and tung. Cotton ceased to be planted in 1998/99 due to a significant decline in yield.

In 1998, the Rodríguez family owned a normal set of farm machinery, a motorised thresher and a chainsaw. They later complemented this set with other CA machinery: two jab-planters, one subsoiler, two knapsack sprayers, one sprayer human traction (four nozzles) and a cart. Rodríguez has access to animal-traction CA machinery through ASDTA. He has his own pair of work oxen, as he did in 1998, but also now has three horses, eight cows, three dairy cows, 12 pigs, 25 ducks, 50 chickens and five geese, which is more than in 1998.

**Soil Conservation**

Bruno Rodríguez did not carry out any soil conservation measures before the introduction of CA on his soybean area. Under CC soil erosion had become a major problem, especially on the steepest part of the farm. This, combined with the absence of contour banks, the burning of crop residues, and an almost completely nonexistent use of fertiliser, greatly contributed to a strong decline in crop yield.

With the introduction of CA in 1999, Rodríguez stopped burning on his farm. He introduced gmcc and started to seed directly on his soybean area. He uses two different gmcc (black oats and Italian ryegrass) and a permanent soil cover. The first hectare of tung, a high value tree from which oil is extracted from the blossoms, was planted in 1993, and then expanded to 2 ha, and as predicted in the 1998 study, it developed into the second most important source of income. Cassava, peanuts, maize, cowpea and other vegetables are grown mainly for family consumption. Pigs, piglets, chickens, ducks, eggs, milk, as well as surplus vegetable, fruits (few), maize, cowpea, garden pea, garden bean and cassava supplement income from soybeans and tung. Cotton ceased to be planted in 1998/99 due to a significant decline in yield.

In 1998, the Rodríguez family owned a normal set of farm machinery, a motorised thresher and a chainsaw. They later complemented this set with other CA machinery: two jab-planters, one subsoiler, two knapsack sprayers, one sprayer human traction (four nozzles) and a cart. Rodríguez has access to animal-traction CA machinery through ASDTA. He has his own pair of work oxen, as he did in 1998, but also now has three horses, eight cows, three dairy cows, 12 pigs, 25 ducks, 50 chickens and five geese, which is more than in 1998.

**Trends in Crop Yields**

Soybean yields had fallen drastically until the introduction of CA. Initially soybean yielded 3,000-4,000 kg/ha on new land cleared of forest. In 1998, production averaged at 2,000 kg/ha, fluctuating widely each year from 1,000 kg/ha to 2,900 kg/ha. Fertiliser had never been used until that year when 50 kg/ha of NPK were applied. With the introduction of CA, his yield was maintained at 2,000 kg/ha, with the use of gmcc (black oats and Italian ryegrass) and 30 kg of NPK.
Cotton yields have also taken a tumble; initially, yields averaged 3,500-4,000 kg/ha, however, these have dropped to an average of 1,200 kg/ha, and variations from 500 kg/ha to 2,000 kg/ha have made cotton a very risky undertaking for Rodríguez, who never applied fertilizer on cotton. Due to the low yields and the low cotton price, he stopped growing it after the 1998/99 season. Maize yields have also fallen; initially, yields averaged 3,500 kg/ha, but these also dropped to 2,500 kg/ha with wide fluctuations between years.

In contrast to the other crops (see Figure 1), peanuts and cassava experienced an increase in yield. Cassava had always yielded about 15 t/ha, but this had increased to 25 t/ha, while peanuts yields rose from 1,200 kg/ha to 1,600 kg/ha. Tung has also shown an increase in yields, but this is due to the matured trees, which produce around 4,200 kg/ha production in 2003.

Overall, crops maintained their yields compared to those of 1998, in spite of having erosion problems on the conventionally cultivated area. The marked rise in cassava yields is an exception; however, this is related to the extension of its cropping cycle. The yields of soybean were stagnant due to not experiencing the full advantages of CA at the time; he seeds directly, has permanent soil cover, uses gmo and has stopped burning crop residues, however, he does not rotate the soybean with other crops.

Results of the Financial Analysis

The financial analysis compares the results of the farm from 1998 under CC to the current situation with the introduction of CA on 50% of the property. The input costs and product prices of May 1998 and October 2003 are used for the first scenario. Whereas, the input costs and product prices of 1998 are used for the second scenario.

In the financial analysis, all activities have been valued separately and a crop budget has been drawn up using the same approach as in the 1998 study. In the crop budget, all activities worthy of being included in a comparison of cultivation systems were included. A simplification has been made in the case of the diverse food crops. The area (about 0.5 ha) dedicated to the growing of food crops (fruits, vegetables) and his garden, which are grown solely for the purpose of family consumption, have been given an economic value on the basis of cassava, peanuts and maize. A further simplification made has been that the income derived from the production of small animals and cassava flour (almidón), has not been included in the crop budget. To have done so would have complicated the analysis.

Since the income derived from these activities would be about the same under both systems, conventional cultivation and CA, their exclusion does not significantly affect the comparative financial performance of the farm analysed. Nevertheless, they are considered in the general opinion of the development of Bruno Rodríguez’s farming performance.

Comparison of 50% of cultivated area under Conservation Agriculture in 2003 to the Conventional Cultivation System in 1998 – The First Scenario

The results of the first scenario financial analysis for 1998 (CC) and 2003 (50% of cultivated area under CA) are summarised in Tables 4 and 5.

The first scenario financial analysis of Rodríguez’s performance in 2003, compared to 1998, shows a remarkable increase, both in net farm income and return to labour. In 1998, the total net farm income was calculated to average G1.5 million (US$543) per annum.

21 Appendix 1.1.2 Table Production.
22 Full details of the first scenario financial analysis of Bruno Rodríguez’s farm can be found in Appendix A 1.1.2.
Table 4. Farm Budget 2003 - 1st Scenario
Bruno Rodríguez
50% of Cultivated Area under Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden pea</td>
<td>0.25</td>
<td>7</td>
<td>1,891 (305)</td>
<td>471 (76)</td>
</tr>
<tr>
<td>Cassava/Maize</td>
<td>0.50</td>
<td>18</td>
<td>1,519 (245)</td>
<td>760 (122)</td>
</tr>
<tr>
<td>Cowpea</td>
<td>0.25</td>
<td>13</td>
<td>459 (74)</td>
<td>112 (18)</td>
</tr>
<tr>
<td>Black oat/Soybean</td>
<td>7.00</td>
<td>67</td>
<td>1,643 (265)</td>
<td>11,501 (1,853)</td>
</tr>
<tr>
<td>Italian ryegrass/ Soybean</td>
<td>2.00</td>
<td>19</td>
<td>1,643 (265)</td>
<td>3,286 (529)</td>
</tr>
<tr>
<td>Maize</td>
<td>1.00</td>
<td>11</td>
<td>614 (99)</td>
<td>614 (99)</td>
</tr>
<tr>
<td>Peanuts</td>
<td>0.25</td>
<td>11.5</td>
<td>1,079 (174)</td>
<td>273 (44)</td>
</tr>
<tr>
<td>Cassava</td>
<td>0.50</td>
<td>16.25</td>
<td>694 (112)</td>
<td>347 (56)</td>
</tr>
<tr>
<td>Different food crops, House,</td>
<td>0.50</td>
<td>15</td>
<td>2,108 (340)</td>
<td>1,054 (170)</td>
</tr>
<tr>
<td>Barn, Garden</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tung</td>
<td>2.00</td>
<td>4</td>
<td>2,530 (408)</td>
<td>5,059 (816)</td>
</tr>
<tr>
<td>Pasture/Sugarcane</td>
<td>4.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>18</td>
<td>143 (23)</td>
<td>911 (147)</td>
</tr>
<tr>
<td>Forest</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20.5</strong></td>
<td><strong>199</strong></td>
<td><strong>24,372</strong> (3,931)</td>
<td></td>
</tr>
</tbody>
</table>

**Return to Labour G/day = 122,450 (US$*/day = 19.75)**

* US$1 = G6,200
1 Garden pea: used in winter in the area of maize and cassava
2 Value based on cassava, peanuts and maize assuming 1/3 each
3 Return and costs included in net income from cattle
4 Calculated with gross margin per ha of cattle and area of pasture/sugarcane

and has increased to date to almost G24.3 million (US$3,931) (see Figure 2). The total labour input decreased from 363 to 199 person days in 2003, which means that the return to labour is around G122,450 (US$19.75) compared to G4,172 (US$1.49) in 1998 (see Figure 3). This makes his work much more valuable compared to five years ago, since the present labour rate per day is at G15,000 (US$2.42) in the region26. Therefore, it is evident that all family members remain on the farm working.

26 The labour rate in 1998 was the same at G15,000 (US$5.36).
The net farm income increased due to the following reasons:

- Larger area under soybean and their more profitable production per hectare;
- More profitability per hectare under tung, and
- Cost reduction due to fewer labour-days.

Soybean is the most important crop in terms of net farm income. Almost 60% of the net farm income is derived from soybean, which is grown on approximately 50% of the cultivated area. This means that the importance of soybean almost doubled in the last five years. When looking at net returns per hectare revenue, soybean generated a net income per hectare of G109,200 (US$39) in 1998, which Rodríguez increased with the introduction of CA to G1.6 million (US$265). Two reasons can be given for this: firstly, the higher commodity prices of soybean, which increased from G420 to G2,000, and secondly, the change in the two cultivation systems, which included a cost reduction. The most significant costs of growing soybean used to be in soil preparation, weeding and harvesting. With the introduction of CA, this has changed considerably. Ploughing and harrowing do not cause costs (1998: 16% of the total production costs). Rodríguez reduced the number of weedicings to only three, which make up to 16% of total production costs (1998: 34%) or total costs of G90,000/ha (US$32/ha) accounting for 28% of total costs (18% in 1998). Another change in soybean cultivation is a result of the number of labour days. Rodríguez reduced his labour/ha in soybean to 10 days, which represents a saving of 16 days or a 62% decrease.

**Table 5. Farm Budget 1998**

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>5.00</td>
<td>130</td>
<td>109 (39)</td>
<td>546 (196)</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.00</td>
<td>29</td>
<td>36 (13)</td>
<td>36 (13)</td>
</tr>
<tr>
<td>Maize</td>
<td>2.00</td>
<td>40</td>
<td>-11 (-4)</td>
<td>-22 (-7)</td>
</tr>
<tr>
<td>Peanuts</td>
<td>0.50</td>
<td>15</td>
<td>238 (85)</td>
<td>120 (43)</td>
</tr>
<tr>
<td>Cassava</td>
<td>1.00</td>
<td>46</td>
<td>227 (81)</td>
<td>227 (81)</td>
</tr>
<tr>
<td>Different food crops, House, Barn, Garden¹</td>
<td>0.50</td>
<td>16</td>
<td>232 (83)</td>
<td>116 (42)</td>
</tr>
<tr>
<td>Tung</td>
<td>1.00</td>
<td>13</td>
<td>274 (98)</td>
<td>274 (98)</td>
</tr>
<tr>
<td>Pasture/Sugarcane ²</td>
<td>4.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>59</td>
<td>48 (17)</td>
<td>218 (78)</td>
</tr>
<tr>
<td>Fallow</td>
<td></td>
<td>4.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td></td>
<td>3.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20.00</strong></td>
<td><strong>363</strong></td>
<td><strong>1,520</strong></td>
<td><strong>(543)</strong></td>
</tr>
</tbody>
</table>

**Return to Labour G/day = 4,172 (US$/day = 1.49)**

³ US$1 = G2.800

¹ Value based on cassava, peanuts and maize assuming 1/3 each

² Return and costs included in net income from cattle

³ Calculated with gross margin per ha of cattle and area of pasture/sugarcane

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24
FIGURE 2. Comparison of Net Farm Income - Bruno Rodríguez.

FIGURE 3. Comparison of Return to Labour - Bruno Rodríguez.

FIGURE 4. Comparison of Labour (persons-days) - Bruno Rodríguez.
As a result, he works his 9 ha of soybean in fewer days (86) than the 5 ha he cultivated in 1998 (130 days) (see Tables 4 and 5).

Change of Cultivation System or Market Conditions?
The Second Scenario

In order to determine if the farming performance of Bruno Rodríguez, within the last five years, has been driven by the adaptation of 50% CA or by marked conditions, a crop budget with the input costs, the product prices and exchange rate (G to US$) of 1998 was created for the present situation. The result of the second scenario is summarized in Table 7.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil Preparation</th>
<th>Weeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>150,000</td>
<td>0</td>
</tr>
</tbody>
</table>

The second most important crop in terms of the overall net farm income is tung, which accounts for 24%. While in 1998 the net income per hectare was around G274,400 (US$ 98), today it accounts for G2.6 million (US$ 408) and is the most profitable source of income out of all his cultivation activities. The increasing importance can be as a result of one of three aspects: firstly, Rodríguez’s tung yield increased from 1,500 kg/ha to 4,200 kg/ha, due to the tung trees being more mature. Secondly, the commodity price for a kg of tung increased from G380 to G650. Thirdly, he reduced the number of labour days per hectare to only 2 days (1998 13 days), which is achieved through less weeding days, resulting from a denser canopy from the tung trees (providing shade to the ground consequently suppressing weeds), and in addition, by the change in harvesting practise; in 2003, he employed contracted labour, paying overall per bag. In 1998, harvest, drying and internal farm transportation were separate working activities and accounted for G180,000/ha or 11.5 labour days.

However, Rodríguez managed to increase the efficiency of his other crops too (e.g. cassava, maize, peanuts). This mainly evolves from the reduction of labour days (see Figure 4). It can be seen that he works less by no longer burning and by less weeding28. In addition, the labour-day reduction is also visible in the calculation for cattle, as a result of having less grazing area for his animals29.

As a result, he works his 9 ha of soybean in fewer days (86) than the 5 ha he cultivated in 1998 (130 days) (see Tables 4 and 5).

Change of Cultivation System or Market Conditions?
The Second Scenario

In order to determine if the farming performance of Bruno Rodríguez, within the last five years, has been driven by the adaptation of 50% CA or by marked conditions, a crop budget with the input costs, the product prices and exchange rate (G to US$) of 1998 was created for the present situation. The result of the second scenario is summarized in Table 7.

The second scenario of Rodríguez’s financial performance in 2003 compared to 1998 also shows a significant increase due to both net farm income and return to labour increasing considerably. Total net farm income was calculated to average around G1.5 million (US$543) per annum in 1998. This has changed to almost G9 million (US$3,172) to date (see Figure 2), which is much less using 2003 prices, but almost 6-times as high as in 1998. Since the total labour input decreased from 363 to 199 person days in 2003, his return to labour is at G44,632 (US$15.94) compared to G4,172 (US$1.49) in 1998 (see Figure 3). This makes his work much more valuable today when compared to five years ago, since the labour rate per day is at G15,000 (US$5.36) in the region. It is therefore evident that all family members remain working on the farm.

The net farm income increased due to the following reasons:

28 Appendix 1.1.2 Tables.
29 The labour-days per ha (see Appendix 1.1.2, Table Cattle) are multiplied by the area used for each activity. Since Rodríguez does not use the formerly fallow 4.5 hectares for his cattle, the number of labour days is reduced.
30 Full details of the second scenario financial analysis of Bruno Rodríguez’s farm can be found in Appendix A 1.1.3.
**TABLE 7. Farm Budget 2003 - 2nd Scenario**

Bruno Rodríguez

50% of Cultivated Area under Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden pea</td>
<td>0.25</td>
<td>7</td>
<td>1,882 (672)</td>
<td>470 (168)</td>
</tr>
<tr>
<td>Cassava/Maize</td>
<td>0.50</td>
<td>18</td>
<td>1,310 (468)</td>
<td>655 (234)</td>
</tr>
<tr>
<td>Cowpea</td>
<td>0.25</td>
<td>13</td>
<td>-140 (-50)</td>
<td>-35 (-12)</td>
</tr>
<tr>
<td>Black oat/Soybean</td>
<td>7.00</td>
<td>67</td>
<td>314 (112)</td>
<td>2,195 (783)</td>
</tr>
<tr>
<td>Italian ryegrass/Soybean</td>
<td>2.00</td>
<td>19</td>
<td>314 (112)</td>
<td>627 (224)</td>
</tr>
<tr>
<td>Maize</td>
<td>1.00</td>
<td>11</td>
<td>134 (48)</td>
<td>134 (48)</td>
</tr>
<tr>
<td>Peanuts</td>
<td>0.25</td>
<td>11.5</td>
<td>308 (110)</td>
<td>77 (27)</td>
</tr>
<tr>
<td>Cassava</td>
<td>0.50</td>
<td>16.25</td>
<td>916 (327)</td>
<td>458 (164)</td>
</tr>
<tr>
<td>Different food crops, House, Barn,</td>
<td>0.50</td>
<td>15</td>
<td>1,081 (386)</td>
<td>540 (190)</td>
</tr>
<tr>
<td>Garden²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tung</td>
<td>2.00</td>
<td>4</td>
<td>1,341 (479)</td>
<td>2,682 (958)</td>
</tr>
<tr>
<td>Pasture/Sugarcane</td>
<td></td>
<td>4.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>18</td>
<td>168 (60)</td>
<td>1,086 (388)</td>
</tr>
<tr>
<td>Forest</td>
<td></td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20.50</strong></td>
<td><strong>199</strong></td>
<td><strong>8,882 (3,172)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 44,632 (US$*/day = 15.94)

*US$1 = G2.800

1Garden pea: Used during winter in the plot of maize and cassava

2Value based on cassava, peanuts and maize assuming 1/3 each

3Return and costs included in net income from cattle

4Calculated with gross margin per ha of cattle and area of pasture/sugarcane

- Expansion of the soybean area combined with a higher profitability per hectare;
- Increased tung yields; and
- Cost reduction due to fewer labour-days.

The most important cash crop under this second scenario is soybean, and the importance of it is at 34% of the total net income, which is the same compared to 1998. The per ha revenue increased to G330,400 (US$118)/G313,600 (US$112); whereas in 1998 it was at G109,200 (US$39). This is due to the fact that Bruno Rodriguez reduced his cost/ha with the introduction of CA (see Table 8). The costs for soil preparation practically disappeared and costs for weeding are almost down to a third of what they were. When considering that the soybean area is now 4 ha larger, the total income derived from soybean is around G2.9 million and more than 5-times higher than under CC.

The second most import crop in this scenario is tung, which generates 30% of Rodríguez’s overall net farm income. Moreover, it is higher than in the first price scenario (24%) and much higher than in 1998 (17%). As opposed to 1998, tung has higher yields (4,200kg/ha) than in 1998 (1,500kg/ha), due mainly to the more matured trees. In addition, he reduced his labour-days which makes his work more efficient, resulting in a better per ha revenue (G1,3 million or US$ 479) than under the conventional cultivation system (G274,400 or US$ 98).
All other crops have higher per hectare revenues, which are related to the reduced labour-days spent. It can easily be seen that he works less by no longer burning and by less weeding. In addition, the labour-day reduction can also be perceived in cattle-related activities, due to a reduced grazing area for his animals.

### Overall Conclusion of the Financial Analysis

After comparing the two financial scenarios, we can conclude from Bruno Rodríguez’s farming performance that his net farm income is much higher under both price scenarios. It is obvious that his better performance in the first scenario is market driven (by soybean), but considering the second scenario, he experiences the advantages of the adoption of CA on his soybean area by reducing his labour requirement, and also a more efficient work system with his other crops. Additionally, tung developed into an important source of income, and will continue to do so as the tung trees mature. When considering the two scenarios, the overall financial conclusion is that Rodríguez obtained the increase of his farming performance by intensifying his production.

### Overall conclusion of the farming system performance

In conclusion, it is clear Bruno Rodríguez’s farming system is that of a typical “sojero” of the region, but only at smallholder level. His income is dependant on the soybean crop, the use of CA for the soybean area, and the dedication of a large share of his total farm area to this crop. Since soybean has always been his favourite crop, all he had to do was “imitate” the neighbouring largeholders’ CA cultivation technique. The infrastructure and competence of retailers in the region allow him to purchase higher quality seeds at a reasonable price (in the form of credit by a private company) and to sell his production on-farm. As opposed to most “sojeros”, Bruno Rodríguez has tung as another important source of income, which provides him with a slight risk reduction.

The greater performance of the farming system, as well as the Rodríguez family’s improved livelihood, is reflected in his improved living conditions. He and his family have not only enlarged their working equipment, but have also purchased more animals. In addition, he was able to buy a house in the village of Edelira, a fridge, a freezer and a television. The improved revenue can be related to the intensification in his farm production, due to a greater sale of animals and an intensified crop production compared to 1998. His enhanced socioeconomic conditions are also reflected by his eldest son being able to study at the University of Hohenau, while all his other children are able to attend school. The latter also expresses the reduced labour requirement since more time is now available.

Due to these reasons, the prediction made in the 1998 study that stated “It is highly probable that Bruno’s family will not survive on their farm for very much longer” was not confirmed since Rodríguez changed his farming system. However, as confirmed...
by the second scenario, his future will depend on soy-
bean prices and the extension of the area under CA. Rodri
guez and his family are aware of this and plan to
continue expanding the CA system on his farm within
the next cropping seasons. Only then, he will start ro-
tating the soybean with other crops, which will make
him experience the full advantages of CA.

Furthermore, Rodríguez wants to dedicate a part
of his farm to reforestation in order to sell wood and
have yet another source of income. With this slight
diversification of production, he seeks to achieve further
risk reduction. Here, a clear influence of the informa-
tion exchange through ASDTA is visible, since many small-
holders of the association are practising this. Bruno
Rodríguez is also interested in amplifying his farm area
by buying land for his sons, but, unfortunately, due to
the high land prices (US$2,500-3,000 per hectare),
this is unlikely to happen.

2.3 CONSERVATION AGRICULTURE
SYSTEMS IN 2003

2.3.1 Introduction

The three farming systems described in this study
are the same ones as in 1998. They represent
smallholder CA farms, which have had long-term
experience with CA (11 years), cultivated either
manually and/or with animals. These farmers belong to
the smallholders’ pioneer group of CA in Paraguay and
are all members of the ASDTA. Through ASDTA the
farmers attend the national assembly of the Paraguayan
Federation of CA for Sustainable Agriculture
(FEPASIDIAS) every year. Furthermore, the farmers
visit and present their work and experience in national
and international agricultural fairs and workshops. In
addition, all farmers receive many visitors from all
around the world on their farms. The extension agent
Magín Meza, who worked initially together with the
extension agent Elba López de Meza, supported them.
In recent years, Magín Meza reduced the technical
assistance to a minimum, since the smallholders require
less assistance in their farming activities.

2.3.2 Case Study II: Teófilo Mendoza

General

The farm of Teófilo Mendoza has been considered
as a representative example of the type of smallholdings,
which are generally less than 10 ha. Crops are sown
manually and farmers usually do not have their own
pair of work oxen. Mendoza’s farming system is detailed
in Appendix A 1.2, Section A 1.2.1.

The property is located about 5 km from the main
asphalt road, and is situated within a valley that slopes
towards a river on its lower boundary. Mendoza started
farming his 9.2 ha farm in 1985; nine years later (1994)
he finally obtained his land title. When he purchased
the farm, the soils were considerably degraded as a
result of 10 years of intensive cultivation by its previous
owner.

Teófilo Mendoza and his wife Augustina Franco
operate the farm. The Mendozaes have five children.
The eldest sons, Cristóbal (17) and Elvio Ramón (16),
both work on the farm while not attending school. The
other three children, Sylvia Rosa (14), Marina Christina
(11), and Rosalino (6) are living on and helping out on
the farm, but are mainly attending school. The
Mendozas contract additional labour only for the
harvest of yerba mate and occasionally for felling trees.

Teófilo Mendoza is an active leader of smallholders
and member of a cooperative. Until two years ago, he
was president of a smallholder’s committee (eight
members), remaining a member to this very day, and
dedicating an average of one day per month for
community work (road and bridge reconstruction,
school and church maintenance). Mendoza accesses
credit through CAH.

The family owns a minimal, but functional set of
farm machinery and equipment, which has enabled
them to expand their productive and profitable activi-
ties in recent years. They also have access to animal-
traction CA machinery through the ASDAT, which are
hardly ever used. Mendoza also has a motorcycle, which
has greatly enhanced the family’s standard of living.
Since the farm is not located on the main road, nor is it
close enough to the Edelira village, the motorcycle has
improved their access to commercial and social
facilities.

During the last few years, the price per hectare rose significantly. Paraguay experienced a soybean-boom in which the area of soybean expanded from 800,000 ha in 1998 to almost 1.5 million ha in 2003. Edelira is located in the Itapúa Department, and forms part of this large-scale CA soybean area in eastern Paraguay. The demand for land is very high following an increase in land prices. M. Meza pers. comm.

33 Details are provided in Appendix A1.2, Section A1.2.1.
Animals play an important role in the farming system. Currently there are four cows, 10 pigs, one horse, 110 chicken and three fish basins (*tilapia*). These animals provide important sources of protein for the family. The sale of pig meat, milk, cheese, eggs, fruits (mandarin, peaches, orange) and cassava flour (*almidón*) is more diversified today than it was in 1998, and makes up an important source of supplementary income.

**Conventional Cultivation System**

In 1985, Teófilo Mendoza started to farm the property of which four hectares of land remained under forest. In the first year, 0.5 ha were cultivated with maize, cassava and cotton. Two hectares were cultivated the following year; 1 ha for soybean and the other for a variety of food crops such as cassava, maize, peanuts, watermelon, rice and potatoes. Technical assistance from DEAg (Magín Meza) was first received in 1989, when the Paso Ita Committee was formed.

The cultivated area was increased each year until 1992. The main crop was soybean, seeded by tractor on 3.5 – 5 ha per year. When there was sufficient cultivatable ground available, 0.5 – 1 ha of cotton was also planted. Most of the remaining forest (3.5 ha) was cleared during 1990-91 and the first area of yerba mate (1 ha) was planted. In 1992, Mendoza planted the high value trees kirí (100 trees) and tung (0.5 ha) for the first time, marking the beginning of a major transition in the farming system. This was also the last year for mechanized planting of soybean.

This period under CC was characterised by considerable soybean and other crop failure. The only measures taken were the construction of contour banks on over 4 ha of the farm in 1993. Mendoza and his wife used hand hoes and required a total of 20 person labour-days, reflecting the concern they had towards trying to conserve their soil, which was rapidly eroding away. An attempt was also made by rotating crops, although as already noted, soybean was always planted in the same area to facilitate soil cultivation and sowing operations by tractor and mechanized harvesting.

**Modifications to the Farming System with the Adoption of Conservation Agriculture**

1992 can be considered the year of change in the cultivation system. This came as a result of no longer ploughing his farm, an increased crop rotation, and the introduction of gmcc (0.2 ha of Italian ryegrass), which, therefore, marks the beginning of a more complete CA system\(^{36}\). In the following year, he increased his yerba mate area to 5 ha, also planting on the recently constructed contour banks. He began to associate the yerba mate with Italian ryegrass and cowpea, and his first harvest of yerba mate yielded 500 kg. From this year on, he continued introducing new gmcc (e.g. velvet-bean, oil radish, black oats), while simultaneously beginning to experiment with other gmcc on smaller spots.

In 1995, he planted more trees (tung, kurupa’y, eucalyptus) introducing an agroforestry system. During this same year, he sold his first 50 stems of kirí and harvested 4,500 kg yerba mate. In the following year he introduced even more winter and summer gmcc (e.g. garden pea, pigeon pea, jack bean, sunnhemp, lab-lab bean) and continued to associate different crops with yerba mate and also with fruit trees.

**Photo 6. Reforestation area of Teófilo Mendoza**

Dirk Lange

Mendoza further diversified his production, by sowing more crops and producing gmcc seeds, which developed into an additional source of income. He expanded his agroforestry sector with *loro negro* and Australian red cedar species, constructed the first fish basin (*tilapia*) and started producing honey, and introduced alfalfa in 1999. The rotation of crops and gmcc became exemplary, which must be related to his willingness to experiment. In 2000, a heavy frost burned his yerba mate trees, leaving him without yield. He only recently recovered from this with the last harvest. Another setback was felt in 2001, during a drought, when a neighbour burned crop residues and weeds on his own farm. A spark reached one of Mendoza’s fields of gmcc, burning an area of 3,000m\(^2\). To make matters worse, his neighbour’s animals entered his farm in search of food and left small patches of his crops destroyed.

\(^{36}\) The changes to the farming system can be traced in Appendix A 1.2.1.
In 2002, prior to planting tobacco *rubio* for the first time, he built a drying shed for the crop and introduced coriander as gmcc. The tobacco *rubio* did not yield as he expected and he consequently suffered a loss, leaving him with debts to the tobacco vendor. As a result, he sold his tobacco shed, and in order to pay these debts, he cleared 0.5 ha of trees (loro negro, eucalyptus, Australian red cedar). Shortly afterwards, he started to build a third fish basin.

**Crop Yields and their Development with Conservation Agriculture**

Yerba mate was first planted in 1990 on 1 ha of ground, and was harvested for first time in 1993 (500 kg). Mendoza then expanded this area, and in 1998, the yerba mate yielded 4,500 kg/ha (Figure 5). As mentioned before, a heavy frost burnt his plants in 2000, which he was only able to recover from during the last harvest (5,100 kg/ha). Yerba mate is always associated with crops, trees and/or gmcc.

Maize has also been grown since 1986, at first yielding around 1,200 kg/ha, but this then decreased to as low as 300 kg/ha. After the adoption of CA, yields rose from 1,500 kg/ha to 4,000 kg/ha in 1998. Since then, this yield has been maintained, but maize is now associated with other crops and seeded at a lesser density (greater distance between plants and slots). Cassava averaged about 20 t/ha under CC (10-month cycle). With the adoption of CA, the yields were maintained at 20 t/ha, but cassava was also associated with other crops, and consequently at a lower density. Today, Teófilo Mendoza produces cassava during a 12-month cycle and the yields have increased up to 42 t/ha. He estimates that the increase per plant has been from 6 kg/plant to 15 kg/plant (Figure 5).

Soybean was initially sown on newly cleared ground, yielding around 3,000 kg/ha. On average soybean would yield 2,000 kg/ha, due to some years when yield would decrease to 800 kg/ha. Although fertilizers were never used, insecticides were applied. After removing all the stumps, Mendoza would sow and harvest by tractor, but would never rotate the soybean with other crops. With the introduction of the CA system, he seeded with jab-planters as he did during the first years. Today, his yield is around 1,200 kg/ha, but seeding density is much wider, since he now practices associations with other crops and gmcc.

Cotton initially yielded about 2,000 kg/ha, but declined until the introduction of CA. In 1995, yields only reached 1,200 kg/ha due to a heavy pest infestation. The following year was the last time he cultivated cotton, mainly to avoid the use of insecticides. Cotton was always rotated with other crops; however, chemical fertilizer was never applied.

**Results of the Financial Analysis**

The financial analysis compares the farming performance under CA2003 to the results obtained in 1998, and to CC before the introduction of CA. For the first scenario, the input costs and product prices of May 1998 for CC and CA1998 are used, and the input costs and product prices of October 2003 are used for CA2003. Whereas, only the input costs and product prices of 1998 are used for the second scenario.

Modifications were necessary to compare the financial performance of the farming systems, under both conventional cultivation and CA. Whereas, in the first study the yield and labour–days of tung and yerba mate were considered the same, they are now calculated like

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**Figure 5. Comparison of Main Crop Yield/ha - Teófilo Mendoza.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava</td>
<td>20,000</td>
<td>17,000</td>
<td>42,000</td>
</tr>
<tr>
<td>Maize</td>
<td>4,000</td>
<td>4,000</td>
<td>4,500</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>4,500</td>
<td>4,500</td>
<td>5,100</td>
</tr>
<tr>
<td>Soybean</td>
<td>1,500</td>
<td>2,000</td>
<td>2,000</td>
</tr>
</tbody>
</table>
the other crops, because yerba mate is now associated with crops and gmcc. Since crops and gmcc are rotated, soil fertility has improved, which can be seen in the increasing yields over the years (see Figure 5). Some simplification had to be made with the different areas since Mendoza associates a variety of gmcc and crops within each plot. It is often not possible to differentiate the area size between a gmcc and a certain crop. In order to give the gmcc an economic value, only the most used gmcc were considered, due to gmcc sometimes being seeded on less than 50m², which would have made the calculation too detailed and complicated. Another simplification has been made in the case of diverse food crops. The relatively small area (about 0.25 ha) of food crops, garden vegetables, and fruits, which are grown solely for family consumption, have been assigned an economic value based on the revenue of cassava, peanuts and maize, 1/3 each. This simplification was necessary, as it would have been too difficult to give separate economic values for the rather smaller areas.

Another simplification made is that the income derived from the production of small animals and the preparation of cassava flour, has not been included. Particularly in the case of cassava flour, an economic value could not be determined since it is produced mainly for home consumption. Since the income derived from these activities would be about the same under CC, CA1998, and CA2003, their exclusion does not significantly affect the comparative financial performance of the farm; nevertheless, they are considered in the general opinion of the development of Teófilo Mendoza’s farming performance.


The financial analysis for the first scenario of CA today, back in 1998, and of the CC system is presented in Tables 9, 10 and 11.

The first scenario financial analysis of the performance in 2003 compared to 1998 shows an increase in net farm income. In CA1998, the result was calculated at G8.9 million (US$3,173) per annum, which has increased to more than G13.1 million (US$2,116), today (see Figure 6). When compared to the CC (G5.5 million), Mendoza increased the net farm income almost 140%. The total labour requirement increased from 143, in CA1998, to 180 labour-days in CA2003, which is also more when compared to the CC (177 labour-days). However, his return to labour in CA2003 is at G72,912 (US$11,76) which is more than in CA1998 (G61,964 or US$ 22.13). Moreover, when compared to the return to labour of the CC (G30,828 or US$11.01), he achieved an overall increase of 130% (see Figure 7). This makes his work much more valuable since the present labour rate per day is G15,000 (US$2.42) in the region. It is therefore evident that all family members remain working on the farm.

In 2003, the most important crops were yerba mate (23%), cassava (27%), maize/cowpea (21%), tung (7%) and tobacco (8%). It is obvious that yerba mate is less important today than in CA1998, in spite of increase yield. The financial performance of each activity can be seen by comparing the net farm incomes for each activity in Tables 9, 10 and 11. The main income changes are mainly due to the following:

- Expansion in the cultivated area;
- Breakdown of the kirí market;
- Less importance of gmcc seeds as source of income;
- Increased yield of cassava combined with slightly better market prices; and
- Elimination of gmcc seed costs.

The cultivated area (crops and gmcc) expanded from 2.75 to 5.4 ha and as a result, so did the cultivation of more income generating crops and gmcc. These have higher net income/ha revenues than yerba mate and at the same time diversify his production and reduce his market risks.

Kirí did not generate any income compared to previous years, which can be explained with the breakdown of the kirí market. Teófilo Mendoza was unable to sell his annual harvest of 40 kirí trees, which had previously been generating G1.8 million (US$656) per annum, and as a result has lost an important source of income.

Mendoza sold only Arachis pintoi L. as gmcc seeds at the time of the survey, which accounts for G840,000 (6%) of the total net farm income, whereas in CA1998, the income of gmcc accounted for 12% or almost G1.1 million. The explanation for this is also due to

37 Appendix 1.2.2, Table Production.
38 Full details of the first scenario financial analysis of Teófilo Mendoza’s farm can be found in Appendix A 1.2.2.

39 The labour rate in 1998 was the same at G15,000 (US$5.36).
40 For the detailed crop budget of each crop refer to Annex 1.2.2.
<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yerba mate (annually)</td>
<td>2.00</td>
<td>0</td>
<td>831 (134)</td>
<td>1,661 (268)</td>
</tr>
<tr>
<td>Black oat - White Lupine/Cassava (in Yerba)</td>
<td>1.00</td>
<td>30</td>
<td>2,108 (340)</td>
<td>2,108 (340)</td>
</tr>
<tr>
<td>Black oat - White lupine/Jack bean - Maize (in Yerba)</td>
<td>0.40</td>
<td>6</td>
<td>713 (115)</td>
<td>285 (46)</td>
</tr>
<tr>
<td>Italian ryegrass/Soybean (in Yerba)</td>
<td>0.20</td>
<td>5</td>
<td>1,804 (291)</td>
<td>359 (58)</td>
</tr>
<tr>
<td>Italian ryegrass/Cowpea (in Yerba)</td>
<td>0.40</td>
<td>9</td>
<td>2,102 (339)</td>
<td>843 (136)</td>
</tr>
<tr>
<td>Tobacco light/Cassava/ Velvetbean/Sugarcane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Velveteen/Tobacco light</td>
<td>0.40</td>
<td>43</td>
<td>942 (152)</td>
<td>378 (61)</td>
</tr>
<tr>
<td>Coriander/Cassava - Velvetbean/Sugarcane</td>
<td>0.40</td>
<td>12</td>
<td>3,620 (584)</td>
<td>1,450 (234)</td>
</tr>
<tr>
<td>Tobacco light/Maize - Velvetbean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jack bean/Tobacco light</td>
<td>0.25</td>
<td>27</td>
<td>942 (152)</td>
<td>236 (38)</td>
</tr>
<tr>
<td>Sunnhamp/Tobacco black</td>
<td>0.10</td>
<td>12</td>
<td>4,129 (666)</td>
<td>415 (67)</td>
</tr>
<tr>
<td>Black oat/Maize - Velvetbean</td>
<td>0.35</td>
<td>6</td>
<td>918 (148)</td>
<td>322 (52)</td>
</tr>
<tr>
<td>Oxalis/ Maize - Cowpea</td>
<td>0.40</td>
<td>12</td>
<td>2,976 (480)</td>
<td>1,190 (192)</td>
</tr>
<tr>
<td>Yerba Mate/Agroforestry/ Arachis pintoi L./Fruit trees/Kírí</td>
<td>1.00</td>
<td>1</td>
<td>1,655 (267)</td>
<td>1,655 (267)</td>
</tr>
<tr>
<td>Yerba mate/Reforestation</td>
<td>0.50</td>
<td>0</td>
<td>831 (134)</td>
<td>415 (67)</td>
</tr>
<tr>
<td>Tung/Pasture/Pisciculture</td>
<td>0.80</td>
<td>2</td>
<td>1,091 (176)</td>
<td>874 (141)</td>
</tr>
<tr>
<td>Different food crops/House, Barn, Garden</td>
<td>0.25</td>
<td>6</td>
<td>1,414 (228)</td>
<td>353 (57)</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>0.10</td>
<td>5</td>
<td>397 (64)</td>
<td>37 (6)</td>
</tr>
<tr>
<td>Pasture jesuita</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kírí (40 trees per year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest (natural)</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest (enrichment)</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>9.20</strong></td>
<td><strong>180</strong></td>
<td><strong>13,119</strong> (2,116)</td>
<td></td>
</tr>
</tbody>
</table>

* Return to Labour G/day = 72,912 (US$*/day = 11.76)

* US$1 = G6,200
* Minor importance
* Value based on cassava, peanuts and maize assuming 1/3 each
* Return and costs included in net income from cattle
* Calculated with gross margin per ha of cattle and area of jesuita pasture
weak market conditions, which could be related to the slow spread of CA amongst smallholders in the region, the limited use of gmcc (for the most part only black oats) amongst large-scale CA farmers—which make up the main market—and, in relation to that, the distance of his farm from the main road.

The grown cassava income, which is mainly due to the yield increase from 17 to 42 t/ha, and the better commodity price at G100/kg also contributed to this change in the farm income. Mendoza also cultivated cowpea (using Italian ryegrass as preceding gmcc), which has a per hectare revenue of G2.1 million, and when associated with maize (oxalis as preceding gmcc) this is closer to G3 million. Herein, maize has a better commodity price than in CA1998. Finally, gmcc seeds do not represent a cost to Mendoza since he produces them for his own use.

Whereas the total income continued to rise, a negative change in CA2003 is that Mendoza spent more labour-days (180) for his activities compared to the CA1998 (139) and conventional cultivation (177) activities (see Figure 8). The reasons for this are:

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**TABLE 10. Farm Budget 1998**

Teófilo Mendoza
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black oat/Peanuts (in yerba)</td>
<td>0.25</td>
<td>6</td>
<td>566 (202)</td>
<td>143 (51)</td>
</tr>
<tr>
<td>Maize/Velvetbean</td>
<td>0.50</td>
<td>10</td>
<td>101 (36)</td>
<td>50 (18)</td>
</tr>
<tr>
<td>Black oat/Cassava (in yerba)</td>
<td>1.50</td>
<td>38</td>
<td>636 (227)</td>
<td>955 (341)</td>
</tr>
<tr>
<td>Italian ryegrass/Tobacco black (in yerba)</td>
<td>0.10</td>
<td>12</td>
<td>1,061 (379)</td>
<td>106 (38)</td>
</tr>
<tr>
<td>Different food crops ¹</td>
<td>0.20</td>
<td>5</td>
<td>434 (155)</td>
<td>87 (31)</td>
</tr>
<tr>
<td>Yerba mate (annual crops)</td>
<td>3.30</td>
<td>7</td>
<td>756 (270)</td>
<td>2,498 (892)</td>
</tr>
<tr>
<td>Yerba mate (Agroforestry)</td>
<td>2.00</td>
<td>4</td>
<td>756 (270)</td>
<td>1,515 (541)</td>
</tr>
<tr>
<td>Tung/Pasture</td>
<td>0.50</td>
<td>2</td>
<td>921 (329)</td>
<td>459 (164)</td>
</tr>
<tr>
<td>Pasture jesuita/Sugarcane ²</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle ³</td>
<td></td>
<td>46</td>
<td>48 (17)</td>
<td>168 (60)</td>
</tr>
<tr>
<td>Kiri (40 trees per year)</td>
<td></td>
<td>8</td>
<td></td>
<td>1,836 (656)</td>
</tr>
<tr>
<td>Jack bean seeds</td>
<td>0.25</td>
<td>6</td>
<td>1,403 (501)</td>
<td>350 (125)</td>
</tr>
<tr>
<td>Dwarf mucuna seeds</td>
<td>0.50</td>
<td>5</td>
<td>722 (258)</td>
<td>361 (129)</td>
</tr>
<tr>
<td>Lab-lab seeds</td>
<td>0.15</td>
<td>3</td>
<td>2,366 (845)</td>
<td>356 (127)</td>
</tr>
<tr>
<td>Forest (natural)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest (planted)</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>9.20</strong></td>
<td><strong>143</strong></td>
<td><strong>8,884 (3,173)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 61,964 (US$*/day = 22.13)

¹US$1 = G2,800
²Value based on cassava, peanuts and maize assuming 1/3 each
³Return and costs included in net income from cattle

Calculated with gross margin per ha of cattle and area of pasture/sugarcane
35

*US$1 = G2,800

1 Return and costs included in net income from cattle
2 Calculated with gross margin per ha of cattle and area of pasture/sugarcane

- Expansion of annual crops and gmcc area compared to CA1998;
- Highly labour intensive cultivation of tobacco;
- Increased yields in cassava production – more work during harvest; and
- Change from chemical to mechanical weeding.

Mendoza extended his cultivated area from 2.75 ha in 1998 to 5.4 ha in 2003, which includes the intercropped areas of yerba mate. This cultivation within the yerba mate area is even more intensive than 5 years ago when he only used 1.85 ha; today he uses 3 ha. The expanded and more intensified intercropping accounts for 167 labour-days, whereas in 1998 he only needed 80 labour days. However, the main consumer of labour-days today is tobacco, which accounts for 80 labour-days on the rather small area of 0.75 ha. This means that tobacco, which is cultivated on 7% of the farm area, requires 44% of his total work, and it is evident that this increase in labour-days is mainly as a result of cultivating tobacco. The third increase in labour-days is as a result of the increase in cassava yields.

PHOTO 7. Yerba mate and Arachis pintoi L. intercropped with reforestation, Teófilo Mendoza

Dirk Lange
FIGURE 6. Comparison of Net Farm Income - Teófilo Mendoza.

FIGURE 7. Comparison of Return to Labour - Teófilo Mendoza.

FIGURE 8. Comparison of Labour (person-days) - Teófilo Mendoza.
Whereas, Mendoza used to spend 6 days/ha harvesting in CA1998, today, 15 labour days/ha are required\(^{41}\).

One of the most significant savings Teófilo Mendoza experienced, when changing the cultivation systems to CA, was the elimination of soil preparation costs; he additionally saved costs for weeding. For the later, the example given in the Sorrenson Study is for cassava and was achieved by a change from only mechanical weeding to a combination of mechanical weeding and the application of herbicides\(^{42}\); the weeding costs were calculated at G45,000/ha (see Table 12).

Today, Mendoza has reverted his weeding practice back to only mechanical weeding, which accounts for more labour days/ha. In the case of cassava, in CA1998 he had dedicated one day to the application of herbicides and two days to mechanical weeding per hectare. In CA2003, the labour days increased to eight days for two weedings per hectare and the weeding costs rose to G105,000/ha. When comparing this to the conventional cultivation (weeding cost G180,000/ha), Mendoza saves four labour days/ha, which is a result of weed suppression due to the soil cover obtained from the association with other crops and/or gmcc (e.g. yerba mate, velvetbean)\(^{43}\).

Nevertheless, herbicides are still used on his farm, but only as desecants in order to kill off the preceding gmcc (but only if necessary). Teófilo Mendoza has changed the use of herbicides for two reasons: firstly, he does not want to affect his food or cash crops by spraying, and secondly, he does not feel comfortable using herbicides. Nevertheless, Mendoza is obliged to use herbicides as desecants due to his intense intercropping system, particularly yerba mate, where he is unable to run through with a knife roller. Even if intended to do so, he does not own work oxen. In addition, the distance from his farm to the main road would take too long to pick up the knife roller from the ASDTA\(^{44}\).

The cultivation system or market conditions? - The Second Scenario

In order to determine if the farming performance of Teófilo Mendoza, compared to five years ago, is driven by market conditions or by the further improvement of the CA system, a crop budget was drafted up with the product prices, input costs (technical and physical) and the exchange rate (G to US$) of 1998 and today. The result of the second scenario financial analysis is summarized in Table 13\(^{45}\).

Under the second scenario, the comparison for Mendoza’s agricultural activities shows a difference to the first scenario. The net farm income did not increase as much, and at G9.4 million his farming performance is only some 6% better than in CA1998 (see Figure 6).

\(^{41}\) Appendix 1.2.2.
\(^{42}\) Sorrenson, 1998.
\(^{43}\) Mendoza, pers. comm.
\(^{44}\) Full details of the second scenario financial analysis of Teófilo Mendoza’s farm can be found in Appendix A 1.2.3.
Table 13. Farm Budget 2003 - 2nd Scenario
Teófilo Mendoza
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yerba mate (annually)</td>
<td>2.00</td>
<td>0</td>
<td>907 (324)</td>
<td>1,804 (648)</td>
</tr>
<tr>
<td>Black oat - White lupine/ Cassava (in Yerba)</td>
<td>1.00</td>
<td>30</td>
<td>1,865 (666)</td>
<td>1,864 (666)</td>
</tr>
<tr>
<td>Black oat - White lupine/Jack bean - Maize (in Yerba)</td>
<td>0.40</td>
<td>6</td>
<td>260 (93)</td>
<td>103 (37)</td>
</tr>
<tr>
<td>Italian ryegrass/Soybean (in Yerba)</td>
<td>0.20</td>
<td>5</td>
<td>440 (157)</td>
<td>87 (31)</td>
</tr>
<tr>
<td>Italian ryegrass/Cowpea (in Yerba)</td>
<td>0.40</td>
<td>9</td>
<td>846 (302)</td>
<td>339 (121)</td>
</tr>
<tr>
<td>Tobacco light/Cassava/ Velvetbean/Sugarcane</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Velvetbean/Tobacco light</td>
<td>0.40</td>
<td>43</td>
<td>106 (38)</td>
<td>42 (15)</td>
</tr>
<tr>
<td>Coriander/Cassava - Velvetbean/Sugarcane</td>
<td>0.40</td>
<td>12</td>
<td>3,215 (1,148)</td>
<td>1,285 (459)</td>
</tr>
<tr>
<td>Tobacco light/Maize - Velvetbean</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jack bean/Tobacco light</td>
<td>0.25</td>
<td>27</td>
<td>112 (40)</td>
<td>28 (10)</td>
</tr>
<tr>
<td>Sunnhemp/Tobacco dark</td>
<td>0.10</td>
<td>12</td>
<td>-790 (-282)</td>
<td>-79 (-28)</td>
</tr>
<tr>
<td>Black oat/Maize - Velvetbean</td>
<td>0.35</td>
<td>6</td>
<td>532 (190)</td>
<td>185 (66)</td>
</tr>
<tr>
<td>Oxalis/Maize - Cowpea</td>
<td>0.40</td>
<td>12</td>
<td>1,274 (455)</td>
<td>510 (182)</td>
</tr>
<tr>
<td>Yerba Mate/Agroforestry/ Arachis pintoi L./Fruit trees/Kirí</td>
<td>1.00</td>
<td>1</td>
<td>1,733 (619)</td>
<td>1,733 (619)</td>
</tr>
<tr>
<td>Yerba mate/Reforestation</td>
<td>0.50</td>
<td>0</td>
<td>907 (324)</td>
<td>454 (162)</td>
</tr>
<tr>
<td>Tung/Pasture/Pisciculture</td>
<td>0.80</td>
<td>2</td>
<td>624 (223)</td>
<td>498 (178)</td>
</tr>
<tr>
<td>Different food crops/House, Barn, Garden</td>
<td>0.25</td>
<td>5</td>
<td>1,061 (379)</td>
<td>266 (95)</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>0.10</td>
<td>5</td>
<td>395 (141)</td>
<td>39 (14)</td>
</tr>
<tr>
<td>Pasture jesuita</td>
<td>1.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>4</td>
<td>109 (39)</td>
<td>260 (93)</td>
<td></td>
</tr>
<tr>
<td>Kirí (40 trees per year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest (natural)</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest (enrichment)</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>9.20</strong></td>
<td><strong>180</strong></td>
<td><strong>9,430 (3,368)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 52,360 (US$*/day = 18.70)

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*US$1 = G2,800

1 Minor importance

2 Value based on cassava, peanuts and maize assuming 1/3 each

3 Return and costs included in net income from cattle

4 Calculated with gross margin per ha of cattle and area under jesuita pasture
This results in a lower return to labour revenue at G52,360 (US$18.70) when compared to CA1998, but is at least 70% higher than under CC. The explanation for this weak labour revenue is the increased labour-days spent (see Figure 8). Nevertheless, his work is still valuable since the labour rate per day is at G15,000 (US$5.36) in the region, and it is evident that all family members remain working on the farm.

The almost equal farming performances between CA1998 and CA2003 can be a result of the following changes:

- Breakdown of the kirí market;
- Negative or low profit crop,
  as is the case for tobacco;
- More labour-days spent; and
- Higher cassava and yerba yields.

The setback in terms of the «disappeared» kirí market means less income from the 21% (see preceding subchapter). In addition, tobacco (light and dark) has an accumulated negative performance at G-8,960 (US$-3), which is due to the high labour costs. Dark tobacco, in particular, is a negative profit crop accounting for a per hectare revenue of G-789,600 (US$-282). The calculation of increased input costs is the same as in the first scenario, due to the fact that Teófilo Mendoza uses only manual labour and the daily wage has not changed since 1998.

However, the negative performance of kirí and tobacco was compensated by the increased yields from cassava (42 t/ha and 26 t/ha in CA2003 compared to 17 t/ha in CA1998), which resulted in a higher profitability/ha. Cassava is intercropped on one plot between yerba mate and preceded by black oats and white lupine. The revenue per hectare is at almost G1.9 million (US$666), whereas, in 1998 the intercropped cassava (in yerba mate) preceded by black oats had a revenue/ha of G635,600 (US$227). Since the costs for weeding increased from G45,000/ha to G105,000/ha (see Table 14), the higher yields have to be seen as the reason for the higher profitability. Additionally, the income from yerba mate and the introduction of cowpea balance the financial setbacks, but it is obvious under the second scenario that the Mendoza family’s income depends mainly on two crops (yerba mate 34% and cassava 33%).

**Photo 9. Yerba mate intercropped with black oats, Teófilo Mendoza**

**Overall Conclusion of the Financial Analysis**

After comparing the two financial scenarios, it can be seen that the increased yield of cassava is the only profitable improvement on this farm and compensates for the setbacks. As a result, Teófilo Mendoza’s farming performance continued to rise from a financial perspective. By considering the second scenario, it is clear that yerba mate is still a cornerstone of his production and that the diversification helped to reduce his risks in terms of market and crop failure. The example for the later was given with the breakdown of the kirí market and the damage by frost of the yerba mate trees in 2000. The ability to recover from these setbacks has not only been related to his extremely good soil conditions, but

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**Table 14. Comparison of Costs/ha for Soil Preparation and Weeding in G Conventional Cultivation, CA 1998 and CA 2003 - 2nd Scenario**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil Preparation</th>
<th>Weeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava</td>
<td>135,000</td>
<td>0</td>
</tr>
</tbody>
</table>

---

46 Appendix 1.2.3, Tables Velvethean Tobacco CA 2003, Jack bean Tobacco CA 2003, Sunnhemp Tobacco CA 2003.
also due to Mendoza’s enhanced management skills. He decided to introduce new crops, such as alfalfa, cowpea, soybean and tobacco *rubio*, and thus diversify his production. These crops make up some 10% of his revenue.

Mendoza also showed a willingness to take market risks by cultivating tobacco *rubio*, which is known to be very labour intensive. This crop proved to be unprofitable, because it was too labour intensive. The decision to stop producing tobacco *rubio* in the future, gives the expectation that in the future the good financial performance will continue, but this will depend on whether he focuses on crops with better commodity prices. It is also likely that he will reduce his labour days, and as a result even the return to labour revenue.

**Overall Conclusion of the Farming System Performance**

The farming system of Teófilo Mendoza is highly diversified and the most complex of this study. Although his farm is on a slope, he currently has no erosion problems (which he used to have when he started farming) and the soil fertility has increased over the years, making it possible to rotate even non-recommended crops and cultivate unusual crop combinations. Today, he has the highest number of crops and gmcc cultivated (see Table 9) by any case study farmer, making it difficult to find an unused square meter on his land. He continues to experiment and intercrop whenever possible. The later is possible as a result of an efficient production of gmcc seeds, which provides him with a secure stock.

The lower costs and higher profits, which were immediately apparent when the cultivation system changed, enabled substantial investment in permanent crops and other activities—tung, yerba mate, agroforestry, production of gmcc seeds, fish production and bee-keeping. In addition, the Mendoza’s have been able to considerably improve their socioeconomic condition, which can be seen by their current living standard. They built a stone house, purchased a motorcycle (better access to village), an electric-powered water supply system, a mobile phone and various domestic appliances including a refrigerator and TV. The family’s nutritional situation has also been diversified, producing almost all of what the household consumes. The overall financial performance of the Mendozas has led to the possibility of sending all children to school.

The oldest sons would like to stay on the farm and do not consider migrating to urban areas, which is generally a big problem in Paraguay.

Mendoza’s increased management skills are visible through the overall reaction to the setback caused by the cultivation of tobacco *rubio*. He sold his tobacco drying shed and took the decision to not grow this crop again, although he will continue to grow dark tobacco for household consumption. In the future, he plans to grow cotton again and amplify the soybean area, which is a direct response to the improved market conditions of these two crops. Moreover, he extended his fish production by digging out a third fish basin and he plans to extend his animal breeding lot (i.e. cattle and chicken production). For this purpose, he built a henhouse (capacity for 2,000 chicken) in the year 2000. One last improvement planned for the future is that he wants to sell more gmcc seeds.

Mendoza is very convinced of the advantages of CA, and would never consider reverting to conventional cultivation. When asked about the advantages of CA, he states the same as in the 1998 study. He additionally emphasises experiencing a high level of respect within his community due to the results of his work. A success, in his opinion, is that his neighbour began CA in 2002, which he had not considered in the last ten years. Mendoza’s experience and exemplary work is been proved by the many invitations to CA workshops and by the many national and international visits on his farm.

**Photo 10. Teófilo Mendoza at the border of his farm to his neighbour’s**

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47 Mendoza, pers. comm.

48 Sons of T. Mendoza, pers. comm.
2.3.3 Case Study III: Florencio Ozuna

General

The fully titled 18 hectare farm of Florencio Ozuna, is representative of 15-20 ha CA farms where CA is practised with work oxen. The farm is located some 300 meters from the main road, has only slight slopes, and was first cultivated by his brother in 1974. At one point, it was completely covered by native forest, but by 1975 forests were cleared and 2 ha of tung were planted. When Florencio Ozuna took over the property in 1986, 11 ha had been cultivated and 7 ha remained under native forest. Soybean was the main cash crop, but some cotton was also grown. In 1997, Ozuna purchased an additional 4 ha of land about 400 m from his farm which is used for cattle grazing.

Ozuna and his son Cornelio (29), who used to live in Buenos Aires, Argentina, work the farm. He employs one permanent adult farm worker who lives on the farm and contracts additional labour for seeding, weeding and harvest. Ozuna is a member of the Colonias Unidas Cooperative from which he is able to obtain permanent credit. He additionally has access to credits through CAH, and is an active member of ASDTA, of which he was the first president.

Animals have always been an important part in the farming system. Currently there are 15 head of cattle (one pair of work oxen, six bulls and cows, two young bulls, two young cows and three dairy cows), 13 pigs, three ducks and 30 chicken, which is more than in 1998. The small animals provide protein supplement for the family and are important sources of supplementary income.

Conventional Cultivation System

Since taking over the farm in 1986, Ozuna continued to cultivate about 11 ha each year. Most of this area, usually about 7 ha, was planted with soybean. He would additionally cultivate about 1.5 ha of cotton, 2 ha of maize, 0.5 ha of peanuts and diverse food crops on a small area of about 0.25 ha. In 1990, 5 ha of tung were planted, followed by 1 ha of yerba mate in 1992, leaving only 1 ha of natural forest. All cultivation was carried out with oxen and soybean was planted practically always on the same plot in order to facilitate mechanical harvesting. No specific soil conservation measures were undertaken, due to erosion not being visible on the farm.

Modifications to the Farming System with the Adoption of Conservation Agriculture

Direct seeding and green manure crops were introduced in 1993\(^5\). One hectare of maize followed by velvetbean was planted. The following year (1994) the area was cultivated with cotton and a further 1.5 ha were incorporated for soybean, followed by out-of-season maize. On these plots, black oats were cultivated as a gmcc in 1995, followed by soybeans. In the same year, an additional hectare of yerba mate was planted.

Florencio Ozuna owns a diverse range of tools and machinery. These include the normal range of hand-tools\(^5\), a small cassava flour machine and a motorised stationery thresher (used previously for threshing soybeans). Access to a wide range of manual and animal-traction CA implements is granted through ASDTA.

The tools can be found in Appendix A 1.3.1.

The changes to the farming system can be traced in Appendix A 1.3.1.
From the very beginning, Florencio Ozuna worked with direct seeders for animal traction.

Ozuna continued to introduce more crops (e.g. wheat, cassava, peanuts and cowpea) and other gmcc (e.g. oil radish, Italian ryegrass, oxalis and white lupine) into his CA system. He would rotate his crops, and apply lime and fertilizer. At the beginning, he would use up to 5 litres/ha of herbicides (e.g. Glyphosate and 2-4D), but reduced this gradually down to 2-3 litres/ha (only Glyphosate) in 2002. The later is a result of less weed appearance. As of 1997/98 onwards, he associated his yerba mate with gmcc and other crops in order to improve the soil fertility and to make better use of the otherwise empty space. Today, many of the gmcc grow naturally in the yerba mate area, which provides labour savings. During the 1999/2000 season, he cultivated sunflower for the first time. Florencio Ozuna is pleased with his farming progress and would never revert to conventional cultivation.

**Crop Yields and their Development with Conservation Agriculture**

Crop yields (see Figure 9) were declining rapidly under CC. On newly cleared land, soybean would yield 3,500-4,000 kg/ha, but this dropped to about 1,200 kg/ha. After the introduction of CA, soybean yields increased, reaching on average 3,000 kg/ha in 1997 and 1998. Through the continuous improvement of his soil fertility, soybean yield rose to 4,000 kg/ha in the year 2000 and Ozuna harvested 4,170 kg/ha during the last cropping season.

Maize and cotton yields also dropped under CC. Average maize yields fell from 3,500 kg/ha to 3,000 kg/ha, while cotton also fell from 2,000 to 1,500 kg/ha. After only five years under CA, yields of these crops have noticeably changed. Over the two seasons, 1997 and 1998, cotton averaged 2,400 kg/ha and maize 3,500 kg/ha, recovering their initial yields. Ozuna stopped growing cotton in 1999 due to the weak market conditions and reluctance to using pesticides.

Cassava has always been cultivated on rather small areas for household consumption. On these areas, Ozuna associated cassava with other crops resulting in yields of 15 t/ha. In 2001/02 he began seeding cassava on an independent plot. Today, his cassava yields improved to 38 t/ha. Yerba mate was first harvested at 4,400 kg/ha, which increased, as the plants matured and when associated with other crops and gmcc, to 6,300 t/ha.

**Results of the Financial Analysis**

The analysis compares the financial results of the farm under CC, the situation in 1998 after five years of CA, and the present farming performance. For the first scenario, the same input costs and product prices from the first study (May 1998) are used for the CC and CA1998, while current input costs and product prices are used for the CA2003 case. For the second scenario, the product prices and input costs of 1998 are used.

As opposed to the first study, yerba mate is calculated with current product prices and input costs (technical and physical), since he has associated this with gmcc and cash/food crops, which has changed soil fertility. A simplification has been made with the area under different food crops (about 0.65 ha); here crops, fruits and vegetables are grown solely for the purpose of household consumption. This has been valued based on cassava, peanuts and maize, assuming the revenue

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51 F. Ozuna, pers. comm.
for 1/3 each. A further simplification has been that the gmcc used in the different plots have been broken down to only those mostly used, because it would have been rather difficult, complicated and time consuming to determine the exact amount for each gmcc. Nevertheless, this was done only if it did not influence the financial results.


The first scenario financial analysis\(^2\) of Florencio Ozuna’s farm under CA today, in 1998, and the CC is presented in Tables 15, 16 and 17.

\(^2\) Full details of the first scenario financial analysis of Florencio Ozuna’s farm can be found in Appendix A 1.3.2 .

The first scenario financial analysis of the farming performance in 2003 compared to 1998 shows an increase in net farm income. In CA1998, the result was calculated at G10.8 million (US$3,853) per annum, which increased to more than G37.7 million (US$6,087) today (see Figure 10). This means that his financial performance increased 2.5-times. When compared to CC (G8 million), he increased the net farm income by almost 350%. The total labour requirement rose slightly from 239 labour-days in CA1998 to 242 labour-days in CA2003, which is overall almost the same difference when compared to the first study, where CC required 300 labour-days. Due to this, his return to labour revenue in CA2003 is G155,744 (US$25.12), which works out to be more than in CA1998 (G45,192 or US$16.14). Moreover, compared to the return to labour revenue of CC (G26,516 or US$9.47), he experienced a general increase of 135% (see Figure 11).

### Table 15. Farm Budget 2003 - 1st Scenario Florencio Ozuna Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black oat/Oil radish - Maize</td>
<td>2.00</td>
<td>24</td>
<td>329 (53)</td>
<td>657 (106)</td>
</tr>
<tr>
<td>Italian ryegrass - Peanuts</td>
<td>0.25</td>
<td>6</td>
<td>1,345 (214)</td>
<td>336 (54)</td>
</tr>
<tr>
<td>Italian ryegrass - Cowpea</td>
<td>0.50</td>
<td>8</td>
<td>614 (99)</td>
<td>307 (50)</td>
</tr>
<tr>
<td>Cassava/Velvetbean (for seeds)</td>
<td>1.00</td>
<td>33</td>
<td>2,982 (481)</td>
<td>2,982 (481)</td>
</tr>
<tr>
<td>Black oat/Oil radish - Rice</td>
<td>0.10</td>
<td>2</td>
<td>2,691 (434)</td>
<td>267 (43)</td>
</tr>
<tr>
<td>Black oat/Oil radish - Soybean</td>
<td>3.00</td>
<td>23</td>
<td>4,693 (757)</td>
<td>14,080 (2,270)</td>
</tr>
<tr>
<td>Different food crops (^1)</td>
<td>0.65</td>
<td>15</td>
<td>2,821 (455)</td>
<td>1,835 (296)</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>2.00</td>
<td>4</td>
<td>738 (119)</td>
<td>1,476 (239)</td>
</tr>
<tr>
<td>Tung</td>
<td>7.00</td>
<td>22</td>
<td>2,195 (354)</td>
<td>15,364 (2,479)</td>
</tr>
<tr>
<td>Sugarcane - Pasture cameroon (^2)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle (tung plus 4 ha)(^3)</td>
<td>106</td>
<td></td>
<td>37 (6)</td>
<td>440 (71)</td>
</tr>
<tr>
<td>Forest</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>18.00</strong></td>
<td><strong>242</strong></td>
<td><strong>37,740 (6,087)</strong></td>
<td></td>
</tr>
</tbody>
</table>

* US$1 = G6,200
\(^1\) Value based on cassava, peanuts and maize assuming 1/3 each
\(^2\) Return and costs included in net income from cattle
\(^3\) Calculated with gross margin per ha of cattle and area of sugarcane/Pasture cameroon

Return to Labour G/day = 155,744 (US$*/day = 25.12)
We can conclude that the high return to labour of G155,744 means that Ozuna’s work is very efficient. When comparing this to the average daily wage of G15,000 (US$2.42) in the region, it is evident that all family members remain working on the farm.

The improved financial performance of Florencio Ozuna’s cultivation activities has come about as a result of the following:

- Higher profitability of tung due to higher commodity prices and yields;
- Higher profitability of soybean due to higher commodity prices and yields; and
- Introduction of cassava as a cash crop.

Tung has always been the main source of income on the farm. While under conventional cultivation tung had a 47% share, this crop accounted for 51% and 41% under CA1998 and CA2003, respectively. Although this percentage has fallen, the net farm income of tung increased from G5.5 million (US$1,946) in 1998 to G15.4 million (US$2,478) in 2003. The profitability is G2.2 million/ha (US$354), which is almost 3-times higher than in 1998 (G778,400 or US$278). This difference is as a result of, firstly the higher commodity price at G800/kg, as opposed to G300/kg, and secondly due to the increase in yields from 2,600 kg/ha to 3,070 kg/ha.

The second most important crop is soybean (preceded by black oats and oil radish). Under CC, soybean had a 32% share, while accounting for 21% and 37% under CA1998 and CA2003, respectively. The total net farm income derived from soybean increased from G2.8 million (US$815) under CA1998 to G14.1 million (US$2,270) under CA2003, despite the fact that Ozuna seeded soybeans on 0.5ha less than in 1998. When comparing these results to those under CC (G2.6 million or US$922), it is clear that the productivity advanced. The very high increase in net farm income is a combination of higher market prices, which increased

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**TABLE 16. Farm Budget 1998**

Florencio Ozuna

Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black oat - Soybean</td>
<td>3.50</td>
<td>24</td>
<td>652 (233)</td>
<td>2,282 (815)</td>
</tr>
<tr>
<td>Wheat - Cotton</td>
<td>1.00</td>
<td>24</td>
<td>1,072 (383)</td>
<td>1,072 (383)</td>
</tr>
<tr>
<td>Maize - Velvetbean</td>
<td>2.50</td>
<td>33</td>
<td>73 (26)</td>
<td>179 (64)</td>
</tr>
<tr>
<td>Black oat - Peanuts</td>
<td>0.50</td>
<td>12</td>
<td>462 (165)</td>
<td>230 (82)</td>
</tr>
<tr>
<td>Different food crops 1</td>
<td>0.25</td>
<td>6</td>
<td>129 (46)</td>
<td>34 (12)</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>2.00</td>
<td>4</td>
<td>504 (180)</td>
<td>1,005 (359)</td>
</tr>
<tr>
<td>Tung</td>
<td>7.00</td>
<td>29</td>
<td>778 (278)</td>
<td>5,449 (1,946)</td>
</tr>
<tr>
<td>Sugarcane - Pasture cameroon 2</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle (tung plus new 4 ha) 3</td>
<td>106</td>
<td>48 (17)</td>
<td>532 (190)</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>18.00</td>
<td>239</td>
<td>10,788 (3,853)</td>
<td></td>
</tr>
</tbody>
</table>

*Return to Labour G/day = 45,192 (US$*/day = 16.14)*

*US$1 = G2,800

1 Value based on cassava, peanuts and maize assuming 1/3 each

2 Return and costs included in net income from cattle

3 Calculated with gross margin per ha of cattle and area of sugarcane/Pasture cameroon

---

The labour rate in 1998 was the same at G15,000 (US$5.36).
Soybean field of Florencio Ozuna

Dirk Lange

Contrary to the first study, soil preparation cost did not change in the comparison between CA1998 and CA2003, which occurred to the main savings when the cultivation systems changed from CC to CA (see Table 18). The costs for weeding increased slightly due to one more labour-day spent for weeding.

The third most important crop under CA2003 is cassava associated with velvetbean. Where in the earlier years cassava was only sown for household consumption, Florencio Ozuna currently generates a significant profit by producing it for commercial purposes. Cassava and velvetbean seeds combined account for 8%, or G3 million (US$481), of the total net income.

The case of Florencio Ozuna is different to the other CA smallholder case studies in Edelira, due to him purchasing his gmcc seeds (with the exception of velvetbean and part of his oil radish, due to regermination). The total costs deduced from this are G150,000 under CA2003. Nevertheless, he took this decision because, in his opinion, the harvest of his own gmcc seeds would take up too much time.
The rather small increase in labour-days (see Figure 12) comes from the cassava harvest, which accounts for 16 days/ha, whereas before the harvest of the lower cassava yield was calculated at 10 days/ha.

Cultivation System or Market Conditions? – The Second Scenario

In order to find out if the farming performance of Ozuna, compared to five years ago, is driven by marked conditions or the further improvement of the CA system, a crop budget with the product prices, input costs and the exchange rate (G to US$) of 1998 was drawn up for the current situation. The result of the second scenario financial analysis is summarized in Table 19.

In the second scenario, the comparison of the financial performance of Florencio Ozuna’s cultivation activities shows a difference to the first scenario. The net farm income did not increase as much as in the first financial analysis (see Figure 10), but has still managed to increase. With G18.9 million, his financial performance is about 75% higher than in CA1998. This results in a higher return to labour revenue with G78,036 (US$27.87) compared to CA1998 (G45,192 or US$16.14), and is at least 72% higher than under CC (G26,516 or US$9.47), however, this is only half as high as in the first scenario (see Figure 11). Nevertheless, his work is still valuable since the labour rate per day is G15,000 (US$5.36) in the region, and it is evident that all family members remain working on the farm.

The increase in total net farm income is related to the higher yields for tung and soybeans. In the second scenario, these are the only crops that experienced a significant rise in net farm income compared to CA1998. The other crops have about the same revenue. The introduction of cassava and velvetbean (1 ha) has additionally generated a significant contribution to the net income with G2.7 million, making it the second most efficient crop. Maize is a crop resulting in a negative net income, which has to be deduced from lower yields. This is due to the fact that Ozuna seeded maize to late in the season.

A difference in the costs for weeding compared to the first scenario is almost non-existent, due to the fact that manual labour wages have not changed. However, the slight difference perceived when comparing tables 18 and 20 is due to the more costly animal weeding under the second scenario.

In the second scenario, the comparison of the financial performance of Florencio Ozuna’s cultivation activities shows a difference to the first scenario. The net farm income did not increase as much as in the first financial analysis (see Figure 10), but has still managed to increase. With G18.9 million, his financial performance is about 75% higher than in CA1998. This results in a higher return to labour revenue with G78,036 (US$27.87) compared to CA1998 (G45,192 or US$16.14), and is at least 72% higher than under CC (G26,516 or US$9.47), however, this is only half as high as in the first scenario (see Figure 11). Nevertheless, his work is still valuable since the labour rate per day is G15,000 (US$5.36) in the region, and it is evident that all family members remain working on the farm.

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**Table 18. Comparison of Costs/ha for Soil Preparation and Weeding in G Conventional Cultivation, CA 1998 and CA 2003 - 1**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil Preparation</th>
<th>Weeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cultivation</td>
<td>CA 1998</td>
</tr>
<tr>
<td>Soybean</td>
<td>135,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>135,000</td>
<td>36,000</td>
</tr>
</tbody>
</table>

The overall conclusion of the financial analysis is that the considerably impressive improvement of Florencio Ozuna’s financial performance, from CA1998 to CA2003, is mainly driven by the market conditions. Tung and soybean particularly experienced the main growth in net income, due to the higher commodity prices and production intensification. Additionally, the introduction of cassava as a cash crop provided a third

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54 Full details of the second scenario financial analysis of Florencio Ozuna’s farm can be found in Appendix A 1.3.3.

55 F. Ozuna, pers. comm.
**Overall Conclusion of the Farming System Performance**

Florencio Ozuna’s farming system is gradually improving. After the introduction of CA, he experienced
a financial progress, which enabled him to purchase an additional 4 hectares of land with the idea of increasing his cattle numbers. He was also able to buy a motorcycle, a TV and a fridge. Living conditions were increased through the diversification of household consumption, by producing milk, cheese and honey; activities carried out during the time he saved with CA. To support these activities, Ozuna has a permanent contracted worker, which is the only case amongst all case study farmers.

The CA system practised is now in its 12th year. His farming system is determined by the main crops, soybean and tung, which are also considered his personal preferences. A change occurred when introducing cassava as another source of income and helped to slightly diversify his production. At the same time, his personal preference for these crops keeps him from introducing other crops, and will be a limiting factor in a further risk reduction. The planning of the cultivation of other crops for each season (crop rotation) is carried out in order to complement them, as these also form part of his household consumption (maize, cowpea, rice, peanuts). The two notable changes within his cultivation practice are a reduction in the amount of herbicides used per hectare and that he only applies these as desecants and not for weeding (with the exception of soybean).

Another characteristic of this farming system is that Ozuna does not like to break down his farming area in several little plots, since he prefers to work with animal traction, and this would only make it necessary to work manually. This can also be expected to limit a further diversification of his crop production.

When looking at the overall farming system performance, Ozuna has reached a level of stability and security by improving his financial performance. His son, Cornelio, came back from Argentina to live and work on the farm. Cornelio is also very enthusiastic about CA, and has started to participate in CA workshops. This shows that the next generation is already growing up with the CA system.

2.3.4 Case Study IV: Víctor Ramírez

General

The farm of Víctor Ramírez is representative of the CA farms of 15-20 ha where CA is practised with work oxen. The property is located on the main road and has a slight slope. Ramírez started to farm his 17.5 ha property in 1974. At this time, it was virgin land completely covered by native forest. During the first year, 16 ha of forest were cleared (with the help of his father and two brothers), and the following year, 2 ha of soybean and a small area of sunflower were planted. By 1979, the originally forested area had been completely cleared.

This fully titled farm is worked and managed by Víctor Ramírez and his wife, Valeriana Prieto. Their son, Cristian (24) studies Agriculture at the National University of Asunción (San Lorenzo) and the eldest daughter Nancy (22), works in San Lorenzo. Their other daughter, Mirian (20), lives and works on the farm. The Ramírez family contract labour when necessary (harvest, weeding). As a difference to the 1998 study, work oxen have been purchased.

Víctor Ramírez is member of the smallholder cooperative Káaguy Poty and he is the current president of ASDTA. Credit is obtained from the CAH. The Ramírez family used to run a little trading shop (almacén) which was closed in 2001, due to many clients not paying their debts. Because of the farm’s main road location, crop trading is made easier and much of the farm’s products are sold directly to traders passing by their farm gate.

Animals are an important part in the farming system. In October 2003, there was one pair of work oxen, one bull, one younger bull, one milk cow, six pigs (three sows and three porkers), 10 piglets and 120 chicken. Cattle, piglets, pig meat and chicken are sold off-farm on the main road. In addition, milk, cheese, eggs, a variety of fruits (e.g. peaches, pumpkin, calabash) and...
cassava flour (almidón) make up a complementary source of income.

The production of food crops, vegetables and fruits is also an important part of the farming system. The area for these was expanded to 1.5 ha; some 20 different fruit plants are grown in this area. The vegetable garden is equipped with an irrigation system, which is an exceptional case amongst all case study farmers. This has helped diversify the family consumption and the sources of income.

The Ramírez family own two jab-planters, one subsoiler, two knapsack sprayers, two hand-hows, two planting sticks, one forrajero and additional small tools. Contrary to 1998, a motorcycle is now owned as well as two bicycles. The family has access to a wide range of CA implements through ASDTA. Additional machinery is contracted for the harvesting of soybean.

**Conventional Cultivation System**

Initially, soybean was the main crop. From 2 ha planted in 1975, the area was gradually increased reaching 8 ha in 1985. This area was maintained every year up to 1992 when CA was introduced on the farm. Sunflower was an important part of the CC when sown as a winter crop on some 3-4 ha, but was grown for the last time in 1990. Declining yields and prices rendered the sunflower as a nonviable crop. Cotton was also grown for income, stabilising at about 2 ha each year; about 1 ha of maize and 1 ha of peanuts provided additional income. Nevertheless, the Ramírez family experienced financial stress on a number of occasions due to low yields of soybean, sunflower and maize.

Prior to the introduction of gmcc and direct seeding, no soil conservation measures were implemented.

**Modifications to the Farming System with the Adoption of Conservation Agriculture**

Direct seeding and gmcc were introduced in 1992\(^6\). Three hectares of maize and velvetbean were sown, followed by soybean. In the same year, 2.5 ha of yerba mate were planted, as were 3 ha of tung. Over the subsequent years, the area under CA was gradually increased and now covers the whole farming system, including the area of food crops, vegetables and fruits.

The system under CA continues to develop. For instance, at the beginning, black oats was the main gmcc used and in 1997 it was grown on 13.25 ha; however, two years before, other gmcc were sown in the yerba mate plot. All together, eight species of gmcc were used for income purposes, including: pigeon pea, dwarf mucuna, velvetbean, jack bean, sunnhemp and lab-lab bean. In 1998, black oats prior to soybeans was substituted with a mixture of Italian ryegrass and oil radish. Calabash and cowpea were intercropped with cotton following black oats. Cotton was last cultivated in the 1997/98 season, because the commodity price declined. After 1998, the cassava area was extended and also intercropped.

In the last years, the crop rotation continued and he increased the variety of gmcc. In the year 2000, Victor Ramírez and his wife Valeriana planted another 3.5 ha of tung and 0.5 hectares of trees (e.g. eucalyptus, Australian red cedar and paraiso gigante), the later in order to diversify their production and to have additional sources of income. Unfortunately, in 2003 the recently felled eucalyptus trees were burned by an unknown person, leaving the Ramírez family with an estimated loss of G2 million.

With the introduction of CA, this smallholder introduced chemical fertilizers, urea and herbicides. Fertilizers were mainly applied in the soybean and cotton areas. Herbicides were used for desecating and for weeding, which reduced the workload\(^7\). In the later years, the use of herbicides changed and they were applied only for drying off preceding gmcc. Chemical fertilizer is no longer applied, because the Ramírez’s consider it unnecessary, which results in a reduction of operational costs. The continuous increase in yields confirms their decision.

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\(^6\) The changes to the farming system can be traced in Appendix A 1.4.1.

\(^7\) Sorrenson 1998.
Crop Yields and their Development with Conservation Agriculture

Crop yields were declining rapidly under conventional cultivation. On newly cleared land soybeans yielded 3,000-3,500 kg/ha, but these would later decline to as low as 800 kg/ha. After six years of CA, crop yields had risen and reached 2,780 kg/ha in 1998, due to the use of gmcc, crop rotation and chemical fertilizers. The increase in yields continued, despite chemical fertilizers no longer being applied. Today, the initial yields of the newly cleared land are reached and average 3,000 kg/ha (see Figure 13).

Under CC, cassava yields averaged about 15 t/ha without noticeable difference per year. With the introduction of gmcc and crop rotation, the yields improved significantly. In 1998, Ramírez harvested 22 t/ha, planted at a low density. He began to associate cassava with other crops and extended the growing cycle to 18 months. Today, the yields have increased to 47 t/ha.

Under CC, maize, which was always planted on the most fertile land, fell from about 3,500 kg/ha to 3,000 kg/ha. Under CA, maize is associated with velvetbean and yields average about 3,500 kg/ha, close to the levels achieved on virgin land.

Peanuts also experienced a decrease in yields under the traditional system, reaching 1,600 kg/ha. With the improved soil fertility, the initial yields have been restored and even improved to 1,800 kg/ha, but were not cultivated on a significant area during the last season.

Yerba Mate yields experienced a significant increase in yields too. Due to the fact that yerba mate was planted in 1992, it is not possible to compare this with CC. Nevertheless, the improvement is quiet impressive and as a result of the intercropping with gmcc and other crops, yields now reach 7,000 kg/ha, which is more than other small-holder farmers produce, and can be related to the CA system.

Results of the Financial Analysis

The financial analysis compares the farming performance under CC, the situation in 1998, after five years of CA, and the current situation. The input costs and product prices of May 1998 and October 2003 are used for the first scenario; whereas, the input costs and product prices of 1998 are used for the second scenario.

As opposed to the methodology used in the first study, yerba mate is calculated with the current product price and input costs, because the Ramírez family associates this crop with gmcc and cash/food crops, through which a change in soil fertility occurred. A simplification has been made with the area of diverse food crops (about 1.5 ha) dedicated to the production of food crops, fruits and vegetables, which have been valued based on cassava, peanuts and maize, assuming the value for 1/3 each. A further simplification is that the gmcc species used in the different plots (particularly in the case of yerba mate) are broken down to only those used the most, because it would have been rather complicated and time consuming to determine the exact amount for each gmcc. Nevertheless, this was carried out only if it did not influence the financial results.

FIGURE 13. Comparison of Main Crop Yield/ha - Víctor Ramírez.
<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black oats - Soybean</td>
<td>2.00</td>
<td>8</td>
<td>2,808 (453)</td>
<td>5,617 (906)</td>
</tr>
<tr>
<td>Cassava/Black oats</td>
<td>2.00</td>
<td>56</td>
<td>6,026 (972)</td>
<td>12,053 (1,943)</td>
</tr>
<tr>
<td>- Velvetbean (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Maize</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Jack bean (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Dwarf mucuna (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White lupine/Garden pea/ Black oats - Maize/Dwarf mucuna/Cowpea</td>
<td>1.00</td>
<td>26.5</td>
<td>8,581 (1,384)</td>
<td>8,581 (1,384)</td>
</tr>
<tr>
<td>Different food crops/House, Barn, Garden</td>
<td>1.50</td>
<td>22.5</td>
<td>4,842 (781)</td>
<td>7,263 (1,172)</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>2.00</td>
<td>5</td>
<td>1,271 (205)</td>
<td>2,542 (410)</td>
</tr>
<tr>
<td>- Cassava</td>
<td>1.00</td>
<td>57</td>
<td>4,278 (690)</td>
<td>8,556 (1,380)</td>
</tr>
<tr>
<td>- Winter gmcc</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Cowpea/Pumpkin</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Dwarf mucuna (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tung</td>
<td>3.00</td>
<td>17</td>
<td>2,784 (449)</td>
<td>8,351 (1,347)</td>
</tr>
<tr>
<td>Sugarcane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle (in tung)</td>
<td>3</td>
<td>236 (38)</td>
<td>707 (114)</td>
<td></td>
</tr>
<tr>
<td>Agroforestry</td>
<td>4.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reforestation</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>17.50</strong></td>
<td><strong>195</strong></td>
<td><strong>53,673 (8,657)</strong></td>
<td><strong>53,673 (8,657)</strong></td>
</tr>
</tbody>
</table>

*US$1 = G6,200
1 Calculated for cassava/black oats
2 Value based on cassava, peanuts and maize assuming 1/3 each
3 Calculated in cassava
4 Winter gmcc: white lupine, garden pea, vetches, garden bean, black oats, Italian ryegrass
5 Return and costs included in net income from cattle
6 Calculated with gross margin per ha of cattle and area of sugarcane.
7 Including 3.5 ha tung without income and 0.5 ha eucalyptus, Australian red cedar and paraiso gigante (5 years old)
**Comparisons between Conservation Agriculture of 2003, 1998, and the Conventional Cultivation System – The First Scenario**

The first scenario financial analysis\(^5\) of the Ramírez’s farm under CA2003, CA1998, and CC is presented in Tables 21, 22 and 23.

Five years later in the CA cultivation system, the first scenario financial analysis of Víctor Ramírez’s farming performance in 2003, compared to 1998, shows an impressive increase in net farm income, due to more than tripling to almost G53.7 million (US$8,657) (see Figure 14). When compared to CC, this smallholder family increased their net farm income almost 7-times. The total labour requirement fell significantly from 350 in CA1998 to 195 person days in CA2003, which means that the labour-days spent account for almost 60% of those under CC. As a result, his return to labour in CA2003 is G275,962 (US$44.51), which works out to be much higher than in CA1998 (G45,836 or US$16.37). Moreover, when compared to the return to labour of CC (G21,506 or US$7.52), it increased more than 10-times (see Figure 15).

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\(^5\) Full details of the first scenario financial analysis of the Ramírez’s farm can be found in Appendix A.1.4.2.

### Table 22. Farm Budget 1998

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$(^*))</th>
<th>Net Farm Income in TG (US$(^*))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italian ryegrass/Oil radish - Soybean</td>
<td>3.00</td>
<td>12</td>
<td>661 (236)</td>
<td>1,982 (709)</td>
</tr>
<tr>
<td>Black oats - Cotton (in yerba) (^1)</td>
<td>1.75</td>
<td>34</td>
<td>1,400 (500)</td>
<td>2,451 (875)</td>
</tr>
<tr>
<td>Black oats - Maize/Velvetbean</td>
<td>1.00</td>
<td>21</td>
<td>-129 (-46)</td>
<td>-129 (-46)</td>
</tr>
<tr>
<td>Black oats - Peanuts</td>
<td>0.50</td>
<td>12</td>
<td>1,086 (388)</td>
<td>543 (194)</td>
</tr>
<tr>
<td>Different food crops (^2)</td>
<td>0.50</td>
<td>12</td>
<td>599 (214)</td>
<td>300 (107)</td>
</tr>
<tr>
<td>Black oats - Cassava</td>
<td>7.00</td>
<td>197</td>
<td>834 (298)</td>
<td>5,841 (2,088)</td>
</tr>
<tr>
<td>Jack bean (for seeds/ in yerba)</td>
<td>0.25</td>
<td>3</td>
<td>1,439 (514)</td>
<td>360 (128)</td>
</tr>
<tr>
<td>Lab-lab bean (for seeds)</td>
<td>0.25</td>
<td>2</td>
<td>815 (291)</td>
<td>204 (73)</td>
</tr>
<tr>
<td>Velvetbean (for seeds)</td>
<td>0.25</td>
<td>2</td>
<td>823 (294)</td>
<td>206 (74)</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>2.50</td>
<td>5</td>
<td>392 (140)</td>
<td>980 (350)</td>
</tr>
<tr>
<td>Sugarcane (^3)</td>
<td>3.00</td>
<td>12</td>
<td>1,047 (374)</td>
<td>3,143 (1,121)</td>
</tr>
<tr>
<td>Cattle (in tung) (^4)</td>
<td>40</td>
<td></td>
<td>48 (17)</td>
<td>146 (52)</td>
</tr>
<tr>
<td>Forest</td>
<td>2.00</td>
<td></td>
<td></td>
<td>(449)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>19.50</strong></td>
<td><strong>350</strong></td>
<td><strong>16,030</strong> (5,725)</td>
<td></td>
</tr>
</tbody>
</table>

\(^*\)US$1 = G2,800

\(^1\) Including pumpkin and cowpea, which are intercropped with cotton

\(^2\) Value based on cassava, peanuts and maize assuming 1/3 each

\(^3\) Return and costs included in net income from cattle

\(^4\) Calculated with gross margin per ha of cattle and area of sugarcane

Return to Labour G/day = 45,836 (US$*/day = 16.37)
In conclusion, the high return to labour means that Ramírez’s work is most efficient. When comparing this to the average daily wage of G15,000 (US$2.42) in the region\[^{59}\], it is evident that all family members remain working on the farm.

The improved financial performance of the Ramírez’s cultivation activities has occurred as a result of the following:

- Higher profitability/ha of cassava due to increased yields;
- Change of maize from a non-profitable to a profitable crop;
- Increased tung production;
- Increased gmcc seed production; and
- Cost reduction due to less labour-days.

The most important cash crop is cassava, which accounts for 19% or G10 million. When compared, cassava generates more income on 3 ha than on the 7 ha cultivated in CA1998 (G5.8 million). The reason for this is that the per ha revenue increased from G834,400 (US$298) in CA1998 to a current G6 million (US$972). This increase is related to the improved cassava yields, which reached 47t/ha (see Figure 13).

The second most important crop is maize, which accounts for 16% (G8.6 million) of the total net farm income. In CA1998, maize was the only crop generating a negative net income of G-128,800. The difference with the current situation is that firstly, the commodity prices (G2,000/kg) are much higher than in 1998 (G200/kg) and secondly, a cost reduction achieved through less labour days/ha (for weedicings and faster harvesting), and fewer herbicides used\[^{60}\].

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\[^{59}\] The labour rate in 1998 was the same at G15,000 (US$5.36).

\[^{60}\] Appendix 1.4.2.
**Figure 14. Comparison of Net Farm Income - Víctor Ramírez.**

- CA 1998: 16,030,000
- CA 2003 (1st Scenario): 53,673,400
- CA 2003 (2nd Scenario): 34,490,400

**Figure 15. Comparison of Return to Labour - Víctor Ramírez.**

- Conventional 1998: 21,506
- CA 1998: 45,836
- CA 2003 (1st Scenario): 275,962
- CA 2003 (2nd Scenario): 177,324

**Figure 16. Comparison of Labour (person-days) - Víctor Ramírez.**

- Conventional 1998: 379
- CA 1998: 350
- CA 2003: 195
The third most import income is generated from tung (16% or G8.3 million), which represents an increase of the tung net income by almost G5 million. Here, the increased yields (from 3,300 kg/ha to 5,000 kg/ha) and the higher commodity prices (G400/kg in 1998 to G650/kg in 2003) are the two reasons for the enhanced revenue. The importance of tung is expected to rise within the next few years, because in 2004/05 the additional 3.5 ha of tung trees planted will be harvested for the first time.

Furthermore, the improved net farm income through the CA system can be seen by the gmcc seed production. Where in 1998 the share of gmcc seeds accounted for G770,000 (16%), in 2003 this value rose to almost G5 million (10%), due to currently selling at least five different gmcc seeds (e.g. velvetbean, jack bean, dwarf mucuna, garden pea, white lupine). Under CC, gmcc seeds were obviously not a feasible source of income. The farm location on the main road facilitates the sale of the gmcc seeds and must be seen as a comparative advantage for the Ramírez family.

However, the increased financial performance, is also due to another reason; the reduction in labour days from 379 under CC, to 350 under CA1998 and 195 today (see Figure 16).

The change in cultivation activities was identified as the main labour savers in the 1998 study. In particular, the soil preparation without burning, ploughing and harrowing saved up to 4 labour days per hectare, which included the preceding gmcc in the CA system. However, for the current situation, there is no significant reduction of labour for soil preparation since no costs occur, which includes weeding as well (see Table 24). The reduction in labour days of 155 days is a result of the reduction in the cassava area from 7 to 3 ha, as well as the change from manual harvesting by the Ramírez family to an all inclusive-price settled with the cassava trader. The Ramírez family receives a lower price for his cassava; whereas, the cassava trader harvests the production, and provides bags and transportation. The labour saving for the family is at least 25 labour days per hectare. Additionally, through the change of harvest method, he saves costs of G470,000 per ha for bags (G500/bag) and almost G1.2 million per ha for transportation (G25/kg)\(^6\). The 2 ha of cassava, that were additionally cultivated in 1998, are currently planted under yerba mate, and therefore, do not account for any labour days today.

In conclusion, the reduction of labour days did not occur as a result of the improved CA system, but because the Ramírez family improved its management skills, which for instance is visible in the change to the cost reducing harvest method. Nevertheless, two notable changes within his cultivation practise, as a result of an improved CA system, are that the Ramírez’s reduced the amount of herbicides used per hectare and that he applies herbicides only as desecants and not for weeding (with the exception of soybean).

### Cultivation System or Market Conditions? – The Second Scenario

In order to find out whether the financial results of Víctor Ramírez’s farm, compared to five years ago, is driven by market conditions or the further improvement of the CA system, a second crop budget with the prices, costs and the exchange rate (G to US$) of 1998 was drafted up for the current situation. The result of the second scenario financial analysis is summarized in Table 25\(^6\).

In the second scenario, the comparison of the financial performance of Ramírez’s cultivation activities shows a difference to the first scenario. The net farm income did not increase as much as with the first scenario (see Figure 13), but is still impressive. With

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\(^6\) Appendix 1.4.2. Tables Cassava Oat CA 2003, Black oats and Cassava CA 1998.

\(^6\) Full details of the second scenario financial analysis of Víctor Ramírez’s farm can be found in Appendix A 1.4.3.
TABLE 25. Farm Budget 2003 - 2nd Scenario  
Víctor Ramírez  
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black oats - Soybean</td>
<td>2.00</td>
<td>8</td>
<td>930 (332)</td>
<td>1,859 (665)</td>
</tr>
<tr>
<td>Cassava/Black oats</td>
<td>2.00</td>
<td>56</td>
<td>4,942 (1,765)</td>
<td>9,844 (3,530)</td>
</tr>
<tr>
<td>- Velvetbean (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Maize</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Jack bean (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Dwarf mucuna (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White lupine/Garden pea/ Black oats - Maize/Dwarf mucuna/Cowpea</td>
<td>1.00</td>
<td>26.5</td>
<td>1,632 (583)</td>
<td>1,632 (583)</td>
</tr>
<tr>
<td>Different food crops/ House, Barn, Garden</td>
<td>1.50</td>
<td>22.5</td>
<td>3,671 (1,311)</td>
<td>5,506 (1,967)</td>
</tr>
<tr>
<td>Yerba mate</td>
<td>2.00</td>
<td>5</td>
<td>1,691 (604)</td>
<td>3,382 (1,207)</td>
</tr>
<tr>
<td>- Cassava</td>
<td>1.00</td>
<td>57</td>
<td>3,326 (1,188)</td>
<td>6,653 (2,375)</td>
</tr>
<tr>
<td>- Winter gmcc</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Cowpea/Pumpkin</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Dwarf mucuna (for seeds)</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tung</td>
<td>3.00</td>
<td>17</td>
<td>1,625 (580)</td>
<td>4,872 (1,739)</td>
</tr>
<tr>
<td>Sugarcane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle (in tung)</td>
<td></td>
<td>3</td>
<td>235 (84)</td>
<td>708 (253)</td>
</tr>
<tr>
<td>Agroforestry</td>
<td></td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reforestation</td>
<td></td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>17.50</strong></td>
<td><strong>195</strong></td>
<td></td>
<td><strong>34,490 (12,318)</strong></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 177,324 (US$*/day = 63.33)

*US$1 = G2,800
1 Calculated for cassava/black oats
2 Value based on cassava, peanuts and maize assuming 1/3 each
3 Calculated for cassava
4 Winter gmcc: white lupine, garden pea, vetches, garden bean, black oat, Italian ryegrass
5 Return and costs included in net income from cattle
6 Calculated with gross margin per ha of cattle and area of sugarcane
7 Including 3.5 ha of tung without income and 0.5 ha of eucalyptus, *australian red cedar* and *paraiso gigante* (5 years old)
G34.5 million, his financial performance is about 115% higher than during CA1998. This results in a higher return to labour revenue compared to CA1998 and is at G177,324 (US$63.33), almost 4-times higher than under CC (see Figure 14). Nevertheless, his work is very valuable since the present labour rate per day is at G15,000 (US$5.36) in the region, and it is evident that all family members remain working on the farm.

The increase in total net farm income is as a result of the following:

- Higher profitability of cassava combined with higher income from gmcc seeds;
- Higher yields of yerba mate;
- Higher yield of tung; and
- Cost reduction due to labour-day savings.

Cassava has an overall net farm income of G9.2 million (27% of total) and increased despite the fact that the cultivation area of cassava was decreased from 7 ha to 3 ha, and that Ramírez associates this with other crops and gmcc. For example, if cassava production is considered as an integral part with gmcc (seeds for income) on the same plot, the net income per hectare of cassava is almost G5 million (US$1,765) and more efficient than in CA1998, where cassava (preceded by black oats) accounted for a net income/ha of G834,400 (US$298). Under the second scenario, the net income derived from gmcc seeds is more significant; these account for 11% or G3.8 million. Additionally, the higher yields of cassava (see Figure 13) contribute a considerable part of the more profitable production.

Yerba mate is more significant than in the first scenario, because the market price Ramírez received in 1998 was G60/kg higher than today. Through increased yields from 2,500 kg/ha to 7,000 kg/ha, yerba mate accounts for 10% of the total net farm income, whereas in the first scenario it is calculated to have accounted for only 5%. Due to this, the profitability per hectare of yerba mate also improved; under CA1998 the net income per hectare was of G392,000 (US$140), while the present net income revenue/ha is almost G1.7 million (US$604).

The third reason for the improved net farm income is the more profitable production of tung. Whereas in CA1998 tung had a per ha revenue of G1 million (US$374), in CA2003 this figure increased to G1.6 million (US$580). Since the labour-days spent per hectare rose from 4 to 6, the higher yields must be seen as the influential factor for the tung improvement.

Yerba mate is more significant than in the first scenario, because the market price Ramírez received...

The soybean production has no significant difference in net farm income when compared to CA1998. Nevertheless, the net income revenue increased from G660,800 (US$236) to G929,600 (US$332). The Ramírez managed to decrease the cost by using black oats as the preceding gmcc, which allowed for weeding costs to be maintained (see Table 26) and the slight increase in yields (see Figure 13) also has an influence...
on the more profitable production. However, due to the reduction of the soybean area from 3 ha to 2 ha, the overall contribution to the net farm income can hardly be felt.

**Overall Conclusion of the Financial Analysis**

The current financial performance of the Ramírez’s is most impressive. They have the highest total net farm income of all smallholder case studies in Edelira. When comparing the results of the two scenarios, it is obvious that the Ramírez family cultivated crops, which experienced an increase in commodity prices compared to five years ago. This has to be considered as the main contributing factor for the improving financial conditions under the first scenario. However, the considerable growth in yields is a strong indicator of the enhanced farming performance, and is proved in the second scenario. Here, it is obvious that the Ramírez family would have still achieved an increase in the net farm income without receiving better prices for their products. The improved yields are a result of the mid-term effects of CA. Improved soil fertility was achieved due to a diversified use of gmcc and crop rotations, and by practising and keeping all elements of CA as an integral part of the farming system. Furthermore, Ramírez was able to reduce the workload.

A number of factors contribute to this impressive rise in the financial performance of the farming system in the last five years. An important factor is the further improved management capability and preparedness of this smallholder family to make positive changes to their farming system. This has enabled them to profitably exploit the existing market opportunities, possibly also based on the experiences gained while working as small shop traders.

**Overall Conclusion of the Farming System Performance**

The farming system of the Ramírez family has undergone a continuous improvement since the introduction of CA. This has paid-off in terms of their financial and living conditions. For example, in 2000 the Ramírez family started to save money for building a stone house. After only three years, in June 2003, the construction of the house began, finishing in September 2003. The house has six rooms, running water, and a large kitchen area. The construction of the house has significantly
improved the living conditions of the family, and at the same time reflects their financial security, which can also be seen with their son studying in Asunción.

The farming system is highly diversified, which can be seen in the complementary sources of income and the increased number of animals. The decision to expand the area of food crops, vegetables and fruits, and work them into the CA system too, has had a significant increase in their production, although most of the production is for home consumption. In particular, the construction of the garden’s irrigation system is another example for the advanced management style and risk reduction techniques this smallholder family experienced through the CA system.

The decision to change the cultivation system has paid off for the Ramírez family, not only in financial terms, but also in terms of the improvement in soil fertility and their whole farming system. They emphasize that their management skills improved and that they want to continue to improve their farming activities by increasing the diversification of production. They plan to construct a fish basin in order to produce fish (tilapia). In terms of market potential, the main road location of the farm is most likely to pay-off in the future. In addition, the fruit produced on the 1.5 hectares of different crops shall be enhanced in order to increase their revenue.

In conclusion, the development process of the Ramírez family seems irreversible and their sustainable development has been enhanced and backed by Conservation Agriculture.

PHOTO 21. The new house of the Ramírez family
3. **FINANCIAL ANALYSIS OF SMALLHOLDER FARMING SYSTEMS IN SAN PEDRO**

3.1 **BACKGROUND**

3.1.1 **The Study Area**

The district of San Pedro de Ycuamandyyu is located within the San Pedro Department in the northeastern part of East-Paraguay. It is a relatively isolated area with a dirt road access to the nearest asphalt road (some 80 km away), and during heavy rainstorms access is made practically impossible. The town of San Pedro, the capital of the department, has minimal facilities; the government-owned Banco Nacional de Fomento (BNF) is the only commercial bank, and there is also an agency of the CAH and a local cooperative (La Norteña Ycuamandyu Ltda), which provides banking and credit facilities to its rural and urban members.

Small farms in San Pedro have been cultivated for up to 100 years, although many areas have only been cleared of forest during the last two decades. Initially soil cultivation on small farms was carried out manually. In the last 20 years, an expansion in the areas cultivated on small farms has come about with the introduction of work oxen for soil cultivation and even by tractor. According to the most recent census data (CNA 1991), there are almost 30,700 small farms of less than 20 ha in the San Pedro Department occupying almost 224,400 ha. The percentages of farms between 1-5 ha, 5-10 ha and 10-20 ha were 28%, 33% and 39% respectively. Within the district of San Pedro there are about 4,200 farms, 3,000 of which are smallholders with farms of 5 to 20 has\(^63\). Colonies of small farms were established in the district of San Pedro in the early to mid 1970s. Farms were mostly 18 or 20 hectares each. Families migrated to San Pedro from various parts of the country.

The San Pedro District has sandy soils and, although the district is mainly flat in terms of contour, soil erosion is a problem and causes rapid degradation of organic matter and the depletion of soil fertility. Due to this, yields have been declining. Soil conservation measures are generally not undertaken, and crop residues are always burned. Whenever feasible, farmers use crop rotations. Fertilisation is not practised as smallholder farmers are not convinced of its benefit and for the most part chemical fertilizers are not affordable. In the case of cotton, for example, crop yields averaged 1,800 kg/ha 10 years ago and have now fallen to 1,200 kg/ha. Nevertheless, the crop yields on small farms in San Pedro are average by Paraguayan standards.

Cotton is the main cash crop grown in the district on small farms. Smallholder farmers also rely on cassava and maize as sources of income, and in the most recent years, through initiatives of the cooperative, cedron and sesame have taken on some importance on a very small number of farms. Cattle, pigs, ducks and chicken also provide important sources of supplementary farm income. A few farmers sell fresh vegetables and other produce at the San Pedro market on Saturdays. Although important to these few farmers, and to town dwellers alike, very few benefit from this local market initiative. However, the cooperative is well positioned to assist a significant number of smallholder farmers to market their surplus produce, although further support will be needed in the short to medium term to carry this out. With 300 urban members and 340 rural members, the cooperative today is a small-scale operation reaching a very small number of smallholder farmers within the San Pedro Department.

During the Mid-90s, a MAG-GTZ Rural Development Project was the first to introduce CA in the district on small farms (less than 20 ha). It worked together with interested smallholders who were willing to change their cultivating system, and providing the necessary machinery to smallholder farmer groups. They also trained the local extension agents on CA. Nevertheless, the spread of CA was slow and at the end of the project in 1998, no further extension of the number of CA smallholder farmers occurred. Although quality support could no longer be provided from the extension agent service, most of the CA-farmers continued to practice CA\(^64\), in spite of local politics promoting the use of tractors for smallholders.

3.1.2 **The Farming Systems Analysed**

As in the 1998 study, three case study farms were analysed in detail as part of this study, and include one CC system and two CA systems. The farming system of Agustín Aquino is typical of small farms in the San Pedro district where CC is used and cotton is the main

\(^63\) F. Cespedes, pers. comm.

\(^64\) F. Cespedes, pers. comm.
cash crop. The farm type is described below in Section 3.2. The other two farming systems studied are representative of two different types of CA farms, which are located in the district of San Pedro and have their own specifications. These farm types are described below in Section 3.3. The CA farms analysed were those of Lucas Ledezma and Ramón Oporto, the same farmers from the 1998 study.

3.2 CONVENTIONAL CULTIVATION SYSTEMS IN 2003

3.2.1 Introduction

A typical small farm in San Pedro today is about 10 ha, of which half of the farm is cultivated each year\(^{65}\). Generally, a crop rotation is practised, no soil conservation measures are undertaken, and crop residues are burnt. Soils are usually ploughed 2-3 times, and then disc harrowed at least once, prior to sowing a crop. Typically a smallholder farmer will cultivate up to 5 ha with animal traction and grow 2 ha cotton, 1 ha cassava, 1 ha maize, 0.5 ha of peanuts and cowpea, banana or cedrón as an additional cash crop, and 0.25-0.5 ha of various food crops for household consumption. Smallholder farmers have fruit trees, especially citrus and mango, banana, as well as dairy cattle, pigs and chicken. Today, for the most part there is no forest area remaining on the farm. Traditionally, farmers grew tobacco on newly cleared fertile land, but stopped after experiencing declining yields, which occurs with low soil fertility.

3.2.2 Case Study V: Agustín Aquino

General

Agustín Aquino started to farm his 8.5 ha property in 1978\(^{66}\). The property is located about a kilometre from the main road and about 5 km from the San Pedro village. When he purchased the farm, five hectares had already been cultivated and the rest of the farm was covered by native forest. At first, only food crops were grown, but in 1981 cotton was sown for the first time. Thereafter 1.5–2.5 hectares were grown each year. In 1994, velvetbean was first introduced and since then is occasionally grown with maize and cassava, and ploughed into the soil. In 1997, an additional 4 ha of natural pasture land was purchased for the purpose of increasing cattle numbers. Three years later, 2,400 m\(^2\) of the main farm were fenced in order to have a separate cattle area. Last year Aquino cleared another small area of his remaining forest in order to plant cedrón. Today, six hectares of the farm are cultivated with crops and almost no forest remains. He uses work oxen for most of his cultivation activities.

![Photo 22. The house of Agustín Aquino](image)

Dirk Lange

Agustín Aquino and his wife have four children; three of whom live on the farm. The eldest sons (23 and 16) work on the farm, whereas the eldest daughter (20), studies in Asunción. The youngest daughter attends school and helps part time on the farm. Aquino is known as an extremely hard working farmer and never contracts additional labour.

Aquino is an active community leader and the president of the CAH users association, from which he has access to credit. He used to be a member of the local Norteña Ycuamandyyu Ltda cooperative, but left a few years ago.

The farm income is generated from the sale of a variety of crops and fruits at the farm-gate. Additionally, chicken, milk and cheese provide complementary sources of income. In October 2003 a pair of work oxen, two horses, 11 cows (four in lactation), six sows, three piglets, two ducks and 60 chicken were incorporated to the farming system.

The Aquinos own a range of hand-tools and various draft animal implements which include: two ploughs, one seeding machine, three animal traction weeder, two caranchas, a harrower, two jab-planters for cotton, two jab-planters for maize, five hand-hows,
three machetes, two knapsack sprayers, two bicycles and a motorcycle. The machinery is more than five years ago.

Soil Conservation

Soil conservation measures are undertaken only partially, although he suffers from erosion where there are slopes (no contour banks on the farm), and the yields are declining. Whenever possible, crops are rotated, the crop residues are incorporated into the soil and, contrary to five years ago when he would burn on a regular basis, he now hardly ever burns on his farm. Velvetbean is sometimes used after crops and is also incorporated into the soil.

Agustín Aquino mentioned two reasons for not practising CA: firstly, he does not have the financial capacity for buying herbicides, which are in his opinion, necessary for practising CA. Secondly, he would not know where to purchase gmcc seeds (with the exception of velvetbean). Nevertheless, he is still satisfied with his crop production

Trends in Crop Yields

The cotton yield has been falling ever since the land was first cleared of the native forest. Initially, cotton yielded 3,500 - 4,000 kg/ha, but these have declined to 2,600 kg/ha in 1998. Fertiliser has never been used on the farm. In the last study, Aquino mentioned that on his neighbour’s farm, where three ploughings are the norm prior to the sowing of all crops, cotton yields have dropped to 800 - 900 kg/ha. Today, cotton yields of 1,150 kg/ha show that crop performance has dropped more than 50% of its production (see Figure 17).

Results of the Financial Analysis

The financial analysis compares the financial results of the farm in 1998 to its current situation. The product prices and input costs of May 1998 and October 2003 are used for the first scenario; whereas the input costs and product prices of 1998 are used for the second scenario.

In the financial analysis, all activities have been valued separately and a crop budget was elaborated, using the same approach as in the 1998 study. In the crop budget, all activities have been included, which are valuable for a comparison of cultivation systems. A simplification has been made in the case of the diverse food crops. The area (about 1.3 ha) includes the house, the barn, and is dedicated to the cultivation of food crops (mainly fruits) and vegetables from the garden. They are grown for the purpose of family consumption and for additional sources of income (e.g. sale of fruits); these have been assigned an economic value on the basis of cassava, peanuts and maize, assuming the value of one-third each. A further simplification made is that the income derived from the production of small animals and cassava flour (almidón), has not been included in the crop budget. To have done so would have com-
plicated the analysis. Since the income derived from these activities would be about the same under both CC and CA, there exclusion does not significantly affect the comparative financial performance of the farm analysed. Nevertheless, they are considered in the general opinion of the development of Aquino’s farming performance.

**Photo 25. The vegetable garden of Agustín Aquino**

Conventional Cultivation 2003 compared to 1998 — The First Scenario

The first scenario financial analysis\(^{68}\) for 2003 and 1998 is presented in Tables 27 and 28.

The first scenario financial analysis of Agustín Aquino’s performance in 2003 compared to 1998 shows an increase, both in net farm income and return to labour. In 1998, the total net farm income was calculated to average G3.5 million (US$1,265) per annum, which has increased to a current G12.4 million (US$1,993) (see Figure 18). The total labour input increased from 183 person days to 225 in 2003, making the return to labour G54,932 (US$8.86) compared to G19,348 (US$6.91) in 1998 (see Figure 19). This makes his work more valuable when compared to five years ago, and since the present labour rate per day is G15,000 (US$2.42) in the region\(^{69}\), it is evident that all family members remain working on the farm.

Overall, the most profitable crops are cassava and pineapple, as can be seen in the per hectare net income returns of G6.2 million (US$1,003) and G5.2 million (US$838), respectively. The net income from maize, which is now grown without velvetbean, is calculated to be negative (see Table 27).

The main reason for the increased net farm income is cassava, generating on its own G6.3 million (US$1,003); close to half of the total farm net income. This is the main net income difference to the 1998 study, where cassava accounted for 35% and was only the second most important source of income at G1.2 million (US$444). The change occurred despite a slight increase in net income with 69 The labour rate in 1998 was at G10,000 (US$3.57).

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\(^{68}\) Full details of the first scenario financial analysis of Agustín Aquino’s farm can be found in Appendix A 2.1.2.

\(^{69}\) The labour rate in 1998 was at G10,000 (US$3.57).
G2.5 million (US$399), based on the higher commodity price of G2,000/kg (G850/kg in 1998). However, the yield decreased from 2,600 kg/ha to 1,150 kg/ha and is, therefore, the main reason for the decreased importance of this traditional cash crop.

When looking in detail at the cassava crop budget\textsuperscript{10}, the most important costs concern weeding and transport, accounting for 25% and 22% respectively. Weeding particularly increased his costs, compared to 1998, from G190,000 to G574,500, because Aquino spent more labour days on this activity. Although, he had only six weedicings, which are two less than in 1998, the total amount of labour days rose from 19 to 31.3 days, which is due to heavier weed infestation. Therefore, the 3-times higher costs for weeding is explained by the increased daily manual labour-day costs from G10,000 to G15,000. Soil preparation costs changed in comparison to 1998, where they accounted for 12%. In fact, these decreased to 9%, but due to Aquino harrowing twice and spending more time on this activity, the total amount of soil preparation cost rose from G115,000 to G195,000 (see Table 29).

Considering the next most important crop, cotton, the soil preparation (25% of total costs) is the greatest cost item\textsuperscript{11}. This is due to the fact that Aquino currently rents a tractor for the first ploughing, which was not the case in 1998. In addition, the second ploughing takes more labour days and increases the costs. However, harvesting costs (24%) decreased by more than 50%, because yields fell to 1,150 kg/ha. By contrast to cassava, weeding costs did not change significantly compared to five years ago.

\textsuperscript{10} Appendix A 2.1.2, Table Cassava.

\textsuperscript{11} Appendix A 2.1.2, Table Cotton.
The increase in labour-days spent from 183 to 225 (see Figure 20) is due to the fact that cassava demands more labour-days. In the cassava crop budget the number of labour-days doubled from 31 to 63 days, although cassava is cultivated on 0.5ha less than in 1998. The reasons, as mentioned, are the increased weeding and harvest days; the latter due to the higher yields. Altogether, cassava, cotton and cattle account for two-thirds of total labour requirement.
Cultivation System or Market Conditions? – The Second Scenario

In order to determine whether the performance of Agustín Aquino’s farm, compared to five years ago, is driven by market conditions or the development of his farming system, a crop budget with the product prices, input costs and the exchange rate (G to US$) of 1998 was drafted up for the present situation. The result of this second scenario is summarized in Table 3072.

The second scenario shows a significant difference to the first scenario. The total net farm income of

72 Full details of the second scenario financial analysis of Agustín Aquino’s farm can be found in Appendix A 2.1.3.
Agustín Aquino’s cultivation performance in 2003 decreased by 13% when compared to 1998. The difference in this performance is due mainly to the lower income from cotton (G243,600), which is based on the decreased yields. Additionally, the more labour-days required, 225 as opposed to 183 in 1998, is another factor for the overall decline in the economic farming performance, since the value for one labour-day is G10,000 (US$3.57). The higher costs for labour-days and the low performance of cotton could not be compensated by the increased net farm income from cassava and pineapple. The latter is, under this scenario, the most profitable crop with a net per hectare income of G5.5 million.

In the second scenario, the costs for soil preparation and weeding have not changed significantly (see Table 31). In this case, cassava costs per hectare for soil preparation slightly increased, which is explained by a second harrowing.

In addition, the return to labour revenue is G13,720, less than in 1998 (see Figure 19) and only slightly more than the regional labour rate of G10,000. Therefore, it would be understandable if the two sons were to leave the farm in search of additional income.

**Photo 27. Cassava preceded by velvetbean which was incorporated into the soil, Agustín Aquino.**

Overall Conclusion of the Financial Analysis

After analysing Agustín Aquino’s current financial performance and comparing it to the 1998 results, it is clear that the higher commodity prices are the main contributing factor to the improved financial performance in 2003. Particularly in the case of cotton, his former main source of income, the better prices compensated the declining yields, which have been proved by the second scenario. The same situation is visible in the net farm income generated from the cultivation of cassava. Whereas, in the first scenario, cassava has an impressive performance of G6.2 million, in the second scenario it accounts for only G1.4 million due to there being no change in commodity prices.

**Overall Conclusion of the Farming System Performance**

Agustín Aquino stated that he is satisfied with his production, which is backed up by his financial performance. In spite of his declining yields, with the exception of cassava resulting from the longer cultivation cycle, and erosion visible on the farm, he generates enough income through his farming system. His daughter is able to study in the capital city of Asunción, which is expensive, and he also expanded his set of working equipment. Nevertheless, commodity prices are an insecure factor in agricultural production (and not only here) and as a result of his declining yields, increased labour-days spent and more production costs, it seems only a matter of time before he may face severe problems. Especially in comparison to the CA farms, his work would not appear as profitable, although Aquino is an extremely hard working farmer.

It can be expected that in about five years time the farming performance will not be sufficient for the whole family and his sons will begin to work part time off-farm. A solution for this would be a change to CA, but the limitations previously mentioned, such as missing investment resources and gmcc seeds, might be constraints to Aquino’s opinion. Compared to 1998, he only diversified his production with pineapple, which is his second most profitable crop per hectare, however, he only cultivates it on a very small area (0.1 ha). Therefore, an enlargement of this area and a further diversification could considerably increase his farming performance.

3.3 **CONSERVATION AGRICULTURE SYSTEMS IN 2003**

3.3.1 **Introduction**

In the early 1990s, the MAG-GTZ Rural Development Project introduced gmcc in San Pedro. Several species were tested, such as vetches, black oats, white oats, blue lupine, white lupine, Italian ryegrass, velvetbean, oil radish, sunnhemp and pigeon pea.
However, only velvetbean has spread significantly. Today, it is estimated that some 600 farmers use velvetbean. About 500 of these farmers are within the district of San Pedro and the remaining 100 in the neighbouring district of San Pablo. Very few of these farmers have adopted CA, and mostly plough velvetbean into the soil. Thus the benefits of the gmcc, such as a soil cover protecting the soil from erosion and providing residual nutrients, are only partially achieved.

The adoption and spread of CA on small farms in San Pedro is still extremely limited. It is estimated that 60 farmers used CA on their farms last year. In the 1998 study it was suggested that these numbers be checked, since they were only estimations. However, these figures remain as estimations due to the postponed CNA 2001, but it is clear that the number of farmers practising CA did not increase. What is known with certainty today is that the 20 farmers, who received intensive technical support in CA from the MAG-GTZ Project, have abandoned their ploughs and adopted CA. These farmers are fully convinced of the value and benefits of CA. Two of these farmers who were interviewed in-depth by the study team in 1998 were already benefiting in their opinion from the adoption of CA and have been included again in this study. The two CA farm types described in this study are differentiated from each other by one factor; one farm is representative for animal traction cultivation and the other for manual labour.

On small farms a number of crops are being grown under CA, which include cotton, cassava, maize, watermelon, tobacco, rock melon and cedrón. It has been possible for farmers to consider growing tobacco again, which is a high soil fertility-demanding crop to be grown economically. It is interesting to see that after one or two years of growing velvetbean in San Pedro, economic benefits from tobacco are once again being felt. Previously, it was only possible to grow tobacco on new land after it was cleared of forest. This shows the significant residual nutrient effects of velvetbean being achieved on the sandy soils of San Pedro.

3.3.2 Case Study VI: Lucas Ledezma

General

The farm of Lucas Ledezma is located in Compania Picada Fernandez, on the main road to Nueva Germania, 5 km from the San Pedro village. He has been farming the 5 hectare property for 49 years (since 1954), however, he only received his land title officially in 1998. Today, he cultivates 3.25 ha of it, since the other 1.75 ha are used by his son. Consequently, Lucas Ledezma rents an additional hectare from his brother for G150,000 to 200,000 per year.

The farm is worked by Lucas Ledezma and his wife. They have nine children (six sons and three daughters) of whom eight no longer live on the farm; two of them work in Canindeyú, two in Asunción, and another two live in the San Pedro village. One son has his own farm neighbouring to the Ledezma property and one daughter lives on another neighbouring property and uses a small area of the Ledezma property for her garden. The other children had to leave due to not being able to obtain land for starting up their own farm. Labour is hired for weeding and, occasionally, their 40 year old son helps them on the farm.

For many years Ledezma was a member of a local cooperative from which credit was obtained for growing cotton. He left the co-operative eight years ago and credit has been obtained from the CAH during 1996 and 1997. Today, he no longer has access to credit due to his 74 years of age and, therefore, investments in his farming system can only be made from his own resources.

Income is earned from the sale of a variety of crops, fruits and velvetbean seeds at the farm gate. Additionally, chicken, pigs, honey, vegetables form his garden and cassava flour are complementary sources of income. In October 2003, six calves, a horse, a young bull, two porkers and 30 chicken formed part of the farming system. In contrast to 1998, Ledezma does not own work oxen and the number of cattle has reduced. This is due to the fact that he was seriously ill in 2000 and 2001, and consequently had to sell all of his older cattle in order to pay the medical bills. During the last year, Lucas Ledezma recovered and started to raise cattle again.

A standard set of manual tools is owned by this farmer, which include: a jab-planter, two hand-hows, an animal traction weeder, two machetes, three axes and a cart. He has access to animal traction CA equip-
ment (knife roller, seeding machine, sprayers); however, due to the missing oxen he is unable to use them. Ledezma sold his plough in 2001, because he considered it unnecessary, which is a contrast to the 1998 study.

**Conventional Cultivation System**

Initially the farm was cultivated manually. Work oxen were first used for ploughing the soil in 1978 when cotton was introduced and became the main crop until 1991. Since then it was no longer grown and income was earned from the sale of food crops, pigs and chicken. In 1993, the opportunity was taken to sell fresh vegetables, chicken and eggs at the Saturday markets in San Pedro, which is continued to this very day. The CC system consisted of growing about 1.5 - 2 ha of cassava and maize, as well as about 0.25 ha of peanuts, cowpea, watermelon and rock melon.

**Modifications to the Farming System with the Adoption of Conservation Agriculture**

Velvetbean was first used in 1995 and with this, CA was introduced on the farm98. The following year Ledezma became convinced of the advantages of CA and has not used his plough since then, although the work oxen were retained until 2001 for weeding purposes. Since then he weeds manually (machete and hand-how) and does not use herbicides. The main gmcc is still velvetbean, but occasionally black oats and/or white lupine are also used to enrich his soil. In general, velvetbean precedes or is associated with all crops, as a gmcc, and the only fertilizer used on the farm; chemical fertilizer was never used on the farm, because Ledezma considers it unnecessary. All crops are rotated regularly and he developed his own rotation system that he maintains:

![Rotation Diagram](Photo28)

Ledezma noted a decrease in pest infestation in his crops and therefore, does not use any pesticides. He additionally enlarged his garden area for a more diversified production and has never applied any chemical inputs; as a result, his production can be considered organic.

98The changes to the farming system can be traced in Appendix A 2.2.1.

**Crop Yields and their Development with Conservation Agriculture**

When starting with cotton, 20 years ago, the yield averaged at 2,000 kg/ha. It decreased to as low as 1,500 kg/ha and in 1992, Lucas Ledezma stopped growing cotton. Maize also experienced a decrease in yields under CC. Initially, the yields reached up to 3,500 kg/ha, but soon declined to 2,500 kg/ha. After the introduction of CA, yields recovered slowly, reaching 3,000 kg/ha in 1998. Today, maize production is approximately 3,240 kg/ha; maize is associated with velvetbean and partially cassava. The latter, experienced an increase in yields after the introduction of CA from 20 t/ha to 25 t/ha, which it maintains to this very day.

The yields of peanuts and cowpea experienced an increase after the introduction of CA. Under CC, both of their yields averaged 1,200 kg/ha. With only two years of CA in 1998, yields rose to 1,600 kg/ha. The current situation is different, while peanut yields continued to rise and are at 2,000 kg/ha, cowpea yields have dropped to 800 kg/ha (see Figure 21). The explanation for this is that cowpea is sown at a lower density.

**PHOTO 28. Peanuts over a velvetbean soil cover, Lucas Ledezma**

![Photo](Dirk Lange)

**Results of the Financial Analysis**

The financial analysis compares the results of the farm under CC, the situation in 1998 after two years of CA, and after seven years of CA in 2003. For the first scenario, the input costs and product prices of May 1998 for CC and CA 1998 are used, and the input costs and product prices of October 2003 are used for CA 2003, whereas, only the input costs and product prices of 1998 are used for the second scenario.
## Table 32. Farm Budget 2003 - 1st Scenario  
Lucas Ledezma  
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velvetbean</td>
<td>0.500</td>
<td>10</td>
<td>2,015 (325)</td>
<td>1,004 (162)</td>
</tr>
<tr>
<td>Velvetbean/Cassava</td>
<td>1.250</td>
<td>48</td>
<td>3,348 (540)</td>
<td>4,179 (674)</td>
</tr>
<tr>
<td>Velvetbean/Cassava/Maize</td>
<td>0.750</td>
<td>30</td>
<td>3,435 (554)</td>
<td>2,579 (416)</td>
</tr>
<tr>
<td>Velvetbean/Maize</td>
<td>0.250</td>
<td>7</td>
<td>1,048 (169)</td>
<td>260 (42)</td>
</tr>
<tr>
<td>Velvetbean/Peanuts</td>
<td>0.100</td>
<td>4</td>
<td>1,172 (189)</td>
<td>118 (19)</td>
</tr>
<tr>
<td>Velvetbean/Cowpea</td>
<td>0.100</td>
<td>4</td>
<td>577 (93)</td>
<td>58 (9)</td>
</tr>
<tr>
<td>Velvetbean/Watermelon</td>
<td>0.125</td>
<td>4</td>
<td>2,976 (480)</td>
<td>372 (60)</td>
</tr>
<tr>
<td>Velvetbean/Rock melon</td>
<td>0.125</td>
<td>4</td>
<td>2,933 (473)</td>
<td>366 (59)</td>
</tr>
<tr>
<td>Velvetbean/Calabash</td>
<td>0.125</td>
<td>4</td>
<td>10,386 (1,675)</td>
<td>1,296 (209)</td>
</tr>
<tr>
<td>Velvetbean/Pumpkin</td>
<td>0.125</td>
<td>4</td>
<td>10,360 (1,671)</td>
<td>1,296 (209)</td>
</tr>
<tr>
<td>Different food crops</td>
<td>0.100</td>
<td>2</td>
<td>1,860 (300)</td>
<td>186 (30)</td>
</tr>
<tr>
<td>Pasture brizantha 2</td>
<td>0.500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture cameroon 2</td>
<td>0.100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane 2</td>
<td>0.100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle 5</td>
<td></td>
<td>9</td>
<td>74 (12)</td>
<td>50 (8)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>4.250</td>
<td>129</td>
<td>11,774 (1,899)</td>
<td></td>
</tr>
</tbody>
</table>

*Return to Labour G/day = 91,264 (US$*/day = 14.72)

1 Value based in cassava, peanuts and maize assuming 1/3 each  
2 Return and costs included in net income of cattle  
3 Calculated with gross margin per ha of cattle and area of pastures/sugarcane
A simplification has been made with the area of diverse food crops (about 0.1 ha), dedicated to the production of food crops, fruits and vegetables from the garden. This area has been given an economic value on the basis of cassava, peanuts and maize, assuming the value for one-third of each. A further simplification made is that the income derived from the production of small animals and the preparation of cassava flour, has not been included into the crop budget. To have done so would have complicated the analysis. Since the income derived from these activities would be about the same under both CC and CA, their exclusion does not significantly affect the comparative financial performance of the farm analysed. Nevertheless, they are considered in the general opinion of the development of the farming performance.


The financial analysis for the first scenario under CA today, in 1998, and of the CC system is presented in Tables 32, 33 and 34.

The first scenario financial analysis of Lucas Ledezma’s farming performance in CA2003 compared to CA1998 shows an increase in net farm income. In 1998 it was calculated at G5.8 million (US$2,063) per annum and has increased to a current G11.8 million (US$2,178) (see Figure 22), which means that the financial performance almost doubled. When compared to CC (G8 million), the net farm income increased almost 7.5-times.

The total labour requirement decreased from 156 person days in CA1998 to 129 in CA2003, which is

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**Table 33. Farm Budget 1998**

Lucas Ledezma

Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velvetbean/Cassava</td>
<td>1.25</td>
<td>28</td>
<td>1,366 (488)</td>
<td>1,705 (609)</td>
</tr>
<tr>
<td>Velvetbean/Maize</td>
<td>2.00</td>
<td>69</td>
<td>1,241 (443)</td>
<td>2,481 (886)</td>
</tr>
<tr>
<td>Velvetbean/Peanuts</td>
<td>0.25</td>
<td>6</td>
<td>1,142 (408)</td>
<td>286 (102)</td>
</tr>
<tr>
<td>Velvetbean/Cowpea</td>
<td>0.25</td>
<td>6</td>
<td>1,210 (432)</td>
<td>302 (108)</td>
</tr>
<tr>
<td>Velvetbean/Tobacco</td>
<td>0.25</td>
<td>30</td>
<td>2,621 (936)</td>
<td>655 (234)</td>
</tr>
<tr>
<td>Velvetbean/Watermelon</td>
<td>0.25</td>
<td>6</td>
<td>605 (216)</td>
<td>151 (54)</td>
</tr>
<tr>
<td>Velvetbean/Rock melon</td>
<td>0.25</td>
<td>6</td>
<td>683 (244)</td>
<td>171 (61)</td>
</tr>
<tr>
<td>Pasture ¹</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane ¹</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle ²</td>
<td>7</td>
<td>48</td>
<td>(17)</td>
<td>25 (9)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>5.00</strong></td>
<td><strong>156</strong></td>
<td><strong>48</strong></td>
<td><strong>5,776</strong> (2,063)</td>
</tr>
</tbody>
</table>

*US$1 = G2,800

¹ Return and costs included in net income of cattle

² Calculated with gross margin per ha of cattle and area of pasture/sugarcane

**Return to Labour G/day = 36,904 (US$*/day = 13.18)**

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* Full details of the first scenario financial analysis of Lucas Ledezma’s farm can be found in Appendix A 2.2.2.
The labour rate in 1998 was at G10,000 (US$3.57). Even a further reduction compared to CC where 164 labour days were required, however, the cultivation area is less than in 1998. Due to less labour-days, his return to labour revenue in CA2003 is G91,264 (US$14.72), which is significantly more than in CA1998 (G36,904 or US$13.18). Moreover, when compared to the return to labour revenue of CC (G9,772 or US$3.49), it increased almost 10-times (see Figure 23). In conclusion, the high return to labour revenue means that Lucas Ledezma’s and his wife’s work is very efficient. When comparing this to the average daily manual wage of G15,000 (US$2.42) in the region, it is evident that he remains working on the farm.

The improved financial performance of Ledezma’s farm production has occurred in spite of cultivating 0.75ha less than five years ago. The net farm income increased due to the following:

- Profitability per hectare of cassava has increased 145% from almost G1.4 million (US$488) to G3.3 million/ha (US$540);
- Cultivation of cassava associated with maize and preceded by velvetbean, which generates an additional G2.6 million (US$416);
- Production of velvetbean seeds for sale; and
- Diversification of production with calabash and pumpkin, which turned into the most profitable crops per hectare, each contributing G1.3 million (US$209) to the net farm income.

Cassava, preceded by velvetbean, is the main revenue and accounts for 35% of the total net farm income. It increased from G1.7 million in CA1998 to G4.2 million in CA2003. Since cassava maintained its yield and the market prices rose from G90 to G200 the latter has to be seen as the main reason. A further cost reduction in terms of soil preparation and weeding, which were the main change from the first study, have not occurred (see Table 35). By contrast, the production costs per hectare have almost doubled due to the increase in labour-day wages from G10,000 to G15,000. Ledezma required an additional 15 labour days, which is understandable with his 74 years of age and the ill-
Figure 22. Comparison of Net Farm Income - Lucas Ledezma.

<table>
<thead>
<tr>
<th></th>
<th>Conventional 1998</th>
<th>CA 1998</th>
<th>CA 2003 (1st Scenario)</th>
<th>CA 2003 (2nd Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>1,596,000</td>
<td>5,776,400</td>
<td>11,773,800</td>
<td>7,604,800</td>
</tr>
</tbody>
</table>

Figure 23. Comparison of Return to Labour - Lucas Ledezma.

<table>
<thead>
<tr>
<th></th>
<th>Conventional 1998</th>
<th>CA 1998</th>
<th>CA 2003 (1st Scenario)</th>
<th>CA 2003 (2nd Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>9,772</td>
<td>36,904</td>
<td>91,264</td>
<td>58,940</td>
</tr>
</tbody>
</table>

Figure 24. Comparison of Labour (person-days) - Lucas Ledezma.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>164</td>
<td>156</td>
<td>129</td>
</tr>
</tbody>
</table>
ness he suffered in 2000 and 2001. Additionally, the costs for bags have increased significantly from G59,000 to G500,000 and currently account for 30% of the production costs.

Today, the second most important source of income is maize in association with cassava, preceded by velvetbean. This combination was neither cultivated in CA1998 nor under CC. The reason behind the current cultivation is that Ledezma gave an area of 1.75 ha to his son, which accounted for a large part of his maize area. In order to compensate for this, and since maize and cassava are a very important food and fodder crops, he decided to associate the two crops on an area of 0.75 ha. Due to the very profitable production of G3.4 million/ha (US$554/ha), this intercropped area contributes 22% of the total net farm income.

One of the changes that occurred in the cultivation system of the farm is the dedication of half a hectare solely to the production of velvetbean seeds. The income derived from this activity is G1 million (US$162) and accounts for 9% of the total revenue. Half of this area was formally dedicated to the production of tobacco, which was the most profitable crop in the CA1998 analysis, however, as a result of the labour intensive production (120 labour-days/ha), he decided to stop growing this crop. At the same time, this is the main reason why the total labour spent reduced from 156 to 129 labour-days (see Figure 24). The other half of the area used for producing velvetbean seeds used to be part of the cowpea and peanuts production area. Today, Ledezma cultivates each crop on 0.1 ha; accounting for yet another change in his cultivation system. Even under CC, these two traditional food crops had larger areas for household consumption and always a small share in terms of revenue. As a result of the reduced area, cowpea and peanuts have lost their importance compared to CC.

Maize production experiences the most benefits when changing cultivation systems, by being associated with velvetbean, and has changed from a non-profitable crop into a highly profitable one\textsuperscript{80}. Maize is currently still a profitable crop, but at G1 million (US$169) per hectare less than the profitability/ha in CA1998. By contrast, maize is now preceded by velvetbean and the seeds of the gmcc are no longer sold, because Ledezma produces these on a separate area. In addition, the weeding costs rose (see Table 35) due to the fact that the labour-days spent increased, because weeding is now done manually and not with the help of an animal traction weeder.

Nevertheless, the minor importance of maize was compensated by diversifying the production with calabash and pumpkin, which are currently the most profitable crops cultivated. Each of these contributes almost G1.3 million (US$209) to the net farm income and accounts for 11%. The decision to cultivate these two crops was influenced by two factors: firstly, Lucas Ledezma’s wife continues to sell them at the local mar-

\begin{table}[h]
\centering
\caption{Comparison of Costs/ha for Soil Preparation and Weeding in G Conventional Cultivation, CA 1998 and CA 2003 - 1st Scenario}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Crop & Soil Preparation & & Weeding & & \\
& Cultivation & & & Cultivation & & \\
\hline
Cassava* & 110,000 & 50,000 & 75,000 & 120,000 & 20,000 & 150,000 \\
Maize* & 240,000 & 85,000 & 75,000 & 320,000 & 120,000 & 180,000 \\
\hline
\end{tabular}
\end{table}

\textsuperscript{80} Sorenson et al., 1998.
**Table 36. Farm Budget 2003 - 2nd Scenario**

**Lucas Ledezma**  
**Conservation Agriculture**

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velvetbean</td>
<td>0.500</td>
<td>10</td>
<td>2,170 (775)</td>
<td>1,084 (387)</td>
</tr>
<tr>
<td>Velvetbean/Cassava</td>
<td>1.250</td>
<td>48</td>
<td>1,481 (529)</td>
<td>1,851 (661)</td>
</tr>
<tr>
<td>Velvetbean/Cassava/Maize</td>
<td>0.750</td>
<td>30</td>
<td>1,523 (544)</td>
<td>1,142 (408)</td>
</tr>
<tr>
<td>Velvetbean/Maize</td>
<td>0.250</td>
<td>7</td>
<td>484 (173)</td>
<td>120 (43)</td>
</tr>
<tr>
<td>Velvetbean/Peanuts</td>
<td>0.100</td>
<td>4</td>
<td>1,450 (518)</td>
<td>146 (52)</td>
</tr>
<tr>
<td>Velvetbean/Cowpea</td>
<td>0.100</td>
<td>4</td>
<td>403 (144)</td>
<td>39 (14)</td>
</tr>
<tr>
<td>Velvetbean/Watermelon</td>
<td>0.125</td>
<td>4</td>
<td>1,075 (384)</td>
<td>134 (48)</td>
</tr>
<tr>
<td>Velvetbean/Rock melon</td>
<td>0.125</td>
<td>4</td>
<td>1,070 (382)</td>
<td>134 (48)</td>
</tr>
<tr>
<td>Velvetbean/Calabash</td>
<td>0.125</td>
<td>4</td>
<td>11,239 (4,014)</td>
<td>1,406 (502)</td>
</tr>
<tr>
<td>Velvetbean/Pumpkin</td>
<td>0.125</td>
<td>4</td>
<td>11,220 (4,007)</td>
<td>1,403 (501)</td>
</tr>
<tr>
<td>Different food crops</td>
<td>0.100</td>
<td>2</td>
<td>1,140 (407)</td>
<td>115 (41)</td>
</tr>
<tr>
<td>Pasture brizantha</td>
<td>0.500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture cameroon</td>
<td>0.100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>0.100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>9</td>
<td>45</td>
<td>(16)</td>
<td>31 (11)</td>
</tr>
</tbody>
</table>

**Totals**  
4.250 129 7,605 (2,716)

*Return to Labour G/day = 58,940 (US$*/day = 21.05)*

---

*US$1 = G2,800

1 Value based in cassava, peanuts and maize assuming 1/3 each
2 Return and costs included in net income of cattle
3 Calculated with gross margin per ha of cattle and area of pastures/sugarcane

---

**Table 37. Comparison of Costs/ha for Soil Preparation and Weeding in G**

**Conventional Cultivation, CA 1998 and CA 2003 - 2nd Scenario**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil Preparation</th>
<th>Weeding</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava*</td>
<td>110,000</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Maize*</td>
<td>240,000</td>
<td>85,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>

* In CA Velvetbean included
ket in San Pedro and secondly, the Ledezma’s can also sell them at the main road, which proves to be a location advantage.

Cultivation System or Market Conditions? – The Second Scenario

In order to determine whether the farming performance of Lucas Ledezma’s farm, compared to five years ago, is driven by market conditions or the further improvement of the CA system, a crop budget with the prices, costs and the exchange rate (G to US$) of 1998 was drafted up for the current situation. The result of the second scenario financial analysis is summarized in Table 36.

The comparison of the financial performance of the cultivation activities under the second scenario shows a difference with the first scenario. The net farm income did not increase as much as with the current product prices and input costs (see Figure 22). Nevertheless, the financial performance is of G7.6 million, about 35% higher than in CA1998. This results in a 50% higher return to labour revenue compared to CA1998 and is G58,940 (US$21.05), about 6-times higher than under CC, but not as high as in the first scenario (see Figure 23). The work is nevertheless very valuable since the labour rate per day in this scenario is G10,000 (US$3.57) in the region, and it is evident that he and his wife remain working on the farm.

The reasons for the improved net farm income are:

- Slightly more profitable cassava production; and
- Calabash and pumpkin production.

Cassava accounts for G1.85 million (US$661) of the total net farm income. This is an increase of 9% compared to CA1998. Since under this scenario the commodity price for cassava is the same as five years ago, the change had to occur by reducing the costs. As can be seen in Table 37, the costs for soil preparation and weeding were not reduced. By contrast, the costs for weeding increased due to the labour-days. However, Ledezma decided to change the transportation method and now pays per bag and not per kg. When looking at the crop budget of velvetbean/cassava, it is clear that the reduced transportation costs save G325,000 per ha, and is the reason for the increased income.

The other notable change in total income compared to 1998 is the introduction of calabash and pumpkin. Both of these are now the most profitable at G11.2 million (US$4,012) per hectare; contributing 18% to the net farm income.

Overall Conclusion of the Financial Analysis

After comparing the two scenarios it can be seen that under the first scenario the better commodity price for cassava is currently the deciding item for the higher net farm income. In addition, it is visible that the introduction of calabash and pumpkin, for revenue reasons, has been a good management decision, because they account for at least 20% of the total net farm income (first scenario). On the other hand, it also proves that the production is slowly becoming diversified on this formerly cassava dominated farm, were the latter accounted for 86% of the total income under the conventional system. Due to this, a further risk reduction was achieved.

After five more years under CA, it is clear that the cost reducing advantages, achieved by the change in cultivation systems, has not advanced, which is visible in the second scenario and by comparing the soil preparation and weeding costs, in spite of Lucas Ledezma reducing his total labour-days compared to 1998. The latter has to be attributed to the reduced cultivating area as the main reason, as well as no longer cultivating tobacco, which was very labour demanding.

Overall Conclusion of the Farming System Performance

The farming system of Lucas Ledezma improved not only financially, as seen in the financial analysis, but also due to the fact that it gained more stability. The diversifi-
cation of production, which is combined with traditional sources of income such as crops, vegetables form the garden, cassava flour, eggs (five dozen per week), honey and small animals advanced considerably. Setbacks, such as the case of illness in 2000 and 2001 that was emphasised by Lucas Ledezma, were overcome. In his opinion, it was possible to overcome the illness, since he was able to continue working during these two years and generate income to pay the medicine. Under CC, the workload would have been too much. The advantage of the CA system can be proved by this example, as well as the fact that, despite his 74 years of age, he continues to work his property.

The improved living conditions of Lucas Ledezma can be seen since he was able to buy a small cart and a horse (approx. cost G2 million) at the beginning of 2003, in order to help sell more products at the local market and further improve his income. This purchase is even more impressive since Ledezma has no access to credits, and the money for this investment had to come from his own production and family. As a further sign of his enhanced social conditions, Lucas Ledezma obtained his land title in 1998.

The seven years of CA improved his experience with the system and he started to create his own version, adapted to his own conditions, personal preferences, favourite crops, and even to his age. The use of velvet-bean as the only gmc is proof of this.

A small step forward in his farming system and success with CA mentioned by Ledezma, was when he reported that his neighbour asked him to provide velvet-bean seeds for the first time, with the intention of introducing gmc on his farm. Lucas Ledezma is very satisfied with his decision to have changed his cultivation systems.

3.3.3 Case Study VII: Ramón Oporto

General

The Oporto farm has 8.5 hectares neighbouring the farms of Agustín Aquino and Lucas Ledezma some 5 km from San Pedro village. Ramón Oporto has been farming the property since 1972, and holds a full land title for the land. At this time, it was almost completely covered by native forest.

The farm is worked by Ramón Oporto, his wife and his two eldest sons (20 and 18) who all live on the farm. The youngest son (13), two daughters, and a granddaughter live there and help working on the farm. The eldest daughters live and work in Asunción. As an exceptional case in this study, Oporto pays his two elder sons a small salary, and labour is never contracted.

Oporto is not a member of the local cooperative and does not obtain credit from any institution or private company. Therefore, all investments in the farming system are directly derived from the farm production.

The farm income is generated from the sale of a variety of crops, fruits and occasionally velvet-bean seeds at the farm gate. Additionally, chicken, eggs (eight to nine dozens per week), pigs, cattle and cassava flour build complementary sources of income. In October 2003, a pair of work oxen, eight cattle, one dairy cow, two horses, four sows and six fattening pigs, three sheep and 150 chicken were owned, which is more than five years ago.
A normal range of manual tools and draft animal equipment belong to the farming system, including a knife roller, a cart, two jab-planters, two ploughs, two animal drawn weeder, two knapsack sprayers, four hand-hoes and three machetes. Additionally the Oportos own a silo for 250 kg, a generator, a forrajero, four bicycles, and an electric water pump. Oporto has access to a wide range of CA equipment, both manual and animal traction.

**Conventional Cultivation System**

Initially, tobacco was the main crop. One hectare was seeded on new land following the clearing of forest. Over the years, the area of tobacco was reduced to 0.2 ha and cotton became the main cash crop, which was first seeded in 1974. Cassava, maize and peanuts were grown for household consumption. Cultivation was always practised with oxen.

Before the introduction of CA, the CC system consisted of growing about 3 hectares of cotton, 1 hectare of cassava intercropped with maize, 0.25 ha of peanuts and another 0.25 ha of diverse food crops; there were 2.75 ha of native pasture, 0.75 ha of planted pasture, as well as small areas of sugarcane and agroforestry. The size of cultivation and pasture/agroforestry areas has been maintained since the introduction of CA in 1996.

No specific soil conservation measures were used. Cotton has always been seeded in the same area and all crop residues were burnt. Soil compaction had been a problem.

**Modifications to the Farming System with the Adoption of Conservation Agriculture**

In 1994, velvetbean was first sown when 10 kg of seed were received from the MAG-GTZ project. Two years later, Oporto participated in the CA conference for smallholder farmers in Hohenau, Itapúa. From this time onwards, he was convinced that CA would provide a sustainable form of farming for him and he has never used his plough again nor has he burnt residues\(^{84}\).

Since its introduction, velvetbean had been the main gmcc used in his farming system, although small areas of jack bean, pigeon pea, white lupine and sunnhemp had also been seeded. Initially, velvetbean was associated with maize, followed by the intercropping of maize, cassava and velvetbean. Later, it was also associated with peanuts and tobacco. Oporto started early with the sale of velvetbean seeds. For this reason, as well as for enriching his soil, the other gmcc were introduced, however, he stopped producing in 1998/99 due to no longer being able to market them. This year, he started sowing gmcc again for the sole purpose of increasing his soil fertility, and included pigeon pea, sunnhemp, leucaena, jack bean and garden pea. Nevertheless, during the last five years velvetbean remained an important part of his CA system, although it is only planted when considered necessary, with the exception of peanuts, where it is seeded before and afterwards.

Through his improved management skills, Oporto produces all of his seeds (crops and gmcc), because he knows that his production depends on good quality seeds\(^{85}\). Alfalfa was introduced in 1999 for the diversification of his production and for improving his cattle feed, developing into a complementary source of income. He always rotates his crops and has developed a rotation system tailored to his needs that he maintains to this very day:

\[
\text{Velvetbean} \rightarrow \text{maize} \rightarrow \text{velvetbean} \rightarrow \\
\text{cassava + maize} \rightarrow \text{velvetbean} \rightarrow \\
\text{peanuts or cowpea} \rightarrow \text{etc.}
\]

No chemical fertiliser has ever been used on this farm and there are no plans to do so in the future. In this farmer’s opinion, fertiliser is too expensive and does not improve the soil very much, which he has observed on the neighbouring farms. Since Oporto stopped growing cotton nine years ago, he no longer applies pesticides, which was the initial reason for dropping the cotton cultivation. Herbicide has also never been used, being considered unnecessary. Therefore, his production can be considered organic.

Oporto is a multiplier of CA. He participated in many workshops on CA (e.g. in Horqueta, Villarica, Independencia) and conferences like the 2\(^{nd}\) Encuentro Latino Americano de Siembra Directa en Pequeñas Fincas in Edelira 1998 and the 3\(^{rd}\) Encuentro Latino Americano de Siembra Directa en Pequeñas Fincas in Pato Branco, Brasil. When the MAG-GTZ project came to an end, he no longer took part in CA workshops or conferences, but he continues to present his experience in the local cooperative. Due to his work, he receives

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\(^{84}\) The changes to the farming system can be traced in Appendix A 2.3.1.

\(^{85}\) R. Oporto, pers. comm.
**Table 38. Farm Budget 2003 - 1st Scenario**  
Ramón Oporto  
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava/Maize</td>
<td>3.00</td>
<td>92</td>
<td>4,526 (730)</td>
<td>13,572 (2,189)</td>
</tr>
<tr>
<td>Cowpea (3 times per year)</td>
<td>0.25</td>
<td>15</td>
<td>1,190 (192)</td>
<td>893 (144)</td>
</tr>
<tr>
<td>Velvetbean/Peanuts</td>
<td>0.25</td>
<td>7</td>
<td>3,373 (544)</td>
<td>843 (136)</td>
</tr>
<tr>
<td>Pineapple</td>
<td>0.40</td>
<td>10</td>
<td>6,504 (1,049)</td>
<td>2,604 (420)</td>
</tr>
<tr>
<td>Calabash</td>
<td>0.25</td>
<td>4</td>
<td>651 (105)</td>
<td>161 (26)</td>
</tr>
<tr>
<td>Different food crops¹/House, Barn, Garden</td>
<td>0.85</td>
<td>26</td>
<td>4,526 (730)</td>
<td>3,844 (620)</td>
</tr>
<tr>
<td>Pasture natural²</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture planted²</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>0.25</td>
<td>10</td>
<td>2,982 (481)</td>
<td>744 (120)</td>
</tr>
<tr>
<td>Sugarcane ²</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture cameroon²</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agroforestry</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle³</td>
<td>40</td>
<td>62</td>
<td>10 (10)</td>
<td>43 (7)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>8.50</strong></td>
<td><strong>202</strong></td>
<td><strong>22,711 (3,663)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 112,592 (US$*/day = 18.16)

---

*US$1 = G6,200  
¹ Value based on cassava/maize  
² Return and costs included in net income of cattle  
³ Calculated with gross margin per hectare of cattle and area of pastures/ sugarcane
Results of the Financial Analysis

The analysis compares the financial results of the Oporto farm under CC, the situation in 1998 after two years of CA, and the present farming performance. For the first scenario, the same input costs and product prices from the first study (May 1998) are used for CC and CA1998, while the current input costs and prices are used for the CA2003 case. For the second scenario only the input costs and product prices from 1998 are used.

A simplification has been made with the area of diverse food crops (about 0.85 ha), dedicated to the production of food crops, fruits and vegetables from the garden. This area has been given an economic value on the basis of cassava/maize, as in the 1998 study. A further simplification made is that the income derived from the production of small animals and the preparation of cassava flour has not been included in the analysis.

TABLE 39. Farm Budget 1998
Ramón Oporto
Conservation Agriculture

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velvetbean/Cotton</td>
<td>1.00</td>
<td>23</td>
<td>1,282 (458)</td>
<td>1,282 (458)</td>
</tr>
<tr>
<td>Velvetbean/Cassava/ Maize</td>
<td>2.00</td>
<td>70</td>
<td>1,593 (569)</td>
<td>3,186 (1,138)</td>
</tr>
<tr>
<td>Velvetbean/Maize</td>
<td>0.75</td>
<td>16</td>
<td>1,190 (425)</td>
<td>893 (319)</td>
</tr>
<tr>
<td>Velvetbean/Peanuts</td>
<td>0.25</td>
<td>6</td>
<td>1,112 (397)</td>
<td>277 (99)</td>
</tr>
<tr>
<td>Velvetbean/Tobacco</td>
<td>0.25</td>
<td>30</td>
<td>3,511 (1,254)</td>
<td>876 (313)</td>
</tr>
<tr>
<td>Different food crops / House, Barn, Garden</td>
<td>0.25</td>
<td>9</td>
<td>1,593 (569)</td>
<td>398 (142)</td>
</tr>
<tr>
<td>Pasture natural</td>
<td>2.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture planted</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agroforestry</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>50</td>
<td>48 (17)</td>
<td>183 (65)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>8.50</strong></td>
<td><strong>203</strong></td>
<td><strong>7,098 (2,535)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to Labour G/day = 34,916 (US$*/day = 12.47)

*US$1 = G2,800
1 Value based on cassava/maize
2 Return and costs included in net income of cattle
3 Calculated with gross margin per hectare of cattle and area of pastures/ sugarcane

Crop Yields and their Development with Conservation Agriculture

Cotton initially yielded an average of 3,000 kg/ha, but dropped to about 2,000 kg/ha. Over a period of 20 years it was grown on the farm under CC. Cotton was last cultivated 9 years ago. Maize yields initially decreased and have maintained about 2,000 kg/ha. It is always intercropped with cassava, yielding around 20 t/ha. Under CA, the two crops are grown with velvetbean, and yields of both crops increased considerably in only two years, reaching 2,500 kg/ha and 25 t/ha respectively. After five years more of CA, the yields of cassava increased to 28 t/ha, or from 4 kg/plant to 8 kg/plant. On the contrary, maize yields fell to 2,300 kg/ha, which is explained by a lower seeding density (see Figure 25).
the crop budget. To have done so would have complicated the analysis. Since the income derived from these activities would be about the same under both, conventional cultivation and CA, their exclusion does not significantly affect the comparative financial performance of the farm analysed. Nevertheless, they are considered in the general opinion of the development of the farming performance.

**Comparisons between Conservation Agriculture of 2003, 1998, and the Conventional Cultivation System – The First Scenario**

The first scenario financial analysis of the farm under CA today, in 1998, and under CC is presented in Tables 38, 39 and 40.

The first scenario financial analysis of the farming performance in CA2003 compared to CA1998 shows an impressive increase in net farm income. In CA1998, this was calculated at G7.1 million (US$2,535) per annum, whereas today this has boosted to more than G22.7 million (US$3,663) in CA2003 (see Figure 27). This means that the financial performance increased more than 3-times. When compared to CC (G4 million), the net farm income increased 5.5-times.

The total labour requirement reduced by one person-day from 203 in CA1998 to 202 in CA2003, which is, therefore, the same difference compared to the conventional system where 163 labour days were required (see Figure 29). Due to the increased net farm income, his return to labour revenue in CA2003 is G112,592 (US$18.16), which works out to be more than 3-times higher than that experienced in CA1998 (G34,916 or US$12.47). Moreover, when compared to the return to labour revenue of CC (G24,808 or US$8.86), he has an overall increase of almost 5-times (see Figure 23). In conclusion, the high return to labour means that Oporto’s work is very valuable. When comparing this to the average daily wage of G15,000

---

**Table 40. Farm Budget 1998**

<table>
<thead>
<tr>
<th>Crop/Activity</th>
<th>Area (ha)</th>
<th>Labour (person-days)</th>
<th>Net Income per ha in TG (US$*)</th>
<th>Net Farm Income in TG (US$*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>3.00</td>
<td>75</td>
<td>759 (271)</td>
<td>2,276 (813)</td>
</tr>
<tr>
<td>Cassava/Maize</td>
<td>1.00</td>
<td>24</td>
<td>1,165 (416)</td>
<td>1,165 (416)</td>
</tr>
<tr>
<td>Peanuts</td>
<td>0.25</td>
<td>9</td>
<td>521 (186)</td>
<td>132 (47)</td>
</tr>
<tr>
<td>Different food crops/ House, Barn, Garden</td>
<td>0.25</td>
<td>6</td>
<td>1,165 (416)</td>
<td>291 (104)</td>
</tr>
<tr>
<td>Pasture natural</td>
<td>2.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture planted</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agroforestry</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle²</td>
<td></td>
<td>50</td>
<td>48 (17)</td>
<td>183 (65)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>8.50</strong></td>
<td><strong>163</strong></td>
<td></td>
<td><strong>4,043 (1,444)</strong></td>
</tr>
</tbody>
</table>

*Return to Labour G/day = 24,808 (US$*/day = 8.86)*

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*US$1 = G2.800

¹ Value based on cassava/maize

² Return and costs included in net income of cattle

³ Calculated with gross margin per hectare of cattle and area of pastures/ sugarcane

---

86 Full details of the first scenario financial analysis of Ramón Oporto’s farm can be found in Appendix A 2.3.2.
**FIGURE 26. Comparison of Net Farm Income - Ramón Oporto.**

<table>
<thead>
<tr>
<th></th>
<th>Conventional 1998</th>
<th>CA 1998</th>
<th>CA 2003 (1st Scenario)</th>
<th>CA 2003 (2nd Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>4,043,200</td>
<td>7,098,000</td>
<td>22,710,600</td>
<td>13,557,600</td>
</tr>
</tbody>
</table>

**FIGURE 27. Comparison of Return to Labour - Ramón Oporto.**

<table>
<thead>
<tr>
<th></th>
<th>Conventional 1998</th>
<th>CA 1998</th>
<th>CA 2003 (1st Scenario)</th>
<th>CA 2003 (2nd Scenario)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>24,808</td>
<td>34,916</td>
<td>112,592</td>
<td>67,200</td>
</tr>
</tbody>
</table>

**FIGURE 28. Comparison of Labour (person-days) - Ramón Oporto.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>163</td>
<td>203</td>
<td>202</td>
</tr>
</tbody>
</table>
in the region, it is evident that all family members remain working on the farm.

The improved financial performance of Oporto’s cultivation activities has been achieved as a result of the following:

- Higher profitability of cassava/maize production per hectare based mainly on the higher cassava market prices;
- Higher profitability of velvetbean/peanuts production per hectare based on increased yields of peanuts; and
- Introduction of pineapple, alfalfa and cowpea as additional sources of income.

The main impact on the increased net farm income is as a result of the more profitable production/ha of cassava/maize and the extension of the cultivated area from 2 to 3 ha. Cassava currently accounts for G4.5 million (US$730) per hectare, whereas in 1998 the per hectare revenue was G1.6 million (US$569). The more profitable production is derived mainly from, firstly, the market prices of cassava having risen from G90/kg to G200/kg and secondly, the yields of cassava increasing from 25t/ha to 28t/ha. Additionally, maize experienced a rise in commodity price and contributes with G350/kg (G200/kg in 1998) to the farm revenue. By contrast, the costs for cultivation increased due to velvet-bean no longer preceding cassava/maize. The explanation for is that the weeding costs doubled because velvetbean no longer suppresses weeds (see Table 41), however, the production costs also rose due to labour-day wages increasing from G10,000 to G15,000 per day. Therefore, the weeding costs are even higher than under the conventional system. The total net farm income of cassava/maize is G13.6 million (US$2,189), more than 4-times higher than in CA1998, and accounts for 60% of the total net farm income.

The other very profitable source of income is peanuts, preceded by velvetbean. This crop has a per hectare revenue of G3.4 million (US$544) and is almost 3-times more profitable than in CA1998. This is a result of the peanuts yields increasing from 1,600 kg/ha to 2,600 kg/ha. At the same time, the commodity prices rose from G1,000/kg to G1,500/kg. Additionally, Oporto harvested 150kg of velvetbean seeds and sold them to the local cooperative.

The third change in net farm income is a result of the introduction of pineapple and cowpea as additional sources of income. Pineapple is currently the most profitable and generates G6.5 million (US$1,049) per hectare. Although, it is only cultivated on 0.4ha of the farm, it accounts for 11% of the total net farm income. If we consider that pineapple replaced velvetbean/tobacco as another source of income, and looking at the profitability per ha of both (see Tables 38 and 39), it is clear this management decision paid-off. The second new crop on the farm is cowpea, but it only generated G893,000. The third new crop is alfalfa, which has a net farm income of G744,000. Although both crops do not have a significant share in the total net farm income, the introduction has to be seen as positive signs for a further diversification.

Cultivation System or Market Conditions? – The Second Scenario

In order to determine whether the farming performance, compared to five years ago, is driven by market conditions or the further improvement of the CA system, a crop budget with prices, costs and the exchange rate (G to US$) of 1998 was drafted up for the current situation. The result of the second scenario financial analysis is summarized in Table 41.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Soil Preparation</th>
<th>Conventional Cultivation</th>
<th>CA 1998</th>
<th>CA 2003</th>
<th>Weeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava/Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conventional Cultivation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1998</td>
<td>44,900</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2003</td>
<td>120,000</td>
<td>65,000</td>
<td>130,000</td>
</tr>
</tbody>
</table>

The comparison of the financial performance shows that the cultivation activities under the second scenario...
show a difference to the first scenario. The net farm income did not increase as much as with the current product prices and input costs (see Figure 27). Nevertheless, the financial performance is of G13.6 million (US$4,842), which is about 90% higher than in CA1998, and 335% higher than under CC. This results in an almost 100% higher return to labour revenue compared to CA1998 at G67,200 (US$21.05), or about 270% higher than under conventional cultivation (G24,808 or US$8.86), but not as high as in the first
scenario (see Figure 28). Nevertheless, his work is very valuable since the labour rate per day is G10,000 (US$3.57) in the region, and it is evident that all family members remain working on the farm.

The reasons for the improved net farm income are:

- Higher profitability of cassava/maize production per hectare based on cost reduction and higher cassava yields;
- Introduction of cowpea, pineapple and alfalfa as additional sources of income.

Even under the second scenario, the production of cassava/maize is more profitable than five years ago, which is the first reason for the increased net farm income. The per ha revenue of cassava/maize is G2.15 million (US$769), only half as high as in the first scenario, but still 35% higher than in CA1998. The reason for this is that cassava yields increased from 25t/ha to 28t/ha, and that Ramón Oporto managed to reduce the production costs, due to not using velvetbean as a preceding gmcc. The difference in costs of almost G33,000/ha was reached in spite of the costs for weeding growing from G65,000 to G90,000 per hectare (see Table 43).

The third reason for the improved net farm income is as a result of the introduction of pineapple as another source of income. Under this second scenario, it is the most profitable crop and with almost G7 million (US$2,490) per hectare it works out even more profitable than in the first scenario. Although, it is only cultivated on 0.4ha of the farm, it accounts for 21% of the total net farm income. If considered that pineapple replaced velvetbean/tobacco as a source of income, and looking of the profitability per ha of both (see Tables 39 and 42), then it would seem clear that the management decision paid-off.

The last important reason is the introduction of alfalfa, which is also a fodder crop in Oporto’s farming system. Alfalfa is not only the second most profitable crop per hectare (G3.2 million or US$1,142), but also contributes G798,000 (US$285) or 6% to the total net farm income.

**Overall Conclusion of the Financial Analysis**

After comparing the two scenarios, it is visible that the better commodity price for cassava and the enlargement of the cassava/maize area are the two most decisive factors for the current higher net farm income under the first scenario. Nevertheless, the diversification of his production, with the introduction of cowpea, alfalfa and pineapple is another important factor for the improved financial conditions of Oporto, since they generate together 18% (first scenario) and almost one-third of the total net farm income (second scenario). In particular, the results of the second scenario confirm that the improved financial performance continues over the years practising CA.
By contrast to the first study, the labour reduction in weeding and soil preparation no longer influences the financial performance. It is rather clear that further labour reduction is achieved by the choice of cultivating non labour intensive crops (as in the case of tobacco).

**Overall Conclusion of the Farming System Performance**

Ramón Oporto’s farming system continued to improve over the following five years of CA, which is not only proved by the financial analysis, but also by the socioeconomic conditions of the Oporto’s. The farming system provides all family members, who live on the farm, with enough income so that, for example, the elder sons do not have to leave the farm seeking additional sources of income. As an exception to the other case study farmers Ramón Oporto was able to buy a 250kg silo.

The diversification increased not only on his cultivated area (pineapple, alfalfa and cowpea), but also by having other sources of income on his farm. Through the enhanced cassava production, the Oportos produce more cassava flour, which they sell to a local chipa bakery. They produce vegetables in their garden and sell them in the local Saturday market, as well as fruits. In addition, the trees planted a few years ago will provide another source of income. This case proves that the enhanced income from the agricultural production under CA also serves for investments, since Oporto has no access to credit. He also stated that his cattle are better fed, which he deduces from the enhanced crop production and the use of alfalfa as a fodder crop.

Overall, Oporto reached a risk reduction within his farming system, which can be related to the CA system’s better production. He adjusted the system to his own preferences and conditions in order to save more time, which he would dedicate to other activities. He showed the will to experiment by not using any other gmcc but velvetbean. As soon as he realized that his soil would benefit from a certain variety of gmcc, he did not hesitate to include them again, reversing through this an unfavourable management decision.

Ramón Oporto feels very secure about the future. He emphasized that he now has recreational time, something he never had under the conventional system. As a result, he is interested in purchasing more land (up to 40 ha), not only for his sons, but also to have more work. The latter is clearly an expression of this farmer’s hard working attitude and that the change in cultivation system was an entrance point for his enhanced living conditions and could be the beginning of a sustainable development process for his family and farming system.
Economics and Evolution of Smallholdings Conservation Agriculture in Paraguay. Mid-Term Experiences.
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