Agrarian structure and land use in the Atlantic Zone of Costa Rica

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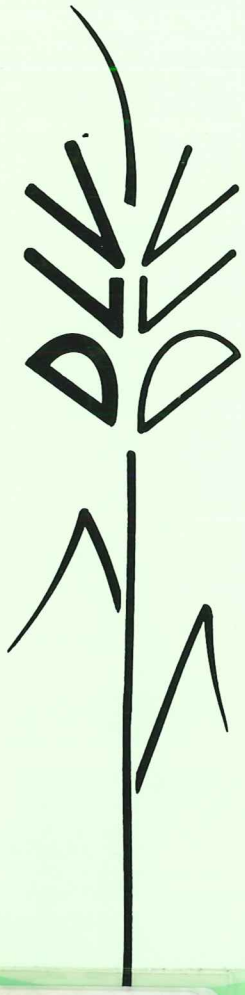
DLV Report no. 3



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The programme "Sustainable land use and food security in developing countries" (DLV) is a cooperative research effort of several institutes in the Netherlands. The major research objective is: "to develop a methodology to integrate agro-ecological and socio-economic information in such a way that options for sustainable land use and food security at a regional level in developing countries can be explored and formulated with the aim of aiding policy makers." The participating institutes are:

Agricultural Research Department (DLO)

- Research Institute for Agrobiology and Soil Fertility (AB-DLO)
- Agricultural Economics Research Institute (LEI-DLO)
- Winand Staring Centre for Integrated Land, Soil and Water Research (SC-DLO)

Wageningen Agricultural University (WAU)

- Dept. of Development Economics
- Dept. of Agronomy
- Dept. of Soil Science and Geology
- Dept. of Theoretical Production Ecology

DLV reports

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DLV is the abbreviation for the dutch programme title "Duurzaam Landgebruik en Voedselvoorziening in de tropen".

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SUMMARY

The objective of this report is to provide an analytical framework for the identification of long term options for sustainable land use and food security in the Atlantic Zone of Costa Rica. Therefore, land use systems and agricultural structure dynamics are analyzed from the perspective of regional policy and farm household objectives to determine the most important trade-offs to be taken into account for future scenario development.

The Atlantic Zone of Costa Rica comprises an area of 9,218 km^2 and can be characterized as a region of recent agricultural colonization through the establishment of tropical lowland settlements. During the last two decades (1963-84) the area experienced population growth (3.5 - 5.3 %) but still maintained a relatively low population density (24.6 per km^2 in 1992). Changes in land use and tenancy structure were significant, especially through rapid deforestation and pasture expansion. The expansion of physical infrastructure opened prospects for highly commercialized agricultural production integrated into (inter)national markets.

The regional economic structure is based mainly on agriculture and commerce, with an increasing importance of (eco)tourism. Banana, plantain, cocoa and maize production are activities with a relatively high land and labour productivity. In the forestry sector important losses occur because of inefficient processing techniques. Livestock land productivity is generally low although pastures occupy more than 60 % of the farm area. The banana plantations are of foremost economic importance with a 84 % share in the agricultural value added and generating 58% of all agricultural employment. Nevertheless, the share of agriculture in total regional employment declined to less than half of total labour force (1992).

Till the early 1980's macro-economic policies were oriented towards import substitution and the export of traditional agricultural products (coffee, cocoa, meat and bananas). Production of basic grains was stimulated through subsidized credit, tariff protection and input price support to control consumers prices. Increasing external debts and budget deficits obliged to structural adjustment programmes that abolished price subsidies, liberalized the exchange rate and oriented agricultural policy towards diversification of (agro)exports. At the same time natural resource management for ecological and tourism development reasons gained momentum in public decisions.

Soils in the northern part of the Atlantic Zone suffer from imperfect drainage conditions (23 % of the area), stony conditions and slopes (43 %). However, in a subregion of the Zone more than 50% of the area is under-used with pastures. Actual land use systems and technologies (LUST's) reflect yield levels above the national average and nutrient depletion under most arable crops. Problems with respect to sustainable production occur because of high biocide and fertilizer use in plantation crops (banana, pineapple), compaction of top soils under poorly drained pastures and fragmentation of natural habitats due to deforestation affecting the regional biodiversity.

Water surplus can be considered as the major yield limiting factor, while yield reducing factors as weeds, pests and diseases are also of major importance in the humid and warm environment of the Atlantic Zone. The combination of excess of water, high biocide and

fertilizer use makes leaching a major concern. However, direct environmental consequences may be limited due to excess of water diluting contaminants. On the economic side labour availability and credit access are limiting factors, while marketing costs and commercial conditions may be considered as income reducing factors.

Alternative land use systems and technologies (LUST's) are based on potential yields levels which input factors are managed in such a way that the efficiency of each production factor is as high as possible at the selected yield level. Tentative calculations indicate that potential production of maize and rice can be twice as high as in the actual situation. Actual LUST's are defined in terms of factor use and real prices of inputs and outputs. In this way they are linked to the purchasing power aspect of food security.

The analysis of the agrarian structure has been based on a stratification of farm types according to major objectives and resource endowments. Three management units have been identified: (i) Peasant households, (ii) Plantations and (iii) Haciendas. Peasant households produce primarily for the market, guaranteeing food security through sufficient purchasing power. Their decisions are guided by consumption and production objectives which can not be separated. Peasant households react to changes in the macro-economic setting, i.e. lower output prices of traditional produce by either diversifying into export crops or by extensification of agricultural production to enable off-farm employment. Plantations are profit oriented firms engaged in banana production or forestry logging, relying on wage labour and utilizing large amount of corporate finance. Plantations react primarily to world market incentives, while government influence is limited to fiscal policy. Their production decisions depend highly on infrastructure, roads and harbour facilities. Haciendas are characterized by quasi-rent objectives. Extensive livestock hacienda investment is in land and cattle. Hacienda production reacts strongly to monetary incentives. Tax incentives and interest subsidies can be considered as suitable instruments to direct livestock expansion.

Local markets in Costa Rica are fairly well developed and integrated, but transaction costs can be high due to poor access. The prices of basic food crops reflect a steady decreasing tendency, while prices for non-traditional crops show strong fluctuations around an somewhat increasing trend. Banana and recently also wood prices show a positive price trend. Real input prices for land tend to decrease over the last decade, but labour costs increased and interest costs reflect strong fluctuations. Consequently, rural incomes of peasant farms that relied primarily on traditional agricultural activities decreased, while net incomes from plantation production and on more diversified peasant farms increased during the last decade.

Average mean family income in the Atlantic Zone is nearly 17% below the national level. Off-farm employment is becoming a more important source of income; Wage labour now represents 76.5 % of total employment. Unemployment rates are low (4.7 % in 1992) due to the stable demand for labour by the banana plantations and other services. The gap between supply and demand is covered by temporary migrants from other areas in Costa Rica and neighbouring countries. Agricultural credit becomes more rationed to specific activities, with emphasis on crop diversification, although special credit arrangements exist for different farm types.

Two major regional objectives can be identified: The improvement of the competitiveness of agricultural production under trade liberalization and natural resource management, especially in the light of expanding eco-tourism. The analysis indicates that improvement of infrastructure with its impact on market functioning and the improvement of credit facilities for small farmers seem to be suitable policy instruments to promote the diversification of agricultural production. At present medium sized farmers dominate the production of non-traditional crops, while the majority of the farms are small peasant households. Natural resource management requires a different approach, with disincentives for excessive biocide use (regulation) and reform of the forestry policies to allow a rational use of forest resources. At present tax incentives for reforestation may be counterproductive.

Food security in terms of food availability depend primarily on income generating and purchasing power capacity and not on local food production. Diversification into non-traditional export crops, (eco-)tourism development and the expanding banana sector should be evaluated against the background of employment opportunities, labour productivity an net value added.

Sustainability prospects are mainly linked to (i) the rate of deforestation and loss of biodiversity, (ii) the losses of biocides and fertilizer nutrients to the environment and (iii) nutrient depletion under natural pastures and various arable crops. The objectives of eco-tourism development and nature conservation (i.e. preservation of biodiversity) can be complementary. Stimulation of product diversification emerges a trade-off among income generation and environmental pollution due to biocide and fertilizer use. Deforestation and/or expansion of the livestock sector does not suit any of the regional objectives. A shift in hacienda production from investment in cattle towards investment in woodlots may be an alternative to forestry policy reform and the abolishment of implicit livestock subsidies.

Long term options for sustainable land use and food security can be summarized in a number of scenarios with diverging emphases. Emphasis on employment generation entails facilitating the banana sector and non-traditional agricultural exports, this scenario coincides with one aimed at foreign exchange generation but puts a pressure on the natural environment. An alternative source of foreign exchange is tourism development, which entails nature conservation and subsequently stricter controls on deforestation and biocide use. Counteracting deforestation implies the conversion of grazing area to woodlots.

1 INTRODUCTION

The dynamics of regional development in zones of recent agricultural colonization[1] are generally characterized by processes of change in land use, with direct consequences for the structure of tenancy, the prospects for employment and the technology of agrarian production. Identification of the causes and effects of land use modifications can be considered as an important starting point for the analysis of regional development policies for food security and sustainable land use.

The present report focuses on present land use, recent land use changes and the development of the agricultural structure of the Atlantic Zone of Costa Rica during the last three decades. This region experienced substantial 'spontaneous' land use modifications (Veldkamp et al., 1992; Huising, 1993). Understanding of these processes may permit further elaboration of a model for policy intervention based on the currently existing production structure.

The Atlantic Zone has been chosen as one of the pilot areas to operationalize the DLV-methodology as proposed for analysis of sustainable land use and regional policy (Hengsdijk and Kruseman, 1993). This methodology aims to capture the relations between two levels of decision making in a region, the farm level and the policy level. The latter determines on the one hand, in combination with the available natural resources, the boundary conditions for management at farm level. On the other hand, the understanding of the potential responses at the farmhousehold level to policy incentives can be considered an essential element in the identification of feasible policy options, e.g. what are the consequences of policy changes for farm households and what will be their reactions on such changes.

1.1 Rapid regional appraisal

This report is devoted to the systematic analysis of the main aspects that determine constraints and options for sustainable land use as described by Hengsdijk and Kruseman (1993). The presented analysis encompasses the first phase of this approach for rapid regional appraisal and directs its attention to the following aspects:

a) Identification of national and regional goals and constraints. Functioning of the region within national context, the role of agriculture in the regional development process and external factors that condition the regional development options.
b) Inventory of the natural resources and assessment of the agro-ecological constraints and potentials.

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[1] Colonization is defined in terms of agricultural expansion and land use conversion in the production frontier, including spontaneous and planned land reclamation and agrarian settlements.

c) Inventory of technical and economic aspects of agricultural activities; Actual and potential LUST's[2], their requirements in terms of factor use (land, labour, capital) and the consequences for sustainability (nutrients, biocides, etc.)
d) Farm type classification, taking into account the factor endowments, objectives and income/employment opportunities.
e) Identification of the socio-economic and institutional environment; Functioning of local markets, infrastructure and transport networks and governmental services.
f) Identification of policy instruments; Qualitative assessment of the possible impact of current policies on food security and sustainable land use.
g) Preliminary identification of regional options and constraints for sustainable land use; Integration of the before-mentioned aspects on land degradation, production levels, employment generation and income generation/distribution.

In the operational phase this methodology has been shared with the Atlantic Zone Programme (AZP), a cooperative research effort of the Centro Agronómica Tropical de Investigación y Enseñanza (CATIE), Wageningen Agricultural University (WAU) and the Ministerio de Agricultura y Ganadería (MAG)[3] in an attempt to arrive at a better understanding of the dynamic interactions between land use, farm households and production structure.

The systematic analysis of the most important elements that characterize regional land use permits the identification of the main bottlenecks that determine the potential response reactions of farmers to policy intervention. The results will be used in succeeding steps in the operationalization of the DLV methodology in which more dynamic and operational themes of land use policy will be addressed to prepare the setting for the subsequent modelling approach of land use policy and response reactions of farm households.

The second phase of the DLV approach aims at a more detailed understanding of policy options that are available for the improvement of sustainable land use and food security prospects. That analysis will be directed towards a further quantification of the interactions between land use by farm types, internal resource endowments and policy instruments[4].

1.2 Scope and structure of the report

The characterization of the Atlantic Zone in terms of available natural resources, development of the production structure and commercialization, actual and potential land use systems and technologies of production, and current programmes for agrarian policy offers a general framework for the analysis of the major problems of agrarian development on regional and farm-level:

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2 LUST stands for Land Use System and Technology

3 The present report makes extensive use of earlier research by staff and students of the AZP programme.

4 See: DLV report no. 4 titled 'Farm Household Modelling for Policy Scenarios on Sustainable Land Use and Food Security in the Atlantic Zone of Costa Rica' (forthcoming, January 1994).

* food security prospects; Regional availability of food products, income distribution and purchasing power of the local population. The latter aspect is related to the availability of land for agricultural production, off-farm employment and other non-agricultural income generating opportunities compared to the absorption of the regional population growth.
* sustainable land use; Modifications of the regional production structure due to macroeconomic adjustment programmes, or land degradation influenced by national/regional development policies (deforestation and pollution of the environment due to side-effects of agricultural activities)

The purpose of this report is to present a descriptive analysis of the options and constraints for sustainable land use and food security in the Atlantic Zone of Costa Rica. Therefore, the exploration of land use and cropping potentials has to be combined with detailed insights in the functioning of markets and institutions for the acknowledgement of possible trade-offs among different development objectives. In a later stage this static description has to be extended towards a more dynamic analysis of the exploration of various scenarios that enable the quantification of the impact of agrarian policies on farm level decisions with respect to land use and food security.

The analysis in this report corresponds largely with phase one in the funnel approach of the integrated DLV framework (Hengsdijk and Kruseman, 1993). It is part of the diagnostic phase characterizing the regional situation in a broad perspective. Finally, this analysis offers scope for the identification of important gaps in knowledge on each of the aspects, as well as for the adjustment of the DLV methodology for rapid regional appraisal.

Chapter 2 describes the regional setting of the Atlantic Zone within the national framework of Costa Rica. Socio-economic indicators are compared with the national averages, and the regional production structure, trends in commodity production and trade, population growth and employment, and public finance and investments are viewed from a national perspective.

In Chapter 3 the natural resources of the Atlantic Zone, i.e. climate and soil characteristics, are described as boundary conditions for regional agricultural production.

In Chapter 4 the concept of LUST's is highlighted and a systematic approach to arrive at a reproducible group of technology sets to be used in farmhousehold models as well as regional models is illustrated. The structural elements of these LUST's, i.e. the input/output relationships in physical and financial terms are basic components which will be related to expected levels of employment absorption and net income generation. The agro-ecological sustainability aspects of the LUST's receive specific emphasis.

In Chapter 5 the development of the farm structure of the Atlantic Zone is identified. Aspects as tenancy structure, number and type of farms, production and marketing levels, and off-farm employment and income generation will receive special attention. Moreover, a classification of the agricultural production structure will be made into so called management units - plantation, hacienda and peasant type - to be used in the

operationalization of farm household models. Farm types are defined according to criteria of size, production system and objective function.

Chapter 6 is closely related to Chapter 5 and focuses on the external socio-economic and institutional environment: the functioning of markets, the availability of infrastructure and the access to services as major elements to implement policy priorities.

In Chapter 7 different policy instruments to achieve certain development goals are described. Main attention is given to the elasticity of response reactions within each of the defined management units towards changes in policy variables like prices, wages, infrastructure and taxes.

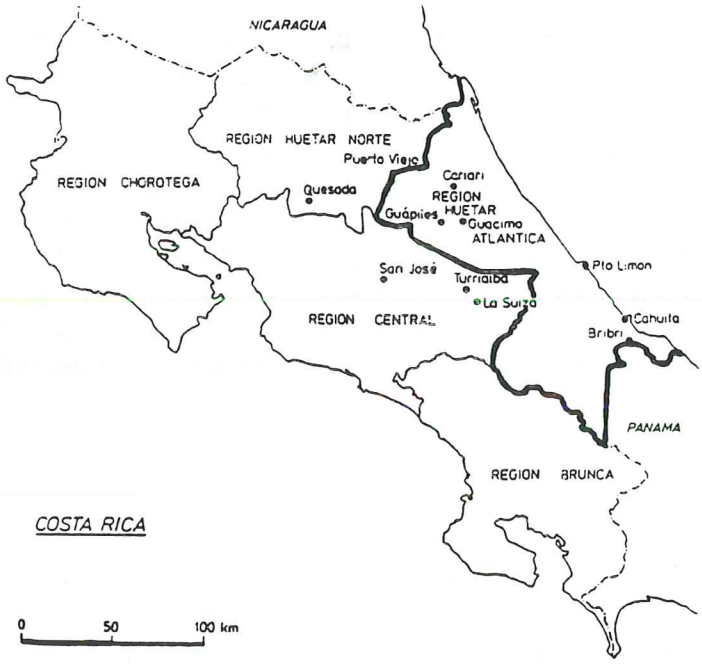
A preliminary identification of options and constraints for sustainable land use will be presented in Chapter 8. Food security and sustainable land use are described in terms of trade-offs which should be taken into account in future scenario development.

2 REGIONAL SETTING WITHIN THE NATIONAL BOUNDARIES

2.1 General description

The Atlantic Zone of Costa Rica is bordered by the Caribbean Sea on the north east, the central volcanic mountain range on the south and west, Nicaragua to the north and Panama to the south east (see Figure 2.1). Several geographically distinct territorial definitions exist of the Atlantic Zone. The CATIE/MAG/WAU Atlantic Zone Programme covers the northern part of the territory and comprises 543,000 ha, only 52.3 % of the administrative and planning region. In this report, unless explicitly mentioned otherwise, Atlantic Zone refers to the province of Limón, which coincides with the present agricultural region "Región Huetar Atlántica" [5]. The Atlantic Zone encompasses 9,218 km^2 (918,316 ha land area) or 18% of the Costa Rican territory, but only 7% of its population and 9% of the agricultural area (See Table 2.1).

Figure 2.1 The Atlantic Zone of Costa Rica.



The Atlantic Zone can be considered as a region of recent colonization through the establishment of tropical lowland settlements. The dynamics of this process have been explained as a mixture of directed and spontaneous colonization strategies, combined with expansion of the livestock sector, forest exploitation and banana development on fertile alluvial coastal soils (Sandner, 1962). During this colonization process regional land use

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5 During a large part of the 1970's and 1980's the Región Huetar Atlántica also encompassed part of the province of Heredia.

showed transformations, both in legal aspects (tenancy structure), as with respect to cropping patterns and land use technologies. Also market orientation of the agricultural production changed due to further development of the regional infrastructure and services networks.

Table 2.1 Basic characteristics of Costa Rica and the Atlantic Zone.

	Year	Costa Rica	Atlantic Zone	Share of Atlantic Zone %
Total Area (ha)	1984	5,070,640	918,316	18.1
Agricultural area (ha) [1]	1984	3,070,340	285,315	9.3
Population	1992	3,099,063	226,264	7.3
Employment	1992	1,086,988	89,617	8.2
Rural credit (C. x 10^3)	1992	4,985	701	14.1

Source: DLV calculations based on DGEC (1987b, 1992b)
Note: 1. Agricultural area includes wildlands located on farms.

Modifications in land use and land cover composition in the Atlantic Zone have been studied by comparing aerial photographs for two periods (1948-52 and 1984), leading to the conclusion that less than 40 % of the land use boundaries remained stationary during this period (Huising, 1993), with major changes occurring in areas with (semi-)natural vegetation and areas of agricultural penetration. Moreover, land cover composition showed important changes, especially for annual crops, pastures and forest areas. Detailed studies on deforestation trends in the Atlantic Zone (Veldkamp et al., 1992) also indicate that clearing rates sharply increased after 1960, due to governmental colonization programmes and banana expansion. Most deforestation took place on fertile soils and in areas close to main rivers or better roads, but after 1981 also less fertile soils in less accessible regions were reclaimed because increasing scarcity of land.

2.2 The role of agriculture

The agricultural sector in Costa Rica accounts for 20 % of the country's gross domestic product (GDP) and about 70 % of foreign exchange earnings. Bananas only represent 18-20 % of agricultural GDP, but 98 % of the banana production is located in the Atlantic Zone (from 1985 onwards, see Annex 5.2). The value added of agricultural production in the Atlantic Zone has been estimated for 1984 at 7,548 million colons (US$ 169.5 million), which represents a 21.7 % share of total value added of the national agricultural sector[6] in 1984 and a 4.6 % share in the gross national product. Its share in the national exports is 15.4 %. Forestry production contributes another US$ 16.2 million to the regional product. The banana production contributes 84 % of total regional value added

6 In this calculation the contribution of the fishery sector has not been included. For livestock only meat production has been incorporated. Detailed data in 1984 for non-traditional crops are not available.

with a per hectare value added of C. 280,000 (=US$ 6,292). Compared with the agricultural labour force (28,600 in 1984) the value added of agricultural production per capita equals C. 253,076 (= US$ 5,683). The mean value added of the agricultural area equals C. 43,500 (US$ 976) per hectare (excluding forestry).

Table 2.2 Regional production structure (1984).

	Area (ha)	Value Added (US$ x 10^3)	Employment (persons)	VA/ha (US$/ha)	VA/labour (US$/person)
Livestock	106,026	6,189.1	3,400	58	1820
Crop production	67,448	163,323.6	25,200	2,421	6481
Forestry	59,033[1]	16,199.2	na	274	na
Tourism	..	34,425.0[2]	na	..	..
Manufacturing	..	na	na	..	na
Total	232,507	220,136.9	na	946	

Sources: DGEC Agricultural census (1987a); MIDEPLAN (1991)
Notes: 1. Excluding forest reserves and wildlands
2. Figure based on national data and regional shares (Fundación Neotropica, 1988)

Indicators of the most important agricultural activities are shown in Table 2.3. In terms of land use pastures and banana production occupy leading positions, followed by cocoa and basic grains (maize and rice). The regional participation in national production is especially important in bananas, cocoa and coco. For food crops like plantain, maize and cassava the Atlantic Zone is an important supplier of the national market.

After 1984 regional land use experienced some modifications: the banana area as well as the pasture increased (banana area was 44,188 ha in 1992). The area basic grains (maize, rice and beans) decreased to 3,505 ha which means a reduction of 79.1 % during the last 8 years (See Table 2.4), the area under cocoa also decreased. The area root and tuber crops[7], plantain and non-traditional crops, like pineapple, palmheart and ornamental plants increased.

7 The major root and tuber crops are: yuca = (cassava) Manihot esculenta; chamol, ñampí = (yam) Colocasia esculenta var. antiquorum; malanga = (yam) Colocasia esculenta var. esculenta; ñame = (greater yam) Dioscorea alata; tiquisque = (tannia) Xanthosoma sagittifolium; yampí = (cush-cush yam) Dioscorea trifida.

Table 2.3 Agricultural area and production (1984).

Activity	Area (ha)	%	Production (x 10^3 kg)	Share of national production	Value Added (x 10^6 C.)
Pastures/Livestock	106,026	61.2	147,885.0 (no. of cattle)	7.2	275.6
Coffee	927	0.5	2,680.3	0.5	38.9
Banana	22,713	13.1	800,484.7	76.0	6,343.3
Sugar	213	0.1	5,519.0	0.2	3.3
Plantain	4,684	2.7	30,991.5	50.5	309.8
Cocoa	12,755	7.4	3,108.3	65.6	234.5
Coco	4,322	2.5	11,920.7 (unit)	83.2	na
Pineapple	200	0.1	10.9 (unit)	8.1	na
Palmheart	1,050	0.6	4,200.0 (unit)	na	na
Macadamia	1,500	0.8	na	na	na
Ornamental plants	1,500	0.8	na	na	na
Beans	724	0.4	280.2	1.6	11.0
Maize	8,842	5.1	10,931.9	21.8	227.5
Rice	7,243	4.2	17,376.4	7.8	101.4
Cassava	775	0.5	6,059.5	18.4	3.1
Total	173,474	100.0			7548.4

Source: DGEC 1987a, MIDEPLAN 1991
Note: Value Added calculations based on BCCR National Accounts

Table 2.4 Area basic grains (in ha) in the Atlantic Zone (1980-1992).

	80-81	82-83	83-84	85-86	86-87	87-88	90-91	91-92
Rice	1300	2600	6900	na	5550	4210	400	310
Maize	11200	16300	15200	17000	21800	14500	6000	2990
Beans	210	400	200	na	550	415	340	205
Total	12710	19300	12300	na	17900	19125	6740	3505

Source: CNP depto. de estudios economicos mimeographs (1981, 1988, 1984, 1992); Steward (1986).

2.3 Population and migration

The Atlantic Zone has been characterized by immigration during the last decades, related to the processes of agrarian colonization and the establishment of IDA settlement schemes[8], widening of access through infrastructural improvement (San José-Limón highway) and more recently, the expansion of banana production and the incentives for non-traditional crops for export.

During the period 1950-1963 the annual population growth in the Limon province was about 5.6 %, higher than the national average of 3.3 %. The period of relatively fast population growth between 1963 and 1973 registered a growth rate of 5.3 % (with a

8 IDA stands for Instituto de Desarrollo Agrario and is a semi-autonomous government agency in charge of the establishment of peasant settlements, mediation in land conflicts and facilities for legal procedures regarding land titling.

national average of 2.3 %), especially because of substantial immigration from the Central zone, as well as from the southern area (Osa-Golfito) and from the Pacific region, Puntarenas-Nicoya (See Table 2.5; CSUCA, 1978; Lok, 1992). In the 1973-1984 period population growth slowed down to an annual rate of 3.5 %, still below the national average of 2.6 %. According to the 1992 population predictions population growth seems to have increased again (3.8%).

Table 2.5 Population, density and population growth in the Atlantic Zone and its Cantons (1963-1992).

	Area	Population (persons)				Population growth (%)			density (/km²)	
Canton	km²	1963	1973	1984	1992	1963-73	1973-84	1984-92	1963	1992
Limón	1,766	29039	40830	52602	69728	3.5	2.3	3.6	16.4	39.5
Pococí	2,404	11196	20688	44187	60344	6.3	7.1	4.0	4.6	25.1
Siquirres	860	11317	18133	29079	38659	4.8	4.4	3.6	13.2	45.0
Talamanca	2,810	3541	5431	11013	15956	4.4	6.6	4.7	1.3	5.7
Matina	773	7561	10489	14723	19825	3.3	3.1	3.8	9.8	25.6
Guácimo	577	5731	11572	16472	21752	7.3	3.3	3.5	4.7	37.7
Total	9,190	68385	115138	168076	226264	5.3	3.5	3.8	7.4	24.6

Source: DGEC (1987b and 1992b)

The geographic distribution of the population in the Atlantic Zone reflects differences between more densely populated districts in the central part of the region (Limón, Siquirres and Guácimo) with an average of 40 persons/km², while in the northern and southern districts population density is below regional average. Also population growth patterns differ between districts during various periods (Table 2.5). Projections for the Atlantic Zone at the turn of the century indicate roughly a threefold increase in 25 years (1973-2000) or a doubling of population between 1984 and 2000 (Lok, 1992).

Net migration rates are the highest of the country and nearly half of the migrants originates from the Central region. Most migration can be characterized by rural-rural movements, both from outside the Atlantic Zone as within this region. The importance of intra-regional migration can be illustrated by the percentage of families that indicate that their birth place lies outside the canton where they are actually living. In 1973 31% of the population was born outside the canton where they lived then (DGEC, 1976), by 1984 this figure had risen to 50% of the population (DGEC, 1984b). These figures imply that internal migration constitutes one third of permanent migration flows.

Immigration patterns showed remarkable shifts during different time periods. In the 1950-1963 period net immigration into the Atlantic Zone was almost zero with positive flows to central Limon and negative flows in other cantons (CSUCA, 1978). In the 1963-1973 period the region experienced a strong immigration and colonization impulse in the Pococí and Siquirres area, while in the 1973-1984 period immigration concentrates in Talamanca and Siquirres.

Employment motives seem to be the most important driving force for immigration, reason why a relative high percentage of migrants form part of the economic active population

(61.1 % against 52.3 %) and their activity rate[9] is also higher (56.8 % against 49.8 %) (Lok, 1992).

Another aspect of the demographic structure of the Atlantic Zone refers to the relative disproportion between male and female population (in 1991: 51.4 % male and 48.6 % female), which is probably related to female-migration to the urban centres in the central region. Also population distribution between age groups is somewhat particular, while declining birth rates and immigration of population in the working age causes a relative high proportion of potential labour force (20-65 years) in the total regional population.

2.4 Income distribution and expenditures

In Table 2.6 the income distribution in the Atlantic Zone is presented; A more than proportional number of families belong to middle income strata (especially wage labour incomes).

Table 2.6 Income distribution in the Atlantic Zone (1986/87).

Income strata (gross income (C.)/year)	% families	Household types
below 9.002	18.2	Family labour, seasonal wage labour
9,003 - 14,635	17.8	Small peasant households
14,636 - 21,544	23.8	Semi-permanent wage labour
21,545 - 34,101	21.3	Medium-size peasantry
34,105 - 803,100	18.9	Hacienda owner, professionals

Source: DGEC (1992a), Encuesta Nacional de Hogares 1986-87
Note: Income strata defined as 20 % groups at national level

The mean gross annual family income in the Atlantic Zone is about C. 278,732 or C. 70,500 per capita (Kreijns, 1993). This income level is nearly 17% below the national average. In Table 2.7 the expenditure pattern for various rural income strata are summarized[10]. The relative shares of the expenditure categories indicate that relatively more budget is allocated for non-consumption ends as income levels rise, while the share of food in the consumption expenditures drops.

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9 Activity rate is the percentage of the potential labour force in the age category of 12 years and above engaged in labour activities.

10 Data for urban households contains errors, when excluding dubious cases, the sample is not large enough to be included in this analysis.

Table 2.7 Expenditure pattern (in shares of income) per income category (in Colones per month) in the Atlantic Zone (1988).

Income category	Gross family income	Destination of income		Destination of consumption		N
		consumption[1]	other[1]	food[2]	non-food[2]	
Y< 5000	3243	79	21	55	45	13
5000<Y< 7500	6411	86	14	61	39	19
7500<Y<10000	8574	74	26	55	45	21
10000<Y<12500	11189	84	16	52	48	35
12500<Y<15000	13728	86	14	50	50	28
15000<Y<17500	16181	78	22	52	48	24
17500<Y<20000	18532	75	25	44	56	26
20000<Y<25000	22497	81	19	49	51	33
25000<Y<30000	27112	75	25	43	57	20
30000<Y<40000	34749	68	32	41	59	31
40000<Y<60000	47870	65	35	36	64	19
60000<Y	86342	57	43	38	62	17

Source: Calculated on basis of DGEC (1992a) household survey 1987/88
Note: [1] percentage of gross income.
[2] percentage of consumption expenditures.

Total expenditures for consumptive purposes represent 76.2 % of the total household income; Food items account for 31.7 % of all income and 41.6 % of all consumptive expenditure. In Table 2.8 a sub division of expenditures on food is given. Products like rice and meat are in general purchased through markets, while commodities like vegetables, milk, beans and fruits are also home produced (Hooijschuur, 1991). Rural families dedicate about 1/3 of their income to basic grains, while this is for urban consumers only 1/5. Substitution possibilities include roots and tuber crops and on an increasing scale also (imported) corn (Hazell, 1991).

Table 2.8 Food expenditures by rural households in the Atlantic Zone (Colones, 1988).

income cat.	maize	meat	milk	dairy products	plantain	pineapple	beans	cassava	other[1]
Y< 5000	292.15	0.0	160.62	31.85	304.62	41.54	502.62	0.0	72.83
5000<Y<7500	100.42	8.53	1293.16	98.53	530.53	0.0	864.95	177.16	257.46
7500<Y<10000	98.57	131.14	853.71	158.57	347.14	0.0	1224.86	205.71	445.49
10000<Y<12500	260.74	51.43	1998.0	426.86	218.06	0.0	1260.0	59.66	545.16
12500<Y<15000	221.79	184.5	2648.57	433.93	375.43	42.43	594.0	176.79	1226.42
15000<Y<17500	257.25	180.0	1614.0	634.5	118.5	67.5	1452.75	112.5	2140.38
17500<Y<20000	217.38	4.85	2443.85	592.62	356.54	0.0	866.08	148.85	1451.6
20000<Y<25000	874.36	132.0	2925.82	597.27	30.0	32.73	1644.55	120.0	2665.57
25000<Y<30000	547.2	270.9	3375.0	994.5	18.9	0.0	1408.5	138.6	1974.15
30000<Y<40000	283.94	210.77	3188.32	382.06	367.55	44.71	1981.74	137.6	3001.53
40000<Y<60000	466.11	197.05	4437.47	817.58	234.0	63.47	3477.79	196.11	1193.79
60000<Y	801.53	631.06	4352.82	2396.1	420.4	52.94	3876.35	664.94	5845.01

Source: Calculated on basis of DGEC (1992a) household survey 1987/88
Note: [1] includes rice

Consumption patterns in the Atlantic Zone are strongly related to the local production. Relative high per capita consumption is reached in traditional root and tuber crops (cassava, tiquisque, ñampi), ayote and plantain, while consumption of market oriented crops (banana, papaya, pineapple) is below national average (Table 2.9).

Table 2.9 Consumption patterns in the Atlantic Zone and Costa Rica.

Product	Atlantic Zone		National average	
	volume	price	volume	price
Pumpkin	0.65	37.15	0.67	28.78
Plantain	35.95	6.56	27.27	6.52
Banana	46.87	1.56	50.97	1.53
Papaya	1.38	29.94	3.43	31.24
Pineapple	1.58	32.77	2.60	28.16
Yampi	1.08	29.49	0.29	27.76
Tiquisque	0.83	38.04	0.44	30.86
Cassava	6.87	19.93	4.30	20.17

Source: Kreijns (1993) based on DGEC (1992a) Household Survey 1987/88
Note: Volume in kg per capita; For plantain, banana and pineapple expressed in units produce. Prices in Colons per kg/unit.

2.5 Infrastructure and services

The road network in the Atlantic Zone covers 2709 km but only 19.5 % of the roads is paved. The railroad network covers 125 km and is used mainly for transport of bananas. The harbour of Limon handles about 70 % of total national foreign trade.

Regional marketing systems are well developed. The rate of commercialization for agricultural crops is beyond 80 % of production for almost all crops; Only beans and to a lesser extent cassava are cultivated for home consumption. Also local markets for land, labour and input distribution became relatively well established (See Chapter 6).

The distribution and access to social and collective services reveals general higher levels of undernutrition, illiteracy and child death rates than the national averages (See Table 2.10). Government services in the fields of medical care, education, water supply and electrification also stay behind national average.

Table 2.10 Comparison of social indicators of the Atlantic Zone and Costa Rica.

Indicator	Year	Atlantic Zone	National	Difference (%)
Persons/House	1984	4.2	5.0	- 19.5
Doctors/1000 habitants	1983	5.7	7.6	- 33.3
Social security enrolment (%)	1984	77.0	81.5	- 5.8
School enrolment (% < primary school)	1989	76.1	62.3	+ 22.2
Rate of illiteracy (% of population)	1984	10.9	6.9	+ 58.0
Pre-school undernutrition (% children)	1983	3.1	2.1	+ 47.6
Birth rate (per 1000)	1987	32.8	27.5	+ 19.3
Death rate (per 1000)	1987	4.2	3.8	+ 10.5
Child death rate (per 1000)	1987	20.6	17.4	+ 18.4

Source: MIDEPLAN (1991) and UNA/MIDEPLAN (1992)

2.6 Forestry resources and deforestation

The forestry sector of Costa Rica witnessed a growing public concern during the last decade although it contributes less than 5% to the agricultural production and less than 2% to the gross domestic product (WRI, 1991). This attention is mainly caused by the rapid decline in forestry resources. Costs of deforestation may include an increased risk of soil erosion, flooding, loss of biodiversity and loss of tourism. In Costa Rica the area covered with forests dropped from 50% to 31% during the period 1970-1987 (Lutz and Daly, 1991; WRI, 1991). It is estimated that about 270,000 ha of forests are left, besides the national parks and reserves. With the current rates of deforestation the domestic supply of logs will be depleted in less than 10 years. With about 32 % of the national forest area within its borders the role of forestry in the Atlantic Zone has a distinct national dimension[11].

Before 1973 deforestation was mainly caused by the expansion of extensive pasture areas which required little labour but assured land possession of speculators[12]. During this period it was not profitable to extract or sell timber due to inadequate infrastructure and commercialization[13]. More than 90% of the felled timber went up in smoke or was left on the fields to decompose (WRI, 1991).

According to Lutz and Daly (1991) banana and other plantations and the timber industry are mainly responsible for deforestation during the last decade. Although there is a

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11 Moreover, with data of Veldkamp et al. (1992) it can be calculated that in one particular subregion of the Atlantic Zone the rate of deforestation tripled the national rate of deforestation during the period 1972-1984.

12 A law from 1941 legalized occupation of land if settlers occupied land uninterruptedly for more than 10 years. Certain rights on the land could even be claimed by the settlers after one year.

13 Veldkamp (1993) analyzing deforestation, showed a close relationship of deforestation and accessibility of the deforested area.

growing awareness of the commercial value of the existing forest resources, still only 54% of the logging volume reaches the processing stage; Total volume losses during the production cycle have estimated at values up to 75%.
The national government developed various incentives to stimulate reforestation (see Chapter 7) but there are indications that these reforestation programs are counter productive. Natural forests are logged and reforested with governmental subsidies, and natural forest ecosystems are destroyed and converted into forest plantations (monocultures) with a lower nature value (Sluys van der, et al., 1992; Brouwershaven, 1993).

2.7 Macroeconomic policies

During the last 8 years economic policies in Costa Rica were defined in relation with the *Structural Adjustment Program*. Main elements of this program include market liberalization, indexation of interest rates, exchange rate adjustment and institutional transformations (privatization) to reduce government expenditure (Fallas, 1992). These policies tend to stimulate more efficient production systems and to create competitive markets.

National fiscal and monetary policies towards the agricultural sector maintained a positive rate of protection during the 1960's and 1970's, leading to a wide range of direct and indirect price distortions (Guardia et al., 1987). However, during the 1980 decade a more liberal exchange rate and domestic price policy was implemented and credit interest subsidies were gradually abolished, leading to an increased negative rate of protection for the agricultural sector. Especially basic grains production and meat exports faced a negative nominal protection.

2.7.1 Exchange rate

The development of the official and shadow exchange rates is reported in Annex 2.1. The local currency Colón has been undervalued with more than 10% during the last two decades. The exchange rate policy of the Costarican government has been directed towards protection of the own industry. A slightly undervalued local currency is instrumental to both import substitution and export stimulation, since it implies an implicit tax on imports and an implicit subsidy on exports.

2.7.2 Balance of payments

The external debt of Costa Rica has been high per capita compared to other Central and Latin American countries, increasing from US$ 142 in 1970 to US$ 1235 in 1980. Structural adjustment has been relatively successful in Costa Rica in the sense that the external debt has been steadily declining as opposed to an average increase in Central America and a stabilization in South America.

The balance of payments shows strong fluctuations over the past decade (see Annex 2.2) However, the available foreign exchange for imports (exports of goods and services, net private and public transfers plus net capital inflow) has increased on average with 17.5% annually in nominal terms.

During the 1980's 48% of all imports consisted of raw material, of which 11% was destined for agriculture. 21% of the imports consisted of capital goods of which a mere 4% was destined for agriculture. During the past decade the share of capital goods imported for agriculture dropped dramatically with 7.5% per annum[14].

2.7.3 Government finance

Government consumption as share of GDP increased slightly during the 1980's (Annex 2.3). Public sector deficit decreased strongly from over 15% in the early 1980's to less than 5% by the end of the decade (MIDEPLAN, 1992). Public investment dropped during this same period indicating that cuts in public investment and not government spending were responsible for the decrease in the deficit.

In 1975 12% of public investment went to the Atlantic Zone (OFIPLAN, 1980); 37% went to transport infrastructure, 32% to housing, 15% to health. Although explicit data are missing for other years, indications are present about the changes in public spending. Through the 1980's expenditures for housing investment diminished, while investment in rural development increased (IDA-RUTA project which started in 1988). Transport infrastructure remains an important area of investment.

2.7.4 Inflation

Except for a few years in the early 1980's inflation has been kept at a reasonable level. Consequently not many distortions will be found in price data since there are no large stabilisation problems (See Annex 2.4).

2.8 Regional policy objectives

Regional development activities with a more direct impact on local conditions of production and environment in the Atlantic Zone can be distinguished in three main categories (MIDEPLAN, 1991):

a) Projects for territorial and intra-regional integration
b) Programmes directed towards agrarian modernization
c) Policies directed at economic diversification

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14 Calculated on basis of MIDEPLAN, 1992.

2.8.1 *Trade and transport*

Infrastructure development represents a strategic area for government investment with the objective to improve the conditions for private investments in production or tourism, as well as to promote living conditions of the population through better supply of goods and services. In the 1991 regional investment plan 65 % of the proposed projects refer to road construction or maintenance, railroad maintenance, improvement of harbour facilities and local electricity and water supply (MIDEPLAN, 1991)[15].

2.8.2 *Agrarian modernization*

The Atlantic Zone is a priority region for the diversification of agricultural exports. Main non-traditional crops include pineapple, ornamental plants, plantain, ñame and tiquisque. To stimulate product diversification the government introduced special tax deduction certificates (CAT[16]) for exporting firms. The objective of the diversification strategy is to increase the competiveness of the Costa Rican agricultural sector.

Regional spread effects through backward and forward linkages can also contribute to increased employment prospects and final demand effects. Because of high initial investment costs the production and marketing of non-traditional crops is mainly concentrated on (inter)national companies, sometimes under arrangements of contract farming with local (medium-size) producers.

2.8.3 *Natural resource management*

More than 60 % of land use in the Atlantic Zone is dedicated to national parks, forest reserves and indian reserves, which represent 40 % of total national reserve areas (See Table 2.11). From a viewpoint of biodiversity and tourism development is natural resource management of major importance.

The policies with respect to natural resources are directed towards protection and conservation of reserve areas, reproduction of the commercial forest areas and modernization or rationalization of the forest exploitation systems. Main instruments include production restrictions (tree cutting permits) and rationing of credit, as well as other legal measures related to unsustainable production practices (prohibitions).

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15 Part of the infrastructure investment became necessary to repair the damage caused by the earthquake of april 1991.

16 CAT stands for Certificado de Abono Tributano.

Table 2.11 Area of national parks, forest and indian reserves.

Category	National (ha)	% (of territory)	Regional (ha)	% (of region)	% (of country)
National Parks	450,443	8.8	294,564	32.1	65.4
Forest Reserves	598,214	11.7	86,125	9.4	14.4
Indian Reserves	325,470	6.3	177,410	19.3	54.5
Total	1,374,127	26.8	558,099	60.8	40.6

Source: Fundación Neotropica (1988) and Jones (1990)

2.8.4 Tourism

The development of (eco)-tourism represents a major alternative source of income and employment for the Atlantic Zone. Infrastructure investment in roads and hotel facilities are considered as a boundary condition to stimulate tourism. Income accruing from tourism accounts for US$ 137.7 million (1986) and represents the third source of foreign exchange. The Atlantic Zone may absorb about 25-30 % of all (eco)-tourism of the country and therefore contributes US$ 34 million to the national income, equivalent with 2.7 % of total export value. Compared to the agricultural value added (See Section 2.2) tourism contributes an additional 20 % to the regional product.

2.9 External constraints

Main agricultural crops produced in the Atlantic Zone - especially bananas and meat - depend on world markets for their commercialization. World market prices for these products show an upward tendency during the last decade (see Table 2.12).

Table 2.12 Export price development (1984=100).

Crop	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Traditional Exports:												
Coffee	151.7	108.7	108.0	94.0	100.0	107.0	170.0	98.8	108.1	89.6	71.7	74.7
Banana	86.8	91.2	91.6	96.4	100.0	99.3	100.9	102.7	101.4	105.4	107.1	126.8
Meat	127.6	104.8	103.0	108.2	100.0	92.9	88.7	102.1	104.1	112.0	113.8	103.6
Cocoa	111.7	73.2	62.5	75.2	100.0	100.6	92.3	91.5	74.9	58.4	48.7	56.4
Non-traditional Exports:												
coco	na	na	na	na	100.0	99.3	100.3	90.7	93.1	93.7	99.8	90.5
pineapple	na	na	na	92.3	100.0	98.4	106.4	108.8	107.0	108.4	104.9	104.2
plantain	na	na	na	94.4	100.0	119.0	110.0	108.2	121.3	128.8	99.1	105.8
cassava	na	na	na	83.8	100.0	117.2	135.4	102.2	102.1	83.5	78.6	133.5
roots and tubers	na	na	na	85.8	100.0	111.0	102.7	103.3	106.5	101.3	117.3	91.2

Source: UNA/MIDEPLAN (1992) and CNAA (1992)

Prices for non-traditional exports are less stable and show a decreasing tendency. In Table 2.13 the net foreign exchange contributions of agriculture to the national economy are presented, since both imports and exports have risen the net contribution has stayed more or less stable.

Table 2.13 Net foreign exchange contribution (in Mln. Colones).

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Total exports	870.4	872.6	1006.4	976.0	1120.6	1158.3	1245.7	1414.6	1448.2	1335.7
Agricultural exports	573.0	557.8	660.0	642.6	711.4	657.8	630.7	654.4	645.4	671.6
Total imports	893.2	987.8	1093.7	1098.2	1147.5	1380.2	1407.7	1737.3	1989.7	1852.8
Agricultural imports	66.8	88.7	89.7	79	69.1	73.0	79.8	85.9	97.3	109.4
- inputs	60.4	78.9	78.1	69.7	61.1	63.9	71.3	76.7	86.7	96.8
- capital goods	6.4	9.8	11.6	9.3	8.0	9.1	8.5	9.2	10.6	12.6
Export %	65.8	63.9	65.6	65.8	63.5	56.8	50.6	46.3	44.6	50.3
Import %	7.5	9.0	8.2	7.2	6.0	5.3	5.7	4.9	4.9	5.9
Net contribution	506.2	469.1	570.3	563.6	642.3	584.8	550.9	568.5	548.1	562.2
Net contribution (%)	88.3	84.1	86.4	87.7	90.3	88.9	87.3	86.9	84.9	83.7

Source: MIDEPLAN, 1992

In Table 2.14 the growth of non-traditional agricultural exports from 5% to 10% of total exports after 1986 becomes apparent. Exports are divided into traditional exports and non-traditional exports. Traditional exports include meat, coffee, bananas and cacao. Non-traditional exports include all manufactured goods and agricultural commodities such as pineapple, palmheart, cut flowers, ornamental plants and other fruits. Roots and tubers although part of the traditional food crops, are considered non-traditional when exported.

Table 2.14 Export of non-traditional crops (1980-1990).

Year	Share agriculture in non traditional exports	Share non-traditional exports in total exports	Share non-traditional crops in total exports
1980	15.0	38	5.7
1981	15.0	37	5.5
1982	15.0	34	5.1
1983	15.0	36	5.4
1984	15.0	34	5.1
1985	15.0	34	5.1
1986	15.3	33	5.0
1987	17.6	38	6.7
1988	21.5	41	8.8
1989	20.1	47	9.4
1990	21.8	48	10.5

source: Calculated on basis of Weller (1992)

Banana and meat exports also face non-market restrictions like import quota - bananas on the EC market, meat on the US market - and quality regulations (meat grading system). The market prospects for non-traditional export crops are still highly uncertain, while the

total market size is limited and there is a strong competition from other producing countries (Baumeister 1990, Weller 1992).

3 NATURAL RESOURCES

3.1 Physiography

The Atlantic Zone is bordered on the west by a mountain range of volcanic origin. The sloping areas of these volcanos are covered with lava and lahar of andesetic composition. In the northern part of the Zone the mountain range passes eastward into a gently sloping plain filled with Tertiary and Quaternary sediments derived from the mountains. This plain encompasses the largest part of the Atlantic Zone (See Table 3.1). Near the coast the gently sloping areas passes into wetlands and swamps consisting of peaty deposits, particularly north of Limon. South of Limon old weathered volcanic (unfertile) soils are predominant, near the coast alternated with younger fertile volcanic soils. South of Limon at the coast elevated Pleistocene coral reefs and Miocene rocks reach up to the sea to form cliffs. The distribution of various physiographic units in the Northern part of the Atlantic Zone is illustrated in Table 3.1 encompassing 59% of the Atlantic Zone.

Table 3.1 Distribution of physiographic units in the Northern part of the Atlantic Zone (in ha and % of area).

	ha	%
Alluvial plains	352,059	(65%)
Volcanic areas	77,445	(14%)
Peat areas	68,173	(13%)
Mountain areas	32,129	(6%)
Coastal areas	13,216	(2%)
Total	543,022	(100%)

Source: Wielemaker and Vogel, 1992; Waaijenberg, 1986)

3.2 Climate

In Table 3.2 historical monthly averages of weather station 'Carmen' are shown. The station is located in the Atlantic Zone at longitude 83 29W, latitude 10 12N, and an at altitude of 15 m above sea level. Precipitation and temperature data cover the period 1973-1991, Potential evapo-transpiration[17] covers the period 1975-1989.

Annual variation of minimum and maximum temperatures is about 10%. July, August and November are the wettest months and take into account 35% of the annual precipitation. The annual water surplus (precipitation minus potential evapo-transpiration) is 2329 mm, with the highest surplus in July (351 mm) and the lowest in March (51 mm).

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17 Potential evapo-transpiration calculated with Penman equation (Penman, 1948). Windspeed (1.5 m s^{-1}) based on annual average of 1991.

Table 3.2 Historical monthly averages of weather station Carmen.

	precipitation (mm)	min T (C)	max T (C)	no. of dry days	pot. ET (mm)
january	281	19.8	29.6	11.4	101
february	188	20.0	29.5	10.0	99
march	170	20.6	30.3	12.7	119
april	217	21.1	30.7	12.9	117
may	275	22.1	31.5	11.2	121
june	327	22.1	31.1	8.3	106
july	457	21.8	30.4	5.6	106
august	417	21.9	31.0	7.2	112
september	224	22.0	31.5	10.6	113
october	283	21.7	31.2	10.1	109
november	414	21.3	30.3	8.3	95
december	377	21.3	29.8	8.8	103
annual	3630	-	-	117.1	1301

Source: DLV calculations based on Carmen weather station data

Within the Atlantic Zone Program weather data of six other stations in the northern part of the Zone have been collected. Analysis of these data takes place within the AZP framework. Weather station 'Carmen' is located centrally in the Zone. The precipitation tends to increase in northeastern direction.

3.3 Land resources

In the northern part of the Atlantic Zone a soil survey has been carried out at a scale of 1:150,000 (Wielemaker and Vogel, 1993) which data are stored in a geographic information system (SIESTA[18]).

To reduce the amount of data collected a grouping of soils into land capability classes has been carried out (Wielemaker and Vogel, 1993; Klingebiel, 1961). In this procedure soil units are classified according to alternative land use types with priority to the most demanding land use types. The distinguished land capability classes indicate general agricultural potential from an agronomic point of view; Nutrient status, soil depth, drainage condition, slope and stoniness were used as soil and terrain characteristics to arrive at the identified land capability classes (Table 3.3).

18 SIESTA stands for Sistema de Informacion y Evalucion de Suela y Tierras del Atlantico.

Table 3.3 Land capability classification for the most common land uses in the Atlantic Zone.

Land capability class		ha.
1.	Deep, fertile soils, suitable for all land use types.	
1.1	Soils with no further limitation, well drained, slopes between 0-8%, no or few stones.	75,879
1.2	Soils as 1.1 but with imperfect drainage.	125,354
1.3	Soils as 1.1.but with slopes from 0-8% and moderately stony	16,596
1.4	Soils as 1.1 but with slopes from 8-30%	7,022
2.	Moderately fertile soils, moderately suitable for nutrient requiring land use types	
2.1	Soils with no further limitation, well drained, slopes between 0-8%, no or few stones.	14,425
2.2	Soils as 2.1 but with imperfect drainage	0
2.3	Soils as 2.1 but with slopes from 0-8% and moderately stony	2,164
2.4	Soils as 2.1 but with slopes from 8-30%	5,276
3.	Nutrient poor soils, only suitable for acid tolerant and little nutrient requiring land use types	
3.1	Soils with no further limitation, well drained, slopes between 0-8%, no or few stones.	2,775
3.2	Soils as 3.1 but with imperfect drainage	605
3.3	Soils as 3.1 but with slopes from 0-8% and moderately stony	0
3.4	Soils as 3.1 but with slopes from 8-30%	59,647
4.	Shallow soils with severely restricted use	
4.1	Rooting depth less than 30 cm	128
4.2	Rooting depth less than 10 cm	12,114
5.	Soils not suitable for agriculture, steep, poorly drained or soils with extreme stoniness	
5.1	Slopes more than 30%	79,546
5.2	Poorly drained	130,793
5.3	Extreme stoniness	7,470
Total area		539,795

Source: DLV calculations based on Wielemaker and Vogel (1992)

Disregarding the soil nutrient status as a soil characteristic results in a more comprehensible overview (Table 3.4). Soils without physical limitations (group 1) include 17% of the northern part of the Atlantic Zone. Soils suffering from imperfect drainage conditions account for 23 %. Group 5 with most limitations accounts for 42% of the area. The remainder of the Zone, group 3 and 4 (16%) have minor limitations caused by stoniness or slopes.

Table 3.4 Aggregated land capability classification into five groups.

1. Soils without limitations:	93,077 ha	(17%)
2. Soils with imperfect drainage conditions:	125,958 ha	(23%)
3. Stony soils on slopes from 0-8%:	18,760 ha	(3%)
4. Soils on slopes from 8-30%:	71,944 ha	(13%)
5. Shallow soils, soils on slopes more than 30%, very poorly drained soils or extremely stony soils:	230,049 ha	(43%)
Total area:	539,795 ha[19]	(100%)

In a subsequent step these land capabilities groups are used to determine the degree to which these groups can satisfy the requirements of various land use types in the Atlantic Zone. Expert judgement forms the basis of this matching. Group five is not taken into account; This group is considered non-suitable for agricultural purposes, successful reclamation of these areas is doubtful. Forest and other natural vegetation seems the only option for areas in this group.

Two suitability orders are identified in Table 3.5: Suitable (S) without any limitations, and non-suitable (N) for the specified land use type; The kind of limitations are shown at the bottom of Table 3.5. A maximum of two limitations is shown although more limitations may exist.

On the one hand the potential suitable area is an underestimation because soils on slopes from 8-30% (land capability group 4) are assumed non-suitable for all land use types (except pasture) due to erosion risks and limitations for mechanical tillage. However, soils on slopes from 8-15% are in general still suitable for mechanical tillage; Moreover, erosion forms on these soils especially under perennial crops a minor problem because of the year round soil cover. On the other hand the potential suitable area for most land use types is notably dominated by the area of imperfectly drained soils, in particularly land capability class 1.2 in Table 3.3. This class accounts for 125,354 ha including more than 50% of the potential suitable area for almost all distinguished land use types. The construction of drainage systems will probably be necessary on parts of these soils to make them suitable for sustainable agricultural production.

19 The total area is larger than the northern part of the Atlantic Zone because the soil survey encompassed also a part of the canton of Limon.

Table 3.5 Suitability order for specified land use types; Potential suitable area in ha.

Land use type	Land Capability Groups (See Table 3.4)				Pot. suitable area
	1	2	3	4	
Maize (manual)	S	Nd	S	Ne	111,837
Maize (mechanical)	S	Nd	Nt	Net	93,077
Rice (mechanical)	S	S	Nt	Net	219,035
Cassava (manual)	S	S	S	Ne	237,795
Cassava (mechanical)	S	S	Nt	Net	219,035
Plantain/banana	S	Nd	S	Net	111,837
Palmheart	S	S	S	Ne	237,795
Cacao	S	S	S	Ne	237,795
Forestry	S	S	S	Ne	237,795
Pasture (natural)	S	S	S	S	309,739
Pasture (improved)	S	Nd	S	S	181,006

N = Not-suitable
S = Suitable
t = Limitation for mechanical tillage and management practices
d = Limitation regarding drainage
e = Risks for soil erosion, limitation for mechanical tillage

It is difficult to compare the potential suitable area with current agricultural area which encompasses 285,315 ha (See Table 2.1 in Chapter 2) but refers to the entire Atlantic Zone. The potential suitable area refers only to the northern part of that Zone (52% of the area). Assuming that the southern part of the Zone is to the same extent suitable for agricultural production suggest that there is still some scope for expansion.

Huising and Wielemaker (1993) used this approach, matching land capabilities and land use requirements, to evaluate whether land in a subregion of the Zone was in accordance with its potential. I.e. the actual land use per capability class was compared with its potential use. Over-use of land was defined as land where requirements of a certain land use type were not met by the soil and terrain characteristics. In Table 3.5 these combinations are indicated as not-suitable. Under-use of land was defined as land where requirements of actual land use are more than satisfied by soil and terrain characteristics. A ranking of land use types was established to decide whether a land use type was over- or under-used; In descending order land use types had increased land use requirements: annual crops and banana plantations, perennial crops, grassland, forest plantation and natural vegetation. Using these definitions about 17% of the total 79,775 ha was overused. Risk for erosion was the main criteria for over-use. More than 50% of area was under-used of which the majority was used as pastures.

4 LAND USE SYSTEM AND TECHNOLOGIES

4.1 Introduction

Agricultural production can be described in terms of input/output relationships which quantify the relations between inputs of production (primary and secondary production factors) and the outputs, desired (produce, in physical as well as monetary terms) as well as undesired (emissions to the environment). An almost infinite number of technologies can be defined, because so many factors affect agricultural production. De Wit (1986) proposed to use yield levels as the starting point in an analysis of agricultural production ('target-oriented'); Derive first the yield level (output) under a set of well defined environmental conditions and determine subsequently which inputs are required to achieve these yields. In the approach of De Wit (1993) substitution of the specified production factors is only possible to a certain extent. In the first place this can be explained from a viewpoint of the physiological function of various production factors within plants; It goes beyond the scope of this report to treat the plant physiological aspects in depth but it is obvious that e.g. radiation can not substitute water and nitrogen can not substitute CO_2. Partial substitution between some production factors seems possible, e.g. between nitrogen and phosphorus. However, this assumption neglects basic principles of sustained production: The application of phosphorus only may increase yields in the short run, but at the same time decreases nitrogen reserves of the soil due to an increased nitrogen uptake in the harvested produce. This can be explained by a change in soil fertility due to crop production. In the long run such methods and consequently agro-ecosystems (LUST's) run into trouble[20].

However, substitution of other production factors that will not necessarily affect the yield level in the short or long term remains possible. This mainly concerns substitution between labour, capital and energy which from a viewpoint of optimal resource allocation has to be taken into account. Disregarding such substitution possibilities would block the prospects for development in certain directions and would neglect basic economic principles. Such substitution possibilities include fixed operations, conditional for any form of crop production at any yield level (sowing, soil preparation, harvesting, etc.), but also less fixed operations, particularly crop protection. Weed control for instance, can be carried out in different ways, mechanically, manually or chemically, without affecting the target yield level. However, the mode of weed control will change the allocation of production factors and the cost structure. For other components of crop protection less substitution options are applicable without affecting the yield level. Integrated pest management methods e.g. have been developed to limit the use of biocides. These methods are based on a combination of better crop management, other varieties, appropriate crop rotations and cultural practices. However, yield reductions are with such practices usually unavoidable.

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20 This theoretical clarification is demonstrated by Breman (1992) in semi arid regions where the introduction of nitrogen fixing species could not offer a long term solution due to an increased phosphorus deficiency of the soil.

4.2 Land Use System and Technology (LUST)

The term LUST developed by the researchers of the AZP describes the input/output relations of various land use types in the Atlantic Zone. A LUST incorporates aspects of the resource base, the activities which can be undertaken using that resource base, as well as the way operations are carried out. A LUST is defined in terms of in- and outputs including their temporal distribution[21].

The elements of LUST's and the way LUST's interact with the main components in the DLV approach can be illustrated by means of:

$$(FHH_1...FHH_i) <= (LU_1...LU_j) * (LUT_1...LUT_k) * (PL_1...PL_l) * (PT_1..PT_m) ==> \text{Regional IMGLP model}$$

FHH	=	Farm household
LU	=	Land unit, i.e. combination of soil and climate.
LUT	=	Land use type, e.g. crop, rotation, mixed cropping, rangeland, nature, etc.
PL	=	Production level, e.g. potential production, nutrient limited production, etc.
PT	=	Production technique, e.g. kind of traction, labour requirements, etc. (also including the sequence of operations)
IMGLP	=	Interactive Multiple goal Linear Programming

The unique combination of a LU, LUT, PL and PT forms a LUST[22].

4.3 Actual LUST's

An understanding of the current agricultural production encompasses an inventory of actual LUST's. The farm survey carried out by Schipper (pers. com.) gives information on the current means of production of various crops in the Neguev region in the Atlantic Zone. These data have been used to specify current LUST's for maize, cassava, plantain, palmheart, cacao in the entire Atlantic Zone. The input/output data for beans and pineapple are based on the accounts prepared by the Banco Nacional de Costa Rica (BNCR) which determines 'standard' labour requirements and inputs for crops that are eligible for farm credit. The input data for rice are estimates, the yield level is the national average rice yield. Labour requirements and biocide inputs for banana were supplied by Bessembinder (pers. com.), the fertilizer input and yield level for banana were derived from Kruiter (1989).

In Table 4.1 the current means of production expressed in input/output coefficients for some major crops are presented. These crops cover 87.5 % of the agricultural area excluding pastures (See Table 2.3 in Chapter 2). It must be emphasised that the division of the labour requirements over the distinguished operations is not always as strict as

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21 For the sake of simplicity and clarity the temporal aspects are disregarded in the succeeding tables and text of this report as far as it does not affect the analysis.

22 The combination of production level and production technique is better known as technology in AZP terminology.

sometimes suggested; Some operations can take place at the same time, such as harvesting and pruning which makes it difficult to assign labour requirements to the various operations. The original data do not distinguish the stages of the various perennial crop cycles and therefore neglect establishment costs. These crops usually show a higher labour requirement and lower yield level in the first year(s) of production[23]. The average labour requirement for palmheart in Table 4.1, 435 man hours ha^{-1} yr^{-1}, is therefore probably an underestimation. The same remark applies to plantain, banana and cocoa. The initial stages of banana production requires about 800 man hours per ha, including drainage construction, planting, infrastructure, etc. The data for banana in Table 4.1 refer to the fourth year of production. The way early stages of production affect the average labour requirements of a perennial crop depends mainly on the management strategy of a farmer. Some farmers prefer to have a crop cycle of a few years with a high frequency of replanting, others prefer longer cycles with less replanting and related operations (e.g. seed preparation) and thus usually a lower average labour requirement. Other inputs (fertilizer use) and outputs (yields) are usually different during the first years of production.

The average maize yield in Costa Rica is 1728 kg ha^{-1}, about 1,000 kg lower than in the Atlantic Zone (FAO, 1991)[24]. The national average cassava yields are ± 1700 kg ha^{-1} lower than the yields in the Atlantic Zone. The average yield of plantain is 8,300 kg ha^{-1} (DGEC, 1987a) and is comparable with the results from the survey.

A special problem is formed by the livestock LUST's. The primary products (pastures and fodder crops) are just intermediate products which have to be converted into secondary products (meat and milk). Moreover, labour requirements are more related to herding than specific crop operations. Information about the livestock sector in the Atlantic Zone is highly fragmented and therefore, only global estimates can be presented partly based on Aragon (1992). The labour requirements per cow per year are estimated at 5.4 days. Milking rates are estimated at 500 kg and meat production at 150 kg per ha per year. Fertilizers are not used on natural pastures and the use of biocides (in particularly herbicides) is usually limited to patches.

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23 The BNCR estimates for instance the labour requirement for palmheart in the first year of production at 804 man hours and in the fourth year at 474 man hours (BNCR, 1992).

24 Yields in the farm survey were sometimes expressed in bags; It is assumed that these weighted 40 kg; This may explain partly the difference between the average yields and those determined in the Atlantic Zone.

Table 4.1 Current input/output relationships of some major crops in the Atlantic Zone (see text and Annex 4.1 for crop specific coefficients).

	maize	rice	cassava	plantain	palmheart	banana	cocao	beans	pineapple[7]
Labour requirements (man hours ha^{-1} yr^{-1}):									
1. Field preparation [1]	4	50	1	31	2	0	0	3	11
2. Planting/sowing	33	25	63	42	20	28	0	25	364
3. Crop management									
a. Fertilizer application	14	15	0	13	18	48	0	10	90
b. Biocide application	43	30	31	34	51	32[4]	8	40	286[4]
c. Weeding	12	30	11	22	54	0	19	20	0
d. Other [2]	27	0	54	141	168	333	95	0	260
4. Harvesting	58	136	157	39	123	518[5]	44	90	590
Total labour requirements:	191	286	318	322	436	959	166	188	1601
Inputs (ha^{-1} yr^{-1}):									
Fertilizer N (kg)	40	50	0	77	117	297	0	15	437
Fertilizer P (kg)	8	10	0	10	9	105	0	45	226
Fertilizer K (kg)	4	5	0	11	4	521	0	15	438
Biocide a.i. (kg)	1.40	4	0.89	3.10	1.25	30.72	0.41	1.16	16.8
Machine hours	0.16	0	0	0	0	0	0	0	10
Outputs (ha^{-1} yr^{-1}):[3]									
Fresh produce (kg)	2,856	3,411	6,727	7,927	5,158	52,374[6]	141	1150	51,000
N-output (kg)	36	34	12	17	9	121	< 1	41	82
P-output (kg)	7	6	4	2	1	14	< 1	5	12
K-output (kg)	10	11	19	45	12	297	< 1	14	156

[1] Includes labour requirements that have to be repeated at the start of the growing season, ploughing hoeing, etc. It does not include clearance of forests (land reclamation operations).

[2] Includes seed treatment, pruning, removing leaves, cleaning area around trees, folding of maize cobs, underpinning of plants, drainage maintenance, transport, etc.

[3] Nutrients in the produce leaving the field.

[4] Includes labour requirements for weeding.

[5] Includes labour requirements for post harvest operations (294 man hours).

[6] Gross yield leaving the field; Net yield is 15% lower due to lots that do not meet quality standards (rejections).

[7] Input/output based on a growth of 18-24 months.

4.4 Alternative LUST's

LUST's describing the actual means of production have their roots in the actual tenancy structure, level of education, infrastructure, etc. These constraints determine at the one hand the current production and on the other hand block productivity growth, which from a bio-physical point is usually still feasible. The scientifically most sound way to estimate such potential yield levels is by means of well validated crop growth simulation models (Van Keulen and de Wolf, 1986). Such models allow quantitative estimates to be made of growth and production of crops under well defined bio-physical conditions.

Although crop growth models for various tropical crops are not yet calibrated let alone validated, some tentative estimations of potential yield levels and derived input levels are possible based on preliminary model results and expert knowledge. In Table 4.2 alternative LUST's for maize and rice are illustrated taking into account the determined potential suitable area for maize (Section 3.2). In Annex 4.2 assumptions about yield level and other

in- and outputs are specified. A description of alternative LUST's for other crops can be found in LUSTPZA[25].

Table 4.2 Input/output relationships of various alternative maize and rice LUST's in the Atlantic Zone (see text and Annex 4.1 for crop specific coefficients and Annex 4.2 for assumptions).

	maize mech. high herb.	maize mech. low herb.	maize semi-mech. high herb.	maize semi-mech. low herb.	maize manual high herb.	maize manual low herb.	rice mech. high herb.	rice mech. low herb.
Labour requirements (man hours ha^{-1} yr^{-1}):								
1. Field preparation [1]	10	10	10	10	50	50	18	18
2. Planting/sowing	3	3	3	3	25	25	3	3
3. Crop management								
a. Fertilizer application	4	4	40	40	40	40	4	4
b. Biocide application	6	4	51	31	61	31	7	5
c. Weeding[2]	0	60	0	60	0	80	0	40
d. Other	0	0	0	0	0	0	0	0
4. Harvesting	6	6	6	6	100	100	6	6
Total labour requirements:	29	87	110	150	276	326	38	76
Inputs (ha^{-1} yr^{-1}):								
Fertilizer N (kg)	206	206	206	206	163	163	110	90
Fertilizer P (kg)	105	105	105	105	130	130	45	40
Fertilizer K (kg)	56	56	56	56	43	43	36	30
Biocide a.i. (kg)	4.59	2.59	4.59	2.59	5.59	2.59	6.12	4.12
Machine hours	28	25	19	19	0	0	37	35
Outputs (ha^{-1} yr^{-1}):[3]								
Fresh produce (kg)	8000	8000	8000	8000	5000	5000	5500	4500
N-output (kg)	103	103	103	103	65	65	55	45
P-output (kg)	21	21	21	21	13	13	9	8
K-output (kg)	28	28	28	28	17	17	18	15

[1] Includes labour requirements that have to be repeated at the start of the growing season, ploughing hoeing, etc. It does not include clearance of forests (land reclamation operations).
[2] Includes only labour requirements for manual weeding
[3] Nutrients in the produce leaving the field.

4.5 Agro-ecological sustainability

One aspect closely related to the way yields are attained are the so-called side-effects (or external effects) of agricultural production, i.e. the impact of processes that affect the state of the natural resources. These processes run parallel with the production cycle of a crop and are to certain extent unavoidable. In the concept of input/output relationships (LUST's) one can consider the effects of these processes as an additional output in addition to the yields. These processes may not pose problems in the short run, but the production potential of a LUST can be affected to greater or lesser extent in the long term depending on the type of process concerned (Kruseman et al., 1993). Moreover, the effects

25 LUSTPZA stands for LUST's at the Programma Zona Atlántica and encompasses a database in which LUST's including the temporal aspects of operations are stored. The database is developed within the framework of the CATIE/MAG/- WAU cooperative research effort.

of some processes are in the short run more detrimental for the adjacent environment than the production potential of a LUST.
According to Van der Sluys et al. (1987) degradation of natural resources due to land use activities appears in various forms in the Atlantic Zone: (1) loss of nutrients, (2) use of biocides, (3) soil compaction and (4) loss of biodiversity. The way and the extent these processes affect natural resources is quite distinct and are therefore analyzed independently in the following Sub-sections.

4.5.1 Loss of nutrients

The loss of nutrients encompasses two aspects, (i) the depletion of soil nutrients and (ii) the leaching of nutrients to the ground- and surfacewater resulting in reduced drinking water quality and changes in vegetation. Decline in shrimp harvests in the Gulf of Nicoya has been associated with contaminations in the coastal waters (WRI, 1991).

Depletion of soil nutrients (i) can be illustrated by means of the nutrient in- and outputs of actual LUST's. Table 4.1 shows that especially under annual crops (including cassava) the nutrient output (nutrients in the produce leaving the field) equals, or is less than the nutrient input (fertilizers). One may also assume that nitrogen, being a mobile nutrient, under the conditions of the Atlantic Zone with an annual precipitation surplus of 2329 mm (See Section 3.2) is susceptible to leaching losses. Potassium, especially mobile on sandy soils, is therefore also susceptible to leaching. For phosphate the situation is somewhat different; Soils from volcanic origin have a high phosphate fixing capacity. From Janssen (1989) it can be derived that for a range of soils[26] in the Zone the maximum phosphate adsorption in the soil top layer (0-30 cm) is at least 1500 kg per ha. This phosphate fixing process seems to a large extent irreversible (Wielemaker, pers. com.). This means that even with a positive phosphate balance (phosphate input > phosphate output) the effect of phosphate fertilizers on the short and medium term might be limited.

Other external inputs, as deposition, biological N-fixation, sedimentation are relatively low. Stoorvogel (1992) estimated a wet deposition of 1.5, 0.15 and 4.9 kg $ha^{-1}yr^{-1}$ for N, P and K. Sedimentation and biological N-fixation are location specific inputs and therefore omitted. These input levels are in general not high enough to bridge the gap between the current level of output and input.

The input/output balances of the annual crops show therefore in general a depletion of soil nutrients, especially nitrogen and potassium. Although results from long-term experiments in the region are not available one may assume that a negative nutrient balance on the long term will result in reduced yields. The effects of declining yields can only be elevated by means of fertilizers (inorganic or organic).

Referring to the mobility of nitrogen the other aspect of nutrient losses, (ii) leaching of nutrients, is evident. In situations where nitrogen fertilizers (input) result in a positive nutrient balance (banana and pineapple) the likelihood to loose fertilizer nitrogen to

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26 Assuming an average soil density of 0.75 kg dm^{-3}.

ground- and surfacewater increases. Detrimental effects of leached nitrogen for the environment depend mainly on the concentration in the leachate. Dilution effects will be considerable taking into account the calculated annual water surplus (23,290 m^3 ha^{-1}) in the Atlantic Zone[27]. Even with positive nutrient balances direct detrimental effects for the environment are limited.

However, reduction of nutrient losses is also from a viewpoint of efficiency pursuable. Form of fertilizer and rate, timing and method of application may reduce losses to the environment. The alternative LUST's described in section 4.3 assume application methods in which losses to the environment are minimized. This is reflected in a higher application frequency with lower rates (and subsequently a relative higher labour requirement). The total input of nutrients is considerably higher than the output, resulting in a positive nutrient balance; In this tentative assessment unavoidable losses were assumed and nutrients leaving the field were completely replaced by fertilizer nutrients; This results in a relatively high input of fertilizers compared to current practices. However, considering the precipitation surplus and ensuing low concentrations of nutrients in the leachate, detrimental effects on the environment are not expected to occur with the proposed fertilizer applications.

4.5.2 Use of biocides

Biocides are developed to prevent or reduce crop damage by yield reducing factors. The use of biocides are also subject to environmental concern mainly because of their toxic side-effects, i.e. poisoning of other organisms than the target organisms. Moreover, many biocides are persistent implying that their effects last during longer time spans.

The description of actual LUST's in Section 4.3 showed that the use of biocides is to a greater or lesser extent common in most land use types. Particularly in banana and pineapple the use of biocides is extensive. The use of biocides is expressed in kilograms active ingredients; This is the common denominator in statistics to encompass the various types of biocides[28].

Major concern on the use of biocides in the Atlantic Zone pertains to the leaching of biocides to ground- and surfacewater. The estimated water surplus (See Section 4.5.1) might be useful to gain insight in concentrations of biocides in the leachate. However, it is difficult to exemplify the consequences for the water quality on basis of the precipitation surplus and biocide quantities applied; Biocides have different characteristics which determine the eco-toxicological impact (See footnote 28). Moreover, a part of the biocides

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27 Assuming (i) a permitted concentration of 11.3 g N per m^{-3} for drinking water (norm used by the European Community) and (ii) that the annual precipitation surplus fully contributes to the drink water resources, the upper allowable limit in the Atlantic Zone is 273 kg N ha^{-1}.

28 For lack of better denominators. Biocides differ a.o. in solubility, persistence, and mobility which determine their ecotoxicological impact. Expression of the amount of biocides in active ingredient does not take these properties into account and represents therefore not the ecotoxicological impact of biocides. It is an indication of the amount of biocides entering the environment.

applied will volatilize, or degrade into nontoxic materials before it will leach or discharge by way of surface water. Degradation processes are accelerated under warm humid conditions as in the Atlantic Zone. However, for more persistent biocides, like the fungicide chlorotalonill, maximum concentrations in the groundwater near banana plantations have been found of 0.02 ug/l.[29] (NN, 1991).

The alternative LUST's described in Section 4.4 show a relatively high use of biocides compared to current practices. This high input level can be explained by the typical climate in the Zone, constantly warm and humid, which is favourable for the development of most yield reducing factors. Moreover, the cultivation of perennial crops, typically for the Atlantic Zone, is advantageous to soil born diseases which can only be controlled without nematicides by means of an appropriate crop rotation; This is for perennial crops not always a feasible option. Recently short rotations (two years) with high plant densities of plantain have been promoted by the extension services allowing a reduced use of nematicides (Jansen, pers. com.).

4.5.3 Soil compaction

Compaction occurs especially on poorly drained pastures which have been deforested with heavy machinery. Infiltration rates under pastures decreased from about 1000 cm day^{-1} to about 40 cm day^{-1} due to compaction (Spaans et al., 1989). Other sources (De Wolff, 1989) indicate that average soil bulk densities under pastures are 25% higher compared to soils under rainforests. It is obvious that the predominant young volcanic soils are susceptible to soil flow at the frequently occurring high soil moisture contents in the Atlantic Zone. However, relationships between type of management and the level of soil compaction are hard to establish. Moreover, soil compaction is a reversible process which primary symptoms can be alleviated relatively easy. Compaction is usually only related to the topsoil which allows light soil cultivation techniques to loosen the soil structure. More permanent solutions have to be sought in the construction of drainage systems although the effects of this kind of control measures on the soil processes (e.g. ageing) is highly uncertain.

4.5.4 Biodiversity

Land use change will affect the biodiversity of ecosystems[30] in several ways; In the Atlantic Zone fragmentation of habitats due to the expansion of agriculture will have the major impact on the maintenance of the regional biodiversity but also nutrient and biocide (residue) loading of soil and surfacewater may contribute to the problem. Although preservation of biodiversity in terms of establishments of nature reserves gets an increasing attention at national level, the issue at the regional level is still rated less seriously because

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29 In Europe and the U.S. the maximum acceptable level of chlorotalonill in drinking water is 0.1 ug/l.

30 In this context biodiversity includes species diversity, within-species diversity and habitat diversity.

short term benefits of preservation are usually less apparent. Illegal, banana plantations still invade natural reserves without major juridical consequences.
Pitelka (1993, See Table 4.3) valued biodiversity from various viewpoints but immediate consequences of loss of biodiversity are still difficult to grasp for individuals. The claimed values are not accepted by everybody because evidence is in most situations poor. Moreover, the supposed values are difficult to quantify.

Recent agreements between the Costarican government and a pharmaceutic company are directed towards the productive use of biodiversity for medicine and biotechnology development, making the benefits more manifest. Even more important is the development of the 'tourist industry' in Costa Rica. A large part of the tourists are attracted by the flora an fauna (eco-tourists). The Atlantic Zone with the volcanic and forested mountain range in the west and the swamp forests (Tortuguero) in the east attract an increasing number of tourists. However, the growth of tourism is rather paradoxical: although the increasing number of tourists may lead to a growing awareness concerning preservation of natural habitats, the same tourists,- actually the required infrastructure to accommodate them-, is a potential danger for the biodiversity of existing ecosystems. Quantification of the impact of tourists on the nature reserve Tortuguero done by Van Bentveld and Van de Broek (1993) seemed a precarious endeavour. Research in this field is necessary to show the trade-offs among benefits accruing from tourists and the supposed habitat fragmentation and resulting loss of biodiversity.

Table 4.3 Values and benefits of preserving biodiversity.

Viewpoint	Reason
1. Economic	Unidentified species may provide valuable food, fibre, drugs, or other products for human use.
2. Evolutionary potential	Genetic diversity in species constitute the basis for natural evolution and artificial breeding/selection programs.
3. Natural laboratory	Natural ecosystems and their species represent information for the study of the earth's natural history.
4. Aesthetic	Natural landscapes and species provide many amenity and recreational values to the public.
5. Ethical	Humans have a moral responsibility to be stewards of the natural environment and protect species.
6. Ecosystem integrity	Diversity must be maintained in order to preserve critical ecosystem service and the integrity of Earth's life -support system.

Source: Pitelka (1993)

5 FARM TYPES AND STRATIFICATION

In this Chapter different types of agrarian households will be classified according to their factor endowments (access to land and capital, intensity of labour use) and the related objective functions (goals and aspirations). The socio-economic stratification of farm households has been based on the tenancy structure as revealed by available agrarian census data for the 1963-1984 period (Section 5.1). Different types of management units have been distinguished referring to particular land use types and farming systems (Section 5.2). Finally the major management units are analyzed with respect to their production (Section 5.3) and employment (Section 5.4).

5.1 Tenancy structure

During the 1963-1973 period the number of farms in the Atlantic Zone hardly varied although the farm area increased with 18% (DGEC 1966a, 1976a, 1987a). Mean farm size increased from 39.4 ha in 1963 to 46.2 in 1973 (see Table 5.1) through colonization of nature areas by expansion of farms.

In the 1973-1984 period the number of farm units in the Limon province increased with 67 %, although the farm area only increased with 17 %. This may indicate that the agrarian frontier has practically been reached and that farm subdivision is now the most important process. Mean farm size decreased from 46.2 ha in 1973 to 30.7 ha in 1984. By consequence the number of owner-managed farms increased during the whole period 1963-1984, although still nearly half of all farm area is managed by administrators.

Colonization and land reform under state guidance have played an important role in the region. Between 25% and 35% of the total farm area is land who's ownership has been arranged through ICTO/IDA[31]. In the 1960's ICTO was mainly involved in the redistribution of state land. In the 1970's and 1980's the government settlement policy was responsible for an increase of small-sized peasant farms. In the latter part of the 1980's and early 1990's land titling and registration has become more predominant. During the 1960's and 1970's the distribution of land tenancy became less unequal, as reflected by diminishing gini ratios from 0.78 in 1963 to 0.76 in 1973 and 0.71 in 1984 (See Annex 5.1).

The general farm-size classification in Table 5.1 is based on commonly used distinctions between four classes [32]:'*minifundio*' (0-3.99 ha), small peasantry, '*finca campesina*' (4-19.99 ha), medium size peasantry, '*finca mediana*' (20-199.9 ha) and large estates or '*latifundio*' (more than 200 ha), including cattle haciendas and banana plantations. These farm size criteria are supposed to be related to the use of external inputs, soil productivity

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31 ICTO stands for Instituto de Colonización de Tierras y Ordenamiento and was the semi-autonomous agency in charge of the establishment of peasant settlements, mediation in land conflicts and the facilitation of legal procedures regarding land titling. IDA (Instituto de Desarrollo Agraria) is the succesor of ICTO.

32 This farm size classification is based on earlier studies in the Meseta Central region, where coffee production on family type farms is the most important activity.

and labour absorption, but do not make any further differentiation between land use and farming systems.

Table 5.1 Atlantic Zone tenancy structure (area in ha).

	1963				1973				1984			
farm size	farms	%	area	%	farms	%	area	%	farms	%	area	%
without land					156	3.0			283	3.0		
0-4 ha	1385	26.2	3574	1.7	1065	20.1	1956	0.8	1749	18.8	3170	1.1
4-20 ha	2529	47.9	26261	12.6	2168	41.0	20542	8.4	4448	47.7	43084	15.1
20-200 ha	1232	23.3	58278	28.0	1724	32.6	76643	31.3	2583	27.7	125479	44.0
>200 ha	135	2.6	119746	57.6	177	3.3	145391	59.5	253	2.8	113583	39.8
Total	5281	100	207859	100	5290	100	244531	100	9316	100	285316	100

Source: DGEC Agrarian Census 1966a, 1976a, 1987a

For operational purposes the definition of farm types in the Atlantic Zone should take into account land use types and related farming systems, especially based on the available resources, the main production activities and the objective function. Therefore a stratification system has been developed as illustrated in Table 5.2.

Table 5.2 Farming systems and land use types in the Atlantic Zone (1984).

Type	Area (ha)	No. of farms	% farm land	% Atlantic Zone
Banana plantations (> 100 ha bananas)	21,064	136	7.4	2.3
Extensive haciendas (> 50 animals)	169,526	1,010	59.4	21.4
Small size peasant farms (0-20 ha)	46,254	6,480	16.2	5.0
Medium size peasant farms (20-50 ha)	48,472	1,690	17.0	5.3
Total farm area	285,316	9,316	100.0	31.1
National parks	294,562	-	-	32.1
Forest reserve	86,125	-	-	9.4
Indian reserves	177,410	-	-	19.3
National lands/ Agrarian frontier	74,903	-	-	8.2
Total area	918,316	-	-	100.0

Source: Total regional area based on SEPSA Land-use map 1984 (cited in Lutz and Daly, 1991). Farm area and farm numbers from DGEC (1987a). Non-farm area for National parks, forest reserves and indian reserves from Jones (1990). National land calculated as a difference between total regional area and farm/non-farm area.

The boundary between small and medium size peasantry generally is fluent, but the 20 ha limit has been chosen because it is equivalent with the mean size of IDA allocated settlement plots, that should guarantee full family labour absorption in agricultural

production. The area of banana plantations above 100 ha covers about 93 % of all banana cultivation in the area. Livestock production is almost exclusively found in the farm strata (> 50 animals) that represent about 59 % of the total regional animal population.

5.2 Management units

According to land use types and predominant farming systems three categories of management units (MU) can be distinguished. The term management unit has been used by Stomph & Fresco (1991) for denoting the biophysical side of land use management. The term is used here in a more economic sense, since objective functions for land use are also included. A biophysical element remains in the sense that a management unit has a distinct set of LUST's at its disposal. Each MU may comprise a combination of major land use types (MLUT) that represent factor endowments, and a specific objective function (G_i) that determines the production function:

$$MU \sim f\,(\sum MLUT,\ G_i)$$

A management unit may be defined as the combination of an actor, his resource endowments (land, labour, knowledge and capital) and long term "production" strategy. The main categories of MU's that should be taken into account in the model are illustrated in Table 5.3. The structure and composition of production on farm household level is of major importance for the modelling of their strategies with respect to resource allocation and resource-base reproduction. Both aspects determine the response reaction of farm households towards agrarian policy measures.

Table 5.3 Combination of major land use types (MLUT) and management units (MU).

MU	Peasant household production	Plantation production		Extensive haciendas	
		Bananas	Forestry	Livestock	Nature
MLUT		I	II	I	II
Crop production	X	X	-	-	(X)
Livestock	X	-	-	X	(X)
Forestry	X	-	X	X	X

X = important, (X) = minor importance

Using general descriptions of the northern Atlantic Zone (De Oñoro, 1990; Waaijenberg, 1990; Wielemaker, 1990) a typology based on land use strategy and resource endowments can be made (See Table 5.4). The first general division is into small and medium scale peasant farms and large scale agricultural production on plantation or hacienda farm types. In the former production and consumption decisions are linked, while in the latter only production objectives drive decision making. Since land use not only refers to agricultural production also other non-agricultural activities should be taken into account, i.e. nature conservation and lumber extraction companies. Forests still account for the largest area in the Atlantic Zone, although the rate of deforestation is high (See Section 2.5), due to

expanding banana plantations, expansion of extensive grazing, lumber extraction by the timber industry, and to a limited extent by squatters.

Table 5.4 Stratification of management units.

Management unit	Objective	Land use types	Actors
Plantation	profit	banana	multinational enterprises
Plantation	profit	banana	national enterprises
Plantation	profit	forestry	lumber companies
Hacienda	rentseeking	forestry	nature reserves
Hacienda	rentseeking	forestry	investors
Hacienda	rentseeking	forestry	livestock ranches
Hacienda	rentseeking	livestock (meat)	livestock ranches
Hacienda	rentseeking	livestock (milk)	livestock ranches
Peasant household	utility max.	forestry	peasant farms
Peasant household	utility max.	livestock	peasant farms
Peasant household	utility max.	annuals	peasant farms

Different actor groups have different objectives, which are partly conflicting. The divergence of public and private costs and benefits is the key to understanding the objective functions of various types of management units, as well as the resulting land use options. Individuals may have income (profit) or rent maximizing objectives, comparing current benefits of actual land use with the private opportunity costs of alternative land use options. Other strategies account for more speculative land use, with negative external effects for other sectors. The maintenance of natural capital can be a public goal in itself, and may constitute a basis for income flows accruing from eco-tourism.

Specific land use types are related to the distinguished management units. The major land use type "forestry" can be divided into a number of sub-units based on criteria concerning legal status and major use:

(1) virgin unclaimed forest, legally belonging to the state, but without any formal protection; Its status as a management unit is ambiguous, because in fact it refers to non-management;

(2) national parks and reserves, (mostly) state-owned forest protected against lumber extraction and agricultural activities; Although the objective function is clear (nature conservation) the output is less easy to quantify other than conserving the area.

(3) forest which is dedicated for lumber extraction, with or without reforestation; the management unit is of the plantation type;

(4) forest which is held primarily as an investment in wild land to be able to convert it to e.g. banana plantations or extensive grazing; This type should be envisaged as land with a legal property status but that is not being managed as such.

(5) Agro-forestry and sylvo-pastoral systems do not represent independent management units but are part of MU's. These systems can be considered as LUST's that may be included in peasant household or hacienda MU's.

The forestry plantation segment includes basically the before-mentioned sub-unit (3) - plantation (lumber) - , while the sub-units (1), (2) and (4) can be classified as forestry haciendas with primarily rent-seeking objectives. Capital intensity of forestry plantation is high, labour use depends on the rate of deforestation. Large scale lumber extraction is done with large chain saws, bulldozers and other heavy machinery. Reforestation technology is relatively simple, trees are raised in a nursery and transplanted into the cleared area. Capital intensity is low and labour intensity is high. Type (5), agroforestry, may be incorporated into the management unit types haciendas and peasant farms. Basic information about the forestry sector is presented in Annex 5.3.

Pastures with extensive grazing encompass the most extended form of agricultural land use in the Atlantic Zone. Within the livestock sector three holding types can be distinguished:

(1) small scale dual purpose livestock production, which is included in the small and medium scale peasant households;

(2) specialized breeding (*cría*), aimed at breeding and raising of calves for sale, characterized by herds with a substantial number of cows often combined with dairy activities; and

(3) specialized meat production (*engorde*), or extensive meat production, characterized by herds with lots of bulls.

5.2.1 *Peasant households*

The MU of peasant household production represents a high level of diversification related to the objective of **utility maximization** and risk aversion. For this type of MU a recursive model can be developed, where 'full income' (Y^F) depends on production decisions that are determined by exogenous prices and LUST options. Labour-supply/leisure ($w*L^L$), home consumption (p_f*C^f) and market purchases (p_m*C^m) define the full income of the agrarian household model:

$$Y^F = w*L^L + p_f*C^f + p_m*C^m$$

Y^F	= full income	($)
w	= wage rate	($/manyear)
L^L	= family labour	(manyear)
p_f	= unit opportunity cost of home consumption	($/vol)
C^f	= volume home consumption	(vol)
p_m	= market price	($/vol)
C^m	= volume market bought consumption goods	(vol)

Peasant production in the Atlantic Zone consists of small size (0-20 ha) and medium size (20-50 ha) farms that are generally dedicated to mixed farming, combining food crops (maize, beans, cassava) with commercial crops (plantain, pumpkin, etc.) livestock and/or non-traditional crops (palmheart, ñame, etc.). Female labour in on and off-farm employment contributes almost one fifth part to family income (Hooijschuur, 1991). Peasant production has a rather strong commercial orientation (except for beans) and a

high labour intensity of production, while optimalization of land productivity is the major objective[33].

The analysis of farm household behaviour will take place for both distinguished peasant household types separately to address the following aspects of the farm household decisions:

a) land use; Selection of crops and their respective technology suitable for each of the soil types available within the farms (so-called LUST), also taking into account sustainability criteria. In a more dynamic analysis, soil properties - and therefore also technical coefficients - may change over time due to natural resource depletion.

b) resource mobilization; Allocation of land, labour and capital resources to different activities, including off-farm employment and land rental. This involves the selection of relevant LUST's (see a) and the respective threshold values for each of the productive resources, accounting for risk and external costs. Land use conversions may occur due to differences in opportunity costs for various resource allocations (Lutz & Daly, 1991).

c) expenditures; Allocation of household incomes from on-farm activities and off-farm employment to the consumption of different commodities may influence the peasant welfare function. Therefore, both the commercialization rate and the consumption elasticities of major commodities determine the profit perspectives at farm level.

Small and medium scale peasant households are a difficult subsector to quantify, for several reasons; In the first place the objective functions of the farm households are complex and depend to a large extent on transaction costs and limited information.

Production aspects dominating the small/medium scale mixed peasant farming systems include different combinations of the following activities:

a) basic grains (maize, beans), both for home consumption[34] but mainly for marketing. Productivity levels are low, mainly because of drainage problems and low external use of inputs.

b) roots and tubers, like cassava, tiquisque, chamol, malanga, ñame and yampi, represent traditional crops in the Atlantic Zone. Production of these crops takes

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33 Further differentiation of peasant farm types could be based on resource access and farming system criteria (Alfaro, 1993). Intraregional differences between farm types with respect to size and land use confirm the general tendency of a higher percentage of cultivated area in smaller farms and a lower input level and rate of specialization in peripheral regions (Schipper, 1992).

34 Rural families in Costa Rica dedicate about 32 % of their income to basic grains consumption; In urban areas the basic grains share accounts for only 20 % of expenditures (Hazell, 1991). Consumption elasticities are slightly negative and in rural areas substitution possibilities include especially root and tuber crops.

place on small size farm households for commercial purposes; Contract farming agreements exist with trading companies for (inter)national commerce, but are subject to strict standards for quality and homogeneity (Stolzenbach, 1990; Smit, 1991).

c) non traditional crops in the Atlantic Zone include mostly (semi)perennial crops like cocoa, plantain, peijibaye, cardomom, pineapple, palmheart and ornamental plants. Fiscal and credit subsidies are available to stimulate their production. However, marketing structures are highly oligopolistic and dominated by a small number of enterprises. Part of the production takes place under contracts with fixed input requirements, quality norms and (sometimes) guaranteed minimum prices. Capital requirements are generally high (minimum of US$ 1000/ha) and direct labour costs represent less than 50 % of total production costs (Weller, 1992); Therefore, cultivated areas are mostly small. Increased use of agrochemical inputs (fertilizers and biocides) has a negative environment impact and affects both financial and economic profitability[35] (den Daas, 1993).

d) livestock and (agro)forestry; Small and medium scale peasant households are mainly involved in animal husbandry oriented towards double purpose or dairy production within mixed farming systems. Although livestock productions tends to be of secondary importance in terms of labour use, its contribution to family incomes is usually important (van der Kamp, 1990).

e) off-farm employment; Schipper (1992) calculated that between 29 % and 48 % of all producers are incorporated in external (non)agricultural wage labour. Revenues accruing from external sources - including remittances - represents a substantial and increasing part of family income.

5.2.2 Plantations

The MU of plantation production can be characterized by high product specialization and strong **profit maximization** objectives. Both banana plantations and forestry logging operations represent a high capital intensity with respect to output value. Labour input is almost exclusively wage labour, with a high incidence of temporary contracts. Labour/land ratios are relatively high, but labour costs represent only a small fraction of the total production costs. Production is highly integrated with processing for external marketing. World market prices directly influence the profit perspectives of plantations. In the case of plantation production and logging no separate analysis of expenditures is necessary, while their company profits only depend on supply markets.

The specific objective function for plantation production represents profit maximization ($max\ Y^{*}$) under fixed (world) market prices for the output ($p_{wm}{}^{*}Q$) through the

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35 The net foreign exchange benefits from non-traditional crops lower substantially if imports of chemical inputs, seed material and other inputs are taken into account (see Weller, 1992).

minimization of input costs for wage labour ($w*L_H$), purchased inputs (p_B*B) and export taxes ($\rho*Q$):

$$\max\ Y^{\pi} = p_{wm}*Q - (w*L^{H} + p_B*B + \rho*Q)$$

Y^{π}	= profit	($)
p_{wm}	= world market price	($/kg)
Q	= production volume	(kg)
w	= wage rate	($/manyear)
L^H	= hired labour	(manyear)
p_B	= market price of inputs	($/vol)
C^m	= volume inputs	(vol)
ρ	= tax rate	($/kg)

Plantation agriculture represents mainly bananas, but also some cocao, pineapple and macadamia[36]. The area with banana increased between 1984 and 1992 from 21,258 ha to 44,188 ha (Stoorvogel & Nieuwenhuyse, 1993). Direct employment in the banana sector has been estimated at 14.000 working places in 1982 and may have increased to 29.000 actually, while indirect employment accounts for another 21.000 labourers[37]. Labour intensity per hectare did not change much during the period 1977-1991, but production per labourer showed a strong growth. Increased labour opportunities have not led to a decrease in unemployment (MIDEPLAN, 1991), due to the fact that much of plantation labour absorption comes from temporary migration which does not enter official statistics. In the plantation sector, at present, only 25% of the labourers have steady contracts. The remaining 75% are covered for 25% by locally available temporary labour and for 75% by temporary migrants. In 1984, the ratio of steady to temporary workers was the opposite. This means that although the area under banana plantations doubled in this period, this did not create additional employment for the local population.

Almost all banana production is concentrated in large enterprises. Within the banana plantation sector two production holdings are found, namely the multinationals and the associated national production companies who supply the multinationals with bananas. About 42 % of all banana plantations are domestically owned, but in recent years direct cultivation by multinational companies is increasing through land acquisitions of forests and buying-out of peasant settlements. Before 1984 the banana plantation area was fairly stable, with area added and area abandoned at about the same rate. However, this does not mean that the net result was zero; As Veldkamp et al. (1992) point out, banana plantations tended to shift towards the most fertile soils. The increase in banana area between 1985

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36 Based on the 1973 agrarian census 45% of the regional cacao production comes from farms larger than 100 ha. However, this figure includes both cacao plantations and cacao haciendas, specialization can be found in the 200-500 ha range: cocoa farmers planting 75% of their farm area with cacao. Low productivity levels (15% below the regional average) seem to indicate hacienda type production. There are strong indications that cacao production in the Atlantic Zone has declined considerably since 1973. Taking into account these considerations regarding cacao and the fact that pineapple and macadamia are minor crops in the Atlantic Zone, the focus on banana plantations is justified.

37 The direct/indirect employment ratio for banana production has been estimated in 1 : 0,84; See F. Ellis (1983) and J.R. Lopez (1986).

and 1991 has been reached almost exclusively through expansion of multinational companies (See Annex 5.2).

Expansion of the area under banana has been accompanied also by technological change and productivity growth. Yields steadily increased during the 1980's because of the introduction of new varieties and better management. Associated producers stay behind in productivity indices; In 1991 these differences accounted for 12 %.

The banana subsector is probably the least difficult to understand, since the forces driving the developments are fairly straightforward. Policy influence is restricted to taxes and regulations. Positive developments on the world market reinforced the process of expansion of banana plantation in the latter part of the 1980's.

Economic and social linkages of banana production are clearly important through the creation of employment opportunities, contributions to government income (export tax[38]) and capital investment for internal and external infrastructure. In addition to the payment of wages the banana companies' social security contributions account for almost 13 % of production value and other forward/backward linkages (packing materials, transport, fertilizers) contribute additionally some 69 % to current production value[39].

Forestry plantations are dedicated to commercial forestry production (logging) are located partly on privately-owned lands in the agrarian frontier zones, although also some exploitation takes place on national lands and private rented land. The management of forests is mostly integrated with processing industries. Recently, large-scale forest cleaning has been executed by banana companies to expand.

5.2.3 Haciendas

The MU of hacienda production represents an intermediate level of specialization with **quasi rent** objectives as most important production principle. The basic orientation of this management unit has been described by the theory of rent and the concept of surplus. Economic rent can be defined as the difference of reward actually accruing to a production factor in a particular use and the minimum requirements to keep it in use (Ghatak & Ingersent, 1984). Quasi rents refer to residual profits that are sufficient to recover amortization[40] costs of the fixed capital invested along with a long-term interest rate that can be considered as a reward for waiting (Robinson & Eatwell 1973). Agricultural surplus refers to the flow of resources resulting after compensation of direct production costs for direct reproduction requirements (ibid). Rent models have a long history starting with the corn rent model of Ricardo (1817) and the Marshallian factor productivity approach

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38 Banana export taxes for each exported box varied between US$ 1.00 in 1974 to US$ 0,15 in 1989.

39 Calculations based on J.M. Guluboay & H. Vega, La actividad bananera en Costa Rica. In: FLACSO/CEDAL (1988).

40 The gradual extinction of a mortgage through the contribution to a sinking fund at the time of each periodic interest payment.

(1890). The classical models focus on the role of the surplus in mobilizing production factors, financing investments and contributing to development. Modern theories (Lee (1971), cited by Morrison & Thorbecke, 1990) dedicate more attention to the rent income as a flow of resources related to fixed investment.

Hacienda management units where surplus generation is predominant can be characterized by the objective function specified in terms of minimum rent income (Y_r^{min}) derived from the property of assets or capital goods (K).

$$Y_r^{min} = K * i$$

Y_r^{min}	= minimum rent income	($)
K	= value of assets	($)
i	= interest rate	(%)

Quasi-rent income accruing to the hacienda owners is the income over and above the minimum rent income. Land can be defined in terms of capital (see Chapter 5 of Kruseman et al., 1993), so that the reward for land is added to the reward for invested capital. In the case of rent-seeking behaviour of hacienda production, rent is the reward for land and capital invested in the land that has become an intrinsic part of that land.

Rent includes compensation for the investments in the reproduction of the land resources. For calculating the rent, the value of the land is used in combination with the going interest rate (opportunity cost of invested capital). To secure the rent, activities (LUST's) have to be undertaken. The strategy of the hacienda management unit is to minimize investment in fixed and working capital related to the LUST's. Increasing stocking rates will therefore coincide with increasing land prices and interest rates. Rent- seeking strategies are possible where it is highly probable that the land for which rent is extracted will continue to increase in value. In the theoretical case that land pressure becomes so high that the extraction of rent by the landlord himself starts to involve high supervision costs, it will be wiser to either sell off the land or defer production to tenants. Endogenous changes in rent income are effectuated by changes in land holding size.

Extensive livestock haciendas are medium and big size farms with a minimum herd-size of 40 animals and a minimum farm size of 50 ha. Traditionally, the livestock sector has been mainly oriented towards extensive meat production, but recently more specialized dairy production and dual purpose (meat/milk) production shows a notable increase (Aragón, 1992). Forestry reserves and national parks, where no commercial wood extraction takes place, but are mainly 'exploited' for tourism are also included in this type of management unit.

During the 1973-84 period the animal population almost doubled, but pasture area more than tripled and the stocking rate only increased marginally. Pasture land increased in the same period from 25.4 % to 37.2 % of the agricultural area. Most important changes occurred in the production target, especially the relative decrease of cattle for meat production and the increase of dairy and dual purpose production (see table 5.5).

Table 5.5 Changes in livestock characteristics in the Atlantic Zone (1963-1984).

	1963	1973	1984
No. farms	1,847	2,385	4,563
Cattle (numbers)	39,246	72,108	147,885
Pasture area (ha)	34,646	62,204	106,026
% Meat	na	97.8	64.8
% Dairy	na	0.9	13.7
% Dual purpose	na	1.3	21.5
Stocking rate	1.1	1.2	1.4

Source: DLV calculations based on DGEC 1966a, 1976a, and 1987a.

The two livestock production units considered as extensive haciendas, undertaken by land owners with extended rangelands and pastures, are specialized breeding and specialized meat production.

Livestock production in the Atlantic Zone relies heavily on pasture availability/quality and credit access. Wide differences exist in cost structure between extensive meat-oriented production and more intensive double purpose or breeding oriented livestock systems (van der Kamp, 1990).

The first variable to explain livestock expansion is the price ratio between livestock and arable crops (Guardia et al., 1987). The favourable price ratio with regard to secondary production (attractive meat/milk prices in comparison with those from arable products), leads to the conversion from arable farming to livestock. This process is further stimulated by government policies, such as the FODEA law[41], which has subsidized investments in livestock operations. This conversion leads to land concentration as ranchers can acquire their land on the land market, where it is supplied by the small and medium scale mixed farming sector and it is supplied at the agricultural frontier. The conversion of land from crop production to livestock can have two secondary effects: a decrease in food supply (less arable land available for food production) and a decrease in labour demand (labour intensities in livestock activities are usually lower than in crop activities). The situation in the Atlantic Zone where there still some agricultural frontier exists, and where livestock production is often an investment activity, favours an expansion in pasture area over the improvement of the pastures. Tax subsidies on reforestation, favour the conversion of grazing land to sylvo-pastoral systems. Although information is lacking this trend in reforestation may even lead at a certain point to the conversion of pasture land into a forest reserve.

Increasing herd sizes and stocking rates may aggravate soil compaction, leading to a decreased production. If production drops, the demand for additional feed sources increases, leading either to further land concentration or to pasture improvement. If production drops dramatically, or looses importance in comparison to other grazing areas, the land might be abandoned. Abandoning the land bears a risk, since this land might be invaded by squatters and consequently de facto confiscated.

41 FODEA stands for ley de Fomento y Desarollo de la Agricultura (Law for agricultural incentives and development)

Part of the forest area (national reserves and private owned but idle forests) can also be considered from a viewpoint of rentseeking objectives: The intrinsic value of unclaimed virgin forest is determined by nature considerations. In national parks and reserves, this intrinsic value is formalized. Labour and capital intensities are low in this land use type. Where forests have a recreational function (eco-tourism), labour intensity is slightly higher, but still low compared to agricultural use.

5.3 Employment

The management units distinguished represent various types and intensities of labour absorption:

* in the banana plantations almost exclusively wage labour is used, mostly (young) male labour for field work activities - crop maintenance and harvesting - and transport, while female labour is more important for processing and packaging. Labour contracts are specified for short periods (up to 3 months), although a substantial part of the activities requires permanent labour. For forestry plantations male wage labour is of major importance, but labour intensity is much lower. Increased labour opportunities have not led to a decrease in official unemployment (MIDEPLAN, 1991), due to the fact that much of plantation labour absorption comes from temporary migration which does not enter in the official statistics. In the plantation sector, at present, only 25% of the labourers have steady contracts. The remaining 75% are covered for 25% by locally available temporary labour and for 75% by temporary migrants. In 1984, the ratio of steady to temporary workers was opposite.[42] This means that although the area under plantations doubled in this period, this did not create additional direct employment for the local population.

* in the hacienda management units labour intensity of production is generally low. Permanent wage labour represents a small part of the production costs, while for periodic activities (e.g. pasture maintenance, fencing, etc.) contract labour usually is hired.

* within the peasant management units the most important labour force is the owner-manager and unpaid family labour. During the peak seasons (land preparation, harvesting) wage labour is usually contracted. Non-traditional crops generally represent a higher demand for wage labour. Moreover, in slack seasons an important number of peasants is engaged in off-farm employment.

Making use of general information about the production structure, a tentative scheme for labour absorption within the different management units can be developed (Table 5.6).

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42 With 75% steady contracts and only 25% temporary contracts in 1984 the balance between local labour and temporary migrants was completely different. Availability of local labour for work in the banana plantations dit not change radically in the 1984-1992 period, which can be observed in a higher percentage of local labour in the temporary labour force in 1984 (67%). The increased labour demand in the banana sector has almost completely been covered by temporary migration.

Table 5.6 Tentative labour absorption by management units (1984).

Management unit	Labour type			
	Wage labour	Self employed[3]	Family labour	total
Banana plantations[1]	12,900			12,900
Haciendas[2]	2,900	500		3,400
Peasant production	2,100[4]	7,600	2,600	12,300
TOTAL	17,900	8,100[6]	2,600[7]	28,600[5]

Source: DLV calculations based on DGEC 1987a, 1987b.

1 Other plantation forms have been excluded for lack of data, for banana plantations labour absorption has been put at 0.667 manyear/ha. (figure taken from relevant literature). The total labour absorption is corrected for temporary migration, i.e. 33% of 25% is subtracted.

2 Pasture area covers about 63% of the hacienda area, extensive livestock has a labour absorption coefficient of 0.020 manyear/ha. (Carvajal, 1988 (op. cit. Waaijenberg, 1990); van Hijfte, 1989). Forests take up 29% with a tentative labour absorption of zero. 8% of the area is taken up by other crops with a higher labour absorption than livestock.

3 This category includes patrons.

4 ALP data (Waaijenberg, 1990; de Oñoro, 1990) indicate that labour absorption is 65 mandays per year of temporary wage labour per farm.

5 Of the employed population 28,600 persons were employed in agriculture in 1984 (DGEC 1987b), official statistics exclude temporary migration.

6 There were 8,100 owner-managed farms in the Atlantic Zone in 1984.

7 Calculated on the assumption that 75% of unpaid family labour is found in agriculture.

Available information on labour allocation on farm household level between on- and off-farm employment and family and wage labour is not completely consistent. Examination of farm survey data collected at 149 farms in three different subregions - Neguev, Rio Jimenez and Cocori - (Schipper, 1992) shows that off-farm employment is an important (additional) income source for 29 to 48 % of all farms. Agricultural work only represented a third of all off-farm activities. Moreover, off-farm employment is particulary important in recent spontaneous colonization zones, while in other areas it seems more related to farm size and the use of external inputs.

A more detailed survey of 20 farms executed during 1992/93 (Schipper, pers. com.) also offers information about the distribution between family labour and hired labour for on-farm activities, as well as the importance of off-farm labour (See Table 5.7). Contract wage labour for on-farm activities proved to be especially important for farms with perennial crops, while family labour was the major category on farms mainly with basic grains. Especially on livestock farm types off-farm labour represented an important part of family income, due to the low labour intensity of production.

Table 5.7 Labour allocation at peasant farms.

Land use type	Farm area (ha)	Labour (days/ha)	Total labour	Contract labour	Family labour	Off-farm labour
				(percentage of labour use)		
Basic grains	16.6	112	1,973	26.9	70.3	2.8
Perennials	15.6	300	4,847	40.7	51.4	7.9
Livestock	19.7	175	3,609	28.7	48.2	23.1
Total	17.6	194	3,489	34.1	44.0	21.9

Source: DLV calculations based on Schipper (pers. com.)

6. LOCAL MARKETS, INSTITUTIONS AND SERVICES

To evaluate the potential impact of agrarian policies on farm level decisions the functioning of local markets and the access to institutions and services are important variables to assess the responsiveness of the producers.

The impact of agrarian policies on land use and production technology choice depends on the response reactions of different management units and the structure of the transaction costs (transportation costs, market structure, banking services, information, legal services, etc) that affect the transmissions of price signals. Moreover, public goods and services (roads, extension, research, health, education, electrification) also influence directly the supply response of agrarian households (de Janvry & Sadoulet, 1992).

6.1 Factor markets[43]

6.1.1 Labour market

During the last two decades the labour market in the Atlantic Zone is restricted as reflected by the low level of unemployment. Even with a relatively high rate of natural population growth and net immigration both, unemployment decreased (See Table 6.1). Educational levels of the labour force are generally low in comparison with other regions of the Costa Rica (31 % of the employed did not finish primary school). Female participation in the labour force is 22.4%. The distribution between occupational categories reveals that wage labour represents a relatively high proportion of labour force (76.6 % in 1992).

Migration is facilitated by the availability of infrastructure and services. Most of the migration can be characterized as '*chain migration*' of relatives towards family members who established themselves earlier in the Atlantic Zone. Migrants started in wage-labour occupations to enable savings for subsequent land acquisition. Recent migrants may be expected to have more problems to acquire land and will therefore show a more permanent engagement in wage employment. The major aspects of migration are reflected in the intensity of squatting and the migration towards urban areas. Besides the direct income generation from employment, the income flow from *remittances*, i.e. income from outside the agricultural sector, which is used for investment or consumptive purposes in the peasant sector, represents a considerable flow.

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43 In Annex 6.11, 6.12 and 6.13 the prices of factor inputs are summarized.

Table 6.1 Labour force composition in the Atlantic Zone.

Category	1973	1984	1992
Total population	115,143	168,076	226,264
Economic active population	71,994	112,213	153,093
Labour force	37,718	53,110	80,065
Employed population	34,742	48,417	76,312
Unemployed population	2,976	4,693	3,753
Inactive population	34,276	59,103	73,028
Activity rate (% labour force in E.A.P.)	52.4	47.3	52.3
Unemployment rate	7.9	8.8	4.7
Wage labour (% of employed population)	75.6	68.4	76.5
Self employment	17.5	21.5	17.6
Family labour	6.2	6.5	3.6
patrons	0.7	3.6	2.3
Agriculture (% of employed population)	55.7	61.6	48.9
Manufacturing and construction	9.2	8.9	13.7
Services, transport and commerce	35.1	29.5	37.4

Source: DGEC, (1976b, 1987b, 1991)

The dynamics of the rural labour market is strongly related to the pull/push effects of the development in the banana subsector and the conversion of arable land into livestock production. Chapter 4 showed that the labour absorption per hectare in the banana sector is 6 times higher than in basic grains production and more than 33 times higher than on livestock haciendas. In terms of labour productivity banana production is also superior, but beans production almost equals extensive livestock.

Wage differences between these sectors can be explained because of various types of labour contracts (See Table 6.2). The real wage rate has increased steadily with a small dip in the early 1980's. This dip can be explained by the high rate of inflation present at the time. The wages were adjusted to the new price levels periodically, but the fact that this happened periodically meant that most of the time the wages lagged behind the price rises.

Policy instruments with regard to the labour market refer to wage and labour regulations which are defined at national level and not specifically geared towards the Atlantic Zone. Nevertheless, labour unions on plantations sometimes are able to reinforce specific labour arrangements because of specific local conditions. Although the banana plantations themselves pay relatively well (on average 40% higher according to Beek & Raabe, 1989), much (hard and strenuous) work is subcontracted to middlemen who pay much lower wages. Subcontracting also gives opportunity for the use of illegal nicaraguan immigrants.

Table 6.2 Wage rates.

Year	General wage rate current C.	agricultural wage rate Current C.	general wage rate Constant C.[1]	agricultural wage rate Constant C.[1]
1976	1081.0	655.0	5933.3	3595.1
1977	1332.0	789.0	6991.2	4141.2
1978	1513.0	870.0	7510.3	4318.5
1979	1804.0	1102.2	8258.5	5045.8
1980	1983.3	1220.1	7627.8	4692.5
1981	2301.0	1412.0	6460.1	3964.2
1982	3255.3	2114.0	4589.7	2980.5
1983	5309.3	3558.9	5940.1	3981.7
1984	7040.3	4555.9	7040.3	4555.9
1985	8176.4	5294.5	7112.2	4605.4
1986	9403.8	6038.4	7214.4	4632.5
1987	12906.1	7768.6	8630.2	5194.8
1988	14965.1	9241.1	8291.6	5120.1
1989	17531.7	10973.0	8307.5	5199.6
1990	21232.9	13538.9	8395.0	5353.0
1991	26078.8	16520.8	7951.7	5037.4
1992	33070.0	22502.9	8327.1	5666.3

Note: [1] base year 1984
Source: Calculated on basis of Alternatives de Desarrollo (1993).

6.1.2 Land markets

Consistent data on land transactions have not been published, only the general data relating to land passing through IDA administration (accounting for 30% of the area) is available in aggregated form. In Annex 6.18 this data is summarized. There have been very strong fluctuations in prices paid by IDA.

Land ownership transactions can be explained because of different factors. Two basic types of reactions exist: a) *shifts* in land use within the same management unit, - mostly concerning the selling of the land improvements ('*mejoras*') on IDA parcels -, are related to the demographic life cycle of peasant families and the availability of external wage-employment opportunities or b) *transfers* of land use because of farm discontinuation and the change of ownership to another type of management unit. These transfers may be characterized as a buyers-market and depend basically on the relative profitability of agricultural activities and the land accumulation potential [44].

Discontinuation of management units in the Atlantic Zone is mainly related to implicit valuation of land and the relative weight of factors like soil type and production potential, location and access to infrastructure, and land improvements.

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44 Land accumulation refers to the development of real land prices due to changes in potential land use (Carter, M.R. et al., 1992).

6.1.3 *Credit and capital markets*

In the Atlantic Zone different types of credit systems and rural financial institutions co-exist and offer credit facilities to farmers under various conditions. The most important financial schemes include:

a) Bank credit by the major state development banks (a.o. BNCR), mostly operating under refinancing conditions of the Costa Rican Central Bank (BCCR).

b) Suppliers credit offered by retail or wholesale companies in advance to the harvest, sometimes with specific conditions regarding the marketing of the product (contract farming).

c) Parallel credit schemes operated by non-governmental organizations or peasant unions on a local basis, generally linked with technical assistance and marketing.

Although detailed information about the volume of operations and the specific lending conditions of these different credit schemes is lacking, some indications can be given about the development of official credit flows in Costa Rica. New credit allocations for agriculture decreased their share in overall credit portfolio between 1985 and 1990 from 32.3 to 18.5 % (Ramirez, 1993). Credit allocation to the livestock sector and for non-traditional crops increased, while basic grains reduced their share in agricultural credit in the same period from 43.8 to 8.1 %. Interest rates have been much lower in agriculture than in other sectors, but subsidized credit programmes were finished in 1990. Transaction costs for rural credit are considered to be high especially for smaller producers.

In the Atlantic Zone financial support for agricultural production has been given through the regular bank credit for C. 121.2 million in 1990. Credit for food crops (basic grains, plantain, cassava) represents 37.5 % of the loan amount, followed by ñame, pijibaye and livestock (see Table 6.3).

Table 6.3 Allocations of agricultural credit (1990).

Activity	Loans (no.)	Ha or Animal	Amount (C. x 10^3)	%
Traditional crops:				
Basic Grains	na	1,713	30,762	25.4
Plantain	39	84	8,598	7.1
Cassava	54	146	6,080	5.0
Non-traditional crops				
- ñame	83	199	40,483	33.4
- pijibaye	17	48	9,879	8.1
- pineapple	7	7	2,930	2.4
- papaya	9	23	1,545	1.3
- tiquisque	3	18	1,938	1.6
- others	27	48	6,143	5.1
Livestock				
- breeding	38	273	9,210	7.6
- dual purpose	13	92	3,020	2.5
- milking	5	13	620	0.5
Total	239	2,286 ha 378 animals	121,200	100

Source: BNCR (1993) and Gutierrez (1992)

The relatively small number of loans and the limited financed area indicates a small coverage rate of credit. In 1990 the total area with basic grains was 6,740 ha (CNP, 1993), so only 29 % of the agricultural area was covered with credit.

Apart from the regular credit programmes specific credit lines for the Atlantic Zone are or were available (Gutierrez, 1991):

a) Trust Funds established within projects operated by MAG for the promotion of non-traditional crops and small animal production (C. 30.6 million)

b) Trust Fund BANCOOP[45] for agricultural diversification by small producers (C. 550 million)

c) PRODAZA[46] credits for medium/long term capital investment and establishment costs of (semi)permanent crops (disbursements of C. 238.5 million in 1990)[47].

d) Lending operations for beneficiaries of IDA settlements with subsidized interest tariffs (C. 18-31 million in 1986/87, finished in 1990).

e) Several local NGO's also offer credit facilities at low interest rates, combined with extension services and organizational promotion.

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45 BANCOOP stands for Banco Cooperativo.

46 PRODAZA stands for Programme for the development of the Atlantic Zone.

47 42.2 % of all credit has been used for the establishment of banana, 20 % for palmheart and 11.2 % for pineapple plantations. The mean lending amount was US$ 52,800 in 1990.

Peasant households are mainly depending on short term (bank or suppliers) credit to finance current production costs (inputs and/or labour), but sometimes also need some medium/long term finance for the acquisition of cattle or machinery. The use of credit funds on peasant households is mainly directed to the financing of variable costs (inputs, transport) for commercial crops and activities. Credit access seems to be positively related to family size, soil quality, crop diversification and organization (Jansen et al., 1992).

The production costs of plantations are mainly covered by corporate finance, including international capital flows. External infrastructure investment, however, receives substantial governmental contributions. Forest plantations receive important fiscal incentives, including tax deductions, transferrable bonds and subsidized credit funds[48]. The hacienda production depends more directly on medium/long term investment credits supplied by the banking system.

Specific credit arrangements have been developed to promote especially the hacienda management units. The FODEA[49] scheme for debt rescheduling has been used mainly by large-scale cattle farms and offers an implicit subsidy to extensive grazing. The DGF[50] reforestation incentive schemes offer tax deductions facilities and transferrable bonds in order to promote large scale forest establishment. In former years an important part of FDF subsidized credits for small scale reforestation has been financed through *debt-for-nature* conversion schemes (Perez, 1992).

During the 1970's the interest rate charged for agricultural credit was heavily subsidized resulting in negative real interest rates up till the mid 1980's. Under structural adjustment soft loans were abolished, the effect was that negative real interest rates became positive adding a cost aspect to loans (See Annex 6.12).

6.2 Input markets

Because of higher transportation and distribution costs, it may be expected that inputs are more expensive in the Atlantic Zone. Moreover, access to inputs depends directly on the availability of credit, or forms part of marketing contracts with commercial companies.

Table 6.4 offers some information whether price differences should be taken into account; Fertilizers and biocides were 5-10 % more expensive in the Atlantic Zone in 1992, while price differences for livestock inputs and tools/equipment are less and sometimes even positive for the region. However there is no significant price differential across time.

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48 For a detailed description see IBRD/FAO (1992). About 69 % of reforestation in the 1964-1989 period has been financed by tax deductions, 13,4 % by CAF certificates, 5.4 % by FDF credits and 12 % by other credit systems (DGF, 1990).

49 The scheme was meant for all farmers, although the nature of it favoured the large haciendas. The scheme benefitted 12543 farmers in Costa Rica: 82% were small farmers receiving 23% of the benefits, 12% medium sized farmers receiving 29% of the benefits and 6% large farmers receiving 48% of the benefits.

50 DGF stands for Direccion General Forestal (Directorate General for Forestry), which is part of the Ministry for Natural Resources and Mining (MIRENEM).

Based on nutrient and active ingredient contents an overall price for non-factor inputs could be calculated (See Annex 6.14, 6.15 and 6.16). While the price of Nitrogen and Phosphorus and the price of biocides dropped significantly during the 1980's the price of Potassium showed large fluctuations and a net increase.

Table 6.4 Retail prices of basic inputs in Colones (1992).

Product	Unit	Atlantic Zone	National mean	Price difference
Fertilizers				
15-15-15	50 kg	1748	1543	13.3 %
26-0-26	50 kg	1920	1735	8.9 %
Urea	50 kg	1722	1615	6.6 %
Insecticides				
Decis	1 lt	3157	2057	53.6 %
Diazinon	1 lt	2570	2370	8.4 %
Lannate	100 gr	683	633	7.9 %
Herbicides				
Grammaxone	1 lt	680	678	0.3 %
Paraquat	gallon	1997	1847	8.2 %
Fungicides				
Antracol	750 kg	641	655	2.2 %
Cupravit	1 Kg	345	426	-23.5 %
Livestock inputs				
Salt	23 Kg	506	650	-28.5 %
Bactericides	50 cc	306	150	104.0 %
Neguvon	kg	2230	2861	-28.3 %
Concentrates	quintal	1121	800	40.1 %
Tools and Equipment				
Machete	unit	464	520	-12.1 %
File	unit	855	940	-9.9 %
Poles	unit	3607	3638	- 0.8 %
Fences	400 vrs	2090	2462	-17.8 %

Source: MAG, Dirección de Mercadeo Agropecuario, Directorio de precios de insumos (sept/oct 1992)

6.3 Product markets

Although peasant farms use a relatively high proportion of their own produced foodstuffs (plantain, cassava, maize and beans) for home consumption, commerce is still above 50 % of the production. The main part of the market supply of bananas, coco, rice and cacao accrues from farms exceeding 50 ha (See Table 6.5).

An exploratory survey of marketing structures and intermediary trade for basic agricultural items has been conducted in 1992 (Belt, 1993). Some general observations on the most important marketing chains of major products may be derived from these studies:

* marketing of bananas, cacao and non-traditional crops takes place within a '*corporate system*', directed by multinational companies (except second grade bananas which are used for local consumption and as feed for livestock) or through '*contractual systems*', with local associated producers who depend on the

multinational companies for their marketing (although they are frequently discriminated through quality regulations).

Table 6.5 Commercialization rates and marketing shares (1984).

Product	Commercialization Rate / All Farms	Marketing Shares: Small Farms (< 20 ha)	Marketing Shares: Big Farms (> 50 ha)
Maize	85.2	51.9	21.7
Beans	37.6	44.3	25.1
Rice	94.8	19.5	66.1
Cassava	79.4	51.8	32.4
Banana	98.3	0.5	99.1
Plantain	86.2	51.6	20.2
Coco	94.3	29.1	59.2

Source: DGEC (1987a)
Note: Commercialization rates as percentage of total production; Marketing shares as percentage of commercial production for each strata.

* the trade in livestock is traditionally an activity of middlemen. With the founding of a cattle auction in Guapiles (1987) during two days a week, some direct trade between farmers became possible, as well as higher prices. Cattle prices are generally higher at the end of the wet season (April/May) and tend to fall at the beginning of the dry season (October/November). Price variation of cattle is highly determined by the seasonal supply/demand situation (Logtensteijn, 1992).

* market structures for forestry products are complex. The Atlantic Zone supplies nearly 50 % of all forest inputs to the national sawmills. Processing takes place in a large number of sawmills, who depend for their supply on independent loggers. Raw material represents only 2-3 % of the price of the finished product (IBRD/FAO, 1992). About 40 % of local households depend on charcoal for fuel wood. In the Limon province only 18.6% of the national saw mill capacity is installed, while the Atlantic Zone accounts for 47.8% of all round wood supply to the national sawmill industry. During the last decade the number of saw mills has sharply reduced because of a process of concentration in order to reach a higher rate of utilization. It should be noted also that 75% of saw mills input-supply depends on services from independent loggers, which indicates a rather weak integration between forest exploitation and wood processing.

* marketing of dairy products becomes increasingly important, especially since the establishment of a dairy plant in Guapiles (1985). Regional production is constrained by a quota system that specifies the relative amounts each region in Costa Rica may deliver to the processing plants. At present milk demand is at full capacity both in terms of processing capacity as well as in terms of final demand. Costa Rica has the highest per capita consumption of milk of Latin America with little scope for further expansion. At present 3760 MT/year of milk is collected in the Atlantic Zone for processing. At the national level 55% of the milk is

industrialized with the rest consumed at home or sold locally as fresh milk (Montero, pers. comm.)[51].

* production of roots and tuber crops (cassava, tiquisque, chamol, malanga, ñame and yampi) takes mainly place on small and medium size farms and is oriented to local consumption and to export markets through contractual arrangements with marketing firms. Producers are price takers, sometimes receiving a guaranteed minimum price, but market prices have a weak and sometimes delayed impact on market supply (Smit, 1991). Only for plantain and cassava the supply/demand situation at the wholesale market exercises some influence on prices (Logtensteijn, 1992).

* Marketing of basic grains takes place through a network of intermediate traders. Supply elasticities for beans and yellow maize are strong (0.5), but demand elasticities for all basic grains are rather limited (Steward, 1991). Since a large portion of the production costs of basic grains (35% in the case of beans, Jimenez Porras, (1990)) is constituted by imported material, the devaluation of the local currency in structural adjustment led to increased production costs.

Output prices of agricultural commodities are summarized in Annex 6.1 through 6.10. In Annex 6.19 price trends are summarized. The real price of maize dropped nearly 40 % during the 1980's. besides maize the prices of beans, cocoa, and milk dropped significantly. The prices of cassava and palmheart fluctuated heavily without presenting a significant positive or negative trend. Significant price increases without strong fluctuations were observed for the prices of roundwood.

6.4 Institutions and services

The institutional environment of the Atlantic Zone can be characterized by the presence of governmental organizations as illustrated in Annex 6.17. It is difficult, however, to determine the regional coverage and operational efficiency of each of these institutions.

The activities of the governmental institutions can be divided into the following four categories (See list with abbreviations for meaning acronyms):

a) Regional Development Agencies, especially JAPDEVA and ASBANA
b) Rural Development through IDA with 5 regional agencies, MAG and CNP
c) Infrastructural Development through RECOPE, INCOFER, MOPT
d) Social and Community Development through agencies like DINADECO, IMAS, CCSS and MINSAP; education through MEP, INA, and the universities centres of the UCR and UNED.

More than 75 % of government agencies are concentrated in the city Limon, while 7 % of the agencies are located in cities like Siquirres and Pococí (MIDEPLAN, 1991). The service networks of the Ministry of Health, the Social Security Council, the National

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51 President of the Camara Nacional de Productores de Leche (National Chamber of Milk Producers).

Council of Production and the Financial System have a better regional coverage. Regional Committees for policy coordination are only functioning for agricultural development, economy and tourism, and cultural affairs.

Major private organization in the Atlantic Zone include labour unions, local development associations, cooperatives and solidarity unions (Table 6.6). Also a number of non-governmental organizations (NGO's) started operations in the region (IUCN, CEDECO, Cecade[52]). About 20% of the population is organized.

Table 6.6 Private organizations in the Atlantic Zone.

Category	Number	Membership	%	Main activities
Labour unions	48	9,662	21.8	Salaries and labour conditions
Development associations	110	12,000	27.4	Local services (water, roads, electrification)
Cooperatives	35	6,040	13.7	Production, credit, marketing, Transport
Solidarity unions	128	11,100	25.1	Popular shops, credit and savings, recreation
Indigenous associations	3	1,500	3.4	Local development, culture, services
Producers organizations	47	2,680	6.0	Prices, marketing, services
NGO/development foundations	6	230	0.5	Environment, rural development
Socio-cultural associations	64	992	2.1	Culture, sports, housing
Total	441	44,204	100	

Source: MIDEPLAN (1990)

52 IUCN stands for International Union for conservation of Nature.

7 POLICY INSTRUMENTS

The inventory of current policies that influence land use and food security in the Atlantic Zone includes both macroeconomic aspects with a general impact on the domestic price and market structure (exchange rates, inflation) as well as more specific policy instruments that influence the terms of trade of each of the management units on regional level.

7.1 Macroeconomic policies

Current policies with respect to small periodic exchange rate adjustments are directed towards a gradual reduction of the effective rate of protection, while monetary and fiscal policies are used in order to control domestic inflation within the framework of increased market liberalization. The consequences of these policies for sustainable land use and food security prospects can be summarized in the following aspects (Gonzales & Camacho 1990):

* monetary policies have been oriented to an unification of different financial markets and reduction of the nominal protection through the application of periodic mini-devaluations (*crawling peg*), but exchange rates are still undervalued. The main objective of this policy was related to export promotion and foreign debt control, but at costs of an increasing inflationary pressure. Most import impact of exchange rate adjustment on land use has been registered through the increase of prices of imported inputs, the reduction of the price margins for domestic cereal production and a stimulus for non-traditional agro-export production (Martinez, 1990).

* financial reform policies are implemented to reduce preferential and subsidized credit programmes and credit rationing through higher legal solvency rates. Partial privatization of the banking system reduced current high transaction costs for financial services. Consequently mean short term interest rates for arable cropping activities increased from 24.6 % in 1985 to 35.7 % in 1991, while for livestock lending operations long-term interest rates increased from 22.0 % in 1985 to 35.7 % in 1991 (Ramirez, 1993).

* fiscal policy is directed towards the reduction of the government deficit and the debt service ratio. Main instruments include a reduction of government expenditure and increase of efficiency of governmental services through privatization of agencies and enterprises. Several measures for tax reform have been launched to increase fiscal income. Moreover, the introduction of tax certificates (CAT) to stimulate export of non-traditional crop commodities and reforestation activities served as a specific subsidy to compensate reduced protection.

The impact of fiscal, monetary and financial policies on land use decisions and food security can be traced in general terms through the effects on input and output prices of tradable commodities. Current policies with respect to exchange rates, interest rates and fiscal tariffs tend to increase input costs. Moreover, the reduction of import tariffs and internal market liberalization may reduce input costs as well as market prices through

increased competition, favouring especially local consumers. Table 7.1 presents a summary of the expected changes in prices due to the different policy measures discussed.

Table 7.1 Price impact of macroeconomic policies

Policy area	Contents	Input price	Output price
Exchange rate	crawling peg adjustment	+	-
Trade tariffs	non-protection	-	-
Interest rates	liberalization	+	-
Fiscal policy	tax reform	+	-
	tax incentives (CAT)	-	+
Marketing	domestic price liberalization	-	-

7.2 Agrarian policies

Agrarian policies by definition having a more direct impact on producers decisions, the most important variables for regional policy intervention can be distinguished in three main categories:

a) market interventions related to pricing and subsidies of inputs and outputs, also including import/export tariffs and tax incentives that modify the domestic pricing structure.

b) external costs/benefits such as infrastructural investments and availability of social and collective services (*government budget incidence*).

c) non-market measures like trade quota (bananas, meat), production restrictions (tree cutting permits) and rationing of credit, as well as other legal measures related to production practices (prohibitions)

To be able to trace the effects of agrarian policies on land use and production technology some basic understanding is necessary on response reactions of different types of management units. These response *elasticities* may vary according to farm type, soil characteristics, location of the farm and intensity of the existing linkages with the markets.

For the Atlantic Zone the following general observations with respect to the orientation of regional agrarian policies can be made (Kruseman, 1990; Weller, 1992). See list with abbreviations for the meaning of the acronyms:

* credit policies; Special credit lines of the Central Bank were established (FODEIN, FOPEX) for the promotion of diversification into non-traditional crops and channelled through the commercial banking system, mostly financed through international donations or loans (AID, BID, IBRD). Also some specific projects for agro-processing (plantain, coco) have been developed.

* export schemes; CENPRO and CINDE developed several incentive arrangements for promotion of non-traditional exports, including tax deductions for exports

(CAT[53]) and import of inputs. Government contributions to the CAT funding accounted for US$ 75 million in 1990, equivalent to 6 % of the central government budget.

* infrastructure improvement; Road rehabilitation (MPOT) and improvement of harbour facilities (JAPDEVA) are considered of main importance for regional development. Also electricity, water and telecommunication investments will be executed in order to improve community facilities.

* land titling; IDA's policies with respect to agricultural settlements give priority to titling procedures (demarcation, mapping, registration) to facilitate farmers' participation in credit programmes.

* technical assistance; Institutional activities with respect to agricultural research and extension (MAG, IDA) are mainly oriented to major commercial crops and non-traditional activities. Some local NGO's maintain extension for improved cropping systems for food crops. In the future, costs for extension will be incorporated in the credit tariff.

* tourism development; receives increasing attention, especially through tax exemptions for tourism enterprises, legal facilities for investments, etc. Employment opportunities for the local population in tourism activities are nevertheless limited. Recently resistance from local pressure groups is increasing because of arbitrary concessions given for hotel construction.

* forest management; Legal regulations with respect to tree cutting and fiscal incentives for reforestation are the most important balancing instruments. Nevertheless depreciation of forest resources continues because of high rates of illegal exploitation (WRI, 1991). The most important problems are related to the availability of practical instruments to enforce the legal regulations.

7.3 Agrarian policy and response reactions

Policy variables will influence decisions on land use of different types of rural actors in varying ways, therefore no linear response reactions can be expected. Because of the imperfect functioning of factor and product markets, prices at farm level do not always correspond to market equilibrium prices. Therefore, it is necessary to introduce so-called adjustment variables that represent *mark-ups* on prices due to imperfect transfer processes. These costs may vary according to farm type, tenancy system, farm size, location, etc.

The most important adjustment variables that should be taken into account at farm household level include :

a) Information costs; Access to information on prices, markets and alternative technologies available to farmers

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53 CAT offers tax deductions up to 15-20 % of nominal export value.

b) Transaction costs; Additional costs that have to be made to guarantee access to certain inputs (especially for credit)

c) Supervision costs; Organizational and management costs related to more complex organizations (in case of external labour supply)

Information costs are related to differential access to factor and/or product markets. As policy measures are transferred towards peasant households through *segmented market structures* they may result in different production costs at farm level (Bardhan, 1980). Side effects on other variables should also be taken into account, especially for factor markets, as well as the linkages between factor and product markets. The combination of different transactions within a single contract shall influence technology choice and production decisions.

Supervision costs are mainly important for scale-related production processes on plantation and hacienda type of management units, although also peasant households may use substantial amounts of contract labour. These costs may modify the implicit wage[54] on plantations because of frequent substitution of the labour force (in order to prevent 'closed shop' situations) and to a less extent on haciendas because of patronage relations with the labour force.

Response reactions at farm household level may be expressed in terms of different supply and demand elasticities (quantity) or in terms of substitution elasticity (technological change). Although these elasticities may have different values for various farm types some general rules may be derived. For analytical purposes, a general classification of the different policy instruments applied in the Atlantic Zone can be formulated, indicating also the impact on relevant factor and product markets (see Table 7.2).

Table 7.2 Classification of agrarian policies.

Policy	Contents	Impact
Land policy	Land titling	land prices, land investments
Credit policy	Interest rates liberalization	input prices
	FODEA law	interest costs
Tax incentives	Reforestation certificates	tax deduction
Import tariffs	Liberalization	input prices
Exchange rate	Overvaluation	import/export prices
Marketing	Liberalization basic grains	domestic prices
	Incentives non-traditionals	export prices
Export tariffs	Banana export tax	export prices, budget incidence
Infrastructure	Road improvement	transport costs
	Electrification	land prices

As can been derived from Table 7.2 several policy instruments simultaneously exercise influence through the same factor or product markets and, therefore, farm level response

54 Implicit wage means that the actual wage paid is corrected for the extra costs directly attributable to the labour unit.

reactions may show partially opposite tendencies. The overall result of these processes will depend on the partial elasticities at farm level and their aggregate effect at sub-regional level. Moreover, individual farm level responses can modify also market equilibria and may influence consequently also decisions of other households.

The relationship between policy change and response reactions at individual farm level can be expressed in terms of *response elasticities*[55], e.g. LUST modifications as a response to changing production conditions (Ellis, 1992). The intensity of response reactions depends on the available resources and the objectives of each management unit, the price elasticities of (factor)demand and (product)supply, and the constraints with respect to factor use (Singh et al., 1986).

The impact of agrarian policies on land use depends essentially on farm level responses to effective domestic prices for relevant inputs and outputs. Taking into account the current farm structure in the Atlantic Zone some general suggestions for most plausible response reactions can be presented.

7.3.1 Infrastructure and services

Government investment for infrastructure improvement and collective services has been an important driving force for the development of local factor and product markets. The establishment of a road connection with the Atlantic Zone caused a strong impetus for land colonization and migration processes. Public investments in infrastructure have been especially important for the increase in plantation production (harbour facilities for banana exports and road transport of wood), for the expansion of tourism, and for the incorporation of peasant households into commercial production of (non-)traditional crops. Finally, also household expenditure patterns may have been modified because of the greater availability of industrial consumer goods.

The development of local market structures, educational infrastructure, extension systems and financial institutions has a strong impact on production and investment decisions by shifting the production frontier or through an increase in the rate of return to private investment (Binswanger et al., 1993). Transaction costs for credit will be reduced and hence input demand will increase. Expansion of primary education possibilities can favour also the use of labour-substituting technologies. Collective services, like rural electrification or telecommunication networks have mainly repercussions on land prices and may favour fixed investment at farm level.

7.3.2 Non-labour input prices and credit

Input and credit policies are important elements for the selection of most appropriate production technologies. Former subsidies on chemical inputs and subsidized interest rates

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55 As a general concept elasticity refers to the way in which any variable is affected by a change in the level of another variable. The proportional changes can be measured statistically through their partial derivates.

are being removed and will possibly lead to an adjustment of the selected LUST's. Credit targeting through loan portfolio regulations are now being widely used to promote crop diversification.

Production processes which rely heavily on imported inputs will suffer from exchange rate adjustment and import regulations. The share of imported inputs is high for banana production and non traditional crops, an intermediate level for maize and rice, and relatively low for livestock, roots and tubers and cacao. Nevertheless, input intensive activities do not necessary reflect a higher response elasticity, as prices may be compensated by multinational companies through intercompany trade or subcontracting arrangements.

Livestock production debt rescheduling measures of the FODEA law represent an implicit subsidy for extensive grazing. Conversion of wildlands into pastures is still considered as an 'improvement' in the sense of higher land valuation of cleared plots.

7.3.3 Output prices

Government policies with respect to basic grains and other annual crops in Costa Rica are mainly directed towards price liberalization (Guardia et. al, 1987). Therefore, especially marginal producers will either economize on input use (fertilizers) or reduce their production volume. Alternatively, the lower reproduction costs for labour may result in a substitution towards leisure.

Basic grain consumption elasticities are slightly negative for maize, beans and rice. Rural families dedicate about a third of their income to basic grains, while in urban areas basic grain consumption account for only one fifth of the income (Hazell, 1991). Policy simulations with alternative price setting with complete market liberalization of basic grains indicate that white maize and bean production increase, rice and yellow maize decrease, and small livestock production (poultry, pigs) also increases because of lower feed costs (Steward, 1991). Final demand for all these products increases in different proportions. In income terms, producer's value decreases less than consumer's purchasing power increase, reason why net social benefits are positive.

Livestock production relies heavily on pasture availability and access to credit. Demand elasticity for beef in Costa Rica has been calculated at - 0.71 with respect to prices and + 0.48 with respect to income[56]. Supply and substitution elasticities to output prices are relatively low in the short term and somewhat higher in medium/long term. Wide differences exist in cost structure between extensive meat-oriented exploitation systems and more intensive dual purpose or breeding oriented livestock systems (van der Kamp, 1990).

For the most important root and tuber crops the national and international prices tend to have a weak (and sometimes delayed) influence on market supply (Smit, 1991). Production decisions for these crops are mainly based on the availability of seed materials and access

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[56] DLV calculations based on CNP (1991) and World Bank tables (1992). See annex 7.1 for exact calculations.

to credit; Production costs for seeds, chemical inputs and labour are relatively high. Yield levels may vary strongly and depend on soil/weather conditions and management practices. For international marketing, product quality and homogeneity are of major importance. For marketing analysis, producers have to be considered as price takers, sometimes with some contractual minimum price guarantee. Marketing structures for non-traditional crops are dominated by a small number of enterprises (sometimes related to the banana companies). Part of the production takes place within the framework of cultivation contracts with fixed input requirements, quality norms for output and a guaranteed minimum price. Therefore, production elasticities can be expected to be relatively low to prices, but stronger related to other variables like transportation and information costs.

Changes in output prices of the forestry sector may have various impacts on logging, depending on the expectations for future timber market development. When logging becomes more attractive, the opportunity costs of forest land for investment purposes also increase. Commercial exploitation depends on increasing market prices for valuable species; Local prices for secondary quality (ply)wood and fuelwood are related to round wood prices.

7.3.4 Legal measures

Land use within remaining wildlands and forestry areas depend mainly on legal measures with respect to the management of national reserves. Land transactions in theses zones are prohibited (although squatters are present), and exploitation of the natural resources is restricted through specific permits.

Land use for forestry is driven by several contradictory incentives; on one hand there are fiscal incentives for reforestation on idle land, while on the other hand commercial transactions value cleared land almost 2-3 times higher than forest land. Therefore, both reforestation and deforestation rates are high at the same time. Deforestation rates are related to the development of road infrastructure (accessibility) and the quality of the soils (Veldkamp et al., 1992).

7.3.5 Fiscal policies

Non-traditional crops in the Atlantic Zone of Costa Rica include (semi)perennial crops like cocoa, plantain, cardamon, pineapple, palmheart, ornamental plants, spices and others (Weller, 1992). Basic policy instruments used to stimulate non-traditional (export) production include fiscal and credit subsidies and institutional reforms (CENPRO, CINDE, etc.).

The production of non-traditional crops creates an important number of direct labour opportunities, as well as indirect job opportunities in the transport and commerce sectors. Nevertheless, labour costs generally represent less than 50 % of the total production costs and capital requirements for initial investment rarely are below US$ 1000/ha, therefore the minimum area for efficient cultivation is two hectares. Special attention should be paid to

the environmental impact of non-traditional crops (high biocide use), as well as to the net foreign exchange effect (taking into account substantial imports of chemical inputs).

7.4 Response reactions

Possible response reactions of different types of management units can be investigated by means of household models that take into account the specified policy variables (input prices, output prices, subsidies and taxes, government investment) and trace their impact on farm level decisions with regard to production, consumption, marketing and technology choice (input demand and labour absorption). Table 7.3 offers an approximation of hypothetical response reactions in the Atlantic Zone.

Table 7.3 Hypothetical response reactions.

	Production volume	Consumption volume	Marketed surplus	Input demand	Labour absorption
with respect to non-labour input prices					
Plantation	--	0	--	-	+
Hacienda	-	0	0	-	0
Peasant household	-	+/-	+/-	--	+/-
with respect to own output prices					
Plantation	++	0	++	++	++
Hacienda	+	0	+	+	0
Peasant household	+	-	+/-	+	+/-
with respect to land					
Plantation	+	0	+	+	+
Hacienda	0	0	0	0	0
Peasant household	+	+/-	+	+/-	-
with respect to price subsidies					
Plantation	+	0	+	+	+
Hacienda	+	+	+	+	-
Peasant household	++	+/-	+/-	+	+/-
with respect to infrastructure improvement					
Plantation	+++	0	++	+	+
Hacienda	+	+	+	0	0
Peasant household	++	+	++	+	-

Note: + or - means positive or negative reaction; The number of signs indicates the expected intensity of reactions ; +/- means that both reaction types are possible; 0 means that no significant reaction can be expected.

The expected response reactions for plantation-type management units reflect behaviour according to traditional supply response models. Taking into account less variable technical coefficients in production and scale economics in processing, production decisions depend entirely on market possibilities and international trade options. Therefore, plantation production is highly responsive to infrastructure investments and looks for any increase in profit margins through the pricing mechanisms. Since output prices are determined on

world markets, local consumption effects are of minor importance[57]. Recent developments on the banana world market - the raising of European trade barriers and the preferential treatment of ACP bananas - justify the hypothesis of no further area expansion in the near future. The responsiveness of input demand and labour absorption can be considered as the main adjustment variables for profit maximization, given the market opportunities. Land prices and taxing mechanism are considered more like fixed costs. Possible incorporation of external environmental effects (biocide emissions) in the price system, will lead to a substantial modification of the current production techniques.

At hacienda-type management units response reactions tend to be less intense, while quasi-rent objectives and risk aversion depend mainly on the value of the quantity of fixed assets or capital stock. Because of more extensive land use and generally low labour intensity of production, scope exists for adjustment of the production techniques through factor substitution. Infrastructure improvement and additional supply of extension and financial services lead mostly to extensive growth (area expansion), but with small effects on labour absorption or input supply. Responsiveness of hacienda production to output prices is also delayed as the stock adjustment requires time. More direct responses can be expected from changes in input prices, export taxes and interest tariffs that modify the rate of return of the actual investment stock.

The specific reaction patterns of the peasant households can be explained on the basis of the simultaneous decisions on production, consumption and labour supply. The implications of input and output prices on household utility objectives may result in both positive or negative response reactions depending on the balance between price effects and the profit effect (Singh et al., 1986). The latter represents repercussions on farm income and labour/leisure choice originating from changes in market prices. The most significant reactions of peasant households can be observed in their reduction of labour supply in response to an output price increase due to substitution of family labour for hired labour. Moreover, wage increases also affect production costs and may therefore even lead to less off-farm employment. Within this framework, special attention should be given to possibilities and limitations to modify land use and production technologies, making use of consistent mix of agrarian policy instruments.

57 Costa Rica is a major supplier of the world market of bananas (about 20 % of total market supply) and thus modifications in production costs and/or marketable volume can have repercussions for market demand.

8. REGIONAL ANALYSIS AND SYNTHESIS

8.1 Regional appraisal

The Atlantic Zone is engaged in a process a rapid structural change related to the integration of production into (inter)national markets, the expansion of tourism and the diversification of economic activities. The description of regional development tendencies within the national setting (Chapter 2) indicates the importance of two major objectives:

a) improvement of the *competiveness* of agricultural production within a liberal market environment, taking into account that further possibilities for expansion of the agricultural area are limited. Policy instruments aim at higher labour and soil productivity and crop diversification. The effective functioning of input and output markets is necessary to induce adequate producers decisions. Also factor markets - especially for land and capital - require substantial improvement (See Chapter 6).

b) natural *resource management* becomes more and more a central aspect of land use, as forest and nature reserves represent a major part of the regional territory. Moreover, income flow accruing from (eco-)tourism accounts for an increasing source of foreign exchange. Opportunity costs of land use conversion towards agricultural use should be balanced against potential tourism income and employment effects.

During the last three decades the agricultural area, - mainly banana and pastures -, expanded at the cost of nature areas. These land use changes were accompanied by an unregulated flow of immigrants and temporary labourers, a relatively high level of public and private investments and an increasing pressure on the natural environment due to the high input of biocides and fertilizers at plantations (banana and pineapple).

While the CATIE/MAG/WAU Atlantic Zone Programme aims at the development of explorative long-term scenarios for sustainable land use, the DLV programme looks for the identification of suitable policy instruments that enable farmers to select the most adequate land use systems and technologies according to their microeconomic objectives. Therefore, the incentive structure ought to be designed in such a way that existing trade-offs among development objectives on farm and/or regional level can be acknowledged in an adequate manner. The most important trade-offs that have been identified in the preceding paragraphs are summarized in this chapter.

8.1.1 Land use

The quantitative assessment of land use changes between cropping, livestock and forestry purposes is related to changes in the tenancy structure. During the 1963-74 period the arable cropping area dropped due to an increase of medium size livestock farms (20-50 ha). In the period (1974-84) the establishment of family farms was promoted by IDA and the arable cropping area recuperated.

The figures on land use changes indicate an increase in pastures, a stable land use for perennial (non)traditional crops and a decrease in forests (Table 8.1).

Table 8.1 Land use changes (1963-1984).

	1963	1974	1984	1963-74	1974-84
Farm structure					
Farm area (ha)	207,859	244,531	285,316	36,672	40,785
Number of farms	5,281	5,290	9,316	9	4,026
Mean farm size (ha)	39.4	46.2	30.7	6.8	-15.5
Gini ratio	0.787	0.760	0.713	-0.028	-0.046
Tenancy structure (% of area)					
Farms 0-20	14.3	10.8	16.2	- 3.5	5.4
Farms 20-50 ha	12.7	16.2	17.0	3.5	0.8
Farms 50-100 ha	9.4	10.6	14.2	1.2	3.6
Farms > 100 ha	63.6	62.4	52.6	- 1.2	-9.8
Land use (% of agricultural area)					
Arable cropping area	17.1	8.5	13.9	- 8.6	5.4
Perennial crops	18.1	17.0	17.1	- 1.1	0.1
Pastures	15.9	25.4	37.2	9.5	11.8
Forest	31.3	36.6	20.7	5.3	-15.9
Wildlands	15.2	10.3	9.5	- 4.9	- 0.8
Other	2.4	2.2	1.6	- 0.2	- 0.6

Source: DLV Calculations based on DGEC (1966a, 1976a, 1987a)

Through legal protection measures 60 % of the regional territory has been defined as national park or reserve area, limiting the prospects for further expansion of the farm area. The use of external inputs is therefore the only alternative to increase agricultural production. Within the framework of a restricted labour supply and (labour intensive) crop diversification programmes, mechanization and mixed cropping have to be considered.

Based on the agricultural area and the labour requirements of the various actual LUST's (Chapter 4) labour absorption, net value added generation and factor productivity indicators can be estimated (Table 8.2). The total labour days is equivalent with an agricultural labour force of about 28,600 persons (with 225 working days/person). Banana production accounts for 58 % of all labour days, livestock contributes 8%, in 1984. Labour productivity is especially high in banana production, followed by perennial crops (plantain, cocoa and coffee), livestock production and basic grains (maize and beans).

Table 8.2 Agricultural factor use and factor productivity (1984).

Activity	Area (ha)	Labour hours/ha	Total Labour (days[2)])	Value Added (10^6 C.)	VA/ ha (C./ha)	VA/ labour (C./day)
Livestock	106,026	30	530,130	275.6	24,513	520
Coffee	927	540	83,430	38.9	41,963	466
Banana	22,713	994[1)]	3762,787	6343.3	279,280	1,686
Sugar	213	440	15,620	3.3	15,493	211
Plantain	4,784	322	256,741	309.8	64,758	1,207
Cocoa	12,755	166	352,888	234.5	18,385	665
Coco	4,322	463[1)]	333,514	na	na	na
Pineapple	200	719	23,967	na	na	na
Palmheart	1,500	436	109,000	na	na	na
Other	3,000	600[3)]	300,000	na	na	na
Beans	724	163	19,669	11.0	15,194	559
Maize	8,842	191	281,470	227.5	25,730	808
Rice	7,243	286	345,250	101.4	14,000	294
Cassava	775	318	41,075	3.1	4,000	75
TOTAL	173,474		6,455,541	7548,4	43,513	1,188

Source: Labour inputs based on LUST's (See Chapter 4); pineapple, beans, coffee and coco based on BNCR data

Notes : 1) including post harvest operations
2) one day consists of six working hours
3) mean labour input for non-traditional crops (Weller, 1992)

There is a major trade-off among infrastructure development and economic incentives: regional development requires a substantial government investment in physical and social infrastructure. The rapid colonization of the Atlantic Zone caused a transformation towards highly commercialized farming systems. Additional economic and financial incentives are necessary to adjust land use systems and techniques in accordance with sustainability criteria, income and employment creation objectives.

The agro-ecological aspects of sustainable land use addressed in Chapter 4 can be characterized in terms of two distinct trade-offs:

a) Conflicts arising between nature conservation and producer's incentives. Agriculture in the Atlantic Zone, -mainly banana and other plantation crops-, is related to economic growth and is an important source of foreign exchange. However, expansion of plantation and livestock agriculture during the last decades went at the expense of nature areas. Considering the suitable area for agriculture in the northern part of the Atlantic Zone (Chapter 3) conversion of nature areas into agricultural land is likely to occur as long as market prices do not reflect opportunity costs. However, the development of the (eco)-tourism sector and the scientific and commercial exploitation of biodiversity can contribute to a sound

financial base for nature conservation. The impact of agriculture and (eco)-tourism on nature (biodiversity) is, however, still difficult to quantify.

In this context can also be referred to the price and fiscal incentives for forest activities which may have contributed to reforestation but indirectly resulted in the deforestation of primary rainforests. In this way biodiverse nature areas were transformed into monocropped, less biodiverse forest plantations.

b) Conflicts arise also between agricultural modernization[58] and the use of biocides and fertilizers. Agricultural modernization is accompanied by a high use of biocides (and residues) and fertilizer nutrients per cultivated area. Losses to the environment are in the humid tropical climate of the Atlantic Zone unavoidable. However, direct environmental repercussions in terms of e.g. exceeding certain threshold values for water quality may be limited due to the annual water surplus. Moreover, nutrient balances of the major arable crops in the Atlantic Zone (e.g. maize and cassava) indicate at present rather a nutrient depletion than a nutrient enrichment of the soil.

8.1.2 Food security

Food security prospects can be analyzed from a viewpoint of regional availability of food staples based on local production, or taking into account purchasing power of the population for buying food produced outside the region.

Regional availability of basic food staples based on local production is fairly above the national average. Although the area dedicated to rice and maize diminished during the last two decades the regional per capita production level in 1984 was still beyond the national average (Table 8.3).

Table 8.3 Regional food availability (1984).

	COSTA RICA (population: 2,467,339)			**ATLANTIC ZONE (population: 168,076)**		
Product	Area (ha)	Production (MT)	Gross availability per capita (kg/cap)	Area (ha)	Production (MT)	gross availability per capita (kg/cap)
Rice	86,439	222,171	9	7,244 (8.4)	17,376 (7.8)	103
Beans	40,672	17,053	7	724 (1.8)	280 (1.6)	2
Maize	50,230	50,067	20	8,842 (17.6)	10,931 (21.8)	65
Cassava	4,231	33,019	13	775 (18.4)	6,060 (18.4)	36
Plantain	9,120	614	0.2	4,648 (51.0)	310 (50.5)	2

Source: DLV Calculations based on DGEC (1987a)
Note: Figures between parenthesis indicate regional shares

58 In this context agricultural modernization, includes stimulation of the productivity of traditional crops which seems feasible for maize and rice (See Chapter 4) as well as diversification into non-traditional crops. Current policies in Costa Rica focus almost exclusively on the latter aspect.

This global analysis of food security prospects requires further specification in two respects: (i) a substantial part of local staple production is marketed outside the Atlantic Zone (See Chapter 5). Although the production of maize, beans, cassava and plantain is for more than 50 % in hands of small farmers (<20 ha), their rates of commercialization are - except for beans - above 80 % of production. (ii) The national availability of food staples not only depends on domestic production, but also the foreign trade balance (imports minus exports) should be taken into account. The policy of market liberalization lead to a decreased national staple production compensated by increased imports. The import share of basic grains for human consumption increased from 36.8 % in 1981 to 42.9 % in 1987 (Martinez, 1990).

Some remarks should be made about the caloric intake that can be associated with the gross regional food availability. According to standard values of the calory components of basic food staples the daily per capita availability only reaches 890.6 Kcal (Table 8.4). Compared with the minimum requirements of 3000 Kcal local staple production clearly falls short to satisfy food security.

Table 8.4 Food Availability and caloric intake (1984).

Product	Availability per capita(Kg)	Kcal per Kg.	Total daily Kcal/capita
Rice	103	1520	430.6
Beans	2	2660	12.4
Maize	65	707[1)]	125.9
Cassava	36	3220	318.5
Plantain	2	644[1)]	3.2
Total			890.6

Source : Table 8.4 and Bosman et al. (1981)
Note : 1) Based on 70 % edible components

The analysis of local food security from the viewpoint of disposable income and purchasing power[59] seems to be more relevant in the Atlantic Zone. The mean per capita income level in the region (1986/87) has been estimated at C. 70,500 (= US$ 1,260) which is nearly 17 % below national average (Table 2.6, Chapter 2).

The most important trade offs among food security, employment and purchasing power can be summarized as follows:

a) The reduction of the arable cropping area - influenced by price disincentives and market liberalization - affected the regional food self-sufficiency and obliged to concentrate the analysis on (wage)employment and purchasing power potentials. In both aspects food security can be reached through agricultural modernization and economic diversification (tourism, services), both with an impact on existing nature reserves.

59 Purchasing power of income can be estimated by correcting nominal income for the consumer price index.

b) The rapid increase of banana plantation activities increased employment opportunities beyond the regional capacity, inducing (temporary) migration. Any decrease in the banana plantation area may affect the food security of the Atlantic Zone as well as other areas in Costa Rica and Nicaragua.

8.2 Perspectives for scenarios development

The feasibility of further scenario development for the Atlantic Zone of Costa Rica depends on the available knowledge about basic aspects that determine farmers response reactions to policy instruments. The preceding description of the natural resources, regional production and marketing structures, and the regional development objectives permits the identification of some bottlenecks that should be addressed before continuing the scenario development:

a) definition of the regional level; the data base of the WAU/MAG/CATIE programme is limited to the northern part of the Atlantic Zone, while policy instruments will be addressed at the level of the Huetar Atlantico province which is the planning region. Taking into account migration and marketing aspects the definition of the planning region comes close to the national level. Therefore, also macroeconomic policies with respect to the exchange rate, inflation and monetary regulations should be incorporated in the analysis.

b) The inventory of actual LUST's is a major problem because existing data sources (farm surveys and BNCR data) are incomplete or show so much variation that it is hard to derive a common description of actual LUST's. Related to this problem is how to handle LUST's from perennial crops. Returns of perennial crops appear usually after a few years. Averaging of the years as practised in most LP-models disregards reality too much in a dynamic analysis; The returns of the first years of production are overestimated, while in the latter years they are underestimated.

c) the definition of alternative LUST's is mainly based on expert knowledge, with the exception of maize and rice LUST's (See Table 4.3). The application of calibrated crop growth models would add more consistent and reproducible results. However, knowledge about growth and development of many tropical crops is lacking to support such an approach. Moreover, the selection of alternative LUST's depends mainly on the attractiveness of these LUST's for the households, taking into account their objective (utility) functions. Alternative LUST's may not be attainable as a first best solution and second best options should be considered also. Therefore, the whole range of options between actual and alternative LUST's needs to be analyzed simultaneously from a technical and an economic viewpoint.

d) the identification of sustainability aspects requires further attention. Indicators related to the LUST definition like nutrient balance, soil compaction and biocides emissions offer scope for operationalization on micro level. Other aspects like biodiversity are in the Atlantic Zone probably more important but are more difficult to operationalize.

e) The expression of biocides in terms of active ingredients is an ambiguous denominator to describe the ecotoxicological impact of biocides (A biocide input of e.g. 5 kg a.i. per ha may have a greater ecotoxicological impact than 10 kg a.i. per ha). Expression of biocides in terms of their intrinsic characteristics, like vapour pressure, half-life time and adsorption capacity to organic matter, as proposed by Wijnands (pers. com.) are probably better indicators to evaluate the exposure to the environment to biocides.

f) the elaboration of a consistent system for farm stratification or farm typology is of foremost importance for the modelling of different response reactions. Actual farm types are defined according to size and land use criteria, while a differentiation based on objective functions should be preferred. The definition of management units is a step towards that direction.

g) the functioning of markets and transaction costs received little attention in the regional analysis. A thorough analysis of input markets for land, labour and capital is still failing. Regional product markets in the Atlantic Zone are strongly integrated with (inter)national markets. Some markets face higher transaction costs (e.g. credit), while for other inputs some market segments may be either missing (e.g. land) or interlinked (e.g sharecropping).

h) The provision of public goods and services like infrastructure, education, social and collective services, extension and information has hardly been analyzed in the Atlantic Zone. The impact of government budget incidence could be established, but further research is needed.

i) The farmers decisions on labour use depend on the availability of family labour, options for hiring wage labour and possibilities for off-farm employment (inside/outside the agricultural sector). These labour categories may face different (opportunity) costs and therefore, the economic results of certain LUST's may vary according to different categories of labour use. The use of LP-models at farm level could show the trade-offs.

j) Food security in the Atlantic Zone can be analyzed most meaningful from the viewpoint of expenditures (purchasing power), as local production in physical terms does not provide enough food production to cover basic needs. While expenditures depend on both production and consumption a thorough analysis of the composition of expenditures in different commodities should be derived from the farm survey data.

k) the way on which policy instruments modify farm household behaviour according to criteria of sustainable land use and food security is still in a preliminary phase. The elaboration of farm household models should be helpful to quantify the impact of policies on the household behaviour.

GLOSSARY

Biocides = All crop-protecting materials, as herbicides, insecticides, fungicides, nematicides, etc.
Chain migration = Migration towards other regions linked to relatives already established in that region
Colonization = Agricultural expansion and land use conversion in the production frontier, including spontaneous and planned land reclamation and agrarian settlement.
Commercialization rate = market integration = The degree to which farmers sell their produce on the market.
Factor endowments = The resources Land, Labour, Capital and Knowledge available to the management unit.
Farm Household = Decision unit on production, consumption, land use and labour supply
Farm type = Specific type of farm household, characterized by the relationship between the availability of productive resources, the structure of production and the related objective function.
Farming system = A decision making unit, comprising the farm household and one or more LUST's (q.v.), that produces crop and animal products for consumption and sale.
Land improvement = Activities that influence the land value.
Land shift = Land use conversions to other LUST's (q.v.) within the same management unit (q.v.).
Land transfer = Land use conversions characterized by the management unit (q.v.), including discontinuation of agricultural production.
Land Unit (LU) = An area of land demarcated on a map and possessing specified uniform characteristics and/or qualities.
Land Use Type (LUT) = A type of land use described or defined in greater detail greater than that of a major land use type (q.v.).
Land Use System and Technology (LUST) = A land unit under a given land use type (q.v.) and with a definite technology (q.v.).
Major Land Use Type (MLUT) = A major subdivision of rural land use, such as crop production, livestock, forestry, etc.
Management Unit (MU) = The defined property relation of land resources and the related decision structure that determines land use and factor intensity.
Opportunity costs = Reduction of the output in other activities in terms of foregone income due to withdrawing of resources for alternative use (with a given technology and fixed resources).
Production level = Yield level determined by a set of well-defined environmental factors.
Production technique = Way in which defined land use types (q.v) are carried out.
Technology = A combination of production level (q.v.) and production technique (q.v).

ABBREVIATIONS

ASBANA	= Associación Bananera
AID	= Agency for International Development (US Government)
AZP	= Atlantic Zone Programme
BANCOOP	= Banco Cooperativo
BCCR	= Banco Central de Costa Rica
BID	= Banco Interamericano de Desarollo
BNCR	= Banco Nacional de Costa Rica
CAF	= Certificado de Abono Forestal
CAT	= Certificado de Abono Tributario (Export incentive bonds)
CATIE	= Centro Agronómica Tropical de Investigación y Enseñanza (Centre for research and education in tropical agriculture)
CELADE	= Centro Latinoamericano de Demografia
CENADA	= Centro Nacional de Abestecimento y Distribucion de Alimentos
CENPRO	= Centro de Promoción de Exportaciones (Centre for promotion of exports and investments)
CINDE	= Coalición de Initiativas para el Desarollo (Coalition for development initiatives)
CORBANA	= Cooperacion Bananero Nacional
CSUCA	= Centro Superior de Universidades Centro Americanos
DGEC	= Direccion General de Enstadisticas y Censos
DGF	= Direccion General Forestal
FAO	= Food and Agricultural Organization
FODEA	= Fomento y Desarollo de la Agricultura
FODEIN	= Fondo de Desarollo Industrial
FDF	= Fondo de Desarollo Forestal
FOPEX	= Fondo de Promoción de Exportaciones
GIS	= Geographic Information System
IBRD	= International Bank for Reconstruction and Development (World Bank)
ICTO	= Instituto de Colonizacion de Tierra y Ordanemento Agrario
IDA	= Instituto de Desarollo Agropecuario
IMGLP	= Interactive Multiple Goal Linear Programming
JAPDEVA	= Junta de Administración Portuario y de Desarollo para el Vertiente Atlántico (Harbour and regional development authority)
LU	= Land Unit
LUST	= Land Use System and Technology
MAG	= Ministerio de Agricultura y Ganaderia (Ministery of agriculture and cattle breeding)
MIDIPLAN	= Ministerio de Planifacion
MIRENEM	= Ministerio de Recursses Naturales, Energia y Mines
MOPT	= Ministerio de Obras Publicas y Transportes (ministery of public works and roads)
NGO	= Non Governmental Organization
SIESTA	= Sistema de Informacion y Evalucion de Suela y Tierras del Atlantico
UICN	= Union Internacional para la Conservacion de la Natura
USTED	= Uso Sustenible de Tierras en Desarollo
WAU	= Wageningen Agricultural University

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ANNEX 2.1 EXCHANGE RATES

Year	exchange rate[1]	shadow exchange rate[2]	Standard conversion factor[3]
1970	6.63	6.49	1.02
1971	6.63	6.76	0.98
1972	6.63	7.00	0.95
1973	6.65	7.26	0.92
1974	7.93	7.99	0.99
1975	8.57	8.07	1.06
1976	8.57	8.07	1.06
1977	8.57	8.12	1.06
1978	8.57	7.98	1.07
1979	8.57	7.94	1.08
1980	9.23	8.41	1.10
1981	21.45	18.40	1.17
1982	38.52	32.79	1.17
1983	41.21	34.92	1.18
1984	44.5	38.16	1.17
1985	50.48	43.36	1.16
1986	55.92	48.99	1.14
1987	62.72	55.33	1.13
1988	75.77	66.20	1.14
1989	81.38	69.50	1.17
1990	91.42	81.55	1.12
1991	122.2		
1992	135.07		
1993	138.08		

1 Calculated on basis of World Bank Tables (1992) and data collected by Alternativas de Desarrollo (1993).

2 The SER is calculated on basis of the World Bank Tables (1992):

$$SER = \frac{\sum_{i=1}^{I} p_i^{domestic} * (X_i + M_i)}{\sum_{i=1}^{I} p_i^{border} * (X_i + M_i)}$$

$p_i^{domestic}$	= domestic price	($/vol)
X_i	= exports	(vol)
M_i	= imports	(vol)
p_i^{border}	= border price	($/vol)

with domestic prices defined as current prices in local currency and border prices in US dollars, and i are tradables.

3 The SCF is defined as the official exchange rate divided by the shadow exchange rate.

ANNEX 2.2 BALANCE OF PAYMENTS 1970-1990

	1970	1975	1980	1985	1990
Merchandise Exports, fob (US$, BoP)	231,000,000	493,065,984	1,000,900,096	939,099,904	1,365,600,000
Non-Factor Service Receipts (US$, BoP)	45,900,000	103,202,688	196,900,000	281,299,968	584,499,968
Factor Service Receipts (US$, BoP)	1,000,000	4,249,520	20,800,000	49,800,000	97,200,000
Exports of Goods & Services (US$, BoP)	277,900,000	600,518,192	1,218,600,096	1,270,199,872	2,047,299,968
Merchandise Imports, fob (US$, BoP)	286,800,128	627,229,952	1,375,200,000	1,000,999,936	1,833,299,968
Non-Factor Service Payments (US$, BoP)	54,300,000	130,399,584	282,500,096	274,000,128	550,400,000
Factor Service Payments (US$, BoP)	16,800,000	70,177,920	239,300,000	339,910,144	390,099,968
Imports of Goods & Services (US$, BoP)	357,900,128	827,807,456	1,897,000,096	1,614,910,208	2,773,799,936
net Private Current Transfers (US$, BoP)	3,400,000	9,470,416	19,800,000	42,600,000	47,800,000
Official Transfers net (US$, BoP)	2,500,000	121,420	(5,300,000)	176,100,000	164,900,000
Current Account Ballance (US$, BoP)	(74,100,128)	(217,697,428)	(663,900,000)	(126,010,336)	(513,799,968)
net Long Term Capital Inflow (US$, BoP)	43,800,000	237,973,344	402,200,064	343,420,160	529,549,824
Direct Foreign Investment (US$, BoP)	26,400,000	68,963,696	48,100,000	65,200,000	108,700,000
Capital Account Ballance (US$, BoP)	70,200,000	306,937,040	450,300,064	408,620,160	638,249,824
Change in reserves	(3,900,128)	89,239,612	(213,599,936)	282,609,824	124,449,856

source: calculated on basis of World Bank Tables (1992)

ANNEX 2.3 PUBLIC FINANCE

Year	GDP	Government consumption	Government consumption as % of GDP	Fixed investment	Public investment	Public investment as & of fixed investment
1970	6524.5	819.8	12.6	1269.8		
1971	7137.0	990.0	13.9	1578.5		
1972	8215.8	1182.0	14.4	1800.2		
1973	10162.4	1417.1	13.9	2251.6		
1974	13215.7	1889.0	14.3	3174.8		
1975	16804.6	2557.9	15.2	3694.8		
1976	20675.6	3306.4	16.0	4846.0		
1977	26330.7	4206.1	16.0	5888.8		
1978	30193.9	5068.6	16.8	6952.4		
1979	34584.4	6243.2	18.1	9049.9		
1980	41405.5	7544.3	18.2	9894.5	3726.057	37.7
1981	57102.7	8986.5	15.7	13737.5	3973.136	28.9
1982	97505.1	14191.9	14.6	19808.5	5269.732	26.6
1983	129314.0	19527.1	15.1	23269.5	7683.002	33.0
1984	163011.0	25500.0	15.6	32679.0	9613.362	29.4
1985	197919.8	31175.0	15.8	38239.8	14076.45	36.8
1986	246579.3	37950.8	15.4	46023.1	15807.74	34.3
1987	284533.2	42651.8	15.0	56313.1	13853.43	24.6
1988	349661.1	54629.6	15.6	66210.9	15496.26	23.4
1989	426633.8	72283.3	16.9	87223.9	20400.46	23.4
1990	522220.0	94329.7	18.1	115473.5	26382.67	22.8

Source: calculations based on World Bank Tables (1992) and MIDEPLAN (1992).

ANNEX 2.4 INFLATION

year	CPI[1]	Inflation rate[2]
1978	20.0	8.1
1979	21.9	13.2
1980	25.8	17.8
1981	35.4	65.1
1982	67.4	81.8
1983	89.3	10.7
1984	100.0	17.3
1985	115.0	10.9
1986	128.7	15.4
1987	150.3	16.4
1988	181.7	25.3
1989	211.6	10.0
1990	252.0	27.3
1991	324.3	25.3
1992	394.9	17.0

[1] Consumer price index based on Alternativas de Desarollo (1993) year average

[2] Inflation calculated from data on december price indices source Alternativas de Desarrollo (1993).

ANNEX 4.1 CROP SPECIFIC COEFFICIENTS

crop	% dm	%N	%P	%K	literature source
maize	86	1.50	0.30	0.40	Erenstein (1989)
rice	86	1.16	0.20	0.39	Van Duivenbooden (1993)
cassava	35	0.55	0.16	0.85	Nijhof (1987a)
plantain/banana	21	1.05	0.13	2.70	Nijhof (1987b)
cocoa	43	1.65	0.29	3.20	Nijhof (1987a)
palmheart	10	1.80	0.17	2.40	Jongschaap (1993)
beans	86	4.15	0.48	1.45	Nijhof (1987b)
pineapple	20	0.80	0.12	1.53	Tonjes (1993)

Note: % N, P and K per kg d.m.

Labour requirements for the various crops are based on van Heemst et al. (1981), van Heemst (1986) and PAGV (1992). The latter, representing dutch task times, were arbitrarily multiplied by two. Labour requirements for manual operations are based on Schipper (pers. com.) and the standard labour requirements of BNCR.

ANNEX 4.2 DESCRIPTION OF ALTERNATIVE LUST'S FOR MAIZE AND RICE

Maize

Six types of alternative LUST for maize are distinguished: A mechanized, a semi-mechanized and a manual type, each with a low and a high input level of herbicides.

Prelimary results with the crop growth simulation model WOFOST[60] showed that a potential production of about 8 ton dry matter per ha is feasible with a sowing date in february. 'Preliminary' indicates that the standard crop parameter setting of the WOFOST model were used. Some crop parameters may be different under conditions of the Atlantic Zone due to specific (local) crop cultivar characteristics[61]. In Table 4.2 a yield of 8 ton ha^{-1} (14% moisture content) is assumed for the mechanized and semi-mechanized LUST. The manual LUST's have a lower yield level (5 ton ha^{-1}) due to a less (manual) favourable field preparation and sowing operation (less uniform plant distribution).

Substitution possibilities, as described in Section 4.1, have been allowed between the use of herbicides and manual weeding (high and low input level of herbicides), and between the means of application of herbicides and fertilizers (mechanized versus semi-mechanized). The latter refers to the possibility to apply herbicides and fertilizers by means of a power driven pressure sprayer and fertilizer appplier respectively, or with a knapsack sprayer and by hand respectively.

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60 WOFOST stands for WOrld FOod STudies (Van Diepen et al., 1988).

61 The simulation results for maize showed that the highest simulated yields coincided with current sowing practices of maize in the Atlantic Zone indicating that the model results point in the right direction.

All LUST's receive at sowing a seed treatment with fungicides and insecticides (total 1.59 kg a.i. ha^{-1}). It is assumed that even the low herbicide LUST's need one treatment with herbicides (1 kg a.i. ha^{-1}). Moreover, it is assumed that the manual LUST's both receive an extra weeding operation due to the absence of a mechanized field preparation which will control the existing weed population better than a manual field preparation.

The apparent nutrient recovery of N and K is assumed 0.5 in the mechanized and semi-mechanized situation. In the manual situation less favourable growing conditions reduce the apparent recovery of N and K (0.4). For phosphate the recoveries are set at 0.2 (mechanized and semi-mechanized) and 0.1 (manual).

Rice

Two types of alternative LUST for rice are distinguished: A high and a low input level of herbicides, It is assumed that rice cropping in the Atlantic Zone only is feasible with a mechanized harvesting operation and field preparation.

Prelimary results with the crop growth simulation model WOFOST showed that a potential production of about 5 ton dry matter per ha is feasible. In Table 4.2 a yield of 5.5 ton ha^{-1} (14% moisture content) is assumed for the LUST with a high input level of herbicides. It is assumed that yield losses are inevitable in situations with a lower input level of herbicides; The yields for the low herbicide input LUST is set at 4.5 ton ha^{-1}.

Substitution possibilities have been allowed only between the use of herbicides and manual weeding (high and low level of herbicides). The latter refers to the possibility to apply herbicides and fertilizers by means of a power driven pressure sprayer and fertilizer appplier respectively, or with a knapsack sprayer and by hand respectively.

All LUST's recieve at sowing a seed treatment with fungicides and insecticides; The total input of fungicides and insecticides during the growing season is 3.12 kg a.i. ha^{-1}). It is assumed that even the low herbicide LUST's recieve one treatment with herbicides (1 kg a.i. ha^{-1}). The apparent nutrient recovery of N and K is assumed 0.5. The apparent phosphate recovery is set at 0.2 for both LUST's.

ANNEX 5.1 GINI COEFFICIENT CALCULATIONS

1963

class	no. farms	% farms	cum% farms	area	% area	cum% area
0-1ha	160	3.03	3.03	150.95	0.07	0.07
1-2ha	391	7.40	10.43	691.82	0.33	0.40
2-3ha	151	2.86	13.29	364.53	0.18	0.58
3-4ha	683	12.93	26.22	2366.49	1.14	1.71
4-5ha	106	2.01	28.23	469.16	0.23	1.94
5-10ha	1423	26.95	55.17	10592.52	5.10	7.04
10-20ha	1000	18.94	74.11	15199.37	7.31	14.3
20-50ha	857	16.23	90.34	26323.05	12.66	27.01
50-100ha	287	5.43	95.77	19613.46	9.44	36.45
100-200ha	88	1.67	97.44	12342.46	5.94	42.39
200-500ha	78	1.48	98.92	22010.36	10.59	52.97
500-1000ha	29	0.55	99.46	19046.53	9.16	62.14
>1000ha	28	0.53	100	78689.32	37.86	100
Total Farms	5281	100.00		207,860	100.00	

Gini coeffficient = 0.787133

1973

class	no. farms	% farms	cum% farms	area	% area	cum% area
0-1ha	349	6.61	6.60	85	0.04	0.0410
1-2ha	287	5.43	12.04	342	0.16	0.205
2-3ha	312	5.91	17.95	680	0.33	0.533
3-4ha	273	5.17	23.12	848	0.41	0.940
4-5ha	235	4.45	27.57	972	0.47	1.408
5-10ha	953	18.05	45.61	6,506	3.13	4.538
10-20ha	980	18.56	64.17	13,062	6.28	10.82
20-50ha	1223	23.16	87.33	33,661	16.19	27.01
50-100ha	337	6.38	93.71	22,101	10.63	37.64
100-200ha	164	3.11	96.81	20,881	10.05	47.69
200-500ha	111	2.10	98.92	33,095	15.92	63.61
500-1000ha	43	0.81	99.73	29,670	14.27	77.89
>1000ha	23	0.44	100.	82,626	39.75	117.64
Total Farms	5290	100.17		244,529	117.64	2,405

Gini coeffficient = 0.759523

1984

class	no. farms	% farms	cum% farms	area	% area	cum% area
0-1ha	560	6.01	6.01	112	0.04	0.04
1-2ha	530	5.69	11.70	624	0.22	0.25
2-3ha	498	5.35	17.04	1,057	0.37	0.62
3-4ha	444	4.77	21.81	1,377	0.48	1.11
4-5ha	465	4.99	26.80	1,899	0.67	1.77
5-10ha	1695	18.19	44.99	11,712	4.11	5.88
10-20ha	2288	24.56	69.55	29,473	10.33	16.21
20-50ha	1690	18.14	87.69	48,472	16.99	33.20
50-100ha	614	6.59	94.28	40,427	14.17	47.36
100-200ha	279	2.99	97.28	36,580	12.82	60.19
200-500ha	194	2.08	99.36	57,602	20.19	80.37
500-1000ha	37	0.40	99.76	24,750	8.67	89.05
>1000ha	22	0.24	100	31,231	10.95	100
Total Farms	9316	100.00		285,316	100.00	

Gini coeffficient = 0.713447

ANNEX 5.2 BANANA SECTOR (1970-1991).

Year	Cultivated area (ha)	Multinational companies (ha)	National producers (ha)	Atlantic Zone Area (ha)	Atlantic Zone Area (%)	Production (x 1000 bx)	Productivity (bx/ha)	Employment	Labour int. (lab/ha)	Labour prod. (bx/lab)	Price (US$/ bx)	Export (x 1000 US$)	Export vol (x 1000 bx)	Own prod. (x 1000 bx)	Assoc. prod. (x 1000 bx)
1970	22,100					41,975	1.899				1.59	66.771	41,975	24,216	17,759
1971	24,270					46,751	1.926				1.37	63.983	46,751	26,519	20,232
1972	25,985					52,931	2.037				1.56	82.830	52,931	31,390	21,541
1973	26,920					57,763	2.146				1.57	90.682	57,763	33,442	24,321
1974	26,883					53,175	1.978				1.85	98.353	53,175	29,951	23,224
1975	25,103					54,414	2.168				2.65	144.061	54,414	31,027	23,387
1976	27,323	16,359	10,964			53,664	1.964				2.77	148.659	53,664	31,877	21,787
1977	25,196	14,054	11,142	18,401	73.03	52,794	2.095				2.66	140.554	52,794	31,862	20,932
1978	25,212	14,683	10,529	18,397	72.97	52,655	2.088	17282	0.685	3047	3.21	169.870	52,655	32,990	19,665
1979	25,291	14,714	10,577	18,566	73.41	53,215	2.104	17373	0.687	3063	3.58	190.511	53,215	32,423	20,792
1980	25,823	14,841	10,982	19,157	74.19	48,925	1.895	17737	0.687	2758	3.74	183.081	48,925	29,392	19,533
1981	26,727	17,805	8,922	19,992	74.80	51,434	1.924	18442	0.690	2789	4.29	220.448	51,343	34,880	16,463
1982	27,398	14,157	13,241	20,958	76.49	50,663	1.849	17961	0.656	2821	3.38	171.167	50,663	26,343	24,320
1983	26,494	12,904	13,590	21,326	80.49	52,199	1.970	17370	0.656	3005	3.36	175.282	52,199	25,977	26,222
1984	24,061	10,867	13,194	20,936	87.01	51,683	2.148	16041	0.667	3222	3.41	176.168	51,683	23,359	28,324
1985	20,535	7,888	12,647	20,140	98.08	44,301	2.157	13690	0.667	3236	3.38	149.616	44,301	18,251	26,050
1986	20,288	7,653	12,635	19,892	98.05	48,637	2.397	13535	0.667	3596	3.79	184.166	48,637	19,742	28,895
1987	20,987	7,755	13,232	20,581	98.07	51,958	2.476	13991	0.667	3714	3.83	199.000	51,958	22,379	29,579
1988	22,023	9,679	12,344	21,610	98.12	56,596	2.570	14682	0.667	3855	3.88	219.593	56,596	25,252	31,344
1989	24,722	14,508	10,214	24,310	98.33	67,519	2.731	16465	0.666	4101	4.12	278.176	67,519	40,723	26,796
1990	28,296	17,248	11,048	27,884	98.54	74,138	2.620	18845	0.666	3934	4.25	315.820	74,138	45,576	28,562
1991	33,400	19,266	14,134	32,988	98.77	80,854	2.421	22378	0.670	3613	4.95	400.492	80,854	47,488	33,366

Source: Sanchez and Barrientos (1992).
Note: bx stands for box

ANNEX 5.3 THE FORESTRY SECTOR (1975-1989)

Year	Forest Permits (ha)		Deforest. Rate	Reforestation (ha)				Recuperation rate		Product	Forestry Industrial	Forestry Forestry	Total Agric.	Agr.	%
	National	Limon	%	National	Limon	National	Limon	%	National	Limon	(mill US$)	Product	Product	GDP	GDP
1975	23,637	3,747	15.9	1.6	0.8	21	0	0.00	0.09	0.00					
1976	19,815	3,456	17.4	1.3	0.7	5	0	0.00	0.03	0.00					
1977	19,348	3,992	20.6	1.3	0.8	12	0	0.00	0.06	0.00					
1978	27,226	3,526	13.0	1.8	0.7	34	0	0.00	0.12	0.00	189	369	558	6,164	3.1
1979	33,345	4,993	15.0	2.3	1.0	413	6	1.45	1.24	0.12	245	414	659	6,399	3.8
1980	22,555	4,550	20.2	1.5	0.9	807	24	2.97	3.58	0.53	294	480	774	7,372	4.0
1981	24,206	5,693	23.5	1.6	1.2	1,098	40	3.64	4.54	0.70	496	598	1,094	13,145	3.8
1982	15,951	4,714	29.6	1.1	1.0	1,357	101	7.44	8.51	2.14	688	767	1,455	23,884	2.9
1983	13,991	3,390	24.2	0.9	0.7	977	161	16.48	6.98	4.75	894	1,221	2,115	28,446	3.1
1984	16,868	2,705	16.0	1.1	0.6	1,286	484	37.64	7.62	17.89	1,365	1,706	3,071	34,572	3.9
1985	16,340	3,099	19.0	1.1	0.6	2,501	572	22.87	15.31	18.46	1,436	1,974	3,410	37,341	3.8
1986	..	..	..	..	..	4,175	574	13.75	n.d	n.d	2,031	2,096	4,127	51,530	3.9
1987	5,885	800	13.6	0.4	0.2	5,303	583	10.99	90.11	72.88	1,631	2,569	4,200	51,417	3.2
1988	9,473	3,542	37.4	0.6	0.7	7,382	1,039	14.07	77.93	29.33					
1989	32,981	16,440	49.8	2.2	3.4	9,257	1,131	12.22	28.07	6.88					
TOTAL	281,621	64,647		19.1	13.2	34,628	4,715								

Source: DGF (1990) and WRI (1991).

ANNEX 6.1 NOMINAL PRICES OF STAPLE CROPS (COLONES PER METRIC TON)

Year	Maize[1]	Rice[1]	Beans[1]	Cassava[2]	Plantain[2]
1980	2186	2048	6106	na	na
1981	3618	3152	10298	1500	2381
1982	7118	6520	19562	6600	4702
1983	10258	10256	27976	6070	6647
1984	10676	11088	30768	4940	5704
1985	11506	11790	33816	6880	9077
1986	12526	13000	37000	11810	10913
1987	12574	13240	34416	9330	9573
1988	12860	14706	34684	7500	10714
1989	14216	17024	40836	14130	12897
1990	17212	21502	48262	24420	14683
1991	na	na	na	17417	21429
1992	na	na	na	16167	28372

Notes: 1 Farm gate prices, colones per metric ton based on Reuben & Morales, 1992.
2 Whole sale prices, colones per metric ton, DLV calculations based on CENADA data.

ANNEX 6.2 REAL PRICES OF STAPLE CROPS (BASE YEAR 1984) (COLONES PER METRIC TON)

Year	Maize	Rice	Beans	Cassava	Plantain
1980	8458	7924	23625		
1981	10215	8899	29074	4235	6722
1982	10569	9681	29045	9799	6982
1983	11484	11482	31321	6796	7441
1984	10676	11088	30768	4940	5704
1985	10001	10248	29394	5980	7890
1986	1735	10103	28756	9179	8481
1987	8364	8807	22892	6206	6368
1988	7079	8095	19093	4129	5898
1989	6717	8044	19295	6676	6094
1990	6831	8533	19154	9692	5827
1991				5371	6608
1992				4094	7184

Notes: Calculations using year average Consumer Price Index, source: Reuben & Morales, 1992

ANNEX 6.3 PRICE INDICES OF STAPLE CROPS (1984 = 100)

Year	Maize	Rice	Beans	Cassava	Plantain
1980	79	71	77	na	na
1981	96	80	94	86	118
1982	99	87	94	198	122
1983	108	104	102	138	130
1984	100	100	100	100	100
1985	94	92	96	121	138
1986	91	91	93	186	149
1987	78	79	74	126	112
1988	66	73	62	84	103
1989	63	73	63	135	107
1990	64	77	62	196	102
1991	na	na	na	109	116
1992	na	na	na	83	126

ANNEX 6.4 NOMINAL DOLLAR PRICES OF EXPORT CROPS

Year	Palmheart[3]	Cocao[3]	Coco[3]	Pineapple[3]	Banana[4]
1980	na	na	na	na	3,74
1981	2,61	1,65	0,41	0,57	4,29
1982	1,12	1,19	0,28	0,18	3,38
1983	0,96	1,29	0,30	0,26	3,36
1984	1,10	1,95	0,32	0,35	3,41
1985	1,09	1,69	0,28	0,39	3,38
1986	1,02	1,50	0,93	0,36	3,79
1987	1,51	1,32	0,43	0,39	3,83
1988	2,73	1,36	0,38	0,40	3,88
1989	1,66	na	0,46	0,40	4,12
1990	1,78	na	0,42	0,40	4,25
1991	2,19	na	na	0,36	4,95
1992	na	na	na	na	na

Notes: 3 export prices in colones per metric ton, DLV calculations
4 export prices in colones per box (of 18.4 kg), based on Sanchez & Barrientos, 1992.

ANNEX 6.5 NOMINAL PRICES OF EXPORT CROPS (COLONES PER METRIC TON, CALCULATED USING THE OFFICIAL EXCHANGE RATE)

Year	Palmheart	Cocao	Coco	Pineapple	Banana
1980	na	na	na	na	34,52
1981	56008	35376	8889	12252	92,02
1982	42966	45953	10927	6901	130,20
1983	39495	53349	12413	10587	138,47
1984	49125	86954	14095	15435	151,75
1985	54878	85126	14130	19569	170,62
1986	57252	84136	52126	20332	211,94
1987	95002	83019	26967	24725	240,22
1988	206673	102856	28888	30555	293,99
1989	135172	na	37323	32552	335,29
1990	162590	na	38853	36618	388,54
1991	268000	na	na	43622	604,89

Notes: Exchange rate calculated on basis of World Bank Tables (1992) and data collected by Alternativas de Desarrollo (1993).

ANNEX 6.6 REAL PRICES OF EXPORT CROPS (BASE YEAR 1984)

Year	Palmheart	Cocao	Coco	Pineapple	Banana
1980	na	na	na	na	134
1981	158126	99877	25096	34591	260
1982	63795	68230	16224	10246	193
1983	44216	59727	13897	11852	155
1984	49125	86954	14095	15435	152
1985	47701	73994	12282	17009	148
1986	44496	65390	40512	15802	165
1987	63191	55220	17937	16446	160
1988	113770	56621	15903	16820	162
1989	63868	na	17635	15381	158
1990	64527	na	15419	14532	154
1991	82643	na	na	13452	187
1992	na	na	na	na	

Notes: Calculations using year average Consumer Price Index, source: Reuben & Morales (1992)

ANNEX 6.7 PRICE INDICES OF EXPORT CROPS (1984 = 100)

Year	Palmheart	Cocao	Coco	Pineapple	Banana
1980	na	na	na	na	88
1981	322	115	178	224	171
1982	130	78	115	66	127
1983	90	69	99	77	102
1984	100	100	100	100	100
1985	97	85	87	110	98
1986	91	75	287	102	109
1987	129	64	127	107	105
1988	232	65	113	109	107
1989	130	na	125	na	104
1990	131	na	109	94	102
1991	168	na	na	87	123
1992	na	na	na	na	na

ANNEX 6.8 NOMINAL PRICES OF ANIMAL AND FORESTRY PRODUCTION

Year	Meat[5]	Milk[6]	Hard RWE[7]	Medium RWE[7]	Soft RWE[7]
1980	8525	3125	1147	1147	664
1981	11195	4432	1534	1534	889
1982	26127	8267	2749	2749	1592
1983	33967	11270	4741	4741	2746
1984	33384	11570	5392	5392	3123
1985	30711	12575	6076	5776	3300
1986	33861	13280	6929	6012	3355
1987	48327	15380	8380	6842	3749
1988	63201	17657	15503	10884	5069
1989	73795	17800	17991	12631	5883
1990	81493	20374	na	na	na
1991	na	31564	na	na	na
1992	na	39642	na	na	na

Notes: 5 Whole sale prices at Plaza de Montecillos, colones per metric ton, based on CNP, Departemento Pecuario, División Fomento de la Producción, 1989, 1991.

6 Farm gate prices, colones per metric ton, DLV calculations based on data of Camara nacional de productores de leche.

7 Whole sale prices in colones per Round Wood Equivalent (1 m^3 RWE = 0.625 m^3 sawn wood), (WRI, 1991).

ANNEX 6.9 REAL PRICES OF ANIMAL AND FORESTRY PRODUCTION (BASE YEAR 1984)

Year	Meat	Milk	Hard RWE	Medium RWE	Soft RWE
1980	32984	12089	4438	na	na
1981	31606	12514	4331	4331	2510
1982	38793	12275	4082	4082	2364
1983	38028	12617	5308	5308	3074
1984	33384	11570	5392	5392	3123
1985	26694	10931	5281	5021	2868
1986	26316	10321	5385	4672	2607
1987	32145	10230	5574	4551	2494
1988	34791	9720	8534	5991	2790
1989	34868	8410	8501	5968	2780
1990	32342	8086	na	na	na
1991	na	9733	na	na	na
1992	na	10038	na	na	na

Notes: Calculations using year average Consumer Price Index, source: Reuben & Morales, 1992

ANNEX 6.10 PRICE INDICES OF ANIMAL AND FORESTRY PRODUCTION (1984 = 100)

Year	Meat	Milk	Hard RWE	Medium RWE	Soft RWE
1980	99	104	82	na	na
1981	95	108	80	80	80
1982	116	106	76	76	76
1983	114	109	98	98	98
1984	100	100	100	100	100
1985	80	94	98	93	92
1986	79	89	100	87	83
1987	96	88	103	84	80
1988	104	84	158	111	89
1989	104	73	158	111	89
1990	97	70	na	na	na
1991	na	84	na	na	na
1992	na	87	na	na	na

ANNEX 6.11 NOMINAL PRICES OF FACTOR INPUTS

Year	Land[8]	Labour[9]	Interest[10]	Machinery[11]
1980	4440	50	10	115
1981	3440	62	16	197
1982	4092	109,5	18	366
1983	6513	162,5	18	446
1984	9610	190,8	22	531
1985	20879	230,3	25	615
1986	19337	266	25	669
1987	22764	301,2	25,3	800
1988	28363	346,8	27,4	940
1989	29934	421	28,5	1064
1990	33895	503	29,3	1370
1991	44648	688	37	1733
1992	na	938	35	2000

Notes:
8 Land prices are estimated on basis of the amounts paid by IDA in the process of land acquisitions, extreme values, due to the political nature of the IDA interventions have been eliminated. Missing years were estimated using the national average price.
9 Labour price is the wage rate for an eight hour working day ("jornal"), using data collected by Alternativas de Desarrollo.
10 Interest rates are the rates for agriculture which were heavilly subsidized in the early eighties.
11 Machine hour prices were estimated using point data from 1988 and 1992 and the index for services published by MIDEPLAN (1992).

ANNEX 6.12 REAL PRICES OF FACTOR INPUTS (BASE YEAR 1984)

Year	Land	Labour	Interest[12]	Machinery
1980	17179	195	-7	445
1981	9711	174	-15	556
1982	6075	163	-38	544
1983	7292	182	-11	499
1984	9610	191	9	531
1985	18149	200	9	535
1986	15029	207	12	520
1987	15142	200	7	532
1988	15613	191	5	517
1989	14144	199	10	503
1990	13452	200	9	544
1991	13768	212	6	535
1992	na	238	11	506

Notes:
Calculations using year average Consumer Price Index, source: Reuben & Morales, 1992.
12 Real interest rate was calculated by dividing through the inflation rate:

$$i_{real} = \frac{1 + i_{nominal}}{1 + \rho} - 1$$

ANNEX 6.13 PRICE INDICES OF FACTOR INPUTS (1984 = 100)

Year	Land	Labour	Interest	Machinery
1980	179	102	-77	84
1981	101	91	-171	105
1982	63	85	-423	102
1983	76	95	-123	94
1984	100	100	100	100
1985	189	105	96	101
1986	156	108	131	98
1987	158	105	81	100
1988	162	100	61	97
1989	147	104	115	95
1990	140	105	96	102
1991	143	111	72	101
1992	na	124	121	95

ANNEX 6.14 NOMINAL PRICES OF NON-FACTOR INPUTS

Year	N[13]	P[13]	K[13]	A.I.[14]
1980	na	na	na	na
1981	na	na	na	na
1982	37,8	52,1	19,7	1831,2
1983	33,4	46,5	15,2	1640,8
1984	40,7	51,6	17	1757,3
1985	44	59,2	30,3	2094,8
1986	33,5	59,4	44,3	2302,1
1987	31,8	58,2	47,9	2560,6
1988	44,4	72,1	44,2	3144,7
1989	39,6	73,8	60,4	3472,6
1990	53	85,4	76,3	3911,2
1991	75,6	126,8	122,4	5196,6
1992	81,8	105	105,4	5788,0

Notes: 13 Prices of N, P and K were estimated using a hedonic analysis of a time series of fertilizer prices.

14 The price of the active ingredient for biocides was estimated by using the average weighed price of commonly used biocides; the weight used was the AI content.

ANNEX 6.15 REAL PRICES OF NON-FACTOR INPUTS (BASE YEAR 1984)

Year	N	P	K	A.I
1980	na	na	na	na
1981	na	na	na	na
1982	56	77	29	2719
1983	37	52	17	1837
1984	41	52	17	1757
1985	38	51	26	1821
1986	26	46	34	1789
1987	21	39	32	1703
1988	24	40	24	1731
1989	19	35	29	1641
1990	21	34	30	1552
1991	23	39	38	1602
1992	21	27	27	1466

Notes: Calculations using year average Consumer Price Index, source: Reuben & Morales, 1992.

ANNEX 6.16 PRICE INDICES OF NON-FACTOR INPUTS (1984 = 100)

Year	N	P	K	A.I
1980	na	na	na	na
1981	na	na	na	na
1982	138	150	172	155
1983	92	101	100	105
1984	100	100	100	100
1985	94	100	155	104
1986	64	89	203	102
1987	52	75	187	97
1988	60	77	143	99
1989	46	68	168	93
1990	52	66	178	88
1991	57	76	222	91
1992	51	52	157	83

ANNEX 6.17 PRESENCE OF GOVERNMENT INSTITUTIONS IN THE ATLANTIC ZONE

Type of organization	Central offices	Regional agencies	Branch offices
Central Government			
- Ministry of Planning	1	-	-
- Ministry of the Presidency	1	-	-
- Interior Ministry	1	-	-
- Minstry of Justice	1	-	-
- Ministry of Labour	1	-	3
Agriculture/Rural Development			
- Minstry of Agriculture (MAG)	1	2	4
- Institute for Agrarian Development (IDA)	-	5	-
- National Council for Production (CNP)	1	4	2
Semi-autonomous institutions			
- Harbour en Regional Development Authority (JAPDEVA)	1	1	-
- National Banana Asociation (ASBANA)	1	1	1
- National Housing Institute (INVU)	1	-	-
Financial Institutions			
- National Bank of Costa Rica (BNCR)	2	2	6
- Bank of Costa Rica (BCR)	-	2	-
- Anglo Costa-Rica Bank (BACR)	-	1	1
- Popular Bank for Community Development (BPDC)	-	2	-
Infrastructural Development			
- Institute for Electricity (ICE)	1	-	4
- Ministry of Public Works and Roads (MOPT)	1	-	4
- National Railways Institute (INCOFER/FECOSA)	1	-	-
- National Refinery (RECOPE)	1	-	1
Social Development and Health			
- National Directorate for Comunity Development (DINADECO)	1	1	-
- Institute for Social Welfare (IMAS)	1	-	1
- Patronate for Childs Welfare (PANI)	1	3	-
- Minstry of Public Health (MINSA)	1	2	33
- Social Security Council (CCSS)	1	-	11
Education and Training			
- Minstry of Public Education (MEP)	1	2	-
- National Training Institute (INA)	1	-	-
- University of Costa Rica (UCR)	1	-	-
- Open University (UNED)	1	-	-
Local Government			
- Municipalities	6	-	-
Total	31	28	71

Source: MIDEPLAN (1991)

ANNEX 6.18 BASIC INFORMATION ABOUT ICTO/IDA LAND TRANSACTIONS

YEAR	N[5]	AREA[1] Mean	AREA[1] Standard Deviation	VALUE TRANSACTION[2] Mean	VALUE TRANSACTION[2] Standard Deviation	NOMINAL PRICE[3] Mean	NOMINAL PRICE[3] Standard Deviation	REAL PRICE[4] Mean	REAL PRICE[4] Standard Deviation
1965	1	8221.34	.	1751013	.	212.98	.	4.61	.
1966	1	200.00	.	50208	.	251.04	.	5.33	.
1971	1	230.72	.	107218	.	464.72	.	8.45	.
1972	2	28.50	21.92	76988	69923	5175.75	6434.29	88.01	109.41
1973	1	1661.36	.	40000	.	24.08	.	0.35	.
1975	2	1145.00	1053.59	510001	551541	388.10	124.58	3.62	1.16
1976	5	645.79	251.92	982250	618549	1801.99	1534.87	17.27	14.71
1977	11	1099.31	1711.18	905380	1310569	1028.02	570.38	9.36	5.19
1978	11	493.46	818.55	1365284	2450889	2997.44	2200.16	25.24	18.53
1979	16	1674.74	2630.64	2590195	2532432	3081.62	2743.58	22.93	20.42
1980	7	1383.03	2088.73	5197967	8139464	7733.27	7261.88	48.86	45.88
1981	1	282.00	.	970000	.	3439.72	.	13.16	.
1982	4	1301.53	2132.81	7645402	11400802	10751.59	8104.59	22.64	17.07
1983	9	629.46	743.08	4673341	3462768	23283.80	38293.31	44.29	72.84
1984	16	595.15	894.07	4230796	4656971	12089.99	14272.24	19.60	23.13
1985	4	466.62	424.42	9403938	9625070	20879.33	11823.90	30.51	17.28
1986	1	449.34	.	18000000	.	40058.62	.	50.71	.
1988	2	174.03	0.00	12214342	2884592	70185.23	16575.24	60.89	14.38
1989	1	1115.20	.	24916236	.	22342.39	.	17.63	.
1990	3	846.11	549.35	35843662	28837404	48884.06	33693.20	30.31	20.89
1991	5	342.59	521.84	10688136	9052288	79056.06	51639.14	39.12	25.55
1993	2	157.01	108.05	26200000	13152186	180878.8	40710.43	75.50	16.99

SOURCE:DLV calculations based on IDA/ICTO data of and transactions (unpublished), courtesy W. Brooijmans

Notes:
1. in hectares
2. in current colones
3. in current colones per hectare
4. in 1981 colones per hectare
5. For some of the years very few samples are available, making estimation difficult.

ANNEX 6.19 PRICE TRENDS

item	trend[1] % growth per year	fluctuation[2]	fluctuation[3]
Land	2.00	33.4	very high
Labour	1.83	5.9	very low
Machinery	0.23	5.6	very low
N	-7.66	18.9	moderate
P	-6.78	10.7	low
K	1.38	25.4	high
A.I	-3.19	9.3	low
Maiz	-5.78	20.0	moderate
Rice	-0.63	10.6	low
Beans	-3.16	12.7	low
Cassave	0.43	32.0	very high
Plantain	-0.31	11.0	low
Palmito	-0.17	29.8	very high
Cacao	-1.65	13.1	low
Coco	1.14	20.4	moderate
Pineapple	-0.24	18.7	moderate
Banana	0.63	7.0	very low
past nat	0.46	8.7	low
past imp	-0.54	15.2	moderate
Meat	-0.41	12.0	low
Milk	-2.52	8.4	low
Hard RWE	7.32	11.4	low
Medium RWE	3.18	9.2	low
Soft RWE	1.01	8.1	low

Notes: 1. The trend is measured using a three year moving average:

$$r = e^{\frac{\ln(\frac{p_{end}^{3yma}}{p_{begin}^{3yma}})}{t}} - 1$$

where r is the growth rate, p_{end}^{3yma} is the three year average of the end period, p_{begin}^{3yma} is the three yaer average of the start period, and t is the number of years between the middle of the start and end periods.

2. The fluctuation is measured as the standard deviation from the normalized trend. The normalized trend is defined as 100 times the actual price divided by the expected price given the trend, i.e. a value on the trend is equal to 100, irrespective of the value, this makes comparisons between different prices possible.

3. The fluctuation catagories are defined in terms of the standard deviation from the normalized trend: very low ≤ 7, low ≤ 14, moderate ≤ 21, high ≤ 28, very high > 28.

ANNEX 7.1 CALCULATION OF THE DEMAND ELASTICITIES FOR BEEF IN COSTA RICA

Table a: Input data 1981-1990

PERIOD	ΔQ/Q[1]	ΔY/Y[2]	ΔP/P[1]
81-82	-0.1174	-0.0788	0.2366
82-83	0.0048	0.0368	-0.0296
83-84	0.1755	0.0752	-0.1178
84-85	0.2647	0.0306	-0.2161
85-86	0.1659	0.0366	0.0130
86-87	-0.0669	0.0550	0.2186
87-88	-0.1432	0.0377	0.0633
88-89	-0.0505	0.0640	0.0014
89-90	0.1070	0.0416	-0.0720

notes: [1] DLV calculations based on CNP (1991): domestic demand for beef.
[2] DLV calculations based on World Bank Tables (1992): domestic consumption.

The partial elasticities of demand, price elasticity and income elasticity, are defined as:

$$\epsilon^y = \frac{\delta q}{\delta y} * \frac{y}{q}$$

$$\epsilon^p = \frac{\delta q}{\delta p} * \frac{y}{p}$$

A combination of the two gives:

$$\frac{\delta q}{q} = \epsilon^y * \frac{\delta y}{y} + \epsilon^p * \frac{\delta p}{p}$$ ¦ ceteris paribus

p	= deflated price of beef	($/vol)
q	= domestic consumption of beef	(vol)
y	= income	($)

The linear regression equation through the origin, estimates the elasticities:

$$\Delta Q/Q = \alpha_1 * \Delta Y/Y + \alpha_2 * \Delta P/P + \mu$$

with μ representing the factor of perturbation.

SPSS/PC+

* * * * MULTIPLE REGRESSION THROUGH THE ORIGIN * * * *

Equation Number 1 Dependent Variable.. DQ

Variable(s) Entered on Step Number
1.. DP
2.. DY

Multiple R	.77868
R Square	.60634
Adjusted R Square	.49386
Standard Error	.10096

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	.10989	.05494
Residual	7	.07134	.01019

F = 5.39081 Signif F = .0383

Variable	B.	SE B	Beta	T	Sig T
DP	-.709625	.257520	-.696528	-2.756	.0283
DY	.483716	.670450	.182366	.721	.4940

Expected demand elasticities are (Tsakok, 1992) for beef are price elasticities between -0.41 and -1.25 and for income elasticities between 0.3 and 0.8 . These figures are based on comparative studies of price elasticities world wide.

The regression results clearly indicate that the elasticities are within the range. However the fact that DY fails the T-test indicates that price fluctuations exert a stronger influence on overall demand than does income.[62]

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62 Please note that the income measure used is a rough approximation. Changes in income distribution and the subsequent effect on demand for beef are not taken into account, i.e. the income measurement is not cross-sectional.