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FARM CLASSIFICATION

Analysis of production and income variation, Atlantic Zone, Costa Rica

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to Anneke and our unborn child

Preface

Writing your M.Sc.-thesis about a country where you have never been is tricky business. You don't know the look and feel of the country and the voice of its people. Unfortunately, I never got the opportunity of talking personally with the farmers on which this thesis is about and discuss their farming business, their problems, hopes and expectations for the future. Many of the crops they grow I've only seen in the university greenhouses or at the local 'toko'. Yet, this thesis is on the farm systems in the Atlantic Zone of Costa Rica. Luckily, I got the opportunity to talk to Rodrigo Alfaro, the person who designed the questionnaire and collected the data. Through discussions with him I was able to get a rough idea of the region and to see the farmers shimmering through the data. I do hope to visit Costa Rica in the near future! *Gracias!*

Being a part time student for 6 years next to my job at the Free University of Amsterdam was a challenge to me and sometimes tough. It proved to be especially difficult in the process of researching and writing this M.Sc.-thesis. Time was my most precious asset. But I was lucky and happy to receive all the support, especially from Anneke, but also from my family and closest friends, who were always interested in the proceedings of my studies at Wageningen Agricultural University. Thank you very much. Most of all I would like to thank drs Ruerd Ruben, for giving insightful and valuable comments on earlier drafts. He professionally guided me through the tasks of statistical analysis and writing. *Bedankt!*

So now my studies at Wageningen University are finally coming to an end. Pretty soon the room where I spent so much time studying and writing will be converted into a baby's room. Papers will have to make room for diapers. The computer must give way for the cradle. A new human being is on its way. I'm preparing myself for another 'study' now. Of how to become a loving dad.

Hans Peter Roersma

Ede, July 1st 1996

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Introduction

1. Objective

The aim of this study is to classify the farm households of the Atlantic Zone of Costa Rica in socio-economic terms, and to analyse their production systems and income composition. In this way, this study wants to make a modest contribution to an already large body of knowledge on farming systems in the Atlantic Zone. A thorough knowledge of the farming systems in this region is important for the formulation and implementation of an agricultural policy aimed at an ecologically and economically sustainable land use in the Atlantic Zone. In pursuit of this goal, both the researcher and policy maker should take into account aspects of farm system diversity, at risk of failure of interventions. For the researcher, it is difficult to come up with evidence for the general agricultural policies which policy makers usually desire. One of the reasons is the evident diversity of farm systems. Not for nothing, some specialists plea for policies that are tailored for very specific regions or production systems and which should be implemented at the local level. As Schiere (1995) puts it; "Ultimately, one might hope that the politicians' (...) 'religion' of simple-to-transfer and universally applicable quick fixes, is replaced with the 'common sense' of niche solutions for niche problems".

In world agriculture a great diversity of farm systems can be distinguished. Also from a national, regional, and even a village point of view, diversity in styles of farming can be observed. When aiming for a classification of farms, it is assumed that there is a hidden homogeneity in the apparent heterogeneity of farm systems. Knowledge of this diversity is essential for further research and the design of agricultural policies. But what is a useful classification, and which criteria should be used? Farms in the Atlantic Zone are heterogeneous from various points of view. In general, one could argue that no farm is the same, so the best classification is one that results in as many classes as there are farms. Unfortunately, a classification like this is impossible to handle. It resembles the notion that the best map of a landscape is the landscape itself, but unfortunately the landscape is not as handy as the map. On the other hand, farms are the same the world over. They use land, labour, capital and various inputs to produce output, consume it or sell it, and in this way earn a livelihood from farming. But seen this way we end up with only one class of farms.

Therefore it is important to state from which point of view we want to make a classification. As said earlier, the objective of this study is to group together farms which are alike with respect to production systems, that is 'the way' they produce output, and the structure of the farm households' income (the 'income composition' of the household). In the end, we would like to be able to distinguish a certain number of farmer types that capture the golden mean between farm system heterogeneity and homogeneity of the farms in the Atlantic Zone.

A classification of farms from this perspective (production systems and income composition), can provide a basis for an agricultural policy that takes into account the evident diversity among farm systems in the region, and can provide a starting point -a framework- for further research.

2. Background

In 1987 the government of Costa Rica adapted a new strategy for the national agricultural sector, named '*agriculture de cambio*' (agriculture of change), as part of a structural adjustment program for the country. The main thrust of this new strategy was the diversification of agricultural exports. This was based on the twofold notion that the agricultural sector of Costa Rica -and thereby the country as a whole- was too dependent on only a few export products (like coffee), and that increasing exports of non-traditional crops had to be balanced against rising imports of maize and rice. Unstable prices on the world market threatened to destabilize the national economy. New export crops like palm heart, pineapple, plantain, and roots and tubers, were introduced and promoted through credit programs, fiscal benefits, and export subsidies.

Price supports for food crops like maize, beans and rice were abolished. Small-scale farmers, of whom many depended heavily on maize production as a source of income, faced difficult times. It proved that the implementation of the new strategy resulted in benefits that accrued mainly to the multinationals and already well endowed farmers (Alfaro, 1994). Small-scale farmers were facing problems of organisation, infrastructure, marketing, and credit facilities, and were lacking the knowledge and the adapted technologies for the production of non-traditional crops. This arrested the transition to a modern agricultural sector; the majority of small-scale farmers continued growing traditional crops by traditional methods, and income from off-farm work became an important source of income. The need for a better understanding of the bio-physical and socio-economic characteristics of the small-scale farmer and his environment became apparent. It was recognized that a policy aimed at the modernisation of the traditional agricultural sector could not be based on aspects of ecology and geography alone, but should also take into account the socio-economic diversity of the agricultural sector in the Atlantic Zone. It is to this new approach this study wants to make a contribution.

3. Research area

The northern Atlantic Zone of Costa Rica consists of *Límon* province and part of the *Heredia* province. *Límon* province is divided into six counties, including Pococí, Guácimo and Siquirres, in which research was done. Some typical features of the research area are (Alfaro, 1994 and Tilburg *et al.*, 1995):

- the soils are relatively fertile and mostly of volcanic origin;
- the climate is tropical and humid, with a rainfall surplus over evaporation of about 3,000 mm, spread over all months of the year; there is no dry season and no marked growing season[1];
- banana production in the area accounts for nearly all of the country's banana exports; multinationals dominate the banana

[1] Interestingly, farmers of the area are of the opinion that deforestation is the cause for some assumed unfavourable changes in climatological conditions. According to them, rains are becoming less frequent and intense, and the average temperature is increasing. They also think that droughts occur more frequently, while floods are less (source; this survey).

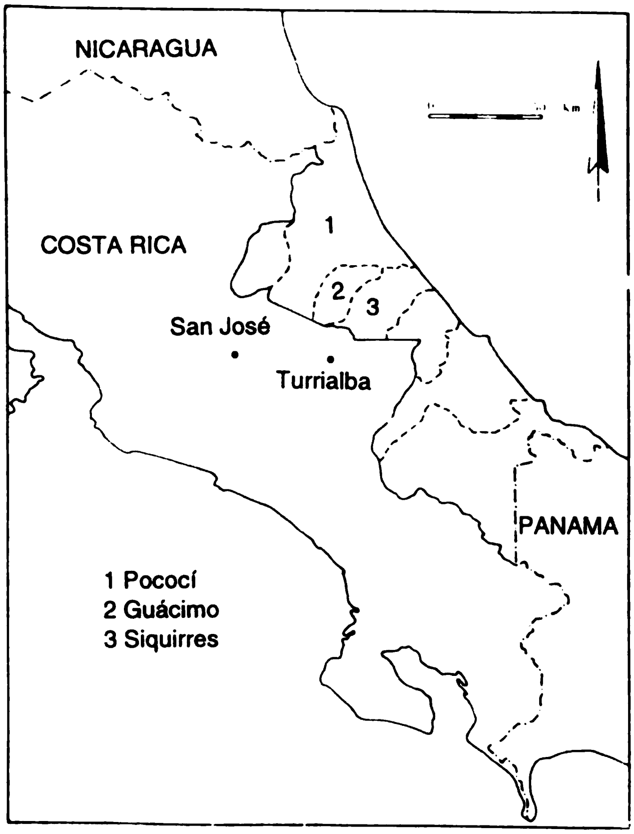

Figure 1.1: *Map of the study area*

sector, especially the marketing process; banana plantations are important as a source of off-farm employment for small-scale farmers in the area;

- agricultural production is mainly market oriented; household needs are almost not considered in crop choice (Tilburg *et al.*, 1995);
- the area was colonized in the 1950s, partly organized by IDA, the government land reform and settlement agency, and partly through spontaneous colonisation ('squatting') by individual farmers; the resulting rapid deforestation is becoming a major concern for the government of Costa Rica[2]. IDAs activities are now mainly limited to the regulation of land titling (Jones, 1990);
- A highway runs from Guápiles to the harbour city *Límon*. Other roads are mostly unpaved and often in poor condition, especially after heavy rainfall;
- Both commercial and subsidized credit are difficult to obtain in the Atlantic Zone. Interest rates are high, and the conditions of a loan unfavourable. A 1995 survey indicated that less than 10 percent of the farmers in the Atlantic Zone have credit.

Nearly three-quarters of the population of the Atlantic Zone live in rural areas, and

[2] Deforestation in Costa Rica is accelerated by ranchers practising 'fence creeping' - literally edging their fences beyond their property lines into national parks.

more than half of the labour force is working in the farming sector. The main market outlets for crop products in the Atlantic Zone are rural traders and *'empacadores'* (local agricultural export business). Also for livestock products rural traders are the main market outlet, followed by cattle auctions and the meat processing industry. Direct sales to consumers are not common. Farmers face serious problems in marketing their products, which is caused, among others, by the fact that rural traders and empacadores have more market power, farmers' organisations do not function well, the perishability of many agricultural products, and the lack of transport and storage facilities (Tilburg *et al.*, 1995).

Labour is relatively scarce in the Atlantic Zone. Labour intensive crops will only be adopted when sufficient on-farm labour is available and when financial returns justify the high labour input. Off-farm activities are often a more attractive option than the cultivation of a profitable, but labour intensive crop. A recent farm survey revealed that more than half of the farmers have off-farm income sources (Tilburg *et al.*, 1995). Off-farm work seems to be partly determined by the distance to alternative labour opportunities, especially banana plantations.

4. Material

The data material for this study was compiled in 1993 by R. Alfaro of the Atlantic Zone Programme. The survey was done in three counties of the Límon province; Pococí, Guácimo, and Siquirres. More than two hundred farmers were interviewed on various items concerning their farming practices by use of a structured questionnaire (Pococí; n=86, Guácimo; n=80, Siquirres; n=37, total N=203).
This questionnaire covers five topics of interest (see the Appendix to this chapter for a full list of the questions that were included in the questionnaire). The first section covers questions on the general characteristics of the farm, the composition of the household, and general labour characteristics. In section two of the questionnaire, farmers were asked about the different soil types on the farm, the crops that are grown, other types of land use, and quantities of livestock. In the third section, farmers could express what factors they take into account in their decisions on agricultural activities and what activities they consider to be the most important for the socio-economic reproduction of the household. It was also asked what income they earn with these activities. A fourth section of the questionnaire consists of questions on credit and inputs. Here, the use and purpose of credit is assessed, as well as the application of mechanical and chemical inputs. A major limitation is that no data were collected on crop specific input use. The last section of the questionnaire deals with questions on the farmers' perception of the socio-economic and bio-physical environment they live in, and the rationality of their agricultural activities. Data entry resulted in a data set of 417 variables on 203 cases. A codebook of the data set was available, as well as a copy of the questionnaire that was used (in Spanish). The filled-in questionnaires were not available. Obvious errors in the data set could only be eliminated through consultation of R. Alfaro.

5. Methodology

The principal research methods applied in this study are literature review and statistical analysis of the available data. Literature review was done to gain insight in theory and practice of farm classification. Simple cross-tabulation, mostly by region and farm size class, was used for tabular presentation of data on production and income in the first part of the study, in some cases with an indication of the significance of differences. Logistic regression was used for the analysis of yield variation. For the analysis of production and income variation, correlation and path analysis was conducted. Cluster analysis was used for the identification of farm classes with income composition as the classifying criterium. Then again, cross-tabulation was used to present production and income data for the distinguished farmer types as well as test statistics on the significance levels of differences. Literature review was done to gain insight in policy aspects of the proposed farm classification. Consultation of key informants was limited; we only had the opportunity to discuss with R. Alfaro on a few occasions.

6. Structure of the report

Chapter 2 presents an overview of the literature on farm classification. A summary of general findings of the survey is presented in Chapter 3, which covers the data on the factors of production, and Chapter 4, covering the production and income characteristics. Chapter 5 is devoted to the analysis of yield variation. Chapter 6 is used for the presentation and discussion of an analysis of production and income variation. In Chapter 7 an attempt is made to classify farms with respect to similarities in the composition of farm income. The resulting classes, or 'farmer types', represent different reproductive strategies of the farm households in the Atlantic Zone. These are further analysed to obtain a better insight in between-class differences in farm income and production characteristics. Chapter 8 concludes the study with some tentative policy considerations based on the proposed farm classification.

Appendix: The questionnaire

This appendix consists of a 'short hand' version of the questionnaire. The original questionnaire was in the Spanish language. Answer categories are not mentioned here.

section A: General characteristics of the farm

1	interview number
2	farmer condition
3 - 5	*farm location* region district community
6 - 11	*farm data* farm size land tenure farm acquisition number of years working the farm age of farmer (category) educational level
12-65	*household composition* (for the 1st to 9th member of household) sex age study occupation off-farm work income contribution from off-farm work
66-67	*housing* quality type

section B: Land and land use

68-95	*soil* (for Tierra negra, T. bermeja, T. colorado, other (1 to 3), swamp) area characteristics use problems
96-199	*crops* (for maize, cassava, plantain, papaya, palm heart, pineapple, yam, tuber, chili, coconuts, beans, elote, other *in year 1992 and 1993*) area sown yield sale consumption
200 - 205	*other land use* (for pasture, forest, fallow *in year 1992 and 1993*) area

206 - 245	*livestock* (for cows, calves, heifers, bulls, pigs, poultry, other1, other2) number number consumed number sold price place of sale

section C: Reproductive activities and income

246	factors taken into account in farm decision making
247 - 295	most important activity (for livestock, agriculture, trading, freighting, wage labour, salary, family support, pension, grant, renting land, other) <activity> is most important activity? which products (for livestock, agriculture, trading) number (for freights and wages) place (for salary) member (for family support) institution (for grant) income from <activity>

section D: Credit and input use

296 - 316	*credit* use of credit? who financed .. ? (livestock, fruit trees, roots & tubers, palm heart, other) how much did you borrow term of credit rate of interest
317-27	*mechanical inputs* (for machinery, rotavator, other1, other2) condition frequency of use per year cost/year of hiring (machinery and rotavator)
328 - 339	*agro-chemical inputs* (for fertilizer n-p-k, nitrogen fertilizer, insecticide, 'round up' herbicide, pasture herbicide, anti-parasitic, vaccines, other) use trade (for insecticide, pasture herbicide and anti-parasitic) quantity/year of ...

section E: Sales of produce (340-347 have missing values for all cases)

340 - 347	*sales* (for cassava, roots & tuber, palm heart, vegetables, fruit, plantain, papaya, other) quantity of sales
348 - 355	*selling place* (for cassava, roots & tuber, palm heart, vegetables, fruit, plantain, papaya, other) place

section F: Farmers' opinions and perception

356 - 357	Have agricultural practices changed during last decade? Which?
358 - 365	Who recommended changes in cropping of; maize, cassava, plantain, palm heart, pineapple, chili, coffee, other?
366	What are the reasons for small farmers to practice multi cropping?
367 - 368	Do you think more chemicals are used in agriculture nowadays? What are the reasons?

369 - 370	Do you know colleague-farmers who work their farms with more devotion towards natural resources? What are their reasons?
370 - 374	What do you think about .. level of rain? temperature? frequency of droughts? frequency of floods?
375	What are the reasons for the changes in climate?
376 - 377	Do you sow the same crop in each plot of farm? If yes, why?
378 - 379	Do you compare output with those of previous years? If yes, why?
380 - 381	Do you participate in any farmers' organisation? If yes, which type?
382 - 384	Do you think the quality of farm land has changed? If yes, how? What are the reasons for those changes?
385 - 388	Which herbicides/fertilizers/practices/other-reason affects soil quality?
389 - 390	Do you think the new road to San Jose changed agriculture in the Atlantic Zone? If yes, in what way?
391	How would you define yourself as a farmer?
392 - 395	What are the advantages of farmers' organisations? Which problems are solved by farmers' organisations? What are the disadvantages of farmers' organisations? Which problems are not solved?
396 - 397	Do you think Atlantic Zone farmers are individualistic? If yes, why?
398 - 399	Have you been working on a banana plantation? If yes, for how many years?
400	What are the main problems for keeping you working as a farmer?
401	Some young people don't want to become farmers. Why is that?
402	Why are *you* still working as a farmer?
403	Imagine the conditions for agriculture would improve. What type of farm would you like under better conditions?
404 - 408	If you won the first prize of the national lottery, what would you do? Why would you buy more land? Why would you become a cattleman? What other crops would you grow on your farm? Why would you plant more trees on your farm?
409 - 410	If you would put the money on the bank, what would happen with your farm? In which activities would you continue working your farm?
411	If you would sell the farm, what kind of job would you do?
412	How do you see the future as a farmer?

Farm classification; *a literature overview*

1. Introduction

The world is a place full of diversity. All scientific disciplines apply methods of classification to bring order in this evident diversity to reduce reality to more manageable parts. This also accounts for the agricultural sciences. When the farm is the unit of analysis, we see that world agriculture shows a great diversity in farm systems. Also within a country, region or even at the village level, one can observe an enormous diversity of ways in which farm households 'farm' (Van der Ploeg, 1990, Bolhuis and Van der Ploeg, 1985). In the process of adapting the farm to the natural, cultural, socio-economic and political environment, distinct farm systems have developed. No farm is exactly like any other, but farms producing under similar conditions tend to be similarly structured (Ruthenberg, 1980).
There is not a large body of literature available explicitly devoted to the subject of farm classification. However, a growing interest can be observed in contemporary literature for aspects of farm system diversity in agriculture. In this chapter an overview will be given of some of the literature on farm classification and related issues. In the first two sections, we define the farm as a system, and summarize some of the literature on farm system diversity. The objectives of farm classifications and the criteria that can be used are discussed in section 4 and 5. Two basic approaches to farm classification can be distinguished; a socio-economic approach and an agronomic approach, which are briefly discussed in section 6 and 7, respectively. Section 8 concludes this chapter.

2. The farm as a system

First we have to be clear about what is understood as 'the farm system', and the reason why a classification should be made at this level of aggregation. Agriculture can be thought of as a hierarchy of systems, ranging from the soil, plant or animal, the crop or the herd, the field or pasture, and the farm, to the agricultural sector. At all levels classifications can be made. At higher levels of aggregation, classifications do not deal with farm level variables and do not provide any insight in farmer decision making, in particular because crucial variables are excluded. Some classifications are based only on elements of farm systems (livestock, crops), but forget about the interactions among the elements that make up the farm as a system. Farm systems classified in the same category may react quite differently depending on characteristics not included in the classification (for example, off-farm income and household composition). So there is benefit in defining and classifying farms *as systems* (Fresco and Westphal, 1988).

A farm system is an organized decision-making unit comprising the farm household, cropping and livestock systems, that transform land, capital and labour into products that can be sold or consumed (Ruthenberg, 1980; Fresco and Westphal, 1988).
From the viewpoint of behavioural sciences, the main reason to classify farms as systems, is because decisions are made at this level. Management is an important

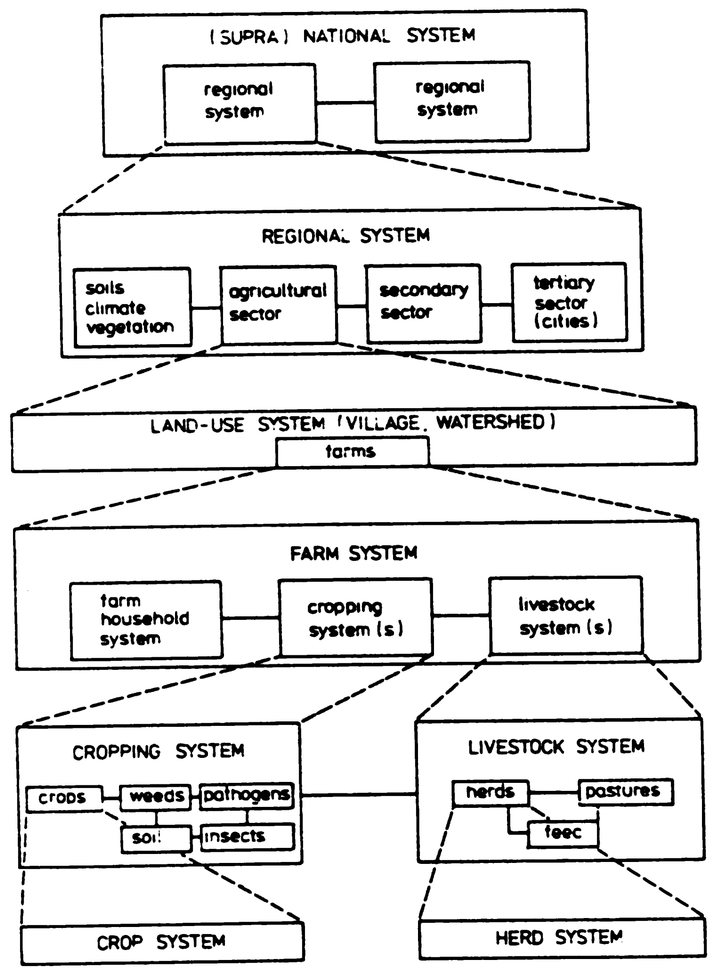

Figure 2.1: *Agriculture as a hierarchy of systems* (Fresco and Westphal, 1988)

variable, for it implies decisions about the objectives of the farm system and the structure of internal and external relationships. This decision-making aspect of the farm system is crucial for analysing farm system diversity and designing interventions.

3. Farm system diversity

Farm system diversity increasingly attracts the attention of researchers (Van der Ploeg, 1990; Hebinck, 1990; Moock, 1992; Steenhuijsen Piters, 1995), and it is this farm diversity that provides the basis for farm classifications.

Farm system characteristics are determined by agro-ecological and socio-economic factors. Together, these factors result in the location-specific environment in which farm households operate. Within a homogeneous ecological zone, farm system diversity is primarily caused by differences in socio-economic conditions. Differences in farm systems are thus deduced from differential choices of products

and production strategies (Fresco and Westphal, 1988). Socio-economic and agro-ecological heterogeneity together determine farm system diversity.
Objective of a recent study in a village in northern Cameroon (Steenhuijsen Piters, 1995) was to contribute to the understanding of the apparent diversity in 'agroecosystems'. It focussed mainly on the explanation of yield variations. It proved that variations in yield are not of a random nature, but are the logical consequence of specific combinations of environment, crop characteristics and management, and the way they interact. This so-called 'agrodiversity', which refers to differences in land use at different spatial and temporal scales, is considered to be a function of farm household diversity (socio-economic) and higher level heterogeneity of the environment (see Figure 2.2). Farm household diversity was found to be the result of differences in available production factors, production goals, and income opportunities outside agriculture.

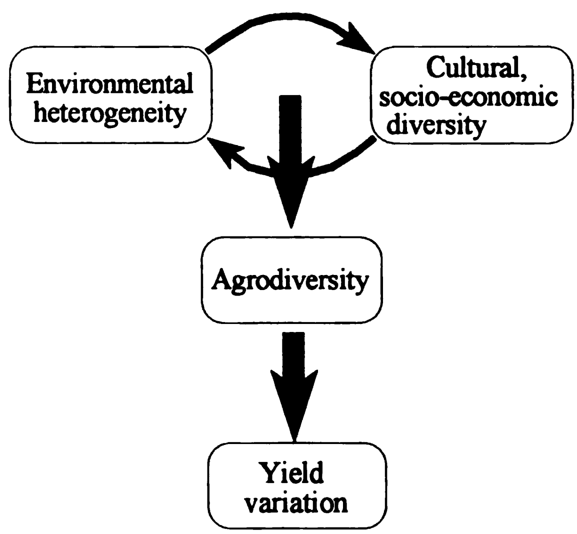

Figure 2.2: *Schematic presentation of 'agrodiversity'* (Steenhuijsen Piters, 1995).

Van der Ploeg and others have build upon the notion of 'styles of farming' for a better understanding of farm system diversity (Bolhuis and Van der Ploeg, 1985, Van der Ploeg, 1990, Van der Ploeg 1991, Gerritsen, 1995, Van der Ploeg *et al.*, 1996). The concept of farming style comprises of three core elements;

- A style of farming represents a specific unity of farming discourse and practice;
- A style of farming entails a specific structuring of the labour process;
- A style of farming represents specific connections between economic, social, political, ecological, and technological dimensions (Gerritsen, 1995).

At the basis of the 'styles of farming' approach lies the idea that markets and technology do not determine one single optimum way of farming. Markets and technology are dimensions that construct an 'action universe' in which multiple positions can be taken. Every position is characterized by a unique set of relations between the farm on the one hand, and markets and technology on the other. Both the internal and external relations of the farm depend on the farmers' strategy.
Differences in farm systems occur mainly because farmers relate in different ways to markets (Van der Ploeg, 1995).

Hayami and Ruttan (1985) can be considered to be the first who have taken diversity as a starting point for analysis. On a continuum of possible strategies for raising production per unit of labour (which can be taken as a proxy for income), two extremes can be distinguished; (i) intensification, in the sense of raising production per unit of land, and (ii) scale enlargement, meaning the increase of the land/labour ratio, either by acquiring more land, or releasing labour to off-farm employment opportunities. It is assumed that the reason for a strategy to occur must be sought in relative factor prices. "Relative prices are the signals that tell firms how to manage their resources to earn the highest rewards" (Gillis, 1992). Depending on these relative factor prices, agricultural development either follows a path of scale enlargement or intensification (see Figure 2.3). It must be kept in mind though, that farmers in developing countries are often faced with imperfect market conditions and high transaction costs at the national and regional level. These market imperfections are reflected in distorted relative prices and rigidities in factor use and resource allocation (Van der Ploeg, 1991). Although Hayami and Ruttan did their analysis based on international data, their line of reasoning have also been

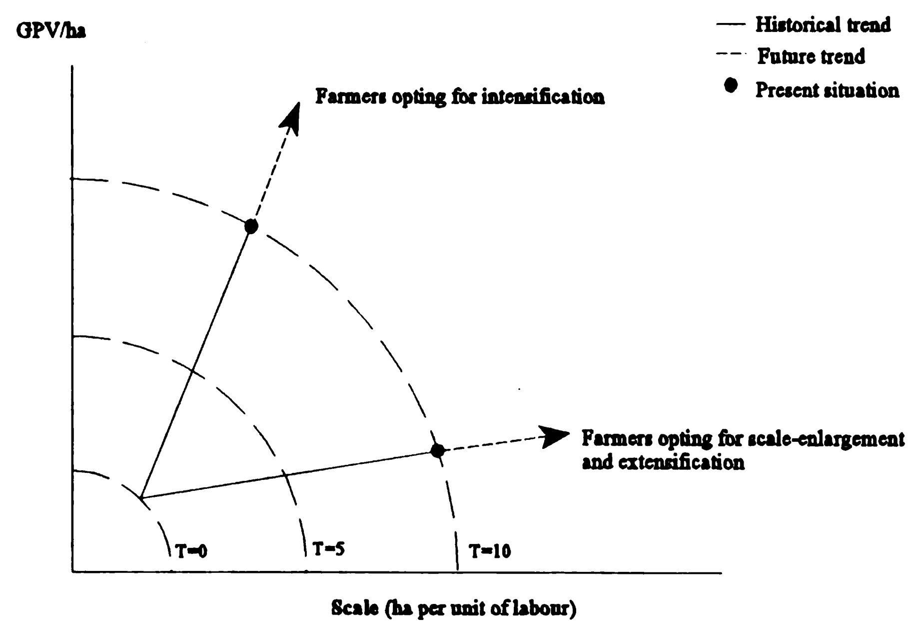

Figure 2.3: *Options for farm development* (Van der Ploeg, 1990)

applied at the farm level. Relative prices of land, labour and capital can vary between countries, but can also differ substantially from one farm to another, resulting in different allocative behaviour and farmer strategies. Consequently, different 'optimums' and different farm systems emerge.

These are just a few examples of the treatment of (farm system) diversity in recent literature, but do illustrate the different approaches to the explanation of farm system diversity.

4. Farm classification objectives

Data from farm system research usually reveal a high degree of variation in farm characteristics. This variation can be reduced by clustering farms which are relatively similar in their organisation, management, economic performance, constraints and problems into one group (März, 1990). But why should we classify farms in the first place? Collinson (1983) states that "all work on farm classification represents an effort to provide a better basis for generalisation". In the early 1970s it was recognized that another approach to agricultural development was needed. The major problem of precedent approaches was the attempt to transfer new knowledge and technology to heterogeneous groups of farmers. A way to deal with this diversity was to distinguish a certain number of farmer groups which could serve as more uniform units of extension and diffusion (Röling, 1988). "Within the context of rural development, it is essential to distinguish between well defined target groups, in order to prevent interventions from ineffective generalisation. To do so, (...) diversity must be accepted as a realistic phenomenon in agroecosystems and considered as an important source of information" (Steenhuijsen Piters, 1995). Nowadays, there is general agreement in the international scientific community that agricultural technology must be increasingly adapted to the specific conditions of farmers who operate in a wide range of ecological zones and under diverse socio-economic constraints (Fresco and Westphal, 1988). Also Ruthenberg (1980) comes to the same conclusion, when he writes that "for the purpose of agricultural development and to devise meaningful measures in agricultural policy it is advisable to group farms with similar structural properties into classes". Nowadays, few agricultural research programmes are likely to start developing agricultural technology without some inventory of potential user groups (Fresco and Westphal, 1988). This kind of farm classifications have now become common, under headings like 'target groups' and 'recommendation domains' (Röling, 1988).

It seems to be increasingly recognized that improved insight into the nature and causes of agro-economic diversity is important for agricultural research and policy, although ideas of researchers and politicians do not always coincide, says De Boer (1985, quoted in: Schiere, 1995):"Formulation and execution of agricultural policy based on [farming systems research] is handicapped by its micro nature. At this level, farm system diversity becomes apparent and the researcher has difficulty coming up with general economic or agricultural policies that consistently produce the desired effect. Policy makers, on the other hand, desire policies that can be implemented with available instruments at the national or regional level. They don't like to hear the specialists' plea that every farm is different, that government policies are contradictory or have no effect on the small farmer, or that policies may have to be tailored for specific regions or production systems and implemented at the local level".

5. Farm classification criteria

The question which criteria are to be used in a farm classification usually depends on the purpose of classification. Also, results of a classification procedure are to a large extent influenced by the selection of clustering variables, and consequently the

classification can only be interpreted in the light of the purpose and use for which the classification was made. März (1990) concluded that a classification is highly dependent on the selection of the criteria used in the classification and that the interpretation of the results are often difficult. He argues that the selection of classifying variables should be clearly related to the problem that is studied and that a simple classification on the basis of just one or two criteria can be sufficient in many cases. Schiere (1995) more or less comes to the same conclusion, when he says that "universal classifications are either too clumsy or too general (...). For practical purposes, it is therefore necessary to suit the classification criteria to the objective and conditions of the study". According to Collinson (1983), problems with past attempts at farm classification have focussed on the criteria to be used, and that a complete definition of the appropriate criteria has been frustrated by the wide variety in sources of diversity in farm systems.
One can look at farms from various points of view. Consequently, many criteria can be used for classification. Two broad categories of criteria can be distinguished; agro-ecological criteria and socio-economic criteria. Past attempts at the classification of farm systems have been mainly concerned with the former criteria, partly because of the problems involved in linking the variety of socio-economic factors to patterns of agricultural production. When socio-economic factors are taken into account, this often results in innumerable types of farm systems. Many of these factors can change considerable over time (prices, household composition), causing such classifications to change rapidly (Fresco and Westphal, 1988).

agro-ecological criteria. A very long list can be presented of possible agro-ecological criteria that can be used for farm classification. In his book on tropical agriculture, Ruthenberg (1980) discerns a number of agronomic farm system features according to which classifications can be made;

- type of land rotation;
- intensity of rotation (the cropping-fallow cycle);
- water supply (irrigated vs. rainfed farming);
- cropping pattern and animal activities;
- use of implements for cultivation.

In addition, soil and climate must be mentioned as the most important ecological factors determining farm systems, because they shape the environment in which crops and animals grow (Fresco and Westphal, 1988; Steenhuijsen Piters, 1995).

A good example of an agronomic approach to farm classification can often be seen in the input-output tables of a country, although these tables are mainly compiled for economic purposes. It is not uncommon that between ten and twenty different farm systems are distinguished, ranging from dairy cattle farming and crop agriculture, to floriculture and bulb growing (for the Netherlands). Another example of farm classification along other agronomic principles is less product oriented, and more based on land use for cropping and livestock purposes (Ruthenberg, 1980; Fresco and Westphal, 1987). Six broad categories of *cropping systems* can than be distinguished; (i) shifting systems, (ii) ley systems, (iii) permanent upland cultivation, (iv) irrigation farming, (v) perennial crop cultivation, and (vi) compound cultivation.
Three broad types of *livestock systems* may be distinguished; (i) nomadism (total, semi, or partial), (ii) ranching (extensive, controlled grazing on natural pastures),

and (iii) stationary animal husbandry (intensive, controlled grazing on artificial pastures). Of course many refinements are possible.

socio-economic criteria. A range of socio-economic variables are superimposed on the ecological factors so that the original environment is modified. Just like with agro-ecological factors, there are many socio-economic criteria which can be used for a classification of farms. If we would list here the criteria used in some recent attempts at farm classifications (Anbar and Birch, 1987; Hardiman *et al.*, 1990; März, 1990), it would take about two pages. But basically, from an economic viewpoint, the following (composite) criteria are suitable for farm classifications;

- resource endowments (land, labour, capital);
- resource allocation (factor intensities);
- production and consumption;
- income and expenditure;
- degree of commercialisation;

None of these criteria is purely economic, but has agronomic dimensions to. The production factor land alone has many properties; it might be owned or leased, fertile or less fertile, irrigated or rainfed, abundant or scarce, etc. The available family labour can be allocated on farm, off-farm or both, and might be skilled or unskilled. Involvement in the output market can be total or partly, structural or incidental. When seen in this perspective, the list of possible criteria is endless.
Sociological criteria can comprise family life cycle, risk aversion, education, gender, ethnicity, religion, status, etcetera. As an illustration, we quote Akkermans (1993), who took a close look at the village of Agrimaga in the Atlantic Zone, "a small settlement (...) diverse in existing agricultural modes, in which the small farmers try to survive. This is not only because of the different degrees in which the problems occur to each farmer, but it is also related to who the farmer is, [which] depends on upbringing, education, experience, religion, origin and social status".

From this discussion it is clear that only broad categories of criteria could be indicated here.

6. Classifications and farm behaviour

Van der Ploeg (1990) is probably right, when he notices that "there are a great many ways to farm, greater even, if that's possible, than the erudite models that have been devised for understanding, managing, and possibly neutralizing such diversity". Here we shortly present three recent examples of socio-economic approaches to farm classifications, to illustrate the diversity in purposes, criteria and resulting classifications.

With respect to the socio-economic factors off-farm employment and income, Fresco and Westphal (1988) make a distinction between (i) subsistence oriented farm systems, (ii) market oriented farm systems, and (iii) off-farm employment oriented farm systems. Subsistence oriented farms have low levels of output and input market integration. Market oriented farms may to some extent still provide in its own household needs, but show relatively high degrees of integration in both output and input markets. For off-farm employment oriented farms farming is only supplementary to income from outside the farm, be it agricultural wage labour or non-agricultural employment.

In a study on choice and uncertainty in a semi-subsistence economy (Huysman, 1986), a classification of farm households was made to facilitate the analysis of how individual households make use of resource endowments and income earning opportunities, and to allow an assessment of differences in management strategies with respect to income risk sensitivity. The following two classification variables were used; 1) the production capacity of the household, which determines the extent to which the household is able to produce sufficient income for subsistence needs, and 2) the family life cycle stage, which determines labour availability, minimum household requirements, and the ratio workers/consumers. On the basis of these classification criteria, two main household categories are distinguished; (i) surplus ('net supply') households and (ii) non-surplus ('net demand') households, depending on the degree in which subsistence needs are met. The distinction is important because of the income distributive effects of agricultural price policies. Changes in prices of agricultural products affect households differently according to whether they are food deficit or food surplus (Ellis, 1992). "Price increases without corresponding alleviation of non-price constraints (...) are likely to merely transfer resources from consumers to producers in proportion to the quantities consumed and produces with little effect on total output" (Pinstrup-Andersen and Pandya-Lorch, 1994).

Recently, some attempts have been made at a classification of farms in the Atlantic Zone of Costa Rica. Alfaro (1994) proposed a farm classification with the aim of identifying groups of farmers with similar strategies with respect to the use of productive resources. The rather ambiguous objective of this research was to understand the way different categories of small farmers develop their strategies for the social, economic and ecological sustainability of their productive resources. Three farmer types were distinguished: (i) the business farmer, who is engaged in a range of economic activities, among others agriculture; (ii) the independent farmer, who is full-time involved in farming, producing mainly for the national markets, and to a lesser extent for export; and (iii) the day-labourer-farmer, who earns a living mainly through off-farm work, and who in addition grows some labour extensive traditional crops on soils of low fertility. In the vocabulary of Fresco and Westphal (1988), the former two farmer types are market oriented, the latter off-farm employment oriented.

These examples of farm classifications are all based on some set of socio-economic characteristics of the farm households and mainly serve analytical purposes, and are not primarily meant to provide a basis for specificity of agricultural policies.

7. Conclusions

A farm system is an organized decision-making unit comprising the farm household, cropping and livestock systems, that transform land, capital and labour into products that can be sold or consumed. Farm systems are, of course, never perfectly homogeneous, even at the village level. This diversity is determined by the interplay of ecological and socio-economic factors. For every farm classification a balance must be struck between the uniqueness of each farm and the characteristics it shares with other farms, which are relevant for the purpose of the classification. Farm classifications can serve as frameworks for further farm system analysis, and can provide a basis for 'target category' policy interventions.

Farm system diversity is neither accidental nor a secondary characteristic of agricultural systems, and can be explained along different lines of reasoning, of which relative prices and 'styles of farming' are the most important.

Farm systems can be classified using (combinations of) agro-ecological and socio-economic criteria, and as such, agronomic and socio-economic approaches to farm classifications can be distinguished.

Factors of production

1. Introduction

The purpose of this chapter is to provide an overview of the data that will be used in the subsequent chapters on yield variation analysis, the analysis of aggregate land productivity and income performance, and a classification of farm households based on income composition. A summary is given of the data that was collected on the main factors of production in agriculture, respectively, land, labour, and capital.

2. Land

Both a quantity and quality dimension of the production factor land was assessed and are presented in this paragraph; *farm size* and *soil type*.

Farm size. Farm sizes in the sample range from very small plots less than 1 hectare (ha), to relatively large 'estates' of more than 50 ha. In Figure 3.1 the frequency distribution of farm sizes is depicted. Average farm size is about 11.5 ha, with a standard deviation of about 100 percent. Farm sizes above 25 hectares are very rare. When the farm sizes found in this survey are compared with data of the 1984 census in the Atlantic Zone (Tilburg *et al.*, 1995), a trend to decreasing farm sizes can be observed. In 1984 43 percent of the farms in the Atlantic Zone were smaller than 10 ha. This figure rose to 60 percent in 1993. This might be caused by land selling and/or land fragmentation through inheritance. Surprisingly, lack of land is only mentioned by 7 percent of the farmers as a problem for earning a living in farming.

Land ownership is predominant in the area (90% of cases). Only 5 percent rent

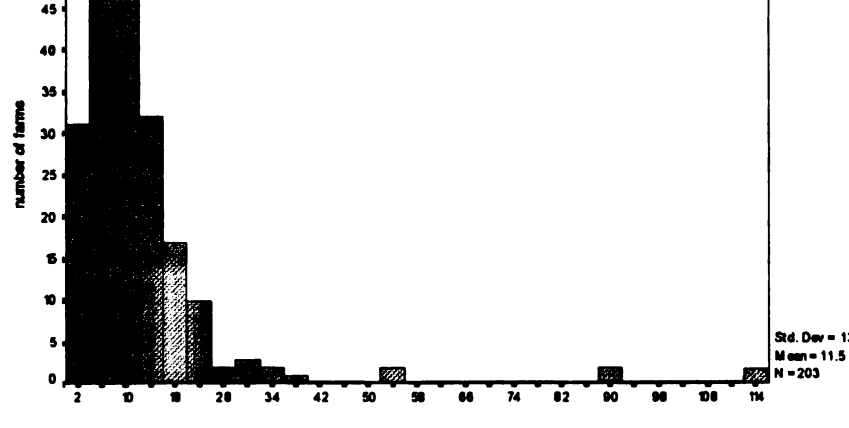

Figure 3.1: *Farm size distribution*

(part of) their land. About 30 percent acquired their land through IDA. Purchase and inheritance account for 45 and 10 percent, respectively. Mean farm sizes are largest (16 ha) for the group of farmers that bought (part of) their land. For the farmers that acquired their land holdings through inheritance or the IDA, average farm sizes are 8 and 11 ha, respectively.

Regional differences in farm size and farm size distribution are presented in Table 3.1. The average farm size in Pococí is higher than in the other two regions, despite the relatively high percentage of small farms in this region. This is apparently offset by the higher occurrence of large farm sizes in Pococí. Farm size inequality seems to be higher in this region than in Siquirres, where three thirds of the respondent farmers have medium sized farms.

Table 3.1: *Farm size distribution* *(by region, in % of cases)*.

	region			
farm size[1]	**Pococí**	**Guácimo**	**Siquirres**	**total**
small	37	30	16	30
medium	44	53	76	53
large	20	18	8	17
total	100	100	100	100
number of households	86	80	37	203
mean farm size (ha)	12.6	10.2	10.6	11.5

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha.

Soil type. In the questionnaire a distinction is made between 5 different kinds of soils; tierra negra, tierra bermeja, tierra colorado, marshy soils, and a category labelled as 'other soils' (not further specified). Tierra negra ('black soil') is the most fertile of these soils, while tierra colorado ('red soil) is the least fertile. A majority of the respondent farmers claims that soil fertility has decreased over the years. Among the reasons mentioned are the abuse of herbicides and intensive soil use. Strangely enough, only a few state this to be a major problem.
Respondents were asked to estimate the acreages of the distinguished soil types on their farm, which were supposed to add up to the stated farm size. Regionwise findings are summarized in Table 3.2, from which it is clear that tierra negra is the dominant soil type in all regions, especially in Pococí.

Table 3.2: *Soil types (in % of total area, by region)*

	region		
soil type	**Pococí**	**Guácimo**	**Siquirres**
tierra negra	82	66	43
tierra bermeja	6	15	8
tierra colorado	8	14	33
swamp	1	2	3
other	2	3	13
total	100	100	100

In Guácimo, tierra bermeja and tierra colorado add up to almost one third of the total soil acreage. In comparison with the other regions, Siquirres has a relatively low prevalence of tierra negra, and a large share of the unfertile tierra colorado soil type.

3. Household composition and labour

Through the questionnaire, basic information on household composition and labour was assessed.

Household composition. In Table 3.3 basic household composition characteristics are presented for three life cycle groups (young, middle-aged, and older households), and for the sample group as a whole. The 'average' family consist of 4.6 members, with 1.5 children. Regional and farm size differences are absent. The table shows that household composition changes with life cycle. Young households are the largest, with more than two children under the age of fifteen. The number of children in the middle-aged group is considerably lower, while total family size decreases only slightly; children matured, but are still part of the household. Family size and number of children are considerably lower for older households, because of fertility decline and grown-up children that have left the household. Important to notice is that young households constitute only roughly 20 percent of the sample group of households, while middle-aged and older households both account for about 40 percent. This might signal a trend of young people leaving agriculture. This is supported by the doubt of the respondent farmers concerning their successors. They report that the hard physical labour and the insecure incomes are the main causes for young people not to aspire a career as farmers. Also mentioned are the attractiveness of studying and 'modern' jobs. Earning a supplementary income through off-farm employment is an attractive opportunity.
With respect to education farm household heads almost never reach an educational level of beyond that of primary school. Only 6 percent were able to receive an education of secondary level or higher. With respect to the other members of the household, it was only registered whether they are studying or not.

Table 3.3: *Household composition, labour and life cycle*

	life cycle group[1]			
	young households (22%)	**middle-aged households** (39%)	**older households** (39%)	**all households** (100%)
family size	5.2	4.9	3.5	4.6
children	2.6	1.4	0.7	1.5
on-farm labour	2.0	2.6	2.2	2.4
off-farm labour	0.6	0.9	0.6	0.8
consumer/worker	2.0	1.4	1.3	1.5

1) Life cycle groups are distinguished on the basis of farmer age. Lower and upper boundaries of the *middle-aged households* are 40 and 60 years of age, respectively.

Labour. Family members can be working *on-farm* and/or *off-farm*. On-farm labour is not specified into labour time spent on different activities of crop and animal husbandry. Also, farmers were not asked on the practice of hiring labour. From Table 3.3, we see that on average two or three family members are engaged in on-farm activities. Both on and off-farm labour are highest for the middle-aged households; adolescents entered the family labour force, and have not yet left the family. On-farm and off-farm labour for the young and older households are similar. The ratio of consumers to workers is higher for the younger households.
Working on banana plantations is an important source of off-farm income for many farmers in the Atlantic Zone. Farmers were asked whether, and if so, for how many years they have been working on a banana plantation. Almost half of the respondents did so, with an average of about 7 years working experience. On the larger farms, the percentage of banana workers is somewhat lower than for the small and medium sized farms (about 40% and 50%, respectively). Regional differences are not large, but in Guácimo the percentage of respondents working on banana plantations is lower than for the other regions (42%, as compared to the 57% and 54% for Pococí and Siquirres, respectively).

4. Capital and assets

In this paragraph some general findings from the data are presented concerning capital and assets. This is done in four sections; livestock ownership, the use of chemical inputs, mechanical inputs, and credit.

Livestock. Farmers were asked on livestock ownership. Findings are presented in Table 3.4. First we observe that the percentage of farmers owning cows is much higher on the larger farms, as compared to the 'small' farms (85, 64 and 37 percent for the large, medium and small farm sizes, respectively). This also accounts for bull-ownership (62, 32, and 6 percent, respectively). The percentage of farmers owning one or more pigs is more or less the same for the farm size classes, while ownership of poultry is slightly more widespread on the larger farms. So, cattle ownership is less widespread on small farms. Livestock *intensity*, though, is considerably higher on the small farms. Particularly the average number of pigs and poultry per hectare is much higher on these farms, as compared to the medium and large size farms. If not calculated on a per hectare basis, we see that bull-owning farm households typically have only one bull. Although no questions were asked on the use of animals, we can safely assume that this one bull is mainly kept for cattle-breeding purposes and for animal traction. Although poultry per hectare is much higher on small farms, the total number of poultry pecking for food on the farm yard seem to have no relation with farm size, as the average number is the same for the three farm size categories (24). The average number of cows is much higher on the larger farms, which is not very surprising, simply because there is more (pasture) land available. The average number of pigs per hectare is considerably higher on the smaller farms. This might be attributed to a strategy of smallholders aimed at "safeguarding the future by the accumulation of capital in the form of animals" (Ruthenberg, 1980).

Table 3.4: *Livestock ownership and intensity (number/ha for valid cases; number of valid cases between brackets, by farm size).*

	farm size[1)]		
animal	**small**	**medium**	**large**
cows[2)]	(23) 1.3	(69) 1.0	(29) 0.9
bulls	(4) 0.2	(34) 0.1	(21) <0.1
pigs	(10) 0.9	(25) 0.3	(5) 0.2
poultry	(19) 7.0	(49) 2.4	(17) 1.1

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha;

2) including calves and heifers, accounting for 0.5 cow and 0.75 cow, respectively.

Chemical use. Some 30 percent of the farmers do not use any agro-chemical input in their farm practice. In Table 3.5 per chemical type, the percentage of respondents using the chemical type is stated, divided over the three farm size classes. From this table it is clear that N-P-K fertilizer is used by about one third, and nitrogen fertilizer by, on average, a quarter of the respondents. There are no large differences in fertilizer use with respect to farm size, as is the case for insecticides and herbicides, which are used by about 10 percent and 25 percent of the farmers, respectively. Small and large farms are quite distinct, though, in the dissemination of pasture herbicide use and anti-parasetics application; a much higher percentage of the large farmers use these types of agro-chemicals, in comparison with the small farms. This points towards a greater importance of livestock on the larger farms. No data is available on the use of animal manure as fertilizer.

Table 3.5: *Agro-chemical use (in % of cases, by farm size).*

	farm size[1)]		
chemical	**small**	**medium**	**large**
N-P-K fertilizer	35	35	29
nitrogen fertilizer	23	28	29
insecticide	11	8	12
'round up' herbicide	29	24	24
pasture herbicide	5	13	41
anti-parasitic	5	25	38

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha;

About half of the farmers are of opinion that agricultural practices have changed over the last decade, especially with respect to the use of fertilizer, insecticides and herbicides. Over 80 percent think that more chemicals are used in contemporary agriculture.

Machinery. The use of mechanical inputs is rare in the sample group of farms. Only a mere 13 percent makes use of machinery for land preparation, and rotavators are not used at all. With the exception of two cases, all machinery is hired. Thirteen farms use machinery only once a year, while eleven farmers make use of machinery 2 to 3 times a year[3]. The farms that do hire machinery, pay a mean amount of about 28,000 colones a time. About 6 percent of the farms own a motor chain saw. Only a few farms own a motor scythe or a motor spray pump.

Credit. Respondents were asked about the use of credit for agricultural purposes. It was asked who provided the credit, the amount that was borrowed, the term of the credit and the rate of interest payed. Almost 80 percent of the farmers did not use credit in 1993, so only a minority makes use of credit in operating the family farm business. About 35 percent of the farmers mentioned lack of capital and credit as a major problem for staying into farming. In the region, both commercial and subsidized credit are difficult to obtain, and interest rates are high.
Table 3.6 gives some basic information on the use of credit in the sample group of farms.

[3] One exceptional case is a farmer using machinery 10 times a year, and paying a total amount of 280,000 colones a year for use of this input.

Table 3.6: *Credit use (number of farms using credit, by provider)*

purpose	*provider of credit* banks	NGO's	local lender	other	total
livestock	10			1	11
fruit trees	5	1			6
roots/tubers	10	2	1	3	16
palm heart	2				2
other	5	4		1	10
total	32	7	1	5	45

Banks are the main providers of credit. The role of local moneylenders is negligible. The credit obtained is mostly used for livestock and root- and tuber crops. From the results of the survey, nothing can be said about differences in interest rates between the credit providers. For this, the available data on credit is too sparse. There is no distinct relationship between credit use and farm size (17 percent of the small farms, 24 percent of the medium farms, and 15 percent of the large farms use credit).

5. Conclusions

In this chapter an overview was presented of the survey findings on the factors of production. Average farm size is about 11.5 ha, with a standard deviation close to 100 percent. Most of the respondent farms are owner-cultivators. Black soil (*tierra negra*) is the dominant soil type. Siquirres has the highest percentage of poor soils.
Especially insecure on-farm incomes are a strong incentive to opt for a regular off-farm job. The average family consists of 4 or 5 persons, of whom two work on the farm. One person is at least partly involved in off-farm activities. The educational level of the household head is low.
Ownership of cows and bulls is much more common on large farms, though the number of animals per hectare is higher on the small (livestock owning) holdings. About one farm out of six own pigs, its average number per hectare being much higher on the smaller farms.
With respect to the use of agro-chemicals, it can be concluded that roughly one third applies chemical fertilizer, irrespective of farm size class. Herbicides are used by about a quarter. In connection with the greater importance of livestock, the use of pasture herbicides and anti-parasetics is more widespread on the large farms.
Only a small group use some sort of machinery, mostly hired. Also the use of credit is not common (only 20 percent). Livestock and root and tuber crops are the main purposes for which the credit is used, and banks are the main providers of the credits obtained.

Production and income

1. Introduction

This chapter deals with an overview of the general findings on production and income measures. First, attention is given to some literature references on land use dynamics in the Atlantic Zone and the regional and farm size differences in land use. Secondly, the topics of multi-cropping and crop yields are briefly addressed. Further, some aspects of crop marketing and commercialisation are discussed, to see whether it is possible to differentiate between food and cash crops on the basis of selling and consumption behaviour. Next, the importance of different sources of income is assessed, as well as regional and farm size differences in income earning indicators. Conclusions are stated in the last section.

2. Land use

In general, it can be assumed that the way a farmer uses the available factors of production is rational, given the level of knowledge and skills, the socio-economic and bio-physical environment of the farm household, and the perception of that environment. Both the environment and the household are not static entities, though, and land use changes accordingly. Land use dynamics constitutes an important feature of agriculture in the Atlantic Zone. Farmers change their land use continuously, mainly in response to changes in factors related to input and output markets, which are in part caused by changes in government intervention. For example, it has been noted that maize, from being one of the most important crops in the region, has now become a crop that is produced mainly for home consumption (Tilburg *et al.*, 1995). This was initiated by the liberalisation of agricultural markets, which had a strong effect on smallholders' maize production. As maize prices decreased, farmers lowered their maize production dramatically[4]. Before the abolishment of price support, smallholders in the Atlantic Zone depended heavily on maize production as a source of income, because sales and prices were secured (Tilburg *et al.*, 1995).
The production of roots and tuber crops fluctuate considerably and show a cob-web-type pattern (Alfaro, 1994; Tilburg *et al.*, 1995); when prices are high, farmers start cultivating it immediately. Consequently supply increases, resulting in a drop in prices when the crop is harvested. The insecure market situation for roots and tubers is a cause for many farmers to refrain from cultivating these crops.
Palm heart is not a traditional crop in the region, and was supported by the government through cheap credit. Palm heart is a permanent crop, and can be productive for an indefinite period of time. Because of the perceived profitability of the crop, many farmers started cultivating palm heart on fields previously cultivated with fruits, roots and/or tuber crops. The increase in supply caused a downward

[4] In Pococí, both production volume and maize area decreased with about 50 percent in only two years.

trend in prices. Prices have recently gone up though, due to increasing demand. The Atlantic Zone is now the main palm heart production area in Costa Rica. It is generally considered to be a crop with good future potential.
Plantain is important in the Atlantic Zone, although its production decreased considerably[5], mainly because of the *'black sigatoka'* disease.

These examples illustrate the variability of land use in the Atlantic Zone in response to changes in the socio-economic and bio-physical environment. The data on which this report is based only provides a snapshot of the land use in the year 1993 (it is cross-section data), and hence does not allow for analysis of land use change. Because secondary data is available on land use in the three counties in 1991, some static comparisons can be made.

In the Appendix to this chapter, detailed information on land use are presented for the three regions and for three groups of farm sizes. In Table 4.1 land use is summarized for small, medium and large farm sizes. It shows that there are evident differences in land use with respect to farm size.

Table 4.1: *Land use (1993, in % of total area, by farm size).*

	farm size[1)]		
land use[2)]	**small**	**medium**	**large**
grains	19	7	3
roots and tubers	21	11	4
fruits	19	5	1
vegetables	9	3	4
other crop	6	5	1
pasture	19	54	67
forest	1	4	16
fallow	7	11	5
total	100	100	100

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation.** Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha;

2) *grains*; maize and elote, *roots and tubers*; cassava, yam, other tubers crops, *fruits*; plantain, papaya, pineapple and coconut, *vegetables*; palmheart, chili and beans.

On small farms, about 75 percent of the land is used for growing crops, while on large farms this is only 13 percent. All crop categories reveal a decline in the share of total acreage, with higher farm sizes. The share in acreage of pasture land is much higher on large farms as compared to the farms with farm sizes that are classified as small (67% and 19%, respectively). This supports the idea that the relative importance of crop income declines with increasing farm sizes, while income from animal husbandry gains in importance for household reproduction.

[5] For Costa Rica as a whole, plantain production area decreased from nearly 12,000 ha in 1985 to 4,000 ha in 1990 (Tilburg *et al.*, 1995).

When the region-wise land uses of this study are compared with available data on land use in Guácimo, Pococí and Siquirres in 1991 (Tilburg *et al.*, 1995), big differences emerge. According to the survey referred to by the latter, in Guácimo region maize was the most important crop, followed by cassava. The data from this survey identifies cassava, elote, papaya and tubers to be the main crops. The 1991 data revealed for Pococí region, palm heart, winged yam, cassava and maize as the main crops. This is also the case in this survey, except for palm heart, which, according to this survey, is a only minor crop in Pococí, and certainly not the most important crop as was the case in the 1991 survey. This reconfirms the notion that land use in the Atlantic Zone is very dynamic.
A large share of the farmers state that securing home consumption is the main reason for farmers to opt for the practice of multi-cropping. Also mentioned are better income earning opportunities of multi-cropping and the spreading of risk. About a quarter of the farmers reported to grow no crops at all. This could be a category of farmers that earns a livelihood from pure animal husbandry, non-farm activities, or a combination. Mono-cropping is practised by about a quarter of the respondents. That leaves roughly 50 percent actually practising multi-cropping.
Surprisingly, multi-cropping is a bit more common on the medium and large size farms. One would expect, because of risk-spreading behaviour and the strive for securing home consumption, that the practice of multi-cropping would be more widespread among small farmers. A reason might be that small farmers are more eager to diversify in both *on-farm and off-farm activities* for risk-spreading, thereby securing household income and consumption, whereas the larger farms opt for diversification of mainly the *on-farm activities*. For the latter, animal husbandry constitute the necessary, reliable source of income, supplemented by some cash cropping, while for the small farms this is secured through an income stream from off-farm jobs by one or more family members.

3. Yields

Crop yields were not obtained by real field measurements, but were based on farmers' recall. The information on crop yields obtained is presented in Table 4.2.

Table 4.2: *Yields of major crops*[1)]

crop	year	mean yield (kg/ha)	st.dev (%)	min. yield (kg/ha)	max. yield (kg/ha)	no. of cases
maize	1993	2,550	74	210	9,200	37
	1992	2,430	59	210	5,520	27
cassava	1993	9,060	69	200	27,600	49
	1992	6,870	62	1,100	18,400	35
plantain[2]	1993	700	84	25	2,400	25
	1992	830	72	60	2,400	18
tubers	1993	6,390	87	640	20,010	33
	1992	5,000	92	510	20,010	28
beans	1993	730	69	30	1840	43
	1992	780	56	120	1840	24

1) crops grown by at least 10% of the farmers, in 1993;
2) in bunches/ha.

From this table we observe that the yields of the major crops in the Atlantic Zone show a high degree of variation. Standard deviations roughly range from 50 to 100 percent. Differences in yields between farm size classes were not significant. In Chapter 5, an attempt will be made at explaining these large variation in yields.

4. Marketing conditions and commercialisation

Farmers in the region face difficulties in marketing their crop produce. Insecure markets and unstable prices are mentioned by 44 percent of the respondents as a major problem. They can never be sure about finding a buyer willing to purchase their produce at reasonable prices. The main problem seem to be the uneven distribution of market power, a problem that is rooted in the perishability of the agricultural products, the absence or underdevelopment of other, competitive marketing outlets, and the low level of organisation[6] of farmers. Rural traders and local agricultural export companies (*'empacadores'*) have a reputation for being untrustworthy concerning their fulfilment of agreements on prices and payments. In Akkermans (1993) it is reported that farmers complain that they are victims of the commerciants and intermediaries who fail to show up to buy the produce, or pay a very low price. Nevertheless, the rural trader and empacadores are the major marketing channels for farmers in the region. This is supported by findings from this survey. Roughly 60 percent of the respondent farmers sell their produce of cassava, vegetables, and fruits to intermediaries. Plantain is almost exclusively (90%) sold to intermediate buyers. Only for root and tuber crops export companies are more important than local traders. More than 30 percent of the cassava growing farmers sell their produce directly to empacadores. Direct sales to consumers is not very common in the area. MAG created a small number of periodic agricultural markets facilitating farmers to sell directly to consumers and thereby obtain a better price. Of the respondent farmers, less than 5 percent of the farmers growing cassava, and other root and tuber crops, sold their produce on these farmers' fairs. This figure is considerably higher for fruits and vegetables (10-25%). This supports the notion that only for a limited number of farmers the *'ferias de agricultor'* constitute an alternative market channel. Others face problems of transport, dominancy of large scale traders, and limited product diversity.
Many of the problems connected to the marketing of crop produce do not account for livestock. Animals do not necessarily have to be sold at a given moment, and the cattle auction is a relatively competitive market where higher prices can be obtained than through farm-gate selling. Still, many farmers sell directly to traders, because it is quick, no transport costs are involved, and prices can be bilaterally negotiated (Tilburg *et al.*, 1995). Of the farmers that participated in this survey and sell livestock products, more than 80 percent sell animals only, 3 percent only milk, and 15 percent both milk and animals.

As a consequence of incomplete and imperfect markets for inputs and outputs, the majority of farm households in developing countries maintain a degree of autonomy

[6] Only a minority of less than 30% of the farmers in this survey participates in some sort of a farmers organisation. More than half of the farmers see Atlantic Zone farmers as being individualistic. Distrust of organisations and 'selfishness' are observed as the main reasons for this.

from the market. This is generally typified by the share of farm output that is consumed as family subsistence instead of being sold on the market (Ellis, 1992). Because farmers in the Atlantic Zone mainly produce for the market (Alfaro, 1994), we will look at the share of the (value of) output that is sold, as an indicator of the degree of commercialisation. In Table 4.3, the basic statistics on commercialisation are presented for the major crops and livestock.

Table 4.3: *Commercialisation of crops and livestock*

product[1)]	mean (%sold)	st.dev	no. of cases
maize	60	46	37
cassava	83	37	49
plantain	87	33	25
tuber crops	90	29	33
beans	17	30	43
livestock	96	11	89

1) for all other crops not in the table the rates of commercialisation are equal or close to unity for the three farm size classes, so for these crops (nearly) all crop produce is sold.

Eye-catching is that beans has by far the lowest degree of commercialisation. As such, it is an important food crop for the 20 percent of the respondents (43/202) cultivating this crop. Maize is both cash and food crop, with an average of 60 percent of the production being sold. Others also reported corn and beans to have become important for self-consumption. All other crops can be classified as being cash crops, although the figures also indicate that they are not solely produced for the market alone, but are used for home consumption as well.

5. Income

Low incomes is one of the main problems mentioned by the respondent farmers (48%). Both on and off-farm income sources are important in the area. In Table 4.4, basic statistics are presented on total income, crop income, livestock income and off-farm income per unit of land and labour, for the three farm size classes. Figures are only for the valid cases. Test statistics are included in the table, to assess whether observed differences in income performance are significant. First we take a look at differences in relative importance of livestock, crop and off-farm income. We observe that among the larger farms livestock is more frequently mentioned as a source of income than on the small farms; of the large farms 74 percent mentioned livestock to be a source of income (25 out of 33), while for the small farms this is only 13 percent. Off-farm income and crop income are mentioned as an income source by three-thirds of the small farms and 50 percent of the large farms.

Looking at the figures on income per unit of land and labour, we observe that these are 'well-behaved', in the sense that both total farm household income and labour income increase with larger farm sizes, while per hectare income from cropping and animal husbandry decreases with larger farm sizes. This inverse relationship of farm size and productivity is well known and documented, based on studies undertaken in the 1970s. In Ellis (1989) reasons for this inverse relationship are brought forward, and summarized from various studies. Key elements are that; a) productivity figures are calculated by division of crop income *by total farm size*, but that larger farms often do not use all of the land at their disposal, or use it for other purposes than crop production (like livestock pasturing), b) smaller farms use more labour per unit area than large farms, thereby achieving higher productivity. The former argument can be verified by division of crop income by the area actually used for cropping.

Table 4.4: *Income indicators by farm size (averages[1),2)], in Colones)*

		farm size[3)]			
income indicator		**small**	**medium**	**large**	**sign.**
total income	(cases)	(61)	(105)	(33)	
for the household		565,000	708,000	1,390,000	.000
per unit of labour		227,000	255,000	453,000	.001
per hectare		275,000	70,000	59,000	.000
crop income	(cases)	(42)	(75)	(17)	
per hectare		96,000	50,000	61,000	.015
per *cropped* hectare		221,000	173,000	281,000	.274
per unit of labour		127,000	177,000	463,000	.001
livestock income	(cases)	(8)	(45)	(25)	
per hectare		40,000	21,000	13,000	.013
per *pasture* hectare		66,000	30,000	18,000	.000
per unit of labour		87,000	87,000	177,000	.198
off-farm income[4)]	(cases)	(42)	(58)	(17)	
per unit of labour		142,000	128,000	132,000	.832

1) figures are rounded to 1,000s;
2) standard deviations are about 100%;
3) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha;
4) off-farm income includes wages, salary and family support.

The inverse relationship disappears (becomes insignificant) when productivity is calculated on a per *cropped hectare* basis. Crop income per unit of labour is clearly positively correlated with farm size, which at least can be partly attributed to the larger land/labour ratio for the larger farm sizes. Income from livestock reveals an inverse relationship both on a per hectare and pasture hectare basis, as is the case with livestock intensity (see previous chapter). Livestock income per unit of labour is positively related to farm size, simply because the number of cattle per labourer is higher on the larger farms. In that sense, the higher labour productivity of crop and animal production is mainly a matter of larger scale. The income per family member that is earned with off-farm income, is about the same for the three farm size classes.

An evident difference between the regions with respect to income performance becomes apparent, if we cross-tabulate some of the income indicators with the three regions. Table 4.5 shows that farm households in the Pococí and Guácimo region are on average similar in their income performance, but that incomes in Siquirres are considerably lower.

Table 4.5: *Income indicators by region (averages[1),2)], in Colones)*

income indicator		region: Pococí	Guácimo	Siquirres	sign.[3)]
total income	(cases)	(84)	(78)	(37)	
for the household		826,000	820,000	577,000	.015
per unit of labour		277,000	325,000	186,000	.001
per hectare		160,000	128,000	73,000	.001
crop income	(cases)	(49)	(59)	(26)	
per hectare		74,000	76,000	28,000	.008
per *cropped* hectare		215,000	240,000	87,000	.018
per unit of labour		181,000	262,000	83,000	.046
livestock income	(cases)	(38)	(25)	(15)	
per hectare		22,000	20,000	16,000	.323
per *pasture* hectare		33,000	33,000	24,000	.134
per unit of labour		140,000	110,000	66,000	.056
off-farm income[4)]	(cases)	(53)	(36)	(28)	
per unit of labour		138,000	148,000	106,000	.074

1) figures are rounded to 1,000s;
2) standard deviations are about 100%;
3) significance of differences in means for Pococí and Guácimo together, as compared to Siquirres;
4) off farm income includes wages, salary and family support.

Total income for Siquirres households is almost 250,000 Colones less, and per hectare income is half that of Pococí. Land and labour productivity of crop and animal production is significantly lower for Siquirres as compared to Pococí and Guácimo. Also off-farm income per unit of labour is lower in Siquirres. For livestock production, only labour productivity is lower.
Reasons for these striking differences must be sought in the differences in bio-physical and socio-economic characteristics of the regions, especially of Siquirres as opposed to Pococí and Guácimo (soils, climate, marketing conditions, etc).

6. Conclusions

Literature suggests that land use in the Atlantic Zone is not static. As a consequence of changes in input and output markets, and changes in agricultural policy, farmers adopt new crops and abandon less promising ones. Differences in land use do not only emerge in a time perspective, but also with respect to farm size and region. On the small farms 75 percent of the land is used for cropping purposes and only 19 percent for pasture purposes, while on the large farms these figures amount to 13 percent crop area and 67 percent pasture land. About a quarter of the farmers do not grow a single crop, and earn a living through off-farm income and/or animal husbandry. There is no evidence that small farms grow more crops than large farms. Multi-cropping is even slightly more widespread among the large farms. A reason might be sought in a tendency for large farms to diversify in on-farm activities, while small farms tend to opt for diversification of both on and off-farm activities.

Crop yields differ considerably over the years, and also between the farm size classes, and the three regions. Farmers face serious marketing problems for their crop produce. Crop income therefore is not a very reliable source of income. For livestock products (mainly meat) the situation is better, because of product characteristics (non-perishability) and the existence of cattle auctions. Beans and maize are the major staple crops. All other crops are cash crops. For the small farms crop cultivation and wage labour are the main sources of income. On the large farms livestock is by far the most important source of income, followed by crop cultivation and wage labour. Labour income for both crop and livestock production is higher for the large farms, due to larger scale. On a per hectare basis, an inverse relationship between farm size and land productivity is found, which disappears when figures are calculated on a per cropped hectare basis instead. From a regional perspective, Siquirres scores considerably lower on income indicators.

Appendix: Land use

In this appendix two tables on land use are presented. To see whether land use is different for small, medium and large farm sizes, in Table 4.6 the share in acreage is given for all crops on which the respondent farmers were questioned. In Table 4.7 figures are presented on land use by region.

Table 4.6: *Land use (in % of total area, by farm size, 1993).*

		farm size[1)]		
land use	cases[2)]	**small**	**medium**	**large**
maize	45	8.2	4.3	1.7
elote	19	10.5	2.6	1.7
cassava	57	10.8	6.0	2.3
yam	20	7.6	0.8	1.5
tuber	37	2.8	4.0	0.5
plantain	27	9.3	2.3	0.1
pineapple	8	1.7	0.2	0.2
papaya	14	8.4	2.0	0.6
coconut	5	0.0	0.7	0.0
palmheart	10	1.1	1.3	1.0
chili	9	3.8	0.1	1.6
beans	52	3.6	1.5	0.9
other crop	36	5.9	4.9	0.6
pasture	101	18.5	54.0	66.9
forest	35	0.7	4.2	15.5
fallow	46	7.1	11.1	4.9
total		100.0	100.0	100.0

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha;

2) number of farmers growing crop.

When looking at Table 4.7 a few conclusions can be drawn about regional differences in land use patterns. 'Major' crops (with respect to acreage) in the Pococí region are maize, cassava and yam. In Guácimo elote, cassava and papaya are relatively important, while in Siquirres these are maize, tuber crops, and plantain. The share of cultivated land in use for pasture purposes is about the same for all regions. Forest coverage is relatively high in Pococí, while fallowing is more prevalent in Siquirres.

Table 4.7: *Regional land use pattern (in % of total area, by region, 1993).*

		region		
land use	cases[1)]	**Pococí**	**Guácimo**	**Siquirres**
maize	45	3.9	2.2	4.2
elote	19	0.8	7.0	0.0
cassava	57	4.0	7.4	0.9
yam	20	2.9	0.6	0.0
tuber	37	1.1	3.3	4.2
plantain	27	0.4	1.8	6.2
pineapple	8	0.3	0.2	0.7
papaya	14	0.3	4.9	0.0
coconut	5	0.0	0.4	1.1
palmheart	10	0.4	1.8	2.1
chili	9	1.9	0.2	0.2
beans	52	1.7	1.0	1.1
other crop	36	2.4	2.0	6.5
pasture	101	60.0	53.3	57.4
forest	35	13.5	6.0	2.5
fallow	46	6.2	7.9	13.0
total		100.0	100.0	100.0

1) number of farmers growing crop.

Analysis of yield variation

1. Introduction

While some authors observe that in contemporary agro-economic literature variation in yield is not considered to be a significant phenomenon (Ploeg, 1990), more recent literature shows a growing interest in the nature and causes of yield variation. Variation has increasingly become an object of research, instead of being perceived as a statistical residue in agro-economic modelling. From a recent study in northern Cameroon, it was concluded that "yield variations are not random side-effects, but are to a large extent the result of *human response* to a *given environment* within a *cultural and socio-economic context"* (Steenhuijsen Piters, 1995).
In the previous chapter, we saw that yields in the Atlantic Zone vary considerably, with standard deviations ranging from 50 to almost 100 percent. In this chapter an attempt will be made at explaining these large differences in yield. We will try to identify the main contributors from a set of predictor variables encompassing both structural and behavioural characteristics of the farm. The analysis will be done for maize, cassava, plantain, tuber crops and beans. First, the set of predictor and dependent variables of the explanatory model will be introduced. The cropwise results of the analysis are presented and interpreted in section 3. Section 4 concludes this chapter with the main findings.

2. The model

The available data lacks detailed structural and behavioural information at the crop level[7]. The only crop specific data is the acreage of the crop, and the reported (not measured) yields per hectare. This lack of data imposes limitations on the analyses that can be conducted for an investigation into the causes of the variations in yield. Regression analysis is virtually impossible, also because the assumption of multivariate normality of independent variables is violated. Discriminant analysis falls away as a possibility for the same reasons. The *logistic regression model* that is used in this chapter requires far fewer assumptions than discriminant and multiple regression models (Norušis, 1992). Logistic regression is a multivariate technique for estimating the probability that an event occurs. In this chapter, 'event' has the meaning of 'high yield'.

Dependent variables. The dependent variable in logistic regression has to be dichotomous. What we are looking for, are independent variables that can be used to predict whether a farmer scores a 'high' yield. To obtain a dichotomous dependent variable for the major crops, reported yields are categorized as low or high. This is simply done by calculating the average yield for the crop, and

[7] e.g; no information was acquired on labour time spent on a particular crop, labour time spent on different activities (sowing, weeding, harvesting etc.), dose and timing of chemicals, and the use of machinery for a specific crop. Also, no data is available on seeds and planting material used.

determining for each valid case whether the yield is lower, in which case it is labelled 'low' or higher than the average yield, in which case it is scored as 'high'. Through this procedure we obtain five dependent dichotomous variables for the yields of maize, cassava, tuber crops, plantain and maize.

Predictor variables. In Table 5.1, the predictor variables that are used in the analyses are listed. As predictor variables we have chosen both structural (e.g. farm size, tierra negra) and behavioural variables. Some are nominal (e.g. years working, herbicide use, labour), others categorial[8] (machinery use, educational level).

Table 5.1: *The predictor variables in the logistic model for yield variation analysis*

variable	description
1. FRMSZE	farm size (in ha)
2. FMLSZE	family size (number of persons)
3. TNEGRA	% of tierra negra soil
4. EDUCAT[1)]	education of farm household head (0; < primary, 1; ≥ primary)
5. YRSWRK	number of years working the farm
6. USEMCH[1)]	use of machinery (0; no use of machinery, 1; use of machinery)
7. LABOUR	labour availability (number of persons per ha)
8. USEHERB	use of herbicides (in gallons per ha)
9. USEINS	use of insecticides (in gallons per ha)
10. USENPK	use of N-P-K fertilizer (in qq[2)] per ha)
11. USENIT	use of nitrogen fertilizer (in qq[2)] per ha)
12. COMMERC	commercialisation; % of total crop production that is sold
13. CROPINT	% of total farm size in use for crop production

1) categorial variables
2) 1 qq=46 kg

As a measure of land quality, the percentage of the tierra negra soil type on the farm is used. The educational level of the household head is categorized simply as below or above primary education. A figure on available farm labour was assessed by recalculation of household composition statistics on a per hectare basis. The predictor variables on the use of agro-chemicals were obtained by division of the total used quantities by farm size. The degree of commercialisation is an indicator of the percentage of crop production that is sold instead of consumed. Cropping intensity is represented by a variable on the percentage of the total farm size in use for cropping purposes.

[8] Categorial variables are allowed in logistic regression

3. **Results**

Running the logistic regression procedure (method; Enter) for the five major crops, with the dichotomous yield variables as dependents and aforementioned predictor variables as independents, results in statistical output from which we can assess whether the model fits the data. The most important statistics are summarized in Table 5.2 (see the Appendix for the SPSS listings).

Table 5.2: *Main results of logistic regression analyses for major crops*

	maize	cassava	tuber	plantain	beans
valid cases	37	49	33	25	43
model chi-square	24.108	13.273	35.245	18.673	24.188
degrees of freedom	13	13	12	11	13
significance	.0302	.4270	.0004	.0672	.0294
% correctly classified	**84**	**73**	**94**	**88**	**79**

The 'goodness of fit' of the model can be assessed by comparing the predictions of the model to the observed outcomes in the classification tables, and evaluating the model chi-square test statistics. The model chi-square tests the null hypothesis that the coefficients for all the variables in the model, except the constant, are 0. This is comparable to the overall *F* test for regression (Norušis, 1992).
From the table we see that for all crops, except cassava, about 80 to 90 percent of the cases are correctly classified. With 73 percent, cassava has the lowest percentage of correctly classified classes. Maize, tubers, and beans survive the chi square test at a significance level of 0.05 (plantain almost, with a significance of .07). For these crops the null hypothesis can be rejected, which means that the coefficient for at least one of the predictor variables is not zero.

To identify subsets of independent variables that are good predictors of the dichotomous yield variable, we have to be cautious interpreting the significance levels of the logistic regression. A low level of significance does not necessarily lead to acceptation of the null hypothesis that the coefficient is 0[9]. For that reason, we will try to identify the predictor variables that contribute most to the crop model, by using the ***backward selection method*** of variables, based on the ***likelihood-ratio test***. Stepwise, variables that do not contribute significantly are removed from the model. Let us have a look at the results of this procedure, as summarized in Table 5.3 (more detailed in the Appendix to this chapter), and try to interpret the results.

[9] This is because of the following problematic property of the Wald statistic; in case of a large absolute value of the regression coefficient, the estimated standard error becomes too large. The Wald statistic then becomes too small, leading the researcher to fail to reject the hypothesis that the coefficient is 0 (Norušis, 1992).

Table 5.3; *Main results of stepwise logistic regression analyses for major crops*

	maize	cassava	tuber	plantain	beans
variables	- farm size - family size - herbicides - insecticides	- machinery - commerciali- sation	- farm size (-) - family size - education - labour (-) - npk - nitrogen	- farm size (-) - t. negra (-) - herbicides - insecticides	- farm size (-) - family size - education - labour (-) - insecticides
model chi-sq.	19.601	9.201	34.097	15.871	16.778
degr. of freedom	4	2	6	4	5
significance	.0006	.0100	.0000	.0032	.0049
% correctly classified	**84**	**65**	**94**	**80**	**79**

First thing to notice is that the percentages of correctly classified cases with the reduced set of explanatory variables are almost as high as the percentages with all thirteen variables in the model; the reduced set of variables have about the same explanatory power as the full model, with higher levels of significance.

Table 5.3 indicates that farm size and family size are important predictors for high yield in all crop models, except cassava. Only for maize, farm size is positively related to high yield. Agro-chemical use is also important for differentiating between low and high yielding farmers of maize (pesticides), tubers (fertilizers), plantain (pesticides) and beans (pesticides). Surprisingly, for crops where family size is positively correlated with yield, labour availability shows a negative relationship.
Soil fertility, as measured by the percentage of tierra negra, does not remain in one of the models as a predictor of higher land productivity. This is also the case for cropping intensity and farmer experience (measured as the number of years working on the farm).

With respect to the relationship between farm size and productivity, there is still some controversy on whether an inverse size-productivity relationship really exists and for what reasons. This inverse size-productivity relationship is generally assumed to be caused by differences in the relative factor prices confronting the small and large farmers. For the small farmers the land/labour price-ratio is higher than for the large farmers, resulting in more intensive cultivation (more family labour per unit of land) and higher output per unit area than on large farms (Ellis, 1992; Dyer, 1991). The idea is that larger farms tend to underutilize the land that is available to them, as compared to the smaller farms, because of "generally less commitment of other resources which combine with land to produce output" (Ellis, 1988). Surprisingly, the variable 'labour' does not survive in each of the models as a predictor variable that positively affects yield. But we must keep in mind that crop specific labour data is not available. We know how many family members work on-farm, but not how many time they have spend on each crop, neither how committed they were to achieve a high yield.
With respect to the relationship between agro-chemicals and yield, Hayami and Ruttan (1985) state that "advances in (...) chemical technology have been induced primarily by a desire to increase crop output per unit of land (..)". This is

especially the case for chemical fertilizers. Pesticides are not so much perceived as factors increasing yields, but as labour saving inputs. But from the table we see that herbicides and insecticides prove to be important for obtaining high yields. In case of labour scarcity, weeds and other crop diseases cannot be effectively combatted by hand, and have a strong negative effect on yield. Because pesticides require less labour, pest management becomes more efficient and effective.

Mechanisation is often posed as being the opposite of bio-chemical technology; the former saves labour by making it more productive, the latter saves land by making it more productive (Colman and Young, 1989). The magnitude of the effect depends on types of machines and chemicals, and the circumstances in which they are applied. But generally speaking, machines are assumed to replace people and are not seen as land-augmenting devices. Unlike machinery, chemical fertilizers can be purchased in almost any quantity and even very small amounts increase yield (Gillis *et al.*, 1992; Hayami and Ruttan, 1985).

After these general remarks, we turn to a brief discussion of the results per crop.

Maize. A large part of the maize produced in the region now serves subsistence needs, while about a decade ago it was one of the major cash crops for smallholders (Tilburg *et al.*, 1995). Only about 20 percent of the farmers now cultivate maize, on roughly 3 percent of the arable land in the region (see chapter 4). Because of the abolishment of guarantee prices, yield maximization was largely abandoned as the leading principle in maize production. Maize is now produced by a minority, both as a cash crop and a food crop. For maize, the inverse size-productivity argument does not hold. The fact that the larger farms obtain higher yields for maize might be explained along the following line of reasoning; for large farms cultivating maize, it is primarily a cash crop, and incentives to obtain a high yield are stronger than for small farms, for whom maize is primarily meant for home-consumption.

Cassava. For cassava, only two variables remain in the model; the use of machinery and the degree of commercialisation (see Appendix). Both variables account for 65 percent correctly classified cases. Important reasons for farmers to grow cassava are its aptness for low fertile soils, and the fact that it does not require much labour and inputs. A major drawback of cassava cultivation is its low price (Akkermans, 1993). Farmers that use machinery for land preparation obtain higher yields than the other farmers. Apparently, mechanical land preparation positively affects soil quality through better ploughing. Farmers are known to be willing to plough their land because it improves yield, but lack of money refrains them from doing it (Akkermans, 1993). The degree of commercialisation is positively connected with high cassava yield. A farmer who intends to produce for the market, and for whom yields directly affect income, has a greater incentive to obtain a high yield, than a farmer whose cassava yield must be sufficient to meet household needs. Low yielding farmers sell about 70 percent of their cassava produce, while high yielding farmers sell almost all (90 percent, significance .058).

Tuber crops. In contrast with cassava, for tuber crops the degree of commercialisation and machinery use are of no importance for differentiating between high and low yielding farmers. Low and high yielding farmers sell almost all of their tuber produce. More than 90 percent of the cases are correctly classified by the predictor variables farm size, family size, educational level, labour and the use of fertilizers. This is the same score as with all thirteen variables in the model.

Plantain. In the Atlantic Zone, plantain is mainly produced by small-scale farmers. The occurence of diseases like *'black sigatoka'* caused a sharp decline in production area during the last decade (Tilburg, 1995). Plant protection requirements are high in plantain cultivation.
For plantain, the percentage of tierra negra soil, the farm size, and the use of insecticide and herbicides remain in the model. Surprisingly, the effect of tierra negra is negative. This must not be interpreted as that tierra negra soil yields less plantain bunches than, say, tierra colorado. Again, we must stress the fact that no crop specific data is available. Having a high percentage of tierra negra, does not necessarily mean that the plantain crop is cultivated on these soils. We might speculate that the most profitable crops will be grown on the best soils as to maximize output and income, while less profitable crops are cultivated on the marginal soils on the farm. So it depends on the relative importance of plantain for household income. If important, and soils are not very fertile, farmers are forced to get a maximum output, despite the poor soils. Farmers for whom plantain is of secondary importance, and are endowed with a favourable ratio of fertile/unfertile soils, the plantain crop is grown on the less fertile soils, and the primary cash crop on the fertile soils. Plantain yields are thus depressed. But, as said, this is only speculation. We simply lack data to confirm this notion.

Beans. In the previous chapter we saw that beans are a staple crop for about a fifth of the respondents. The larger farms tend to consume a higher percentage of the produce than the smaller farms, but obtain lower yields. Because land is less scarce for the large farmers, the incentive to maximize output per unit of area is less strong than for the small farmer. To feed the family, a large farmer can afford to use a larger piece of land for growing a food crop like beans. The incentive for small farmers is also greater, because for them beans are part cash crop and staple crop, while beans are primarily a staple crop for the larger farms. Larger farms might aim for a target yield (securing home consumption), while the small farms try to optimize yields for both home consumption and maximum income. As with maize, family size positively affects yield, probably because more hands are available for crop husbandry.

4. Conclusions

In the Atlantic Zone of Costa Rica yields of the major crops -maize, cassava, tubers, plantain and beans- show large variations. A model was proposed for identification of structural and behavioural variables that explain the large yield variations. A logistic regression model was used to test the null hypothesis that the coefficients of the model are 0. For all crops, except cassava, this could be rejected; the coefficient of at least one of the variables is not zero. To identify a sub-set of variables, the backward selection method based on the likelihood-ratio was used. It proved to be possible to select a small number of variables that predict a high yield (see Table 5.4) and correctly classify a large percentage of the cases. As such, these explanatory variables are 'responsible' for the large variations in yield.

Table 5.4: *predictor variables for high yield of the major crops*

crop	**variables**
maize	farm size, family size, herbicides, insecticides
cassava	machinery, commercialisation
tubers	farm size (-), family size, education, labour (-), N-P-K and nitrogen fertilizer
plantain	farm size (-), tierra negra (-), herbicides, insecticides
beans	farm size (-), family size, education, labour (-), insecticides

The well-known inverse size-productivity relationship is confirmed for tubers, plantain, and beans. The use of agro-chemicals is important in all major crops, but cassava. Family size, determinant of labour availability and food requirements of the family, positively affects yields of maize, tubers and beans.

Of course, this is a rather crude form of analysis. It must be kept in mind, though, that the available data on structural and behavioural characteristics of the farm household are not crop specific. Therefore, refined analysis at crop level was not possible, and we opted for only some rough analysis on the possibility of identifying predictor variables that differentiate between low and high yielding farmers.

Appendix; SPSS Logistic Regression output

In this appendix detailed statistics are presented of the logistic regression analysis runs (method; Enter) for the five major crops. Table 5.5 contains the detailed output of the analysis of maize, Table 5.6 to 5.10 only contains the variable statistics of the stepwise logistic regression for maize, cassava, plantain, tuber crops and beans.

Table 5.5 *Logistic regression output for maize*

```
Dependent Variable..   YMAIZ93

Beginning Block Number  0.  Initial Log Likelihood Function

-2 Log Likelihood   50,615144

* Constant is included in the model.

Beginning Block Number  1.  Method: Enter

Variable(s) Entered on Step Number
1..       FRMSZE    FMLSZE    TNEGRA    EDUCAT    YRSWRK    USEMCH    LABOUR
          USEHERB   USEINS    USENPK    USENIT    COMMERC   CROPINT

Estimation terminated at iteration number 8 because
Log Likelihood decreased by less than ,01 percent.

 -2 Log Likelihood        26,507
 Goodness of Fit          24,243

                     Chi-Square    df Significance

 Model Chi-Square         24,108    13         ,0302
 Improvement              24,108    13         ,0302

Classification Table for YMAIZ93
                 Predicted
                  low    high   Percent Correct
                  0      1
Observed         --------------
   low   0        19     2        90,48%
                 --------------
   high  1         4    12        75,00%
                 --------------
                        Overall   83,78%


---------------------- Variables in the Equation ------------------------

Variable              B        S.E.      Wald    df       Sig        R   Exp(B)

FRMSZE            ,2631       ,1482    3,1517     1     ,0758    ,1508   1,3009
FMLSZE            ,6271       ,2962    4,4831     1     ,0342    ,2215   1,8722
TNEGRA            ,7614      1,6887     ,2033     1     ,6521    ,0000   2,1413
EDUCAT(1)         ,2781       ,7195     ,1494     1     ,6991    ,0000   1,3206
YRSWRK          -,0289       ,0838     ,1193     1     ,7298    ,0000    ,9715
USEMCH(1)       -,8457      1,1019     ,5891     1     ,4428    ,0000    ,4292
LABOUR          1,7426      2,5063     ,4834     1     ,4869    ,0000   5,7122
USEHERB         6,3889     13,7184     ,2169     1     ,6414    ,0000 595,2009
USEINS         50,2212    150,8456     ,1108     1     ,7392    ,0000 6,47E+21
USENPK         -1,5542      2,2590     ,4733     1     ,4915    ,0000    ,2114
USENIT          -,1400      1,4287     ,0096     1     ,9219    ,0000    ,8694
COMMERC           ,8790      2,0063     ,1919     1     ,6613    ,0000   2,4084
CROPINT          1,5638      3,3151     ,2225     1     ,6371    ,0000   4,7770
Constant        -8,4565      4,1463    4,1597     1     ,0414
```

Table 5.6: *Summary statistics of stepwise logistic regression for maize*

Model Chi-Square	19,601
Degrees of freedom	4
Significance	,0006
Correctly classified	83,78%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
FRMSZE	,1546	,0677	5,2254	1	,0223	,2524	1,1672
FMLSZE	,5729	,2496	5,2663	1	,0217	,2540	1,7733
USEHERB	3,4870	2,7048	1,6619	1	,1973	,0000	32,6868
USEINS	39,7557	74,9862	,2811	1	,5960	,0000	1,84E+17
Constant	-5,7410	2,0407	7,9146	1	,0049		

----------------- Model if Term Removed -----------------

Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR
FRMSZE	-18,824	6,635	1	,0100
FMLSZE	-19,451	7,889	1	,0050
USEHERB	-18,201	5,388	1	,0203
USEINS	-17,147	3,279	1	,0702

Table 5.7: *Summary statistics of stepwise logistic regression for cassava*

Model Chi-Square	9,201
Degrees of freedom	2
Significance	,0100
Correctly classified	65,31%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
USEMCH(1)	-,8315	,4253	3,8224	1	,0506	-,1644	,4354
COMMERC	3,1463	2,2615	1,9355	1	,1642	,0000	23,2506
Constant	-2,1997	2,1773	1,0206	1	,3124		

----------------- Model if Term Removed -----------------

Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR
USEMCH	-31,457	4,698	1	,0302
COMMERC	-30,931	3,646	1	,0562

Table 5.8: *Summary statistics of stepwise logistic regression for tubers*

Model Chi-Square	34,097
Degrees of freedom	6
Significance	,0000
Correctly classified	93,94%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
FRMSZE	-4,7381	3,2667	2,1037	1	,1469	-,0484	,0088
FMLSZE	5,2021	3,5777	2,1142	1	,1459	,0508	181,6528
EDUCAT(1)	25,5818	239,0385	,0115	1	,9148	,0000	1,29E+11
LABOUR	-86,4824	59,7738	2,0933	1	,1479	-,0459	,0000
USENPK	-50,5246	614,5373	,0068	1	,9345	,0000	,0000
USENIT	101,2979	456,6201	,0492	1	,8244	,0000	9,84E+43
Constant	20,9748	240,5280	,0076	1	,9305		

----------------- Model if Term Removed -----------------

Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR
FRMSZE	-9,723	9,291	1	,0023
FMLSZE	-8,748	7,341	1	,0067
EDUCAT	-9,855	9,556	1	,0020
LABOUR	-9,072	7,990	1	,0047
USENPK	-8,940	7,726	1	,0054
USENIT	-15,560	20,966	1	,0000

Table 5.9: *Summary statistics of stepwise logistic regression for plantain*

Model Chi-Square	15,871
Degrees of freedom	4
Significance	,0032
Correctly classified	80,00%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
FRMSZE	-,2250	,1487	2,2892	1	,1303	-,0927	,7985
TNEGRA	-2,6890	1,6836	2,5509	1	,1102	-,1279	,0679
USEHERB	6,5424	4,3654	2,2461	1	,1340	,0855	693,9488
USEINS	-12088,3	92207,570	,0172	1	,8957	,0000	,0000
Constant	3,4103	1,9423	3,0830	1	,0791		

----------------- Model if Term Removed -----------------

Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR
FRMSZE	-10,386	2,992	1	,0837
TNEGRA	-10,689	3,598	1	,0579
USEHERB	-10,352	2,924	1	,0873
USEINS	-13,236	8,692	1	,0032

Table 5.10: *Summary statistics of stepwise logistic regression for beans*

Model Chi-Square	16,778
Degrees of freedom	5
Significance	,0049
Correctly classified	79,07%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
FRMSZE	-,2218	,1225	3,2767	1	,0703	-,1464	,8011
FMLSZE	,5694	,2225	6,5503	1	,0105	,2763	1,7671
EDUCAT(1)	1,1787	,5609	4,4161	1	,0356	,2014	3,2502
LABOUR	-8,9732	3,8328	5,4810	1	,0192	-,2417	,0001
USEINS	9,1661	8,3261	1,2119	1	,2709	,0000	9567,042
Constant	1,3521	1,5949	,7187	1	,3966		

----------------- Model if Term Removed -----------------

Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR
FRMSZE	-24,938	7,066	1	,0079
FMLSZE	-26,180	9,549	1	,0020
EDUCAT	-24,111	5,411	1	,0200
LABOUR	-27,391	11,973	1	,0005
USEINS	-24,973	7,136	1	,0076

Analysis of production and income variation

1. Introduction

In the previous chapter, we tried to identify the farm characteristics that partly explain the high observed variation in physical yields of the major crops. But, not only the yields of the different crops vary considerably. Also aggregate land and labour productivity are characterized by standard deviations of about 100 percent. By use of correlation and path analysis, the interrelations between a set of farm characteristics and farm productivity will be investigated. This will be done seperately for aggregate crop and animal production, both on a per hectare basis (section 2 and 3, respectively). Income per unit of family labour, being an approximation of labour productivity (Ploeg, 1990) will be the next topic of analysis, presented in section 4. Then, in section 5, the effect of mechanisation on crop production will be assessed. This will also be done for the effect of participation in a farmers' organisations on agricultural income. These variables are not included in the correlation and path analysis because of their dichotomous nature, but are assumed to be relevant for explaining differences in productivity and income. Section 6 concludes this chapter with the main findings.

2. Crop production

Crop production per hectare, measured as gross production value per hectare, is characterized by a mean value of about 60,000 Colones and a standard deviation of more than 100 percent. Our aim is to construct a path diagram for crop production through a quantitative analysis of farm characteristics. This is done with the objective of getting a clear picture of the mutual relationships of these variables that are assumed to determine crop production per hectare. The following variables are included in the model;
(1) crop production; the gross value of crop production per hectare;
being the dependent variable, and the following independent variables;
(2) cropping intensity; the percentage of the total farm size cultivated with crops;
(3) fertilizer; the total amount of fertilizers per hectare;
(4) pesticides; the total amount of herbicides and insecticides per hectare;
(5) labour; labour availability per hectare;
(5) commercialisation; the percentage of total crop production value that is sold;
(6) tierra negra; the percentage of tierra negra soil on the farm.

Hypotheses. Certain relationships between the dependent variable and 'independent' variables are assumed. A distinction can be made between factor-product relationships (e.g. the relation between crop production and fertilizers, all other factors held equal), and factor-factor relationships, for example the relationship between pesticide use and labour (Colman and Young, 1989). In general, crop production value per hectare is thought to be positively affected by, amongst others, labour and chemical use (both in quantity and quality), soil fertility and the degree of crop commercialisation.

The application of chemicals in crop production is primarily induced by a desire to increase crop output per unit of land area (Hayami and Ruttan, 1985). Although it is generally assumed that chemical innovations are labour-using, Ellis (1988) states that this is not necessarily the case for weedicides, which he assumes to be mainly labour-saving. Therefore, in our analysis a distinction was made between fertilizers and pesticides. Fertilizer use per hectare is thought to correlate positively, and pesticide use negatively with labour use per hectare. With respect to soil, not many will question the assumption that a better soil fertility should positively affect crop production. In the Atlantic Zone, tierra negra is the most fertile soil, and therefore in our model, crop production is thought to correlate positively with the percentage of tierra negra soil on the farm. But we must not underestimate the effect of human action on soil fertility. A majority of the respondent farmers claimed a decline in soil fertility over the years, because of abuse of herbicides and intensive soil use.

In the model, the variable cropping intensity is introduced, which is supposed to indirectly affect crop production. It seems plausible that a farmer growing mainly cash crops (e.g. has a high degree of crop commercialisation), uses a larger share of his farm land for cropping purposes. The same is thought to be valid for farmers with higher shares of tierra negra. Also, a direct effect is expected between output market integration ('commercialisation') and crop production. Crop producers with the purpose of selling the larger share of the produce, are expected to be more committed to obtain a higher productivity than farmers for whom securing home consumption is the main goal. Of the former group, income maximization is supposed to be the leading motive, while the latter are likely to opt for a strategy where total crop produce should be sufficient to cover the food needs of the household.

Correlation and path analysis. In Table 6.1 the correlation coefficients between the variables included in the crop production model are displayed. The path diagram (Figure 6.1) was constructed by use of partial correlation coefficients (Duncan, 1971; Steenhuijsen Piters, 1995).

Table 6.1: *Pearson correlation coefficients for the crop production model (N=134)*

	variable (1)	(2)	(3)	(4)	(5)	(6)
1. Crop production						
2. Fertilizer	.60**					
3. Pesticides	.28**	.13				
4. Labour	.33**	.34**	.05			
5. Commercialisation	.23**	.19*	.09	.09		
6. Tierra negra	.25**	.21*	.20*	.12	.00	
7. Cropping intensity	.37**	.41**	.25**	.33**	.29**	.23**

* = Signif. < .05 ** = Signif. < .01 (2-tailed)

From the path diagram we can draw the following conclusions. The assumed relationships, outlined above, are nearly all confirmed, though some only weak. The factor-output effect of chemicals on crop production is beyond any doubt, and highest for fertilizers (+.51). The direct effect of labour is significant but weak.

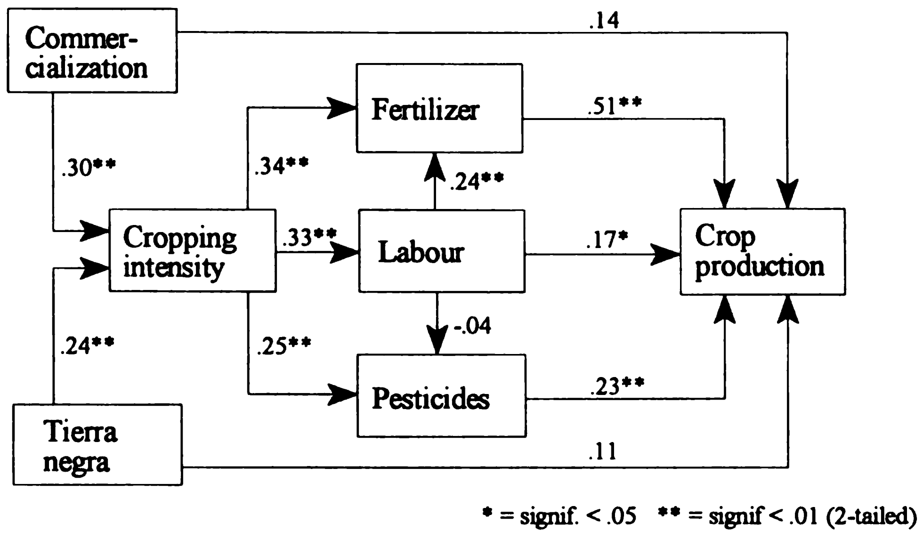

Figure 6.1: *Path diagram for crop production (per hectare)*

Surprisingly, a direct effect of soil fertility on crop production is absent. This could be attributed to soil exhaustion and mismanagement, as observed by farmers. Tierra negra is a soil *type* which used to be fertile, and once was a reason for choosing a high cropping intensity, still reflected in a positive effect between the two variables (+.24). But fertility differences of the soil types might have disappeared, and now depends more on conservation measures (a.o. crop rotation, fertilizer use), than on initial fertility. With respect to factor-factor relationships, the following are worth to notice. The labour-using nature of fertilizers is confirmed (+.24), but the labour-saving aspect of pesticides is absent, although a very weak negative correlation was found, be it unsignificant.
The degree of commercialisation is positively connected with cropping intensity, but has no direct relationship with crop production per hectare. It must be understood as that higher degrees of output market integration, goes together with higher input use (fertilizer, pesticides), resulting in higher crop income.

3. Livestock production

Livestock production, measured as gross production value per hectare, is characterized by a mean value of 18,000 Colones per hectare and a standard deviation of close to 80 percent. So land productivity of animal husbandry is considerably lower as compared to that of cropping. Being involved in animal husbandry generally means that a certain part of the available land is reserved as pasture, with some number of cattle grazing on it. Products that can be sold are milk and meat. When aiming for an explanation of the observed differences in land productivity, we must face the fact that essential information is missing, that is on breeding and feeding practices. Significant relationships with available farm characteristics were found to be almost absent, and the construction of a sensible path diagram proved to be impossible, despite several trials. Of course, a positive relationship was found between stocking rate (number of cattle per ha) and livestock production (+.51, significance < .01) and between pasture intensity and livestock production (+.30, significance < .01). Naturally, there is a factor-factor relationship between pasture and stocking rate (+.31, significance < .01). For the analysis of variation in livestock production differences more detailed data is necessary, so we suffice here with the aforementioned relationships between stocking rate, pasture and livestock production.

4. Income

Total income per unit of family labour, being a measure of labour productivity, is characterized by a mean value of 235,000 Colones and a standard deviation of about 60 percent. Three major sources of income are distinguished; income from crop production, off-farm income, and livestock income. Just like with crop production, our aim is to construct a path diagram for labour productivity from a quantitative analysis of a set of variables representing relevant income performance and farm characteristics. The following variables will be included in the model (variables 1-8 are per unit of family labour);
(1) total income; income from crop, livestock and off-farm activities;
(2) off-farm income; income earned with off-farm jobs;
(3) crop income; income earned with crop production;
(4) livestock income; income earned with animal husbandry;
(5) crop area; hectares under crops;
(6) pasture area; hectares in use as pasture;
(7) cattle; the number of cattle;
(8) chemicals; the quantity of both fertilizers and pesticides;
(9) commercialisation; the percentage of total crop production value that is sold on the market.

Hypotheses. Total income per unit of family labour can consist of (combinations of) crop income, livestock income and off-farm income. Households either diversify or specialize in income sources. Within the family some family members will be fully employed on-farm, while others work (partly) off-farm. With respect to the sources of income, we assume they are negatively correlated among each other. For example, the higher the amount earned with off-farm activities, the lower the income from other income sources. At a point in time, labour time can be allocated to either crop production, livestock production, off-farm work, leisure time or general household tasks. But during a day, labour time can be allocated among these different activities, so we expect these relations to be significant, but not very strong. The relationships of the income sources with total income can be viewed as indicators of the relative importance of these sources for total labour productivity in the region.
Labour productivity is determined by the land/labour and capital/labour ratios. In the model a distinction is made between crop income and livestock income per unit of family labour, both ratios are also specified. Relevant for crop income are the crop-area/labour ratio and chemicals/labour ratio. For livestock production, the number of livestock/labour ratio is important, as wel as the pasture/labour ratio.

Correlation and path analysis. In Table 6.2 the correlation coefficients are listed between the variables in the income model, which provides a basis for the construction of a path diagram for income per unit of labour (labour productivity). This path diagram is depicted in Figure 6.2.

Table 6.2: *Pearson correlation coefficients for the income model* (N=182)

	variable [1] (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Total income								
2. Off-farm income	.41**							
3. Crop income	.55**	-.27**						
4. Livestock income	.27**	-.11	-.18*					
5. Crop area	.22**	-.24**	.53**	-.18*				
6. Pasture area	.01	-.12	-.13	.46**	-.06			
7. Cattle	.22**	-.06	-.05	.66**	-.06	.62**		
8. Chemicals	.27**	-.16*	.44**	-.09	.55**	-.04	.06	
9. Commercialisation	.11	-.21**	.50**	-.29**	.47**	-.17*	-.19**	.33**

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)
1) variables 1-8 are per unit of family labour

The following conclusions can be drawn from the diagram. First we observe that for crop income, off-farm income and livestock income contribute significantly and positive to total income per unit of labour in decreasing order of effect, which can be considered as an indication of their relative importance. The effect of livestock income is the weakest of the three, which might indicate that only for a relatively small number of farm households that are specialized in animal husbandry total income per unit of labour can be raised through an increase in livestock income. We see that all three income categories are negatively correlated to each other. This correlation is strongest (-.27) between off-farm income and crop income; the higher

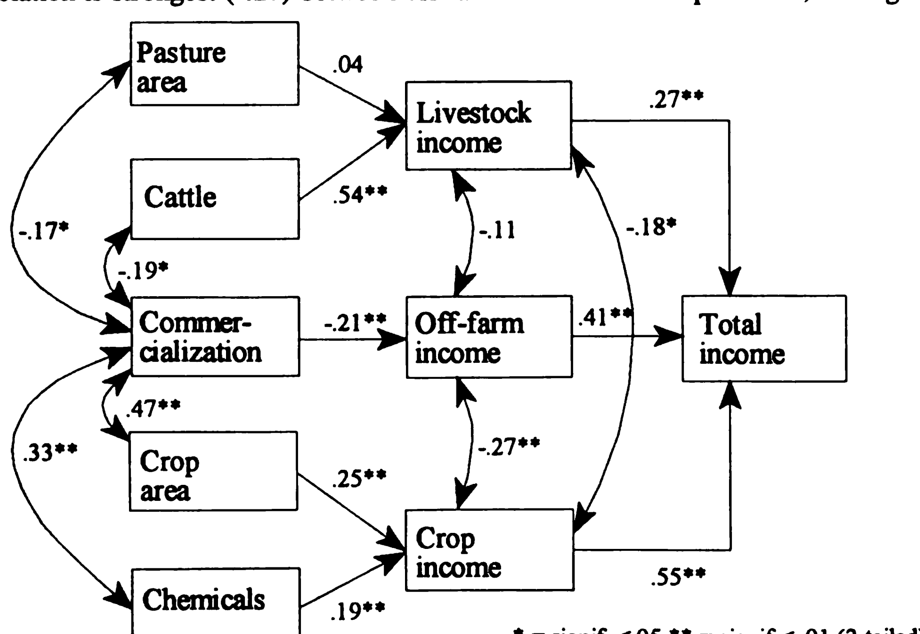

Figure 6.2: *Path diagram for income (per unit of labour, except commercialisation)*

the off-farm income, the lower the crop income. This relation is also represented in the negative correlation between commercialisation and off-farm income, indicating that with increasing off-farm incomes, less crop produce is sold, and hence less crop income is earned.
With respect to income from livestock, the amount of pasture is not decisive for livestock income per unit of labour, but the number of animals per unit of labour, being a measure of scale. Thus, the strong relation (+.54) must be read as that scale is an important determinant of livestock income. For crop income, crop area per unit of labour can be seen as a measure of scale, and also here, scale proves to be an important determinant of crop income per unit of labour (+.25), as is the case with chemicals (+.19).

5. Mechanisation and organisation

In this section the effect of mechanisation and organisation on land and labour productivity will be assessed and discussed briefly.
Hayami and Ruttan (1985) state that "the major economic force leading to the greater use of mechanical equipment in agriculture is the drive to reduce labour costs." So generally speaking, mechanisation raises labour productivity. Not all types of mechanisation is labour-saving, though (Ellis, 1992, Colman and Young, 1989). For example, the introduction of irrigation by means of pumps, requires more labour (Ellis, 1988). But machinery which is used for land preparation (e.g. ploughing) is widely assumed to enhance labour productivity. In Table 6.3 differences in land and labour productivity are listed for two groups of farmers; those using machinery for land preparation, and those who do not.

Table 6.3: *Effect of machinery use on land and labour productivity* (in Colones)

		use machinery		
income indicator		**yes**	**no**	*signif.*
crop income	(cases)	(23)	(111)	
per hectare		123,000	54,000	.000
per unit of labour		426,000	150,000	.000

The effect of mechanisation on labour productivity is beyond doubt. Surprisingly, this is also the case for land productivity, though to a lesser extent. Reasons for this might be sought in deeper and better ploughing enhancing crop growth and thereby land productivity.

Farmers' organisations are thought to play a crucial role in agricultural development, by serving the collective interest of the members (Van den Ban *et al.*, 1988). These interests are mainly the exchange of know-how to become better farmers (and thereby increase productivity) and obtain better prices for both inputs and agricultural products. So we can put forward the hypothesis that input use (chemicals) and agricultural incomes are higher for members of farmers' organisations. To test this, in Table 6.4 differences between agricultural income and chemical use (both per hectare) between members and non-members of farmers' organisations are presented.

Table 6.4: *Effect of organisations membership on income & chemical use*

		member of organisation		
indicator		**yes**	**no**	*signif.*
	(cases)	(49)	(115)	
agricultural income		85,000	54,000	.019
chemical use		2.7	1.5	.028

The agricultural income per hectare and chemical use per hectare are significantly higher for members of farmers' organisations. In this regard, it is interesting to put forward the recommendations made in a recent study on agricultural marketing in the Atlantic Zone (Tilburg *et al.*, 1995). It was adviced to "improve the countervailing power in the market through coordination of supply", and more generally, to "consider whether farmer organisations [can] have a role in financing *production* and *marketing* of agricultural products" (our italics).

6. Conclusions

Land and labour productivity are characterized by large deviations from the mean. In order to get a picture of the factors at play in this variation, and between-factor relationships, a correlation and path analysis was undertaken for land productivity of crop and animal production, and for total labour income as well.
Variation in crop production proved to be directly connected with differences in the use of agro-chemicals and labour. Fertilizer use was found -as expected- to be labour-using, but no proof was found for the assumed labour-saving character of pesticides. Both the degree of commercialisation and the percentage of tierra negra indirectly affect crop production through a higher cropping intensity, though a direct effect of these two variables on productivity is absent.
Variation in livestock production could only be attributed to differences in stocking rates and pasture area, because of lack of specific data on animal husbandry.
Variation in total labour income is a composite of the variations in labour income of crop and animal income, and off-farm income. Of course, the land/labour ratio is important for explaining differences in crop income per unit of labour, as well as the capital/labour ratio (here only measured as the amount of agro-chemicals). Differences in livestock income per unit of labour is to a large extent determined by the cattle/labour ratio, and not by the pasture-land/labour. One can have a lot of pasture, but ultimately the number of animals per unit of labour (and production per animal) determines labour income. Off-farm income, crop income and livestock income are negatively correlated, which might be interpreted as that as labour incomes from either source rise, the other sources become only supplementary (partial specialisation) or even drop to nill (complete specialisation). This might be interpreted as evidence that farm households aim to specialise in either livestock income, crop income, or off-farm income. The other income sources then become

only supplementary.
Use of machinery is not common, but its effect on land productivity (better/deeper ploughing, improved soil structure?) and labour productivity (more cultivated land per unit of labour) is strong. Because less than 20 percent of the farmers involved in crop production makes use of machinery, herein lies a possibility for raising agricultural incomes. In addition, farmers who participate in a farmers' organisation typically use more chemicals and have considerable higher incomes per hectare. Whether this is caused by more bargaining power in both input and output markets and better dissemination of knowledge and information among members, is not studied here.

Towards a classification of farms

1. Introduction

The main objective of this study was to obtain a classification of farms based on similarities in income composition, with the purpose of identifying groups of farms showing greater homogeneity in behavioural and structural farm characteristics than the sample group as a whole. In this chapter the results from this classification of farm households in the Atlantic Zone of Costa Rica are presented and discussed. First, the procedure of classification is discussed. The main characteristics of the resulting farm classification, and the regional and farm size distribution of the farmer types are presented in section 3. Also, in this section a comparison is made between the proposed farm classification and how farmers defined themselves during the questionnaire survey. In section 4, between-class differences in factor intensity are investigated. Farm classes are compared with respect to aggregate production characteristics and income indicators in section 5. Then, in section 6, we discuss the farm classes that were distinguished as styles of farming and as household strategies. The concluding section summarizes the most salient findings from the farm classification proposed in this chapter.

2. Procedure

The statistical technique used for the proposed classification of farms is *cluster analysis*. The goal of cluster analysis is to identify homogeneous groups of cases. The cluster analysis was done with *income composition* as the classification criterion. For each farm household the composition of household income was summarized in a number of calculated variables, representing the income shares from livestock, off-farm activities[10], roots and tuber crops, fruits, vegetables, grains, and other crops and activities, adding up to 100 percent.

Often a large set of farm characteristics are used for the cluster analysis (März, 1990; Hardiman *et al.*, 1990; Anbar and Birch; 1987). For two reasons, we chose to use only a single criterion for classification. First, and here we paraphrase März (1990), is that "a simple classification on the basis of just one or two criteria can be sufficient in many cases". Second, we postulate that in the relative income composition of the farm, the productive strategy becomes manifest. For example, two farm households that earn the larger share of their income with the same activity (say wage labour), are considered to have relatively similar household strategies, and thus should be grouped together. For both households, off-farm income is by far the most important source of income, and that is, for our purpose, an important characteristic they have in common. Next step is to look at the farm household characteristics, and see what more they have in common (farm size,

[10] including income from wage labour, salaried jobs, and remittances ('family support' in the questionnaire)

input use, etc.) besides the composition of farm income. Moreover, to shed light on differences in farm characteristics between the farm classes that are distinguished.

3. Farm classification

In this section we first present the proposed farm classification which is based on household income composition. Then we take a look at the regional and farm size distribution of the farmer types, to see whether farmer types are location specific and typical for certain farm size classes. Finally, we relate this classification to how farmers classified themselves during the questionnaire survey to roughly assess the justification of the proposed classification.

Farmer types. Running the hierarchical cluster analysis procedure and interpretation of the output, results in five classes of farms. These classes of farms are quite distinct in their farm household income composition; as such they can be seen as distinct household strategies. In Table 7.1 some of the main characteristics of the clusters are presented.

Table 7.1: *Main characteristics of the farm classification*

cluster	cases	main source of income	income share[1)]	farmer type
1	22	livestock	88	*stock farmer*
2	87	off farm income	74	*wage labourer*
3	32	roots & tuber crops	74	*roots&tubers farmer*
4	21	fruits/vegetables	90	*fruits&vegetables farmer*
5	41	other crop/activity		*(other)*
total	203			

1) in % of total farm household income

In the table, the clusters are labelled ('farmer types'), with the purpose of capturing their main strategy for income earning. This 'farmer typology', or 'farm classification', will be used in this chapter. There are four main farmer types in the Atlantic Zone, the stock farmer, the wage labourer[11], the roots&tubers farmer, and the fruits&vegetables farmer. More than 80 percent of the farmers in the Atlantic Zone can be categorized into one of these four farmer types. Eye-catching is the high degree of specialisation; the four farmer types earn 75 to 90 percent with their main activity. In a way, the classification is based on differences in market *orientation*. The farmer types are similar with respect to the markets in which they operate (the market for meat and milk, the labour market, and the market for crop produce). In the vocabulary of Fresco and Westphal (1988), the wage labourer is

[11] Though it is seems strange to talk about wage labourers as a *farmer* type, we do so in this chapter.

off-farm employment oriented, while the other farmer types are *market oriented*. A farm classification with even fewer classes is possible if we group fruits&vegetables farmers and roots&tubers farmers into a single group, which we could label as 'crop farmers'. Thereby we would end up with a farm classification that only distinguishes between stock farmers, wage labourer farmers, and crop farmers. But because we expect significant differences in resource endowments, factor intensities and income indicators between the two crop farmer categories, we stick to the distinction between roots&tubers farmers and fruits&vegetables farmers. For about 10 percent of the respondents animal husbandry is the main source of income (it constitutes almost 90 percent of their total household income). The major source of income in the Atlantic Zone, proves to be off-farm income. For more than 40 percent of the farmers this constitutes the main source of income. Of the crops, roots&tubers and fruits&vegetables are quite important, with 16 and 11 percent of the farmers specialising in these crop categories, respectively.

Regional distribution. To get a simple picture of the regional distribution of the farmer types and possible differences, in Table 7.2 a cross-tabulation is presented in this regard. The wage labourer is the most important farmer type in all regions, ranging from one third of the farmers in Guácimo, to more than 50 percent of the farmers in Siquirres, stressing the notion that off-farm activities are very important in the Atlantic Zone. The percentage of stock farmers is highest in Pococí. This is consistent with findings by Tilburg *et al.* (1995), who writes that "Pococí region is the most important cattle production area within the [Atlantic Zone], both in terms of herd size and number of farms". Roughly a fifth of the farmers in Pococí and Guácimo are roots&tubers farmers, while this farmer type is almost non-existent in Siquirres. Eye-catching is the fact that fruits&vegetables farmers are mainly located in Guácimo. More than 20% of the farmers in this region can be classified as such.

Table 7.2: *Regional distribution of farmer types (in % of cases)*

	region		
farmer type	**Pococí**	**Guácimo**	**Siquirres**
stock farmer	14	10	5
wage labourer	45	35	54
roots/tuber farmer	21	17	3
fruits/vegetables farmer	1	22	8
other	19	16	30
total	100	100	100

Farm size distribution. Not only regional differences in farmer type occurence can be observed. From Table 7.3 we see that farmer type distribution is related to farm size. Most important fact to notice, is that almost 30 percent of the households with large farm sizes can be characterized as stock farmers, a much higher percentage than for the small and medium farms. 'Small' stock farmers are almost non-existent. On the other hand, the percentage of wage labourers is considerably higher on the small farms, although for all three farm size classes the larger share can be classified as wage labourers. No clear relationship between farm size and the occurence of roots&tubers or fruits&vegetables farmers emerges.

Table 7.3: *Farm size distribution of farmer types (in % of cases)*

	farm size[1]		
farmer type	**small**	**medium**	**large**
stock farmer	2	10	29
wage labourer	57	36	38
roots/tuber farmer	12	19	15
fruits/vegetables farmer	13	8	12
other	16	27	6
total	100	100	100

1) the division between the *small* (n=62), *medium* (n=107) and *large* (n=34) farm size categories is based on the formula: **mean farm size ± ½ standard deviation**. Lower and upper boundaries of the *medium* case are 5.7 and 16.9 ha.

The farmers' self-classification. Respondent farmers were asked the following question[12]; "How would you define yourself as a farmer?". They could classify themselves as either trader-farmer, wage labourer-cum-farmer, salaried farmer, business farmer, or independent small farmer. This follows the hypothetical typology of Atlantic Zone farmers as proposed by Alfaro (1994). More than 90 percent of the farmers classified themselves as either independent small farmer or wage labourer/salaried farmer (roughly 60 and 30 percent, respectively). Only a few farmers consider themselves to be a trader or business farmer (5 and 1 percent, respectively). This low occurence does not necessarily mean that these categories are almost non-existent, but may be attributed to unclarity of the question and answer categories (e.g. trading is business!), and perhaps the attractiveness of characterizing oneself as being 'independent'.

How does this self-classification relates to the classification based on income composition presented in this chapter? The latter classification identifies roughly 40 percent as wage labourers. About 80 percent of these farmers are classified as wage labourers on the basis of their income composition, so we can say that both categories (the self-classified wage labourer/salaried farmer, and the farmer indentified as wage labourer based on his income composition) coincide to a large extent. When seen as a kind of test statistic of the classification procedure used in this chapter, we can say that roughly 80 percent are correctly classified as wage labourers.

4. Production factors

In the previous section, four farmer types were indentified based on income composition. How distinct are these farmer types with respect to factor intensity, credit use, and level of organisation?

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[12] Question nr. 391 of the questionnaire (see Appendix I to Chapter 1).

Factor intensity. To test possible differences in factor intensities, mean values for the production factors land, labour and capital are presented in Table 7.4, with an indication of the significance of the differences between farmer types.

Table 7.4: *Factors of production for main farmer types*

	farmer type				
characteristic	**stock farmer**	**wage labourer**	**roots/tuber farmer**	**fruits/veg. farmer**	**sign.**
land					
farm size (in ha)	29.5	9.2	10.9	9.3	.000
tierra negra (% of area)	82	63	55	70	.148
labour					
family size	3.7	4.9	4.8	3.7	.013
on-farm labour	2.3	2.3	2.6	2.2	.578
off-farm labour	0.1	1.2	0.6	0.4	.001
assets					
livestock (nr/ha)	1.2	0.7	0.4	0.3	.000
machinery use (%)	0	5	44	14	.000
chemical use (qq/ha)	0.2	1.1	2.2	5.0	.000

As we might have expected from the discussion so far, stock farmer have relatively large farms. Surprisingly, the percentage of tierra negra soil is also highest for this farmer type. The stock farmer prefers to use his land as pasture, despite the (assumed) higher crop productive power of tierra negra.

With respect to labour, the table clearly reveals that; a) the number of family members working on-farm is about the same for all four farmer types, b) involvement in off-farm activities is very low among stock farmers, while being quite important among crop producing farmers. For roots&tubers farmers and wage labourers family size is significantly higher.

The use of machinery is quite common among the roots&tubers farmers. With only 14 percent, machinery use is low for the fruits&vegetables farmers. This difference might be explained by the perennial nature of most fruit crops, for which ploughing is not required, while use of machinery can be beneficiary for the cultivation of roots and tuber crops (labour saving, land-augmenting). Almost no stock farmer and wage labourer makes use of machinery implements for land cultivation. For these farmers crop cultivation is of secondary, or even tertiary importance. As might be expected, chemical intensity is highest for the farmers specializing in the crop categories. Livestock intensity is of course highest for the stock farmer, and also quite high for the wage labourer.

Credit use. In Table 7.5 the use of credit for investments in livestock, fruits, palm heart and root and tuber crops are summarized for the four farmer types.

Table 7.5: *Credit use of the farmer types (in % of cases)*

	farmer type			
purpose of credit	**stock farmer**	**wage labourer**	**roots/tuber farmer**	**fruits/veget. farmer**
livestock	**18**	3	6	0
fruit crops	0	0	3	**19**
palm heart	0	2	0	**5**
roots & tubers	0	7	**25**	0

Of course this is almost a tautology; credit for livestock is used by stock farmers only, credit for fruit crops and palm heart is obtained mainly by the fruits-&vegetables farmers, and credit for roots and tuber crops by the farmers that are classified as roots&tubers farmers. The fact that the credit figures 'fit' the farm classification supports its validity, as was the case with the comparison of the farm classification proposed in this chapter with the farmers' self-classification.

Organisation. Also of interest, is that the level of farmer organisation is highest for the specialized crop farmers. Nearly half (47%) of the roots&tubers farmers and a third of the fruits&vegetables farmers participate in some farmers' organisation. For the stock farmers and wage labourers these figures are 18 and 28 percent, respectively.

5. **Production and income**

Table 7.6 summarizes some production characteristics on land use and degrees of commercialisation by farmer type. If we use the typology of farms of the 1970 World Census of Agriculture which is based on the destination of the agricultural output, both the roots&tubers and fruits&vegetables farmers can be categorized as typical cases of commercialized farming (Ruthenberg, 1980). These farmer types sell almost all of both crop and livestock produce. Only 1 to 10 percent of the produce is used for home consumption. The stock farmer and wage labourer are clearly distinct from the former farmer types with respect to output selling. Both stock farmer and wage labourer mainly cultivate crops for home consumption, as the percentages of crop produce sold is only 23 and 41, respectively. But both the stock farmer and wage labourer can also be viewed as commercialized households, the former selling all livestock produce, while the latter is integrated in the labour market.

Table 7.6: *Production characteristics for the farmer types*

	farmer type				
characteristic	**stock farmer**	**wage labourer**	**roots/tuber farmer**	**fruits/veg. farmer**	**sign.**
land use					
pasture area (%)	79	28	14	16	.000
crop area (%)	5	27	49	43	.000
number of crops	0.9	1.4	2.8	2.0	.000
commercialisation					
crop produce (% sold)	23	41	92	99	.000
stock produce (% sold)	100	98	89	89	.013

In Table 7.7 the income indicators are presented for the four farmer types. About half of the stock farmers earn an additional income from crop production, and only a few are involved in off-farm activities. For about half of the wage labourers, crop income is supplementary. A third of the wage labourers earns an additional income from livestock. For roughly a quarter of the crop farmers, livestock income is of some importance for total household income. This is also the case for the fruits-&vegetables farmers. For roughly a third of the roots&tubers farmers off-farm activities are an important source of income. So, although many of the farmers are fully specialized in the activity that distinguishes them from other farmer types, many earn additional incomes from other activities as well.

Table 7.7: *Income indicators for main farmer types*

	farmer type				
income indicator	**stock farmer**	**wage labourer**	**roots/tuber farmer**	**fruits/veg. farmer**	**sign.**
total income (cases)	(22)	(87)	(32)	(21)	
for the household	716,000	672,000	1,010,000	1,276,000	.012
per unit of labour	311,000	225,000	301,000	547,000	.001
crop income (cases)	(10)	(43)	(32)	(21)	
per hectare	8,000	41,000	93,000	140,000	.000
per *cropped* hectare	127,000	111,000	242,000	458,000	.000
per unit of labour	77,000	67,000	264,000	522,000	.000
livestock inc. (cases)	(22)	(31)	(8)	(4)	
per hectare	33,000	15,000	11,000	16,000	.042
per *pasture* hectare	36,000	25,000	25,000	43,000	.535
per unit of labour	268,000	55,000	41,000	80,000	.002
off-farm inc. (cases)	(2)	(87)	(12)	(1)	
per unit of labour	75,000	161,000	53,000	17,000	.010

When we compare labour incomes, we see that these are about the same for the stock and roots&tubers farmers, lowest for the wage labourer, and highest for the fruits&vegetables farmer. The relative security of wage income might compensate for the fact that labour income of wage labourers is lowest. Indirectly, we can deduce from the table the high degree of specialisation of farm labour. For the fruits&-vegetables farmer 95 percent (522,000/547,000) of total income per unit of labour stems from crop production only, and the shares of other income sources (livestock and off-farm) are very small. The same is the case for the stock farmer; livestock income per unit of labour constitutes almost 90 percent of total labour income. The wage labourers' income originates for more than 70 percent from off-farm income (161,000/225,000), with crop and livestock income accounting for 15 and 9 percent, respectively, which makes the wage labourer the least specialised of the four farmer types. The high crop income per (cropped) hectare of the fruits-&vegetable farmer can be mainly attributed to higher levels of chemical use, as discussed in previous chapters. Chemical use by fruits&vegetables farmers is more than twice that of roots&tubers farmers (Table 7.4). The high level of livestock income per unit of labour for the stock farmer is not so much determined by the stocking rate calculated on a per hectare basis, as with the number of cattle *per unit of labour*. Livestock incomes per pasture hectare are not significantly different between the farmer types, while for crop income, land productivity differences are evident.

Summarizing, we observe that differences in labour income from livestock are primarily a matter of scale (land/labour ratio, animal/labour ratio), while differences in labour income from crop production can be mainly attributed to differences in land productivity, as a consequence of differences in input use (chemicals and machinery).

6. **Farmer strategies**

We assume that farmers belonging to a specific farmer type have similar reproductive strategies. These strategies become manifest in the income composition of family labour, and are reflected in differences in resource endowments, resource allocation, input use and productivity, as we saw in the previous sections.

Two important dimensions of agriculture which are relevant for understanding the diversity in farmer strategies and define options for future development are *intensity* and *scale* (Van der Ploeg, 1991). The notion of *scale* can have different meanings. Scale can, for example, simply be calculated as the number of hectares per unit of labour, or number of cattle per unit of labour (Van der Ploeg, 1991). Scale can also refer to the economic size of a firm, in terms of all resources used in production (Ellis, 1988). Seen that way, fruits&vegetables farmers are characterized by a larger scale than roots&tubers farmers, not because of a higher land/labour ratio (which is about the same for both), but because of their higher level of input use. Intensity can have the meaning of production per unit of production factor, for example gross return per hectare.

In Figure 7.1, scale (the land/labour ratio) and intensity (agricultural income per hectare) of the farmer types are depicted, as well as the direction of possible future

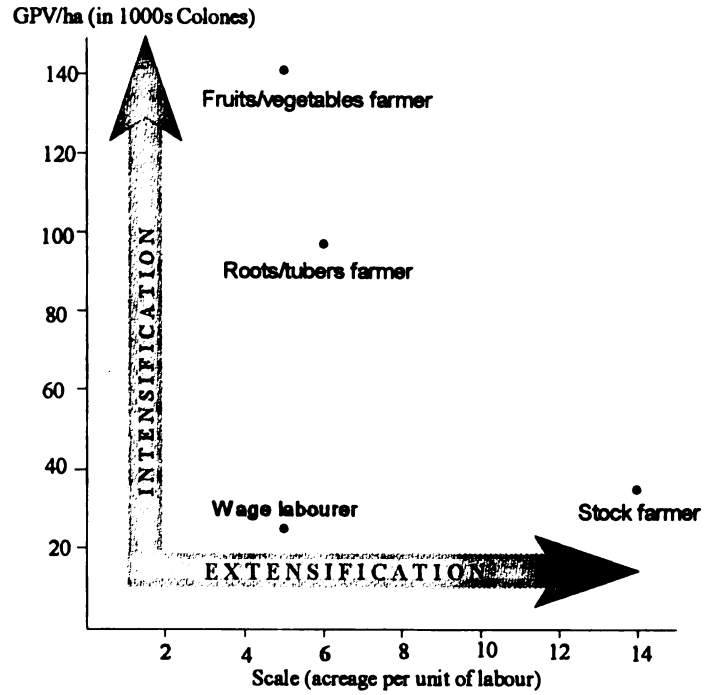

Figure 7.1: *Scale and intensity of farmer types: options for future development*

development (intensification and extensification). From this figure, evident differences in scale and intensity between the farmer types become visible. Livestock farmers are characterized by a low intensity and large scale, and the crop farmers by a low scale and a high intensity. For the wage labourer both intensity and scale are low.

If we define development as increasing labour incomes (which is the product of scale and intensity), what options for future development are feasible? Raising incomes can either follow the road of extensification, intensification, or both. Relative prices of land, labour and capital determine the direction of this 'path of development' (Van der Ploeg, 1991; Hayami and Ruttan, 1985). With only 2 to 3 family members working on-farm, options for increasing the land/labour ratio by releasing (more) labour for off-farm employment is limited. Land might become available with a farmer population growing grey and young people leaving agriculture (see Chapter 2, section 4).

Options for stock farmers to increase agricultural income per unit of labour are twofold; a) increase output per animal, and b) increase the number of animals. Both are intensifying options. Just with increasing the land/labour ratio, incomes will not improve. Possibilities for increasing both the quantity and productivity of animals depend on breeding and feeding practices, and other aspects of animal health care. The livestock-carrying capacity of the land can become a limiting factor, although this can also be increased by more intensive systems of animal husbandry. It is worth investigating in the optimization of interrelationships between crop and animal husbandry. Animal by-products (traction, manure) can be either sold or used for own cropping activities. Own or bought crop residues can be used as animal fodder. With regard to crop-livestock integration, Schiere (1995) writes that "good social relations can exist between cattle keepers and crop producers due to between farm system integration".

Options for crop farmers (the roots&tubers and fruits&vegetables farmer) to raise agricultural incomes per unit of labour also seem to lie mainly in raising incomes per hectare. Income per hectare can be raised by increasing physical yields and by overcoming marketing problems, like low prices offered by intermediaries, storage problems especially in fruit and vegetables (Tilburg *et al.*, 1995). Raising physical yields can be pursued by higher levels of chemical use and mechanisation (chapter 6).

Options for wage labourers are more difficult to pin-point. The incentive for raising agricultural income is probably low, as crop income and livestock income are supplementary. Crop production mainly serves household needs only. As off-farm income become more secure through labour agreements and employment legislation, it is possible that wage labourers move to the origin in Figure 7.1; they leave agriculture, to become professional labourers in the agri-business, in industry, or in services. Whether and when this will happen depends on markets and prices, risk and uncertainty, family life cycle, and other factors. When prospects in crop and livestock production improve relative to off-farm income, it is not unlikely that some will turn into stock farmers or crop farmers.

7. Conclusions

In this chapter a farm classification is proposed for the farm households in the Atlantic Zone of Costa Rica, based on income composition. Income composition is chosen as the classifying criterium, because it is assumed that herein the productive strategy of the household becomes manifest.

Four farmer types are distinguished; the stock farmer (10%), the wage labourer (43%), the roots&tubers farmer (15%), and the fruits&vegetables farmer (10%), together accounting for roughly 80 percent of the farm households. The remaining 20 percent remains 'unidentified' and are not further analysed. The stock farmer and the fruits&vegetable farmer are highly specialised, with 90 percent of total household income coming from animal husbandry and crop production. Specialisation is high for all farmer types, although many earn some additional income from other activities as well. Stock farmers have relatively large farms and are mainly located in Pococí and Guácimo, just like the roots&tubers farmers. Fruits&vegetables farmers are mainly located in Guácimo. Wage labourers are the dominant 'farmer type' in all regions. Membership of farmers' organisations is relatively common among the crop farmers. Crop production of the stock farmer and the wage labourer is mainly for home consumption. Input use (machinery, chemicals) is highest among the crop farmers. Livestock farmers are characterized by a low intensity and large scale, and crop farmers by a (relatively) high intensity and small scale. For wage labourers both scale and intensity are low, as their main interest for earning a living lies outside agriculture. Options for future developement of crop and stock farmers seem to lie primarily in the realm of intensification, e.g. raising production value per hectare/animal.

Policy considerations

1. Introduction

Information about the farm systems in a region (in both a static and dynamic context) is essential for choosing policies for agricultural development. The analysis of farm systems is important to the subject of development, because the farm is the major unit of decision making in agricultural development. Agricultural policies that take into account farm system diversity are more likely to be succesful than policies that assume a high degree of homogeneity of farm systems. Farm classifications can provide a basis for the targetting of agricultural policies. They can also provide a framework for further studies of agricultural development. In this chapter we first address the issue of targetting of agricultural policy in relation with farm classifications (section 2). Expected effects of agricultural policies for the different farmer types are presented and discussed in section 3. The implications for agricultural policy with regard to the proposed farm classification will be briefly addressed in section 4, while section 5 concludes this study.

2. Policy targetting

In almost every country in the world, governments intervene in the agricultural sector, because the market's own allocation is either considered inefficient or unacceptable to (certain groups in the) society. The argument of 'market failure' is usually brought forward as the legitimate reason for these government interventions (Stiglitz, 1987). Many agricultural policies are thus designed to affect the workings of the markets and control the level and stability of prices in those markets. Objectives of agricultural policies can be quite diverse. They can aim at political and social stability, increased export earnings, economic growth, employment, and so on. They can be aimed at the agricultural sector as a whole, *or at specific groups* (e.g. to raise the income of small farmers) or regions (e.g. to improve fertilizer use in a certain province) (Ellis, 1992).

This report is concerned with the farm systems in the Atlantic Zone of Costa Rica. Therefore we are primarily interested in policies that affect the farm system. In recent literature a growing interest for the targetting of agricultural policies can be observed. Ellis (1992) discerns between *administered targetting*, where exclusion and inclusion are determined and administered by specialised bureaucratic agencies, and *self-regulating targetting*, where the population that is targeted is self-defined, by geographical location and/or socio-economic characteristics. Ruthenberg (1980) explicitly links the issue of targetting of agricultural policies to the need for farm classifications, when he says that "for the purpose of agricultural development and to devise meaningful measures in agricultural policy it is advisable to group farms with similar structural properties into classes". Over the last ten years or so, the notion has become common that agricultural research and extension should tailor their products and services to members of so-called 'target categories', who are homogeneous in access to resources, production objectives, and opportunities (Röling, 1988). This 'target category approach' often encompasses not only research and extension alone, but consists of a mix of different policies; "Reaching different categories of farmers requires the targetting of extension and research and often of input, credit and price policies as well" (Röling, 1988). The concept of 'mix' implies that it is the *synergetic combination of instruments* which is effective, and not the perfection of each of the instruments seperately. The target category approach consists of five consecutive steps: (1) *segment* a heterogeneous population into categories, (2) *analyse* farms within each category on aspects which are important to decision making about interventions, (3) *design* intervention programme content and strategy, (4) *test* content and strategy with representative members of the target category, (5) *implement* the intervention so as to cover the intended target category selectively (Röling, 1988). The study so far covered the *segment* and *analysis* steps. So now we can turn to step three, the *design* phase.

3. Policy effects

The aim of this study was to classify the farm systems of the Atlantic Zone of Costa Rica according to similarities in production systems and income composition, as to provide a basis for improved understanding and better interventions.
On the basis of this study it is difficult to come up with detailed policy advices for the four farmer types. We simply lack information on specific aspects, needs, problems and possibilities of the farmer types. Because of this limited insight, we restrict ourselves to some general, tentative policy considerations and implications.
Broadly following Ellis (1992), six policy areas can be distinguished which, in potential, can address the problems that farmers in the Atlantic Zone of Costa Rica face, and which are mainly concerned with badly functioning markets for inputs, outputs, and credit;
(i) *output policy*, which includes price and marketing policy; price policy tries to increase agricultural output and change income distribution through price adjustments; marketing policy aims to improve the structure, conduct and performance of agricultural markets;
(ii) *input policy*, which tries to influence the use of variable inputs (chemicals, seeds, feeds, and others) through the price level, the delivery system, and by means of agricultural extension;
(iii) *credit policy*, which mainly tries to alleviate the capital constraints of farmers by introducing credit subsidies and/or improve the workings of rural financial markets, so that farmers can make investments and purchase (modern) inputs;
(iv) *mechanisation policy*, which aims to influence the pace and direction of farm mechanisation;
(v) *research policy*, which is concerned with the generation and diffusion of new agricultural technology;
(vi) *labour and wages policy*, which tries to influence the nature of labour agreements and the level of wages of agricultural labourers.

Although the four types of farmers have similar problems (e.g. low output prices and capital constraints), this does not necessarily mean that policies aimed at alleviating these problems affect them in the same way. In Table 8.1, a rough 'plusminus' indication is presented of the different effects the aforementioned policies can have on the incomes of the four farmer types.

Table 8.1: *Effects of policies on the income of the farmer types*

policy	stock farmer	wage labourer	roots&tubers farmer	fruits&veg. farmer
	farmer type			
output (crops)	(- /+)	(- /+)	+	+
output (livestock)	+	(-/+)	(- /+)	(-)
machinery	0	0	+	(+)
input	0/(+)	(+)	+	+
credit	+	(+)	+	+
research	(+)	0/(+)	+	+
wages/salaries	0	+	(-)	-

Note: o = no effect; + = improvement; - = deterioration. Parentheses indicate a slight effect.

Policies that change farm gate prices of crops and livestock products will affect the farmer types differently, depending on whether they are (mainly) producers or consumers of the products. If we roughly categorize roots&tubers farmers and fruits&vegetables farmers as producers of crops, and stock farmers and wage labourers as consumers, an increase in the price of crops will be beneficiary to the former (both indicated with a '+' in the table), and detrimental to the incomes of the latter. It is not completely correct though, to label stock farmers and wage labourers only as consumers of crops. In the previous chapter, we saw that half of the stock farmers and wage labourers earn supplementary incomes with crop production. Whether the effect of a price increase of crops will have a positive or negative effect on the incomes of these farmer types, depends on the balance between crop selling and buying behaviour of these farmers, which can be different for each farm household (which is represented by the '-/+' indication in the table). The same line of reasoning holds for policies affecting the price of livestock products. Here, of course, the stock farmers are the main producers of livestock products, and the other farmer types potential consumers. Because fruits&vegetables farmers are not involved in animal husbandry, the effect on household income of higher consumer prices for livestock products will probably be negative. Of the roots&tubers farmers and wage labourers, roughly a quarter earn an additional income with the sale of livestock products, so for them the effect can be either positive or negative, depending on livestock sales and consumption. Marketing policies aimed at improving the workings of the markets for agricultural products have the potential of raising producer prices, while unaffecting retail prices. In the present situation, it is suspected that monopoly profits are earned by rural traders and local export companies, who are in the position of offering very low prices to farmers. Other, competative market outlets are absent or underdeveloped. An output marketing policy aimed at the establishment of more competative markets for agricultural products can bring about potential gains for the producers, while leaving consumers at least unaffected (not in indicated in the table).

With respect to mechanisation, we saw that roots&tubers farmers are the main users of machinery for land preparation, and that machinery use positively affects yields

(chapter 5) and income (chapter 6). As such, there is scope for increased and improved machinery use among the crop farmers, though to a lesser extent for the fruits&vegetables farmer because of the perennial nature of many fruit crops (indicated in the table with '+' and '(+)', respectively). If we define mechanisation more widely as "the use of non-human resources of power for undertaking agricultural tasks" (Ellis, 1992), and not just land preparation, the scope can be wider (picking, sowing, weeding, harvesting, transport).
As we might expect, chemical use is highest among the crop farmers. A policy aimed at making chemicals cheaper, the delivery system of chemicals more effective, and/or farmers better informed about sensible use of these inputs, will therefore primarily benefit the roots&tubers farmer and fruits&vegetables farmer (indicated with a '+'). Of course, this also accounts for other input categories like improved seeds and planting material. The effect of input policies on the stock farmer can be positive when pasture improving inputs, livestock feeds, and other inputs that raise animal productivity, are included in the input policy content.
Many farmers state lack of capital and credit as a major problem for staying into farming. A credit policy aimed at making credit cheaper and/or more easily available can alleviate this problem, and can in potential be beneficial to all farmer types, by facilitating investments in capital and inputs. For example, stock farmers can invest in animals and pastures, wage labourers in education, and crop farmers in land, crops and inputs.
The returns to state investment in agricultural research appear to be high (Ellis, 1992). Research and extension programmes aimed at groups of farmers can be highly beneficial, although to a lesser extent for livestock projects (Crotty, 1980). Research and extension programmes targetted at roots&tubers farmers and fruits-&vegetables farmers might have positive 'spill-over' effects to wage labourers and stock farmers who are involved in crop production (indicated with '(+)'). Fruits-&vegetables farmers are mainly located in Guácimo (see Table 7.2), offering potentials for a 'self-regulating' targetting approach by setting up a fruits &vegetables research and extension programme in this region.
Interventions in wages, labour contracts and collective agreements can improve the situation of wage labourers, when resulting in higher and more secure incomes from off-farm labour. Higher wages can have a negative impact on labour hiring crop farmers. This will be especially the case for farmers growing labour intensive crops, like fruits and vegetables. Stock farmers are probably largely indifferent to higher wages, as they are assumed to make no use of hired labour.

Now that we have discussed the tentative effects of broad categories of policy interventions on the different farmer types, we can now turn to the implications for a target category approach.

4. Policy implications

On the basis of this study and the literature on agricultural policies, we suggest to adopt a target category approach for the Atlantic Zone, aimed at organisations of farmers belonging to one of the the farmer types distinguished in the previous chapter. Whether a target category approach will be feasible and must be implemented for all farmer categories, broadly depends on issues of politics and economics. Programmes which are economically sound, might not be so from a political point of view, and vice verse. This type of considerations are not discussed here, though. Here we only indicate a tentative policy approach that takes into account the diversity in farm systems in the Atlantic Zone.

Farmers' organisations are thought to play a crucial role in this approach, as *partners* in both the design and implementation of an appropriate policy mix consisting of three policy areas; marketing, credit and research. A target *category* approach then becomes a target *group* approach (Röling, 1988). If we assume that the farmer types have similar productive strategies and hence, share interests and problems, there is benefit in the establishment of regional, or even local, farmers' organisations of stock farmers, roots&tubers farmers, fruits&vegetables farmers and wage labourers. Why should these three policies make up 'the mix', and why put emphasis on farmers' organisations? In literature on agricultural policies, explicit mention is made of favourable aspects of linking agricultural policies to farmers' organisations;

Marketing policy. Agricultural production in the Atlantic Zone is mainly market oriented (Alfaro, 1994; this survey). Insecure markets and unstable prices are mentioned as major problems. Rural traders and local agricultural export companies are the main marketing channels in the region. Because of the monopsony power of the rural traders and the empacadores, farmers are confronted with very low prices for their produce, and often have to deal with defaulting buyers (Akkermans, 1993; Tilburg *et al.*, 1995).
The view that private traders are able to exploit scattered and ill-informed farmers by the excise of local monopoly power is widely prevalent as a reason for marketing interventions (Ellis, 1992). In this regard, Ellis stresses the need for the creation of farmers' organisations to substitute for private 'parasitic' traders.

Credit policy. Working capital is often needed to finance higher/better levels of input use. In chapter 6 we saw that the use of chemical and mechanisation contribute to higher yields and as such are explanatory variables for the observed variation in yield. Farmers themselves mention productive advantages of land preparation with ploughs (Akkermans, 1993). Farmers state the lack of access to credit as a major problem. Of the distinguished farmer types, about 20 to 25 percent have credit, mainly provided by banks (Chapter 3). State credit provision, often at subsidized rates, has been the traditional response to badly functioning rural finance markets. Experience with this type of intervention indicate that it fails to create sustainable rural financial markets. Group lending and group accountability for loan repayments have proven to be more promising ways of organising loans. Groups can be formed according to common interests (Ellis, 1992). So, also with respect to the search for more efficient and effective credit policies, advantages of farmers' organisations have been recognized.

Research policy. Research policy deals with the generation and diffusion of new agricultural technology. The late 1980s and early 1990s saw a shift in emphasis from 'farming systems research' to 'farmer first research', which sees the transmission of new technology as a circular process, starting and ending with farmers (Ellis, 1992). "Let farmers define the research agenda", says Van der Ploeg

(1991), which is typical for this new approach. According to Hayami and Ruttan (1985) interaction between farmers, researchers and administrators is likely to be most effective when farmers are organized into (...) local or regional farmers' organisations.

In summary, agricultural policies are likely to be most effective when policy specification and implementation is done in cooperation with farmers' organisations. Tilburg *et al.* (1995) and Akkermans (1993) stress the importance of farmers' organisations in the Atlantic Zone as (i) 'countervailing' market powers, (ii) a way to finance production and marketing, and (iii) to facilitate direct contact between domestic and foreign markets. Quoting Röling (1988): "Improving rural lives, enabling people to utilise technology and obtain credit and inputs, marketing produce, and defending farmers' interests, requires organisation (...). Farmers' organisations can bargain for better prices, a greater share of resources and better opportunities and can help to make research agencies relevant to local needs, potentials and realities". Policy makers and farmers' organisations can thus become partners in the specification of policy strategy and content. In a way, this is a mix of administered and self-regulating targetting (see above). It is administered in the sense that policy makers only 'do business' with farmers' organisations, and it is self-regulating in the sense that farmers' can decide for themselves whether to join an organisation or not. How to set up farmers' organisations, why they do not come into existence by themselves, why existing farmers' organisations function poorly, and how to prioritise interventions among farmers' organisations, is another question.

5. Conclusions

For agricultural policies to be more effective and efficient, a target category approach is called for. The farm classification proposed in this study provides a basis for this approach. It covers the segmenting of the farmer population and provides analyses on aspects which are important to decision making about interventions. The farmer types distinguished are relatively homogeneous in access to resources, production objectives, and opportunities for future development. The fact that policies can be targetted to a specific farmer type, does not necessarily mean that other farmer categories remain unaffected. Neither farmer type is fully specialized; some crop farmers are also involved in off-farm labour, some livestock farmers are also commercially involved in crop production and many wage labourers have cattle and grow crops. Possibilities for agricultural policies to be more efficient and effective probably lies in aiming specific marketing, credit and research policies at organisations of stock farmers, wage labourers, and crop farmers. The target *category* approach then becomes a target *group* approach. Policies are not targeted at categories of similar individuals, but at organised groups of farmers with similar interests. As such, policy makers and farmers' organisations can become partners in tackling the problems of insecure markets, unstable prices, and capital constraints.

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