Diplomarbeit
zur Erlangung des akademischen Grades Diplom-Agraringenieur
an der Fakultät für Agrarwissenschaften der Universität Hohenheim

Early adoption of *Arachis pintoi* as a forage legume by farmers in Huetar Norte, Costa Rica

Tobias Wünscher

eingereicht am:

Institut für Agrar- und Sozialökonomie in den Tropen und Subtropen
Fachgebiet Landwirtschaftliche Entwicklungstheorie und Entwicklungspolitik
Prof. Dr. rer. pol. Franz Heidhues
und
Institut für Pflanzenproduktion und Agrarökologie in den Tropen und Subtropen
Fachgebiet Biodiversität und Landrehabilitation in den Tropen und Subtropen
Prof. Dr. Rainer Schultze-Kraft

Diese Arbeit wurde gefördert aus Mitteln der Vater und Sohn Eiselen-Stiftung, Ulm

Hohenheim, Juli 2001

7 Summary

In the summary the most important aspects of all chapters will be summarised. The summary therefore follows the same sequence of chapters as was applied to the main part of this study.

Introduction

Degradation of pure grass pastures is a frequent problem in the tropics. Reason for that is, among others, the problem of insufficiently adapted pasture species. The legume *Arachis pintoi* was found to show a number of characteristics which can contribute to the development of sustainable and productive pastures in the tropics. For these reasons *A. pintoi* was introduced to Costa Rica in 1987. Yet, the process of adoption of new forage technologies is complex and slow. Therefore the objective of this study is to answer the following research questions:

1. What is the adoption rate of *A. pintoi* as a forage legume by farmers in Huetar Norte?
2. What are the factors with an influence on adoption and to what extent do they influence adoption?
3. What are the experiences cattle owners have so far made with *A. pintoi*?
4. Do farmers have an economical benefit from *A. pintoi*?
5. What could be done to accelerate the diffusion process (recommendations)?

Theory

All definitions of innovation have in common that they try to describe innovation as a new or further development in comparison to the status quo (GABERSEK 1990). There are also a number of different classifications of innovation. One of the most frequently quoted classifications is that of KNIGHT (1967) who distinguishes, among others, product, service and process innovations.

In agri-sociological literature adoption is described as the taking-over of an innovation by an individual or another "taking-over unit". Some authors work with a variable of two values for "yes, adoption has taken place" and "no, adoption has not taken place". Other authors work with a continuous variable describing the extent of adoption. The adoption process was described by WILKENING (1953) to pass through five stages: The awareness stage, interest stage, evaluation stage, trial stage and adoption stage. Campbell (1966) extended this model. ROGERS (1958) divided adopters into 5 categories: Innovators, early adopters, early majority, late majority and laggards. Whether or not adoption takes place is influenced by characteristics of the innovation itself, by characteristics of the farmer and by characteristics of the society which the farmer lives in.

SCHULZ (1977) describes diffusion as the process of dissemination of an innovation among all potential adopters. The process is often illustrated by a S-shaped curve. Planck and Ziche (1969) explain the shape of the curves on unstructured communication between potential and actual adopters. Lionberger (1963) offers a similar approach, but it is based on structured communication. The structured communication takes place among innovators, key communicators and influentials. Some diffusion processes stop at a certain stage. HARTMUT ALBRECHT (1969) developed a model based on force fields. The force fields can support or hinder the diffusion process. Based on these

force fields ALBRECHT divides the diffusion process into four phases: Disturbing phase (the innovator as a trouble-maker), critical phase (the diffusion process gets going or stops), starting-off phase (the diffusion process turns into a self supporting process), slowing-down phase (the diffusion process gradually comes to an end).

Research region and research object

Costa Rica is situated in Central America. It has an area of 51 100 km^2 and a population of 3.3 million people. Climate is very diverse. Annual rainfall can be up to 6 000 mm. Costa Rica is divided into six regions following socio economical aspects. One of the regions is Huetar Norte. Agriculture contributes to 17% of the gross national product. Beef is one of the most important agricultural goods. In 1992 Costa Rica dedicated about 32% (16 500 km^2) of its national territory to cattle farming. There is an export market for milk. Three cattle production systems can be encountered: Specialised milk production, dual purpose and specialised beef production.

Huetar Norte has an area of 9 804 km^2 (21% of national territory) and a population of 227 205 people. Climate is very diverse. Annual rainfall ranges from 3 000 to more than 4 500 mm, average temperatures from 20 °C to 25 °C, the region's altitude from 20 to 2 000 m above sea level. Most common soils are inseptisoles and ultisoles. Of the commercially used land in Huetar Norte 73% is covered by pasture. 48% of the total milk production of Costa Rica originates from Huetar Norte. Crops and perennials are grown on approximately 90 000 ha. Of these, oranges cover 20 000 ha and beans 13 000 ha. Costa Rican government buys large farms and distributes them to landless people. In Huetar Norte 10 533 families have received land within this programme. The MAG employs 13 extension agencies with 74 extension workers in Huetar Norte.

Arachis pintoi originates in South America. It had been brought to Costa Rica in 1987. The legume is used as a pasture plant, as a cover crop in plantations, as a ground cover on roadsides and steep slopes, and as an ornamental plant. It forms a dense layer of stolons. It grows relatively well in acidic and highly aluminium-saturated soils. It survives long dry periods, tolerates shade and as a legume it fixes nitrogen. The initial establishment is slow but, once established, the legume is persistent due to its good stolon and underground seed production. Eradication can be difficult. It can be grown pure to form protein banks or it can be grown in association with grass species. It can be sown from seed or stolons. The various methods to establish it differ substantially in total costs, labour input and success. *A. pintoi* can be fed to various animals including horses, donkeys, sheep, goats, pigs and chicken. The leaves have a high protein content and good digestibility. With relatively little area of pure *A. pintoi* good extra weight gains can be achieved. Jansen et al. (1999) showed that a pasture association with *A. pintoi* is more profitable than another improved pasture system.

Methodology

Huetar Norte was chosen to be the study region because both milk and beef production are predominant farming activities. It was decided to gain relevant information by means of thoroughly structured interviews. The farmers were visited on their properties to be directly and personally interviewed. Target population were livestock holders and owners of pastures. The frame popula-

tion was a list of 7131 livestock holders. A simple random sampling was applied to the frame population. 115 interviews were conducted within the simple random sample. 34 more farmers were interviewed in a directed sample. Two questionnaires were used in the interviews. A smaller version for the random sample which took 15 to 30 minutes, and a longer version for farmers known to have already worked with *A. pintoi*. This version took 45 to 90 minutes. In this study the concept of the "single practice adoption behaviour" is followed. Hence, farmers either qualify as adopters or they do not. Interviews were conducted by 21 MAG extension workers and the author of this study. The questionnaire was thoroughly pretested. All interviews were conducted between the 4th of January and the 29th of March 2000. The collaboration of the farmers was outstandingly good. An "agreeing tendency" or "social-desirability-response-set" (SCHNELL ET AL. 1999) was occasionally observed. Reasons for dropouts were, for example, poor quality addresses, farmers who could not be encountered, lack of vehicles and illness. Despite of dropouts and other frame-population related errors, the realised extent of the survey gives reason to assume that the raised data allows meaningful results.

The average farm size in the random sample is 69.8 ha. The average farm is made up of 52.5 ha of pasture, 3.3 ha of perennial plantations, 1.9 ha of annual crops and 12.1 ha of land with other uses like woods. 98.6% of all pastureland is the property of the interviewed farmers. The average herd size is 86.4 head of cattle per farmer. 96.1% of all cattle are the property of the interviewed farmers. The most frequent pasture species is Ratana (Ischaemum indicum). The most frequent improved pasture species is Estrella (cynodon nlemfuensis). 104 farmers (90.4%) had already heard about *A. pintoi* and 29 farmers (25.2%) had already sown the legume on their land, mostly for ornamental purposes. 8 farmers said to have sown it for farming reasons. Of these, 6 sowed it for the use as forage legume. Of these 2 had already rejected it.

Empirical Analysis

The empirical analysis consists of two parts. The first is the descriptive analysis, the second the econometrical analysis.

Comparison of adopters and non-adopters

Adopters have an average age of 44.0 years whereas non-adopters have one of 49.9 years. 42.4% of the adopters and 6.4% of non-adopters have gone to university or technical college. Adopters acquire information about farming matters more intensely than non-adopters do. For example, 66.6% of adopters and only 34.3% of non-adopters have visited at least one workshop in 1999. Adopters lived at an average distance of 8.4 km (as the crow flies) to the nearest "*Arachis pintoi* centre" (e.g. ITCR), non-adopters at an average distance of 11.6 km. Adopters have an average farm area of 128.2 ha and an average herd size of 196 animals compared non-adopters with an average farm area of 69.9 ha and an average herd size of 86 animals. Adopters have an average of 93.2% of total land as pastureland, whereas non-adopters hold 74.7% of total land as pastureland. Adopters have herds with an average of 49.8% being dairy cattle, whereas non-adopters have herds with only 19.8% of dairy cattle.

Adopters and non-adopters have a similar problem structure in on-farm on-farm forage production. The most prevalent problems of adopters and non-adopters in on-farm forage production are "abundance of rain", "pests and diseases" and "weeds and Ratana". Very few saw a problem in soil erosion (27.3% and 26.5%). Both adopters and non-adopters prefer to improve existing pastures instead of increasing the pasture area (87.9% and 84.7%). 53.3% of adopters and 75.6% of non-adopters would do this by sowing improved pasture species. Most prevalent problems of adopters and non-adopters in cattle production are "pests and diseases", "low pasture quality", "excess of rain" and "low prices, bad market". The improvement of pasture was seen by 34.4% of adopters and 40.9% of non-adopters as the most important tool to improve cattle production.

42.4% of adopters and only 15.0% of non-adopters belong to the highest gross income category. Similarly, only 9.1% of adopters and 17.8% of non-adopters belong to the lowest income category. Of all adopters and non-adopters who have applied for credit 94.7% and 91.7% received it. Adopters generate 68.8% of total income with cattle and 8% with off-farm activities. Non-adopters generate only 54.7% with cattle but 23.1% with off-farm activities.

Adopters and their experiences with A. pintoi as a forage legume

The majority of adopters received information about *A. pintoi* through the MAG (40.6%) and the ITCR (15.6%). 59.4% of the adopters acquired the planting material from one of the three "*Arachis pintoi* centres". The majority of plots were sown with stolons (82.2%). The reason for planting *A. pintoi* was in 50% of all answers intention to improve pasture quality. 51.5% of all adopters planted *A. pintoi* in association with grasses. 48.5% planted it pure. The majority of farmers feed it to all types of cattle, some only to milk cows, calves or sick cattle. The 4 adopters in the randomly selected sample have planted a total area of 3,65 ha with the legume, which is only 0.0006% of total pastureland in this group. Within the group of all interviewed adopters (33 farmers) the total area planted with the legume was 73.87 ha.

Of all adopters 87.9% or 29 farmers said to be satisfied with the results they have so far obtained. 3 farmers (9.1%) said to be more or less satisfied and 1 farmer (3.0%) said to be not satisfied. Advantages of the legume were seen in "good quality feed" (36.6%), "increases cattle production" (15.9%), "persistence" and "ability to improve soil fertility". Most frequent disadvantages mentioned by adopters were "attracts slugs" (12.8%) and "difficulty of broad leaf weed control". The majority of the adopters found that the establishment of *A. pintoi* is slow. 73.1% of the adopters said that their cattle did not need time to get used to the legume. 37.5% of adopters said *A. pintoi* can disappear when mixed with improved grasses. Nearly a third of the adopters found it performed better than other improved grass species in the dry season. 81.8% of adopters want to increase the area planted with *A. pintoi* in the next five years.

Establishment and maintenance costs differed substantially within the group of adopters. The establishment costs ranged from 57.60 US$ to 348.67 US$ per ha. The maintenance costs ranged from 6.40 US$ to 91.39 US$ per year. The maintenance costs for other pastures ranged from 34.67 US$ to 156.67 US$ per year. On nearly all interviewed farms the maintenance of the *A. pintoi* establishment was less cost intensive than the maintenance of another pasture. The largest dif-

ference in maintenance costs between an *A. pintoi* establishment and another pasture on the same farm was 114.00 US$ per year. Not a single farmer who had planted Maní forrajero had taken credit to pay for the investment.

Non-adopters and their perceptions of A. pintoi

Of 109 interviewed non-adopters, 98 (89.9%) have already heard about *A. pintoi* and of these 22 said to have already sown it on their farm, mostly for ornamental purposes. The majority of non-adopters (51.6%) has obtained information about the legume from colleagues, neighbours or friends. 62.4% of the non-adopters expressed the knowledge that the *A. pintoi* is used as a feed for cattle. 55 (58.5%) of the farmers think that the legume could serve them on their farm. The majority of these farmers would use it in association with grasses for grazing (51.7%). Most frequent reasons for not using the forage peanut for farming purposes on own land was "lack of information" (27.9%) followed by "seed is not readily available" (13.4%).

Rejecters and their experiences with A. pintoi

Of the 7 rejecters in this survey most important reasons for planting the legume were good qualities as a feed, the incorporation of nitrogen into the soil and its aggressive growth. The main disadvantages were seen in cost intensive establishment and little persistence. It was stated that it does not compete well because of its low growth and because of cattle liking it too much and too heavily grazing it. Other disadvantages mentioned are: low growth causes intensive work to cut it. Cattle need time to get used to it. It attracts slugs. It requires good soil.

Econometric Analysis

One of the objectives of this study was to assess the influence of a number of factors on adoption of *A. pinoi*. In order to do this, an econometric analysis was applied. In this analysis a logistic regression model was used. 21 independent variables were examined. The dependent variable was adoption. 7 variables were eventually used for the model. Of these, 5 variables have a significant influence on adoption. The most significant variable (1%-level) is "education". All other significant variables ("distance", "information", "problem with lack of fertiliser", "percentage of improved pasture") have a significance level of 5%. All variables but "distance" have a positive influence on adoption. The results are to be interpreted in the following way: The better the educational level of a farmer the larger the probability that the farmer is an adopter. The larger the distance between a farm and the nearest "*A. pintoi* centre", the smaller the probability that the farmer is an adopter, etc.

Discussion and Recommendation

It was shown that the estimated adoption rate of *Arachis pintoi* as a forage legume is very low in Huetar Norte. An estimated 3.48%, or 248 farmers had planted an estimated 0.0006% (252 ha) of total pastureland. Thus the diffusion process is at a very early stage. The future development of the adoption process is very unstable because the percentage of adopters and area is very small and some of the adopters are still in the trial stage according to WILKENING (1953).

In the econometrical analysis 5 factors were found to significantly influence adoption. These are the distance of the farm to "*A. pintoi* centres", the level of education, the acquirement of information, percentage of improved pasture and the presence of the problem "lack of fertiliser". Distance of farm to "A. pintoi centre" negatively influences adoption because availability of information and availability of planting material decreases with increasing distance. The education level positively influences adoption because individuals with a higher level of education tend to be more open minded to progress and changes and thus tend to have a stronger interest in innovations. They also have better access to information. Acquisition of information positively influences adoption because farmers who go to workshops, read magazines and belong to a farming organisation have more information at hand and also have more social contacts to exchange information. The percentage of improved pasture positively influences adoption because it is assumed that there is a general sequence of pasture development following the pattern: natural pasture species, introduction of improved grass species and, eventually, introduction of legumes. Lack of fertiliser positively influences adoption because *A. pintoi* delivers a fertiliser substitute through the fixation of nitrogen.

Most critical experiences that have been made with *A. pintoi* are those encountered during the establishment of the legume and those regarding persistence. The establishment was seen by a lot of farmers as a very time consuming, costly and longsome matter. Persistence was often seen to be missing. After establishment farmers generally reduced expenditures in maintenance and thus experienced an economical benefit from the legume.

In order to accelerate the adoption process it is recommended to find technologies that ensure a relatively cost extensive and secure establishment of the legume as well as technologies that ensure its persistence. Moreover, it is recommended to intensely train extension workers and ensure a number of establishments in a very good state.