Der Tropenlandwirt, Beiträge zur tropischen Landwirtschaft und Veterinärmedizin,
97. Jahrgang, April 1996, S. 3 - 16.

Adoption and Adaption of Contour Hedgerow Farming in the Philippine Uplands: Results of an Early Case Study

M. Stark*

Key words: agroforestry, soil and water conservation, contour hedgerow farming, adoption, on-farm research.

Abstract

In 1992 the International Institute of Rural Reconstruction (IIRR) conducted a survey to identify possible modifications in the technical design of an agroforestry practice for soil rehabilitation newly introduced to a degraded upland area in the Philippines. Simultaneously to the on-farm assessment of selected tree species for contour hedgerow farming, an interview survey on the adoption of the agroforestry innovation by local farmers was conducted. The paper presents some of the relevant findings of this survey. The main constraint in the adoption of the contour hedgerow farming technique seems to be its high labour demand in the establishment and maintenance of the technology. Among the examined social and economic factors which possibly influence the adoption process only household size and gender ratio showed statistically significant differences between the relatively small adopter and non-adopter sample groups. A lower number of household members and a higher percentage of female members who do not usually help with the hard labour of establishing contour hedgerows could prevent farmers from trying and adopting the innovation. Modifications of the technology and promotion of more simple alternative options together with a more flexible extension approach are recommended.

1 Introduction

In the Philippine uplands soil erosion has become a serious threat to the productivity of cultivated land during past decades - mostly the result of population increase, lowland-upland migration, excessive logging and mining and large-scale commercial farming [18]. The ban on shifting cultivation, the enforcement of a new land reform - the 'Comprehensive Agrarian Reform Law' of 1988 [17] - and the implementation of the 'Integrated Social Forestry Programme' in 1982 by the Philippine Government, has not yet prevented upland soil erosion [18]. A number of governmental and non-governmental organisations concerned with rural development in the Philippines have introduced

* Marco Stark, Teichstr. 2A, D-23701 Eutin.

agroforestry technologies to rehabilitate degraded upland soils. Although agroforestry has got the unique opportunity - as a comparatively recent arrival on the development scene - to incorporate new strategies into its approach to technology-generating research, adoption rates of agroforestry innovations are still low.

It has become obvious and generally accepted, however, that low adoption rates are not due to farmers' ignorance, but to the inappropriateness of many of the introduced methods [21]. In most cases the technical design of the innovation does not match with very specific bio-physical, and especially socio-economic features.

Answers to the question "Why farmers do not adopt new or improved technologies?" must serve as the basis for future strategies to increase the adoptability of innovations. Investigation of factors possibly influencing the adoption process are not only necessary at the design and development stage of a potential innovation, but also at the time the new technology is introduced and disseminated among farmers. In an iterative process of 'rediagnosis' and 'redesign' [16] researchers, extensionists and farmers can join efforts to modify the technical components of a candidate innovation as well as adapt the extension approach, and thus accelerate the adoption process. The present paper addresses the above questions and identifies future development needs for the case of a newly introduced soil and water conservation technology among small-scale farmers in a degraded upland area in the Philippines.

2 The soil and water conservation project

2.1 The technique

The International Institute of Rural Reconstruction (IIRR) has started a number of on-farm research programmes in the Philippines to improve rural farming conditions. IIRR, established as a research and training centre in 1960, is a private, non-profit rural development agency. It is a direct outgrowth of the 'Mass Education Movement' in China which was founded by Dr. Y.C. James Yen after the First World War [12]. In 1991 IIRR introduced improved farming practices, including agroforestry technologies, to a degraded upland area in the province of Cavite through farmer-to-farmer dissemination. The emphasis was on the so-called 'Soil and Water Conservation' (SWC) technology, a contour hedgerow farming practice developed in the 1970s by World Neighbors (a private development organisation) as part of their 'Sloping Agricultural Land Technology' (SALT) for the rehabilitation of degraded Philippine uplands. The soil and water conservation system for sloping areas normally uses a combination of all the following features:

1. Contour canals which hold the water on a field, allowing more water to percolate into the soil, thereby increasing soil moisture and ground water supply.
2. Contour hedgerows of perennials planted closely together along the contours, forming a living wall. This barrier blocks the rainwater's pathway while soil is caught behind the plants.

3. Drainage canals that intercept run-off water coming from adjacent fields above the farm and/or drain water from the contour canals.
4. Check dams which help prevent gully erosion by slowing down the downward movement of water in the drainage system.
5. Soil traps to further slow down water movement. Heavier soil particles settle on the bottom of the traps, thus keeping them from being washed away.

The vegetative plant barrier with its productive as well as protective functions usually consists of a double hedgerow of multipurpose trees and a single row of Napier grass *(Pennisetum purpureum)* below. The distance between hedgerows depends on the slope. For a slope of 15%, an alley width of 6 to 8 metres is recommended. Basic maintenance operations are needed to keep the system intact. These are: weeding and pruning of hedgerows, removing accumulated soil from canals and soil traps (and re-distributing it to the fields above) and clearing check dams of debris and soil deposits [11].

2.2 Features of the project area

The village Layong Mabilog was selected for the implementation of the agroforestry programme, because it is located in a particularly degraded upland area. An initially conducted participatory rural appraisal (in 1991) had identified soil degradation, low yields, increasing shortage of fuel wood, scarcity of green feed during dry season, weeds and drought as farmers' main problems. During one of the traditional village meetings, IIRR extensionists suggested introducing the SWC technology to address the identified major problems, and a number of farmers expressed their interest to participate in the programme.

The village Layong Mabilog is located at the foothills of a mountain range which builds the border between the provinces Cavite and Batangas on Luzon Island (Fig. 1). The terrain is rolling to steep, with an average slope of 8 to 15 percent and an altitude between 50 and 250 m above sea level. Houses are scattered throughout the village and usually located within the farmer's respective land. According to village elders, the area used to be mostly under forest cover until the lowlands were converted into 'sugar lands' during the boom of the sugar industry in the 1970s. To meet the need for fuel the upland areas were cleared leaving only shrubs and grasses.

The climate of the area is semi-humid and characterised by two pronounced seasons. the dry season from November to April, and the wet season during the rest of the year. Annual average rainfall is approximately 2.600 mm [5]. In 1992, the area faced a prolonged dry season with hardly any rainfall until June. The soil in the area is classified as clay loam, which is by origin residual soil of volcanic tuff, belonging to the 'Magallanes Series'. Organic matter content is fair (1 - 1.5%), the NPK level low and the pH of cultivated soils ranges between 6.4 and 5.2.

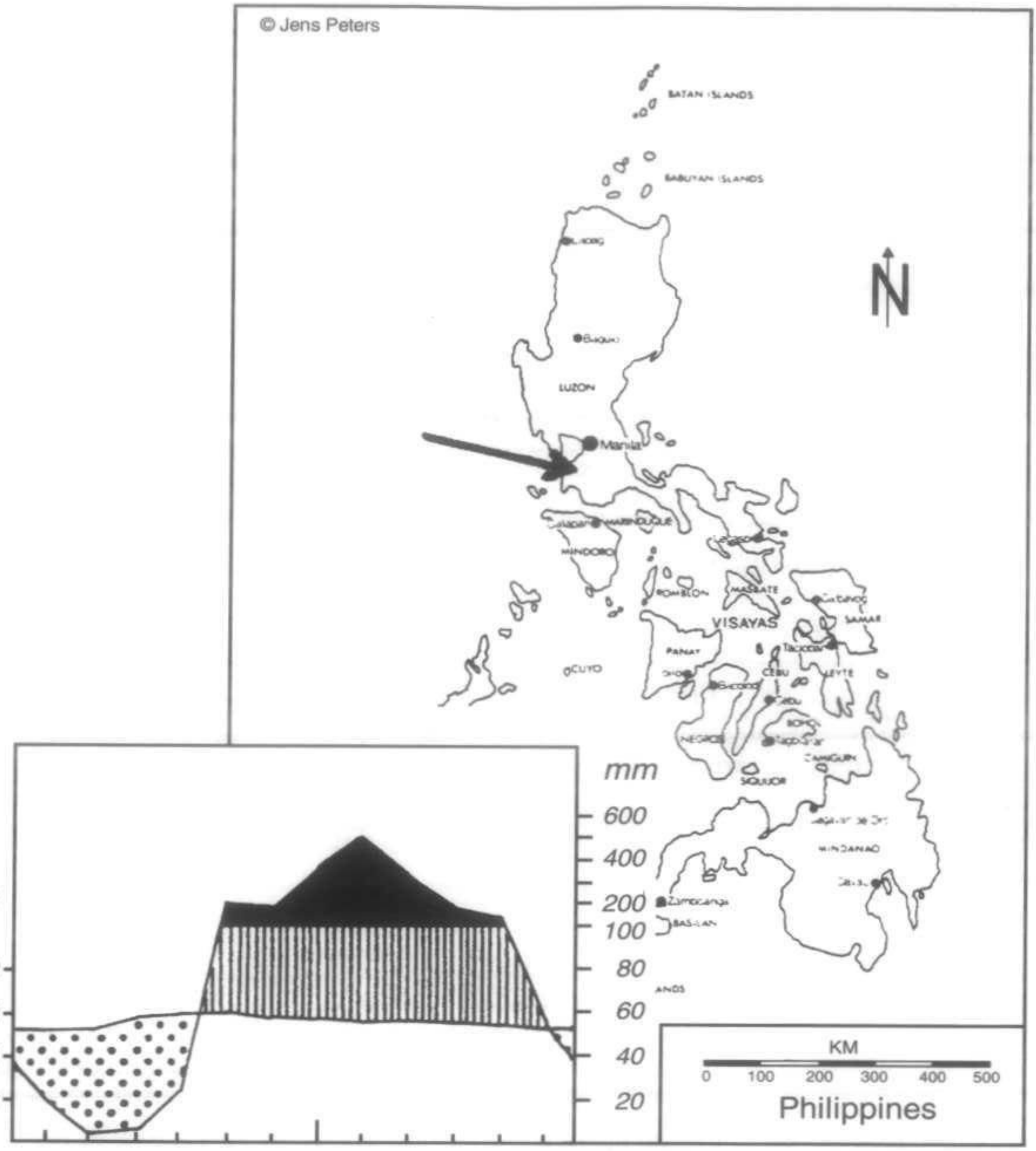

Figure 1: Locational map of the project area (Source: [15]) and climatic diagram for the province Cavite (Source: [6])

The number of households in the village is 144 with a total of 651 inhabitants, equivalent to 145 people per square kilometre [3]. Corresponding with the country's literacy rate of 94% in 1990 [14], villagers in Layong Mabilog have a high educational level. Access to land varies in the village, farmers are mostly share-holders. The prevailing labour arrangements are either hired labour or the exchange of labour [1]. Land use in the study area is predominantly subsistence farming, and each farming family has an average land area of 3 to 5 ha. The main crop is upland rice, but only 0.5 to 1 ha of the farmers' lands are devoted to rice cultivation. Most farmers use approximately 0.25 to

0.5 ha of their land for bamboo production for 'lumber', especially in areas that are prone to erosion (i.e. big gullies and along creeks). Other secondary crops include maize, pigeon pea, vegetables, bananas and other fruit crops which are partially sold. Land which is not planted with a crop is either left fallow or converted into temporary pasture until it becomes shrub land. This is true for farmers holding more than 3 hectares. The rotation period for rice production is between 2 and 4 years, for steep lands up to 10 years. Before these lands are cultivated again, they are cleared traditionally by slashing and burning. Cattle and carabao are commonly used in land preparation. Other domesticated animals in the village include swine, goat and chicken.

3 Objectives and methodology of the adoption survey

Until late 1992, out of the 112 farming households in the project area Layong Mabilog 35 farmers had participated in the training in the Soil and Water Conservation technology, which included informal lessons in theory and practice by the IIRR staff and trained farmers, including discussions and visits to successful project sites outside the area. By the end of 1992, one and a half years after initiation of the project, a total number of twenty farmers had started using the method on part of their land. Most of these farmers are still in the 'trial' stage with respect to the adoption process and have devoted between 1000 to 2000 m^2 of their land to the new technique, while a few innovators are gradually increasing their area under SWC coverage and are keen to convince other farmers of the technology's benefits.

Figure 2: Intergrating perennials into annual crop production systems increases the productivity and sustainability of the system - an indeigenous intercropping practice in Layong Malibog [20].

As part of IIRR's research concept to adapt the introduced technology to farmers needs and to specific socio-economic conditions, a survey was conducted by the author in October 1992. IIRR wanted to know why certain farmers had adopted or tried the innovation while others were still hesitant. Within the given facility and time frame, the emphasis of the study was on a mainly quantitative investigation of social and economic factors in the technology adoption process. Specifically, objectives were:

1. Identification of social and economic factors influencing the innovation's adoption,
2. Information on farmers' attitudes towards the introduced technology, and
3. Identification of farmers' present main problems, goals and ideas concerning the SWC and other conservation technologies, and farming in general.

The data collection method employed in the study was that of a systematic questionnaire. The structured questionnaire used both pre-coded and open-ended questions, with emphasis on collecting quantitative information. Additional (qualitative) information was obtained by the author through direct observation at the time the interviews were taken and during his stay in the village, and through informal discussions with key informants.

The total number of 20 adopters, all having attended IIRR's training, were the respondents for the treatment ('adopter') group in the present study. Because the period after project implementation was relatively short, no other farmers could be identified to date as adopters of the SWC technology (or its modified version). Respondents for the control group were identified by simple random sampling from the total of non-adopter farming households, trained and not trained by IIRR. For the purpose of the study a rather broad definition for 'adoption' was used, i.e. not only farmers which applied the innovation on a large scale in preference to old methods were included [24], but also farmers who had tried the technology once on part of their land, had maintained the SWC structure and continue the practice or plan to increase their area under SWC coverage. Eventually a total number of 20 adopters and 18 non-adopters were interviewed. The reason for the difference in number is that one respondent of the control group was initially mistaken as a non-adopter.

Most data was coded and analysed with the 'Special Program for Social Science' [19] by cross-tabulation and subsequent chi-square test to prove significant differences between adopter and non-adopter sample groups for selected socio-economic factors. The answers to a number of open-ended questions were processed 'by hand' and interpreted qualitatively. The limited number of respondents made it necessary to use broad classifications in coding the data for the statistical analysis, and results can only show general trends.

4 Results

Most of the investigated household and socio-economic characteristics listed below did not show significant differences between respondent groups. This might be related to the relatively short time period since the introduction of the SWC technology and the limited number of respondents.

List of key factors of the household survey

- Household size, labour force and gender ratio
- Age of household head, educational attainment and experience in farming
- Land tenure arrangement
- Area left fallow and area affected by soil erosion
- Ownership of draught animal (carabao, cattle)
- Income and income sources
- Shortage of fodder and firewood
- Traditional knowledge and use of soil and water conservation practices
- Farming related problems and future goals
- Attitude towards SWC technique promoted by IIRR

Only the factors 'household size' and 'gender ratio' showed statistically significant differences between treatment and control group. For most other key factors, however, general trends could be detected.

4.1 Adoption of the SWC technology as related to household characteristics

Most of the family farms in 'developing countries' are characterised, among others, by their sub-optimal size and seasonal bottlenecks in the availability of labour [9]. The size of the twenty adopter sample households lies between 2 and 12 members (mean: 6.2), while the size of the eighteen non-adopter sample households ranges from 3 to 9 members (mean: 5.7). The higher number of adopter household members, i.e. a number greater than 5, was statistically significant at the 5% level (Fig. 3).

Closely related with the household size is the labour force which can be calculated, according to STRÖBEL (1987), from the economically active population as follows:

	years	count (m.e.)
Adult	**16 - 55**	1.0
Adolescent	**14 - 16**	0.8
Senior adult	**> 55**	0.5

The unit 'm.e.' stands for 'man equivalent'. No distinction is made between male and female labour. In the study area, a high portion of youths below the age of 16 attend school and help with farm work on weekends only.

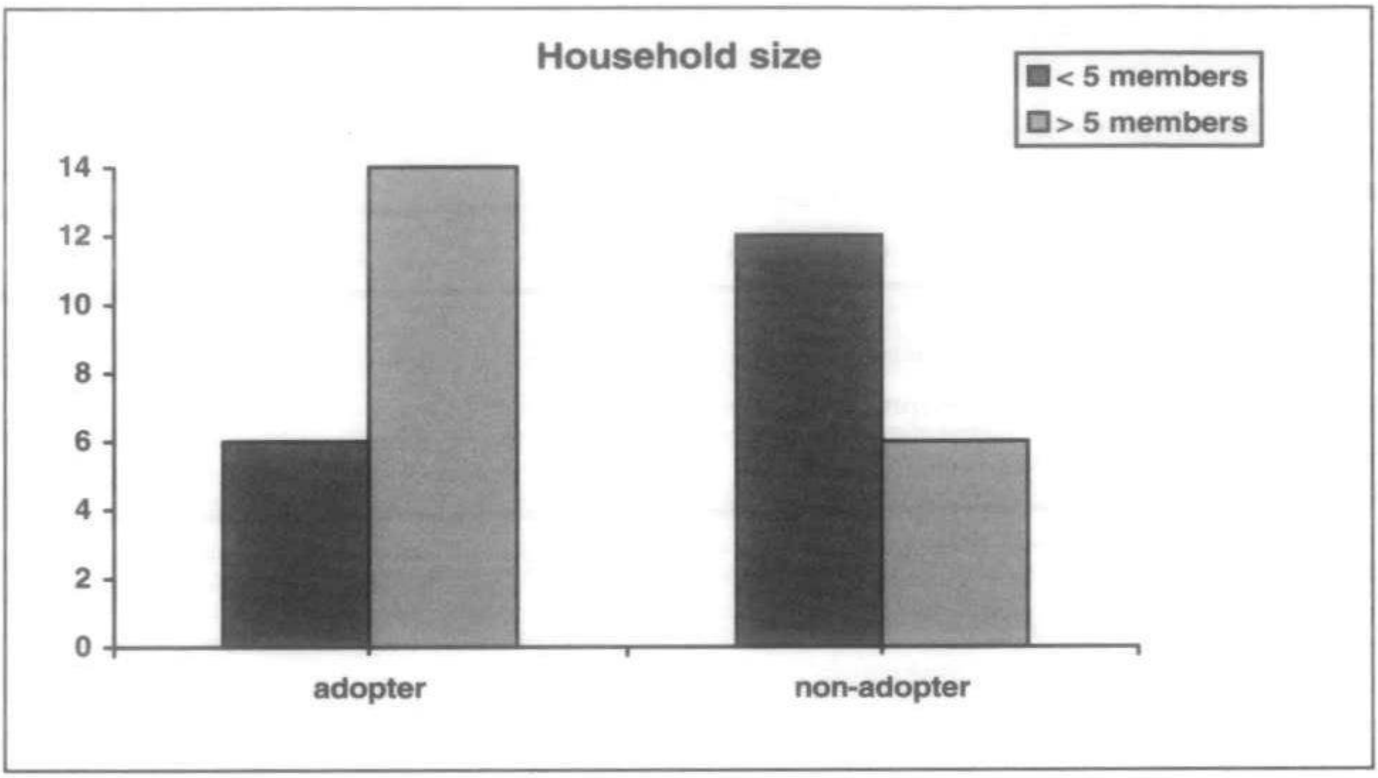

Figure 3: Household size among adopter and non-adopter sample households (Significant differences between sample groups, p=5%) (Source: [20])

The number of economically active household members is, again, lower in the non-adopter households, but no significant difference was found. On the average almost four members of the adopter households and approx. three members of the non-adopter households, respectively, account for the economically active population within a household. Thus, more than half of the household members constitute the household labour force among respondents.

The hypothesis that a smaller family size and a lower number of economically active household members are disincentives for the adoption of the labour-intensive SWC technology, could be statistically supported for the factor 'family size', but not for 'number of economically active household members' in the survey. The hypothesis is supported by the fact that most non-adopters, contrary to adopter respondents, mentioned lack of labour as the main reason for not trying or adopting the SWC technology, for not participating in the maintenance of the village nursery and as one of their most pressing problems in farming.

Looking at the gender ratio, the number of sample households consisting of more than 50% of female members is significantly higher (p=5%) for the non-adopter households (Fig. 4), although the significance is not high. On average, approximately 47 % members of the adopter and 54 % members of the non-adopter sample households, respectively, are female. Since female household members in the study area do usually not help with hard labour tasks such as constructing the SWC structure, a higher proportion of women could be a possible disincentive in adopting the innovation. Obviously, the total number of economically active <u>men</u> per household is crucial for the adoption of the SWC technology.

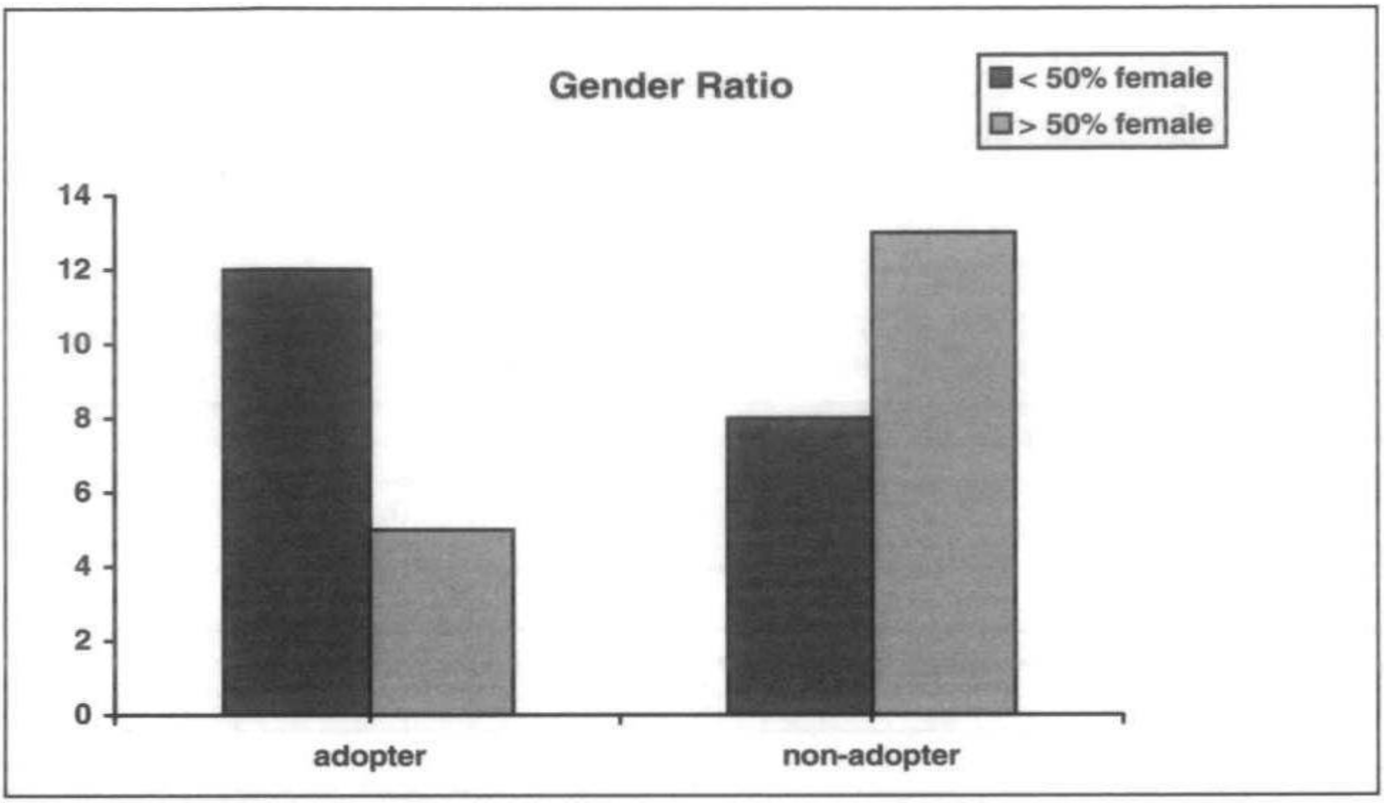

Figure 4: Gender ratio per adopter and non-adopter sample households (Significant differences between sample groups, p= 5%) (Source: [20])

The adopter household head being, on average, younger in age and having attained a higher education than the head of a non-adopter household, and thus acting less conservative, is a hypothesis which was not supported by the sample groups of the study.

4.2 Socio-economic factors influencing the adoption process

Land tenure was not found to have a statistically significant negative influence on the adoption of the introduced innovation. The number of farmers being share-tenants on the land they use is, however, rather high in the project area which is often thought to be a strong disincentive in the adoption of long-term innovations [10], especially in 'developing countries'.

Lack of draught power, another possible disincentive, seems to be higher among non-adopters, but no statistically significant difference was found compared to the adopter group. Also income and income sources as well as the average farm size were not significantly different for the two respondent groups, contrary to one of the survey's hypothesis that wealthier farmers might more easily use part of their land to a try a new farming practice. Surprisingly, scarcity of fuel wood and fodder was hardly mentioned by respondents as being a major problem, in contrast to findings of the initially conducted appraisal.

4.3 Traditional soil conservation strategies and extent of erosion

A number of traditional SWC methods are known and practised among respondents in the study area, as presented in Table 1.

Supported by qualitative observations, adopters practise a larger number of traditional SWC technologies and have established these practices on a larger area of their land. Although results have not been statistically analysed, it seems obvious that farmers who know and traditionally use some form of soil conservation practice to increase the productivity of their land are more likely to try and adopt improved techniques.

Table 1: Traditional soil and water conservation practices among sample adopters and non-adopters (multiple answering possible) (Source: [20])

Practice	Adopter (n--20) No.	Non-adopter (n=1 8) No.	Total (n=38) No.
1) Alley cropping or intercropping*	10	6	16
2) Planting steep or eroded areas to trees or grasses	7	9	16
3) Living fences or border planting	8	1	9
4) Constructing of 'Pilapil'**	5	3	8
5) Incorporating of organic materials	4	4	8
6) Mulching	2	5	7
7) Piling of organic materials along semi-contours	2	0	2
8) Canals and soil traps along the slope	2	0	2
9) Planting of taro in deep holes (soil traps) in badly eroded areas	0	1	1
Total	40	29	69
None	1	2	3

* Alley cropping and intercropping with pigeon pea or banana.

** Pilapil = terracing the slope by piling soil along semi-contours.

Adopters claimed soil erosion not to be a serious problem in farming anymore on land protected by the SWC structure. Non-adopters on the other hand, did not mention soil erosion as one of their most important problems. For both respondent groups major problems were pest damage of crops and lack of capital, and - as mentioned previously - for the non-adopters, lack of labour. Noteworthy, almost half of the adopters mentioned facing no problems regarding farming at all, compared to only one respondent for the non-adopter group. The author however felt that this answer was sometimes given by adopters just to please the IIRR extensionists who put a lot of effort in improving the local farming systems. The fact that farmers knew IIRR would distribute a small number of goats and cattle to successful adopters of the SWC technology might have been a strong influence on responses, too. For the non-adopter group, the unawareness of an erosion problem could be a reason for them not to adopt the innovation, especially when the technology in question adds to specific problems in the short run; like lack of labour and capital, and physical constraints of the potential user. Determining the average slope of farmers' fields could have been done to draw conclusions on the influence of soil erosion risk on farmers' decision-making. From qualitative observation however, there seemed to be no difference between the sample groups.

5 Conclusions and recommendations

The survey on social and economic factors affecting the adoption of the SWC technology was conducted at a very early stage of the project. Preliminary results seems to support recent findings on technology adoption in 'developing societies', which claim that personal characteristics such as age or education are relatively inconclusive for predicting adoption [13]. It is stressed by NAPIER (1989) that exceptions could be land tenure, educational levels and access to information. The latter was, however, not the subject of the present study.

Among the factors influencing the adoption of the introduced SWC technology; the complexity of the technique, for example, its high labour-requirements for establishment and relatively long-term benefits, seem to be major constraints for a number of farmers in the project area to adopt or continue the practice. Investment in a technology which does not maintain or increase the over-all productivity of the farming system in the short run cannot lead to a sustainable adoption by (generally) rational thinking farmers.

The SWC technology, which includes a whole system of contour and drainage canals, soil traps and check dams, had proved to be adoptable for IIRR's project area in the province of Albay where farmers hold relatively small areas of approximately one hectare on hillsides with slopes up to 45 percent. In Albay, lack of labour was not a problem in contrast to the study area. However as in Layong Mabilog, farmers see the need to apply conservation measures, since most of them practise some form of traditional soil conservation and, in general, expressed their interest in trying the SWC technology or other improved conservation measures to maintain farm productivity.

One possibility to reduce labour requirements could be to promote times for tree planting and pruning outside the peak periods for crop production ('to even out the peaks'; [2] and promote the use of green biomass for mulching [4, 23]). Besides its positive effect in protecting and improving the soil, mulching reduces the labour requirements for weeding substantially. Hand weeding is one of the most labour-demanding activities in farming in the project area. Adapting the SWC technology and providing simpler options for soil protection have to be considered in order to make soil conservation measures more adoptable in the area. A case of farmers' adaption and adoption of an introduced SWC technology - similar to the practice promoted by IIRR - was described by FUJISAKA (1993). Over a period of four years, farmers developed hedgerow establishment methods which required less labour. They eliminated grasses (napier) too competitive with crops and even stopped planting trees *(Glericidia sepium)* initially intended to produce green manures and instead planted species with future direct cash returns (e.g. mulberry trees, widely spaced, and pineapple). In the project area, a number of farmer adaptations of the presently promoted SWC technology were observed which could be alternative, less labour-demanding or more productive options in responding to the soil erosion problem, i.e.:

- Constructing 'contour' lines not with the A-frame, but with the 'eye-frame' as some farmers jokingly said.
- Omitting the construction of soil traps, check dams, contour and drainage canals.
- Planting contour lines purely with napier grass, which is commonly used as fodder. (Combined planting of trees and grasses was mostly given up due to napier being too competitive.)
- Mixing contour hedgerows or grass strips with food crops, such as pigeon pea, banana, cashew and timber trees.
- Planting field crops, e.g. maize, on the contour strips in the juvenile stage of hedgerows.

However, a draw-back in determining contour lines not according to the A-frame could be consequent 'dips' (in the lines) and exacerbated gully formation, as reported by FUJISAKA and CENAS (1992).

Recently, interest has been re-directed towards natural vegetative buffer strips, left unploughed during land preparation and consisting mainly of wild grasses, as an efficient and low-cost method to reduce soil erosion and water run-off. Also, the need for appropriate soil management techniques, such as mulching - as mentioned earlier - cover cropping, and reduced tillage, to effectively reduce or prevent soil degradation on the alleys in contour hedgerow systems has become a major research focus. More results from ongoing research can be expected in the next few years [8].

In conclusion with the above discussion, IIRR has to go beyond solely promoting the construction of the complex SWC structure, and rather emphasise the planting of multipurpose tree species or of napier grass in pure stand along the contours without constructing contour and drainage canals. The integration of food crops, be it fruit trees or field crops, on newly established contour lines to compensate for short term yield reductions due crop area lost to hedgerows, could enhance farmers' motivation in adopting a technique needed to conserve their resource base. Other identified constraints, needs and anticipation of villagers need to be addressed, too, such as for example labour-reducing practices in farming, measures to reduce weed and pest problems and income-generating activities. More flexibility in the research and extension approach with a continuous focus on farmers' own technology development and modification, will help prevent the indiscriminate promotion of innovations as a cure-all or general panacea in future and will make rural reconstruction truly sustainable.

6 Zusammenfassung

Akzeptanz und Modifizierung von konturhecken in den philippinischen Uplands - Ergebnisse einer Fallstudie

Um Modifizierungen einer eingeführten Alley Cropping Methode durch Kleinbauern zu identifizieren, führte IIRR (International Institute of Rural Reconstruction) eine Studie in seinem Projektgebiet, einem degradierten ‚Upland'-Gebiet der Philippinen, durch. Parallel zu On-Farm Versuchen zur Bewertung von potentiellen Spedes für die Heckenbepflanzung wurde 1992 eine Befragung durchgeführt, um die Akzeptanz und Modifizierung der Konturhecken durch Landwirte zu untersuchen. Der Hauptgrund für die geringe Annahme der Bodenschutztechnologie in dem Projektgebiet scheint der hohe Arbeitsbedarf für Anlage und Instandhaltung zu sein. Von den untersuchten Faktoren, die möglicherweise den Akzeptanzprozess beeinflussen, zeigten ‚Familiengröße' und ‚Anteil an weiblichen Familienmitgliedern' statistisch signifikante Unterschiede zwischen ‚Adopter' und ‚Non-Adopter' Gruppe. Eine geringerer Familiengröße und ein höherer Prozentsatz an weiblichen Mitgliedern scheint einen negativen Einfluß auf die Akzeptanz von Bodenschutzmaßnahmen zu haben. Modifizierungen der Bodenschutztechnologie und die Einführung einfacherer, weniger arbeitsintensiver Methoden zur Erhöhung der Nachhaltigkeit kleinbäuerlicher Landwirtschaft, gekoppelt mit einem flexibleren Beratungssystem, sind anzuraten.

7 Acknowledgement

The present study is based on the author's six-month internship period in the International Institute of Rural Reconstruction (IIRR). Results were used in preparation of his thesis in partial fulfilment of the requirements for the degree of Diploma Engineer in International Agriculture at Kassel University.

The author would like to express his deep gratitude for the help and warm reception by his Philippino colleagues and friends in IIRR and Layong Mabilog. He would also like to mention his academic supervisors, Dr. Barbara Becker and Dr. S. Amini, and other staff of Kassel University, who helped with valuable advice.

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