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Development of Sustainable Ecological Vegetable Production Systems in Matara District, Sri Lanka: an Intervention Approach

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ABSTRACT. *In Sri Lanka, most of the vegetable farmers apply modern agricultural techniques such as intensive land preparation methods, synthesized fertilizer, hybrid seeds, and agrochemicals. Ultimate results are high cost of production, environmental pollution, biodiversity reduction, habitat destruction and risks to human health and welfare. Sri Lankan people consume the fresh vegetables in their day- to- day meals, knowing that nutritional value and safety of the fresh vegetables are very important. By increasing farmers' knowledge, there is potential to develop ecological farming systems to control the ill- effects of modern farming technologies. To test this hypothesis, a number of interventions were considered. Farmers in Udupila village, Matara district were surveyed to determine the present situation of the sector. As part of the strategy to increase farmers' knowledge, training programs, workshops, field visits, and on-farm research were conducted during ten months of intervention from June 2006 to March 2007. After the intervention, farmers were consulted again. Most of them had experienced rapid improvement in their yield and income. Farmers explained that this was due to increased use of compost, planting more vegetable species, soil conservation measures taken and properly planned farming activities. Many farmers also pointed out that much of the increased yield was due to reintroduction of traditional cultivation methods including ecological concepts. Therefore, it is clear that, the role of an agroecologist during an intervention period was very important. It can be concluded that the knowledge of the farmers who were following ecological farming concepts in study area was developed during the period of the study program. Application of an intervention approach for promoting ecological vegetable farming in Matara district is strongly associated with the sustainability of the ecological vegetable production system.*

INTRODUCTION

After the green revolution, use of synthetic fertilizer, pesticides, hybrid seeds, genetically modified crops, intensive land preparation methods, irrigation techniques, and heavy

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machinery became prominent in the modern agriculture sector (Peterson, 2000). Therefore, the agriculture sector became a business. It helped to increase productivity of the land and helped to produce food to meet the demand of a growing population (Manion, 1995). But, the modern agriculture sector is identified as a high-input cultivation system (Lundquist *et al*., 1999). Therefore, the cost of production of the farm unit has rapidly increased. In addition, environmental pollution occurres due to use of higher doses of synthetic fertilizer and other agro- chemicals (Hodges, 1981; Scow *et al.,* 1994; Temple *et al*.,1994).

Sustainable production has been suggested for enhancing productivity for future generations through the use of locally available resources such as manure and compost (Dima *et al.,* 1997; Lefroy *et al.*, 2000; Hurn, 2000; Gimenez, 2001). Palm and Sandell (1989) observed that reducing dependency on chemically synthesized fertilizers for maintaining yields is an important step towards increasing agricultural production in the long run. The importance of bio-fertilizers such as manure and compost is widely documented (Russell, 1988; Brady 1990; Pasztor *et al.,* 1990).

The reason for the focus on ecological farming is the rapid development of the ecological sector in the world, especially in Sri Lanka. One key objective of this paper was to find out feasibility of participatory approaches in order to improve the knowledge of farmers to achieve sustainable vegetable production in the Matara district and find out effectiveness of interventions in this regard. The specific objectives of this study were to change farmers' attitudes in ecological farming (economical benefits, market demand, high price, social welfare, environmental protection and health condition of the family), to investigate the influence of new and different agronomic practices on ecological farming systems in the region (application of cow dung, green manure, mulching materials, preparation and application of compost and vermicompost) and to determine the influence of different educational activities on farmers' movements towards ecological farming (training program, workshops, field visits and field research).

MATERIALS AND METHODS

Study area selection

The study was conducted in the Udupila village in Matara district, the Southern part of Sri Lanka. Many vegetable farmers in this village applied ecological concepts in their fields. This was the reason for the selection of this village for the study. More than 200 farmers cultivated a 10 hectare area together, called a "*Yaya*" but the unit area for farmer was about 50 m^2. Vegetable farmers in the village were organized as a farmer organization named "*Parakrama govi samithiya*". There were more than ten types of local vegetable species found in the area, such as pumpkin (*Cucurbita maxima*), bitter gourd (*Momordica charantia*) , snake gourd (*Trichosanthes cucumerina*), ridge gourd (*Luffa accutangula*), long bean (*Phaseolus vulgaris*), winged bean (*Psorphocarpus tetragonolobus*), radish (*Raphanus sativus*), brinjal (*Solanum melongina*), okra (*Hibiscus esculentus*), chilli (*Capsicum annum*), tomato (*Lycopersicum esculentum*), Sesbania (*Sesbania grandis*), spinach (*Bassel alba*) and mukunuwanna (*Alternanthera sessilis*).

The name data base of the above farmer organization was used to select farmers. There were 120 names of farmers who were following ecological farming concepts. The preliminary survey was done in order to collect information from all farmers in name data base. Thereafter, 60 farmers were selected randomly using the name data base for further studies. The 1st survey helped to identify real life situations in ecological farming and food systems in the area by using concrete experiences. Intervention of the researcher helped to create new 'future wanted situations' with the farmers and to develop action plans in order to achieve their target. Role of the researcher as a facilitator was directly based on the monitoring and receipt of feedback from the farmers. The research was conducted from June 2006 to March 2007, and the intervention period covered different farming activities.

Climatic conditions of the region

The Matara district belongs to the low country wet zone. Average annual rainfall of the area is about 1520 mm, with a high amount of rain recorded in the *Maha* season compared to the *Yala* season. Farmers cultivate vegetables in both seasons. The mean daily average temperature is about 29 ($\pm$ 3) ^{o}C. The main soil types are bog and half bog soils situated in poor drainage classes in flat terrains. Peaty soils and coastal salinity due to sea water intrusion are the main soil problems of the region and also acid sulphate soils in the *Nilwala* basin.

Preliminary survey

A preliminary field survey was done in order to select farmers in the Udupila village. Sixty farmers were interviewed. Detailed questionnaires were used for the survey. According to the survey results, a "rich picture" was developed by the researcher to identify relationships between different parts of the system and the present situation of ecological farming systems in the area. After that, SWOT analysis was done and three key issues were identified. These were more or less similar to the research questions which were selected initially.

Training programs

Many farmers are traditional so that they were not mere objects of scientific study (Forget, 1992; Forget, 1997). Their experience with research is very low. However, as participants, they played a major role during the intervention period. It is more important to develop bottoms-up strategies than the top-down approach (Roe, 1996). According to the results, the "future wanted situations" of the farmers and identifying key issues of the systems, the following five training programs were conducted; pest and disease control, compost making using locally available resources, on farm seed production, use of green manure and mulching in ecological farming systems and selection of new crop species/varieties and nursery preparation for new crops. Invited guest specialists carried out these training programs. These five training programs helped to increase farmers' knowledge on ecological farming.

Workshops

Two workshops were organized and conducted to develop a "visionary thinking approach". This was done to obtain a rich picture of the ecological vegetable production sector in the

region and to develop a 'future wanted situation' of the system. A second workshop focused on biodiversity conservation under field conditions.

Semi-structured interviewing

This is an informal and relaxed way to gather data, structured by using a checklist of topics. This method was often used with individual men and women. The order of questions and topics were not fixed. The place where the interview took place was important as the person to be interviewed should feel comfortable.

Target group discussions

Based on the survey results, 60 farmers were selected randomly. Target group meetings were held regularly with farmers in order to discuss their problems in ecological farming. Target group discussions were used to identify a future required situation of the farmers. A "visionary thinking seminar" appeared to be more important as farmers who were more interested in ecological farming methods attended the meetings.

Individual discussions

Discussions were held individually with the 60 selected farmers. Detailed interviews were conducted on the individual units to collect more information. Invited farmers who are specialized in ecological farming were used to conduct interviews. It helped to share experiences and ideas among both parties.

Detailed survey

After ten months, a detailed survey was done by using a questionnaire with the 60 selected farmers.

Statistical analysis

Statistical analysis was carried out using the software packages SAS and SPSS. Non parametric tests were used when required. Most of the data which was collected through questionnaires was categorical. Therefore the chi square (X^2) test and Spearman correlation rank test were used to analyze data. Venn diagrams, web diagrams, bar charts and column charts were used in order to summarize and present data.

RESULTS AND DISCUSSION

Farmers' attitudes towards ecological farming

In the preliminary survey, three groups of farmers were identified based on level of interest in ecological farming. Although many farmers have been applying ecological concepts in their fields, some of them were really not interested in them. They applied ecological farming concepts because of the encouragement and materials provided by some NGOs. One farmer said that, NGO's used to provide organic fertilizer and seeds free -of -charge for the farmers who were following ecological concepts. One said that, he changed his fields to

ecological farming simply because of the trend in the farming area. The interest in ecological farming was significantly increased (correlation coefficient= 1.0) among participating farmers after the ten month period of intervention (Figure 1).

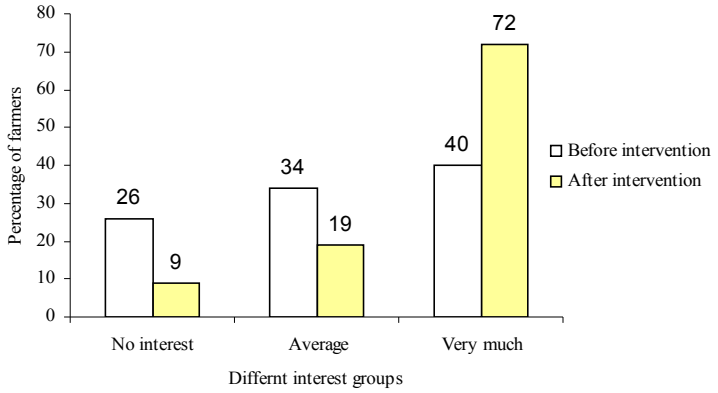

Figure 1. Adoptability of ecological farming before and after the intervention

Farmers were converted to ecological farming due to reasons such as health concerns of the family, low cost of production, high market demand, environmental friendly methods and higher market prices for the products. Some farmers adopted conversion for two or more reasons. Figure 2 shows the behaviour of the farmers with combinations of reasons for their conversion. The results indicate a compounding of several reasons for change, or it could be said that farmers have multiple goals of achievement.

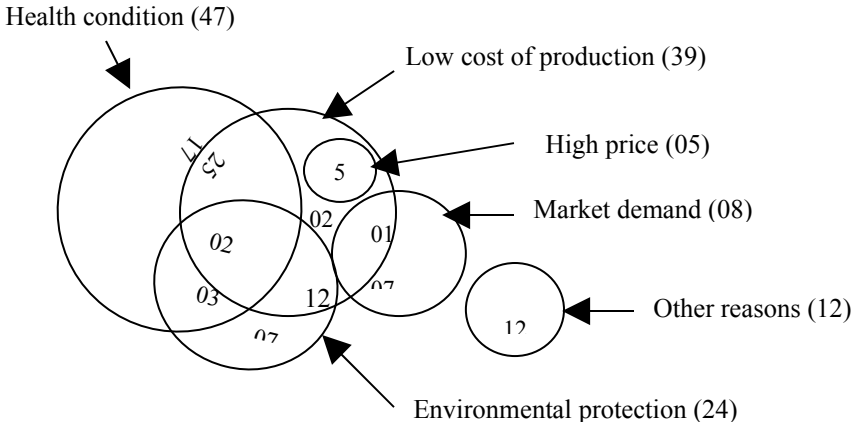

Figure 2. Number of farmer converted to ecological farming due to different reasons

Improvement of agronomic practices

As agronomic practices, application of cow dung, compost, vermicompost, mulching, green manure, crop rotation and pest and disease control were taken into consideration. In this

study, application of cow dung did not significantly increase among farmer groups after the training program (x^2= 0.626, df = 2, p = 0.731).

There was a significant association between green manure application and training programs (Figure 3). Application of green manure in order to increase soil fertility significantly increased among the study group of the farmers' association (x^2= 12.913, df =2, p = 0.002). 20% of farmers moved into the group that applied satisfactory levels (> 25 kg/100m^2/ yr) after intervention. Farmers who applied

≤10 10-25 ≥25 kg/100m^2/yr was reduced by 28%. More farmers applied green ory level after the training (Figure 3).

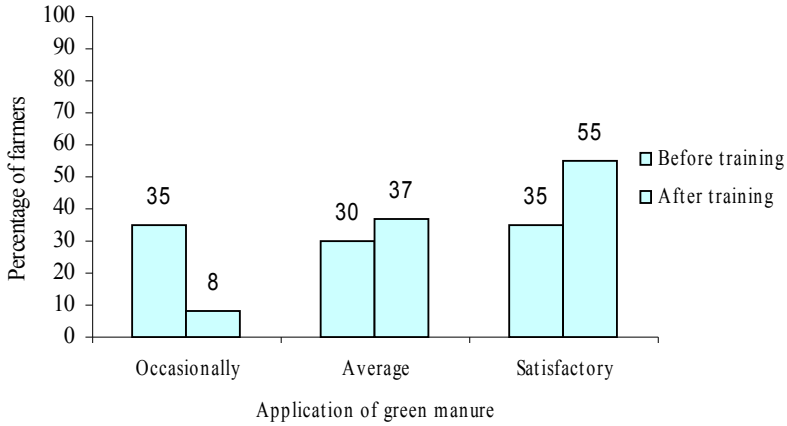

Figure 3. Observed percentage of farmers applying green manure into the fields before and after the training

(Values with same letters is not significantly different at p< 0.05)

Numbers of farmers who applied mulching materials into their field changed (co-relation co-efficient = 0.5) due to the intervention.

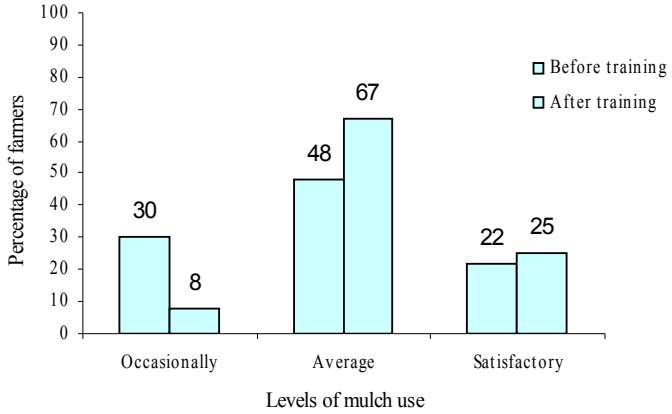

Figure 4. Application of mulching materials into the fields before and after the training

Application of compost is very common in ecological farming systems in the world (Drechsel *et al.*, 1998). There was a significant relationship (correlation co-efficient= 0.997) between training programs and farmers' changes on compost application. Farmer interest in compost application has always been high in this area. Farmers applying compost at satisfactory level (before every season) increased by 18% and the average group (once in two seasons) changed from 13% to 25%. Farmers who occasionally (once in more than two seasons) applied compost (28%) reduced by 6%. Despite the effect of exposing them to different compost preparation methods, farmers in the region always practice the heap method.

Preparation of vermicompost and vermiwash was significantly enhanced among farmers in the area. Majority of the farmers (67%) did not know about vermicompost before the training which was held during the intervention. After 10 months, 61% of the farmers adopted the practice of applying vermicompost. Farmers realized that vermicompost and vermiwash provide significant effects on growth and yield of vegetables, especially on leafy vegetables. There was an interaction between crop rotation and farmers' positive changes ($p = 0.05$) after the intervention period. The education program appeared to have influenced the changes of farmers using this technology; 45% of farmers changed to a satisfactory level of rotation.

Biodiversity in the farming systems

According to the experience gained through the research, ecological farming lands have a very high floral diversity, especially in weed species compared to conventional vegetable farming systems in the area. According to Sinha (1998) it helps to achieve diversity of sources of income, minimizes the risk of crop losses due to natural hazards and protects against the incidence of pests and diseases. Most of the conventional farmers continuously apply herbicides in their fields in order to control weeds. But, ecological farmers apply mulching materials and use some mechanical weed control methods such as weeders. Before the intervention, 45% of the farmers cultivated 1-3 crop species, and this group was reduced to 23% because some of them (10%) started growing 4-6 crops after the intervention. It appears that there was a significant effect of the intervention on crop diversity in the area. It may be due to farmers' knowledge about changes in polyculture systems and the advantage of new sources of farm income.

Farmers' education and ecological farming

Importance of farmer education programs held during intervention period was evaluated by asking about different categories such as training programs, workshops, field visits and field research. After 10 months period of intervention, farmers' personal interest on different educational methods changed. Figure 5 shows comparative changes in different farmer educational categories. The highest number of farmers changed their interest in field research; the difference in number of farmers interested before and after intervention was 23. Seven farmers were now more interested in training programs and field visits, 3 more farmers changed their interest in workshops.

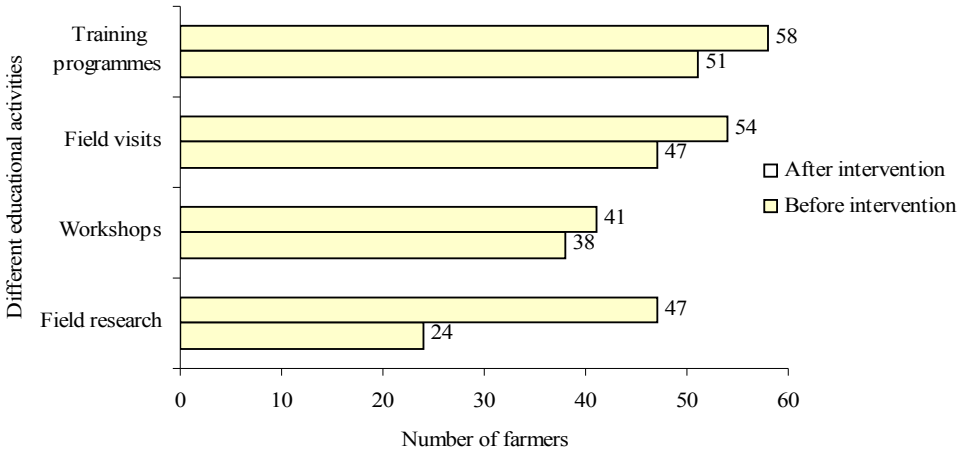

Figure 5. Importance of different educational activities to farmers before and after the intervention

According to the experience gained, this was the first opportunity for many farmers to meet a researcher, to participate in research (on-farm), to participate in demonstrations and to work with research students. Those may be the reasons why farmers' interest changed on field research. But most of the farmers knew about importance of training programs, field visits, and workshops even before the intervention. Field visits provided a good impression on ecological farming systems.

Visionary thinking process was applied to identify key issues and a future wanted situation by farmers for the production area. This procedure was difficult to apply for many farmers. According to the farmers' point of view, it was difficult to understand how the procedure worked. A trained facilitator was needed essentially to maintain the focus of the activity. Therefore, this concept was not always applicable for development of "future wanted situations". Five percent of farmers said that application of the visionary thinking process in order to change the present system was complex. 17% of them said that this process is difficult to understand.

Economic benefits

Sixty farmers who were following ecological farming concepts and 30 who were following conventional agricultural practices were selected for the data collection. Table 1 shows the comparison between ecological farming systems and high input modern farming system with income, cost of production, net profit and benefit/ cost ratio. Cost for seeds, fertilizers, pesticides, fuel, hired vehicles and labour were used as cost components. Labour for land preparation, seeding/ transplanting, weeding, watering, fertilizer and pesticide application, transport, harvesting and packing were considered, as well as losses due to pest and diseases that were considered as cost components (Eltun *et al*., 2002).

Table 1. Cost/ benefit analysis of the two farming systems for vegetables

Farming system	Income/ha/Year (Rs.)	Cost of production/ha/Year (Rs.)	Net profit/ha/ Year (Rs.)	Benefit/Cost ratio
Ecological farming	120,000.00	35,000.00	85,000.00	2.4
Modern farming	180,000.00	63,200.00	116,800.00	1.8

SLR- Sri Lanka Rupees (1US$ = 107 SLR) ha = hectare

Benefit/ cost ratio for the ecological farming sector for vegetables was 2.4. In modern farming the benefit/ cost ratio was about 1.8. Therefore, it may be clearly observed that ecological farming provides more net benefits than conventional, high input farming. However, it was extremely difficult to collect detail information regarding income and cost components since many farmers did not keep farm accounts properly. Farmers were also growing different vegetable species and prices for those were different and fluctuating. Therefore, the accuracy of the calculated values of benefit/ cost ratio was not satisfactory.

CONCLUSIONS

Local farmers in Sri Lanka are reservoirs of valuable indigenous knowledge, yet there is no guarantee that their understandings behind these applications are scientifically correct. Farmers' knowledge on applications of ecological farming was improved after intervention and the role of an agro-ecologist is important in this regard. Therefore, education is often needed and outside expertise is essential to assist local people to understand, identify, and develop future situations of the ecological vegetable production sector. From this program, it was apparent that farmer knowledge of soil fertility building, crop selection, and land preparation could be increased by using experts. Approaches that were applied during intervention period changed farmers knowledge substantially. Although it is not possible to estimate a direct cause-effect relationship, the evidence is very strong that the educational program contributed to the sustainability of the ecological vegetable system in this region.

ACKNOWLEDGEMENTS

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