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On-farm Research with and for Farmers: Experience from PARDYP in Nepal

Bandana Prajapati Merz[1], Pravakar B. Shah[1], Gopal Nakarmi[1], Narayan P. Bhandari[2]

[1] ICIMOD, Kathmandu, Nepal (PARDYP-Nepal)

[2] Horticulture Centre, Paanchkhal, Nepal

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Abstract

Farmers with good access to markets are increasing their incomes by diversifying their farming systems to produce food for the growing markets. This is resulting in agricultural intensification in areas with access to irrigation. This intensification is creating problems in Nepal's middle mountains with soil fertility depletion, the increased use of external inputs, and very high demands for irrigation water. The People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project's Nepal initiative (PARDYP Nepal) has initiated several on-farm activities to address these issues in the Jhikhu Khola watershed. This watershed lies to the east of Kathmandu in Kabhre Palanchok and Sindhupalchowk districts. Promising options are being demonstrated and disseminated to local communities. The present paper discusses the approaches taken to involve farmers to adapt, demonstrate, and participate in the research. It then illustrates how the dissemination of the adapted technologies has been carried out.

Introduction

The rapidly growing population pressures in the Jhikhu Khola watershed are leading to an increased demand for food. To meet this demand and to increase farm incomes farmers with access to markets and favourable climatic conditions have been increasing their cropping intensities. One example from the Jhikhu Khola watershed shows that the rate of population growth increased from 1.8% per annum between 1947 and 1990 to 2.6% from 1990 to 1996 (Shrestha et al. 2003). Food production has kept pace with the increasing population. The average number of crop rotations have increased from 1.3 to 2.5 per year between 1980 and 1994 (Schreier and Shah 2000) and by 2001 had reached 2.8 rotations per year. Some farmers have started to grow four crops per year on prime irrigated land in valley bottoms (Von Westarp 2002). The consequences of this are depleted soil fertility and increased agrochemical inputs and irrigation water demand.

Schreier and Shah (2000) say that soil fertility is decreasing because of this intensification. The carbon and available phosphorus have dropped to well below desirable levels and soil pH values have become inadequate with pHs of less than 5.0 in about 80 per cent of soil samples taken by these authors. The same authors further report particular concerns about red soils as many of them have pH values below 4.3. These levels favour the solubility of aluminium and iron which can result in aluminium toxicity and create problems with phosphorous availability. Available phosphorous can react with iron and aluminium to make phosphate insoluble.

Farmers try to compensate for reduced soil fertility by applying high doses of mineral fertilisers. Merz et al. (2003) reports farmers in the Jhikhu Khola watershed applying up to 400 kg urea (46% nitrogen), 800 kg diammonium phosphate (18% nitrogen, 46% phosphorus), and 800 kg of complex fertiliser (20% nitrogen, 20% phosphorus) per hectare to their main cash crop of potatoes. An additional 200 kg/ha per annum of other fertilisers are applied to some other crops. A large portion of this applied fertiliser gets washed through the soil into the river system adversely affecting water quality. Farmers are growing more cash crops such as vegetables. To avoid the danger of pest damage farmers are using pesticides in much higher doses than recommended (Shrestha and Neupane 2002).

The main cropping pattern in irrigated land *(khet)* in this watershed's valley bottoms is rice during the monsoon season followed by potato, tomato, or other vegetables. Around a third of farmers do not have enough irrigation water (Merz 2003). An inadequate supply of irrigation water for dry season cropping is the main constraint for these farmers. The average rainfall in the watershed was 1200 mm between 1993 and 2000. More than 80% of precipitation falls during the monsoon months of June to September. The watershed does not have any rainfall-rich area to fulfil dry season irrigation water demands (Merz et. al. 2000). Diesel or kerosene pumps are used during dry seasons to pump water from springs or streams into fields for irrigating winter cash crops. The diversion of water sources to irrigate winter crops is resulting in the drying out of some streams during the winter and is reducing the ground watertable (Nakarmi and Neupane 2000).

Maize is the main monsoon crop on rainfed land *(bari)*. It is followed by wheat, barley, mustard, or the land is left fallow. Farmers grow winter cash crops only in a few small plots where irrigation water is accessible. The watershed's 38% of its agricultural land that is rainfed is mostly left fallow during the dry months due to water shortages. According to Postel et al. (2001), in developing countries irrigated land generally yields twice as much food as rainfed land. Extending irrigation to rainfed areas thus seems to be a good possibility for increasing food production without having to intensify cropping of irrigated land.

PARDYP Nepal has started the following interventions to improve the livelihoods of farmers in the Jhikhu Khola watershed:

- drip and micro sprinkler irrigation system for dry season irrigation;
- demonstrating the system of rice intensification (SRI) to improve yields of monsoon rice;
- demonstrating plastic lined water-harvesting ponds on rainfed land to collect monsoon rainwater for irrigating dry season crops;
- incorporating lime in red soils on rainfed land to enhance soil pH and productivity; and
- introducing alternative pest management using extracts from local plants.

The project has also worked on improving household incomes. Nutrition rich fodder grasses and hedgerow species were introduced to the milk producing farmer groups to increase milk production. This intervention is also increasing farmyard manure production for composting. The project offered farmers the following 11 species: stylo (*Stylosanthes hamata*), molasses (*Melinis minutiflora*), dinanath (*Pennisetum pedecellatum*), vetiver (*Vetiveria lawsoni*), flamengia (*Flemingia microphylla*), tephrosia (*Tephrosia candida*), sunhemp (*Crotalaria juncea*), Guatemala grass (*Tripsacum laxum*), Napier grass (*Pennisetum purpureum*), broom grass (*Melinis minutiflora*), and sunflower (*Tithonia diversifolia*).

The present paper mainly discusses the approaches taken by the project to introduce and adapt these technologies to local conditions and to involve farmers in on-farm research.

Project Approaches

The project has taken different approaches for the adaptation, demonstration, participatory research, and dissemination of new farming practices. The approaches have varied depending on the nature of the technology. The project has mainly worked through implementing:

- research trials and demonstration;
- on-farm participatory research trials and demonstrations;
- farmer to farmer visits;
- networking with different organisations; and
- demand-driven programmes.

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Research trials and demonstration

Many of the technologies tested and promoted by PARDYP are new to farmers. The project has therefore taken the approach of first testing and demonstrating these technologies, mostly at the Ministry of Agriculture's Paanchkhal Horticulture Centre and later at the other four main sites shown on Figure 3.1. This allows the project to get scientific data and experience on how to use and adopt technologies to the local environment. It also gives farmers the chance to observe them before trying it out. Firstly, trials for demonstrating and monitoring activities are established at Paanchkhal Horticulture Centre to allow farmers to observe the effectiveness of new technologies. The second phase will implement participatory trials and demonstrations in farmers' fields.

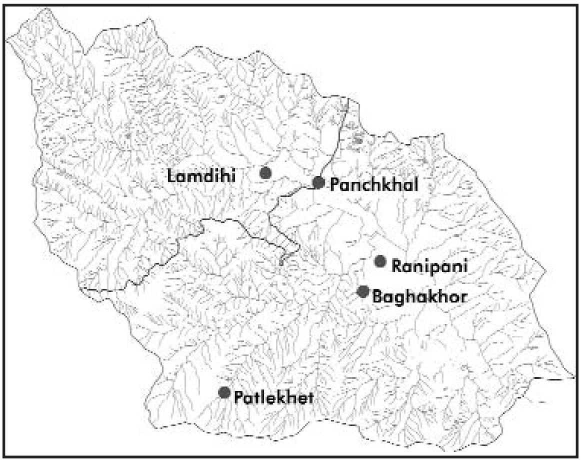

Figure 3.1: **Jhikhu Khola Watershed showing main PARDYP research sites**

In the first phase farmers, as they visit the horticulture centre to obtain seeds, seedlings, and information, observe the new technologies being tested. The project team discusses these technologies with them and explores the possibility of establishing trials on their farms. The project has taken this approach with drip irrigation, SRI, grass and hedgerow species for fodder and composting, and organic pest management.

On-farm research trials and demonstrations

Some technologies tested and promoted by PARDYP are not new to farmers. For these the project team directly approaches farmers to carry out trials without prior research demonstrations. The issues are discussed with farmers and the farmers' concerns and questions addressed. Farmers who are convinced of the technology's promise then go ahead and establish trials in their fields. The farmers select the trial sites in collaboration with the PARDYP team. Fellow farmers are encouraged to contribute to the trials. The project has followed this approach for demonstrating the plastic lining of water harvesting ponds and the incorporation of lime into red soils on rainfed land to enhance soil pH and productivity.

Farmer to farmer visits

Farmer to farmer visits are an effective way of disseminating technologies. Before starting work with a new group of farmers, the project team discusses the problems they are facing in their farming systems. Probable causes and possible solutions are identified. A number of farmers are then taken to the PARDYP demonstration sites where other farmers are already tackling these types of problems using simple technologies. Sometimes, before starting to set up demonstration trials, interested farmers are taken to the demonstration site in the horticulture centre to discuss issues of concern.

Demand driven programmes

In the course of PARDYP's interactions with farmers, many of them have asked for support for income generating activities that do not come within PARDYP's research agenda. PARDYP has supported the following activities to encourage farmer participation in its research activities:

- mushroom cultivation, vegetable nursery management, and seed production training;
- a farmers field school on growing potatoes;
- fruit tree seedling distribution;
- demonstration of solar dryers; and
- soil nutrient analysis.

Trial Results

The results from the trials carried out by PARDYP Nepal in the Jhikhu Khola watershed in PARDYP phases 1 and 2 are summarised and discussed below.

Drip irrigation

Drip irrigation has been described by Postel et al. (2001), Katz (2001), and Haile et al. (2003) as water-efficient irrigation systems. Standard drip irrigation systems are expensive sophisticated systems designed to serve large areas of commercial cash crop horticulture. They are not suitable to be broken down to fit small plots such as farmer's fields in Nepal. In recent years the South Asian NGO, International Development Enterprises (IDE) has been marketing locally fabricated, low-cost drip irrigation systems mostly in the west of the Nepal. The system includes a plastic container and weatherproof lateral pipes with discharge holes at intervals along the pipes (Figure 3.2). Each hole is baffled to ensure that water regularly reaches the plant root zones. Lateral pipes are connected to the container. The systems are simple to use and available in capacities to irrigate areas of between 40m^2 to 500m^2. The initial investment is low at about US$20 to irrigate 60 to 120 sq^2 of land depending upon the crop.

The Phase 1 trials with drip irrigation were carried out at Paanchkhal Horticulture Centre to grow bitter gourd vegetables. It was set up with one drip-irrigated plot and another plot where the crop was irrigated with a bucket. The drip system used 50% to 60% less water than the bucket system for the same yield. The 2001 trial at the centre produced about 640 kg of bitter gourds from the drip and bucket-irrigated plots, corresponding to about 44 t/ha. Figure 3.3 shows water use and crop production on the 144m^2 sized drip and bucket irrigated plots in 2001. The trials also showed that the drip irrigation needed much less labour. The labour demand for the application of irrigation water was six times less for the drip than the bucket system (Prajapati-Merz et al. 2002).

Figure 3.2: **A simple drip irrigation system**

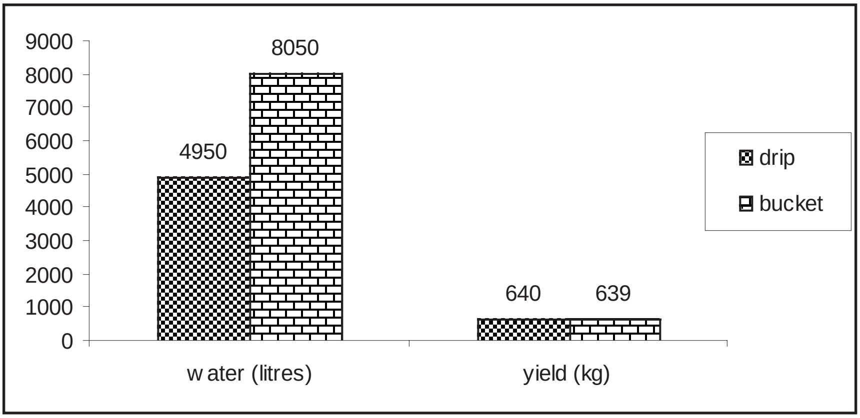

Figure 3.3: **Water use and crop production from drip and bucket irrigated plots at Paanchkhal Horticulture Centre**

In the second phase, a trial was started with a farmer on a rainfed plot in Lamdihi (Figure 3.1). Lamdihi is a low-lying area in the Paanchkhal valley with good access to the nearby Araniko highway. Local farmers started to grow cash crops for the nearby markets of Banepa and Kathmandu after this highway was built and malaria was eradicated. In the valley bottoms farmers grow two to three crop of vegetable in addition to a crop of monsoon rice. The area is only a few minutes walk from the road in the valley bottom, but farmers still concentrate on growing monsoon maize and winter wheat. The Rayale irrigation canal runs through Lamdihi and provides plenty of irrigation water until October each year. From then on the water supply gets scarcer until by the end of January to early February it dries up completely. From February to the onset of the monsoon farmers face serious shortages of irrigation water.

Participating farmers proposed growing bitter gourd as a trial crop and using a smaller plot for the bucket irrigation control. Plots of 144m^2 were put under drip irrigation and 80 bitter gourd plants were planted at 1.2m intervals plant-to-plant and 1.5m between rows. A plot of only 18m^2 with 10 bitter gourd plants at the same spacing was prepared for bucket irrigation. Fertiliser input was the same for both plots with 33 t/ha of organic matter, 170 kg/ha of diammonium phosphate, 450 kg/ha of urea, and 100 kg/ha of potash applied. The fertilisers were applied in split doses for efficient uptake. In this trial the farmers managed to save 45% of water whilst getting 14% more yield from their drip plots. They reported yield figures of 44 t/ha on the drip irrigation plots and 39 t/ha on the bucket-irrigated plots. The results from the bucket-irrigated plot were extrapolated to give the comparison in Figure 3.4. The average market price for bitter gourd was around NR 17/kg at the time, thus giving a gross income of NR 10,000 from the drip-irrigated plots.

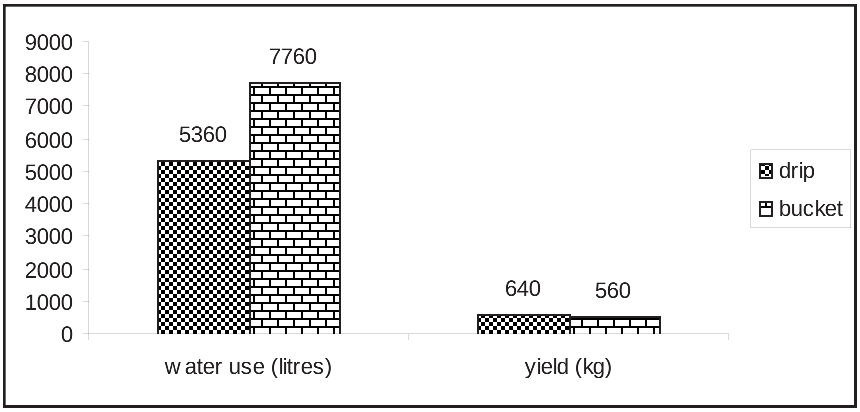

Figure 3.4: **Water use and production from drip and bucket irrigated plots at Lamdihi**

These successful results led to five more local farmers adopting the system in 2003. Their gross income from their drip plots has been NR 9,000 to 12,000 per plot growing the same crop.

PARDYP organised the dissemination of this new technology through farmer to farmer visits. Many farmers visited the Paanchkhal Horticulture Centre and Lamdihi sites to observe drip irrigation in action. Along with promotion by local NGO Ranipani Gram Sewa Kendra, these demonstrations have led to about 70 farmers starting to use drip irrigation.

PARDYP is continuing to support the NGO with technical advice. For example, PARDYP facilitated a field visit programme for farmers from Ranipani to observe the drip irrigation sites at Lamdihi. The visiting farmers asked practical questions about growing crops with drip irrigation.

System of rice intensification

The system of rice intensification (SRI) involves changing certain standard management practices to get higher rice yields. It was developed in Madagascar and has been tested in several Asian countries. The results from a number of trials are given in Uphoff and Fernandes (2002). The practice involves transplanting two-leaf rice seedlings singly within 15 to 30 minutes of taking them from the nursery bed, planting them in a widely spaced square pattern, and keeping the soil moist but not flooded during the vegetative stages (Figure 3.5).

Figure 3.5: **SRI rice ready to harvest showing wide spacing**

The first PARDYP Nepal SRI trial was carried out in the Paanchkhal Horticulture Centre in 2002 alongside a control plot of the same size of 140m^2 where rice was grown traditionally. Single two-leafed 12-days-old seedlings were transplanted at distances of 25 x 25 cm in the SRI plot. In the traditionally managed (TM) plot 30-days-old seedlings were transplanted at an average distance of 10 x 10 cm with bunches of three seedlings planted at each point. The same amount of fertiliser was applied to both plots (50 kg N/ha, 30 kg P/ha, and 30 kg K/ha). The SRI plot was irrigated weekly during its vegetative growth phase and flooded only during the reproductive phase while the traditionally managed plot was kept flooded throughout. Both plots were drained 20 days before harvest.

The harvested yield was 20% more in the SRI plot. The main drawback of the SRI system is that it is very labour intensive, especially at planting time when it needs skilled labour for line planting and weeding. Also, weed growth was more in the SRI trial as the soil was only kept saturated and not flooded. The SRI plot needed nearly three times more labour than the traditionally managed plot for planting and weeding and overall needed twice the time for crop management (Table 3.1).

Table 3.1: **Comparison of labour requirement for SRI and traditionally managed plots**

	SRI (hrs)	Traditionally managed (hrs)
Plot preparing	3	3
Planting	7	2
First weeding	7	0
Second weeding	14	7
Harvesting	3	3
Total	34	15

A survey on SRI adoption has shown that the extra labour involved makes it less suitable for small holding farmers. Thus PARDYP in 2003 investigated how to reduce the labour involved.

The requirements of the SRI system were discussed with interested farmers before the monsoon rice season began in 2003. The problems they identified were:

- the difficulty of getting the young seedlings from the nursery and transplanted into the field within 15-30 minutes; and
- excessive weed growth.

These problems were reviewed and the following solutions suggested.

- Raise seedlings on a dry seed bed in a field with good soil and a reliable water supply. When the seedlings are ready for transplanting at the two-leaf stage after eight days, remove patches of 5-10 cm^2 of seedbed with soil attached to a depth of up to 5 cm to protect the roots. Transport these seedling patches to the site for transplanting and keep them in a corner of the field in a moist condition. Take them out from the patches just before transplanting. The seedlings can be kept in the fields in this way for up to 10 hours.
- Use a type of hand weeder developed by farmers in Sri Lanka to make SRI less labour intensive (Uphoff and Fernandes 2002). This weeder is manufactured in Nepal by the National Agricultural Research Council (NARC) in collaboration with the International Maize and Wheat Improvement Centre (CIMMYT). It is pushed along and clears the areas in between the widely spaced rows of rice plants.

In 2003, SRI experimental plots were established at the Paanchkhal Horticultural Centre. Four different treatments, three for SRI and one for traditional management were established over 140m^2 plots. Plot SRI 1 was irrigated once a week and weeded manually. In the SRI 2 plot soybeans were planted in-between the rice rows to study what effect this had on reducing weed growth and its effect on rice yield. In plot SRI 3 no supplementary irrigation was applied during the period of vegetative growth and the crop was left to be irrigated only by the monsoon rains. This was done to test whether the monsoon rain alone provides sufficient moisture. Climatological data shows that the longest period without rain during the monsoon season in the Paanchkhal area is only 10 days. Also in this plot the seedlings were planted using seedlings removed from the nursery bed in clumps with soil attached, as suggested above. The mechanical weeder was used for weeding. Fertiliser input was the same for all plots (N: 50 kg, P: 30, K: 30 kg/ha).

Table 3.2: **Average number of tillers, fertile tillers, and plant height in SRI trials at Paanchkhal**

Plots	Tillers	Fertile tillers	Height (cm)
SRI 1	22	18	104
SRI 2	20	15	108
SRI 3	24	19	106
TM	11	9	102

The rice plants in the SRI 3 plot produced the most tillers with an average of 24 per plant (Table 3.2). The plants in the traditionally managed plot had the least with 11 per plant. The average number of fertile tillers was also highest in SRI 3 and the least in the traditionally managed plot. Average plant height was greatest in the SRI 2 soybean plot and the least in the traditionally managed plot (Table 3.2).

The three SRI treatments gave similar grain and biomass yields (Figure 3.6). In plot SRI 2 an additional yield of 666 kg/ha of dry soybeans was harvested The grain yield of the SRI plots was on average 21% higher and the biomass yield 12% higher than in the traditionally managed plot.

Using the weeder reduced the time needed for weeding to a tenth of that in the standard SRI plot (SRI 1). SRI plots 1 and 3 were weeded twice while SRI plot 2 only needed weeding once

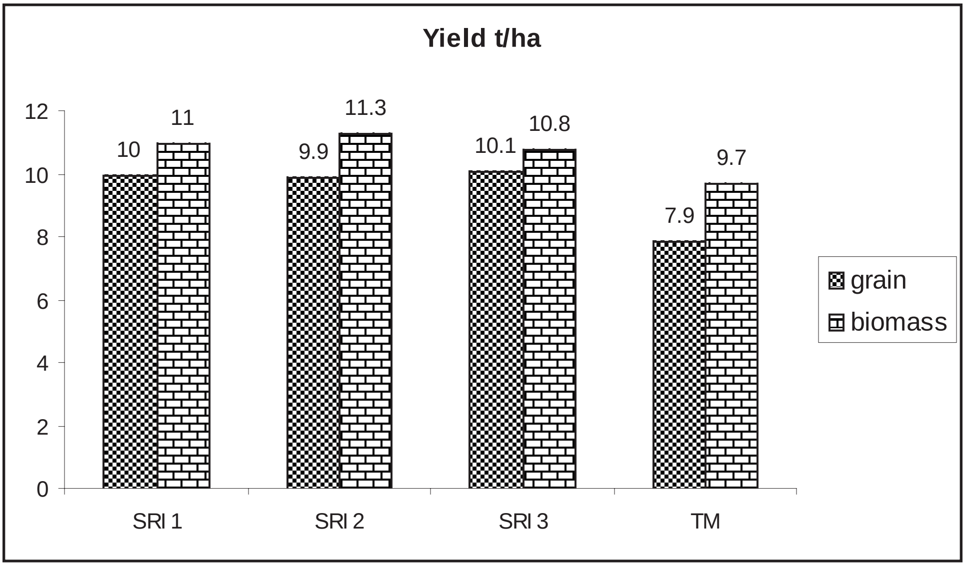

Figure 3.6: **Comparisons of grain and biomass yield of different SRI and traditional treatments**

as the soybean plants suppressed weed growth. Intercropping soybean reduced the weeding time to nearly a half compared to the traditionally managed plot (Table 3.3). Planting seedlings from patches had no affect on the survival rate of the planted seedlings and on yield.

Table 3.3: **Comparisons of labour needed (hr/plot) for different SRI treatments**

	TM	SRI 1	SRI 2	SRI 3
First weeding	0	7	4	1
Second weeding	7	14	0	1
Total	7	21	4	2

These trials suggest that farmers would benefit most by using SRI practices under rainfed conditions and by planting soybean in between rows. These results need replicating over a few years before any definitive recommendations can be made to farmers.

Before these SRI trials began a number of Paanchkhal farmers visited Sitapaila, Kathmandu to see the fields of a farmer who had been practicing SRI for two years. The same farmers also visited the SRI demonstration plot at the Paanchkhal centre to familiarise themselves with the technology. Their observations and other farmer-to-farmer interactions have helped to promote this new technology.

In 2003 six Jhikhu watershed farmers tested SRI in plots of between 20 and 80m^2 on three types of irrigated terraces and two different soil textures. The terraces were *kanle khet* (well-irrigated land), *tari* khet (irrigated), and *pakho khet* (unirrigated former bari land). The soil textures were loamy (black) and clayey (red). The rice varieties Makawanpur 1, Naya Parwanipur, Malika, and Panta 10 were tested (Table 3.4). The rice variety and the fields were selected by the farmers. Most farmers selected their lower yielding fields.

For all six farmers the grain and biomass yields were significantly higher in their SRI plots than in their traditionally managed plots irrespective of khet type and variety used. The grain yield was between 20% and 50% more and the biomass between 2% and 40% more in the SRI plots (Figures 3.7 and 3.8). These first year results produced good yields on marginal khet lands without permanent irrigation systems, but need further testing in different rainfall conditions before firm recommendations can be made.

Neighbouring farmers observed these trials and helped with harvesting and calculating the final yields. Their interest suggests that more farmers will try out SRI.

Table 3.4: **Characteristics of six 2003 SRI trial sites in the Jhikhu Khola watershed**

Farmer No.	Khet type	Soil texture/colour	Rice variety	Remarks
1	Kanle	Loamy/dark grey	Makawanpur 1	Good irrigated site
2	Kanle	Loamy/dark grey	Naya Parawanipur	Shaded irrigated site
3	Kanle	Clayey/reddish brown	Naya Parwanipur	Irrigated
4	Tari	Clayey/red	Malika	Former unirrigated bari
5	Tari	Clayey/red	Malika	Former irrigated bari
6	Pakho	Clayey/red	Panta 10	Former rainfed bari (unirrigated)

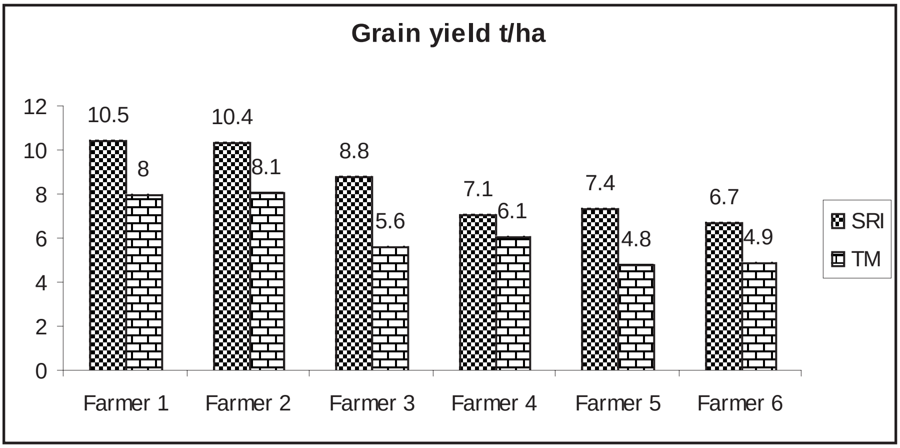

Figure 3.7: **Grain yield differences between SRI and traditionally managed rice**

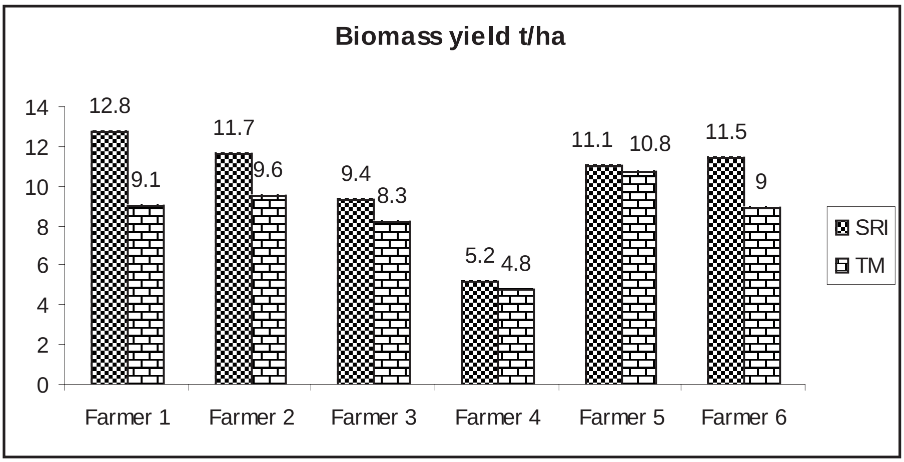

Figure 3.8: **Dry biomass differences between SRI and traditionally managed rice**

Organic pest management

Most farmers in the Jhikhu Khola watershed are involved in commercial vegetable production. They use increasing amounts of chemical pesticides often in higher than recommended doses. Apart from being harmful to human health this may lead to the build up of resistance among pests, ecosystem destruction, and environmental pollution. PARDYP has therefore been investigating the potential or organic pest management.

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Experimental trials were first carried out in 1999 at Paanchkhal Horticulture Centre to test the pesticidal value of local plant extracts. The plants used were bakaina (*Melia azaderach*), titepati (*Artemisia vulgaris*), simali (*Vintex negundo*), nimtel (*Eclipta prostata*), lemon grass (*Cymbopogon citrates*) and kantakari (*Solanum xanthocarpus*). The initial results in controlling the most common and prevalent pests and diseases in cash crops, showed that bakaina, titepati, nimtel, and simali were promising for controlling *Helocoverpa armigera* (fruit borer), and lemon grass and kantakari for controlling *Phythoptera infestans* (late blight) (Prajapati Merz and Bhandari 2002).

The treatment technology and methods for preparing the extracts were discussed with farmers. Four on-farm trial plots were established in 2000 with four farmer groups associated with the NGO the Centre for Environment and Agricultural Policy Research, Extension and Development (CEAPRED). The trials saw good success in controlling pests and diseases, but the farmers were not keen to adopt this technology as preparing the plant extracts is labour intensive whilst chemical pesticides are cheap and readily available.

The NGO Ranipani Gram Sewa Kendra approached the PARDYP team in 2003 for support to organise an organic pest management programme specifically to control *Lissorhoptrus oryzophylus* (rice water weevil) on rice. The beetle was proving particularly problematic as it was becoming resistant to Metaphos or Phorate — the strongest chemical pesticides available in the market, and ones classed by the World Health Organisation as 'extremely hazardous'.

Experimental plots were established on a farmer's field with an equal area of control and treated plot. The farmer applied pesticides and fertiliser in the control plot according to normal practice. Extracts of simali, bakaina, and titepati were used as pesticides. Equal proportions of green biomass of all three plants was combined and applied directly at the rate of 0.25 kg/m^2, a week before rice planting to control any weevil eggs or larvae in the soil. One month after planting the treated plot was sprayed with a 10% solution of the mixed extract every week until the flowering stage, then at two weeks and four weeks later. Spraying in the control plot only began after the onset of damage with about 5% of the plot being damaged. This area was sprayed with the chemical pesticides Forate, Nuvan and Fanfan once every four days.

Full results are not available for these treatments as the farmer did not record detailed data on the impact of the treatments on pest populations in the different paddy growth phases. It was however reported that there was no loss of plants in the plot sprayed with plant extracts and it had about 5% more yield of paddy than the control plot.

Grasses and hedgerow species for fodder and green manure

Introducing new species of grass and hedgerow bushes and trees has great potential to improve the availability of fodder, provide green manure to improve soil fertility, and lessen soil erosion loss.

The first trial was established in 1996 at the Baghkhor PARDYP experimental site in the Jhikhu Khola watershed. The aim was to test the performance and adaptability of nitrogen and non-nitrogen fixing grass and hedgerow species to local conditions. About 15 species were tested. The site was established to produce seeds and other planting materials and to grow-on promising species to promote to farmers. The PARDYP team discussed the usefulness of these species for fodder and green manure when visiting farms. Amongst these demonstration species, 11 were picked out by farmers as potentially useful (Table 3.5). However, farmers were only able to try out five of them because of the limited availability of planting material.

Table 3.5: **Grass and hedgerow species selected by farmers to test on-farm**

Forages		Hedgerow species	
Legume	**Grasses**	**N- fixing**	**Non N-fixing**
Stylo	Molasses	Flemingia	Guatemala grass
	Dinanath	Tephrosia	Napier grass
	Vetiver grass	Sunhemp	Broom grass
			Tithonia

The first on-farm demonstration trials were established in 2000 on 50 farms. The farmers found Napier grass, molasses, broom grass and flemingia the most useful species and tithonia the least useful. They reported biomass of 4.6 kg/m^2 over a period of a few months for sunhemp followed by Napier with 4.2 kg/m^2, broom grass (4.0), and molasses (3.9). Tithonia, although known to be a valuable green manure, was least preferred because it is only palatable to goats amongst the livestock kept by farmers. The species that are easy to establish and readily eaten by the range of livestock are most preferred by farmers. Stylo, although being a good fodder, had a lower rating because of its poor germination and slow initial growth.

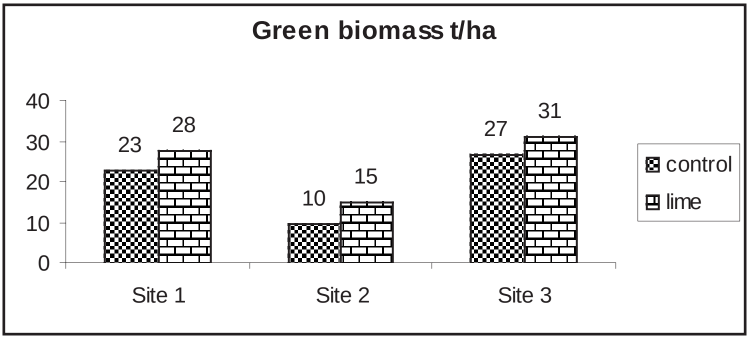

Figure 3.9: **Maize green biomass yields on limed and non-limed treatments in the Jhikhu Khola watershed**

More than 700 farmers across the Jhikhu Khola watershed have started growing fodder grasses and hedgerow species on terrace risers for supplementary animal feed during the dry season and to provide animal bedding material.

Soil liming trials

A number of Jhikhu Khola farmers suffer from deteriorating soil pH, especially in rainfed fields with red soils. The negative impact of this on yields is a major concern for farmers. The PARDYP team held discussions with farmers and proposed adding lime as a possible way of increasing soil pH. The farmers selected six possible rainfed fields for carrying out the lime trials. Three whole-terrace plots ranging from 34 to 90m^2 and with pHs from 4.2 to 5.5 were selected. Treatment plots with lime added and control plots with no lime added were set up at each site. Farmers 1 and 3 used the Dolakha variety of maize to grow whilst farmer 2 used the Jhikhu Khola local variety. The dosages of lime were calculated depending on soil pH and soil texture according to standard recommended figures (HMGN Ministry of Agriculture 2001). Recommended doses of NPK and organic matter were applied (N: 35, P: 30, K: 30 kg/ha and 10 t/ha of organic matter). The lime was applied 17 days before sowing the maize in plot 1, 33 days before in plot 2, and 28 days before in plot 3. The site 2 farmer applied lime and fertiliser only along the line where the maize was to be sown. At the two other sites lime and fertiliser were broadcast over the plots.

The lime showed a positive impact on the productivity of both maize varieties on all soils. Green biomass increased by 14 to 50% and grain yield (12% moisture content) increased by 22 to 41% over control (Figure 3.9 and 3.10).

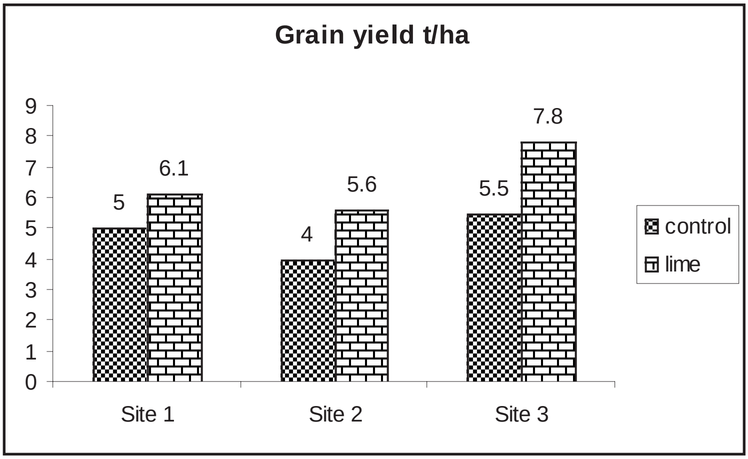

Figure 3.10: **Maize grain yield on limed and non-limed fields in the Jhikhu Khola watershed**

The preliminary results of liming were encouraging. The farmers reported increased yields and noticed that the land had become easier to plough after treatment. They wanted to continue to treat their fields with lime. In coming seasons the project plans to test the effect of adding lime on different crops and in split doses. The pH of the plots has remained the same or has slightly increased in the limed plots and it is too early to show any significant changes. It usually takes more than one year for liming to make a significant difference on soil pH.

Plastic-lined water harvesting ponds

The 2002 PARDYP drip irrigation trials in Lamdihi determined that about 5000-6000 litres of water was needed to drip irrigate an area of between 144 and 200m^2 to grow cash crops during the dry season. Precipitation data for 1999-2001 indicates that the pre-monsoon season can be drier than 2002 conditions. These issues were discussed with farmers and the decision was taken to build 8,000 to 9,000 litre capacity ponds as backup sources of water for the drip irrigation systems. A plastic-lined 9,000 litres water harvesting pond was built in Lamdihi in 2002 measuring 3m x 2m and 1.5m deep. A shaded site was selected to minimise evaporation. The cost of building it was about US$30. The stored water was used to irrigate bitter gourd. Three more of these ponds were built by local farmers to supply their micro-sprinklers and drip irrigation systems.

Collaboration

PARDYP's research trials and the dissemination of the results are being carried out in collaboration with a range of local and national organisations.

In 2003, a two-day participatory monitoring and evaluation workshop was held to discuss the approach taken and the progress made by PARDYP in the Jhikhu Khola watershed. Representatives from government line agencies, district development committees, village development committees, and farmers, and NGOs participating in the programme were invited to evaluate the contribution of PARDYP's work. This workshop gave the project team valuable feedback that will be used to improve research activities and activity planning.

Figure 3.11: **A plastic-lined water harvesting pond**

PARDYP-Nepal has worked closely with the following four organisations.

Horticulture centre — From the beginning of its Phase 2 in 1999 PARDYP has run collaborative programmes with the Paanchkhal Horticulture Centre. Research and demonstration plots have been established to test new technologies and varieties of cash crops. Trials on the System for Rice Intensification, drip irrigation, biofertilisers, organic pest management, and tomato varieties have been carried out. The centre is providing technical support and training to local farmers.

Patlekhet Model Village Development Committee — The following activities have been successfully initiated and demonstrated in Patlekhet VDC in collaboration with this committee:

- cultivating off-season vegetables using drip irrigation and micro-sprinklers;
- building plastic-lined water harvesting ponds for off-season vegetable production;
- cultivating fodder grasses and hedgerow species on terrace risers;
- intercropping bush beans in rainfed maize;
- distributing improved fruit seedlings and introducing new fruit varieties;
- demonstrating soil conservation technologies on rainfed terraces; and
- running training courses on mushroom production, vegetable nursery management, and seed production.

Ranipani Gram Sewa Kendra — This local community development NGO looked at PARDYP's work and picked out drip irrigation and organic pest management as the most promising activities for promoting community development. It has promoted these by distributing subsidised drip irrigation systems. The organisation seeks future collaboration and PARDYP support especially for improving soil fertility.

The Centre for Environment and Agricultural Policy Research, Extension and Development — CEAPRED is a national NGO working on agricultural development and related issues. It has worked in the Jhikhu Khola watershed with vegetable farmer groups to promote the growing of off-season vegetables and on the organic pest management trials.

Other collaboration

PARDYP has also carried out its work in the Jhikhu Khola watershed by:

- sharing ideas on innovative farming practices with the District Agriculture Development Office. This office is one of the main candidate organisations to spread the PARDYP-introduced technologies.
- exchanging knowledge, especially on soil fertility issues, with the National Agriculture Research Council (NARC);
- contracting the Centre for Agriculture Technology (CAT) to provide trainings and technical advice on mushroom cultivation;
- contracting the Agriculture Technology Centre (ATC) to provide technical support for soil fertility analysis. PARDYP is currently evaluating ATC's soil testing kit for farmer use;
- getting planting materials from the Australian-funded Third Livestock Development Program (TLDP). PARDYP has tested TLDP's recommended seed varieties in the Jhikhu Khola watershed for their performance and suitability to local conditions. Multiple options have been provided to farmers to test forage and grass species on terrace risers and in private forests;
- sharing ideas with the Swiss-funded Sustainable Soil Management Program (SSMP). This project has a PARDYP staff member on its technical advisory committee; and
- sharing ideas with the SRI-Nepal Network. This network of 13 organisations works on adapting SRI to use in Nepal by exchanging knowledge between its members. PARDYP is a founding member.

Discussion and conclusions

PARDYP's current work in the Jhikhu Khola watershed has two phases. In the first phase demonstration activities are established to test and then modify potential technologies for the local environment. This also allows farmers to observe their effectiveness. In the second phase, participatory trials and demonstrations are carried out with farmers to see if these technologies can be adapted by farmers. This allows the project team to test technologies under different management conditions.

Farmer to farmer visits have given farmers the chance to evaluate the benefits of new technologies with other farmers and find out how to use them. This builds up a network of interested farmers within the watershed. Collaboration and networking with other organisations is enabling the exchange and dissemination of knowledge generated at field level. This can be very useful for disseminating a particular technology to another part of the watershed.

PARDYP's overall approach is to implement its activities by fostering dialogue and interaction between farmers and local organisations. The project's findings are being shared with district line agencies and local organisations to further adapt and scale-up the new technologies and farming practises.

In summary, the approaches used to implement project activities have had both positive and negative impacts (Table 3.6).

Table 3.6: **Impacts of PARDYP Nepal's work in the Jhikhu Khola watershed**

Approaches	Positive aspects	Negative aspects
Research trials and demonstrations	• Trial design is under researchers' control leading to less errors than in farmers' fields • Makes it easy for farmers to understand and observe technologies being tested, promoting discussions amongst them • Increases awareness and participation of farmers to select appropriate technologies • Assists researchers to modify technologies to fit local condition s before testing in farmers' field • Failed trials do not reflect too much on the project's credibility	• The participation of farmers is passive during this first phase • There is a controlled research environment and findings may not apply to farmers' fields
Participatory trials and demonstrations	• Farmers are active partners in demonstrations and adapt technologies to better suit them • Farmers are the direct beneficiaries • Documented results are based on practical not hypothetical conditions	• Trial design is part icipatory and so may not be scientific • Farmers are directly affected if trials fail and there is a danger of the project losing credibility
Farmer to farmer visits	• A good way of disseminating findings • Allows farmers to observe farm interventions directly • Facilitates networking between farmers from different parts of the watershed	• Sometimes participating farmers' interest can be just touristic (but even so may stimulate interest)
Collaboration with other organisations and projects	• Promotes knowledge shari ng and dissemination amongst partners • Helps avoid duplication • Helps farmers understand new technologies	• The interest of partner organisations can suddenly change
Demand driven interventions	• Encourages active participation of farmers • Encourages sense of ow nership among farmers	• Initiatives may not fulfil project objectives

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