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Participatory Crop Improvement Project in Chitwan and Nawalparasi Districts of Nepal.

Baseline Report

LI-BIRD

List of Abbreviations

CAZS	Centre for Arid Zone Studies
CBO	Community Based Organisation
CIMMYT	International Maize and Wheat Improvement Centre
PCI	Participatory Crop Improvement
PVS	Participatory Variety Selection
PPB	Participatory Plant Breeding
IRD	Informal Research and Development
ECC	East Chitwan Cluster
WCC	West Chitwan Cluster
NPC	Nawalparasi Cluster
DADO	District Agricultural Development Office
ASC	Agriculture Services Centre
AIC	Agriculture Input Corporation
HH	Household
NRSP	Natural Resources Systems Programme
PSP	Plant Sciences Programme
DFID	Department for International Development
UK	United Kingdom
HPPS	High Potential Production Systems
IAAS	Institute of Agriculture and Animal Sciences
FAMPAR	Farmer Participatory Research
VDC	Village Development Committee
NARC	Nepal Agricultural Research Council
WBPH	White Backed Plant Hopper
FYM	Farm Yard Manure
DAP	Di-ammonium Phosphate
NGO	Non-governmental Organisation
IDP	Intensive Data Plots
CDR	Central Development Region
WDR	Western Development Region

BASELINE STUDY OF PARTICIPATORY CROP IMPROVEMENT PROJECT IN CHITWAN AND NAWALPARASI DISTRICTS, NEPAL

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1. INTRODUCTION

1.1 Participatory Crop Improvement (PCI) Project

A participatory crop improvement (PCI) project jointly funded by Natural Resources Systems Programme (NRSP) and Plant Science Programme (PSP) of the Department for International Development (DFID), UK was initiated in parts of Chitwan and Nawalparasi districts of Nepal in October 1996. The main objective of the project was to develop and promote strategies for the introduction of new crop varieties and improved agronomic practices in High Potential Production Systems (HPPS). The project endeavored to demonstrate that participatory methods were effective in increasing cultivar diversity and in improving agronomic practices in HPPS environments.

The rationale of the project was that the varietal choice in the HPPS was limited because of less efficient conventional breeding methods and low level of farmers' participation in technology development and verification. This resulted in slow turnover rates of cultivars, which implies that farmers were forced to grow inferior genetic materials with less than optimum levels of inputs. Dependence on relatively old cultivars has become a liability because of increasing susceptibility of these cultivars to pests and diseases. In such circumstances, ample potential existed for participatory approaches in HPPS for the introduction of superior varieties and improved agronomic practices. Moreover, participatory research, often used in marginal areas, has not been tested in HPPS. Thus, the project provided an opportunity to test the participatory approaches in HPPS environments.

Within participatory research there are mainly two approaches, namely Participatory Variety Selection (PVS)/Farmer Participatory Research (FAMPAR) and Informal Research and Development (IRD). These two approaches have been compared to test the cost effectiveness and suitability in terms of adoption by extension agencies in the Nepalese context.

1.2 Study Sites

The PCI project was conducted in HPPS of Chitwan and Nawalparasi districts of Nepal. Project sites were organised into three clusters namely, East Chitwan Cluster (ECC), West Chitwan Cluster (WCC) and Nawalparasi Cluster (NPC). The site selection process deliberately focused on better-off environments within the districts. As a consequence, the sites may not necessarily be representative of the district as a whole. The LI-BIRD and UK team members made use of secondary sources of information and consultations with the District Agriculture Development Offices of Chitwan and Nawalparasi prior to visiting potential field sites. Only after the field visits and interaction with farming communities were the actual sites selected for implementing project activities. The name of villages in each cluster is shown in Table 1.

The project activities were spread across 18 villages covering over 3000 households. As mentioned earlier, the project was designed to compare FAMPAR and IRD approaches. Nine out of 18 villages in the project fell under FAMPAR activities while IRD activities were conducted in the remaining nine villages. Out of six villages per cluster, three villages were dedicated to FAMPAR and the remaining three to IRD.

In each cluster there was one cluster office, which was staffed by two Community Organisers with front line staff responsible for dealing with community members within the cluster. The PCI field office with a field co-ordinator was stationed in one of the clusters. The project leader, on behalf of LI-BIRD, manages the project.

Table 1. List of selected villages for Farmer Participatory Research (FAMPAR) and Informal Research and Development (IRD) activities.

Name of the cluster	VDC/Municipality	Name of the selected villages	
		FAMPAR	IRD
East Chitwan	Chainpur	Kunaghari	
	†Birendranagar	Six Group	
	Kathar	Kharkhutte	Kathar
	†Ratnanagar		Debauli
	†Panchakanya		Krishna Mandir
West Chitwan	Gitanagar	Devnagar Amarbasti	
	Shivanagar	Radhapur	
	Patihani		Pakaudi Ganganagar
	Parwatipur		Parawatiput
Nawalparasi	Tamsariya	Chormara	
	Kaluwa	Abhiyun	
	Shivamandir	Koilapani	Purbatola
	Deurali		Deurali
	Nayabelhani		Arungkhola

†These three VDCs were later merged to form the Ratnanagar Municipality.

1.3 Mandate Crops

The project was basically designed to work on the staple food crops as listed below. The crops were identified based on their importance to food security, income generation and the overall farming systems. The mandated crops were as follows:

- *Chaite* rice
- Main season rice
- Winter maize
- Spring maize
- Lentil
- Wheat

2. OBJECTIVES OF THE BASELINE STUDY

The overall objective of collecting baseline information was to profile the farming system prior to the effects of introducing new varieties in the project area. The specific objectives of the study included the following:

1. to help identify the constraints (and opportunities) for farmers to adopt new varieties;
2. to provide a perspective on "trends" in farming practices;
3. to determine the degree of exposure of farmers to public extension services;
4. to explore farmer access to markets and agronomic inputs;
5. to provide baseline data such that the impact on the farming system of introducing new varieties can be measured over time;
6. to allow future determination of the influence that differences in physical and socio-economic baseline conditions (i.e. farm size, wealth status, ethnicity, reliability of irrigation, sharecropping, education of household head, access to public extension, membership in groups etc.) have on:
   - the adoption rates of new varieties, and
   - aspects of the farming system.
7. to provide baseline data enabling the broad impacts of new varieties on local "sustainability" to be evaluated.

METHODS

3. METHODOLOGY ADOPTED FOR BASELINE STUDY

The information was collected at the household level using structured survey questionnaires. PCI team members developed the questionnaire and discussed it with field staff and team members from UK. Based on feedback from different groups the questionnaire was then refined. The refined questionnaire was put for pre-testing in the field and further modification was made mainly to make sure that the interview time did not exceed 40 minutes on average.

Nine B. Sc Agriculture students from the Institute of Agriculture and Animal Science (IAAS) were employed as enumerators for the field exercise on daily payment basis. During field exercise enumerators were resident in the village. They were first briefed on the project objectives, approaches and the expected outputs. This was followed by discussion of each question and clarification of any ambiguity left in the questionnaire. General tips to be followed while conducting interviews were provided. A mock exercise was conducted in order to give the enumerators confidence in the fieldwork.

Prior to administration of the survey questionnaire, a wealth ranking exercise was conducted in all the FAMPAR villages. Key informants from within the village put individual household in one of the three wealth categories. The idea of conducting a wealth-ranking exercise was to select participant farmers for FAMPAR trials from different wealth classes. The underlying assumption was that the amount of inputs the crops and varieties varied with wealth status. As a consequence, the benefits derived from the adoption of any new technology would vary with wealth classes. The decision-maker of the household was selected as a respondent for the interview. The fieldwork was performed in the months of May – July 1997. Collected information was entered into the computer and analysed using SPSS software.

RESULTS

4.1 General Features of the Project Districts

Chitwan lies in the inner *terai* of Central Development Region (CDR) of Nepal and enjoys a tropical climate with a mean maximum of 36°C and a mean minimum of 7.6°C with an annual mean rainfall of 2070 mm. It has an area of 2220 km^2 with 44390 ha under cultivation, of which 12730 and 15650 hectares are all year and monsoon irrigated, respectively. The district has good road networks and market centres (DADO Chitwan, 1997/98).

The Nawalparasi district lies in Western Development Region (WDR) of Nepal with an altitude range of 90 to 1930 m asl. The hottest period of the year is April to July with an average temperature of 36°C and the coldest month being December with a minimum of 10°C. The wettest period of the year is May to September with an average monthly rainfall of 500 mm. The district has 114900 hectares of cultivable land. Road access and market centres are fairly well developed within the district (DADO Nawalparasi, 1997/98).

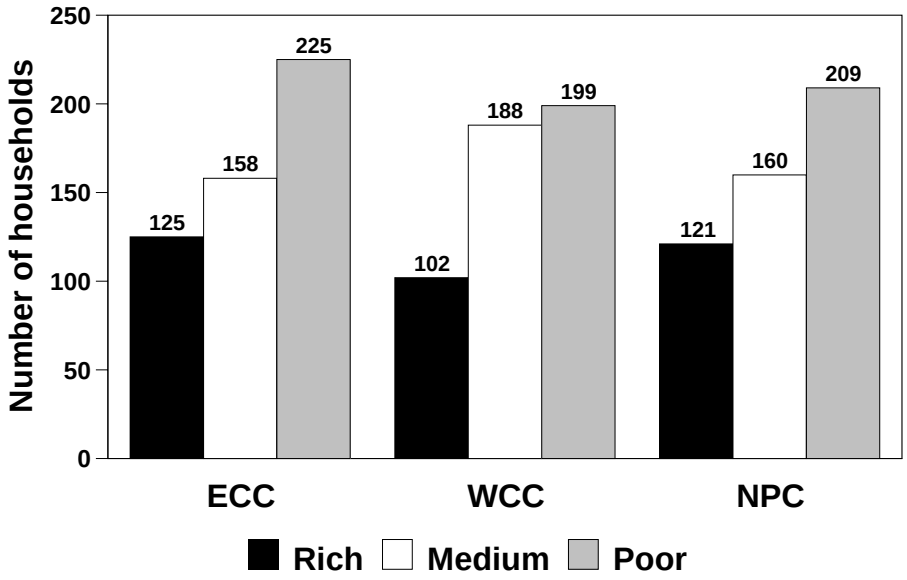

Figure 1. Households by wealth category in different clusters. The number of respondents was 508 in Eastern Chitwan Cluster (ECC), 489 in Western Chitwan Cluster (WCC) and 490 in Nawalparasi Cluster (NPC).

4.2 Family Profile

Understanding family characteristics helps in explaining adoption behaviour of the household. The decision at the household level is influenced by many internal and external factors. Internal factors, to name a few, include family size, population distribution by age, present place of residence of the family members and education level of the decision makers. An effort has been made in the study to characterise households in terms of the above mentioned factors (Table 2).

Table 2. Family profile of households in the project area where profiles have been prepared taking ethnic/caste as the basis for classification. Values in parentheses are the corresponding percentages

Variables	Brahmin / Chhetri	Gurung/Magar /Rai/Limbu	Indigenous	Kami/Damai/ Sarki	Others
Total population	5455 (55.7)	1245 (12.7)	2367 (24.2)	579 (5.9)	154 (1.6)
Average family size	6.5±0.1	7.1±0.3	6.6±0.2	7.0±0.4	7.3±0.6
Age	2.2±0.1	2.2±0.1	1.9±0.1	2.2±0.1	2.2±0.3
>16 year old male	2.1±0.0	2.1±0.1	1.9±0.1	2.3±0.2	2.2±.2
>16 year old female					
<16 old male	1.7±0.0	2.0±0.1	1.8±0.1	2.0±0.2	1.7±0.2
< 16 year old female	1.8±0.1	2.0±0.1	1.9±0.1	2.0±0.2	2.1±0.3
Present place of residence					
Within village	5.5±0.1	6.1±0.2	6.2±0.2	6.0±0.3	5.3±0.4
Outside village	2.3±0.1	2.4±0.4	2.0±0.3	2.4±0.4	3.1±0.8
Education level of the head of the household					
Illiterate	105 (13.2)	24 (17.6)	85 (25.0)	37 (45.1)	2 (10.0)
Primary	353 (44.4)	78 (57.4)	208 (61.2)	36 (43.9)	12 60.0)
Middle	229 (28.8)	28 (20.6)	41 (12.1)	8 (9.8)	6 (30.0)
Secondary and above	108 (13.6)	6 (4.4)	6 (1.8)	1 (1.2)	-

Studies conducted in the past have shown that ethnic/caste have a strong association with the education level, access to land, formal credit institutions, public extension services etc. which in turn affect the level of adoption of any innovation (Subedi and Garforth, 1998; LARC, 1995).

The project villages had a total population of 9800 with an average family size of 6.6 members. Brahmin and Chhetri had a family size below the mean whereas Gurung, Magar, KDS[3] and other castes had larger families (Table 2). When the population was disaggregated by sex it was apparent that females outnumber males by a small margin in many castes. The figures of above 16 years of age indicated that, on average, two male and two female members of the family were economically active in the population. However, those working on the farm may be fewer because some members were working outside the village. Others could be too old to work on the farm but were counted in the survey. Family members below 16 years of age refer to school-going children, who contribute to agricultural activities on a part-time basis only. An appreciable number of households had family members working outside the village, and the remittances from these members complement household income.

The educational status of respondents (decision-maker) has a direct relation to access to information and adoption of innovation (see access to public extension services). The related figures showed that 18% of the respondents were illiterate, 50% have primary education, 23 had middle and 9% secondary and above education level (Table 1). However, the disparity in level of formal education attainment was evident across castes with a higher number of indigenous and Kami, Damai and Sarki (KDS) populations being illiterate. As a whole, the project area has quite a high proportion of farmers with formal schooling when compared with the national (46%) average (CBS, 1998). This fact could have a positive impact on the adoption of improved varieties and the level of participation in the research processes.

[3] KDS stands for Kami, Damai and Sarki (occupational caste) from whom water is not acceptable according to Hindu customs.

4.3 Profile of the Farming Systems

Farming systems in Nepal are subsistence oriented with farmers growing a number of crops primarily to meet their household food requirement and to sell surplus in the market. Similarly, they keep a few livestock to supply them with manure, milk and meat. Farming households depend on forest resources for fuel wood, fodder, bedding material etc. The interaction in terms of complementary and competition among the components of farming systems result in a complex and diverse system. Intervention in one component is bound to have implications for the whole system. Moreover, farmers' ability to take risk and make sound decisions based on adopting new interventions largely depend on the amount of resources he/she has access and control over. Therefore, understanding different components of farming systems and their interaction and resource endowment of farmers is quite essential in this project.

4.3.1 Farmers' land resources

Land is the most precious asset owned by the farmer. Adoption of interventions (new varieties in this case) in agricultural require access to land, directly or indirectly. The baseline survey questionnaire was designed so that the ownership arrangement of land was captured in detail. The ownership of land is an important factor that has direct influence on the level of management and other inputs that go into the soil.

Out of 1487 households interviewed 97% have their own land whereas 3% did not. It is apparent that farmers in WCC had a significantly higher ($p<0.000$) land holding for both *khet*[4] and *bari*[5] compared to the ECC and NPC (Table 2). Irrespective of the cluster the proportion of *khet* land was more than three times that of *bari* suggesting that rice-based cropping was dominant in the area. Besides *khet* and *bari* land, farmers in all the clusters had a reasonable amount of land under vegetable, orchard and

[4] *Khet* is bunded land (i.e. land enclosed by raised bunds) where transplanted rice is grown.

[5] *Bari* is the unbunded land where upland crops are grown.

private tree plantations (mainly *Dalbergia sissoo* and *Melia azadarac*). All the clusters had some wasteland and public pasture, though the pasture is relatively abundant in NPC and least in ECC. NPC is a relatively new settlement compared to WCC and ECC. As the settlement gets older, encroachment by the later settlers of the pasture area occurs.

In terms of poverty focus of the programme it was important to compare land resources across wealth category within clusters. There was a clear disparity in land holding especially that of *khet* land across wealth class within the cluster (Table 3). In the case of *khet* land the size of landholdings did not vary greatly whereas there was much variation in land ownership amongst the rich. Since the amount of land owned by different wealth groups varied significantly ($p < 0.000$) in favour of better-off farmers it is crucial to include farmers from all wealth categories in the research programme. This would allow them to have equal opportunity and access to test the new genetic materials and adopt them as per their circumstances. Furthermore, the varietal performance and adoption and diffusion pattern across wealth categories might be worth noting.

Sharing in-and-out of land was practised in all the clusters but the intensity was greater in the case of ECC with 24% households sharing in and 11% sharing out land. The practice was least common in WCC with only 9 and 2% households engaged in sharing in-and and 2% involved in sharing out. In other words, WCC had a higher number of cultivator farmers and who make decisions on adoption or rejection of varieties. This may not be the case where sharing in-and-out was more prevalent. The sharing in-and-out arrangement has a traditional root in Nepalese society and reflects the resource sharing between resource rich and poor for mutual benefits. Moreover, this arrangement reflects the level of land holding, absentee landowner etc.

Table 3. Land holding by ownership of the land

Variables	East Chitwan Cluster (EEC)	West Chitwan Cluster (WCC)	Nawalparasi Cluster (NPC)	(*p*-value)
1. Owned area				
Khet[6]	0.63±0.03 (449)	0.94±0.05 (457)	0.57±0.03 (424)	0.00
Bari[7]	0.12±0.02 (145)	0.36±0.07 (36)	0.19±0.02 (159)	0.00
2. Shared In				
Khet	0.36±0.03 (116)	0.41±0.04 (40)	0.44±0.04 (69)	0.69
Bari	0.20±0.07 (3)		0.20±0.06 (6)	-

Figures in the parenthesis indicate number of respondent households.

Table 4. Land holding information by wealth categories within clusters.

Variables	*Khet*	*Bari*	*p*-value for *Khet* only
EEC			
Rich	1.19±0.06 (125)	0.24±0.04 (46)	0.000
Medium	0.54±0.03 (155)	0.09±0.02 (43)	

Poor	0.29±0.02 (169)	0.05±0.01 (56)		
WCC				
Rich	2.10±0.16 (99)	0.44±0.12 (12)		0.000
Medium	0.80±0.03 (187)	0.50±0.14 (11)		
Poor	0.41±0.02 (171)	0.16±0.05 (13)		
NPC				
Rich	0.96±0.08 (116)	0.29±0.05 (40)		0.008
Medium	0.54±0.03 (154)	0.19±0.02 (55)		
Poor	0.30±0.02 (154)	0.13±0.01 (64)		

Figures in the parenthesis indicate respondent number

Regarding the number of parcels of land, irrespective of the cluster, the majority of households in the project area have single parcels. In WCC, land fragmentation was least visible whereas in ECC and NPC this could be a major problem in years to come. Nevertheless, more than 80% of the households have fewer than four land parcels. A few farmers in ECC and NPC reported as many as eight parcels of land. In the project area, the number of land parcels could not be regarded as a major factor having impact on adoption of improved varieties.

4.3.2 Soil fertility status

Farmers' perception of the fertility status of their *khet* and *bari* land was collected in the survey. It was acknowledged that the fertility status would vary considerably within a farm depending on inherent capacity of the soil and the management practices followed by the farmer. Conversely farmers' level of management (amount of FYM and chemical fertiliser application) depended on his/her perception of the fertility of the land.

Farmers in all the clusters perceived that the majority of their land was either fertile or medium fertile (Figure 2). Only a handful of farmers responded by saying that their land had a poor fertility status. However, this information was purely based on the perception of the farmer.

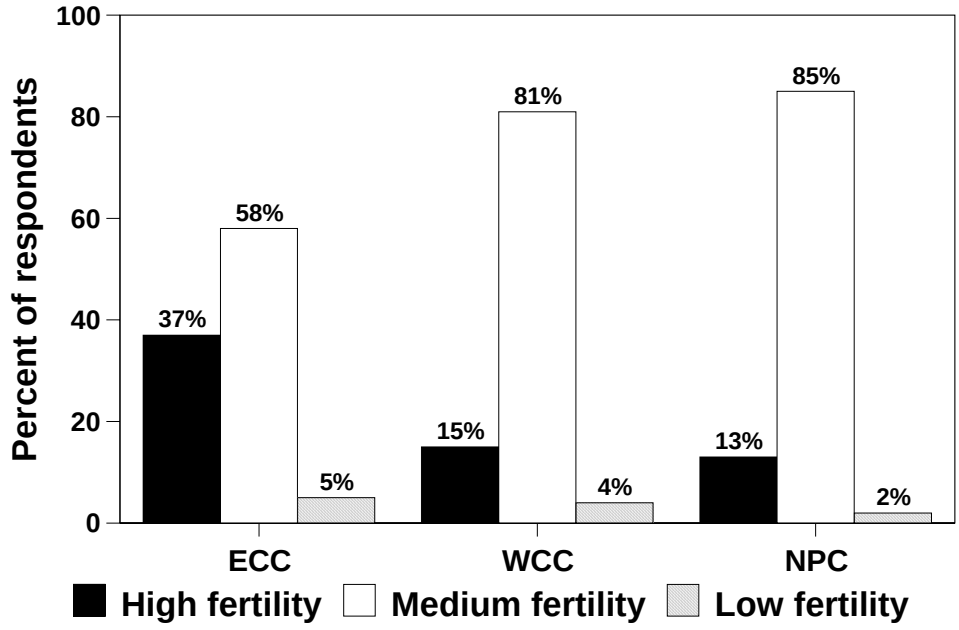

Figure 2. Farmers perception of the fertility of *khet* land. The number of respondents was 446 in Eastern Chitwan Cluster (ECC), 460 in Western Chitwan Cluster (WCC) and 423 in Nawalparasi Cluster (NPC).

Adoption of varieties partly depended on the farmer's perceptions of the fertility demanded by the variety to realise higher yield. Farmers reported that some of the varieties demanded more fertility and performed well under high fertility conditions, whereas others performed well under medium or low fertility conditions and lodged in high fertility conditions. This factor has to be taken into consideration when providing varietal choice to the farming communities.

4.3.3 Irrigation

Surface irrigation through a canal was the main source of water in ECC and WCC with 85% and 92% farmers. Farmers also used pumps for shallow and deep tube wells to irrigate their field. This practice was more common in ECC. However, the use of a pump set increased the cost of production since the operating cost of a pump set is higher than the tariff for canal water. This factor would have a direct influence on the types of intervention that the household adopts. Similarly, the cropping intensity and production potential of varieties is influenced by the availability of adequate water during the growing period of the crop.

Water availability and reliability varies by the season of the year (Figure 2). The majority of the farmers in all clusters have either plenty or adequate water for their crops. However, in ECC and WCC a good number of farmers reported a scarcity of water whereas very few farmers faced this problem in NPC. All-year-round irrigation facilities were mostly available in NPC followed by ECC and least in WCC. From a water availability and reliability point of view, WCC seemed to be in the most disadvantaged region. Again this factor must be borne in mind when providing options of varieties to the farming community in any of the clusters. Availability of water would determine the domains of the varieties for adoption. Failing to appreciate this factor would result in wastage of resources with limited impact on varietal adoption.

4.4 Main Crops and Cropping Patterns

The main cropping patterns on *khet* land was rice based whereas *bari* was maize based (Table 5. Farmers reported over 115 different cropping patterns on *khet* land in total from three clusters. Similarly, there were over 50 different cropping patterns for *bari* land in total.

Table 5. Main cropping patterns reported by the farmers in the project area.

Cropping Pattern	
***khet*:**	***bari*:**
1. Rice-Fallow-Rice	1. Maize-Tori-Fallow
2. Rice-Wheat-Maize	2. Maize-Potato/wheat-Fallow
3. Rice-Lentil-Maize	3. Maize-Vegetable-Vegetable
4. Rice-Maize-Fallow	4. Maize-Millet-Fallow
5. Rice-Maize-Vegetables	5. Maize-Sesame-Fallow
6. Rice-Vegetables-Fallow	6. Maize-Blackgram-Tori
7. Rice-Vegetables-Maize	7. Maize-Fallow-Vegetables
8. Rice-Fallow-Fallow	8. Maize-Tori+Lentil

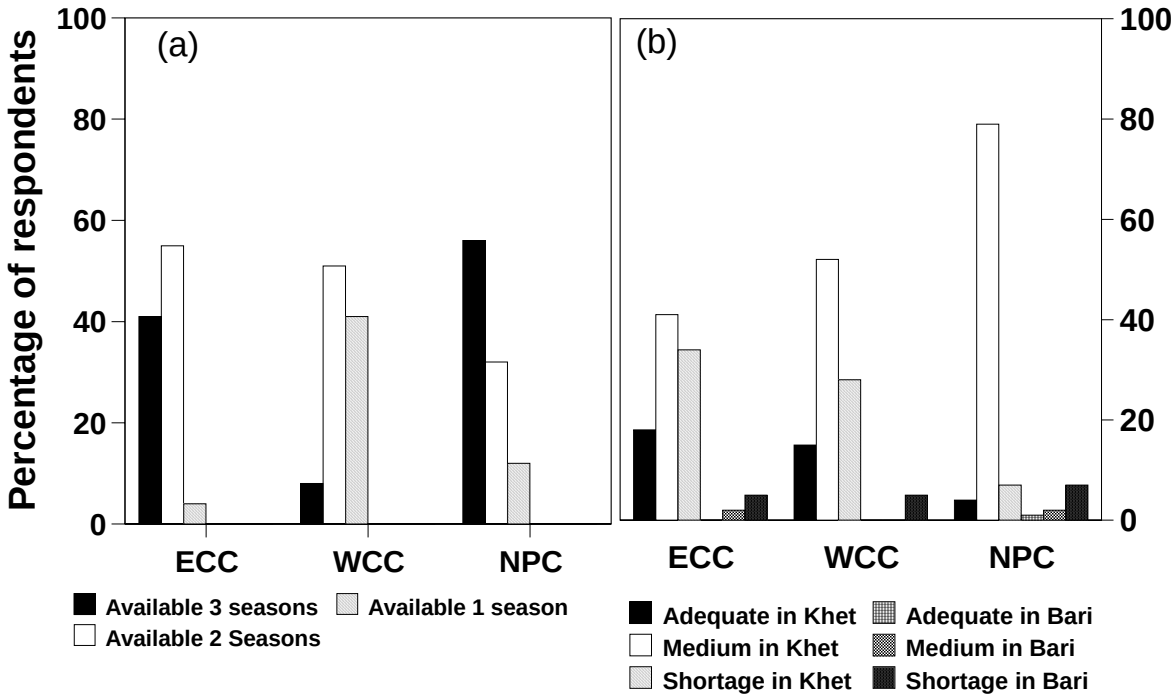

Figure 3. Survey of (a) the availability of irrigation water across seasons in East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC) clusters where the number of respondents was 445 (ECC), 460 (WCC) and 436 (NPC) and (b) the adequacy of irrigation in Khet and Bari land with 479 (ECC), 486 (WCC) and 469 (NPC) respondents.

4.4.1 Main season rice

The importance of rice (*Oryza sativa* L.) in Nepalese society can be traced back to many references made in Hindu religious books. In the present day context, apart from the religious and cultural significance, rice has acquired an important socio-economic role in Nepal. At a national level around 60% of the total cultivable area is planted under rice and contributes 52% of the grain output (CBS, 1998). In Chitwan rice covers 30,000 ha, and in Nawalparasi 46,100 ha, with a mean yield of 3.3 t ha^{-1} in Chitwan and 4 t ha^{-1} for improved varieties in Nawalparasi district (DADO Chitwan, 1997/98 and DADO Nawalparasi, 1997/97).

Information on area covered and productivity was collected on a variety basis for rice, maize and wheat. This information also provided the baseline varieties against which the adoption of the introduced varieties would be judged.

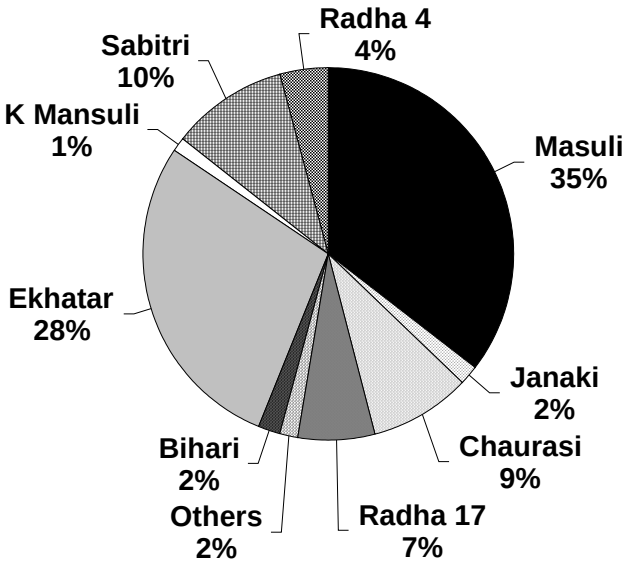

Figure 4. Varietal diversity of main season rice in the East Chitwan Cluster (EEC). Values refer to the percentage of total rice land allocated to different rice varieties in EEC.

In ECC, 12 different rice varieties were grown by the farmers and one farmer grew on average 4-5 varieties on the farm. Among the varieties grown in ECC, Mansuli was predominant, accounting for 35% of the *khet* land. This was followed by another improved variety locally known as 'Ekhatar', Sabetri and Chaurasi (Figure 4). Farmers reported to grow recently released varieties such as Radha 4, Radha 17 and Kanchi Mansuli in their farm.

Another important factor that emerged from the analysis of the traits of the varieties farmers grew was that the types of varieties they were planting were complementary rather than competitive in nature.

When varietal diversity was analysed for WCC a different picture emerged. In total, six varieties were grown by the farmers in WCC, which was 50% less than in ECC. The over dominance of one variety, Mansuli was striking with 98% of the total *khet* land devoted to it (Figure 4). Market acceptability of the variety was such that it was the standard against which all the varieties were evaluated. Almost 30% of Mansuli produced in the area was sold in the market. This is quite large considering the magnitude of area under the crop. Given such a strong market incentive it is only natural that farmers have stuck with it for so long.

The varietal diversity situation at NPC was more or less similar to ECC. The area under Mansuli was 69% of the total rice area. Sabitri occupied 22% of the rice area followed by other newly released varieties such as Radha 4, Radha 7, Radha 17, Kanchi Mansuli (KM) (Figure 6). Farmers have access to new genetic materials released by the formal research system contact with the public extension service by individual farmers was quite limited. This indicates that farmers receive the genetic materials from other sources such as farmer-to-farmer network and private dealers.

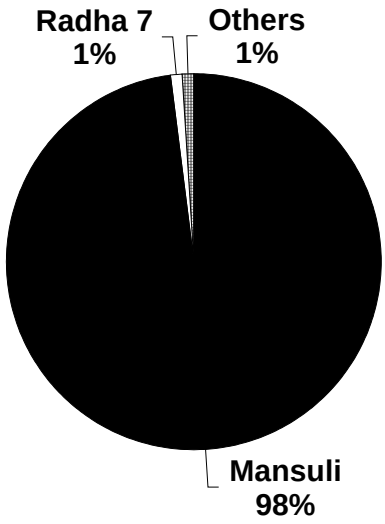

Figure 5. Varietal diversity of mains season rice in West Chitwan Cluster (WCC).

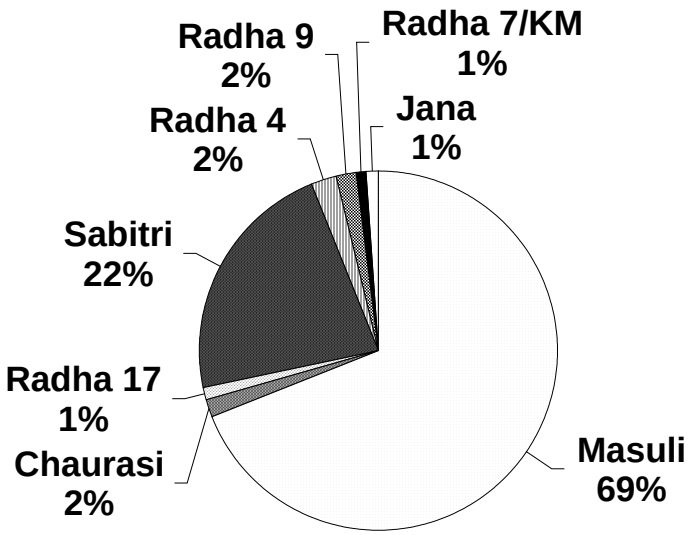

Figure 6. Varietal diversity of main season rice in Nawalparasi Cluster (NPC).

Farmers have found new varieties like Radha 4 as promising. However, this variety was adopted in the domains not occupied by Mansuli. These new varieties were short duration and fitted well with multiple cropping systems (three crops per year). In the context of vegetable cultivation, winter vegetables were gaining momentum amongst farmers and it would be appropriate to concentrate on short duration varieties with good grain quality.

Analysis of the productivity figures of main season rice varieties indicated that farmers in ECC realised a slightly higher yield compared to WCC and NPC for all the major varieties grown (Table 6. Productivity figures were in agreement with the amount of fertiliser applied by the farmers. Farmers in WCC reported the lowest yield for all the major varieties across clusters. Farmers' yield estimate and the area covered by individual varieties corresponded well with the higher yielding variety covering the largest area and *vice versa*.

Table 6 Productivity of major varieties of main season rice in different clusters. Values refer to t ha^{-1} ±s.e. mean.

Varieties	ECC	WCC	NPC
1. Mansuli	3.0±0.1	2.0±0.0	2.2±0.0
2. Radha4	2.5±0.2	1.9±0.3	2.1±0.1
3. Sabitri	2.7±0.1	2.1±0.9	2.3±0.1
4. Kanchi Mansuli	2.6±0.3	2.0.±0.0	2.3±0.3
5. Ekhatar	2.3±0.1	-	-
6. Radha17	2.4±0.1	-	2.1±0.2
7. Chaurasi	2.6±0.1	-	2.6±0.2

4.4.2 *Chaite* rice

Chaite rice planted in February-March and harvested in July-August is commonly known as '*Chaite dhan*'. Since the crop is grown in the dry summer season it can be grown only in areas under 1000 m asl and with irrigation facilities. Unlike the main season rice the history of growing *Chaite* rice is quite recent, dating back to the early 1950s with the introduction of the 'miracle variety' called CH45 from China. Surprisingly still today 90% of the *Chaite* rice area in Nepal is planted under this variety. Although Nepal Agricultural Research Council (NARC) has released several new varieties of *Chaite* rice, they have yet to find popularity amongst the farmers. This fact is supported by the evidence from farmers field where most of the *Chaite* rice growing area in ECC, WCC and NPC was covered by single old variety CH45 (Figure 7). Farmers clearly lacked varietal diversity in *Chaite* rice.

Until very recently this variety was performing in farmers' field, however, the problem of white backed plant hopper (WBPH) in 1996 was so severe that the whole crop was destroyed in several locations at the periphery of the PCI project (Status Report, 1997). As a result, farmers became desperate looking for an alternative variety to replace it partly or fully.

While providing a choice of new varieties in *Chaite* rice it should be noted that CH45 is mainly used to prepare beaten rice and has wider adaptation in varying fertility and water regimes. Thus the new variety having characteristics similar to CH45, but tolerance to disease and insect pests such as WBPH, would most likely be adopted by the farmers. Yield of *Chaite* rice varieties differed little by varieties across clusters. The yield level of about 2 t ha^{-1} was much lower than the potential yield of *Chaite* rice varieties (Table 7.

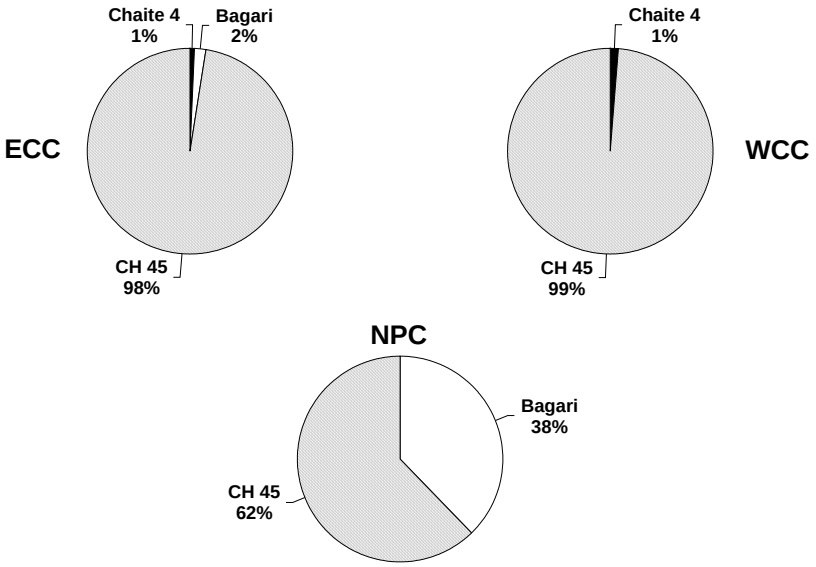

Figure 7. Varietal diversity of Chaite rice in the Eastern Chitwan (EEC), Western Chitwan (WCC) and Nawalparasi Clusters.

Table 7 Productivity of early rice at different clusters (t ha^{-1}).

Varieties	ECC	WCC	NPC
CH45	2.2±0.1	2.3±0.0	1.8±0.2
Chaite4	-	1.1±0.5	-
Bagari	2.3±0.8	-	1.8±0.1

Maize

Maize, (*Zea mays* L.) after rice, is the second most important staple food crops in Nepalese agriculture. The crop is grown in an area of about 0.8 million ha (30% of total cultivable area) with an average productivity of 1.6 t ha^{-1}. The majority of maize growing area lies in the mid-hills, and the *terai* accounts for about 22% of the total maize production area under winter and spring maize (NARC, 1997). The demand for maize is increasing mainly as livestock (poultry) feed and winter maize for roasted maize cobs. In the case of the PCI project area, winter maize was not important in terms of area and household heads covered. Hence, the statistics presented relate to spring maize only.

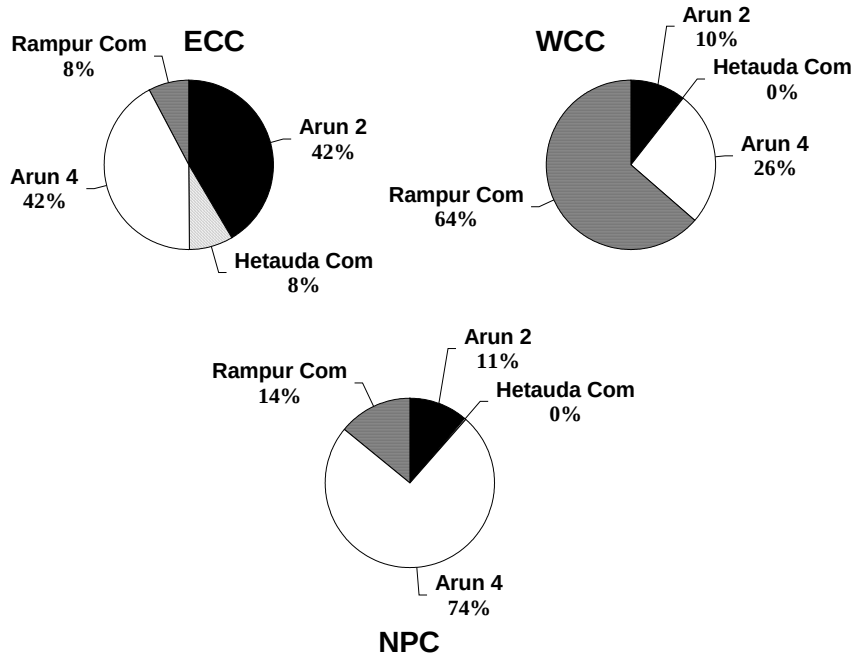

Figure 8. Percentage area coverage by different maize varieties in the East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC) clusters.

The total area under spring maize in surveyed villages was 166 ha in ECC, 104 ha in WCC and 40 ha in NPC. The area covered by different varieties across clusters is presented in Figure 8. In total there were five different varieties of maize grown by farmers. Rampur2 was grown only in ECC and this variety was released recently. None of the farmers from within the project area reported growing hybrid maize though this could be seen in eastern Chitwan area along the east-west highway. Arun 4 and Arun 2 predominated in ECC and NPC, whereas Rampur composite was popular in WCC (Figure 8)

When the productivity of maize was analysed for all the clusters it is apparent that the yield reported by farmers for all varieties was lower than the national average of 1.7 t ha^{-1} (NARC, 1997). In NPC the yield reported by farmers was consistently low for all the varieties (Table 8, which was about 0.5 t ha^{-1}. The scenario was not much different in other two clusters. The only variety that gave reasonable yield was Rampur Composite (medium duration variety) whereas Arun series were short duration varieties that fitted in with a three crops per year cycle. Farmers in general, regard the maize crop as a less stable and reliable crop compared to the rice crop. This fact has to be seen in the context when a huge amount of FYM was applied to spring maize crop.

Table 8 Productivity of spring maize (t ha^{-1}) in different clusters.

Varieties	ECC	WCC	NPC
Arun2	1.0±0.1	0.6±0.1	0.5±0.0
Rampur composite	1.6±0.7	1.3±0.4	0.5±0.1
Rampur2	1.2±0.3	-	-
Arun4	1.0±0.1	0.8±0.1	0.6±0.1

4.4.4 Wheat

Wheat (*Triticum astevium* L.) is the most important winter crop in Nepal with an area coverage of 0.66 million ha and an average productivity of 1.6 t ha^{-1}. (CBS, 1998). Wheat is not a traditional crop of Nepalese farmers. Cultivation of wheat gained momentum with the introduction of semi-dwarf wheat from the International Maize and Wheat Improvement Centre (CIMMYT). In addition, control of free grazing has enabled farmers to grow winter crops, which was not possible otherwise. An increase in population has forced farmers to adopt multiple cropping which has placed further stress on the fertility status of the soil.

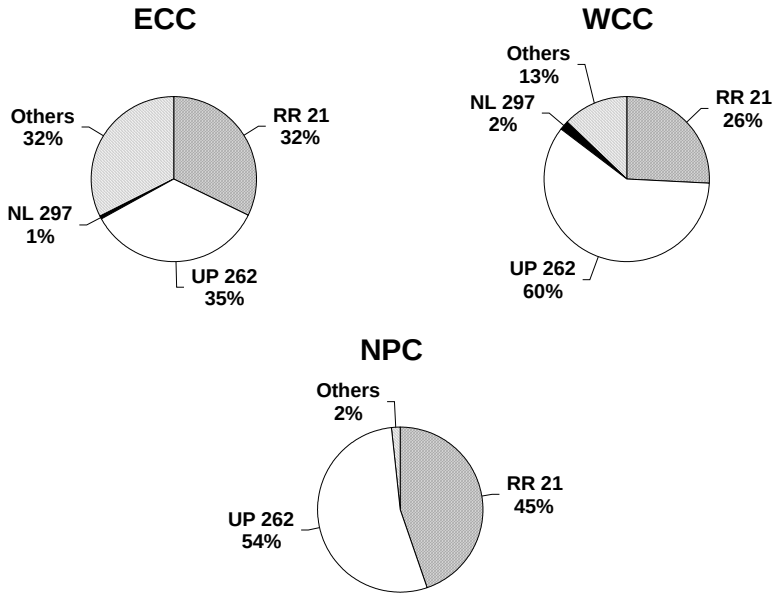

Figure 9. Percentage area by different wheat varieties in the East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC) clusters.

Wheat in surveyed villages covered an area of 53 ha in ECC, 93 ha in WCC and 72 ha in NPC. Farmers could identify three distinct varieties of wheat and some farmers failed to specify the names thus the common term 'Others' has been assigned to such cases. Among the varieties reported, UP 262 was the most commonly planted wheat across all clusters (Figure 9). This was followed by RR 21, which was one of the oldest varieties of wheat widely grown by the farmers. NL 297 has recently been recommended for wide scale cultivation.

Varietal diversity was rather limited in case of wheat. Farmers reported an unattractive market price as one of the major reasons for declining interest in wheat. One of the farmers commented that there has been no price increase in wheat for last 10 years or so whereas cultivation costs have increased tremendously. This was supported by the high amount of chemical fertiliser applied to wheat, which was highest in WCC and NPC with the exception being ECC where main season rice received the highest amount of fertiliser followed by wheat.

Farmers again reported low levels of wheat yield in general across clusters (Table 9. Newly released variety (NL 297) seemed to yield more than predominant varieties farmers were growing.

Table 9. Productivity of wheat varieties (t ha^{-1}) grown in different clusters where ECC, WCC and NPC refer to the East Chitwan Cluster, West Chitwan Cluster and Nawalparasi Cluster, respectively.

Varieties	ECC	WCC	NPC
RR21	1.0±0.1	0.9±0.1	1.0±0.2
NL 297	1.1±0.1	1.1±0.1	1.3±0.1
Other wheat varieties	1.1±0.1	0.9±0.1	0.6±0.1

4.4.5 Lentil

Lentil (*Lens esculentus* L.) is one of the major leguminous winter crops in the project area. The cultivation of lentil is becoming popular mainly because it requires fewer inputs in terms of labour and capital. Moreover, the market price and market guarantee of the product has played a key role in the increase in area. The area and the productivity of lentil are presented in Table 10. Farmers were unable to name the lentil variety they were growing.

Table 10. Area and productivity for lentil in across clusters.

Clusters	Number of farmers	Area (ha)	Productivity (t ha^{-1})
1. ECC	297	94	0.6±0.06
2. WCC	124	39	1.0±0.5
3. NPC	114	24	0.2±0.02

4.5 Labour

Farm families contribute a major source of labour for agricultural activities in Nepal. Both male and female farmers are equally involved in different agricultural activities. But there are certain tasks that are performed only by man such as ploughing and making straw stake whereas activities such as weeding and transplanting are the females' domain. However, the present study did not focus on time allocation, rather it considered both the male and female work force as an asset of the household which could be mobilised whenever needed. Availability of adequate family labour allowed the household to perform different agricultural activities on time and at the same time, retain hard cash which otherwise would have been used to pay for hired labourers. The labour situation in different clusters is presented in Table 11.

Table 11. Availability of labour at the household level across clusters.

Variables	ECC	WCC	NPC
Average family size	6.8±0.2	6.6±0.2	6.5±0.1
Full time farm worker			
Male	1.6±0.1 (430)*	1.5±0.1 (386)	1.4±0.0 (342)
Female	1.8±0.1 (460)	1.6±0.1 (455)	1.5±0.0 (441)
Part time farm worker			
Male	1.4±0.1 (211)	1.4±0.1 (201)	1.3±0.0 (181)
Female	1.6±0.2 (61)	1.6±0.1 (127)	1.5±0.1 (158)

- Figures in parenthesis indicate number of houses.

Analysis of the labour situation indicates that more females work full-time as well as part-time in agriculture compared to men, and this was consistent across clusters. Likewise, the number of households with men working full-time in agriculture was less than that for women.

However, there were more households with men working part-time compared to their female counterparts.

Besides family labour, farmers have to depend on outside labour during the peak of the agricultural season for activities such as rice transplanting, weeding, harvesting and threshing. Agricultural wage rates differ for male and female workers because they perform different activities. Men undertake work that requires physical strength and men, in general, are paid more than women. In some areas a reciprocal labour exchange commonly termed as '*parma*' exists among the community members, but this practice is fast disappearing under economic pressure.

4.6 Vegetable Cultivation

Vegetable cultivation on a kitchen garden scale is a common practice in Nepalese farming systems. In recent times growing vegetables on a semi-commercial or commercial scale has gained popularity amongst farmers in Chitwan and Nawalparasi district due to market access.

Table 12. Scale of vegetable cultivation across clusters

Variables	Kitchen garden (no. of farmers)	Mainly for home consumption (no. of farmers)	Commercial (no. of farmers)	Statistics (p value)
ECC	53 (12.7)	338 (80.7)	28 (6.7)	
WCC	52 (11.6)	381 (85.0)	15 (3.4)	0.000
NPC	260 (56.2)	187 (40.4)	16 (3.4)	

Figures in parenthesis indicate row percentages

The scale of vegetable cultivation was divided into three categories; kitchen garden, mainly for home consumption and commercial scale production. The second scale was taken as a transition from kitchen garden to semi-commercial to commercial cultivation where production of vegetables moved beyond the traditional kitchen garden fences. It was calculated that a high proportion of farmers were involved in vegetable cultivation on different scales across clusters (Table 12). Though the percentage of farmers involved in NPC was higher, the majority were basically involved in kitchen garden scale. More farmers in ECC and WCC were shifting towards commercialised vegetable production as compared to NPC. This was a reflection of ready availability of irrigation water for vegetables, easy road access, market linkages and market opportunities enjoyed by the farmers in these areas.

Many farmers in ECC and WCC cultivated vegetables all year round, however, the area under vegetables varied from season to season. This was not the case in NPC; here farmers mainly produced vegetables in summer and winter only, followed by all year round production. This indicated that off-season vegetable production (spring and autumn) was yet to be adopted by the majority of farmers in NPC.

4.7 Livestock Resources

4.7.1 Types and number of livestock resources

Livestock occupy a central role in Nepalese farming system having close interaction with forestry and crops and their by-products. As a result, the majority of farmers (85%) in PCI project area owned livestock. Having livestock (improved and total number) reflected the wealth and status of the household in the rural community, which was evident while conducting wealth ranking exercise prior to field administration of the baseline questionnaire. Buffalo was the main livestock kept for milk, manure and meat (he-buffalo) by households in all the clusters. Buffalo was also used for pulling carts, which was an important means of transportation in rural areas, especially for transporting grains to the market and bringing in supplies. The number of improved buffalo in

WCC was significantly higher (p>0.00) as compared to ECC and NPC. In fact, many farmers were engaged in the dairy business in WCC and here they keep more of the improved than local buffalo breeds (Table 13). The wealth category of farmers was significantly (p>0.00) related to the number of large ruminants kept, with better off farmers owning more livestock and *vice versa*.

Table 13. Farmers' livestock resources.

Variable	ECC	WCC	NPC
Total Livestock†	1055	2835	1082
Average livestock†	2.9±0.1	4.1±0.1	3.0±0.1
Buffalo			
Improved	2.1±0.2 (n)	2.4±0.1	2.3±0.2
Local	2.0±0.1	2.3±0.1	1.9±0.1
Cow/Ox			
Improved	2.2±0.3	2.4±0.2	2.6±0.4
Local	2.2±0.1	2.4±0.1	2.6±0.1
Goat (Improved and local)	3.6±0.2	3.3±0.1	3.0±0.1
Pig (Improved and local)	2.0±0.8	1.5±0.2	1.4±0.1
Chicken (Improved and local)	11.0±2.1	99.7±52.3	39.0±14.0

† Total and average livestock numbers were calculated considering only buffalo and cow.

Farmers keep improved cattle for milking purposes whereas the local cow (ox) is for draft purpose. NPC has a higher average number of improved cattle as compared to ECC and WCC. Increase in improved buffalo and cattle population is explained by the fact that a large number of dairy co-operatives and milk-collection centres have been established at grassroots level. As a consequence, selling milk and milk products has emerged as an important source of cash income in rural economy, not to mention its positive effects on soil fertility through manure production.

Around 50% of the households in the project area keep goats with an average of 3.3 goats per household. They are mainly reared for meat purposes and provide quick cash to the farmer. Improved breeds of goat are not popular among farmers thus the majority of the goat population is indigenous. The average goat population is more in ECC compared to WCC, and NPC has the least.

Pigs made the smallest contribution to the farming system of the project area because only 2% of the total population in the project area reared pigs with an average number of 1.5 per households. NPC has a much higher number of households (22) engaged in pig rearing compared to ECC (5) and WCC (6).

In the case of chickens there are two distinct purposes of the rearing system: commercial and domestic. Depending upon the purpose of rearing the number of chickens varied greatly. It was also observed that local chickens were mainly kept for domestic consumption and improved for selling in the market either for meat or eggs. The majority of households, irrespective of the cluster, reared chicken for home consumption with an average of 12 birds per households. Only a limited number of farmers (maximum of 7 in WCC) were engaged in commercial poultry business and they keep ca. 40% of the total chicken in the project area. Poultry manure is becoming an important source of nutrients to the soil.

Farmers keep improve cattle for milking purpose whereas the local cow (ox) is for the draft purpose. NPC has a higher number of improved cattle as compared to ECC and WCC. Increase in improve buffalo and cattle population each explained by the fact that a large number of dairy cooperatives and milk collection centres have been established at grass root level as a consequences, selling milk and milk products has emerged as an important source of cash income in rural economy, not to mentions its positive impacts on soil fertility through manure production.

4.7.2 Rearing system

Farmers practiced intensive stall-feeding system for rearing animals. Farmers were asked to specify the feeding systems for three growing seasons; summer, winter and spring. The rearing system did not vary much between seasons.

A shift from a free grazing to stall feeding system occurred quite sometime ago due to the limited amount of pastureland and high cropping intensity. Goats, which were traditionally reared under free grazing have also come under tethering. The shift in rearing system also indicated the level of cropping intensity and coverage under winter and spring crops. Without the change in livestock rearing system it was neither possible to make substantial changes in cropping pattern nor in varietal level. Intensive rearing systems also indicated the importance given to livestock in the farming system. With the change in rearing system the composition of feed was bound to change and so did the labour requirement at the household level. Traditionally children have been entrusted to look after livestock when free grazing was practised, but the changed situation might have added a burden to other members of the household especially the women farmers.

Stall-feeding was a norm in all the clusters. Comparison among species suggested that irrespective of cluster slightly higher number of cows and goats were allowed to free graze as against buffalo. Moreover, this also suggests that buffaloes are more valuable milk animal compared to cows and thus are provided with an intensive care system.

4.7.3 General trend in livestock rearing system

An effort was made to gather information at the household level on trends in livestock rearing system over the last five years. The information collected suggests that not much change has occurred within the specified time. Rather the change in rearing system took place much earlier than the time specified in the questionnaire, thus the questionnaire could not actually capture the changes in the system as expected. It also became clear that information was best collected at the community level through PRA techniques. The information thus collected was more reliable and gave a true picture of the dynamics of the system.

Farmers' response to the question was very much related to the present rearing system being practised. The response focused more on change from free grazing to staff-feeding systems. Therefore, in all the clusters farmers response was ‘same’ or ‘less’ and very few respondents replied ‘more’. The result was consistent across clusters and agreed with the present livestock rearing system. Instead of just looking at trends in livestock rearing system it would be more useful to understand the underlying reasons and the implications of the changes in the farming system.

4.8 Important Farming Systems Interaction

Diagnostic surveys conducted in Rupandehi district of Nepal under rice-wheat systems concluded that system interactions occurred for organic matter management, livestock feed composition, fuel sources, FYM and chemical fertilizer application, farm machinery and animal power etc. (Hobbs *et. al.,* 1996). Similar interactions can be expected in the case of Chitwan and Nawalparasi district since they are in the same agro-ecological zone
In the following sections some effort has been made to document those interactions

4.9 Livestock feed

Livestock forms an integral part of the farming systems responsible for supplying much needed manure to replenish depleting soil fertility. An equally important role played by livestock is the draft power supplied for ploughing, transporting farm supplies to-and-from the market etc. Livestock also supplies farm families with milk, meat and eggs. For a few households in the project area livestock and there products have become a chief source of cash income. Livestock in turn depend on forest and farm for fodder, forage, crop by-products etc for subsistence. To understand the sustainability of the system it is important to understand the status of the natural resource base, especially the availability of fodder and forage resources. In addition, the feed composition and feeding trend of livestock gives

some indication of the importance as a feed source.

In order to get a clear picture of the natural resource base of each cluster, farmers were asked to comment on the status of fodder and forage resources on their farm. More farmers in ECC faced acute problems with fodder and forage compared to WCC and NPC. The majority of farmers in the NPC face mild shortages of fodder and forage. The number of farmers reporting to have adequate fodder and forage resource is quite limited in ECC and NPC. In this respect farmers in WCC seem to be better off than their counterparts in other clusters. It is interesting to note that quite a few farmers have adequate forage for their livestock. As discussed earlier, this is probably a reflection of the importance accorded to livestock enterprise in the cluster.

The overwhelmingly feeding system of livestock in Nepal is straw based. Information on the contribution of different feed stuff to the total diet intake indicate that straw forms the bulk of the intake contributing 72% in ECC, 59% in WCC and 51% in NPC (Figure 10). Straw is supplemented by concentrate feeding which usually comprise crop by-products such as rice bran, broken rice, mustard cake, wheat and maize flour. More concentrates are fed to milking animals and oxen during heavy work. Concentrates constitute 16% of the animal diet in WCC – the highest among the clusters. Similarly, the share of concentrate in total feed intake is around 13% in the remaining clusters. A third important source of animal feed is forage grass in ECC (9%) and WCC (14%). The situation for NPC is slightly different with forage contributing as much as 18% of the total diet. Grass intake from grazing is substantial in the case of NPC (15%) and WCC (9%) whereas in ECC the contribution is less (4%). Farmers in NPC and WCC depend on natural forest and farm forestry, for forage grass. In all the clusters, the contribution of fodder to total diet is negligible. This information supports the earlier statement where farmers reported an acute shortage of fodder in all clusters.

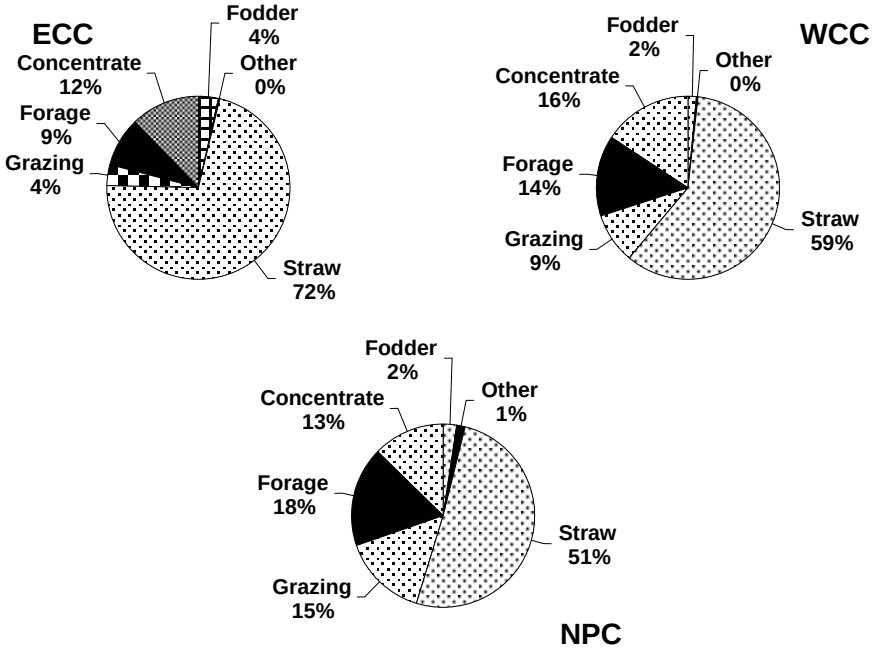

Figure 10. Contribution of different feedstuff in livestock diet across the cluster of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC).

It was clear that there was a lack of fodder and forage resources within the farm to sustain the livestock productivity in all the clusters. Unless the resource base of the HPPS environment is improved substantially the sustainability of the system, which is integrated in nature, has a fragile base. Utilising wasteland / uncultivable and public pasture for planting multi-purpose trees might be one of the options. But farmers need to do something on their farms also. Agro-forestry might be a better way out at a household level. But further discussion and planning with

farmers is required before any action is taken. Bringing more area under forage grass is likely to compete with other edible crops and this practice is more likely to benefit those with larger land holdings. Farmers with livestock mainly kept for subsistence may not be interested in planting forage grass on their land. Therefore, a feasible option would be to utilise rice bunds and other marginal areas for planting fodder trees.

The next step comprised of understanding the trend in composition of feed over time. The trend in feed composition of buffalo across clusters presented mainly because of the importance it plays in the household economy (Figure 11). A high number of respondents reported that the amount of concentrates, straw and forage grass being fed to animals remained the ‘same’ or unchanged over the specified time frame. But the interesting part of the system is to analyse the interaction between the components where major shifts have taken place i.e. have either increased or decreased (defined here as ‘more’ and ‘less’). The feeding of concentrates and straw has increased in all the clusters but the situation was more pronounced in ECC and WCC and least noticeable in NPC. Likewise animal feed comprised less fodder and forage grasses compared to five years ago. Free grazing of animals has become a thing of the past since crop intensification has increased and public pastures have decreased in all the clusters.

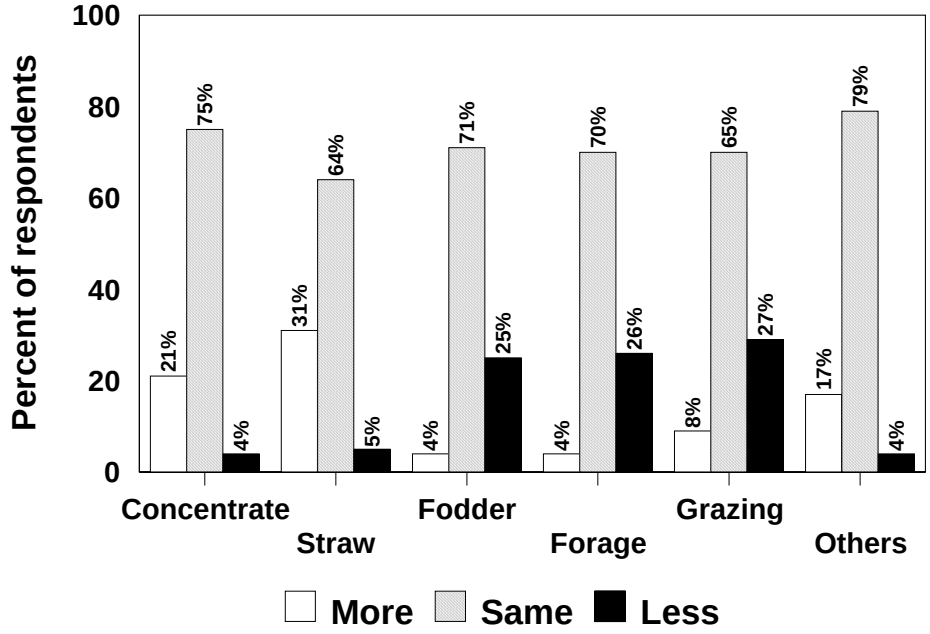

Figure 11. Trend in livestock feed composition in PCI project area.

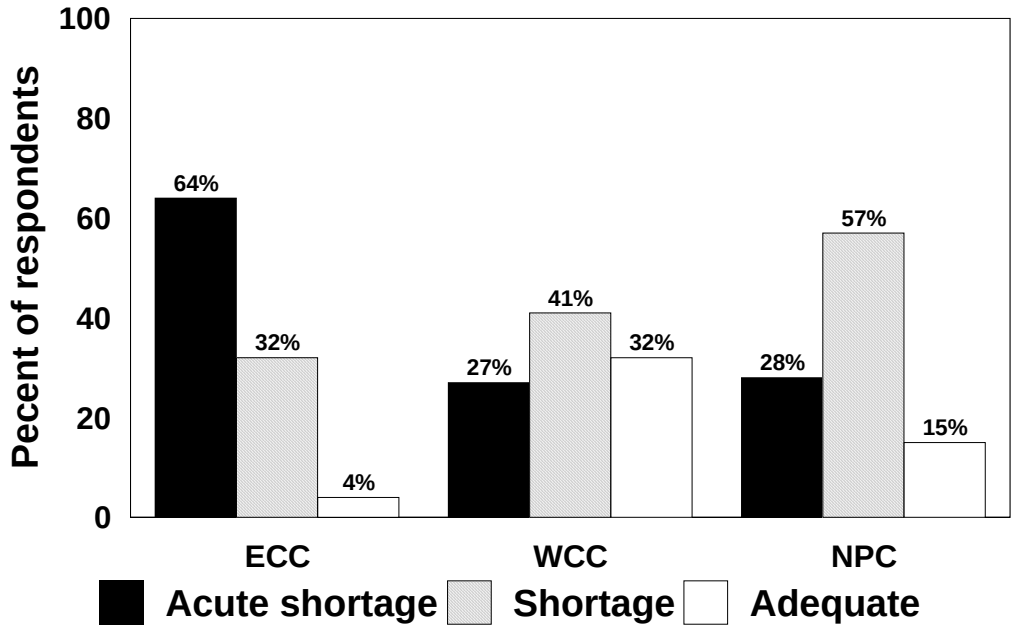

Figure 12. Status of the fuel wood availability across the clusters of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC). The number of respondents was 482, 476 and 475 in ECC, WCC and NPC, respectively.

4.10 Fuel sources

Firewood is the major source of cooking fuel for farmers in the project area. A PRA study conducted in the study area revealed that farmers depend more upon their fodder residues, trimmed branches and twigs of fruit, fodder and timber trees around the farm boundary. In some instances farmers depend on residues trimmed from trees along road and canal sides (PRA Report, 1997). Farmers also have access to government forests during winter for a limited number of days mainly to collect thatched grasses and twigs of dead trees.

As in previous sections, the first step was to understand the status of fuel sources across clusters, and then to look at the contribution of different sources of cooking fuel. Emphasis was laid on eliciting information on use of dried dung cake and sticks because of its direct but negative impact on the fertility of the crop fields.

Information on the status of fuel sources (basically fuel wood) suggest the majority of farmers in ECC suffer acute shortages of fuel for cooking (Figure 12). Only a handful of households are self sufficient in terms of fuel energy for cooking. The situation is slightly better in NPC though the majority of farmers still reported having a shortage of fuel wood. However, the number of households with enough fuel wood has increased, suggesting that at least a certain population in the area is self-sufficient. WCC is in a far better position as regards the availability of fuel sources for cooking. Still the aggregated figure for 'acute shortage' and 'shortage' category of farmers far outnumber 'adequate' fuel sources. The situation for fodder and fuel wood is similar because whatever the number of trees farmers have they are mostly multi-purpose trees. Therefore, whether farmers have or do not have trees on the farm will determine the household's standing as far as fodder and fuel wood is concerned. This is apparent from the fact that WCC has better fodder and fuel wood resources because it has more trees on the farm and *vice versa* for other clusters. Having trees on-farm is also governed by the availability of adequate land to plant them in the first place. Consequently, better off households would be more self reliant compared to other categories of farming households.

After having looked into the status of fuel sources in different clusters it is appropriate to examine how farmers are managing their fuel sources to meet their daily needs. The figures at the cluster level indicated that irrespective of clusters, farmers heavily depend on fuel wood (72-96%) for cooking purpose (Figure 13). The dependence is least in WCC and most in NPC. Kerosene stoves are becoming very popular even in rural areas with 11% of the households in ECC relying on it. This figure is slightly less for WCC (9 %) and negligible for NPC. Farmers, except in ECC (3 %), do not appreciate the contribution of crop residues to cooking fuel. Biogas has emerged to be a very strong alternative source of fuel energy for cooking meals. There are good reasons to promote this technology in rural areas. One of the greatest benefits is the positive impact it has on the health of women. On an agricultural front, farmers acknowledge that the slurry and dung output from the biogas plant is of high quality for crops. The government has a strong policy with subsidies to push this technology in feasible areas. The impact can be seen in WCC with 15 % of the households relying on biogas for cooking and lighting purpose. There are only limited households in the project area who use LPG and electricity for cooking purpose.

As far as burning dried dung cake and stick is concerned the practice was reported only in one village (Majhue) in ECC and one farmer in WCC. In ECC, the contribution of dung cake is substantial (7 %) considering the fact that it was reported from one location only. This is a traditional practice found amongst mostly indigenous people. Obviously, the use of dung cake for cooking would imply that less FYM goes into the soil. To compensate for this loss, more fertiliser has to be added to maintain crop productivity, which means the cost of production would be higher with lower net return. Along with this burning dung cake has serious implications for soil fertility and soil health.

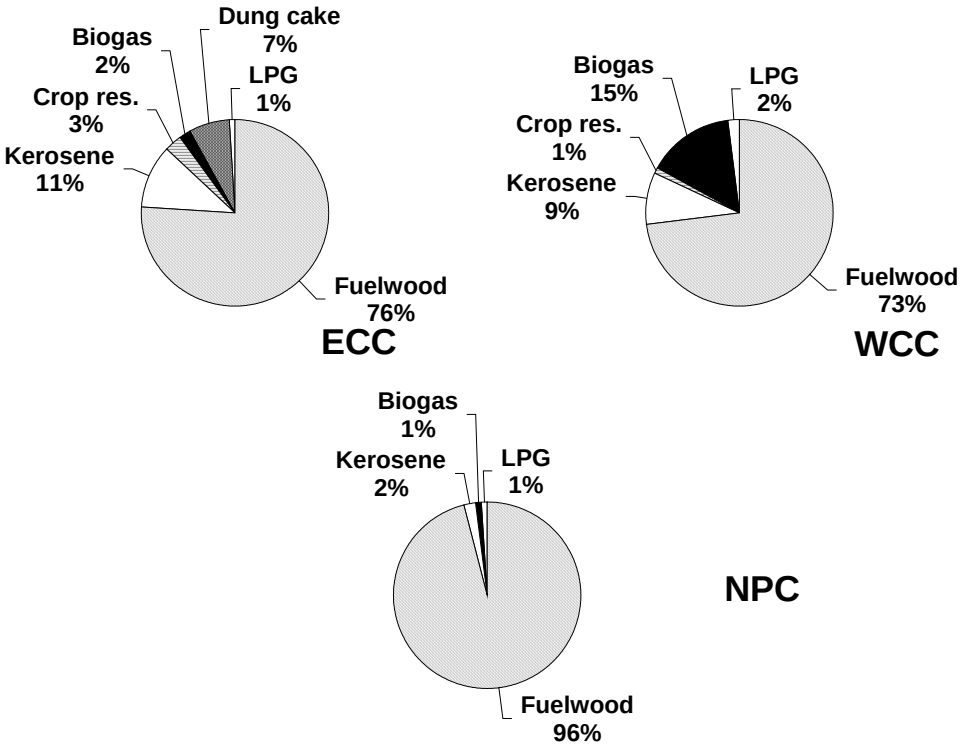

Figure 13. Cooking fuel sources across the cluster of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC).

4.11 Farm yard manure, chemical fertiliser and pesticide application

Information on the level of farm yard manure (FYM) and chemical fertiliser application was gathered. In addition, farmers also provided information on the changes in situation of FYM and chemical fertiliser application compared to five years ago. This gave a trend in nutrient supply to the soil. Furthermore details of types of chemical fertilisers and the amount used have been noted. In recent times the use and abuse of pesticides increased considerably, therefore, some effort has also gone to gather information in this regard. Information collected in this respect is limited to a number of farmers using pesticides and trends in their use.

FYM has been the main source of nutrients to the soil in traditional farming systems. But in recent years farmers increasingly used chemical fertilisers to supplement nutrients. Based on the farmers' response it is concluded that a vast majority of farmers apply FYM in the field (Figure 14). The number varies across clusters with the highest figure in WCC and lowest in ECC and NPC. It was observed that farmers usually do not use either FYM or chemical fertiliser alone, instead a combination is used.

The variation is explained by the fact that ECC has relatively fewer livestock with a poor resource base (fodder and fuel wood), and part of the FYM produced is burnt as cooking fuel. In case of WCC, due to its higher livestock population, and relatively better resource base, a considerable amount of FYM is produced to pump back into the soil. The practice of burning dry dung cake is also not practised. As a result, whatever dung is produced directly goes into the soil. Fewer farmers in NPC applied FYM and chemical fertiliser. This is perhaps a reflection of the low resource endowment of the area.

Information on FYM/compost application to different mandated crops is presented in Figures 14-16 for the three different clusters. Among the mandated crops in ECC a maximum number of farmers were reported to apply FYM to spring maize. A high number of farmers were also reported to apply FYM to main season rice, winter maize, wheat and early rice. However, the

number of farmers reported to apply FYM was dependent on the number of farmers that grow the crop in the first place.

Therefore, instead of going by the numbers of farmers it would be more informative to analyse the trend in FYM application. This indicates how the priority of FYM application to crops has changed at the cluster level. It also indicates the importance accorded to a particular crop by the farmers. For instance, although a majority of farmers reported applying FYM to spring maize, the majority applied either the same amount or less than recommended. In contrast, fewer applied FYM to early rice but a greater proportion of farmers applied more than less FYM than recommended. This indicates that farmers are diverting their scare manure to apply where they see the greatest benefit is derived. Another example is wheat on which farmers have clearly lost interest. Dwindling interest is measured by the decreased amount of FYM applied to the crop.

FYM application to different crops at WCC revealed that main season rice was the most important crop in the area, even from a compost application point of view. In the case of other crops such as *Chaite* rice, spring maize and wheat, the number of respondents giving a positive response was more or less the same. Winter maize is not a major crop of the WCC. It is apparent from Figure 17 that more farmers are convinced that applying FYM to main season rice and early rice pays off better than any other cereal crops. FYM for spring maize and wheat has remained unchanged, with the majority reporting to apply the same amount and almost a similar number reporting to apply either more or less. Farmers in WCC can afford to apply more in some crops without much effect on others because they have sufficient manure resource.

The case of NPC is slightly different from that of ECC and WCC, mainly because there is no particular crop that more farmers have reported to apply more FYM. Application of FYM was similar for main season rice, spring maize, *Chaite* rice and wheat, although the response for *Chaite* rice was slightly less than the others. With limited FYM produced, application appeared to be rather uniform across crops. This indicates that farmers have no special preference for crops when it comes to applying compost.

The application of FYM/compost was determined based on the farmers' judgement of the return from the crop. FYM application has direct relation with the application of chemical fertiliser and any green manuring practice followed by farmers. No questions were asked on this topic and so the study was unable to reach any firm conclusions in this regard.

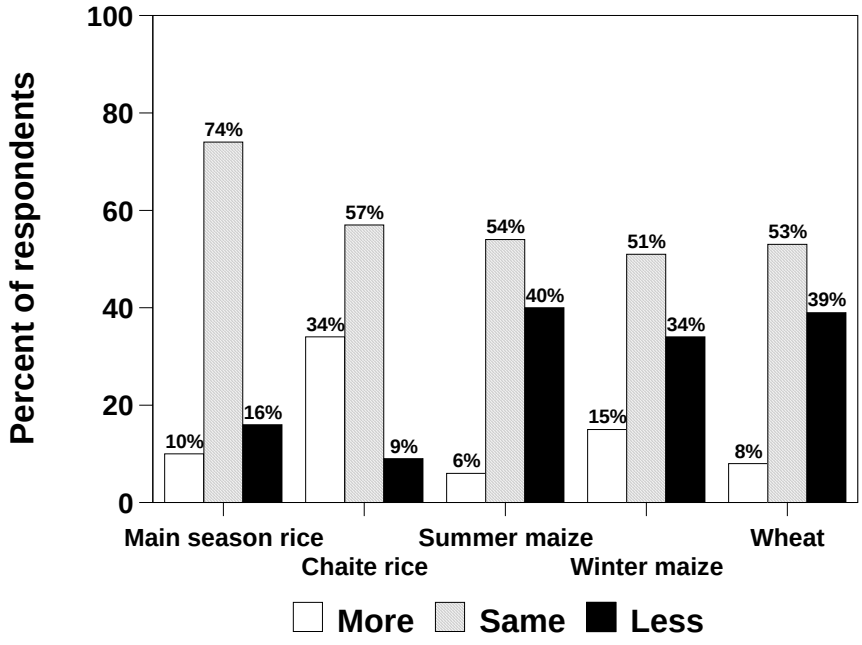

Figure 14. Farm yard manure application to crops in the East Chitwan Cluster relative to that of 1997.

Fertiliser application to different crops across clusters indicated that the ECC main season rice received the highest amount of chemical fertiliser (Table 14). This is because the amount of FYM applied to main season rice was limited. In the case of WCC and NPC, winter maize received the highest amount of fertilizer, but the number of farmers growing the crop was limited in these clusters. Wheat received considerably more fertiliser in WCC and NPC than in ECC because it is an important crop in these clusters. The amount of fertiliser applied is more or less consistent for all the crops except main season rice in the ECC. The same applies to other crops in WCC and NPC.

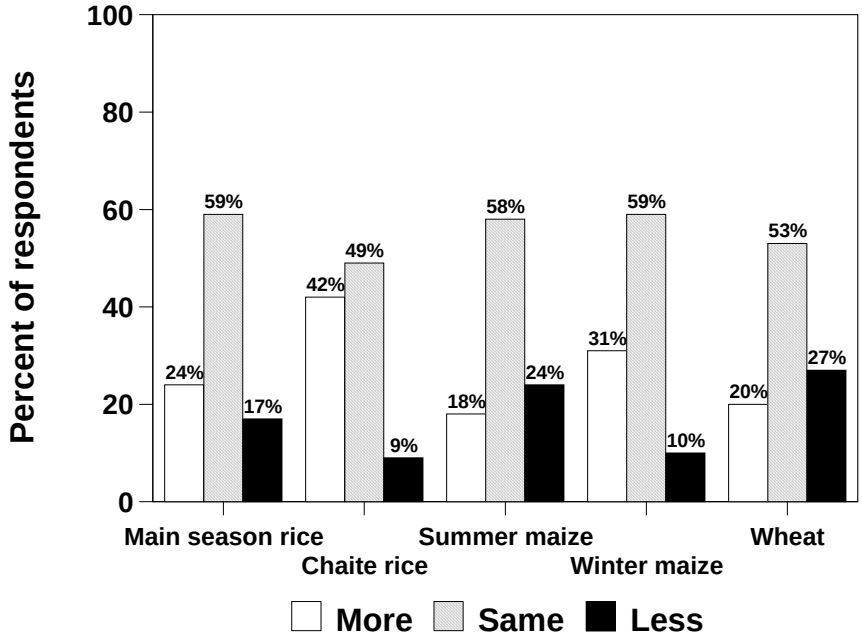

Figure 15. Farm yard manure application to crops in the West Chitwan Cluster relative to that of 1997.

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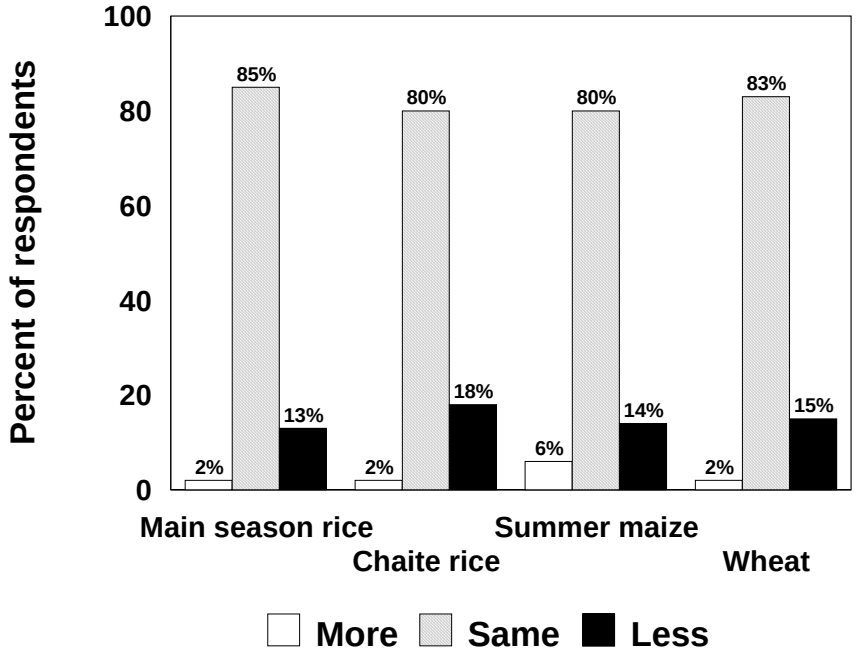

Figure 16. Farm yard manure application to crops in the Nawalparasi Cluster relative to that of 1997.

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Farmers applied all types of fertiliser available in the market with the majority of farmers in all the clusters applying a urea/DAP mix to the crops. Some farmers applied urea alone, mostly for top dressing of crops.

Trends in fertiliser use for main season rice indicated that an increasing number of farmers relied on fertiliser to achieve higher yields. Irrespective of the cluster, a higher number of farmers were reported to apply 'more' fertiliser to main season rice than those responding 'same' and 'less'. The actual number responding 'more' was greater in WCC than ECC and NPC (Figure 17, 18 and 19). Similarly, the lowest number of farmers responded 'less' in all the clusters but the actual numbers were higher in ECC and WCC. Perhaps this indicated that farmers in these clusters have already realised that excessive dependence on fertiliser has a negative effect on soil fertility in the long term, with the result that they have to apply increasing amounts of fertiliser even to achieve stable yields over time.

Table 14. Fertiliser application on different mandated crops.

Mandated crops	ECC (kg/bigha)*	WCC (kg/bigha)	NPC (kg/bigha)
Main season rice	56.5±2.1	34.7±2.0	35.3±1.10
Chaite rice	44.6±3.0	27.7±2.2	30.8±1.3
Spring maize	42.9±3.3	29.1±4.2	26.1±3.5
Winter maize	40.7±2.7	59.0±14.6	63.3±28.5
Wheat	42.7±2.9	55.1±3.4	49.3±2.7

- 1.5 bigha = 1 hectare

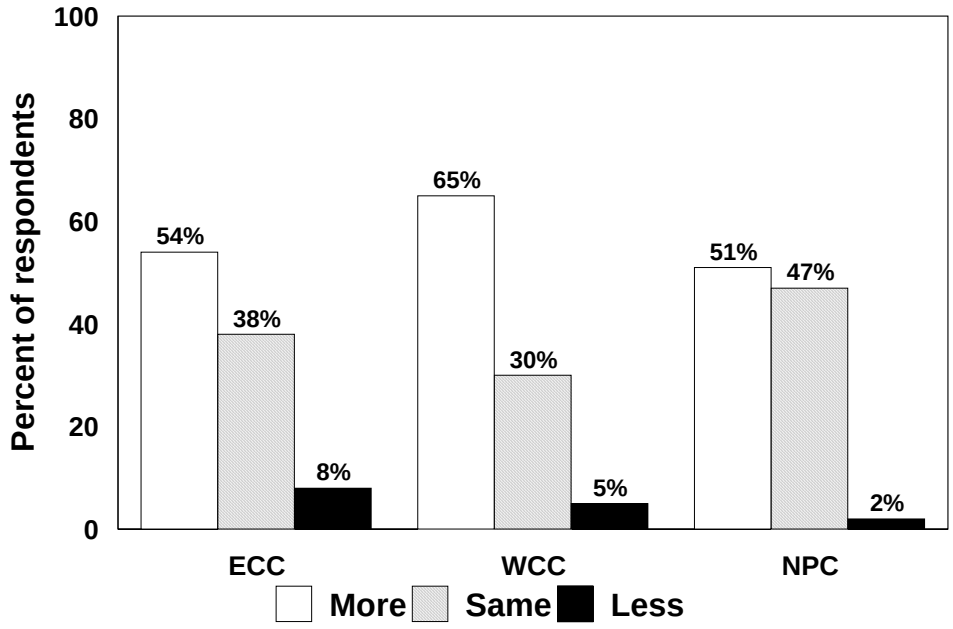

Figure 17. Trends in chemical fertiliser application to main season rice (compared with 1997) across the clusters of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC). The number of respondents was 376, 373 and 284 in ECC, WCC and NPC, respectively.

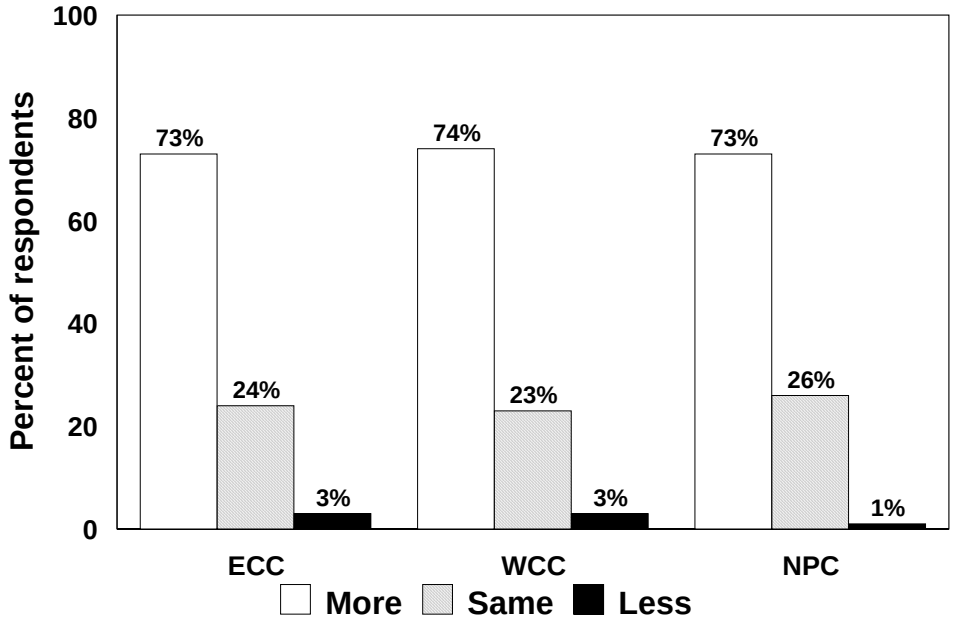

Figure 18. Trends in chemical fertiliser application to *Chaite* season rice (compared with 1997) across the clusters of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC). The number of respondents was 131, 204 and 131 in the ECC, WCC and NPC, respectively.

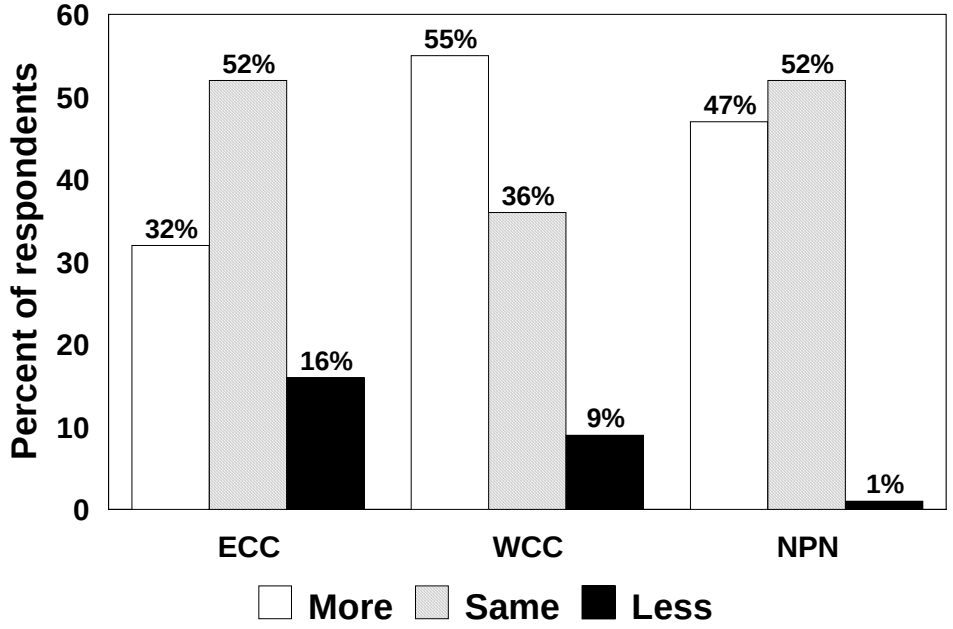

Figure 19. Trends in chemical fertiliser application to wheat (compared with 1997) across the clusters of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC). The number of respondents was 126, 222 and 235 in the ECC, WCC and NPC, respectively.

A similar pattern emerged when the trend in fertiliser application was observed for *Chaite* rice. Use is undeniably increasing in all the clusters, however, the rate of increase was more in WCC compared to ECC and NPC. Only a few farmers were reported to use 'less' fertiliser compared to five years ago. The trend suggests that more FYM and fertiliser were applied in order to realise higher grain yield in *Chaite* rice.

The trend in fertiliser application for wheat was different from those discussed above. Wheat was clearly a secondary crop in ECC with many households reporting to be applying the 'same'

or ‘less’ fertiliser compared to five years ago. Still, the figure for ‘more’ was greater than for those responding ‘less’. Nevertheless, the figures from WCC and NPC indicate that more farmers are applying either ‘more’ or the ‘same’ amount of fertiliser compared to five years ago. Quite a few farmers in WCC were reported to have applied ‘less’ fertiliser.

4.12 Farm mechanisation

In HPP environments a certain level of mechanisation is expected. In this study, emphasis was placed on ploughing because that is the one activity where the use of the tractor has been widespread. For other activities such as transplanting, harvesting and threshing, not much has been mechanised except for wheat threshing. The rationale for focusing on ploughing is that this is the one activity that requires maximum input in terms of person-days or cash, ultimately reflecting the economic return/profit margin of the household.

It is apparent that there are only eight tractors each in ECC and WCC and two in NPC. Because there are few tractors in the cluster the majority of farmers (68 % in ECC and 47 % in WCC) depend on hired tractors to till their land. The result is consistent for ECC and WCC and for both the crops presented herein. Actually very few farmers depend on their own/hired oxen for ploughing in ECC, however, the number increased in WCC and an overwhelming majority in NPC depend on their own/hired oxen for ploughing land for main season rice and wheat.
In the light of the decreasing fodder and forage resources keeping a pair of oxen just for ploughing and manuring might have proved to be a costly business. Logically farmers disposed of their oxen and concentrated on keeping only milking animals on the farm. For ploughing hired tractors from within the village were used. Provided the tractor is readily available and the price reasonable this practice is likely to become more widespread.

4.13 Availability of farm inputs, animal and farm labour

Ready availability and timely farm inputs, animal power and available farm labour have positive effects on production. A questionnaire was designed to capture farmers' perceptions regarding access to production inputs for crops. Basically the information concentrated on getting farmers' response on chemical fertiliser, pesticide, seed, animal power and labour force. Details are presented in the Tables 15.

From the tables above it is apparent that the availability of chemical fertiliser with time and required quantity is a major problem in the area since most of the households used the input. This is a national problem since Nepal does not produce any fertiliser and everything has to be imported and farmers face a scarcity during the cropping season. For other inputs such as pesticides, the majority of farmers used these on main season rice, supplied by private dealers. Access is not a problem but technical information related to the application of pesticides may be a bottleneck since the Agriculture Services Centre (ASC), with the responsibility to provide technical backstopping, are thinly scattered within the district.

Availability of quality seed of different preferred varieties is a problem in the project area. Farmers generally used their own seed source for next year planting and frequent change of seed is not practised. This is an important aspect given that the Agriculture Input Corporation (AIC) is gradually withdrawing its programmes on seed business and the private sector is yet to establish itself in the cereal seed supply business.

Table 15. Ease of availability of production inputs for (a) main season rice, (b) *Chaite* rice and (c) wheat in the clusters of East Chitwan (ECC), West Chitwan (WCC) and Nawalparasi (NPC). Values refer to the numbers of respondents.

(a)

Variables	ECC		WCC		NPC	
	Yes	No	Yes	No	Yes	No
Chemical fertiliser	343	165	258	231	240	250
Pesticide	263	245	159	330	83	407
Seed	320	188	372	117	245	245
Bullock	292	216	381	106	329	161
Labour	413	95	433	56	377	113

(b)

Variables	ECC		WCC		NPC	
	Yes	No	Yes	No	Yes	No
Chemical fertiliser	172	336	174	315	143	347
Pesticide	165	343	145	344	96	394
Seed	141	367	208	281	121	369
Bullock	97	411	234	255	183	307
Labour	167	341	245	244	220	270

(c)

Variables	ECC		WCC		NPC	
	Yes	No	Yes	No	Yes	No
Chemical fertiliser	159	349	142	347	188	302
Pesticide	65	443	46	443	30	460
Seed	147	361	210	279	208	282
Bullock	137	371	200	289	256	234
Labour	205	303	248	241	288	202

Tractors have been used to address the problem of lack of animal power to till the land in the project area and the trend towards this has increase. However, lack of labour during peak agricultural activities is a concern, but again this opens up new opportunities for land-less families to engage in agricultural activities within the village and make a living, which would reduce out-migration from the village. Provided the agricultural activities are well spread across seasons the opportunities for employment on-farm would be greater for marginal groups within the village. The introduction of varieties of different maturity could help to spread the timing of different agricultural activities within the village.

4.14 Percentage of Farm Produce Retained for Home Consumption

Production of crops is primarily to meet household food demand, and surplus is sold to the market. However, in a crisis situation the family households (mainly resource poor households) have to sell their produce. The percentage of farm produce retained at the household level indicates the nature of the level of subsistence of the crop – the higher the level of retention the more the subsistence nature of production.

Table 16. Percentage of farm produce retained for home consumption.

Crops	ECC	WCC	NPC
Normal rice	79.1±1.1	69.4±1.1	87.0±1.0
Early rice	82.9±2.1	47.0±1.9	82.5±1.7
Spring maize	67.7±1.7	73.0±1.9	89.7±1.4
Winter maize	68.7±2.1	74.1±7.3	85.7±9.2
Wheat	66.2±2.4	54.9±1.9	78.6±1.7
Lentil	51.6±2.3	55.1±3.2	84.2±2.2

Farmers were asked to specify the amount of farm produce retained for home consumption (Table 16). There is marked difference in retention of farm produce among clusters with farmers in NPC retaining the most and WCC the least. Among the crops grown, lentil serves as a cash crop for the farmers with almost 50% of the total produce finding its way to the market in ECC and WCC. The situation is different for NPC with over 80% of the produce retained for home consumption, except for wheat (79 %).

On a percentage basis, the bulk of the main season rice produced within the project area was retained for home consumption. Rice is the staple food of the Nepalese, particularly in the case of *terai*. A substantial percentage of early rice is retained by the household for making puffed rice to be consumed mainly as snacks with tea. This is a common practice in ECC and NPC. The practice is less common in WCC, as a result, above 50% of the early rice produced in the area arrives at the market.

Nepalese people in general cannot be regarded as avid wheat eaters. Maize is mainly retained at the household level to be prepared as a livestock feed, and partly consumed when green (roasting) and partly as popcorn. The amount sold in the market mainly finds its way to the poultry feed industry. Consuming maize grits (whole grain maize coarsely ground) is considered inferior in the community, thus only a handful of resource poor households consume maize as staple food.-

Looking at the retention figures for the major crops in the project area it is apparent that the production systems were largely subsistence in nature. The chances are, however, that farmers have understated the amount sold in the market for various reasons.

4.15 Farmers' Access to Public Credit and Extension Systems

4. 15.1 Farmers' access to credit sources

Farmers' access to formal credit institutions is vital for making any major investments (pump set, tractor, thresher, bullock, seed, fertiliser etc.) in the agricultural sector. Thus, some information was collected from farmers regarding these aspects. Farmers mainly depend on their own resources for making any investment in the farm. Only a few farmers approach formal credit institutions to seek loans, and this was consistent across clusters. This clearly shows that formal institutions have yet to cover the rural sector in loan disbursement.

Besides their own resources, farmers also approached informal sources (money lenders) within the village for loans. The interest rates charged by informal sources are higher (>24% per annum) than the formal institutions but still farmers approach them.

Farmers' access to public extension services

Farmers' access to new technology in terms of material inputs and information is vital to derive any benefit from its adoption. However, adoption in turn is dependent on factors such as the level of exposure of farmers, risk bearing capacity, appropriateness of technology, resource endowment of household, education level of decision maker group.

Public extension services at different levels have a mandate to provide individual farmers and the groups with extension services. With recent changes in government extension policies from an individual contact to a group approach, all the

extension services provided by the government are channelled through groups (Subedi, *et. al*., 1998). Thus, farmers who are not members of the groups are less likely to be served by the extension services unless the individual makes an effort to go to the service centre and consult with technicians. At the same time, with liberalisation of the economy many private entrepreneurs have entered the fray. As a consequence, an increasing number of farmers are relying on private seed dealers for material and information inputs (Subedi, *et al*., 1998). In some instances, due to the proximity and free access to the Indian market, farmers directly approach and get the required seed. However, there are few of these innovative farmers is limited. A vast majority still depend on the 'farmer-to-farmer' network for the new technology to reach their farm (Subedi and Garforth, 1998).

In general, farmers were found to have limited contact with public extension services (Table 17). Whatever the level of contact, the contact across different categories of farmers was found to be statistically significant except among the clusters. Data from the field confirm too
the general belief that access to public extension services is biased in favour of resource rich male farmers of high caste having a good education compared to resource poor female farmers with a lower educational status. Being a member of a farmers' group definitely improved access to information and material inputs.

A shortcoming of the present study was that it failed to ask farmers about the role of private seed dealers in the dissemination of new technology. A recent study conducted in Nepal (Subedi *et al*., 1998) has proved that private dealers play a major role in providing information and material input to farming community.

4.10.3 Membership of groups

It is a tradition amongst Nepalese people to join forces whilst undertaking any social welfare activities in the community. Whilst the concept and practice of working as groups is not new to Nepalese people, working in formal groups is. Thus, one can expect to find both formal and informal groups operating in the community. Of course, the size of the group, objectives and the success of their operation is highly variable.

With recent changes in government policy the number of groups registered has really surged. It has become mandatory to form groups to derive any benefit or seek advice from government extension services and this applies to many of the services provided by NGOs also. However, many issues on equity such as access to membership from different categories of farmers, including gender and ethnicity balance needs to be looked at in more detail. There are several groups operating within the project areas, with different objectives (Table 18).

As stated earlier resource-poor and female members of the community have relatively poor access to extension services compared to their better-off, male counterparts. In fact, these groups tend to have limited access to membership of groups (Table 19).

Farmers' access to training and exposure visits

Training and exposure visits to farming communities are the means to impart technical skills to farmers. In this regard, many government organisations (GOs) and NGOs are actively involved in imparting training to farmers on various subjects. Therefore, farmers were asked to specify the level of access to training on different subjects and visits to government farms and research stations within Nepal.

From the farmers' response it is apparent that only 8% of the total households within the project area took part in training, visits or both. However farmers have limited access to training and visit programmes organised by either GOs or NGOs.

Table 17. Access to extension services by different categories of farmers.

Variables	Access to public extension (no. of households)		Statistics (p value)
	Yes	No	
1. Cluster			
ECC	31 (6.3)	461 (93.7)	0.95
WCC	20 (4.2)	459 (95.8)	
NPC	36 (7.4)	448 (92.6)	
2. Wealth category			
Rich	39 (11.4)	303 (88.6)	0.00
Medium	32 (6.4)	467 (93.6)	
Poor	16 (2.6)	598 (97.4)	
3. Ethnicity			
Brahmin/Chhetri	61	770	
Gurung/Magar	1	170	0.00
Indigenous people	24	329	
KDS/Others	1	99	
4. Respondent's sex			
Male	67	796	0.00
Female	20	571	
5. Education of respondent			
Illiterate	8	319	
Primary	37	571	0.002
Middle	26	275	
Secondary and above	9	75	
6. Membership of group			
Member	43	528	0.03
Non-member	43	834	

Table 18. Number and types of groups operating in the project area.

Groups	ECC
1. Bee keeping group	86
2. Buffalo development group	5
3. Co-operative (*Sahakari*)	25
4. Credit and saving group	383
5. Farmers' group	50
6. Forest user group	16
7. Water user group	179
8. Women development group	259

Table 19. Membership of groups by categories of farmers.

Variables	Membership (number of farmers)	Non membership (number of farmers)	Statistics (p value)
1. Wealth category			
Rich	157 (46)	184 (54)	0.000
Medium	214 (43.1)	283 (56.9)	
Poor	202 (32.8)	413 (67.2)	
2. Gender			
Male	367 (42.6)	494 (57.4)	0.002
Female	205 (34.7)	386 (65.3)	

Figures in parentheses indicate row percentages.

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