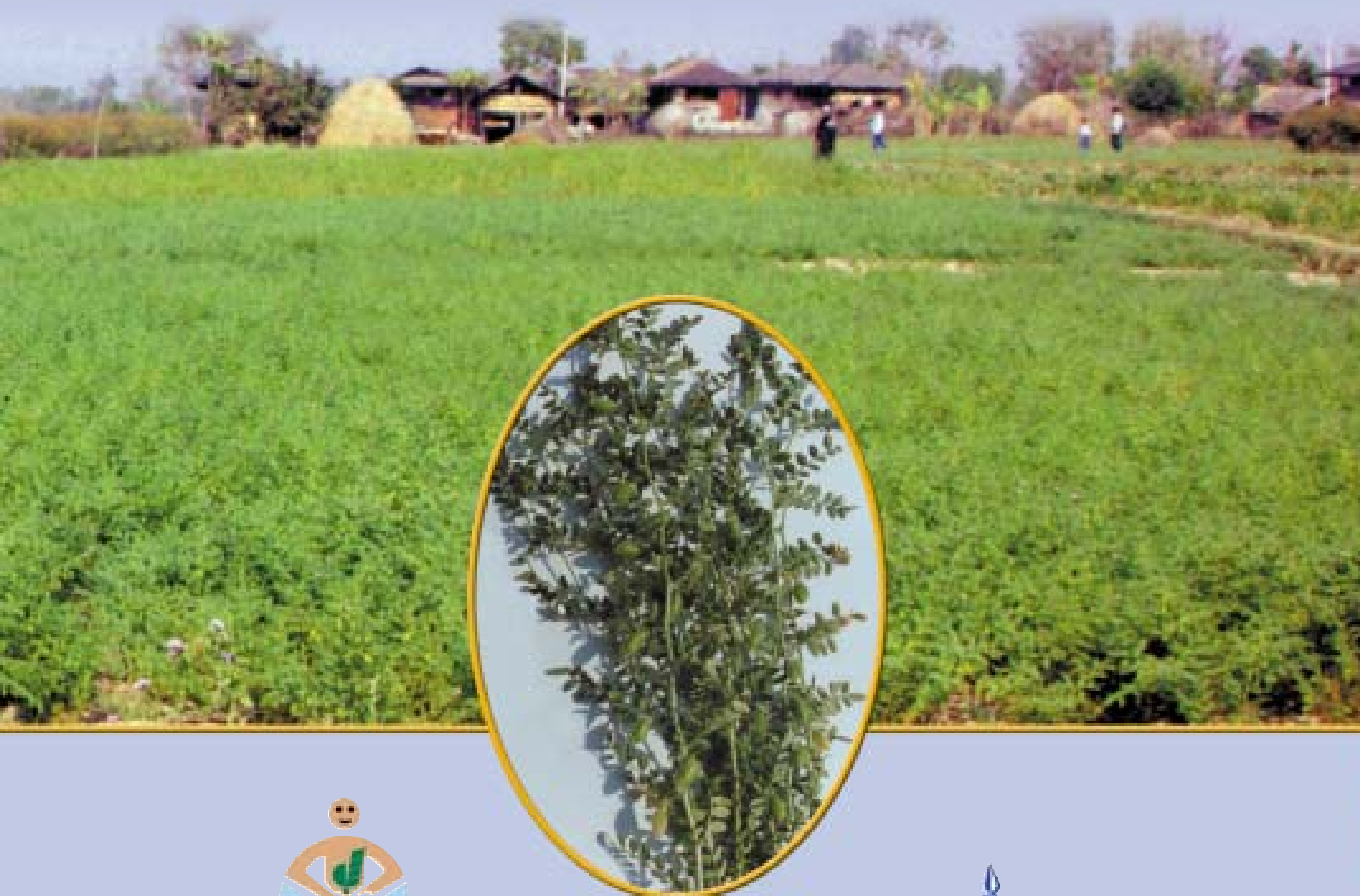

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Chickpea Production Constraints and Promotion of Integrated Pest Management in Nepal

On-farm IPM of Chickpea in Nepal 1

International Crops Research Institute for the Semi-Arid Tropics
Natural Resources Institute (NRI) and University of Greenwich
Nepal Agricultural Research Council
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Abstract

Chickpea production in Nepal drastically came down to 19,000 hectares in 1997/98 from 54,000 hectares in 1981/82. This was mainly due to biotic and abiotic stresses. To overcome these drawbacks and address the plight of chickpea producers, ICRISAT and NRI in collaboration with NARC launched an aggressive program. To diagnose chickpea production environment at micro level, the entire hillside-*Terai* region of Nepal was selected for the study. In all, 500 chickpea producers were selected for the study. It was found that rotation of chickpea cuts down the use of chemical fertilizers and also enhances the output of paddy significantly. If the joint mission of ICRISAT/NARC with the IPM package overcomes biotic and abiotic constraints then it will enhance the socio-economic life of chickpea farmers in Nepal.

Acknowledgments

This study is a part of ICRISAT/DFID research project 'On-farm IPM-chickpea in Nepal'. We are thankful to Philip C Stevenson of the University of Greenwich, Chatham Maritime, and JN Rao of ICRISAT, Pantancheru, Andhra Pradesh, India. We are also thankful to the Executive Director, Nepal Agricultural Research Council (NARC), scientists and field staff of NARC. Our sincere thanks to RN Chaudhary, Baidhyanath Jha, TB Ghemeray, VK Dutta, Rameshwaran Maharjan, DN Pokherial and S Mohatto of NARC for data collection. We shall remain thankful to the 500 farmers who participated in this activity. The coordination of the production process by TR Kapoor is gratefully acknowledged.

About ICRISAT

The semi-arid tropics (SAT) encompass parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, chickpea, pigeonpea and groundnut – five crops vital to life for the ever-increasing populations of the SAT. ICRISAT's mission is to conduct research that can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services and publishing.

ICRISAT was established in 1972. It is supported by the Consultative Group on International Agricultural Research (CGIAR), an informal association of approximately 50 public and private sector donors. It is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank. ICRISAT is one of 16 nonprofit, CGIAR-supported Future Harvest Centers.

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Contents

Preface

The study *Chickpea Production Constraints and Promotion of Integrated Pest Management in Nepal* is an effort to identify the constraints and opportunities in chickpea production. This study is a part of an on-farm IPM of chickpea in Nepal conducted by Nepal Agricultural Research Council (NARC), Natural Resources Institute (NRI) and International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). The Crop Protection Program (CPP) of the Department for International Development (DFID), UK, has funded the study. The study was designed to identify biotic and abiotic stresses on chickpea production and the possible impact on farmers' family income, nutrition and poverty. Pod borer, wilt and botrytis gray mold (BGM) were the major constraints that compelled farmers to substitute their land in favor of less remunerative crops. To overcome these, NARC, ICRISAT and NRI jointly launched a program in 1999/2000 to propagate IPM in major chickpea-growing regions through farmer participatory approach. This study documented the feasibility of IPM package and identified the constraints encountered by farmers in its larger adoption.

The authors have put in a tremendous effort to tackle various issues and have been successful in disseminating the advantages of IPM approach in chickpea production to many farmers across the hillside-*Terai* region of Nepal.

William D Dar
Director General
ICRISAT

Executive summary

Chickpea was a principal pulse crop in Nepal in the 1980s. This trend changed in 1997/98 with chickpea going down to the fifth place at 19,000 hectares. Since then chickpea supply in the country has been declining rapidly than demand. If appropriate technological and policy interventions are not implemented, then by 2010 the country would be forced to import chickpea. Pod borer infestation, wilt and botrytis gray mold (BGM) disease have compelled farmers to substitute the area in favor of less remunerative crops or leave it unsown. To overcome these constraints, Integrated Pest Management approach was launched in the hillside-*Terai* region of Nepal. The International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Natural Resources Institute (NRI) and the Nepal Agricultural Research Council (NARC) jointly launched a program in 1999/2000 to propagate the Integrated Pest Management (IPM) in the major chickpea-growing regions through farmer participatory approach. The purpose was to arrest and reverse the declining trend of chickpea production in Nepal and demonstrate the potential benefits of IPM package to the farmers. This study documented the feasibility of IPM package and identified the constraints encountered by farmers in its larger adoption. The study is based on a sample of 500 chickpea farmers, randomly selected from different regions in Nepal. These included both adopters and non-adopters of IPM technologies. The target domain of the study was entire hillside-*Terai* belt of Nepal: eastern, central, western, farwest and midwest.

The available information showed that a minuscule of farmers (about 7%) were following some components of IPM package in the hillside-*Terai* region. However, there was an enthusiasm for its adoption provided the existing constraints were appropriately addressed. Application of insecticide in chickpea was negligible. Its share was insignificant in the production cost; highest being in farwest region (11%). It was found that IPM package was highly profitable when compared to non-IPM techniques.

The average net income of those who adopted IPM components was substantially higher (NRs 1025/katha) than the ones who did not adopt it (NRs 310/katha). The unit cost of production was 60% lower on IPM farms than the non-IPM practitioners.

The key constraint in adoption of IPM technique was non-availability of recommended variety of seed. The household-level seed storage losses were extreme and the existing seed sector was too weak in the country. Other constraints reported were non-availability of right bio-substitutes for chemicals and lack of appropriate knowledge on IPM practices. Community participation (particularly women folk) in seed storage and production of NPV need to be encouraged in the chickpea growing areas of Nepal.

IPM is a ‘knowledge-intensive’ and ‘cost-saving’ technological intervention to overcome the devastation caused by diseases and insect-pests.

A strong training program on IPM for chickpea producers would speed-up the percolation benefits of a promising technology that is eco-friendly, cost-effective and income augmenting.

1. Introduction

Chickpea was a leading pulse crop in Nepal until the early 1980s. However, the trend reversed and the crop came down to the fifth place after lentil, grasspea, blackgram and pigeonpea (Pandey et al. 2000). The area under chickpea drastically reduced to only 19,000 hectares in 1997/98 from 54,000 hectares in 1981/82. The descending trajectory of chickpea was mainly due to its susceptibility to several diseases and insect-pests. Pod borer (*Helicoverpa armigera*) that feeds on maturing seeds was the worst pest. Wilt (*Fusarium oxysporum* f.sp. *ciceri*) and botrytis grey mould (BGM) caused by *Botrytis cinerea* were the key diseases that dramatically reduced the harvestable commodity. Principal reasons for a steep decline in chickpea production were uncertainty among farmers to depend on the crop and non-availability of appropriate technology for managing constraints. Hence, ≥75% of the rice areas with adequate moisture in which chickpea could be grown was left unsown.

To address production losses and technology gaps research into the development of resistant varieties and the subsequent release of improved varieties has been carried out for several years (Pandey et al. 2000). However, in the absence of an effective technology extension process and ineffective seed distribution, these varieties remained unavailable to farmers. To overcome these problems, ICRISAT and NRI in collaboration with NARC launched an improved technology adoption program with emphasis on pest management in the hillside region (inner *Terai-Terai*) of the country. The Crop Protection Program (CPP) of DFID, UK, has been funding this initiative. The aim of the program is to increase chickpea productivity by promoting the use of Integrated Pest Management (IPM) technologies and improve the livelihoods of farmers. Chickpea is a highly nutritious, versatile and valuable food crop.

The initiative of the proposed program was to integrate available technologies to manage insect-pests, diseases and raise chickpea production to make it more competitive. Before developing location specific technological options, it was considered to identify existing production constraints and explore prospects of location specific Integrated Pest Management (IPM) options for chickpea intensification in Nepal. More specifically, the purpose of this study was to: characterize chickpea production systems in Nepal, identify constraints limiting chickpea production and assess opportunities for promoting IPM in chickpea.

2. Methodology

Nepal lies between China and India. It is 800 km long and varies in width between 130 and 240 kms. There is a wide climatic variation ranging from semi-arid tropic low lands to temperate areas above 400 m and cold tundra above 3000m (Figure 1). The hillside-*Terai* region between sea level and about 300m is the most fertile and productive belt. While the adjoining Indian *Terai* witnessed green revolution as a result of improved agricultural technologies, the Nepal *Terai* remained largely untouched by these advances.

2.1 Study area

The *Terai* and adjoining hillsides are divided into five regions: eastern, central, western, midwest and farwest. Approximately 90% of chickpea is grown in the *Terai*. To understand and diagnose the chickpea production environment better, sites were chosen from

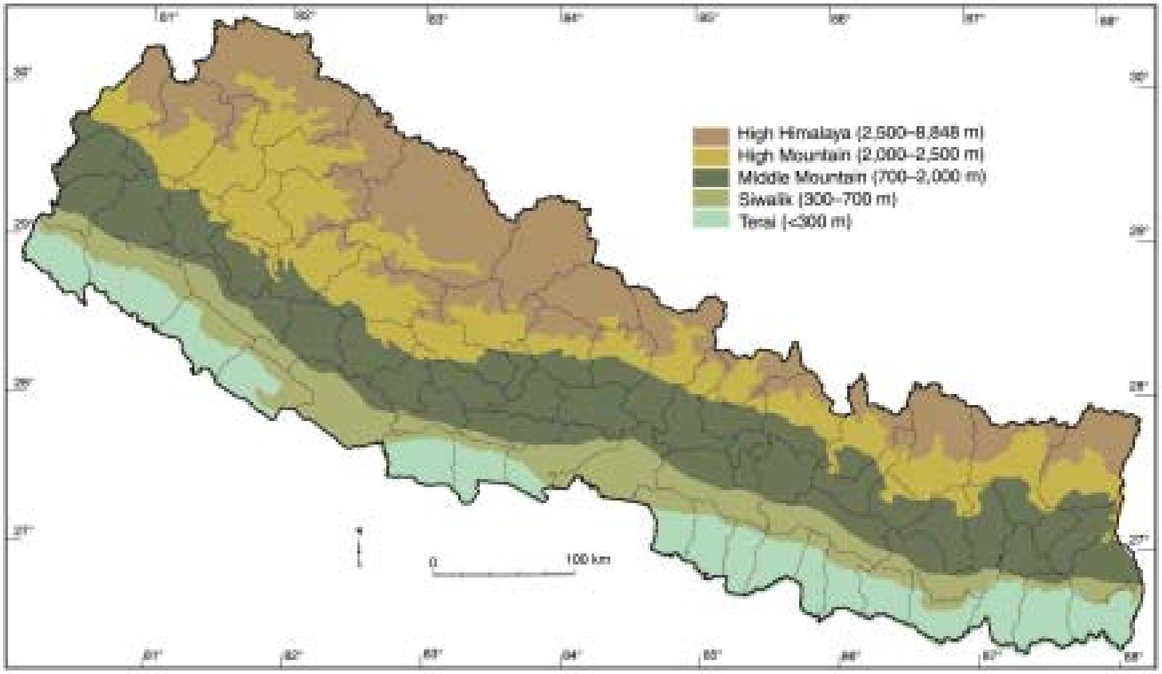

Figure 1. Physiographic regions of Nepal (Source: Topographic survey branch, Department of survey, His Majesty's Government, Nepal, 1983).

the entire length of the *Terai*. Temperatures range from 17 to 30°C with an average annual rainfall of 1400mm in midwestern region and 1872mm in wetter eastern region. Of the total arable land, irrigated area ranges between 21 and 35% (Table 1). About 80% of rainfall is between June and September (*kharif* or monsoon). Therefore, rice is the crop of choice in the five regions during this period. In the postrainy season (*rabi*), rainfall is low and limits the use of land for agriculture to crops like chickpea and lentil (*Lens esculenta*). These crops depend entirely on residual moisture and occasional rain (Manandhar and Sakya 1996, Pandey et al. 2000).

2.2 Sampling

Nepal lacks accurate information on production and socioeconomic constraints. Therefore, focused group meetings were held

Table 1. Agro-ecological features of different administrative regions in Nepal.

Region	Annual rainfall(mm)	Temperature (C°)		Irrigated area(%)
		Maximum	Minimum	
Eastern	1872.5	30	18	28.6
Central	1515.2	28	18	34.7
Western	1687.2	30	18	26.2
Midwestern	1388.9	30	17	20.8
Farwestern	1671.9	30	17	33.1

Source: Manandhar, Dhruba M and Shakya Deep M 1996. *Climate and Crops of Nepal.* NARC and SAFDC Nepal pp 38-48.

to explore quantitative and qualitative information during the initial reconnaissance survey conducted in 20 villages across different regions. The strategy during this phase acquainted the surveyors with farmers' experiences of chickpea production and marketing.

Five hundred chickpea farmers were selected randomly from 16 districts distributed across all the five regions of the *Terai*. The number of districts chosen from each region was based on the extent of chickpea growing in that region. Appendix 1 gives the list of districts selected for the study. Villages were selected randomly from these districts and chickpea producers were selected randomly from each village. The number of chickpea producers selected in each region was based on the proportion of land sown with chickpea in that region (Table 2).

Table 2. Number of sample households in different regions.

Region	Number of farmers	% of total sample
Eastern	55	11
Central	75	15
Western	95	19
Midwestern	235	47
Farwestern	40	8
Total sample	500	100

2.3 Data

Data was collected in a pre-tested questionnaire (Appendix 2) and given to farmers in local language. It was pre-tested in D-Gaon of the midwestern region of Nepal. Farmers were asked questions on general information, land use pattern, enterprise choices, economics of chickpea and other competitive crops, benefits of chickpea production and constraints. Information was also sought on marketing and consumption of chickpea.

3. Chickpea in Nepal

Chickpea in Nepal contributed to about 5% of the total pulse production during 1997/98 (Pandey et al. 2000). It was 12% during 1984/85 and 24% in 1980/81. In terms of harvest, this is equivalent to 13.7 thousand tons in triennium average ending (TE) 1997/98 from 32.8 thousand tons in TE 1981/82 and 16.6 thousand tons in TE 1991/92. The decline in production was faster during 1980s than 1990s. The annual compound growth rates in production showed that production declined by 9.1% during 1981-90, which was –3% during 1991-98 period. This showed that decline in production continued but slowed during the later period.

Chickpea area in the country came down to 19,000 hectares in TE 1981/82, which was 54.3 thousand hectares in TE 1981/82; a decline at an annual rate of 6%. The fall in area under chickpea during 1981-90 was much faster (-8.8%) than during 1991-98 (-6.4%). Under no-choice condition, chickpea was largely substituted by less remunerative crops like lentil, peas, rape and mustard (Pandey et al. 2000).

In the 1980s, chickpea yield which stood at 600kg/ha was lower than the yields in neighboring states of India and Bangladesh. This marginally improved during the 1990s at 717 kg/ha (Table 3). This was due to a fall in production in low yielding, high insect prone regions (mainly eastern region) and rise in production in high yielding regions (mainly western part of the country).

More than 60% of total chickpea area in the *Terai* region is confined to the western regions comprising western, midwestern and farwestern regions (Table 4). The midwestern region achieved almost 800kg/ha, although this is still substantially lower than the potential of 1.8t/ha (Pandey et al. 2000). This was the only region to experience a growth of about 9.3% in production during the 1990s. This was possible due to the expansion of the area under production (contributing 75% of the increase) and productivity.

Table 3. Area, production and yield of principal pulses in Nepal.

	1984/85			1998/99		
Crop	Area(000 ha)	Prod(000 t)	Yield(Kg/ha)	Area(000 ha)	Prod(000 t)	Yield(Kg/ha)
Lentil	98.65	58.90	597	174.60	132.30	758
Chickpea	25.90	16.00	618	16.05	12.80	798
Pigeonpea	14.30	10.50	734	22.70	18.33	808
Blackgram	9.10	4.70	516	27.36	18.32	670
Grass pea	51.20	28.60	519	16.55	10.48	634
Horse gram	10.60	5.60	528	9.02	5.61	622
Soybean	11.30	6.20	549	23.05	17.82	773
Miscellaneous	7.20	3.70	514	18.70	13.17	705

Unless decline in chickpea production is arrested with the help of improved crop management practices like IPM and higher yielding varieties, the country will have to rely on imports to satisfy its consumption needs (Joshi et al. 2000). The demand for this crop is high as it is versatile and a preferred foodstuff. The present production is sufficient to meet the current demand. However, the demand is growing at an annual rate of 3.2% and simultaneously the production is falling at 3% (Joshi et al. 2000). It has been projected that chickpea demand will be approximately 21,000 tons by 2010 and going by the current rate of decline this will result in a shortfall in supply (Joshi et al. 2000).

Table 4. Changes in annual compound growth rates in area, production and yield between 1984/85 and 1997/98 in different regions, Nepal (percent per year).

Region	Area	Production	Yield
Eastern	-8.85	-8.27	0.63
Central	-9.59	-8.17	1.56
Western	-3.39	-4.11	-074
Midwestern	-5.02	-2.09	3.08
Farwestern	7.06	9.27	2.06

Source: Derived from Government of Nepal (1995, 1996, 1997, 1998).

4. Characterization of chickpea farmers in Nepal

4.1 Average size of holding

At less than one hectare per farmer the size of land holding in Nepal is small when compared to other developing countries. But this is slightly higher in the *Terai* region at approximately 1.40 ha/farmer. Across the regions, farm sizes vary from 0.83 ha/farmer in the central region to 2.58 ha/farmer in the farwestern (Figure 2). Majority of the chickpea producers cultivate land both in rainy

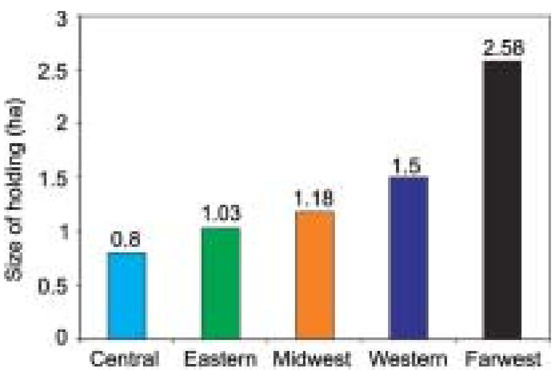

Figure 2. Average size of holding in different regions, Nepal.

Source: Based on household survey, 2000

and dry winter seasons. But a large area is left fallow during the winter after the rice crop. It is this fallow land that can be used for chickpea production. Some land is cultivated in the spring season in central, western and midwestern regions but does not make a substantial contribution for farm productivity. The average cropping intensity of Nepal is 200% and ranges from 150 to 200%.

4.2 Enterprise choice

Rice is the principal staple crop in Nepal followed by wheat. Other important crops are mustard, lentil and maize and this pattern of production is followed in all regions (Table 5). Some notable exceptions do occur, for example, sugarcane is specifically important in western *Terai*, while both sugarcane and pigeonpea are important in central *Terai*.

In the sample farms, more than 80% of the total cultivated area in the *Terai* region during winter was wheat, lentil and mustard. There was some variation in enterprise choices across different regions (Table 6). Chickpea appeared to be a minor crop covering only about 4.5% of the total cropped area during winter (Table 7). Among different regions, the area under chickpea cultivation was largest in midwestern region (15%), followed by far west and midwest regions. These three regions cover more than 90% of the entire chickpea area in Nepal. Most of the chickpea was cultivated in non-irrigated or rainfed conditions with the midwestern region having the largest area under rainfed chickpea (Table 8). Wheat, lentil, mustard, sugarcane and pigeonpea occupied more than 80% of all the irrigated area in the sample households. Many preferred to grow chickpea as a rainfed crop. This was because the marginal returns of water to chickpea was lower than wheat, mustard and lentil. However, good soil is preferred for chickpea cultivation. Future chickpea research and development efforts must concentrate on rainfed production.

Table 5. Cropping pattern on sample farms in different regions of Nepal (% of gross cropped area).

	Region				
Crop	Eastern	Central	Western	Farwest	Midwest
Rice	51.36	28.30	42.60	41.88	39.08
Wheat	25.83	28.30	17.99	25.04	11.40
Maize	0.00	9.99	4.28	6.62	9.16
Lentil	7.61	1.61	11.78	9.16	15.58
Pigeonpea	5.01	8.80	2.17	0.00	2.49
Chickpea	0.33	0.59	1.14	1.66	7.68
Peas	1.34	0.00	0.62	1.27	4.92
Kidney bean	0.00	0.00	0.00	0.02	0.00
Mustard	7.52	6.08	9.67	11.18	9.27
Sugarcane	0.00	10.61	9.29	0.96	0.00
Vegetables	0.97	5.63	0.43	1.68	0.37

Source: Based on household survey, 2000.

Table 6. Cropping pattern during winter season on sample farms in different regions of Nepal (% of winter cropped area).

Crop	Region				
	Eastern	Central	Western	Farwestern	Midwestern
Wheat	53.11	45.91	33.87	49.12	22.03
Lentil	15.65	2.61	22.17	17.97	30.12
Pigeonpea	10.30	14.27	4.09	0.00	4.83
Chickpea	0.69	0.96	2.16	3.26	14.85
Peas	2.76	0.00	1.17	2.50	9.51
Mustard	15.46	9.87	18.20	21.93	17.93
Sugarcane	0.00	17.21	17.49	1.90	0.00
Vegetables	2.01	9.13	0.81	5.19	0.46

Source: Based on household survey, 2000.Note: Sugarcane and pigeonpea are long duration crops and occupy land during winter season.

Table 7. Distribution of pulses during winter (% of winter pulses area).

Region	Crop				
	Chickpea	Lentil	Peas	Pigeonpea	Kidney beans
Eastern	2.35	53.20	9.40	35.04	0.00
Central	5.37	14.57	0.00	79.53	0.00
Western	7.22	74.14	3.91	13.69	0.00
Farwestern	13.8	75.60	10.53	0.00	0.07
Midwestern	24.73	50.13	15.83	8.04	0.00

Source: Based on household survey, 2000.

Table 8. Crop wise irrigated area (%) during the winter season.

Crop	Region				
	Eastern	Central	Western	Farwestern	Midwestern
Wheat	70.45	48.87	29.91	0.50	19.67
Lentil	34.06	1.96	20.41	0.50	25.25
Pigeonpea	16.01	13.76	1.47	0.00	4.05
Chickpea	1.60	0.00	0.28	0.39	9.33
Peas	4.22	0.00	0.00	0.22	22.00
Mustard	30.85	11.51	18.85	0.89	14.61
Sugarcane	1.74	16.30	23.02	0.00	0.00
Vegetables	1.89	19.93	0.18	0.00	0.21

Source: Based on household survey, 2000.

Lentil is a key winter pulse in the *Terai* region of Nepal. More than half of the total pulse area during winter season is lentil followed by pigeonpea (27%) and chickpea (11%). Pigeonpea finds a particular niche in eastern and central regions. Chickpea is usually grown when there is no chance to grow lentil. Better marketability and high returns for green pea is posing to be another threat for chickpea. This problem can be addressed by alleviating the production constraints through adoption of improved technologies and varieties.

4.3 Crop rotation and management

Chickpea is often sown in sequence with rice and to a lesser extent maize. The most competitive rotations are rice-wheat, rice-lentil and rice-mustard. Chickpea is largely grown as a sole crop but sometimes it is mixed with mustard and lentil. About 30% of the sample households reported that the crop is inter-cropped with mustard. The practice of intercropping with mustard is more common in western region (Table 9). Often in successive years, chickpea crop is on rotation in different plots. More than 75% farmers in the whole of *Terai* region reported that they followed rotating of chickpea crop. All farmers in eastern region followed this practice. The reason farmers reported for this practice was that chickpea improves soil fertility through nitrogen fixation and allows the crop to escape from soil borne diseases (Table 10).

4.4 Adoption of improved cultivars

During the last two decades, only six improved chickpea varieties were released in Nepal (Table 11). But there is no information on their adoption. About 8% farmers used improved varieties in 1999/2000 and the adoption of improved chickpea varieties was highest in the farwestern region. Popular improved varieties of choice were *Koseli, Sita, Tara, Trishul, Dhanush, Radhe* and *Avrodhi*. Adoption of improved varieties in these regions was due to efforts of NARC under a research and action project on Secondary Crops. This region is relatively less prone to abiotic and biotic constraints. Reasons reported for non-adoption of improved varieties was non-availability of seed and a lack of knowledge about improved

Table 9. Area under different intercropping systems with chickpea (% of total chickpea area).

	Intercrop with chickpea			
Region	Lentil	Peas	Mustard	Sole chickpea
Eastern	12.72	0.00	0.00	87.27
Central	2.66	0.00	2.66	94.66
Western	9.56	2.50	70.05	20.00
Far Western	5.00	0.00	30.00	65.00
Midwestern	20.00	3.40	42.97	26.38
Average	10.99	1.18	29.14	58.66

Source: Based on household survey, 2000.

Table 10. Reasons for rotating chickpea area over the years (% of total respondent).

	Region					
Reason	Eastern	Central	Western	Farwest	Midwest	Average
Improve soil fertility	65.45	61.34	65.23	70.00	53.21	63.05
Avoid soil borne diseases	34.55	30.66	8.42	5.00	12.34	18.19
No response	0.00	8.00	26.35	25.00	34.45	18.76

Source: Based on household survey, 2000

Table 11. Improved varieties of chickpea in Nepal and their target domain.

Variety	Release year	Origin	Traget domain
Trishul	1979	Nepal	*Terai*
Dhanush	1979	Nepal	*Terai*
Radhe	1987	India	*Terai*
Sita	1987	India	*Terai*
Kosheli	1990	India	Western and inner *Terai*
Kalika	1990	India	Midwest dry land *Terai*

management practices and IPM. But these reasons are common for all the crops in Nepal. Therefore, this needs to be addressed as a policy in seed sector and technology transfer to augment chickpea production in Nepal.

4.5 Economics of chickpea production

Chickpea is a less labor-intensive crop and cheap. On an average, human and bullock labor constituted a 75% share of the total operational expenses for chickpea production (Figure 3) and more than 85% in eastern and western regions (Table 12). The cost of labor in the farwestern region, which cultivated maximum chickpea, was only 55%. The leftover amount was spent on technology inputs to control insects and diseases. Despite

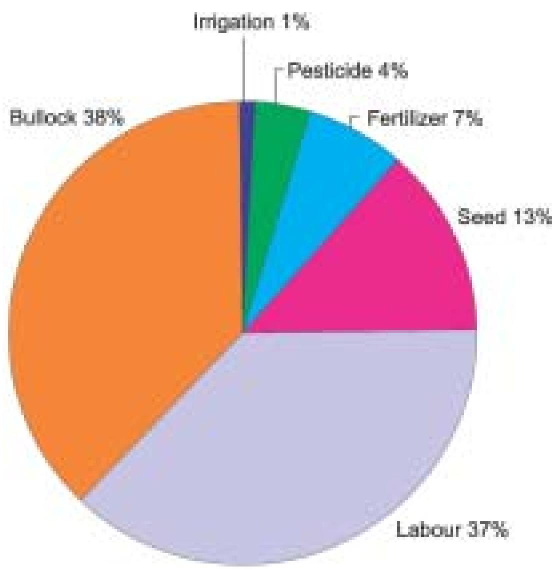

Figure 3. Share of different inputs in total production cost of chickpea, Nepal.

Source: Based on household survey, 2000

Table 12. Factor share for chickpea production in different regions (% of total cost).

	Region				
Item	Eastern	Central	Western	Farwestern	Midwestern
Seed	13.02	14.84	8.57	18.15	10.00
Fertilizer	0.00	6.94	4.43	15.10	8.07
Pesticide	0.00	1.15	1.00	11.33	4.22
Irrigation	0.00	0.00	0.00	0.00	3.70
Labor	35.10	44.27	44.92	29.71	33.34
Bullock	51.87	32.78	41.21	25.75	40.42

Source: Based on household survey, 2000

suffering huge crop damage due to insects and diseases, farmers rarely applied insecticides or pesticides.

The cost of chickpea cultivation was lowest in farwestern region (Figure 4) at NRs 9420/ha when compared to NRs 18480/ha in midwestern region. The net profit from chickpea cultivation was highest in farwestern region at NRs 15450/ha.

4.6 Benefits of chickpea

At present, the crop is grown to meet household consumption, but there are non-monetary or nutritional benefits that also arise from chickpea cultivation. Chickpea a legume from the sub-family *papillionoideae* fixes nitrogen in soil, improves soil nitrate content and saves fertilizer costs in subsequent crops. As reported earlier, farmers grow chickpea (Table 13) knowing very well that it improves soil fertility. There is evidence that in comparison to wheat or fallow land, chickpea has enhanced the yield of subsequent rice crops by 25-35% (Pande and Joshi 1995).

Farmers reported a cut in inorganic and organic fertilizer use in plots where rice was grown in sequence with chickpea as

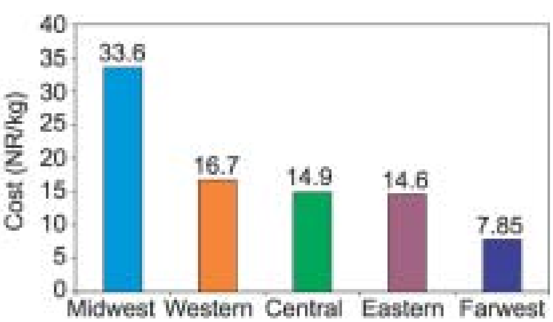

Figure 4. Unit cost of chickpea production in different regions, Nepal.

Source: Based on household survey, 2000

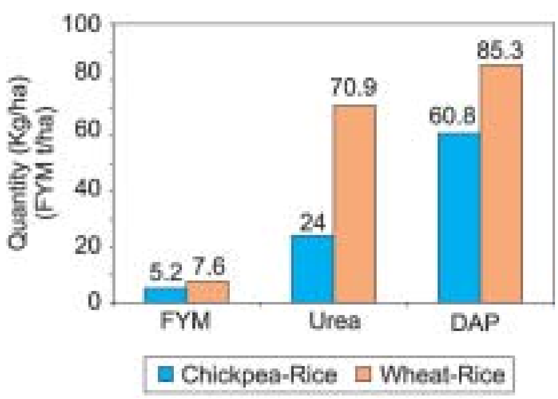

Figure 5. Consumtion of fertilizer in rice under different rotations, Nepal.

compared with wheat. Farmers in rice crops used 24 kg/ha of urea, 60.8 kg/ha of diammonium phosphate (DAP) and 5.2 t/ha of compost when rotated with chickpea (Figure 5). The corresponding quantity of fertilizers in rice when rotated with wheat was 70.8 kg/ha of urea, 85.3 kg/ha of DAP and 7.6 t/ha of compost. This shows that substantial savings in fertilizer that can be achieved. Interestingly, the yield of rice was higher when rotated with chickpea in comparison with wheat (Figure 6). The highest yield advantage was 46 percent in the western region (Table 14). In other regions, the gain was between 30 and 31 percent. These evidences clearly reveal that chickpea enriches soil fertility and improves savings in rice cultivation.

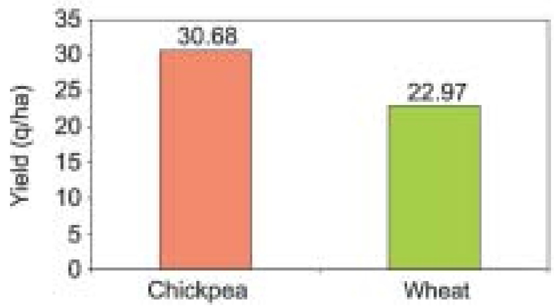

Figure 6. Yield of rice in different crop rotations, Nepal.

Table 13. Distribution of sample farmers according to efficiency of chickpea production (% of sample farmers).

	Region				
Cost-price ratio	Eastern	Central	Western	Farwestern	Midwestern
> 1.00	71.42	62.50	78.57	2.70	71.76
0.75- 1.00	28.57	12.50	7.14	13.51	12.94
0.50- 0.75	0.00	25.00	10.71	13.51	8.82
0.25- 0.50	0.00	0.00	3.57	67.56	6.47
< 0.25	0.00	0.00	0.00	2.50	0.00

Source: Based on household survey, 2000.

Table 14. Rice yield under different rotations (kg/ha).

	Crop rotation		Change in rice yield	
Region	Chickpea-rice	Wheat-Rice	Kg/ha	Percent
Eastern	3192	2425	767	31.60
Central	2985	2290	695	30.30
Western	2985	2045	940	45.90
Farwestern	2926	2250	676	30.00
Midwestern	3252	2475	777	31.40
Average	3068	2297	771	33.60

Source: Based on household survey, 2000.

5. Constraints in chickpea production

This section provides a description of the major constraints in chickpea production addressed by farmers in the PRA. There are three major constraints in chickpea production. These are broadly related with biotic, abiotic constraints and non-availability of seed. These constraints adversely affect the production and profitability of chickpea.

5.1 Abiotic and biotic constraints

Compared to cereals, oilseeds and other pulses, chickpea faces more biotic and abiotic constraints in production. Pod borer is the key insect-pest and devastates chickpea production in all regions (Figure 7 and Table 15). According to reports, pod borer (local name *Bahadur kira* or brave insect) infestation occurs every year. It is a threat to food and nutritional security of farmers and can damage the entire chickpea crop.

Of the diseases, wilt (*Fusarium oxysporum* f.sp. *ciceri*) and BGM (*Botrytis cinerea*) cause serious crop damage and can severely affect chickpea production. Wilt usually affects the crop early in the season owing to the susceptibility of seedlings to the disease. Moreover, the disease is seed-borne. BGM is a problem that usually strikes in the month of January when cool nights take more

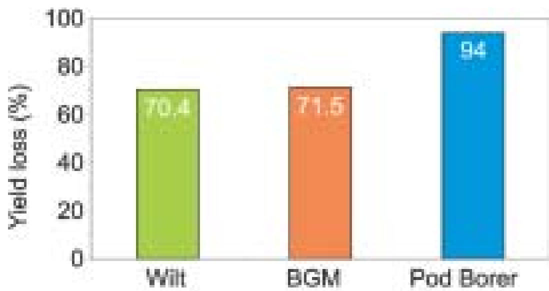

Figure 7. Damage due to biotic constraints in chickpea, Nepal

Table 15. Chickpea area (%) affected due to major biotic constraints in different regions of Nepal.

Region	Constraint	Area affected (%)	Rank
Eastern	Pod borer	98.20	1
	BGM	92.40	2
	Wilt	87.60	3
Central	Pod borer	100.00	1
	BGM	95.60	2
	Wilt	85.70	3
Western	Pod borer	81.60	1
	BGM	76.20	2
	Wilt	45.60	3
Farwestern	Pod borer	93.10	1
	Wilt	60.15	2
	BGM	40.05	3
Midwestern	Pod borer	92.60	1
	Wilt	72.80	2
	BGM	51.00	3

Source: Based on household survey, 2000.

time to warm up. The mist hangs over the crop well into the morning and this is the ideal time for the growth of BGM on flowers and foliage.

Drought is a serious abiotic constraint in the western part of Nepal.

5.2 Seed

Non-availability of good seed is another major constraint. Lack of improved seed can have a severe impact on successful chickpea production. Many farmers use seeds stored in houses. With no proper methods adopted to preserve seed (Figure 8), more than 33% is damaged in the storage period. Furthermore, farmers also reported high germination losses due to poor quality seed. This suggests that the post-harvest constraints in chickpea are very important and have to be considered in any IPM program.

Lack of knowledge, non-availability of improved seeds and poor output markets are a few socioeconomic constraints (Table 16) that have been identified through discussions with the farmers.

5.3 Profitability

Contrary to the general perception, production in sample farms has been found to be more profitable than lentil and mustard (Table 17). This is primarily due to farmers cultivating chickpea crop in assured environments and adopting some or all IPM measures to control biotic and abiotic constraints suggested by the

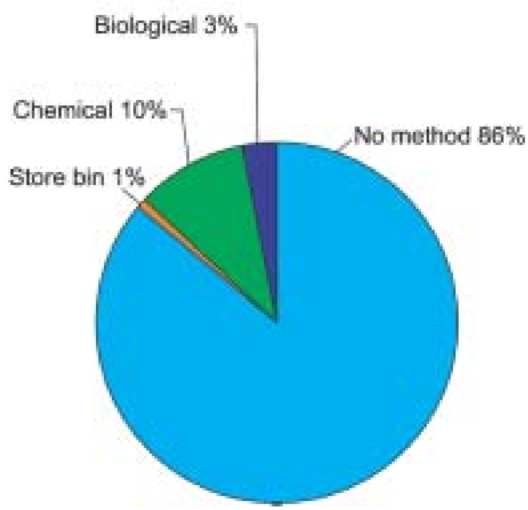

Figure 8. Control measures for storage of chickpea seed, Nepal.

Table 16. Institutional and infrastructural constraints in chickpea production in different regions of Nepal.

Constraints	Region: Eastern	Central	Western	Farwestern	Midwestern	Average
Institutional						
Agrochemicals	24	44	37	0	95	200
Seed	30	25	40	0	104	199
Inputs	14	22	60	32	62	190
Proper advise	10	17	22	4	89	142
Knowledge	31	36	1	4	49	121
Infrastructural						
Seed storage	31	45	18	33	84	211
Irrigation	12	16	43	4	53	128
Marketing	11	13	3	3	56	86
Transport	0	1	0	0	12	19

Source: Based on household survey, 2000.

Table 17. Net profit (NRs/ha) of crops competing with chickpea in different regions in Nepal.

	Crop			
Region	Chickpea	Lentil	Wheat	Mustard
Eastern	12290.00	n.a.	-415.00	n.a
Central	8925.00	n.a.	3059.00	n.a
Western	14582.00	4888.00	7384.00	n.a.
Farwestern	15207.00	6689.00	n.a	23085.00
Midwestern	-5277.00	2749.00	1208.00	18500.00

Source: Based on household survey, 2000.n.a.: Due to too less observations the economic analysis was not done.

project team. Chickpea in Nepal is being cultivated in places where it is the most assured crop. Under such situations, profitability of chickpea is better than other crops. When compared to chickpea, low cost cultivation was a reason for expansion of lentil and mustard. Unlike chickpea, these crops are assured under diverse agro-climatic environments and require less input, agronomic management and care. Lack of appropriate output market is another reason for limiting chickpea production.

6. Economics of IPM

The Integrated Pest Management (IPM) package was developed to manage diseases, insect-pests and improve production of chickpea in on-farm trials in Nepal. The package consisted of improved agronomic practices such as plant spacing, seed treatment with Rhizobium, priming and application of specific quantities of fertilizer, use of high yielding and moderately resistance chickpea varieties to diseases and insect-pests, judicious application of pesticides and use of biocides (when available). Details of the IPM package are given below:

The IPM package consisted of improved chickpea cultivar- *Avrodhi*; seed treatment @ 2g kg^{-1} seed with a mixture of commercial fungicides, Thirum + Bavistin in 1:1 ratio; application of Rhizobium inoculum; diammonium phosphate (DAP) @ 3 kg $katha^{-1}$ and need-based foliar spray of pesticides (fungicides and insecticides) to control BGM and *Helicoverpa* pod borer. The fungicide Bavistin @ 1g lt^{-1} of water (17 lt $katha^{-1}$) was used to control BGM. Thiodan @ 3 ml lt^{-1} water (17 lt $katha^{-1}$) was used to manage pod borers. The first prophylactic spray of fungicide was at the flowering to pod formation stage of the crop (60 –70 days after sowing). Subsequent fungicide sprays were decided on prevailing weather conditions like temperature, length of foggy hours per day and number of days, percentage of humidity and cloudiness favorable for BGM development.

In general, these spray schedules coincided with vegetative–flowering, pod-formation and pod-development stages of the crop. Insecticide was sprayed once during flowering and twice during pod-filling stages.

Adoption of improved package was modest in the early stage of propagation. On an average, 7% farmers in the *Terai* region adopted IPM practices (Figure 9). Adoption was concentrated in western and midwestern regions. More than 27% farmers in midwestern region and 8% in western region adopted IPM practices. At the time of the survey, the package was not adopted in eastern, central and farwestern regions.

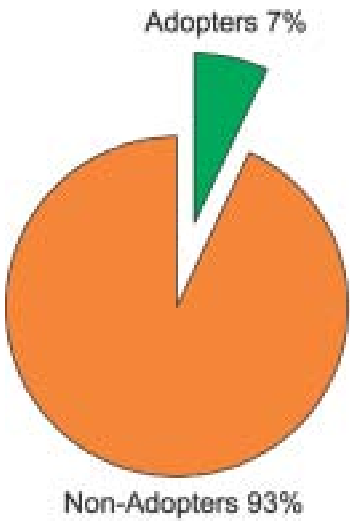

Fig. 9: Adoption of IPM by chickpea farmers in Terai, Nepal (%).

The economics of the IPM package recommended to farmers was compared to non-IPM package (Table 18). On the basis of information gathered, it was calculated that IPM package on area basis was marginally dearer than the non-IPM package. The cost of IPM package was 13% higher than the non-IPM package. But the net returns for farmers using the recommended IPM package was NRs 1056 katha^{-1} compared to only NRs 310 katha^{-1} without IPM package; a gain of about 240%.

The cost of one kg IPM chickpea was NRs 9.3/kg when compared to NRs 17.5/kg without IPM package, approximately 62% less (Figure 10). The unit cost of chickpea with IPM was 15% lower than the most efficient chickpea producing farwest region (NRs 7.85/kg). The benefit-cost ratio of IPM package was estimated to be 2.02 in comparison to non-IPM at 1.61.

The data reveals that the IPM package was highly profitable and cost-effective. For a sustainable and substantial impact, the benefits of IPM have to be promoted to farmers on a much larger scale.

Table 18. Economics of chickpea production with and without IPM (NRs/ha).

Particulars	Without IPM	With IPM	Change over without IPM (%)
Material cost	4252.00	4332.00	1.88
Operational cost	10540.00	11950.00	13.38
Interest on working capital	170.00	172.00	1.18
Total cost	14962.00	16454.00	9.97
Gross income	24120.00	35440.00	46.93
Net income	9158.00	18986.00	107.00
Unit cost of production (NRs/kg)	17.53	9.26	47.18

Source: Based on household survey, 2000.

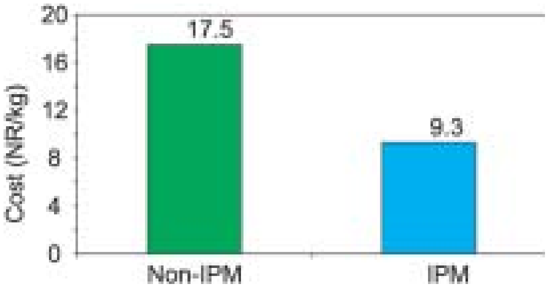

Fig. 10: Unit cost of chickpea production with and without IPM

Source: Based on household survey, 2000.

7. Constraints in IPM

This section discusses the principal constraints that can be encountered in large-scale adoption of IPM practice in Nepal. Constraints like seed sector, availability of biopesticides and need for knowledge of IPM are discussed here.

7.1 Seed sector

During the last ten years, six improved varieties of chickpea were developed and released for large-scale production in Nepal. These varieties are high yielding and have moderate resistance to some diseases – notably *Fusarium wilt* and BGM. Most of the varieties were developed by NARC in collaboration with ICRISAT or came from India. These varieties are *Trishul, Dhanush, Radhe, Sita, Kosheli* and *Kalika*.

Unfortunately, the seed sector is too weak in Nepal. Majority reported using their own stored seed and more than 40% of the farmers interviewed said they had difficulties in obtaining seeds of improved cultivars. There was a loss in seed quality of their own produce during storage. Farmers in farwestern, central and eastern regions reported more seed damage during storage when compared to the midwestern region (Table 19). Ironically, storage of chickpea has always been a low priority job. This has resulted in significant reduction of seed germination and subsequent productivity. Developing an appropriate seed sector can minimize these losses.

7.2 Biocides

Biocides are important components for a broad based and sustainable approach to IPM practice in chickpea production. The most important subject in chickpea production is

Table 19. Losses due to seed storage and germination.

Region	Seed stored (kg/household)	Damage during storage (%)	Damage during germination (%)
Eastern	4.50	0.00	5.00
Central	2.30	63.15	51.25
Western	2.80	17.53	6.24
Farwestern	7.03	25.24	30.41
Midwestern	22.40	10.27	30.41
Average	7.80	23.23	24.66

Source: Based on household survey, 2000.

Helicoverpa armigera nucleopolyhedrovirus (*Hear*NPV). However, there is no production and marketing mechanism of biopesticides in Nepal.

More than 40% farmers reported that even conventional chemical insecticides were not always available in the *Terai* region and are often adulterated. The constraint appears to be more of a demand-led problem than a supply issue. This is because of inadequate resources and knowledge about agro-chemicals.

7.3 IPM knowledge

IPM is a new concept in Nepal and 95% farmers are not aware of its principals and components. Farmers in eastern and central regions are poorly informed about IPM or any other chickpea production technologies. About 56% farmers in eastern region and 48% in central region reported a lack of knowledge about the potential and availability of improved technologies. Farmers in the western region were better informed because of a participatory evaluation program of IPM technologies conducted on their fields. Both NARC and ICRISAT initiated these IPM activities in western Nepal in 1998/99 soon after the BGM epidemic. This epidemic destroyed the crop in Nepal leaving no chickpea seed for sowing in the following year. Later, during 1999/2000 seasons, IPM in chickpea successfully expanded and the crop has been established in several fields in central and eastern Nepal.

8. Strategic options

This section presents important strategic options that have cropped up from farmer interviews. The feedback will help in alleviation of production limitations by addressing specific constraints.

8.1 Improved seed

Good quality improved seed is the key for improving chickpea yields. This survey found that farmers primarily use their own stored seed, which is often damaged and has poor germination potential. The seed replacement rate is also low. These two factors are critical and are directly responsible for low chickpea yields. The chickpea seed sector is weak. Though high yielding and moderately disease-resistant varieties are available, the distribution channels are poor. An alternative approach to address this problem is to set up 'seed villages' where production of good quality seed is taken up. Under close supervision of scientists from NARC, a few villages were selected as 'seed villages'. Initially, seed was sold at a subsidized rate. But once farmers in 'seed villages' were assisted in producing improved quality seed and store properly, it created a sustainable basis for chickpea production.

High incidence of seed damage is a major constraint in the storage period. Chickpea is prone to storage insect-pests like *Callosobruchus* spp. Our survey indicated that farmers need to be informed about improved, cost-effective and sustainable methods of seed storage. Simple methods are already available but due to lack of poor extension service and a subsequent lack of knowledge, farmers know nothing about them. Training programs, particularly for women, on methods of post-harvest management of seed have to be organized. This is because women often control the storage process. Possibilities of involving non-government organizations (NGOs) in seed production and storage have to be explored. These organizations can help in forming self-help groups for seed production and storage. Village women should be encouraged to participate actively in these groups. Members of self-help groups can eventually sell seed of improved varieties and earn more profits.

8.2 Technology transfer

The technology transfer via public sector extension systems in the survey area was very weak. This was apparent throughout Nepal and needs to be strengthened. The responsibility of distributing technologies has to be taken by NARC and sufficient resources have to be allocated for this process. There is a strong need of an interface between farmers, extension personnel and scientists to disseminate new information for higher returns in agricultural research. Some innovative approaches can be introduced to involve farmers in deciding research needs and their ultimate dissemination. In this context, the on-going program is wholly dependent on farmer participation and is expected to set a model for large-scale technology transfer.

8.3 Training schools on IPM

IPM is a new concept for farming in Nepal. Since chickpea is more prone to insects and diseases, farmers have to be educated about various components of IPM. It is important to launch training schools on IPM. These schools can also be the production units of bio agents as well as improved varieties of seeds.

9. Conclusions

This survey along with additional information has found that chickpea production has declined very quickly in Nepal due to the persistent problems of insect damage and disease. Today chickpea production in Nepal is threatened because most of the farmers are growing inefficiently and cannot compete with other countries where production is highly mechanized. In the absence of appropriate technology and policy intervention, the area under crop will shrink further despite the presence of fallow lands in winter. As labor is cheap in Nepal, this crop can be made competitive even on a small scale and subsistence level. Inefficient production and low profitability are mainly due to insect damage, disease, inferior quality seed, non-availability of improved varieties and lack of knowledge about production technologies.

To enhance the profitability of chickpea, better quality and high yielding varieties should be available to farmers. High potential production slots need to be identified in the hillside-*Terai* region. Initially, these production slots should be given a high priority status. Here high yielding varieties, training schools and educating farmers about improved chickpea technologies have to be introduced.

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Conversions

1hectare = 29.53 Kathas
1hectare = 01.47 Bighas
$1 = 77.00 NRs

Acronyms

BGM	Botrytis gray mould
FORWARD	Forum for rural welfare and agricultural reform for development
HMG	His Majesty's Government
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPM	Integrated Pest Management
NGO	Non government organization
NARC	Nepal Agriculture Research Council
NRs	Nepalese rupee
PRA	Participatory rural appraisal
RRA	Rapid rural appraisal
Ha	Hectare

Appendix

Appendix 1. Sample districts and number of samples from different regions

Region	District	Sample farmers (No.)
Eastern	Sirha	24
	Saptari	25
	Sunsari	6
Central	Mohatari	13
	Saralahi	21
	Dhanusha	26
	Makawanpur	1
	Rauhatat	7
	Bara	7
Western	Naval Parasi	49
	Kapil Vastu	35
	Rupendahi	11
Midwestern	Bardia	158
	Banke	71
Farwestern	Kailali	8
	Kanchanpur	2
Total sample	16	500

Appendix 2. Questionnaire

Date:
Year: 1999-2000

1. Farmers ID:

Ecoregion ....

District..................... Ward No .... VDC ....Village...........................

Name of respondent: ....

Male .... Female .... Age .... Cast............. Education ....

Land Use:

Size of Land holding ....

Season	Cultivated area	Irrigated area	Source of irrigation
Rainy season			
Winter season			
Spring season			

2. Cropping Pattern

Season	Crop or inter-crop	Area	Irrigated area
Rainy season			
Winter season			
Spring season			

3. Chickpea Cultivation:

1. During the last 10 years chickpea area has increased/decreased /constant

Reason for increasing/decreasing/constant.

....

....

....

2. Since how long chickpea is grown ....

3. Current area under chickpea ....

4. Crop before chickpea in rainy season ....

5. Crop after chickpea in rainy season ....

6. Inter crop with chickpea ....

   a.Name of Inter crop ....

   b.Proportion of Inter crop ....

7. Land Quality preferred for chickpea cultivation

   a. Good Soil .... b. Inferior Soil ....

   c. Irrigated condition .... d. Unirrigated condition ....

8.Chickpea is grown every year in same plot/ landYes /No

If answer is no, please give the reason.

....

....

9.Chickpea yield during

   a.Good year .... kg/katha

   b.Bad year .... kg/katha

   c.Normal year .... kg/katha

4. Resource use Pattern and Crop Yields (information to be collected/katha)

Resource	Chickpea				Competing crop		
	Unit	Quantity	Labor	Bullock/ Machine	Quantity	Labor	Bullock/ Machine
Seed							
Fertilizer							
a)							
b)							
c)							
d)							
e)							
Pesticide							
Insecticide							
Weedicide							
Irrigation							
Land preparation							
Harvesting							
Threshing							

Total Production (Production per katha area under chickpea)

a) Main product							
b) Use of byproduct							

Marketed

Main product							
Price received							

5. Resource use Pattern and Crop Yields(Net season crop)

Input	Unit	Sequencing with chickpea	Sequencing with wheat
Fertilizer			
1			
2			
Yield Obtained			

6. Constraints of Crop Production Crop: Chickpea

Constraints	Area affected	Yield with constraints	Probability of occurrence
Diseases			
Insects			
Weeds			
Drought/water deficit			
Water logging			
Alkaline soil			
Acid Soil			
Soil erosion			
Other			

7. Storage Losses

a. How much seed was stored last year ....kg

b. Did you use any control methodYes/No

c. What methods were used 1.......................... 2. .... 3 ....

d. If not , how much was the damaged caused .... kg

e.Seed germination losses ....

8. Other Socio-Economic Constraints

(A) Institutional constraints

Constraints	Ranks
1. Poor transfer of technology (total lack of knowledge)	
2. Poor technical guidance	
3. Untimely availability of inputs	
a) Seed	
b) Fertilizer	
c) Agro chemicals	

(B) Infra structural constraints

Constraints	Ranks
a. Poor irrigation facilities for chickpea	
b. Poor seed storage facilities	
c. Poor marketing facilities	
d. Poor transportation for marketing	

9. Other Technology Related Constraints:

Do you grow improved chickpea varieties

If yes, name the variety

If no reason for not growing

a. Do not know

b. Seed of improved variety is not available

c. Price of seed of improved variety is high

Are you adopting improved insect management methods? Yes/No

If yes, Name the methods ....

If no, reason for not adopting

....

....

If discontinued, reason for discontinuing

....

....

10. Reasons for Producing and Consuming Chickpea

For production ....

For consumption ....

Any other information ....