Conclusions and Recommendations

On the final day of the workshop, participants divided themselves into two discussion groups as follows:

Group A - Special Features of Mountain Agriculture and Farming Systems.

Group B - Mountain Crop Genetic Resources.

An extensive and in depth discussion took place in both the groups. During the final plenary session, the following summary of discussions and recommendations was adopted.

a) **Discussion Of Group A On Mountain Farming Systems**

1) *Characteristics of Mountain Farming Systems*

It was, first of all, recognized that any effective research and development in farming systems must take into account the complex nature of Mountain Farming Systems(MFS). The following characteristics set MFS apart from other agricultural production systems:

a) **Fragility:** Mountain Farming Systems, although consisting of considerable diversity in ecosystems and genetic resources, are generally extremely fragile due to steep slopes, erodable soils, intense rainfall, intensive cultivation and uncertain markets. Consideration of the issue of stability is needed in introducing change in MFS.

b) **Diversity:** MFS over short distances exhibit different micro ecosystems(different crops, varieties, cropping patterns, etc.). Altitude is a major factor influencing this diversity. It was suggested that with increasing altitude this diversity narrows and more simple MFS are found. Aspect(direction of slope), slope and soil type are other important components of this diversity.

c) **Community-linked production:** MFS, particularly those with grazing or agro-forestry components, imply community issues(allocation of

resources, cooperative production), distinct from individual issues involved in private production in MFS. Community organization in MFS may be weakening as rural-urban links are made.

d) **Information Limitation:** MFS have little documented information available both within a country and between regions. Language considerations limit access to some national information (Spanish, Chinese). The high mountain farming systems are particularly lacking in documented studies.

e) **Low Political Priority:** MFS due to their remoteness and complexity, are usually accorded the lowest priority for research and development activities in most national strategies, after those of lowland rainfed and irrigated production systems.

f) **Dynamic Evolution:** MFS are changing to meet new physical and cultural influences. Some influences(out-migration, erosion) are of critical concern in the consideration of the future of MFS. Other changes (shifts in production patterns - potatoes for buckwheat in Bhutan) reflect the positive dynamic adjustment of MFS to these influences.

Recommendations on Mountain Farming Systems

In view of the issues and characteristics indicated above, greater emphasis is needed on systems research of MFS. Additional support to national programmes in conducting research on the biological and physical components of MFS is suggested.

The implication is that governments, donors, and researchers must consider longer-term support and commitment to research and development activities in MFS. Major advances in research or development of lowland agricultural systems occurred only after the cumulative effort of many years of research and development support. The above characteristics of Mountain Farming Systems must be carefully considered if improved mountain farming systems are to be developed for greater productivity and stability.

2) *Components of Mountain Cropping Systems*

a) A holistic approach to research in mountain areas is clearly essential in view of the extreme complexity of the issues involved. Nevertheless, it was decided to concentrate the discussion on cropping systems and the components of cropping systems, in order to arrive at some specific recommendations in line with the overall theme of the meeting, i.e., the exchange of information and germplasm between different mountain regions. This is also consistent with the fact that this meeting is the first of a series to be

hosted by ICIMOD to look at different aspects of mountain agricultural systems, leading to a symposium in 1988 in which these various aspects will be integrated.

b) The value of the exchange of information between various countries and mountain complexes was stressed. Such information exchange could include, but would not be limited to, topics such as training, land preparation and cultivation techniques, irrigation and drainage techniques, rotation and appropriate tools.

c) In view of the increasing importance of potatoes in many areas, this crop should receive some priority in the future exchange of germplasm and information between various regions. Knowledge about traditional potato and bitter potato cultivation and post-production techniques of the Andes, for example, could prove very valuable in the Himalayas. Ways should be sought to strengthen the interaction between these regions, and also others where potato cultivation is important. CIP, which is already active in germplasm and information exchange, is probably best placed to continue to coordinate these activities. However, extra donor and other assistance may be required in order to focus more attention on traditional high mountain systems of cultivation.

The prominence given to potatoes in the discussion does not imply that other crops were considered of secondary importance, but rather that there was insufficient time to consider all the species and that, in any case, this topic would be addressed by Discussion Group B.

d) It is often difficult to conduct conventional agronomy and yield trials in mountain environments. More work should be done on developing and/or disseminating information about alternative experimental designs appropriate to mountain conditions.

Recommendation for Information Exchange

1) It was recommended that consideration be given by ICIMOD to producing a regular newsletter to facilitate information exchange on mountain agricultural systems covering all major mountain complexes in the world. This would be an informal 'newsletter' rather than an international scientific journal. The utility of such a newsletter would be greatly enhanced if it were to be produced in both English and Spanish.

2) A large data base on Andean agriculture is being developed in Peru and this information is available to researchers worldwide. Similar data bases should be developed for other mountain complexes.

3) Exchange visits of scientists between different mountainous regions is

a very effective way of exchanging information and knowledge. ICIMOD and donor agencies should consider ways of encouraging and supporting such scientific exchanges.

b) **Discussion Of Group B On Mountain Crop Genetic Resources**

1. It was recognized that exchange of mountain crop germplasm is needed in order to develop more stable, sustainable and productive mountain agricultural systems and to improve the conditions of those who depend on agriculture in mountainous regions. Information on the crops themselves, where they are adapted, how they are used, is an important component of such exchanges.

2. A table was developed containing lists of mountain crop species which could be exchanged between regions or countries. This table, shown below, is to serve as a guide to facilitating the bilateral exchange of mountain crop germplasm.

3. It was recommended that each country provide a brief description for each of the crops that can be exchanged. The description is to include:

   - Altitude range, aspect and slope where the crop is grown.
   - Average rainfall.
   - Soil pH.
   - Cropping Systems.
   - Yields.
   - Dates planted and harvested.
   - Special traits.
   - Uses.
   - A line drawing of the crop.

   The address of the scientists and institutions that can provide the germplasm for each crop and a short description of the procedure required to exchange germplasm should be provided from each country.

   It was recommended that ICIMOD compile these descriptions into a booklet for distribution.

4. In many countries, government regulations or policies make exchange difficult. It was recommended that participants draft a strong letter to their respective governments, reflecting the consensus at this meeting that increased exchange between different mountain regions in the world is necessary to develop improved agricultural systems.

5. The following types of exchanges were recommended:

   a) Direct exchange of mountain germplasm material. This should start immediately with country-to-country exchange of true seeds.

   b) Exchange of small groups of scientists.

   c) Multi-disciplinary expeditions of 5-7 members, including farmers from different Andean countries, to different countries in the Himalayas, and vice versa. Organizations such as ICIMOD, IBPGR, IDRC and national governments should be involved in facilitating these exchanges. Such expeditions could lead to much greater understanding about how mountain crops can best fit into new environments.

6. Roots, tubers and perennial crops require tissue culture methods for exchange and conservation. Suitable methods of tissue culture should be worked out for these crops.

7. There is need to match up similar environments in different regions in order to increase the probability of successful introduction. Several methods of describing and classifying environments should be examined, including climatological and geographic descriptors and uses of indicator crops in classifying environment. The local uses of the crops to be exchanged is an important factor in understanding the cultural environment.

8. Participating countries should exchange highly variable land races rather than genetically homogenous lines. This will improve the chances of adaptation and help to promote more stable production.

9. National institutions have the primary responsibility for collecting, storing and improving many of the mountain crops.

   a) Stress should be laid on improving the national capability for storing germplasm of these crops.

   b) Collection of many mountain crop species is needed urgently to conserve the valuable genetic diversity which is being lost in many cases.

10. International Agricultural Research Centres have a role to play in collecting, documenting, conserving and exchanging those mountain crops for which they have a mandate. National scientists should make use of the resources of these international centres.

11. In the exchange of crop material, suitable quarantine regulations must be observed to prevent the spread of pests, diseases or nematodes.

12. Improved communications and information in mountain regions is an important agent in the evolution of mountain agricultural systems from subsistence towards cash crops. The crops being exchanged or improved must reflect the present and expected evolution of these systems.

13. The use of computers as a valuable tool for documenting genetic resources and classifying environments is encouraged.

14. It was recognized that ICIMOD has a central role to play in collecting and disseminating information, and in facilitating the exchange of people between mountain regions.

CROP EXCHANGE TABLE

	Andes		Hindu Kush -Himalaya		Africa	
TYPE	Native crops to be sent out	New crops for introduction	Native crops to be sent out	New crops to be introduced	Native crops to be sent out	New crops to be introduced
Creal/Grains	Amaranthus spp.LR Chenopodium LR (Quino, Kanawa)	Amaranthus spp.LR Chenopodium spp.LR Eragrastis tef Hordium spp.PE Fagopyrum spp.	Amaranthus NP,IN Hordium spp.LR,NP,IN Fagopyrum,NP,PA,IN Eleusine spp.LR,NP Panicum LR,NP,IN Triticum spp.LR,PA,IN Zea mays spp.PA,IN Oryza Sativa spp.PA,IN	Amaranthus NP,IN,AF Hordium spp. LR,CH,IN Triticum spp. LR,IN Zea mays spp. IN High Alt. disease res. Res. Oryza Sativa PA,IN Fine rice PA	Eragrostis tef Hordium spp. LR Triticum spp. Oats	Amaranthus Chenopodium quinoa Fagopyrum spp. LR
Tubers/Roots	Arracacia spp.LR Oxalis tuberosa Tropaeolum tuberosum Ullucus tuberosus Polymnia sonchifolia Lepidium meyenii Solanum,(bitter hi.al.)		Colocasia spp. LR,IN	Oxalis tuberosa LR,NP,CH Solanum bitter potato CH,NP Ullucus tuberosus NP,CH Lepidium meyenii NP,CH Pollymnia sanchifolia NP	Coleus adulis Coccinia abyssinica	
Legumes, Pulses, Oilseeds	Lupinusmutabilus Vicia faba	Disease resistant Lens culinaris Brassica spp.	Vicia faba PA Lans culinaris IN,NP Brassica spp IN, CH Horsegram-Dolychis Biflorus NP Blackgram Phaseolus mungo NP Glysine Max NP Cannabis spp. IN Agropyrum CH	Brassia spp. IN,CH Campestris CH Nepis CH Cicer spp. PA Phaseolus calcaratus IN Blackgram NP Pisum sativum Var aravensepeir NP	Vicia faba Lathyrus sativa Lupinus albas Cicar spp. Guizotia abyssin (Niger) Trifolium	Brassica spp. Perilla fruitescins Lihum sp. Madhuca butyracea Oil crops requested !
Fodder trees	?	Request from NP	(?)Brassiopsis glomerata NP		Numreous available from ILCOT	
Fruits	Carica spp. Cyphomandra spp. Prunus Calpuli Opuntia Passiflora spp.	Vegetables dis.res.	Apricot,Peach, Apple Walnut, Pear PA	Appricot res. fruitfly, PA Apple, Cashew PA Walnuts, Pecannuts IN Sunflower res. PA		
Medicinal Plants	+	Cardamon	Medicinal Plants NP	Medicinal Plants IN Tea, Olive 2000m PA		

Legend to Crop Exchange Table

1. In most cases it is stated that well known crops requested such as, maize, wheat, rice, refer to high altitude cold resistant and/or disease resistant crops or land races.

2. Spp = any number of species LR = various land races NP = Nepal IN = India PA = Pakistan CH = China AF = Africa(East African highlands).