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Passive Solar Greenhouse in Ladakh:
A Path to Income Generation and Livelihood Improvement

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About the organisations

The Renewable Energy and Environment Group (GERES) is a French NGO created in 1976. GERES works in a dozen countries in Asia and Africa promoting renewable energy resources and energy efficiency through a development process controlled by the local people. GERES encourages the use of local resources with the aim of respecting the environment and providing well-balanced development schemes.

GERES has been working for more than twenty years for the benefit of local development in the Hindu Kush-Himalayas (HKH), with a focus on promoting well-adapted and eco-friendly technologies to enable local communities to access modern services while preserving the fragile environment of the Hindu Kush-Himalayan region.

The main field activities are concerned with energy saving (passive solar buildings, improved stoves and income generation (solar greenhouses, solar poultry farming, ecotourism, food and wool processing).

GERES' first project in the Hindu Kush-Himalayas was set up in 1984 in Ladakh (India). At present, GERES supports local NGOs in India, Nepal, China and Afghanistan in various activities.

GERES focuses on privileged partnerships with various government and non-government organisations and the participation of the local population.

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Ladakh Environment and Health Organisation (LEHO) has been working since 1991 on ecological agriculture, passive solar houses construction, handicrafts (*pashmina*), health and environment. In partnership with GERES, LEHO has developed the improved greenhouse design that is now being promoted by the project, and shares its experience on that field with the other NGOs of the network. It is working on the greenhouse project in Leh belt, Markha valley and Sham area.

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ECOSPHERE

LEHO
Ladakh Health and Environment Organisation

LEDeG
Ladakh Ecological and Development Group

LNP
Leh Nutrition Project

MUSE

SKARCHEN
Society for Knowledge and Responsibilities of Culture, Health, Education and Nature

STAG
Spiti Transhimalayan Action Group

Summary

The issues of food security and nutrition are at the very core of sustainable mountain development, and yet they tend not to be given due consideration. Socially and economically marginalised, mountain people are more vulnerable to food shortages and chronic malnutrition due to a variety of factors, such as their isolation, the harshness of the climate to which they are exposed, and the difficulty to grow nutritious crops on a difficult terrain.

In this regard, the implementation of the passive solar greenhouse project offers a valuable experience as to the possibilities of supporting small-scale farmers living in cold arid regions improve their livelihood. The greenhouses, heated entirely by sunlight to keep the inner temperature high enough to grow vegetables even when outside temperatures drop to -25°C, support the development of seasonal and off-seasonal vegetable production (crops such as spinach, coriander, onions or garlic) that improves: (i) the dietary intake of populations living in remote areas; and (ii) the access of vulnerable farming communities to an increased amount of basic services through income generation. Simple to build, using cheap locally sourced material and labour, each greenhouse constitutes a relatively minimal investment, to which the owner contributes the largest part, mostly in kind.

Based on reinforcement of local capacities, technology transfer, R&D and a network of local NGOs, the methodology has taken into account a great variety of contexts thanks to a flexible approach of the implementation phase. This flexibility, and capacity of adaptation, ultimately proved to be key factors in the project's overall success.

Thanks to its sustainability, its reliance on local resources (both human and natural), and its positive environmental impact in the longer term (through the reduction of vegetables imports by air or truck), this project has been awarded at the 2009 Ashden Awards.

Key Words
Food security – Malnutrition – Passive solar energy – Solar greenhouse – Protected agriculture – Cold arid region – Ladakh – GERES India – Ashden Awards 2009

Socially and economically marginalised, mountain people are more vulnerable to food shortages and chronic malnutrition.

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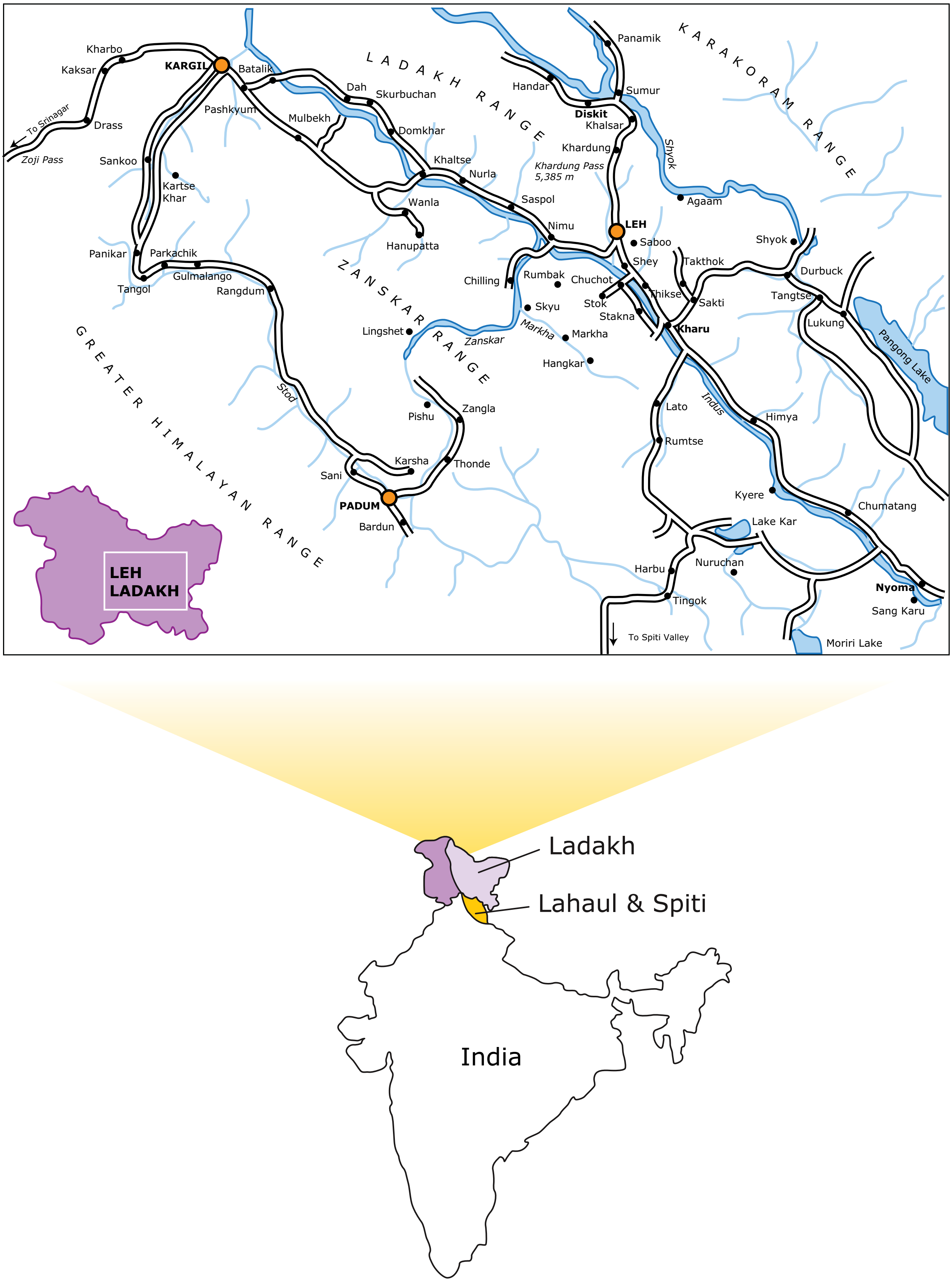
ACRONYMS AND ABBREVIATIONS

CIGH	Commercial Improved Greenhouse
CoP	Community of Practice
GERES	Groupe Energies Renouvelables Environnement et Solidarité
GGH	Government Greenhouse
GH	Greenhouse
HKH	Hindu Kush-Himalayas
IGA	Income-Generating Activities
IGH	Improved Greenhouse / Passive Solar Greenhouse
LAHDC	Ladakh Autonomous Hill Development Council
LEDeG	Ladakh Ecological Development Group
LEHO	Ladakh Environment and Health Organization
LIGHT	Learning Income Generation in Himalaya Together
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
NGO	Non-Governmental Organisation
R&D	Research and Development
RP	Resource-Person
STAG	Spiti Transhimalayan Action Group

Currency
1€ = 65 INR

Map of the project area



Source: Compare Infobase Pvt. Ltd.

Introduction

Food security and nutrition are nowadays core issues in sustainable mountain development but paradoxically they are often not given due attention. Socially and economically marginalised, mountain people are more vulnerable to food shortages and chronic malnutrition due to their isolated, inaccessible and remote location.

Regarding the situation, the passive solar improved greenhouse (IGH) offers one possible answer, if built efficiently, particularly in cold mountainous arid regions where concerns about food security are even greater.

A passive solar greenhouse is a greenhouse heated entirely by sunlight, the temperature inside the greenhouse kept high enough to grow vegetables throughout the year, even in winter. The main benefits of solar greenhouse are:

- off season vegetable production (particularly during winter);
- fulfilment of basic subsistence needs in remote areas; and
- income generation in peri-urban areas.

The LIGHT project: 2005-2009

The "Learning Income Generation in Himalaya Together" (LIGHT) project has been financed by the European Commission, and co-funded by Fondation Ensemble and the Lord Michelham of Hellingly Foundation. The project's duration is four years; it started in April 2005.

The project objectives:

Overall objective:
Improvement of the livelihood of the rural populations

Specific objectives:
1. To assist rural populations in developing additional income generation activities in order to earn financial resources for accessing basic services;
2. To empower rural women by increasing their self-confidence and financial independence;
3. To build the capacities of local NGOs, so that they can manage development projects and implement and monitor income generation activities; and
4. To improve health by enabling the communities to produce balanced food (vegetables, eggs, etc.) during the six months of harsh winter.

The project had six components; three of them targeting individual promoters:
- Dissemination of passive solar greenhouses;
- Development of passive solar lambing sheds to improve the life expectancy of animals during the harsh winter; and
- Development of passive solar poultry farms.

Three activities target community-based groups, either based on Self-Help Groups (SHG) or village communities for the set-up of:
- Food Processing (SHG);
- Wool Transformation (SHG); and
- Micro Hydro Power Unit (based on village communities).

The project has been implemented by two European NGOs, i.e. Groupe Energies Renouvelables, Environnement et Solidarités (GERES) and Bremen Overseas Research and Development Association (BORDA). BORDA has been specifically responsible for the rural electrification component. Both organisations have been relying on a network of local NGOs to carry out project activities:

- LEDeG (Leh, Kargil)
- LEHO (Leh, resource NGO on IGH component)
- LNP (Leh)
- SKARCHEN (Leh)
- STAG/Ecosphere (Lahaul & Spiti)

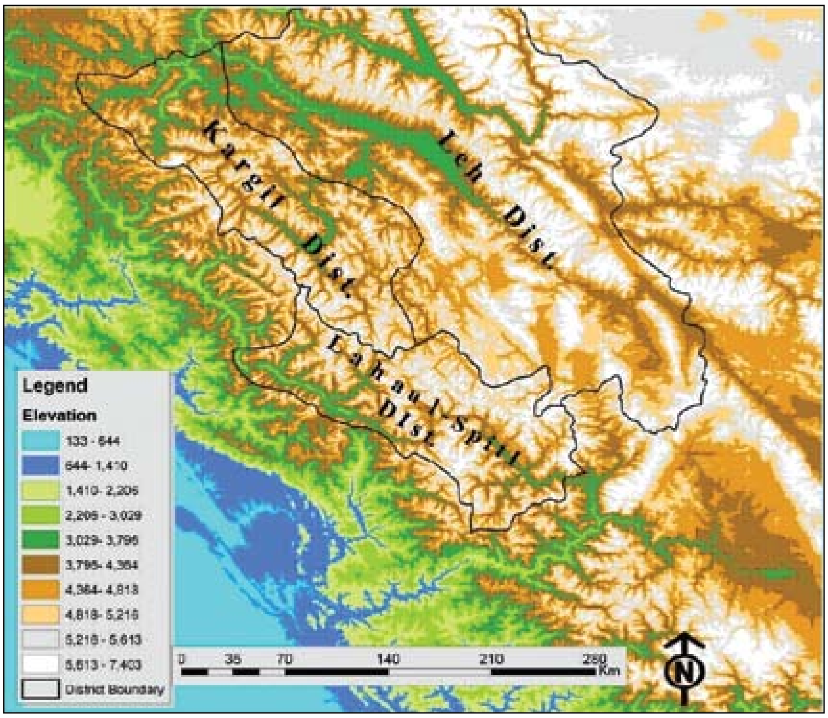
The present case study looks at the results obtained by the passive solar Improved Greenhouse (IGH) component and focuses in particular on the following issues:

- Provide in-depth analysis and assessment of the project relevance, effectiveness in achieving the results and overall impact; and
- Consolidate and enhance the knowledge by learning from the experience to date, especially by identifying emerging key issues, strengths and weaknesses of the project.

I Context

1.1 Geographical context

Situated remotely in the Himalayan hills of the Indian states of Jammu & Kashmir and Himachal Pradesh, the project area (Leh, Kargil, Lahaul and Spiti districts) lies at more than 3,000m above sea level and shares its borders with both Pakistan and China which makes it a politically sensitive area.



The project covers an area of about 73,000 sq. km, which roughly corresponds to the area of the Republic of Ireland. The region has a cold and dry climate, and the landscape is mainly composed of rocky-mountains with little or no vegetation. Agriculture is limited to places where there is some source of water either along streams or natural springs.

During the harsh and long winter, temperatures frequently fall below -25°C whereas summer season experiences temperatures reaching 30-35°C. During winter, Ladakh is only accessible by air (to Leh airport) and some areas are totally cut off from the rest of the world for more than six months per year, access to passes being closed by heavy snowfalls (Zangskar, Keylong valleys). Telephones, which have recently been installed, remain the only way to communicate with Leh when electricity is available.

Travelling through these mountainous areas takes time. In summer, the trip from Leh to the main city of Zangskar, Padum, takes 2 days; the trip from Leh to Kargil takes 1 day with good weather conditions (*see map on page 8*).

Difficult conditions:

- Cold and arid climate with low precipitation (100mm) and fertility index;
- Road connectivity and communication are poor although important public investments have been made to improve the situation in recent decades.
- Ladakh has the lowest population density in India (3,5 per sq. km), about 260,000 inhabitants are scattered over 40,395 per sq. km (2001 Census).
- Villages are small with populations that rarely count more than a few hundred persons and are spread out along different valleys which intensify isolation and connectivity problems between villages and even hamlets.

1.2 Economical conditions

Ladakhis have developed a small-scale farming system adapted to this unique and extreme environment. Traditionally, families rely essentially on subsistence agriculture based on barley and wheat that constitute the main crops as well as on rearing of livestock such as yaks, *dzos*[1], cows, sheep and goats. Families are usually self-subsistent, each household producing its own cereals, fodder, vegetables, butter, milk, and handicrafts. During the short summer season, the main activities are agricultural work and dung collection for winter heating whereas few activities are undergone during winter due to the harsh conditions.

However, since the 50s, the population has been steadily growing as the region has been experiencing several "immigration" waves (Tibetan refugees, army settlements, civil servants, employees of the third sector, tourists and seasonal workers).

All those new actors have participated in changing the local economy from subsistence agriculture to a market economy particularly around the district capitals (Leh, Kargil and Keylong). With important government employment opportunities, a strong presence of the army, and the development of the tourism industry (guesthouses, hotels, travel agencies, souvenir shops, etc), the off-farm activities have increased, contributing to the development of a system based on a market economy.

The army provides rather high employment opportunities, especially in remote areas where a significant percentage of the youth is currently enrolled in the army.

The availability of government and army jobs, new infrastructure and the tourism industry has accelerated the migration from farm labour towards a market economy to a certain extent and has encouraged

[1] *A dzo is a hybrid of a yak and domestic cattle.*

migration from the villages to the main economic centres, agricultural work being less profitable.

Although tourism accounts for 50% of the current region's GNP, tourism activity employs only 4% of Ladakh's working population. Most of the Ladakhis have not benefited from the expansion of tourism and rely still on subsistence agriculture and livestock rearing.

Poor rural communities

- Amongst the 260,000 inhabitants of Ladakh, 85% live in rural areas and depend solely on subsistence agriculture and livestock rearing;
- 80% of the population is under the poverty line (less than 0.7€ per day and per capita).

1.3 Vulnerability

The project area is composed of a patchwork of several communities and different religions: in Spiti and Zangskar a Buddhist majority is found whereas Kargil is mainly composed of Shia Muslims. Some Hindus are settled in Lahaul and an important Sunni community lives in Leh and its surroundings. The region is experiencing high cultural erosion with a rapid transformation of social values, local institutions and traditional practices. As a result, traditional institutions (e.g, the *Goba* system) are getting weaker, undermined by a loss of capabilities and organizational strengths, partly due to the replacement of traditional authorities by the Indian decentralized government representatives.

Traditional safety nets are getting weaker while the market economy concepts remain an unknown territory for most people. Most deprived people that essentially rely on subsistence agriculture and unskilled labour are dropped out of the economic development. As the traditional links such as barter and solidarity mechanisms are becoming less and less strong, alternative solutions have to be developed.

With the growing influence of Indian cultural values, the role of Ladakhi women within the society has changed from a matriarchal organization to a society driven by men. Whereas women were often considered as very active, they are much less involved in rural enterprise projects than men, often because of the resistance of men to see women participating in such projects.

Women have increasingly taken over the burden of agriculture work while men earn cash from non-farming activities.

1.4 A mixed agricultural system

At altitudes of 3,000 to 4,300m, the growing season is only a few months long every year, from May to September, and agriculture is limited to places where there is some source of water. The region receives an average precipitation of 100mm per year and has a low fertility index. 98% of the cultivations are irrigated by a system of channels that ensures an optimum use of water coming down from the glaciers.

Agricultural production remains mainly in the hands of small-land-owners who work their own piece of land. The traditional crops are barley and wheat.

The average land surface per household is rather low, often less than one acre. On average, a land surface of 5-7 Kanals[2] (equivalent to 0,6 to 0,9 acre) is under grain cultivation and ensures self-sufficiency for 7 to 10 family members for a year long. Income generated by the production of traditional crops is rather low, around 3,500 Rs per kanal under cultivation.

Moreover, income from agricultural production vary greatly from one village to another mainly because of the agro-ecological zone and the socioeconomic context of each area (plot size, soil quality, access to market, competition, etc). Level of crops also depends on the seasonality, which makes people even more vulnerable.

For instance, in Saspol village, land productivity is rather high compared to other places because of very good climatic conditions whereas Gya village, located at higher altitude, has less fertile land. In Kargil, the income is lower because of a fragmented landholding system due to a specific socio-cultural context.

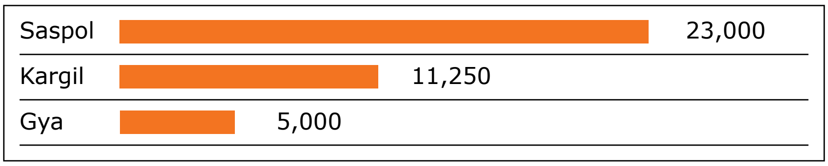
A great variety of agro-ecological zones

The average LGP (Length of Growing Period) for the area is 90 days but it encompasses a great variety of agro-ecological zones: the agricultural production is generally limited to one crop per year but in the lower Sham region, which is warmer than Leh, two crops are ensured. Conversely, on the high plateaus of Changtang and for any villages lying at more than 4,000m even basic crops such as wheat and barley cannot be grown because of extremely harsh climatic conditions and a very low fertility index. The inhabitants who are mainly pastoralist nomads rely on livestock rearing and bartering.

[2] *One acre equals 8 kanals.*

However, the agricultural sector is undergoing a transition towards a mix of cash crops and traditional cultivations. The production of potatoes, peas, radish, cabbage, turnips, carrots, coriander or spinach has a steadily growing place along with traditional crops such as barley, mustard or wheat that ensure the family supply in flour, oil and fodder. But more than 80% of the land still remains devoted to traditional crops while less than 20% is dedicated to cash crops.

Household annual income from agriculture (in Rs)



Source: GERES, Judith Bel, Household Survey, 2005

1.5 Food security: a growing concern

Household food security exists when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life[3]. Mountain communities often suffer from malnutrition[4] and micro nutrient deficiency[5]. They can often only access an imbalanced food intake that usually lack of essential vitamins and minerals.

The small-scale agriculture is not sufficient to cover the needs of Leh, Kargil, Keylong and the neighboring block capitals; thus, during summer most of fresh vegetables are imported by truck from the Indian plains.

But from November on to May, the two main access roads (from Manali and Srinagar) are closed and the capital city, Leh, is the only place to get fresh supplies, sent by air. Villages benefiting from a small economic centre (such as Nyoma) can have access to basic commodities, fresh vegetables being rarely available.
Market prices are tripled compared to summer prices and few products are available.

During this period, most of the families do not have access to fresh vegetables, either because they live in remote areas or because the prices are too high, which makes them more vulnerable to disease and prevents them from having a balanced and nutritious diet.

[3] World Food Summit, 1996.
[4] Physiological condition resulting from inadequacy or imbalance in food intake or from poor absorption of food consumed, ESNP, FAO, 2002.
[5] Lack of essential vitamins and minerals resulting from unbalanced food intake and specific problems of absorption of food consumed, ESNP, FAO, 2002.

Since the 70s, with the rapid increase in population, and the development of tourism —between 20,000 and 30,000 visitors per year— food supply is becoming an even more sensitive issue.

Since the early 90s due to high demand from army camps (± 700,000 Kg) and tourism (± 500,000 Kg), and secondly from a steadily increasing Ladakhi population, demand of vegetables has considerably increased.

Access to a balanced and nutritious diet

Some places such as Sapi in Zanskar or Keylong in Lahaul are totally isolated during the long winter. They can only rely on the crops they have stocked during summer mainly constituted of grains and dry vegetables that merely cover the daily dietary energy requirements in terms of vitamins and minerals. Fresh vegetables are non-existent for more than half of the year.

Challenges

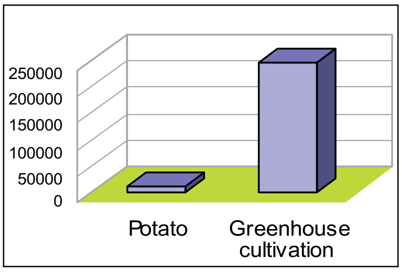
- How to optimally use the scarce natural resources available?
- How to improve people's diet during winter so as to have a better health condition?
- How to involve small farmers currently dropped out from the transition to market economy?
- Overall, how to alleviate poverty, ensure access to basic services, reduce vulnerability and improve food security in remote areas?

II Initiating the project: a learning process

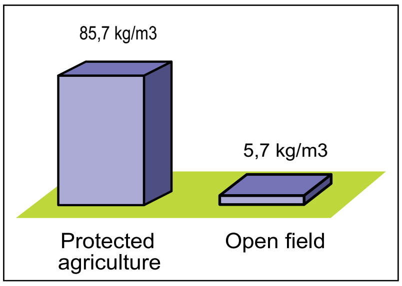
2.1 Activity rationale

In Ladakh, as the landholding per capita is low, arable land limited, water scarce, cultivation season short and climatic conditions harsh, optimisation of land use is crucial. Open field cultivation is the prevalent agricultural system and is far less profitable than cropping systems under greenhouse. They are limited in the season, constrained by weather, and less productive. Protected agriculture offers an intensive and dynamic form of crop production in which both the environment and timing of production can be controlled and yields can be substantially improved. In addition, IGH allows a much better optimization of water and land use, with greater enhancement of local livelihoods.

Gross added value/kanal (in Rs)



Productivity of 1m^3 of water



Source: GERES, Judith Bel, 2006

Required conditions to implement an IGH

- A substantial amount of sunshine throughout the year and high solar radiation to ensure an optimal use of the passive solar technology;
- High demand for fresh vegetables especially during winter; and
- Motivated farmers having basic agronomy skills.

The IGH technology is suitable for being used on degraded and water-deficient areas or other non-productive lands. If simple structures are used, the technology is both affordable and sustainable. Thus, by opting for a holistic approach and taking into account socioeconomic, environmental and cultural factors, the IGH supports the vulnerable farming communities to improve their livelihoods.

2.2. The introduction of greenhouse in Ladakh

Greenhouse technology was introduced in Ladakh during the 80s, resulting from a close cooperation between local and international NGOs, among them GERES and LEDeG, that had already started intensive research activities on different designs at that time mainly made of glass.

During the 90s, a new model was developed by the government: replacing the glass by a polythene sheet. More than 15,000 greenhouses have been constructed all over the region. Nevertheless, the Government's greenhouse design (GGH) did not allow vegetable production during winter time when temperatures frequently fall under -20°C.

Government greenhouse scheme limitations

- 15,000 greenhouses planned and financed but, after ten years, only 10% are still in use;
- Remote blocks (Zangskar and Spiti) are not covered by the scheme;
- Design not adapted to winter production (simple walls, no roof) and summer production (absence of a ventilation system);
- Pest management system overlooked;
- Promoters not trained on agro-techniques and maintenance;
- Subsidy given in cash (except for the polythene sheet) and based on equality principle (1 house = 1 greenhouse regardless of income); and
- Absence of construction follow-ups.

2.3 Launching the pilot project

In 1998 a pilot project was launched by GERES and a Ladakhi NGO, LEHO, to develop and implement an innovative design of greenhouse allowing farmers to grow vegetables in peak winter.
The pilot had three phases:

1. R&D in partnership with a locally based research institute, the SKUAST and preliminary tests with four farmers;
2. Launching the pilot with the participation of 45 voluntary farmers; and
3. Evaluation of the results to identify the most appropriate target group.

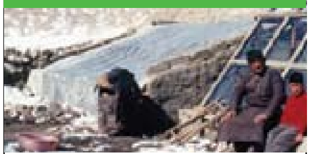
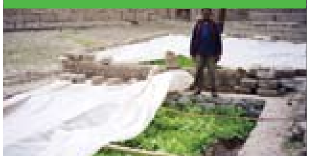
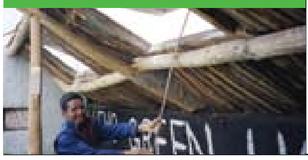
The following points were carefully studied:

• Technical specifications of the greenhouse (type of material available, type of walls, polythene sheet, skills required, etc.)
• Running aspects (type of crops, use of the greenhouse, agro-techniques & working time required, etc.)
• Socioeconomic approach (greenhouse size, market potential, habit of grow & sell vegetables, competition, land & credit access, etc.)
• Financial studies (farmers' investment capacity, running and maintenance cost, benefits, payback period, etc.)

To gather the information required, the following activities were undertaken:

• Construction of fifty demonstration IGHs and monitoring of the results depending on the agro-ecological zone and the socioeconomic context (inner temperatures, production level, crop type, etc.);
• Monitoring the results obtained by the different standard greenhouse designs (trench, tunnel, simple wall, etc.);
• Promotion of the results obtained to convince farmers; and
• R&D in crops, saving periods, pest control management.

Existing greenhouse designs in the project area

Design	Advantages	Disadvantages	Agro-ecological zones	Objectives
Tunnel 	Low cost	Not adapted for extreme weather, no ventilation, sensitive to pest	Areas below 2,500m	Vegetables and seedlings production after March
Government 3 simple walls 	Low cost	Low production in winter, no ventilation, sensitive to pest	Not adapted for peak winter temperatures in Ladakh	Vegetables and seedlings production after March
Trench 	Very cheap	Small area under cultivation	Areas below 4,000m	Self consumption, low production levels after March
Project improved design 	High productivity, ventilation system, resistant polythene sheet	Investment needed	Production all year round up to 4,500m	Self consumption and income generation (high productivity, seedlings production)

The improved greenhouse design optimizes the use of water and allows farmers to grow vegetables in peak winter.

2.4 IGH technical specifications

The IGH is a concept that combines an innovative technology with cheap locally sourced materials, and simple skills.

The IGH is based on the use of passive solar energy using simple and locally available materials, for which construction, maintenance and costs constraints are limited. Spare parts, mainly polythene sheets, are available at rather low cost all year round in district capitals' markets.

This technology is based on 5 concepts: i) solar gain; ii) heat storage; iii) heat release; iv) efficient thermal mass; and v) natural ventilation.

The IGH is composed of three double-walls to ensure an efficient thermal mass, made of mud bricks or stones depending on the material locally available. The UV resistant polythene sheet[6] is south oriented in order to accumulate as much solar radiation as possible during the day and the roof slope – 35° – has been calculated in order to optimise the solar radiation gain in winter.

The north and east oriented double-walls – painted black – will store an important amount of heat during the day that will be released throughout the night, preventing vegetables from freezing even with an outside temperature falls below -25°C. During winter, a cover applied on top of the greenhouse during the night reduces heat-loss through the polythene sheet.

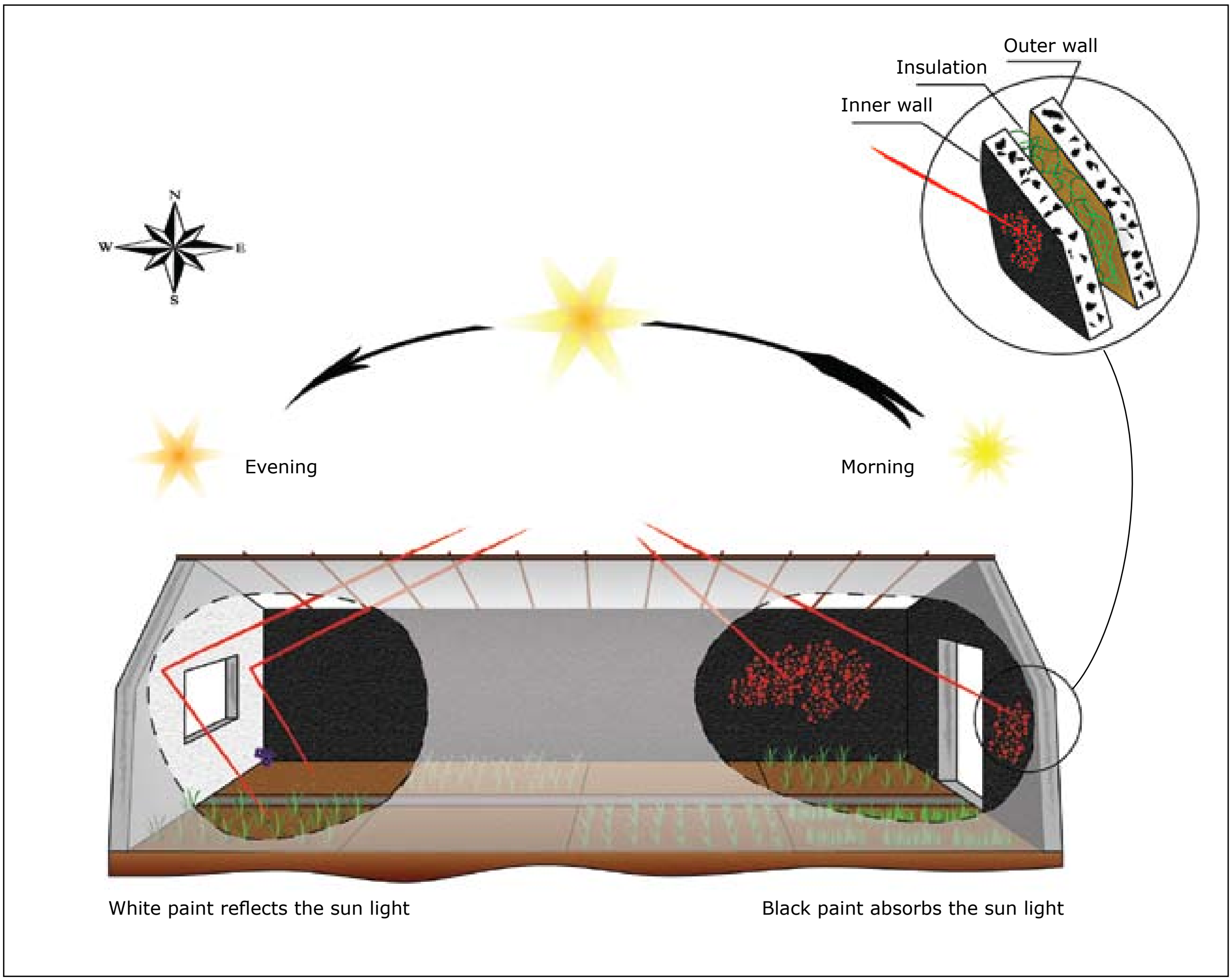
To avoid overheating and to regulate humidity inside the IGH, an air circulation system has been set-up with two roof windows, a door and a window in the west-oriented wall.

The construction materials are cheap and locally sourced, often provided by the farmer. It consists of mud brick or stones, sand and beams.

The construction requires very simple mason work. No more than a two-day training is necessary.

[6] *The "silpaulin" polythene sheet used is Ultra Violet Stabilized and is out-sourced from Mumbai. The use of this type of polythene is recommended to withstand the strong UV radiations that exist at high altitudes. UV stabilized polythene sheet has an average lifespan of 5 years compared to a 1 or 2 years lifespan for standard polythene sheet.*

Passive solar improved greenhouse design



The structure requires basic maintenance such as polythene sheet replacement, wall plastering and painting every four or five years[7].

The whole structure has a global lifespan of more than 10 years:

- Wall structure: 20 years;
- Roof: 10 years;
- Windows, doors and ventilator: 5 years;
- UV polythene sheet: 5 years; and
- Wall plaster: 4 years.

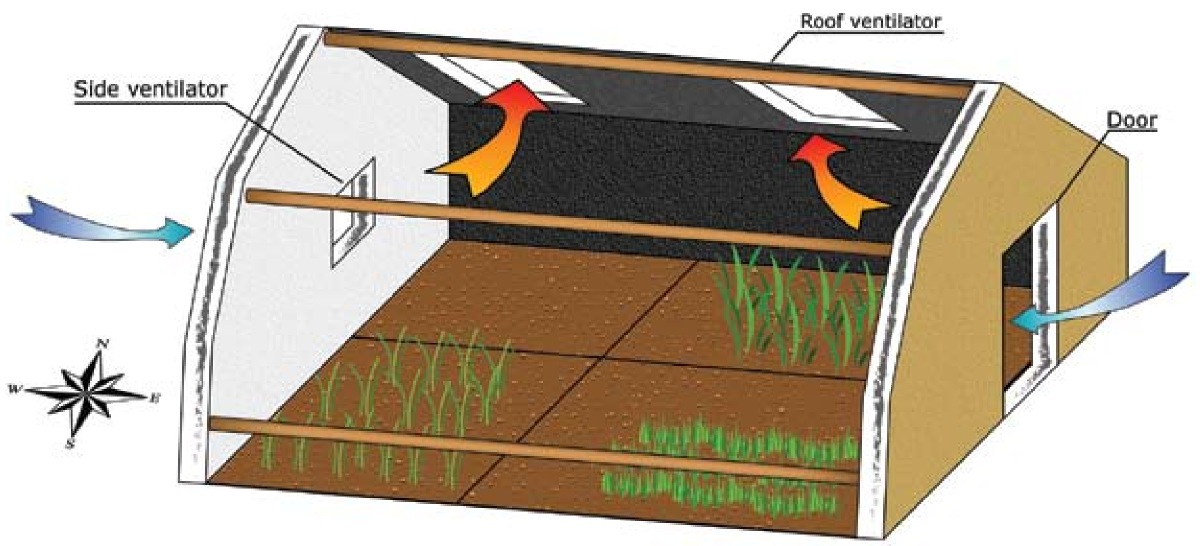
[7] *For more details: Vincent Stauffer et al.,* Solar Greenhouses For The Trans-Himalayas, A Construction Manual*, GERES, 2009*

Main technical advantages

The key points for IGH technology success are:

- Energy-efficient as the structure sustains itself by picking-up and storing solar radiation and does not need extra heating during winter;
- Affordable and sustainable in the long-run;
- Based on material locally sourced;
- Simple to build; and
- Easy to maintain.

Improved greenhouse ventilation system



2.5. The running aspects

Running an IGH requires very simple skills in agronomy and ventilation that can be taught in a few days training for a production possible all year round. A longer training might be required if the selected people do not have the habit to grow vegetables in open fields.
One person can easily manage the workload, estimated to an hour per day.

A compost pit composed of the most suitable and available mix of organic waste is also built for each IGH in order to maintain the soil fertility inside the greenhouse and to subsequently maintain high yields.

On the whole, the IGH offers a large range of uses depending on the objectives and workload of the farmer, the climatic constraints and the economic conditions.

1) Peak winter vegetable production
The IGH design allows leafy vegetables production such as chard or spinach during the coldest months of winter. This type of vegetable has been selected as it provides regular income (it can be harvested every two weeks) and is resistant to cold up to -5°C.

Advantages/Constraints: High market prices, absence of competition, improvement of food security and nutrition. But a close access to water is necessary.

2) Seedling production in spring
As the LGP (Length of Growing Period) is very short, production of seedlings (cabbage, tomato, onion, cauliflower) inside the IGH, transplanted during the month of May, allows cultivation of vegetables that would not be possible without IGH.

Advantages/Constraints: Higher productivity and production levels of open field crops that significantly enhance income.

A tool easy to run

- Simple to use , only basic agronomic skills and a training on ventilation required.
- Regular income all year round.
- Not time-consuming.

3) Summer production of exotic varieties
Thanks to a good ventilation system, summer crops that require lots of heat can be grown under the greenhouse even with high temperatures (chilli, cucumber, eggplant).
Exotic varieties such as strawberry also represent interesting cash crops.

Advantages/Constraints: high competition with imported crops but highly profitable cash crop, but access to market is required.

4) Extension of the summer season
By using the IGH, the growing season can be extended to allow longer production of vegetables.
Vegetables such as tomato can be grown in the IGH without polythene sheet during summer, and then can be covered from the last week of September.

Advantages/Constraints: High competition with imported vegetables from Indian plains, low market prices.

2.6 The socioeconomic approach

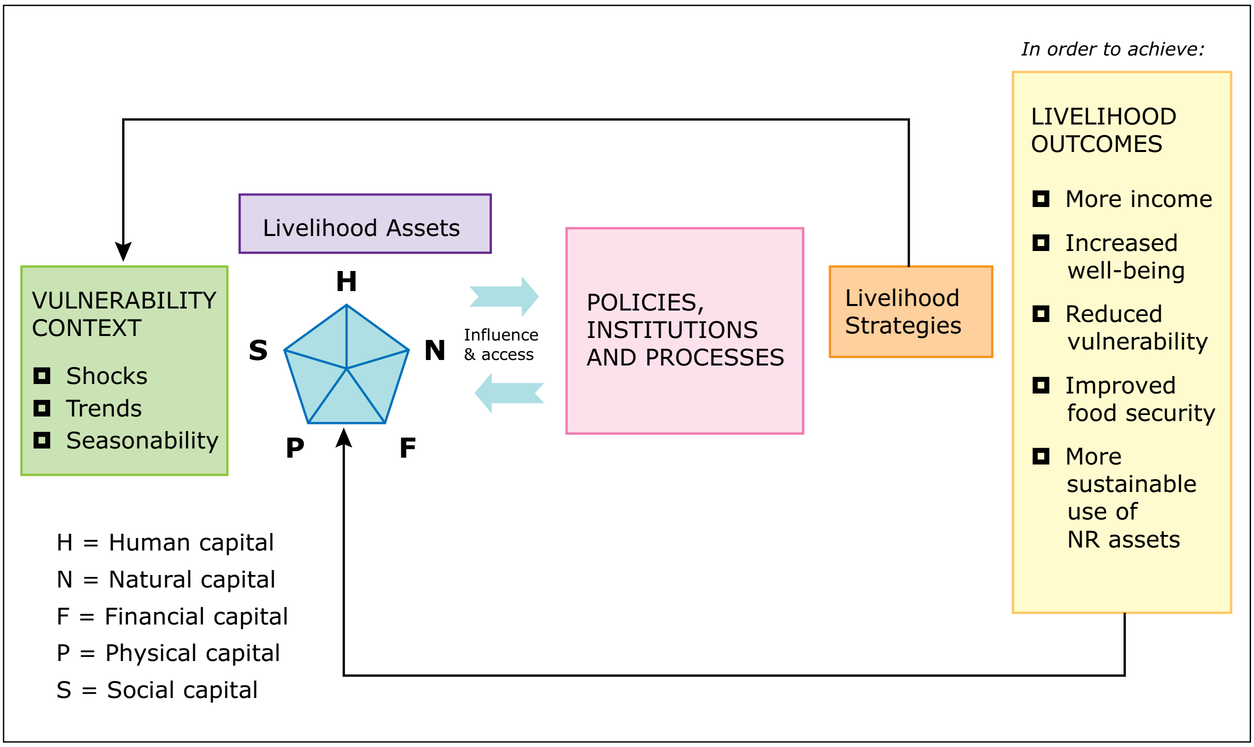
The study of the socioeconomic context is necessary to develop an appropriate methodology for diffusion of the design on a larger scale.
It is even more relevant in the context of Ladakh where a high diversity is found from one valley to another in terms of culture, religion, social organization, agro-ecological zone, access to market and land, habits in growing and selling vegetables and investment capacity of farmers.

The study of beneficiaries' capital and social assets; the link between the household and the community; existing public schemes and policies; their influence on the proposed activity and the vulnerability context such as agricultural price volatility, seasonality and competition are important criteria.

The IGH activity has been developed in order to improve poor people's livelihoods, to ensure complementary income along with better chances to achieve transition from subsistence agriculture to market economy. As market channels are short –without a middleman–, farmers and women's groups engaged in IGH are likely to reach autonomy much more easily. It is even easier if the selected people are already used to market open field crops. They already have access to market information such as prices, demand or competition.

The access to land and water is essential for the project success.
In Ladakh, most people have ac-

Analytical framework of livelihoods



Source: FAO: Working with local institutions to support livelihoods, 2003

cess to land, the issue being rather on the size. In average, the landholding is about one acre per household, but in some places such as Kargil, due to specific socioeconomic conditions, the average landholding is much smaller and oscillates around 0,5 acre. Usually, land is inherited, and the sale of any plot is rare.
Water access during winter as well as in summer is also a major constraint that should be carefully studied.

2.7 Extension phase: the launching of LIGHT

Methodology and activity objectives have been drawn-up from the pilot project held in Leh belt in partnership with LEHO as both results and farmers' motivation proved to be more than encouraging. A strategic framework has been established for the dissemination of IGH on a larger scale with a network of 5 locally based NGOs in the context of the cold desert areas of Ladakh and Lahaul & Spiti districts.

2.7.1 Project objectives

The target group of the LIGHT project is the poor rural population of Ladakh and Lahaul & Spiti, living with less than 0,7 € per day and per capita income, depending on self-subsistence agriculture and living with very limited resources. They own a limited cultivable land; they have basic skills in agriculture.

The target population is not involved in the modernisation process undertaken in the main economic centres. They cannot afford to get consumer goods imported from the Indian plains and have no access to basic services. They encounter major difficulties in paying children's studies, electricity and sufficient quantity of balanced food (sometimes not even government subsidised basic food).

The project's aim is to help poor and isolated families to adapt to the market economy that is about to become the prominent system. The introduction of income-generating activities (IGA) in a subsistence economy might have some important effects on traditional institutions

Key challenges

- The analysis of each area allows to take into account a great variability of contexts and thus to adapt the methodology to each zone (technical specifications, production level, project contribution, expected income and impact, etc.);
- The comparison between the traditional and the new tool gives beneficiaries the advantages of the newly introduced tool and helps in convincing/motivating them to adopt it; and
- The technical and financial analysis will give beneficiaries the expected incomes, the investment needed and the payback period. Having clear information will avoid the non fulfillment of beneficiaries' expectations.

Objectives and expected results

Overall Objective: Access to services

Activity specific objectives:

1) Implementation of an Income Generation Activity (IGA);
2) Women empowerment;
3) Health improvement: vegetables consumption doubled in winter, better access to health services; and
4) Local partner NGOs capacity-building.

Expected results:

- 500 IGH and 500 compost pits built = 500 families enabled to run an IGH
- 150 metric tons of vegetables produced per year = 300 Kg/IGH/year
- 34 village-based resource persons trained and engaged, 50 local masons trained;
- Doubling the vegetables consumption during winter;
- 80% of women promoters and an overall women gain in self-confidence; and
- Local partner NGOs able to implement similar activities.

Main impact expected from IGH activities: on health, income & women empowerment

- Improvement of food security through higher income and availability of fresh vegetables;
- More revenues allocated for education and access to basic services, etc.;
- Health improvement through an increase of vegetable consumption; and
- Women empowerment with gain in self-confidence, higher decision-power in family income allocation, etc.

and structures, where bartering and strong solidarity mechanisms prevail. Nevertheless, the project is also attentive to the way social relations get affected by the development of IGA to avoid a major disruption in local communities.

2.7.2 Project activities

Several activities have been planned in order to reach the above objectives:

1. Adaptation of the IGH design to the climatic conditions and material availability of each area;
2. Setting up demonstration farms in Kargil, Lahaul, Spiti, Zangskar and the Nubra valley;
3. Setting-up a financial mechanism based on limited subsidies to implement the construction of 500 greenhouses;
4. Training of masons and carpenters to construct greenhouses;
5. Selection of the villages and beneficiaries according to target group criteria;
6. Construction of 500 greenhouses and compost pits in 50 villages; and
7. Setting-up sustainable input supply channels (seeds, polythene sheets, tools) in each district.

Several project components have also been defined:

R&D

• Construction and follow-up of demo-farms in each targeted area to have appropriate performance of IGH, constraints and farmers' perceptions;
• Study of the local markets demand, potential and price for different cash crops that can be produced under greenhouse by season and area-wise; and
• Comparison of the performance of different crops under greenhouse.

Measuring the market access and potential for vegetable production will directly specify the incomes that can be generated by one IGH. This factor will also determine the size of the greenhouse (apart from water access and land size):

• Domestic IGH (15x32 feet) mainly dedicated to rural and remote areas for family consumption, bartering and complementary income
• Commercial IGH (16x90 feet) to enhance local agricultural commodities marketing, support the development of a peri-urban agriculture and fully support a family in terms of income.

Technology transfer

• Utilization of demo-farm structures with participating farmers to increase the adoption of the technology;
• Creation of a local NGO network composed of 5 grassroots organizations to follow-up the activity; and
• Formation of a Resource-Person (RP) network to transfer technology within the local communities.

Training and human resources development

• Organisation of trainings in agro-techniques, IGH construction, activity follow-up for RP and local NGO staff; and
• Production of training manuals and technical booklets in the local languages.

III Implementation technology

3.1 The strategy for dissemination in a large area: the local NGOs network

The implementation of the activity is based on a network of 5 local partner NGOs and GERES. The project area covers three districts and two different states: Leh and Kargil districts in Jammu & Kashmir and Lahaul & Spiti district in Himachal Pradesh, which represent a vast area sparsely populated and particularly remote.

Local NGOs often act as link between foreign NGOs, donor agencies, government departments and traditional institutions. They are usually out of any partisanship systems, thus they are less sensitive to political conflict and favours and are able to implement the project efficiently. Their role in the project implementation will be the occasion to reinforce their skills and capacities.

Moreover, they are relevant organisations to approach local communities as they have a deep-rooted knowledge of the local context.

Each NGO based in one or several specific valleys has an extensive knowledge of its intervention area, and as a consequence, the great variety of contexts (socio-cultural, religious,) that often differs from one valley to another can be more consciously factored in the project strategy.

The responsibilities of each NGO have been defined during the project design and are divided in two categories i.e. *resource* and *proximity* NGO. LEHO (Leh) has been designated as the Resource NGO, considering their involvement in the pilot phase, and LEDeG (Leh, Kargil), LNP (Leh), SKARCHEN (Leh) and STAG/Ecosphere (Lahaul & Spiti) were designated as proximity NGOs.

The overall responsibility of LEHO is to identify training needs, to organize the activity follow-up and provide technical support to the proximity NGOs that are directly dealing with local communities. In its own area, a resource NGO also acts as a proximity NGO.

The proximity NGOs are responsible for project implementation, community mobilisation, identification and training of promoters and Resource persons (RP) as well as collecting the data to conduct the follow-up activities.

LEHO responsibilities:
- Organization of workshops (jointly with GERES), including review workshops;
- Creation of communication tools as a support for proximity NGOs during promoter's mobilization (posters for explanation of criteria, design, materials required, running costs, etc.);
- Identification and organization of training when required (when nearest NGO is not skilled enough);
- Organization of field visits when required (especially during construction and training in sensitive/remote areas);
- Monitoring and evaluation: Aggregation and analysis of the data collected by proximity NGOs regarding follow-up activities; and
- Research and development: testing different designs and crops either in collaboration with the government department of horticulture or individually.

In collaboration with GERES, the resource NGO has in its prerogatives the R&D to allow the proximity NGOs to work with local communities and better focus on promoter mobilization.

GERES has the overall responsibility for the completion of objectives, the general management, to monitor the progress and resolve any conflict that arises. GERES has to support the resource NGO in methodology design, monitoring and evaluation, planning and reporting when required. This help progressively decreases over the years while the responsibilities of the resource and proximity NGOs increase.

Within four years, partner NGOs will be autonomous in most of the IGH activities and will have gained skills in technical, administrative and managerial competence thanks to the interaction, the experience-sharing process and exposure allowed by the network.

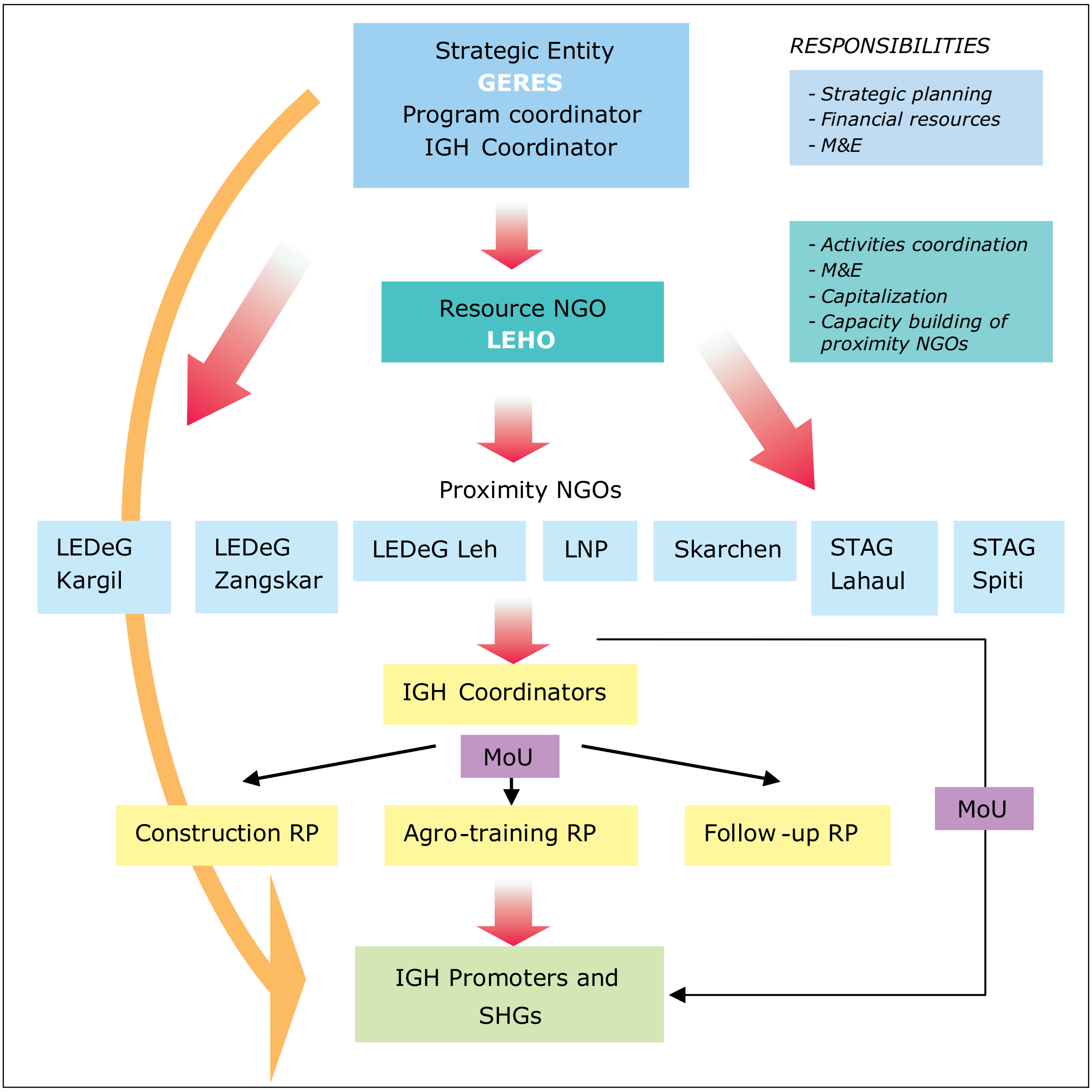
NGOs network

Positive points	Limitations
NGOs are effective links in bridging the gap between GERES and local institutions/promoters.	It could be risky if the resource NGO does not respect its engagements or if the NGO is not skilled enough.
Efficient way to get grassroots/field knowledge area wise and to better understand specific context (social and economic).	All the NGOs do not always share the same vision (different methodology, local politics, etc) and collaboration could be complicated.
Capacity-building of partner NGOs that will ensure activity's sustainability beyond project's end.	Work overload of resource NGO, availability of qualified people, etc.






NGO network organisation in GH activity



3.2. Definition of operational zones and phases, a key factor

To answer to a high diversity within the project area, the methodology has been based on two main concepts, the zone and the phase. Different zones have been defined and fixed at the beginning of the project implementation, each of them having specific objectives in terms of target group, project contribution, production and sales levels and expected impacts.

Once the objectives defined, results have been measured along the four-year project timeframe to monitor the progress made starting from initial to ongoing and final phases. The objective being to reach the final phase for the three zones at the end of the project.

3.2.1 Definition of operational zones

The project team has delineated three operational zones, i.e. *remote*, *transition* and *development* in order to adapt the methodology to an important variety of contexts and carry out IGH activity in the most effective way.

The areas are defined in terms of access to market, geographical and climatic features, communication facilities and agricultural land under cultivation.

With the information collected, the project team is able to quantify the potential for each area (and thus the objectives) in terms of:

- Market demand and competition;
- Agronomic skills of the farmers and knowledge in greenhouse running;
- Average potential production depending on the agro-ecological zone;
- Project contribution level depending on the availability and price of materials required for construction, etc.; and
- Type of IGH (commercial or domestic design) to be built.

A matrix has been developed to help the partner NGOs in defining the zones

Matrix for the definition of zones

	Indicators	Remote	Transition	Development
Market	Time to reach main market[1]	More than 4 h	From 2 to 4 h	Less than 2 h
	Time to reach secondary market[2]	More than 2 h	Less than 2 h	
	Secondary market potentialities	Only homestays and restaurants	Army camps or restaurants and/or Govt employees	Army camps, shops, govt employees
Agro ecological zone	Winter climate conditions compared to Leh	Much colder	Colder	Same or warmer
	Possibility to grow summer veg during summer in open field	Risky	Possible	Easy
Communication	Road availability	No road (only trek path)	Secondary road	Main road across the village
	Bus service frequency	No bus	Daily	Twice a day or more
Agronomy skills	Surface of vegetables grown in open field during summer	Less than ½ kanal	From ½ to 1 kanal	More than 1 kanal

Remark: Access to market is a critical factor to be taken into account to define the area potential.

[1] *Main market is located in district capitals (Leh, Kargil, Keylong, Kaza). In these cities, the vegetable market is open all year round, even during winter. The market is located either on the pavement or in a dedicated place. Seedling sales takes place during spring.*

[2] *Secondary market is located in block capitals (Tangtse, Padum, Diskit, Karu, Kaltse, Sanku). During winter, vegetable markets are non-existent, and during summer vegetable markets are available as well as other opportunities for vegetable sales such as restaurants, army camps or government employees. During spring, seedlings are not sold on a large scale but only exchanged casually between farmers.*

Once the area is defined, specific objectives are set according to each context.

Definition of objectives for the different areas

Zone	Context	Target group	Project contribution	Expected impact
Development	Near to main market centers where market potential is large and beneficiaries are used to grow vegetables for income generating activities	Families with very low incomes	7,000 Rupees	Increase of incomes (from complementary to full income) and the development of a peri-urban agriculture
Transition	Near to secondary market centers, where there is a market and where people can easily grow vegetables	Families with low incomes	9,000 Rupees	Increase complementary income and improvement of the diet due to higher vegetables consumption during winter
Remote	Far from market centers, where IGH are not well-known. The aim to demonstrate successful stories to foster replication mechanisms	Motivated families, selection is not based on social criteria for successful stories so to ensure ownership and replication	9,000 Rupees	Health improvement due to a more nutritious diet

3.2.2 Project phases definition

Three different phases have been distinguished i.e. *initial*, *ongoing* and *final* to define appropriate operational methodology and objectives for each year in order to progressively introduce the technology to reach sustainability at the end of the project and to ensure scaling-up.

In the initial phase, the newly introduced tool efficiency and benefits are not known among the community members. Target production, proportion of vegetables to be sold and income levels to reach are not too high. People investing in this new technology take a risk that the poorest fringes of the population would not dare to take. Targeted people will mainly serve to demonstrate and publicise the benefits of IGH to enable replication.

Progressively, the IGH efficiency being well known among community members and the network of Resource Person (RP) being set-up, the ongoing phase target indicators will be more demanding, with higher production and income targets along with stricter social criteria for promoter's selection.

Results to be achieved according to the phase			
	Initial Year 1 to 2	**Ongoing** Year 2 to 3	**Final** Year 4
IGH number	No successful IGH	Newly constructed IGH	Critical mass reached
Resource Person (RP)	No RP	RPs under training	RP network finalised
Vegetable sales (% of total production from IGH)	Dev.: min 50% Trans.: min 25% Remote: min 20 %	Dev.: min 60% Trans.: min 40% Remote: min 30 %	Dev.: min 70% Trans.: min 55% Remote: min 40 %
Total benefit per year from IGH (in Rs)	Dev.: min 5,000 Remote: min 2,000	Dev.: min 7,800 Remote: min 3,900	Dev.: min 10,500 Transition: 8,000 Remote: min 6,000

3.3 Targeting strategies

The selection of promoters has been carried out with care, in a participatory manner with local communities. The target group has to live below the poverty line (with less than 0.7€ per day per capita) and have to have a suitable site to construct the IGH. The interested family has to be keen on making a success by using the IGH.

The concept of "promoter" has been preferred to the term "beneficiary". Here the farmers are considered as entrepreneurs rather than recipients of a contribution. They are part of the project and involved in each and every activity to ensure their active participation which fosters project's ownership.

Therefore, promoter's selection is a major step as it has a great influence on the success or failure of the activity's implementation. The selection process has to take into account several points in order to attain the project's target:

- social criteria to targeting the poorest;
- technical aspects to ensure the activity feasibility; and
- promoter's motivation to attain project objectives.

Each criterion has to be quantified to facilitate the selection process from "very good", "good", "medium" to "rejected".

3.3.1 Social criteria

A methodology has been set-up in order to select the promoters depending on their social status according to the area and phase as defined above.

Targeting the poorest has been consciously factored in *ongoing* and *final* phases. The selection process is a sensitive step that requires attention. The extreme poor are likely to be hesitant in showing interest for the activity due to low self-confidence and little trust in their ability to manage an Income-Generating Activity (IGA). Limited awareness and social exclusion are among the factors that may hinder the poorest in participating in any IGA.

Thus the project team paid great attention to self-exclusion processes.

Social criteria depending on area and phase				
	Rejected	**Medium criteria**	**Good criteria**	**Very good criteria**
Total annual income per capita (in Rs)	20,000 or above	From 10,000 to 20,000	From 6,000 to 10,000	Less than 6,000
Part of agricultural income/total income	0 to 25 %	25 to 50%	50 to 75%	75 to 100%
Government job	Class 2 or more than 1 civil servant in the household	Class 3	Class 4	Nil
Assets	Car or truck	Nil	Nil	Nil

3.3.2 Site feasibility

Site feasibility criteria have been elaborated along with social criteria in order to select promoters who can set-up an IGH in good technical conditions i.e. where the soil is fertile, the sunshine is sufficient, and water is available during winter.

Site feasibility criteria				
	Rejected	**Medium criteria**	**Good criteria**	**Very good criteria**
Sun duration	Less than 4 hours	4 to 6 hours	6 to 7 hours	More than 7 hours
Land	Rocky	Muddy	Sandy	Fertile, fine soil
Shading	More than 2 hs a day	1 to 2 hours	1 hour to 30 min	Less than 30 min
Water access in winter	More than 300 m	150 to 300 m	50 to 150 m	Less than 50 m
Land orientation	Rejected if the plot is on a north-orientated slope			

3.3.3 Criteria for assessing promoter's motivation

To have better chances of success, manpower availability for field work as well as promoter's motivation have to be measured.

Motivation criteria				
	Rejected	**Medium criteria**	**Good criteria**	**Very good criteria**
Motivation in vegetables growing	Nil	Government greenhouse in bad shape and not in use	Government greenhouse in bad shape but in use	Government greenhouse in good shape and in use
Manpower	Nobody available to work in fields	Only 1 person available, but not all year round or part time	1 person fully available for fieldwork	More than 1 person available for fieldwork
Seedling production	Nil	Seedling production for basic species (mongol, chard, cabbage...)	Seedling production for basic and exotic species (tomato, onion...)	Seedling production for basic and exotic species for home purpose and marketing

3.3.4 IGH and women SHG

Women SHGs have also been included in the selection process. During the selection, several interested SHGs have taken the initiative to contact the partner NGO directly in order to take part in the project.

In case of women, group marketing often offers better bargaining power for women as they feel less shy. This avoids them to receive non-remunerative price or to have unfair or exploiting relations with middlemen.

3.4. Implementation of the methodology in the field

The selection process has been implemented in six steps:

1. Meeting with the village representative to explain the project objectives, selection criteria, expected results and impacts;
2. Organisation of a village or hamlet meeting to present the project, the main concepts of IGH, material required for construction, project contribution, target population, main concept on running;
3. Compilation of a long list of interested people/groups within 2-3 days;
4. Cross checking the long-list by the village representative in order to ensure that people meet the social criteria; Organization of a door-to-door survey to analyse the on-site feasibility, to check social and technical criteria as well as to evaluate promoter's motivation; Analysis of the questionnaires and elaboration of the short list against survey results;
5. Organization of an exposure visit with short-listed promoters; and
6. Signature of a MoU between the NGO and the IGH promoters selected to clearly state the responsibilities of each entity.

Implementation methodology

	Advantages	Limitations	Lesson learned
Village meeting to get the long list	Allows high transparency on selection process, and makes people aware of the opportunity	Difficult to gather the whole village, particularly people who are not targeted	Presentation of the project should preferably be done by the NGO staff to better control information and avoid bias. Explaining selection criteria during meeting is highly required. Posters are very useful to explain IGH concepts, material required for construction and selection criteria
Cross check information by the village rep.	Since the village representative is mandated to qualify households and individuals for anti-poverty govt. schemes, he will easily short list people that meet the social criteria	Bias against certain social group might exist	To work in collaboration with local institutions will ensure better collaboration and thus greater sustainability after project's completion
Door-to-door survey	Good tool to find relevant and detailed information on households; Helpful to measure motivation and technical site feasibility	Resource and time consuming process; Difficult to get correct and unbiased information	The quality of responses highly depends on the clarity of the questions asked. The questionnaire should not be long and should only include most important criteria for selection
Exposure visit with short listed people	Very useful to increase motivation and knowledge of selected people (concept, running, marketing…) Experience-sharing between experimented and new promoters	Time consuming & costly	Essential step in promoters' motivation

3.5 The Resource-Person network: Capacity building of local communities & enhancement of knowledge-sharing process

Building the local capacities and supporting technology transfer have been major milestones for the project sustainability. This has been achieved by the development of an efficient and well-organised resource person network.

3.5.1 The presentation of the RP network

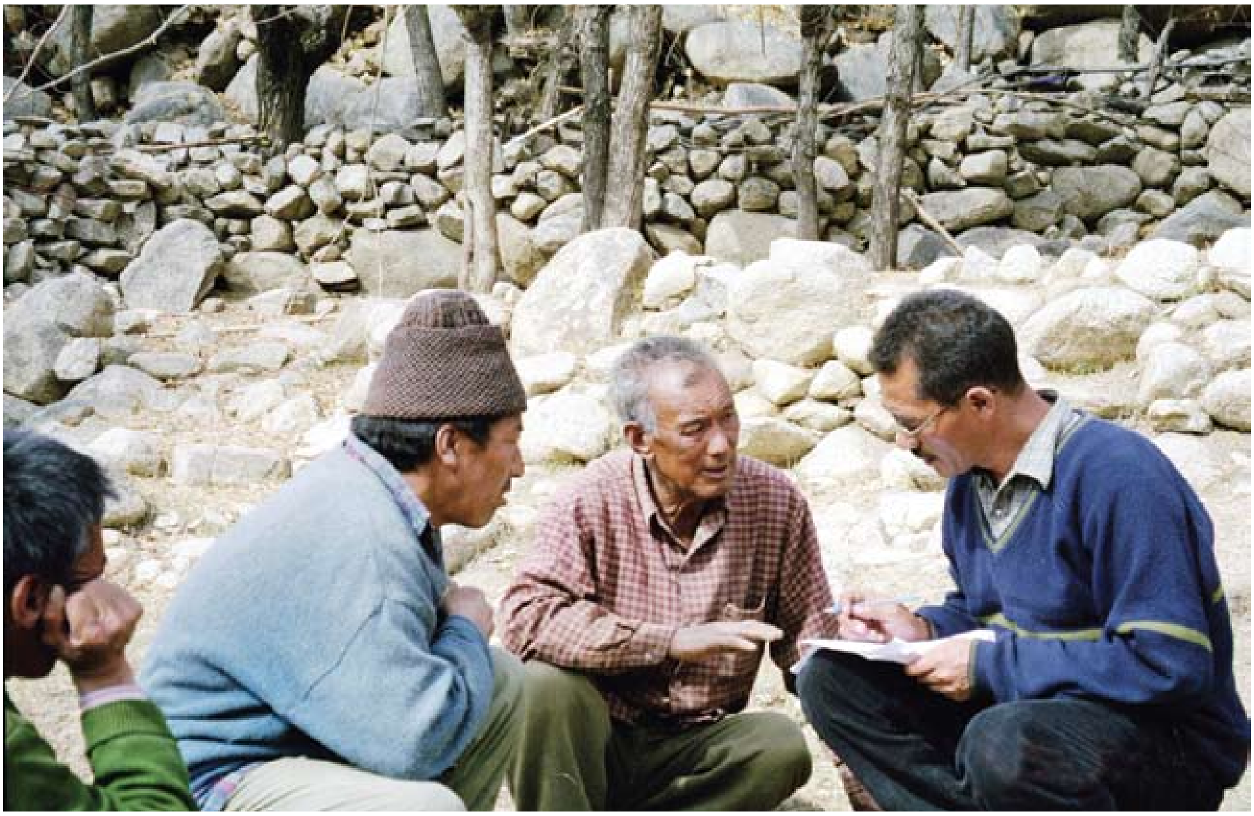
Village-based Resource Persons (RPs) have been trained and engaged by local NGOs in order to follow directly on the field the IGH activity and provide daily assistance to promoters in order to build local capacities in the long term. Three different kinds of person have been recruited depending on the field of intervention. Recruited RPs are trained and experimented in their field, and intervene at different levels of the activity implementation:

- Construction RP who supervises the construction of the new IGH in his cluster (three times a week during construction);
- Agro-techniques RP who organises 2 trainings a year (winter production seedlings in spring) to all promoters of his cluster in horticulture and organize exposure-visit;
- Follow-up RP who is in charge of onsite assistance and monthly follow-ups of his cluster concerning production; and
- Village coordinator in remote areas such as Zangskar or Changthang, that makes the link between the NGO in charge of the area, the RPs and the promoters.

Clusters, groups of villages, composed of 3 to 6 villages depending on the IGH number and village expanse, have been defined to facilitate the intervention of the RP over such a vast area.

Methodology

- Definition of network area;
- Selection of RP by proximity NGOs for each cluster;
- Signature of a MoU between the RP and the local NGO to seal their engagement and responsibilities.
- Up-grading of RP capacities through trainings organized by the resource NGO;
- Strengthening of local communities capacities through RPs trainings; and
- Regular follow-up and evaluation of RPs done by proximity NGOs to ensure high-quality training.



Role of the Resource Person		
Construction RP	**Agro-techniques RP**	**Follow-up RP**
• To draw foundation lines • To check roof inclination • To monitor the double-wall, door and ventilation system construction • To fix the polythene sheet	• To organise trainings on winter crops management, seedlings production and summer production (winter, spring, summer sessions) • Seeds supply • Pest management	• To weekly follow the promoter onsite by giving practical advices to complete the agro-techniques and NGO trainings

3.5.2 Organisation of the follow-up activities

The key factor to ensure success in the activity implementation is the quality of the follow-up.
To ensure a good and constant support and transfer of knowledge, RPs need incentives and are therefore remunerated by the NGO depending on the time required to perform their mission and on the quality of their work. RPs are thus regularly assessed by NGOs with the help of questionnaires in order to ensure the beneficiaries a good quality support.

Resource Person's remuneration

Resource Person	**Case 1**: if greenhouses are close	**Case 2**: if RP has to walk more than 1 hour	**Case 3**: if RP has to go by bus
Construction	250 Rs / IGH	350 Rs / IGH	250 Rs + bus fare
Agro-techniques	400 Rs – training fee 100 Rs – DA or for food 200 Rs – for room rent if required Transportation organized by NGOs		
Follow-up	70 Rs / IGH / month	100 Rs / IGH / month	70 Rs / IGH / month + bus fare
Village coordinator	750 Rs		

To build up a system of regular visits, a set of tools has been created to help each RP in its task:

- The construction RP has a check list to follow during the IGH construction;
- The agro-training RP receives feedback at the end of each of his trainings in order to help him improve; and
- The follow-up RP has a questionnaire to fill-in for every visit conducted to promoters.

The RP Toolkit

A toolkit has been elaborated by GERES and LEHO (resource NGO) in order to provide all the information needed for the RP network to sustain:
- Organization of RP training;
- Definition of formats for RP selection, follow-up and evaluation;
- Creation of communication tools for technical support such as posters, training manuals, standard training content and movies.

Resource Person's network evaluation

Positive points	Limitations
Village-based experienced RPs have an important psychological impact on promoters. They are closely integrated on the field and have a good understanding of local context. They are also much more aware of difficulties that could not be visible to outsiders.	The quality of monitoring, reporting, and feedback is lower than the NGO one.
Capacity building of local community members that will remain beyond the project completion and will help to foster replication mechanisms. Increase project ownership by the use of participatory implementation methods.	The network in its formal structure might not be sustainable in the long run, when RPs will cease to be remunerated by the project.
Decrease workload for NGOs and project logistics costs while locally increasing job opportunities.	—

Capacity building

Capacity-building of the local communities through RP network

The RP network has significant advantages in terms of building-up local communities' capacities. It throws the basis of a knowledge-sharing process management through:

- Transfer of knowledge through enhancement of technical expertise and know-how;
- Increase project ownership;
- Increase local job opportunities; and
- Reinforcement of the role of civil society in influencing decision-making process and policy-makers.

Expected outcome:

The expected outcome of such a network is the dissemination of the technology among local communities during and after the project's end.

IV Financing

4.1. Context

The project is embedded in a specific context that should receive attention. Three main points need to be highlighted concerning financial issues.

• Firstly, mountain communities' systems are not based on loan but rather on a saving system. Ladakhis feel very uncomfortable with debts and even Muslims are not allowed to work as usurers. Thus, microfinance systems developed through Self Help Groups (SHG) haven't had much success compared to the rest of India because of cultural barriers;

• Secondly, the access to formal financial services has remained confined to rich households as poor lack collaterals. It also does not provide appropriate design loans, i.e. small loans; and

• Finally, it is worth saying that greenhouses in the project area have been for long the subject of important governmental subsidies, and it makes people expect money for the construction of any of them.

4.2 IGH investment cost

The average cost of an Improved Greenhouse is about 30,000 Rs (460€). Half of the cost is dedicated to construction materials sourced locally such as wood for the roof frame, mud bricks or stones, which can be collected rather than purchased and are expected to be provided by the prospective owner. The owner is also expected to provide the labour to build the walls and roof either directly or by paying a skilled mason.

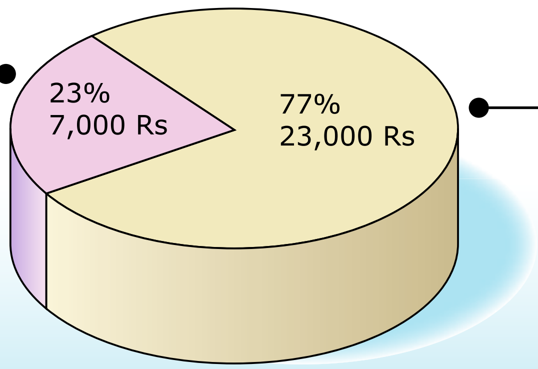
Greenhouse investment

Project contribution in kind

Ventilators	2,700 Rs
Insulated door	2,300 Rs
UV polythene sheet	2,000 Rs

To be provided by the owner

Labour	7,000 Rs in cash or in kind
Materials	16,000 Rs in cash or in kind



The timing of the greenhouse construction is arranged carefully to synchronize with the agricultural year. New owners are selected in the spring, so that prospective owners have time to collect material and make mud bricks.

The greenhouses are built at the end of the agricultural season, when the fields are empty and products are sold. Thanks to a high cash-flow, promoters are able to finance the greenhouse investment in one installment and pay for the materials and/or the skilled mason.

4.3 Farmers' investment capacity, a crucial step

To have the biggest impact, it is essential to study the investment capacity of the target group and its access to loans as the construction of the IGH requires a small investment. The design is based on the average investment capacity of the target group. This study allows the project to fix appropriate investment cost and subsidy rates for the construction of the IGH. It is also interesting to study the existing linkage between the target population and formal as well as informal credit and saving institutions.

Since the IGH requires an investment, farmers can sometimes not afford it as the results of the investment capacity study have shown[8]. Two options to enhance farmers' investment capacity are either the loan or the project contribution.

The project team decided to couple the two options. A linkage has been built between local communities, i.e. hamlet SHGs composed of women, and interested promoters and the project also contributed up to 30% of the total cost. When no credit system was found, i.e. an area with no SHG, local NGOs have encouraged materials lending/bartering (mainly bricks and beams) from neighbours or relatives.

Enhancing farmers' investment capacity

Local community based loans can be successful because of the social pressure it implies that guarantees loan's refund. But in the case of the project, loans provided by SHGs have been limited by the number of SHGs in the project area itself and by their weak capacities in micro-finance management.

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[8] Judith Bel, *Le financement de l'équipement agricole: les serres maraîchères au Ladakh, entre crédit et subvention,* 2006

Project contribution according to area and phase

	Initial phase	Ongoing and final phases
Development and transition areas	Door, ventilators, polythene sheet, paint (equivalent to 7,000 Rs)	*Idem*
Remote area	Door, ventilators, polythene sheet, main beam and paint. (equivalent to 9,000 Rs)	Door, ventilators, polythene sheet and paint. (equivalent to 7,000 Rs)
SHG	Door, ventilators, polythene sheet, paint and 7 mason working days (equivalent to 9,100 Rs) Beams in remote areas.	

4.4 Project contribution

Contributions are in kind to contain the "subsidy effect", to reinforce project sustainability, and to be sure that the contribution will effectively be used to build-up the IGH.

Project contribution is aligned to the government one for greenhouse scheme and based on area and phase. In most cases, the project pays for and provides the door, the air-vents (windows) and the UV stabilized polythene sheet (up to 25% of the total cost).

Key challenge

The most challenging element in the contribution system is to decrease the support over the years, to progressively reduce the promoters' subvention dependence.

In order to achieve this major step, it is essential to properly inform the farmers during the selection process that the contribution will be decreasing if they decide to be involved in the project later on.

The contribution is based on geographical location rather than on social criteria such as income per capita because on the one hand the potential of an IGH depends clearly on the area and, on the other hand, the Ladakhi society is relatively homogeneous inside a village and nobody is really poor. In development areas opportunities are considerably higher, with good market potential, construction material easily available, better road infrastructures, friendlier climate whereas remote zones are synonymous of harsh climatic conditions, a low and less creditworthy demand, and a difficult access to construction material such as mud bricks or wood.

The objectives of the contribution are multiple, other than helping the household in covering the investment, it also allows the project management to be entitled to:
- A certain quality in the design with a proper ventilation system and a door; and
- Monitor and follow-up the activity

The cash investment for the farmers varies depending on the area and from one promoter to another. For instance in Kargil, which benefits from a warmer climate, wood is more easily available and less expensive than in Leh belt. Differences are also found among farmers; some are able to provide most of the materials and manpower needed for the IGH construction from the unqualified work to beams, logs and mud bricks, by procuring it on their own land or by bartering it.

Example of farmer's contribution variations

Item	Pashkum	Sakti	Minji
Beams	850	1,500	0
Bricks (production & transportation costs)	0	1,500	1,280
Stones	500	440	2,000
Mason labour	1,750	1,500	1,960
Unskilled labour	0	1,500	2,240
TOTAL	3,100	6,440	7,480

Source: GERES, Judith Bel, 2006

V A green revolution in Ladakh

The introduction of passive solar greenhouse in Ladakh and Lahaul & Spiti, has allowed people to grow vegetables during peak winter for the first time. A total of 586 families have been enabled to run an IGH since the beginning of the scheme in 1998. Seven IGH of commercial size have been constructed and the remainder of domestic size; nearly all of them remain in use. Locally produced winter vegetables are now available in markets at lower prices, typically 35 Rs/kg to 40 Rs/kg compared to 60 Rs/kg for imported produce.

The impact of IGH has been remarkable, particularly on health, by an improved diet, as vegetable consumption has been multiplied by more than 5 times for each family. More than 50,000 people benefit directly and indirectly from the construction of the greenhouses, about 25% of the local population. In addition, the development of IGH has not only contributed to reinforce men and women's self-esteem and confidence but also helped them to move beyond subsistence livelihoods in integrating the market economy and therefore made them able to play an active role in society.

Know-how on greenhouse construction, management and maintenance has also been spread among the local population, through the development of a "learning loop" integrating capacity building of local partner NGOs and the training of more than 200 masons and almost 100 community-based Resource Persons (RPs).

5.1 Monitoring and Evaluation (M&E)

5.1.1 Objectively Verifiable Indicators

In the framework of M&E, a set of indicators has been defined during the log frame design. Indicators allow checking if the project answers the needs of the promoters, and if not entirely, allows the adoption of corrective measures.

The purpose of OVI is also to capture the changes operated by the project on local community members.

Production levels, economical and social data given by farmers are collected and analysed each year. The monitoring is carried out for each IGH owner and results are aggregated per zone and according to proximity NGO.

Objectives

A. Overall objectives: access to services

A.1. Increase in income generation
A.2. Use of income
A.3. Social change induced by the utilisation of the income

Specific objective 1: income generation activities

1.1. Number of tools set up
1.1.1. Greenhouses
1.1.2. Compost pits

1.2. Production
1.2.1. Vegetable production (Kg)

1.3. Additional income
1.3.1. Number of persons enabled to set up activities
1.3.2. Turnover (cash)
1.3.3. Benefits (cash + money saved - running cost)

1.4. Training and assistance by NGOs for end-users
1.4.1. Number of training sessions
1.4.2. Capacity of local stakeholders to construct IGH (number of local masons)

Specific Objective 2: Women's empowerment

2.1. Technical empowerment
2.1.1. Proportion of women in greenhouse cultivation

2.2. Financial and self-confidence empowerment
2.2.2. Gain in self-confidence

Specific Objective 3: Health improvement

3.1. Comparison of the quantity of fresh vegetables eaten by owners (% increase before/after)
3.2. Number of persons eating vegetables in winter

Specific objective 4: NGOs capacity building

4.1. Area
4.1.1. Remote area covered by the project

4.2. NGOs empowerment
4.2.1. Capacity to manage the local implementation of the project (%)

4.3. Networking
4.3.1. Number of workshops
4.3.2. Number of trainings
4.3.3. Number of local NGOs trained

Specific objective 5: Sustainability

5.1. Income
5.1.1. Availability of replacement equipment and input in sufficient quantity from the local market
5.1.2. % of IGH damaged/repaired

5.1.2 Biannual follow-up

The impact follow-up provides data for close follow-up activities on a biannual basis. The data are collected by proximity NGOs in April/May to assess the winter production and in September/October to analyse seedling production results and summer production.
The following indicators are monitored:

- Production (in kg)
- Income in cash from vegetables sold
- Money saved from self-consumption
- Increase in income compared to project baseline (%)
- Running charge
- Total benefits
- Use of income generated
- Number of indirect beneficiaries
- Consumption of dry and fresh vegetables before and after project
- Incomes generated by seedlings

M&E activities

Regarding M&E activities, several studies have been conducted over the years:

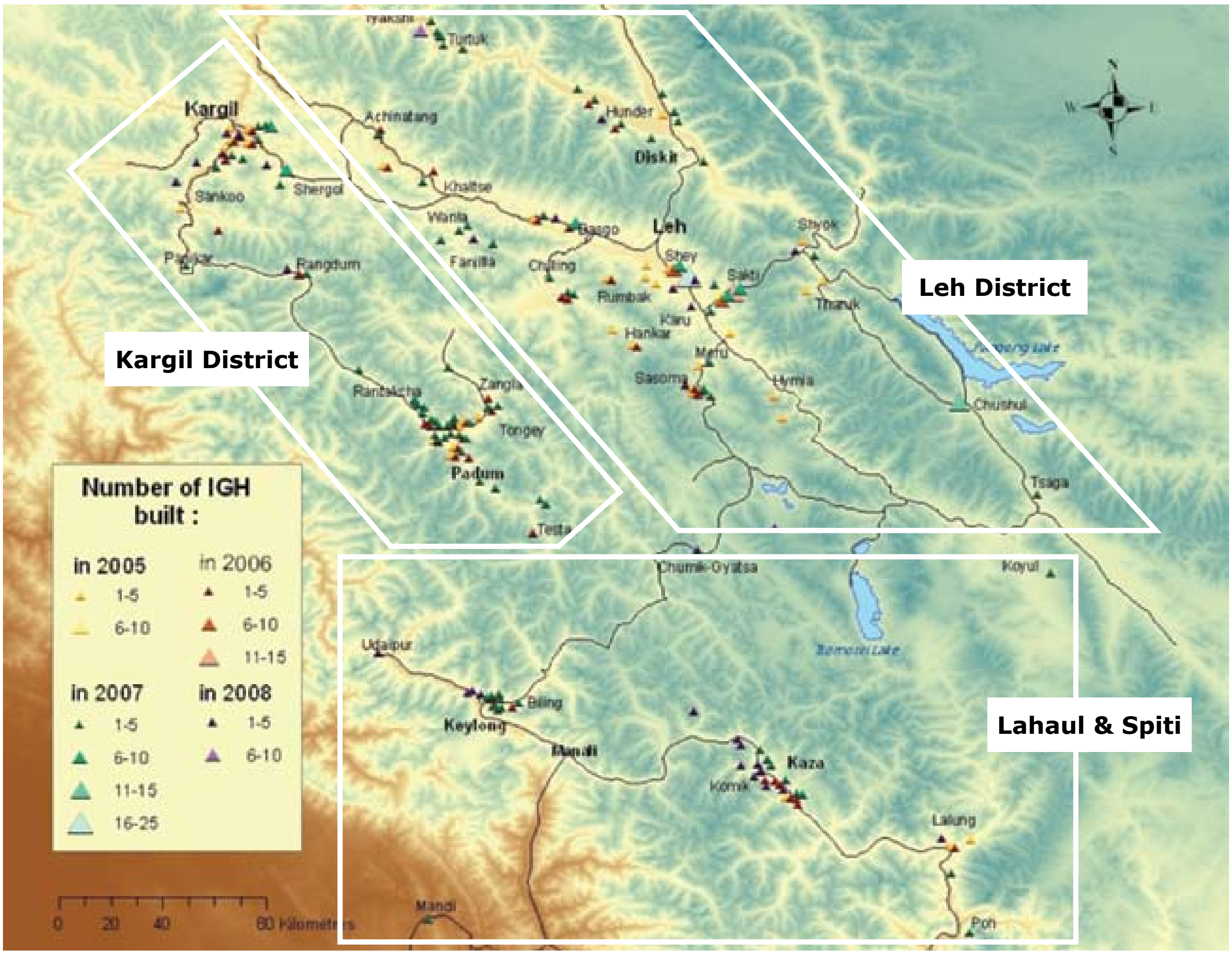
- Two impact surveys and one study on gender in 2007;
- One mid-term evaluation in 2007; and
- One final evaluation in 2009.

5.2. Reaching the critical mass

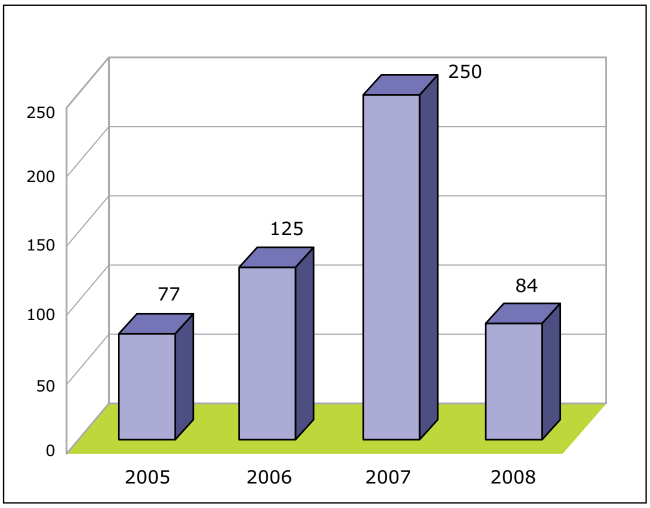
More than 586 greenhouses and 144 compost pits have been constructed in 163 villages, -benefiting the same number of families-representing more than 40% of the villages in the project area. 10 women SHG have been involved in the management of the IGH.

50 standard improved solar greenhouses were constructed during the pilot phase (1998- 2001), and 529 standard as well as 7 commercial improved greenhouses have been built during the extension phase (2005-2008).

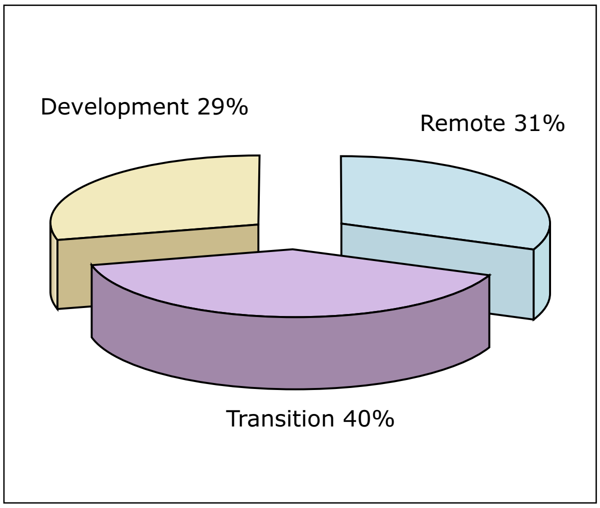
Project coverage



Number of IGH built during the extension phase



Distribution of farmers per zone



The project has enabled farmers to:
- produce 300 tons of vegetables per year in average;
- increase their incomes by 30%;
- increase their consumption of fresh vegetable by 8 times during winter;
- give their children a better access to education;
- increase significantly their access to health services;
- increase their saving capacity; and
- more generally, move from self-subsistence to market economy.

Fresh vegetables in Zangskar

In Zangskar, one of the most remote areas in the project, greenhouses are the only source of fresh vegetables during winter since roads are closed due to snowfalls.

In the village of Sapi, cut off from the rest of the world for more than 6 months, IGH has changed the life of villagers, allowing for the first time vegetables production during winter. Moreover, to see green vegetables in winter has a very positive impact on people's mind.

5.3 Social benefits

Greenhouses owners have gained social standing in their respective communities by providing vegetables for the whole of the community for either regular consumption or for festivals, and by earning better income.

5.3.1 Health improvement

There are yet no statistics in Ladakh to show the impact of fresh vegetable consumption on people's health but there is substantial anecdotal evidence as well as qualitative/quantitative studies that show positive changes in health.

M&E studies have shown that consumption of fresh vegetables during winter has grown by a factor of eight for families owning an IGH. Farmers' families have reported to eat fresh vegetables two or three times a week in contrast to twice a month in the past. According to the results of the last impact follow-up conducted in May 2009, out of 368 promoters interviewed, 13% report that improvement in health constitutes the most important impact of the IGH activity.

Awareness on the benefits of this improved diet has also been raised, taken over by doctors.

As the qualitative study done in 2007 has shown, an overall improvement in health has also been supported by the increase of income:
- In *development* areas: most part of income is spent on personal hygiene;
- In *transition* areas: income is mostly used for buying medicines; and
- In *remote* areas: the money is spent mostly on transportation cost to visit doctors in Public Health Centres that may be located far from the village.

5.3.2 Access to a better education

Farmers' families have increased their children's access to education in terms of education expenditures, money spent on extra tuition fees, extra or missing stationery and money saved for future studies outside Ladakh. The importance given to education is even more important within women SHGs involved in IGH.

According to the impact follow-up 2009, the extra income earned by families in selling vegetables is spent on *education purposes* for more than 27% of the respondents, the second most cited after *house-running expenses*.

5.3.3 Women empowerment

One aim of the project was to provide new opportunities for rural women. This has been achieved. For the first time, women are able to sell vegetables in two important markets of the project areas (Kargil and Padum) and most women involved in IGH, 70% of the promoters, have also reported an increase in self-confidence. They feel more confident by earning income, by having developed their skills, and by having gained more power in family decisions.

Thanks to their socioeconomic empowerment, women have become active decision-makers concerning family's investment, agricultural production strategies and children's education, and overall, have received a better recognition from the community. They have globally increased the whole household's well-being since they usually allocate more money than men in education purposes and hygiene.

The impact of the scheme has been particularly remarkable on the 10 women SHG (comprising about 150 women) involved in the greenhouse management. Group emulation and dynamics have been important in remote areas where benefits for the group are far more relevant than the ones of each individual and have consolidated the group to give women more power and recognition.

As Mr Chosphel, LEDeG Coordinator in Zangskar, recalls, "thanks to the development of IGH in Zangskar, women SHGs have become a powerful group, able to defend their ideas and interests. They have been able to apply for government money and have refused an alleged case of corruption".

"Women Self Help Groups have become a powerful group, able to defend their ideas and interests".

5.4 Economic benefits

5.4.1 Increase of income

The project area benefits from the limited opportunities for employment and any way of generating income is welcome. The income from sale of vegetables varies between families depending on how much is consumed by the family and neighbours, how much is bartered and how much is sold for cash, given their access to market, cultural context and climatic conditions. According to the results of the impact follow-up conducted in May 2009, most of the promoters interviewed (52%) stated that the increase in income was the most important impact of IGH activity.

In remote areas, the greenhouse is seen as a gift to the community and the owner has to make everybody enjoying it. Traditionally, community transactions are based on barter and gifts rather than sales in a society that keeps alive strong solidarity mechanisms. Nevertheless, as Mr Ishey Paljor, LNP IGH Coordinator, has pointed out, "the idea to market the production in order to increase incomes and ensure IGH maintenance is slowly being understood by farmers and will increase over the years".

The average owner sells vegetables to nine other families and exchanges vegetables through barter with another six families.

The average increase in family income from the sale of vegetables and seedlings amounted to 8,250 Rs/year (127€/year) or about 30%. In few cases, up to 70% of a family's annual income has come from greenhouse production. For families living in remote areas and not earning more than 15,000 Rs per year, the slightest additional income makes a huge difference.

Besides, the few commercial greenhouse owners have increased their incomes by more than 30,000 Rs in a season. The commercial size has a huge potential for the development of a peri-urban agriculture and this design is likely to be replicated on a larger scale.

In development areas impact on income is higher since all the conditions are met:

- Existing habit to market goods, especially vegetables;
- Higher demand for vegetables consumption; and
- Easy access to an important market (army, city, administration).

To pay back the entire cost of a standard greenhouse takes in average less than 4 years and to pay back the cash investment is less than a year.

The activity is sustainable in the long term, the investment being paid back by vegetables sales.
During winter, in urban and peri-urban zones (i.e. development areas) fresh vegetables, mostly chard and spinach, are sold at least 40 Rs/kg. In rural areas (i.e. transition/remote areas), IGH promoters can either barter the vegetables or sell them at 30 Rs/kg.

Average increase in income for a domestic solar greenhouse disaggregated by zone

Zone	Average increase in income
Remote	+ 36%
Transition	+ 28%
Development	+ 72%

Source: GERES, Annual Report 2008

Additional incomes

↓

Full income

Kargil context

In this Muslim area, people own very little land compared to Leh, but conversely, the region benefits from a warmer climate. As business opportunities are very low, IGH owners are motivated; they dedicate a lot of energy to the IGH and obtain good results.

Average increase in income for a domestic solar greenhouse according to farmer's experience

Experienced promoter (after 3 years)	New promoter (during first winter)
15,000 Rs/year (230€)	6,000 Rs/year (92€)

Source: Impact follow-up 2008

5.4.2 An improved saving capacity

Surveys show that families save between 500 Rs and 1,000 Rs on vegetable purchases in winter. Moreover, meat, which used to be the only type of food available to give a little variety to the meals, has been significantly replaced by vegetables in many areas which helps families making further savings.

According to the impact follow-up results, globally, the money saved is usually allocated on education purposes. Secondly, the promoters devote their money to house running expenditures.

5.4.3 Access to market economy

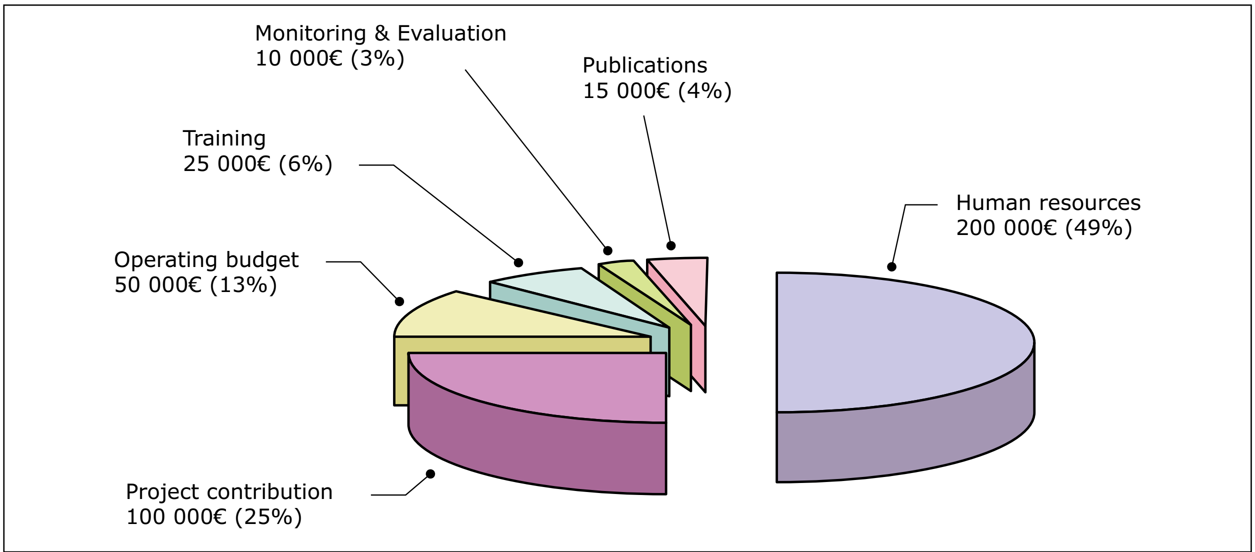
Most IGH owners have the feeling to have moved from self-subsistence to market economy since they undertook the activity according to the 2007 impact study. The most important changes are felt among promoters located in transition areas such as Kargil and Sakti where 100% of promoters have the feeling of integrating the market economy. For remote areas, the situation is slightly different: market economy is still very limited because of reasons already mentioned, thus, promoters of these areas have felt less difference.

5.5 Project financing

5.5.1 Budget

The development of the IGH activity has been based on a 400,000€ budget over a four year period.

IGH breakdown costs



GERES Internal Evaluation 2009

5.5.2 Carbon finance

Passive solar greenhouse relies on solar energy only and does not require any additional heating to guarantee vegetable production, even during peak winter. Hence, the IGH ensures a low-carbon vegetable production that replaces imports which were previously brought by truck during summer or by air during winter. Thus, the project contributes to reducing greenhouse gas (GHG) emissions.

In cooperation with MyClimate, a Swiss based organisation, a baseline scenario has been developed in order to estimate reductions of GHG emissions. It was assumed that without the project, vegetables would be imported during winter and would lead to GHG emissions due to air transportation. It has been estimated that the additional quantity of vegetables produced annually by one greenhouse (500 kg in average) contributed to the reduction of CO_2 emissions of 835 kg per year.

Since the beginning of the project up to 2008, the scheme allowed the reduction of 1,343 t CO_2-eq.
A Project Design Document has been presented on the voluntary market, considering the fact that UNFCC methodology was not designed for projects enabling small volumes of CO_2 emission reductions.

GHG emission reduction scenarios

Phase I: without CO_2 financing scheme

	1998	1999	2000	2001	2008	Total	Unit
Number of IGHs constructed per year	5	10	15	20		50	#
Total number of IGHs constructed	5	15	30	50	50	50	#
Number of IGHs running*	5	14	27	45	45	45	#
Amount of CO_2 reduced per year	4	11	23	38	38	**338**	tCO_2-eq

** with 90% success*

Phase II: with CO_2 financing scheme

	2005	2006	2007	2008	Total	Unit
Number of IGHs constructed per year	77	125	250	84	536	#
Total number of IGHs constructed	77	202	452	536	536	#
Number of IGHs running**	73	192	429	509	509	#
Amount of CO_2 reduced per year	61	160	359	425	**1005**	tCO_2-eq

*** with 95% success*

5.6 Developing local capacities and reinforcing knowledge sharing processes

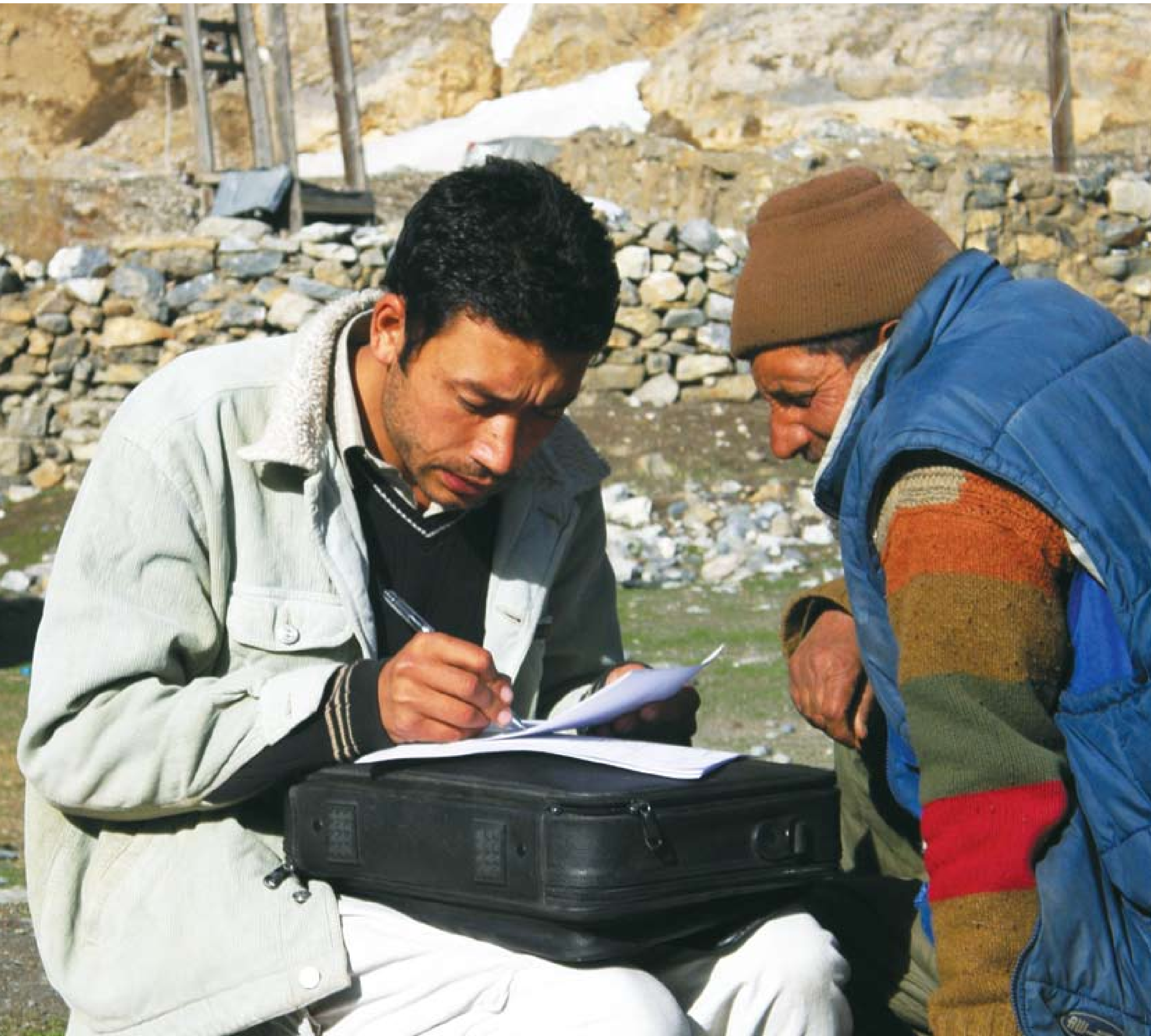
5.6.1 At the community level

Developing local capacities has also been a major focus of the project. More than 320 villagers have been trained and involved in the project implementation:

- 226 local masons and 15 carpenters;
- 16 construction RPs;
- 22 agro training RPs;
- 47 follow-up RPs; and
- 5 village coordinators.

Local capacities development

	Y1	Y2	Y3	Y4	Total
Number of trainings organised by NGOs	10	18	19	27	74
Number of promoters involved	72	236	355	410	---
Number of field visits organised by NGOs	140	242	271	270	688



Each farmer has also received extensive support from the local partner NGOs:

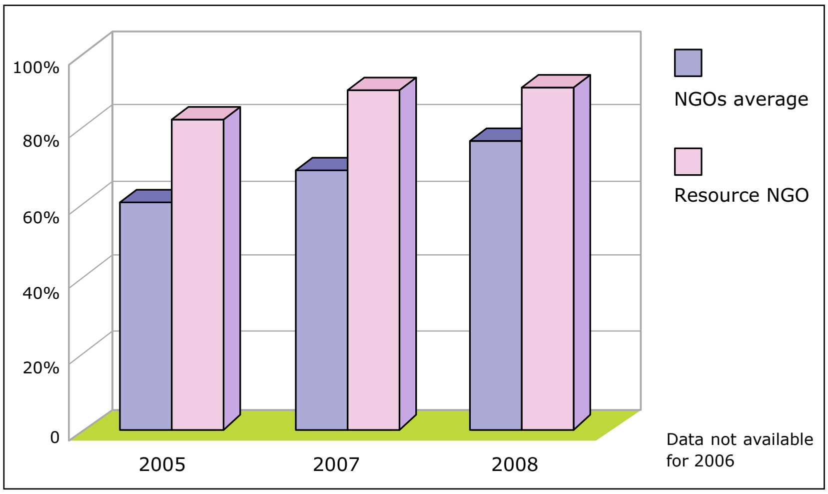
- 30 training sessions on winter production, agro-techniques, seedling production, compost-making, exposure visits were organised by local partner NGOs; and
- More than 680 field visits were done by local partner NGOs to monitor the progress and support the farmers.

5.6.2 At the NGO level

The 7 local partner NGOs have also benefited from an extensive training program and have gained important exposure in project management and in IGH activities:

- 9 biannual workshops have been organised to discuss the designs, implementation methodology, monitoring and evaluation; and
- 19 NGO staff members have been trained on project implementation.

Local partner NGOs capacity-building



Conclusion

Main IGH impact:

1) Improvement of local communities' livelihoods:

- Improvement of food security because of greater quantity of fresh vegetables and higher incomes;
- More revenues allocated for education and access to basic services, etc.;
- Nutrition improvement through an increase of vegetable consumption; and
- Women empowerment with gain in self-confidence, higher decision-making power in family allocation of incomes, etc.

2) Reinforcement of local institutions capacities:

- Capacity building of local NGOs; and
- Awareness-raising within local government bodies on passive solar energy technology.

The IGH, a tool to:

- Foster women empowerment;
- Ensure household food security and fight malnutrition problems;
- To enhance livelihoods and incomes of poor farm families by promoting rural employment through the integrated value-chain approach;
- Modernize agriculture towards the development of an improved cropping system; and
- Address rural migration in retaining young people into villages by the creation of a sustainable Income-Generating Activity (IGA).

VI Exit strategy & sustainability

6.1 Conditions for reaching sustainability

Project sustainability is intimately linked to risks and uncertainties faced by a project. To avoid or mitigate these risks, an exit strategy has to be carefully considered to take the adequate steps. Common factors affecting project sustainability are:

At the individual level
- Technical viability (inputs locally available, necessary skills to operate the available tools)
- Social viability (technology answer to a need)
- Economic viability (market access, subsidy dependence, agricultural prices volatility)
- Financial viability (cost recovery, cash flow, capacity to finance recurrent cost)

At the institutional level:
- Commitment & robustness of grassroots organizations in social support to continue the participation of beneficiaries and local communities through new projects
- Institutional support & government commitment (key central and local agencies with availability of funds.

6.2 Exit strategy & sustainability at the promoter level

6.2.1 Fostering skills, securing supplies and financial capacities

With the end of the project support, the 586 promoters have to be able to maintain and replace the IGH material and provide inputs by themselves. An exit strategy has been elaborated in year 3 and implemented mostly during the final year to secure inputs supply for construction (mainly UV stabilized polythene sheet) and for IGH running (high-yield variety seeds). The polythene sheet needs

Results of promoters' knowledge assessment

Promoters' knowledge	Results
Polythene sheet, door and windows maintenance	100%
Polythene sheet price and retail outlets	80% Limited to one supplier (horticulture department) and one polythene type
Budget availability for maintenance/replacement of material	80%
Windows/doors prices and retail outlets	80%

to be carefully sourced. It has to be tough and UV resistant. Silpaulin, a Mumbai-based manufacturer makes polythene sheet with additional UV block that satisfies the project requirements.

To secure enough money for covering these recurrent costs, the project had to validate a minimum income, i.e. a minimum level of sales, for each cluster (group of villages) based on the results obtained after a year of implementation.

In the final year, an assessment was conducted to evaluate the knowledge and practices the IGH owners had in terms of maintenance and replacement of the polythene sheet, doors and windows, the supply of seeds as well as cash flow availability.

Once the assessment was done, a training plan was organised by the proximity NGOs to fill-in promoters' lack of knowledge and practical experiences so that each and every promoter were trained on how, where and at what price to replace his door, windows and polythene sheet.

Promoters were also informed of the different types of polythene sheet they could find on the market (plain, silpaulin, woven), as well as their differences in quality (thickness, UV resistance, etc.). A list of area-wise input suppliers was distributed to each IGH owner.

6.2.2 A sustainable investment for farmers

The IGH has to be seen as a sustainable investment and constitutes a real asset for farmers. The global lifespan of IGH components is as follows:

IGH sustainability

Wall	20 years
Roof	10 years
Window, door and ventilator	15 years
UV resistant polythene sheet	5 years
Plaster	4 years

To measure the sustainability, in other terms project ownership at the promoters' level, the quality of maintenance has been monitored to demonstrate the promoter's motivation in maintaining the tool in a proper working condition.

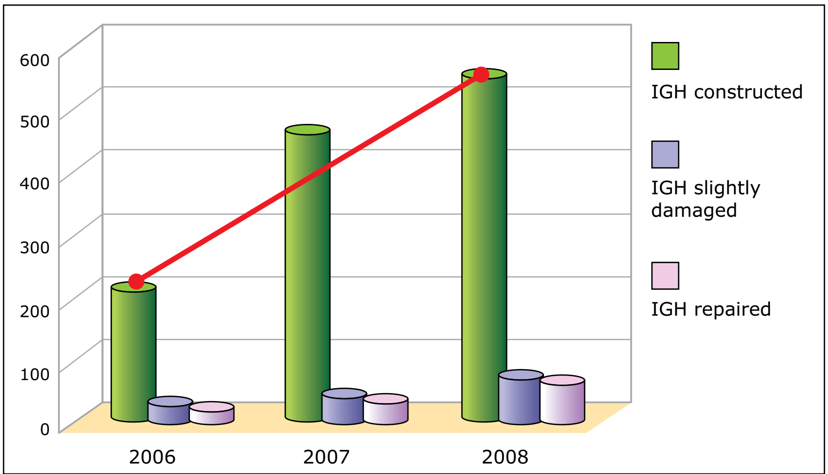
The graphic on the next page shows good results in terms of project sustainability. Out of the IGH slightly damaged (defective plaster, holes in polythene sheet, etc.) 86% of them have been repaired which demonstrates a high interest of promoters in sustaining the activity on the long-term. Since materials are locally sourced, basic structural maintenance is required to maintain the IGH in a good condition.

Overall approximately 97% of the total IGH built is still in a functional condition since the beginning of the project.
Concerning serious damage "IGH totally wiped out by natural disasters (floods, landslide, etc.) have been immediately reconstructed" recalls Ishey Paljor, LNP IGH coordinator.

IGH failure rate

Year	IGH Constructed (cumulated)	% Slightly damaged	% Repaired/ damaged	% failure/ total
Y1	77	NA	NA	NA
Y2	202	11%	95%	0,5%
Y3	452	8%	83%	1,3%
Y4	536	13%	84%	2%
Total	**536**	**23,5%**	**86%**	**3,3%**

Number of IGH well maintained



6.3 Exit strategy and project sustainability at the project's level

6.3.1 Building local NGOs capacities
Local partners are likely to contribute to the sustainability of the project's impact since they have been key partners in implementing the project activities and have contributed to strengthening the capacity of the promoters. Along the four years, local NGOs capacities have been built-up in project (Monitoring and Evaluation) and IGH (design, selection methodology, training, and follow-up) management.

Their new capabilities allow them to secure larger funds and create new partnership to launch similar projects. On the long run, NGOs will be able to extend the diffusion of greenhouses long after the project completion and, equally important, to secure funds for prospective activities.

Limitations

- Local NGOs have developed high-quality technical skills but they still lack experience for approaching funding agencies, especially in proposal writing; and
- They have to face a shortage of qualified human resources through a better management of "talent pool".

6.3.2 Strengthening knowledge-sharing and learning processes
The RP network has reinforced existing community capacities in IGH technical (construction) and running aspects (agro-techniques & follow-up) but also capacities for future development prospects beyond project's completion.

Limitations

The long run sustainability of the RP network can reasonably be discussed. The system is functional because RPs receive a small remuneration in exchange of their services. With the project's end, farmers might not want to remunerate the RP for such intangible services as IGH agro-techniques and monitoring. But the sense of community, still very strong, might compensate the financial gap and instead of daily assistance, the RP might visit the farmers monthly

The construction RP is likely to "survive" project's end as this person supplies a very concrete output that farmers will be willing to pay: the greenhouse.

VII Replicability and dissemination

The project estimates that there is a potential demand for at least 3,000 IGHs in Ladakh and possibly 6,000 more if provision of vegetables for the large military presence in the area is included.

7.1 Fostering replication mechanisms

7.1.1 Impact of the RP network

Replication is intimately linked to knowledge availability. But capturing knowledge is not an easy task as it includes elements of explicit and tacit know-how that cannot be easily captured into books or best practices. Local communities keep their know-how alive by sharing, building and adapting it to their own use.
In the case of the implementation of IGH, the Resource Person (RP) network has played an important role in the dissemination of knowledge in local communities through a unique learning and knowledge management process.

7.1.2 A communication campaign to reinforce visibility

From year 2 to year 4 a mass media communication strategy has also stimulated replication and scaling-up at the community level. Several radio and local TV programs have been arranged by project management as well as local initiatives external to the project.

7.1.3 Reaching the critical mass by a significant number of success

The project size has also an important impact in launching a replication mechanism. At the end of the project, including the pilot phase, a critical mass of 586 IGH has been reached.

Project village coverage

District	Leh	Kargil	Lahaul-Spiti	Total
Block coverage	100%	60%	100%	87%
Village coverage	62%	37%	26%	41%

Almost half the villages over three different districts have been covered by the project. Most of the villagers are now aware of the existence of IGH and its benefits. A strong psychological barrier has fallen down, in the sense that earlier, people did not believe it was possible to grow vegetables during peak winter. In the early stages of the project, people were surprised to see green vegetables growing during the coldest season, and the greenhouses aroused curiosity among villagers.

One can ask, however, if the coverage reached by the project can prove sufficient in initiating a sustainable replication mechanism at the community level? It remains an important question.

7.1.4 Impact of the subvention policy in replication mechanisms

The project has contributed up to 25% (7,000 Rs) of the total IGH cost, to make it affordable to the poorest and to align with the government greenhouse scheme.

However, villagers have been for long accustomed to subsidised schemes.

So far, people have shown a high interest in IGH. During the project implementation, only one third of the demand was fulfilled which implies that the replication process will be important.

Challenges

- How will these contributions, either from government or project, affect replication mechanisms?
- What are the villagers' expectations in terms of financial support?
- How can these subsidies on the IGH construction be phased out?

Project supply against demand

Village name	Number of interested persons (after information meeting)	Number of IGH planned	Demand covered by project (%)
Sakti area (transition area)	65	21	32%
Gya area (remote area)	18	7	39%
Thiksey (development area)	30	10	33%
Sham area (transition area)	20	6	30%
Average	133	44	**33%**

Some replication mechanisms have already been initiated and reported as follows:

1) Within the target group, farmers already running an IGH, have extended their activity by building one or several more IGH (in one case up to 8 more);
2) Villagers that were not selected during the project as they did not meet social criteria have constructed their own greenhouse themselves without any support;
3) Local artisans have received orders for the construction of greenhouse metallic frames.

The commercial IGH has met an important success among middle-class households as it can fully support a household in terms of incomes. This design answers today's socio-economical needs where the development of a peri-urban agriculture is now felt (compared to 1998 where the commercial design did not receive much success). Commercial IGH is likely to expand over the coming years.
The commercial IGH is the adaptation of the standard IGH to the Ladakhi and Indian social and economical development in the recent years.

With the contribution of the National Horticulture Board, the Basgo village councillor has planned the construction of 8 commercial IGH. In the coming year LEHO will focus on extending the commercial potential of the IGHs with a target of 60 commercial units in Markha valley and Leh areas.

Problem faced

The replication of IGH is restrained by land size and water access as well as opportunistic strategies.

The process has been initiated within the target group for the construction of a second greenhouse and outside the target group i.e. within the middle-class as prospective owners do not expect any subsidies.

The mechanism is likely to expand to lower strata in a second phase.

Key factors for replication at the individual level

1) Subsidy dependence;

2) Farmers' investment capacities to finance initial investment & recurrent cost;

3) Material availability & tool affordability and simplicity;

4) Number of successes;

5) Access to information & knowledge within local community on the tool and its benefits (transaction costs);

6) Input supply organisation (seeds); and

7) Current socio-economical needs.

7.2 Linking local institutions: fostering partnerships

7.2.1 Local NGOs

Local partner NGOs have an important role to play in the extension of the activity after project completion. Along the four-year project, they have capitalized an important knowledge on IGH activity that has to be shared with outsiders. The creation of new partnership is a way to enhance knowledge-sharing processes.

So far, the project resource NGO, LEHO has already launched 3 new partnerships for the diffusion of the IGH at the local level with for example:

• the Swedish Nature Conservancy (SNC);
• the French NGO Solidarités; and
• the Watershed Development Program, a central government scheme where LEHO will act as the implementing agency in some village clusters of Ladakh.

Dozens of other local NGOs and organisations not involved in the project have replicated the project design, for example:

• Nyamtung (under Watershed Program) Pragya NGOs and Munselling School in Lahaul & Spiti;
• Rural Development & You, Health Inc., an amchi (traditional doctor), the Mahabodhi centre (Centre of Buddhist studies) in Leh district;
• Appropriate Technology for Asia (ATA), AP Tibet, Stongdey school in Leh, Zangskar and Kargil areas.

7.2.2 Policy linkages: a proactive step

To properly scale-up a project and have a significant impact it is necessary to work at the policy level in order to influence policy-makers in the form of advocacy work. It is a proactive process where trust plays an important role.

R&D program

A Research and Development program was conducted at the beginning of the pilot phase in 1998, in close cooperation with the SKUAST, a Leh-based research institute in order to give solar greenhouse the necessary legitimacy at the institutional level. Several demo farms were built to compare the solar greenhouse results to traditional ones for winter production. Results were particularly conclusive, the solar greenhouse had overall better characteristics than the traditional ones, and thus, the project was carried on a larger scale.

During the extension phase (2005-2009), cooperation with local institutions continued. In cooperation with the government Agriculture and Horticulture Departments, several different solar greenhouses were compared (wall, insulation, polythene sheets, crops, etc.). Because it resulted in slight differences, results were not convincing. Some agricultural research activities were also conducted by NGOs in demo farms or in their compound but results are not conclusive.

Problem faced

- Monitoring of the experiment has been done by NGOs and farmers that were not enough qualified. Scientists rather than social workers would have been more appropriate; and
- Positive results obtained from the R&D program have not been promoted enough within the institutional sphere (before government bodies especially).

Bottom-up linkages
At the initiative of the project management, several meetings have been organised at the grassroots level between the promoters, local elected representatives (councillors) and interested farmers to show the interest that the project has aroused among local communities. IGH visits were organized during peak winter to show councillors the results and socioeconomic benefits at the village level (food security enhancement, increase of incomes, health improvement, etc.). Once the councillors were convinced, they brought up the case at the highest political body (LAHDC) and tried to influence policy.

Through this advocacy mechanism, the government has started to support several individuals in building their solar greenhouse. Unfortunately, due to a lack of follow-up and landline Departments resistance, the results have been limited.

Top-down process
The local government has shown a high interest in the design of the solar greenhouse and this willingness to cooperate took shape in the second experiment phase in 2005 with the active participation of the agriculture and horticulture departments.

During the last year, a meeting was held between project managers and local government highest representatives (executive and chief councillors) to discuss a potential up-scaling of the IGH project through a government scheme.

High-level meetings were also held with the Member of Parliament (MP) from Ladakh, the State Minister and the State Head of the Agriculture Department.
Overall, several official presentations were given to:

- LAHDC Leh (Ladakh Autonomous Hill Development Council);
- LAHDC Kargil; and
- Lahaul & Spiti Tribal Development Department (Himachal Pradesh State govt.).

However due to sensitive relations between government and NGOs and within the government itself through partisanship systems, setting an effective and sustainable collaboration is an arduous process.

Results achieved

Local governments have either accepted to fund greenhouses or have started replicating by themselves the solar greenhouse design:

- In Himachal Pradesh State, with the Tribal Development Department and STAG/Ecosphere as an implementing agency;
- In Kargil District, the Commissioner started promoting the solar greenhouse design (with double walls and roof);
- In Leh District, the Agriculture Department funds 50 IGH and commercial greenhouses designed with roof; the Horticulture department of Leh has shifted from single-walls to double-wall design. The design is considered as the standard design for further promotion.
- Several local councillors support the construction of IGH in their jurisdiction.

The ideal step in the advocacy work would be to fully integrate the project components into a government funded scheme that would not be limited to design replication but that would include the training and follow-up components (design-target group-training-follow-up).

Key challenges

- Government has to match project's vision especially concerning target group (equality vs. equity) and implementation methods
- Internal rivalries between elected representatives and administration embedded in a partisanship system hamper effective collaboration
- Opposition between government and NGOs

7.3 Regional scaling-up strategies

7.3.1 Expansion of the project in Hindu Kush-Himalayas / Central Asia

Several IGH projects have been already launched in Central Asia and Hindu Kush-Himalayas based on the experiences accumulated in Ladakh, for example in:

• Kyrgyzstan in partnership with the NGO BIOM;
• Tajikistan, implemented by Oxfam in Khalton province and Little Earth;
• Afghanistan implemented by the French NGOs Madera and Solidarités, as well as Kabura and the Ministry of Agriculture;
• Nepal by ACAP and many local NGOs; and
• China where villagers have replicated the design based on the construction manual available on the ICIMOD website.

Limitations

Minor to significant modifications are required to adapt the design to local conditions such as farmers' investment capacities, climatic conditions (simple/double walls), material availability, etc.

The challenge lies into replicating the scheme from the design itself to the implementation methodology that includes important socioeconomic components.

7.3.2 Launching a Community of Practice on IGH

A Community of Practice (CoP) has been launched to expand the dissemination of IGH for the cold-arid regions of Asia: www.solargreenhouse.org. The main objective of this collaborative platform is to stimulate knowledge-sharing and learning processes within end-users groups and implementing organisations by:

• Providing information on the technology;
• Creating a repository of knowledge;
• sharing ideas, issues and experience for further improvement of passive solar greenhouse; and
• improving communication among field-level stakeholders.

By delivering effective knowledge-sharing services on IGH to a large number of partners, the CoP will participate in the dissemination of the technology and contribute to further improvements in adapting the scheme to a great variability of climatic conditions and socio-economical contexts.

7.3.3 The passive solar greenhouse awarded at the Ashden Awards

The passive solar greenhouse scheme has been awarded at the Ashden Awards for Sustainable Energy 2009, the world leading award on green energy. The aim of the Awards is to reward projects that use local energy in a sustainable way which benefits the environmental, social and economic spheres of a specific region. The Awards also provide funding for future developments of the activity.
The award has brought a substantial package of benefits:

• prize money to be used for up-scaling initiatives;
• a documentary film of the project;
• publicity, press release and broadcast media interviews on international and local media;
• awareness-raising of the project benefits as example of best practice; and
• long-term development support.

The internationally recognized award gives the project the necessary legitimacy for further development and replication schemes.

7.4 Knowledge management and communication

Along the four years, several communication tools have been developed for end-users as well as for project managers in order to participate in the dissemination of the technology within the local communities and among new organisations. These communica-

tion tools are freely available and the project encourages replication. The idea is to facilitate the flow of information concerning the greenhouse to make it freely available to the majority of people, in the same manner as a public good.

7.4.1 Manuals & case-study

1. Case study published at 1,000 copies on experience capitalization, general methodology and socioeconomic aspects intended to project managers and field workers (available in English);
2. Tool kits (in English) intended to NGO technical staff;
3. Construction manual for managers, technicians and farmers (in English, Tadjik & Russian); and
4. Running manual for:
• Managers & technicians (in English, Tadjik, Kyrgyz & Russian)
• Technicians (in English, Ladakhi, Urdu)
• Farmers (in English, Ladakhi, Urdu)

7.4.2 Movies

• Advocacy movie for NGO promotion (in English)
• Technical movie on solar greenhouse construction (in English, Ladakhi, Russian, Tadjik & kyrgyz)
• Technical movie on solar greenhouse running (in English, Ladakhi, Russian, Tadjik & Kyrgyz)
• Ashden Awards/BBC movie on solar greenhouse promotion (in English)

These documents and movies are available free of cost at:
• ICIMOD (www.icimod.org)
• Mountain Forum (www.mtnforum.org)
• www.solargreenhouse.org

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