DEVELOPMENT AND DISEMPOWERMENT
APPROPRIATE TECHNOLOGY IN DEVELOPMENT AID
IN THE HIGH HIMALAYA

by

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ABSTRACT

Since the second World War, western nations have been involved in various forms of *development.* as their contribution to the social and economic well being of the world population. In spite of these efforts, inequities and injustices prevail. Throughout this period, question have been raised on the effectiveness of this aid to development. Although strides have been made in global economic growth, development aid appears to have failed in the context of the cultural and spiritual needs of those receiving it. This has lead to the conceptualization of Appropriate Technology. The tenant of Appropriate Technology is that it emphasizes self-reliance and equity over simply growth. This study examines a model of development in terms of the concepts of Appropriate Technology and explores the basic physical and spiritual needs of people, as well as the impact on the environment.

This thesis addresses a case study of solar cookers as Appropriate Technology aid in Ladakh, India. The specific objectives are to: (i) examine the theoretical foundations of conventional development and of Appropriate Technology; (ii) describe the Ladakhi society in terms of its spiritual-traditionalism and of the impacts of recent, rapid change; (iii) use a case study involving the promotion of solar-box cookers, to examine the application of AT; (iv) analyze the relationship between components of solar box cooker programs on villager-perceived benefits and impacts of use; and (v) suggest possible improvements in the Appropriate Technology program's frameworks. The thesis concludes that development must address a central problem within its theory, that of pluralistic world views, in order to meet a mandate of improving the lives of the impoverished.

The findings of the case study concluded that there is no one *appropriate* technology, that societies are in flux and that local people must be involved in the identification and implementation of any growth that occurs. Technological change *per se* may result only in fragmentation of the social and cultural aspects unless the people affected are involved. The thesis concludes that development must address a central problem within its theory; that of pluralistic world views, in order to meet a mandate of improving the lives of the impoverished.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

> Talleyrand, asked for a definition of non-intervention, said it was a term used in politics that meant intervention (Black, 1991:1).

1.1 Objectives

The world has experienced over 40 years of *development.*[1] Conceived in 1949, development offered a model of global economic and social transformation. It produced a conventionalized and universal framework for poverty-alleviation through economic growth. *Development as a program* has undergone changes due to numerous failures in implementation. *Development as a singular mode of global social transformation* is now questioned. The loss of biophysical and cultural diversity, increasing violence, and rise in economic inequities casts a dubious shadow on the efficacy of development[2].

Technology transfer remains problematic, especially within the two-tiered structure of a developed-underdeveloped world. This is particularly true in instances of aid originating from the scientific-materialistic world view being transferred to a spiritual-traditional society[3]. Dissatisfaction with the concept, practises and results of development has led to a growing demand for careful evaluation of aid programs. This thesis examines the current model of development in terms of its ability to address the basic spiritual and physical needs of people and its impact on the environments in which they live. The thesis highlights the concepts of Appropriate Technology (AT) as a form of development aid designed to bridge the growing gap between aid deliverers and recipients. The study catalogues the components of the AT concept to determine how components relate to one another and create programs capable of addressing the conditions of the poor. The analysis is conducted with reference to a case study of AT aid in Ladakh, India, where technological

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1 Development, once simply meaning change or evolution, is now commonly used to describe both the philosophy of global change modeled on Euro-American experience, and the practice of aid programs intented to bring change to pre-industrial, impoverished societies.

2 Critiques of development include Black, *Development in Theory and Practise* (1991), Button, *The Green Fuse* (1989), Gran, *Development by People,* (1983), Moon, *The Political Economy of Basic Human Needs* (1991), Pereira, *Asking the Earth* (1989), Sachs, *The Development Dictionary* (1992), Shiva, *Staying Alive* (1989), among others whose opinions can be found in such journals as *Development Dialogue, The Ecologist* and *Third World Resurgence.*

3 See Pollard *Appropriate Technology: Appropriate or just a misfit?* in The Ecologist, Vol. 13, #1, 1983:27-34; or Henryk Skolimowski, *Ecology, Education and the Real World,* in Trumpeter 8:3, Summer 1991, for a discussion about the problems faced when transfering world views between societies.

change is resulting in fragmentation within a traditional society. As an example of AT, this study looks at the use of solar cookers to address fuel problems in hinterland and urban areas in this remote, Himalayan district. In this sense, the study provides useful insights on the gulf between concept and practice in development aid.

The objectives of this thesis are to (i) examine the theoretical foundations of conventional development and of Appropriate Technology (AT); (ii) describe the Ladakhi society in terms of its spiritual-traditionalism and of the impacts of recent, rapid change; (iii) use a case study, involving the promotion of solar box cookers, to examine the application of AT; (iv) analyze the relationship between components of solar box cooker programs on villager-perceived benefits and impacts of use; and (v) suggest possible improvements in the AT program's frameworks.

1.2 Background to the problem

As a concept and practise, development is born of an occidental world view. It was adapted from its ecology-based meaning of "unfolding of the predetermined" to encompass humanity's move toward a more perfect form of political, social and economic organization (Esteva in Sachs 1992:8). The means to reach this perfect society were based within the scientific-materialist world view that provided for the industrial and technical revolutions in the West. Development was based on a monologue as the mode of transfer, economic growth as the tool, and poverty alleviation as the goal[4] (Rosenthal, 1984:88-9).

The bi-polar world of the developed-underdeveloped came into being within an altruistic reasoning to continued and rapid economic growth[5]. Under-development is credited with creating the Fourth World[6], where societies and their environments became further impoverished through their forced participation in a process of westernization (Pitt, 1976:266). After 20 years of aid, there were calls to redefine the approach to development. In 1973, Robert McNamara declared "development has been a failure" (IBRD, 1981:242). Thirteen years and several redefinitions later, the World Commission on Environment and Development reminded the world that "The gap between rich and poor nations is widening-

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[4] Through both the Marshall Plan and International Development Aid.

5 In early development document, from the Truman era, U.S. goals are clearly stated as using aid to produce economic security and continued growth, halting the spread of communist fundamentalism and supporting the moral obligation to alleviate poverty. See Goldsmith, 1992:12.

[6]The Fourth World consists of Third World, subsistence peoples who became impoverished through warfare, dislocation and particularly through the development or modernization of their society.

not shrinking-and there is little prospect, given present trends and institutional arrangements, that this process will be reversed" (WCED, 1987:12). Again, in 1992, the UNDP declared the 1980s were "a decade that shattered many lives and many hopes-with mounting external debt, faltering economic growth, increasing unemployment, growing civil strife, rising ethnic tensions, threats to the environment and the persistence of abject poverty" (UNDP, 1993:9). Why, after years of restructuring approaches and shifting goals within development, has impoverishment persisted?

E. F. Schumacher began questioning development while working as an economist in Burma. "If 90% of these people are impoverished according to global standards," he wrote in his letters home (Wood, 1984:260), "then why are they so happy?" Schumacher used his questions to conceptualize a different form of aid, *development as if people mattered.* His Intermediate Technology Development Group (ITDG) explored a pluralistic world development, which allowed room for a developed society outside the occidental paradigm (Pollard, 1983:32). Its tools and techniques stressed meeting local needs and localized definitions of sufficiency, balance and change. Successful development was dependent on reinvesting in knowledge at the village level, where people made informed choices about their future (McRobie, 1981:2).

AT is one manifestation of Schumacher's work. As ITDG looked for an intermediate technology, not modern nor traditional, AT looked for technologies within development programs that were locally appropriate (Carr, 1985:45). AT's technology is people's technology; not that reserved to the already rich and powerful. The philosophy is contained within India's *swa-raj* (self-rule) and *khadi* (wholescale self-reliance) (Hoda, 1976:145). The idea was not to develop toward an externally defined utopian vision, but to fit change into existing local social, economic and political systems.

AT challenged some of the assumptions and actions of conventional development. *Pluralistic development* implies accepting that there are many possible models of a developed society. *Khadi* and *swa-raj* suggest decentralization and self-reliance over inclusion in the global economy (Kantowsky, 1980:11). AT tends to channel aid through grassroots movements, and stresses redistribution of wealth and intellectual ideas over economic growth (Daly and Cobb, 1989:290; Freidman, 1992:74). In essence, AT uses the eastern concept of the *middle path,* striving toward balance before growth, meeting needs before unlimited wants (Sen, 1992:104). On paper, AT appears to be capable of

using an already existing global institution (development aid) to create self-reliance and support a sustainable system.

In practice, the radically different mode of development suggested by AT remains within convention in some important ways. Underlying AT's benign conceptualization are practices of enforced change and imported world views. Critics[7] question the degree to which AT allows indigenous value systems to define *appropriate.* They also argue that techniques, purpose, use and approach behind a given tool, remain largely western within the market system. It is a band-aid approach to traditional culture's breakdown in the face of rapid change (Nandy, 1983:149).

When the world view of a spiritual-traditional culture comes into contact with that of a growth-centred, modernist and powerful society, is an *exchange* within change possible? Among the Buddhist peoples of the Western Himalayas, the question of what form development will take, is fundamental to their survival. When *development* brings its technologies and strategies for growth, resource exploitation and market competition, the local people have great difficulty understanding the purpose of this change. Unless chosen technologies and programs coincide with their spiritual world view, it is debatable whether or not the transferred technology can address local needs and improve standards of living.

While the debate continues, trillions of dollars are spent each year for development. While programmers try to fit design to need within a world of confusing political barriers, the results are increases in the incidence of hunger, violence and environmental degradation (WCED, 1987:7-29). Development agencies, whether multi-lateral or grassroots, might be better served by asking the recipients of aid, *why development?*

This question of *why* was taken to some aid recipients in Ladakh, India. A case study of solar box cookers within AT aid, is used to compare the promises of the "middle path" of AT to actual field performance (Schumacher, 1973:56). The study offers empirical data, gathered from aid program directors and hundreds of aid recipients who participated in four different programs, on the impacts of aid. The study is incorporated into this thesis, which offers information within the vein of conciliatory problem-solving. It provides suggestions, already evident to some of the villages surveyed, for improvement in development program structure.

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7 See, for example, David Burch, Nicolas Jequier, Nigel Pollard, Witold Rybczynski, C. P. Timmer, and M. Willoughby.

The rationale for this work is founded on the belief that the complexity of problem solving and the multi-disciplinary nature of programming within the development arena, demand accurate data and careful analysis. Problem evaluation should be carried out within an interdisciplinary framework, with attention to workable, conciliatory suggestions for change. Conclusions are directed toward positive change, at a local or project level, within development, rather than creating yet another critique of development as a whole.

1.3 How does this apply to Resource Management?

The fact that *outside-intervened, imposed social change has never been successful in the long run*, (Friere, 1970:122-3, Illich, 1968:41) is of fundamental importance to the critique of past development aid and its philosophy, to the evaluation of AT in Ladakh, and to all professionals within resource management fields. How can development survive and how can resource managers be effective in their work unless this central tenet is recognized and dealt with? As deliverers of *development* - ideas, technologies, programs, projects, management schemes and the power they represent, - resource managers must realize that investment of ownership of all of these must be within the local community. In the future, resource managers will fulfill a new and important role in communities, that of liaison, supporting local choices in social change. Resource managers may work as facilitators, providing the outside input needed to initiate change, encouraging cross-cultural communication, and interfacing between the possibly extremely differing world-views of the deployers and recipients of aid.

1.4 Why Ladakh?

Ladakh, a district within the state of Jammu and Kashmir (J&K), India, occupies the westernmost edge of the Tibetan Plateau. It is a high altitude desert, isolated from neighbouring regions by the highest mountain ranges in the world. Over thousands of years of habitation, durable relationships between humans and nature were established in this land of scarce resources and harsh climate. Lacking exploitable resources, change did not come to Ladakh in the form of invasions or conquests. Instead, it came either along trade routes (stretching west to Istanbul and east to Beijing), or through the religious teachers (and texts) of Mahayana Buddhism. However, over the past 30 years, Ladakhis have experienced a new form of change. Through the efforts of the Indian National Government and numerous international aid agencies, *development* has come to Ladakh.

For numerous reasons (e.g., its geographic isolation, resource scarcities and isolationist policies of India) Ladakh escaped the full onslaught of numerous development fashions. It was not *severely* impacted by massive industrialization, the green revolution, human development or other early forms of aid. It has experienced these, but generally later and in less volume than did other parts of the Third World.

Again, for many reasons (including road construction connecting Ladakh to the outside world; an Indian program emphasizing Wastelands Development; the growing dependence on IMF loans; and tourism), Ladakh is currently experiencing a large influx of aid. Typically, development in Ladakh takes one of two forms. Some aid is within national progress programs, to electrify villages, build road linkages and provide social system infrastructure. Money invested in these programs is generally delivered by the Centre[8] and projects tend to be large-scale and directed by outsiders. The second form of aid is that of sustainable, grassroots or AT development. These strategies pay more attention to existing ecological threats, cultural maintenance and meeting basic human needs. This aid tends to be internationally financed, supporting smaller, participatory projects and is decentralized in delivery. Almost all aid in Ladakh retains the development paradigm: a universalized definition of poverty, that this poverty is the nemeses of progress, that economic growth will alleviate poverty, and which uses the materialist world as the model to follow (Angorama, 1992).

However, some aid agencies in Ladakh have discovered that societal goals cannot be met within conventional aid strategies. The traditionalism of the Ladakhis considers spiritual growth, social balance and ecological co-existence as their concept of progress (Norberg-Hodge, 1991:137; Rizvi, 1982:115). How, the agencies asked, can international aid be used to help meet local goals within a country and, a world, increasingly turning to another economic paradigm?

Within AT aid in Ladakh, a full spectrum of the concepts, practices, technologies and goals exists. Some aid is geared toward economic problems, other forms target the rapidly-growing problems within self-reliance. These differences allow undertaking a comparative study of the impacts of aid. One particularly problematic introduced technology supported

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[8] The Centre is the national government in New Delhi.

through AT is the solar box cooker (SBC)[9]. Programs use SBCs (as a part of holistic community health strategies) to address growing fuel shortages and expenditures, and energy-related health issues. The SBCs make use of some of Ladakh's abundant supply of solar energy to cook food and heat water. The cookers are designed as a supplementary cooking stove, to be used in conjunction with traditional or kerosene stoves. To differing extents, the programs encourage village sufficiency and respect for traditional tools and practices. Encouraging use of SBCs is difficult in that these tools must interface with the traditionally-important kitchen and hearth. Within this problem, the social, technical and economic aspects of technology transfer can be seen. How aid groups approach the puzzle, and how the users adapt to a new technology, allows for an evaluation of AT in practice.

Ladakh presents numerous advantages to the researcher wishing to study the intentions and impacts of aid[10]. First, the entire history of development aid is immediate in Ladakh; it is known to the people currently living there. First-hand experience is common and documentable in almost all villages. Second, records of most development projects *in situ* can be examined. Third, many technologies (used in development work) are still in place, so the technical capabilities of these devices can be rigorously tested. Finally, there are people, both outsiders and Ladakhis, living in the area who question the impacts and effectiveness of aid, along with the contribution development makes to this isolated society. These people can contribute a great deal of relevant information and experience to any development study conducted in Ladakh.

The dilemma presented by the Ladakh case study is that of a perceived need to develop a region supporting a culturally rich, long-lived society that appears under-developed, within western measures of gross economic production. Recognition of this dilemma helps to address the fundamental question I am interested in here: *"Is development needed?"* Furthermore, the Ladakhi case offers some answers to the question: "Can *aid support cultural diversity and meet basic needs, while accepting the potential for differing definitions of 'developed'?"*

This study documents the lack of attention to, and consensus on, the definition of *needs* in a community. It attempts to illustrate the numerous factors affecting the acceptance,

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[9] Solar box cookers, solar cookers, cookers and SBCs all refer to the passive solar technologies used within AT aid programs in Ladakh. These terms will be used interchangably throughout the thesis.

[10] This information is based on personal experience from a 1989 research project on the impacts of AT tools and programs on the agro-ecology system in Ladakh.

effectiveness and impact of development projects. It asserts that many of these factors are neglected in planning and implementing development aid. It documents the need to recognize local values that assist in producing community self-reliance and self-respect. Finally, the study suggests areas where program changes might result in more appropriate expenditures in development aid. The Ladakh case study presents all the necessary components for an in-depth exploration of issues fundamental to the development argument, and for opening the dialogue between the various factions within the development problematique.

1.5 Research Questions

This study focuses on the use of AT aid to provide greater energy self-reliance in Ladakh. From a case study of the introduction and use of solar cookers, two main issues emerge. The first addresses whether solar cooker technologies are an appropriate supplement to traditional and fossil fuel source. The second issue looks comprehensively at local people's needs, and asks if solar technologies can meet these needs. Specific questions addressed in this thesis are:

1. Are locally-defined *needs* in energy use patterns reflected in *methods used to address needs* in AT development programs in Ladakh?

2. Are technically-capable solar box cookers promoted by the AT programs in Ladakh? are these cookers actually being used by local peoples? Do these capabilities address locally-defined needs?

3. Are AT programs structured to facilitate positive impacts, acceptance and use of solar cookers?

4. Is there a correlation between frequency of use of solar cookers and village-defined need, willingness to use, tool capability, the user's understanding of the tool, net positive impacts in villages, and ease of use?

5. Are there significant differences between villages or between AT programs in Ladakh with respect to solar cooker use?

6. What conclusions can be drawn from this particular case study in reference to the design of future AT programs and their solar technologies?

These questions are addressed first by examining the development-underdevelopment problematique from the more Hegelian viewpoint of the AT movement. The study looks at AT's methodology of working within the conventional framework of development aid, while supporting self-reliance and diversity in cultures. The questions are then dealt with in the context of an seven month case study of solar box cooker programs supported by AT development aid in Ladakh.

1.6 Limitations and Scope

As a work that addresses the technical, cultural and spatial attributes contributing to the acceptance of new technologies and their introductory programs, this thesis is inter-disciplinary by nature. It depends on contributions from numerous branches of study, in particular, concepts drawn from anthropology, engineering and planning, sociology and theology, all contained within development studies. However, due to time and length constraints, there are aspects of the biophysical, socio-economic and political impacts of development aid that are not fully explored.

This thesis depends heavily on work published by people of the "Third World" on the impacts that aid and technology have had on them. India, and its grassroots movements, is a leader in the anti-development and alternative development approaches. All too often, these voices are heard only through the interpretations of western scholars, or are seen in studies published by researchers who spend little time in the field. What is lost in such translations is unknown. While recognizing the valuable contribution many western authors have made to development theory, I prefer to draw on the works of those impacted by development whenever possible.

One of the inherent limitations of grassroots movements is their lack of funds and infrastructure to undertake careful scientific and policy analysis of aid impacts and the technologies they introduce. The groups working in Ladakh invest most of their time and money on the day-to-day functioning of projects and organizations, so few resources are available for research. Often there is great disparity among what is known to these groups, the perceptions of visiting outside researchers, and what is published in Western journals. The capability of introduced technologies, the people's reactions to and the overall impact of these technologies, and the change in policy over the years of development aid, can be intelligently discussed by many working in Ladakh, but it remains largely unpublished. This is a reflection more of grassroots and alternative development groups' priorities, not

of their knowledge of the subject. This study is, as far as this author is aware, the first systematic evaluation of use, impact and technical capability of four AT programs' solar box cookers projects, over three seasons' use in Ladakh. This study could not have been completed without the previous work undertaken by the Ladakh Project, the Ladakh Ecological Development Group, the Leh Nutrition Project, and the Central Tibetan Relief Committee.

The key to research on use of ATs is an understanding of the reasons why people use, or do not use, technologies, the desired impacts of using technologies, and the significance of villagers' household organization. It should be clear to other social scientists that eight months in the field is insufficient time to gather accurate ethnographic data. One of the premises of the development critiques is that universal frameworks, designed from very small trials, working across religious, cultural, biophysical, socio-economic and spatial bounds, are limited. I agree with this belief and think that the value of the results from my study in Ladakh are best suited to the application of AT work in Tibetan and Ladakhi communities.

1.7 Methods

In order to carry out the research in this thesis, the following methods were employed. First, a literature review and consultation process was undertaken. This addressed issues within the theories of development and AT approaches to aid and served as preparation for field work. Second, interviews and archival research in Leh, Ladakh, provided information not available in North America; in particular, the unpublished reports from AT programs operating in Ladakh. A field survey was conducted within Ladakh. Data analysis of information gained in the field, exploring means and trends was undertaken. Finally, a test of the AT theoretical framework for *appropriateness* was conducted.

Within the field survey, data were gathered through seven means. An experiment was conducted to test the technical capability of the solar cookers used in the AT programs. Interviews with program directors and technicians supplied programmers' views on the AT projects. Surveys of 283 solar cooker users were conducted in 26 villages. Observations were used to supplement or validate survey information. Repeat visits were made at 13 survey sites. Finally, a participatory research program was undertaken in the Tibetan refugee camp in Ladakh. The program was used to test the technologies and methods used in other cooker programs, and to offer suggestions for future changes. Conclusions drawn

from this entire body of work are used to suggest i) areas of needed future work on this topic, ii) suggestions for change within AT programs in Ladakh, (iii) concepts relating AT to community self-reliance and (iv) some implications for resource managers.

The nature of the question, *does technology transfer work?*, demands information from multiple sources and numerous disciplines in the natural and social sciences. The question suggested collection of empirical data from the deliverers and users of technologies, and from within the context of its use. This was undertaken in several ways. First, making use of a case study allowed for the exploration of unique, contemporary events (AT aid programs and their adoption by AT users) over which there was little control. The case study allowed for collection of information on how programs were structured and received, how components of programs interacted, and why certain assumptions on needs and ways to address needs were developed. By comparing four differing AT programs in the case study, internal and cross-program comparisons could be used to help explore the impacts of solar cooker use as a form of technology transfer (Patton, 1980:64-5).

In addition, the research question demanded a cross-cultural study, including an interface between aid donors and recipients. Information gathered in surveys was supported with data from the cooker experiment, interviews, and observations. First hand experience with each of the cookers used in the AT programs added to the researcher's ability to evaluate results. The experiment provided important, comparative data on all models of cookers used in the four AT programs. Researchers, program directors, technology users and non-users, and village leaders offered unique views about the value of SBC projects. Together they offer a more representative picture of what was happening within the four programs in Ladakh. Numerous translators and several different surveys and observation techniques were helpful in obtaining the qualitative data.

Due to the lack of previously published data, knowledge was generally located within the experience of the people participating in development. The researcher was an active participant in the introduction and evaluation of one of the four SBC programs; located within the Tibetan Refugee camps of Ladakh. The disjoiner created by traditional research methodologies of *whose* knowledge or social reality is valued, is only just developing in Ladakh (See Chambers, 1983:54-56, and MacGuire, 1989:8). Most of the study's participants did not recognize a positivist hierarchy of fact and knowledge (that is, only that of recognizing observable facts as valuable). To avoid suggesting a hierarchy of knowers in a social reality, and practicing "research imperialism", all persons' observations were

accepted on equal grounds. It was hoped that participants would not be distanced from the work, its results, and their confidence in their own form of knowing.

The data collected in surveys and observations often dealt with concepts and phenomena commonly known only to the Ladakhi and Tibetan people. For example, the data included views on the presence of *lhas* (spirits) in the house and appropriate treatment of, or coexistence with, these spirits, even though these phenomena are outside the experience of the researcher. What has significance to the Ladakhis and Tibetans themselves is reported in this study. The closeness of the researcher and client, made possible through the use of participatory work in the refugee camps, aided in bridging the knowledge gaps found early in the field work. This practice was vital to clarify both problems and solutions. It is therefore suggested that participatory research was the most logical choice for this particular study.

I remained as objective as possible in undertaking and carrying out this research. Never-the-less, it is inevitable that personal biases may have emerged. I have taken great pains to ensure the integrity of this work by presenting various viewpoints throughout the text while attempting to clearly state my own position.

1.8 Organization

In the next chapter the theoretical context of the thesis is presented. In order to access the impacts of AT within Ladakh, it is imperative that the contexts of aid and Ladakhi society be understood first. A brief history of development aid is accompanied by questions raised concerning the impact of conventional aid programs. Doubts about the efficacy of aid, and the redefining of development, gave rise to the Intermediate or Appropriate Technology approach to aid. The chapter then explores the components of AT that may offer potential for bridging the gap between conceptual goals and practical results in development aid.

The context of the case study is set in Chapter Three. Salient aspects of Ladakhi society, especially the dynamics of traditional social change and their system of spiritual ecology, are explored. The geography, history, basic village socio-political structure and response to recent development aid are examined to offer a greater understanding of Ladakh. The different institutional structures that provide continuity and stability to the traditional societal framework are described. The indigenous sense of self-reliance, sufficiency, and self-respect are contrasted to the world's perception of Ladakh as under-developed. This

contributes valuable information to local and outsider differences in defining *appropriateness*, and will aid in understanding Ladakhi reactions to outside-intervened change.

Chapter Four presents the results and discusses the case study of four AT programs making use of SBCs in Ladakh. It describes the archival work, survey methods, survey design and nature of the SBC performance testing used in the field. It presents the results from technical capability tests of six models of SBCs, used by the four AT programs. It uses the AT framework for determining *appropriateness* to examine the technical capability and social acceptance of the cookers. It does this through presenting survey results of questions addressing the users' need for change, willingness to use, SBCs technical capability, program frameworks and support systems, locally-incurred benefits from use, and frequency of SBC use. Results are discussed by comparing the performance of cooker models, components within each of the programs, and relationships between these and actual use of the cookers. Finally, it lists areas where programs might improve performance and acceptance, and the local barriers to change suggested from the data.

In the concluding chapter, differing perceptions of development are considered. Determination of *appropriateness* is considered within the case study of solar cooker use, and from the distinct Ladakhi viewpoint. Components of the *appropriateness* equation that contributed to use of some cookers, and, through their absence, to the non-use of others, are identified. Through comparing areas where successes were seen in the four programs, of suggestions are offered for future improvements in AT delivery. Finally, the numerous barriers to the acceptance of AT are discussed. These include the impacts of using a global model within development, mismatched goals within development aid, the "foreclosure of options" through investment in inappropriate technologies, and the loss of self-respect in a culture defined as underdeveloped. It considers the "Trojan Horse concept"[11] of a pioneer technology bringing unintentional or uncontrollable change into a society.

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11 "Throughout all classes, nationalities and religions the consensus was for 'more technology' because technology was viewed as powerful but neutral, entirely at the service of the user. In reality, of course, a model of civilization follows hot on the heels of modern technology. Like the entry of the Trojan horse in the ancient myth, the introduction of technology in the Third World paved the way for a conquest of society from within." (Sachs,1992:13).

CHAPTER TWO
DEVELOPMENT WITH A HUMAN FACE

> The Age of Enlightenment, and the theory of progress to which it gave rise, was centred on the sacredness of two categories: modern scientific knowledge and economic development. The act of living and of celebrating and conserving life is sacrificed to progress, and the sanctity of life has been substituted by the sanctity of development. (Shiva, 1988:xiv)

In this chapter, the history of development is briefly examined. The link of multiple world views to failings within conventional development is considered. One radical departure from basic development precepts, that of Appropriate Technology (AT), is explored[12]. The potential for success within this movement, which invests aid in simple technologies and indigenously-designed programs, is discussed. Finally, the AT's potential for addressing locally-defined needs within pluralistic developments is considered.

2.1 Identifying the problem

Development is a word with great power. It is used to denote the process of global social transformation, revealing power through that process' implied scope and scale. However, it is also a 'plastic word' artificial and pliable in that it encompasses concepts so varied that it loses meaning (Porksen, 1992:1). Taken literally, it is the act or process of growing, progressing or developing. Within the context of international development aid, it encompasses humanity's move toward a more perfect form of political, social and economic organization (Lele, 1991:607). In practice, development is meant to use economic growth to increase human welfare and bridge the gap between the impoverished, traditional world and that of modern affluence (Berthoud, 1992:72; Simmons, 1992:16).

A problem with implementing development is its polarization of diverse cultures into just two categories, the developed and the underdeveloped. The terms intone a superiority to the lifestyles that define the western world. Using the western world as a model of development, it then suggests a singular path in a competitive economic system and a

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[12]The following convention will be adhered to: AT (initials capitalized) will denote the general concept and concept as practised associated with the Appropriate Technology movement, AT represents the movement, innovation, strategy or mode of technology-practice. Technology or tool (plain text) is the actual technology, the artifacts themselves as used in the movement. Italics will be used when emphasis is warranted or to signify an oxymoronic use of the term.

consumer-based society These foundations make multi-faceted change questionable (Chossudovsky, 1992:10).

2.1.1 From colonization to development

As a concept, development slowly emerged from the word's biological and evolutionary use in the late 1700s. It was seen as:

> ...the process through which the potentialities of an object or organism are released, until it reaches its natural and complete, full-fledged form (Esteva in Sachs, 1992: 8).

Development moves from the *appropriate* form of a being towards an *ever more perfect* form. Social scientists adapted the biological use of development to suggest there existed a uniformed perfection in social structures (Wilbur and Jamieson in Wilbur, 1984:12). This application of the concept within societal development is problematic in two ways. First, it negated the human and environmental "surprise" in evolution, especially the creativity shown within adaptation (Pannikar, 1993:6). Erroneously, people were catalogued into mechanistic and predictable units to be developed by outsiders. Second, it became accepted that the industrial mode of production and social institutions in the west were components of the model for the ever more perfect form. Developing the entire within a singular model was first implemented through colonialism and then realized through development aid (Rosenthal, 1984:88-9).

Colonization provided for the concentration of wealth underlying industrialization and creation of modern empires (Chandra, 1973:24-25). In this process, colonization supported a paternalistic relationship between Europe and the colonies, and created the wealth and power to globalize this two-tiered world (Banerji in Bagchi, 1983: 38). Colonization allowed for the construction of infrastructure for resource exploitation, transplanted the European socio-political system, and encouraged de-skilling of people and dishonouring of traditional knowledge and culture (Nandy, 1983:148).

The ideology and institutions nurtured by colonial rulers remained in place after independence (Moon, 1991:215). By the end of the Second World War, colonialism and imperialism became politically unpalatable to the war victors. Economies had grown dependent on an international market system (Dube, 1990:1-2; Moore-Lappe, 1987:146). The newly independent countries were led in-large by colonial-trained cadres in search of a national vision. The post-war structural adjustment left western economies in search of

new directions. The budding scientific and technical revolutions needed peace-time challenges. Continued economic expansion was dependent on creating greater ability to consume products and services. The threat posed by the spread of communism was seen as the post-war challenge in the west; the threat of capitalist market capture and exploitation of the liberated colonies to be defended by the communist world (Pereira, 1988:10; Webster, 1984:89; Weismann, 1974:38-39). Development as an altruistic yet rational investment met the goals of the new world order (Dedijer, 1972:22). The spirit of the time is reflected in President Harry Truman's inaugural address:

> The peoples of the earth face the future with grave uncertainty. In this time of doubt, they look to the United States as never before for good will, strength and wise leadership. It is fitting therefore that we take this occasion to proclaim to the world that...We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas. More than half the people of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to more prosperous areas. For the first time in history, humanity possesses the knowledge and skill to end the suffering of the people. The United States is preeminent among peoples in industrial and scientific techniques. I believe that we should make available to peace-loving peoples the benefits of our stores of technical knowledge in order to help them realize their aspiration for better lives. And in cooperation with other nations we should foster capital investment in areas needing development. Such new economic development must be designed and controlled for the benefit of the peoples of the area in which they are established. The old imperialism - exploitation for foreign profit - has no place in our plans. What we envisage is a program of development based on concepts of democratic fair dealing (Truman, 1967:341).

2.1.2 Problems in the paradigm

Development was born in the west, within post-war leaders who made clear the economic, political and social intents of development aid. Development's mandate was to 'transform all self-sufficient, subsistence forms of existence by introducing them to progress' (Groynmeyer in Sachs, 1992:66). Both in its pragmatism and its altruism, it was designed to deal with the growing poverty in the non-industrialized world. Just as the development conceptual model had transferred from Europe to North America, technological advances and wealth concentration could create the same positive change elsewhere. While there was no room for the 'old imperialism' in development, there was also little questioning of

transferring Euro-American technology as the means to deal with poverty. (Hancock, 1989:70).

The first twenty years of development resulted in enormous advances, particularly in infrastructure, agriculture and medicine. Yet poverty persisted and by the 1980s was growing in many parts of the Third World. Redesigning the development process, and redefining the nature of the poverty-problem and economic growth-solution, did not lead to success (Shiva and Bandyopadhya, 1989:112). Max Weber (quoted in Kantowsky, 1980:181) believed the social evolution of Asia could not "catch up to Europe" until it adopted "Euro-American Protestantism and discarded its "other-worldliness". In a 1990 World Bank report on aid in India, it was stated that chances for the success of aid were limited as aid continued to be "concentrated in areas where [it was] not likely to have large impacts on growing poverty" (Lipton and Toye, 1990:41).

Here, critics say, is the heart of development's failure. According to Esteva (1993:22), development was not a *sense* of western culture, but *wholly* western. Development was not to be a synthesis of global ideas, or a locally-controlled process. Instead, its "underlying presupposition of a western anthropology and cosmology" only supported only one world view, one set of social institutions and one societal goal (Panikkar, 1993:2). This scientific materialism paradigm based life goals on hard work for individual gain, stress on capital accumulation, and the importance of scientific and technological advances. Two assumptions were made: first, that all societies should, could and wanted to participate in a global modernism; second, that the scientific-materialist world view held the path to poverty elimination (Kothari, 1981:14-15). Within this critique of aid, Shiva (1988:10) wrote:

> Satisfying needs through self-provisioning mechanisms was equated to poverty; the cultural perception of prudent subsistence living as poverty has provided the legitimization for the development process, and through dispossession and deprivation the development process created real poverty. Insufficient and inadequate participation in development was labeled the cause for underdevelopment. *But actually, loss of political control through enforced participation in development creates underdevelopment.* (emphasis added)

The possibility that involvement in development could create under-development[13], merits examination, as it is central to the genesis of alternative development movements.

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[13]Rarely was the term *underdeveloped* used to refer to people living in Europe or North America. More commonly, *impoverished* was used, often to describe living conditions in minority communities or rural

2.2 Dualism within development

Self-reliance, as described in the Cocoyoc Declaration of non-aligned countries in 1974, would probably not lead the Third World to the wealth of Euro-American development. It would, however, support a development that met the very different goals of societies that could not find legitimacy in modernism. Cocoyoc development supported:

> ...self-confidence, reliance primarily on one's own resources, human and natural, and the capacity of autonomous goal-setting and decision making. It excludes dependence on outside influences and powers that can be converted into political pressure (Sen, 1989:750).

Fromm describes the spiritual-traditional society as one based on *being* rather than *having*. The traditional society has difficulty with competitive materialism and its endless, unfulfilled desires (Fromm, 1979:114). Tonnes perceived healthy societies as those of mythical wholes, where knowledge, participatory governance and direct relationships with local environments preserved values and collective rights. According to Tonnes (quoted in Jones, 1983:142), the myth, legend, folklore, poetry, and magic necessary to create the social institutions and ultimate meanings of traditional societies could not fit in "fragmented, self-motivated, ego-centric, *gesillschaft* societies".

These traditional societies made high demands on, and limited the freedom of individuals. Complex kinship and family ties created an interwoven web that, while it did not provide for individual freedom, maintained the basis for self-respect and security. "No sustainable society is possible when nobody owes anything to anybody else" (Berthoud in Sachs, 1992:85). What was seen as violations of rights to outsiders, were considered the constraints which provided for harmony of the community as a whole.

Sarvodaya is the Indian traditional society's conceptualization of development. Translated as 'the welfare of all,' *sarvodaya* supports economic, social and political self-reliance at the village or regional level (Kantowsky, 1983:182-183). Inequity and resource exploitation are discouraged through a complex system of inter-relationships, self-reliance is possible at the regional level, but not the individual (Kothari, 1982:211). Gandhi (1965:52) supported

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areas with a large percentage of the population was dependent to some degree to subsistence farming. A clear distinction was made between the not-evolved intoned by underdeveloped, and the not-materially sound impoverished.

the movement as a means to adapt modernism into existing traditions to suit local needs and avert the chance for devastation:

> God forbid that India should ever take to industrialism after the manner of the west. If (we) took to similar economic exploitation it would strip the world bare like locusts.

When India gained its independence in 1947, Gandhi, philosophic leader of the *Quit India* movement, offered advice to the new prime minister of the country. He suggested that India not follow the path of its colonial past, nor that of its colonial ruler. He dismissed the modernization thesis of a high technology, capital- and energy-intensive world seen in both the West and the USSR. Gandhi suggested *sarvodaya* as a means to support the diversity of India's cultures and make use of the knowledge, science, technology, and human resources already in place. He fought the argument that *sarvodaya* could not function in the modern world, with its set of complex problems. Gandhi suggested that there "was absolutely no evidence that industrialism can function in today's world, with its set of complex problems" (Gandhi 1968:336). If India were to survive, Gandhi insisted, then all of its diverse cultures must be empowered to improve their own lot (Hoda, 1972:40).

Biswas (in Sen, 1992:264-265) uses a story about the *Vynad* people of the Western Ghats of India to illustrate the problem of development. "The politicians and international do-gooders were sent to the tropical, mountainous home of the *Vynad* because the tribals were backward, and experts could bring them forward". Without asking the people, the *Vynad* houses were replaced with ones inappropriate for the climate; they tended to melt in the rains. The project was undertaken because of a nationalized development scheme that stated traditional homes, *kuccha,* of simple mud and thatch, were to be replaced by those *pucca* ('good') ones, of brick and mortar. As soon as the experts left the villages, the *Vynad* "returned to building *kuccha* homes, not understanding why the outsiders insisted on something different". Homes that were *pucca* in Delhi made no sense locally.

In 1981, the newly-appointed Development Officer of Ladakh, responsible for the modernization of this 'backward' district, commented to a long-time resident of the area, 'people were not particularly interested in sacrificing their leisure or pleasure simply for material gain...If Ladakh is ever going to be developed we have to figure out how to make these people more greedy. You just can't motivate them otherwise" (Norberg-Hodge, 1991:141).

Appropriate aid does not abandon the 'other-centred worlds' but makes room for their concept of progress (Sen, 1983:762). In recent years the re-designing of aid recognized the value of pluralistic world views. It allows for capital development in some geographic areas and societal realms, and non-material development in other realms (Daly and Cobb, 1989:165-169; Freidman, 1992:72-74). It insures that costs and benefits are defined in meta-economic terms, and are accounted for locally. Pluralism solicits the full participation of the people defined as underdeveloped and values their ability and right to identify community needs. To temper this, it makes clear distinctions between wants and needs and provides for security over large-scale capital risks (Rau, 1992:68; Shiva, 1989:67).

2.3 Development as if people mattered: Appropriate Technology

One such form of re-development, AT, grew out of the threats modernism presented to traditional societies or marginalized peoples. Its conceptual roots can be traced to *sarvodaya,* M. K. Gandhi and, in particular, E. F. Schumacher. Projects were aimed at recreating sufficiency, in ecologically, socially, politically, economically, scientifically and culturally sustainable systems. AT works within the premise that technology always changes a society; therefore, the closer the match between tool and societal goals, the better the chance of change being appropriate. In post-independence India, AT developed as a middle path to change.

2.3.1 Let goods be home-spun

Worried about the negative impacts of continued technological or economic dependence, the *sarvodaya* approach to development was espoused by some of the great philosophers of India (Narayan, 1978:2-3). A national program of *antyodaya,* the decentralization of economic and political power to the grassroots, they said, would be economically sound, allow for local control on resources and change, and move India toward *appropriate* development (Gandhi, 1966:61; Hoda in Jequier, 1976:146).

Prime Minister Nehru (quoted in Narayana, 1972:67) fundamentally disagreed with this utopian, vision. He was determined to liberate the 'insular and backward' villagers, who were the barrier to India's ability to become 'internationalized and advanced'. India must be competitive first, not sufficient on the micro-level, with large-scale industrialization, modern infrastructure and support of urban workers. Although *sarvodaya* was rejected by post-independence governments, it flourished in the informal sectors of tens of thousands

of villages. Having no access to the international development aid of the 1950s and 1960s, these villagers created their own agricultural, technological and economic possibilities to deal with emerging problems[14] (Krishnaswamy in Kurien, 1991:171; Srinwasan in Sethna, 1979:262-265).

2.3.2 Technology with a human face

Some of the results of India's industrialization were in sharp contrast to the concepts of the Gandhian model[15]. Aid programs seemed to create greater disparity and impoverishment[16] (Douthwaite, 1992:233). Hoda (1976:149-150) saw development not as a deliberate form of exploiting India, but "largely incapable of aiding India" as it was "largely incapable of understanding India." In the 1950s, E. F. Schumacher[17] visited Asia to study the dilemma of development (Willoughby, 1990:59,62). His experiences in Burma, then later, India and Nigeria, led to the founding of a new form of aid within the Intermediate Technology Development Group (ITDG).

During Schumacher's time in Burma, and later in India, he noted that his perceptions of underdevelopment were inaccurate. Although people had low monetary incomes, they did not perceive themselves as poor, but culturally rich and economically sufficient. He noted that in most cases, the aid did not meet people's stated needs, nor did it result in an improvement in their cultural and economic well-being (Wood, 1984:245). Examining these failings[18], Schumacher explored the possibility of locally-controlled economic systems meeting locally-defined needs, *sarvodaya.* (Schumacher, 1962:1-3).

After his work in India, the influence of *sarvodaya* spurred Schumacher's formulation of ITDG (McRobie, 1981:18-20). Production by the masses, not mass production, would

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[14] There was a global shift from rural community support to urbanization, industrialization and infrastructure development in the post-war era.

[15] This model drew from numerous other philosophers in India, including but not limited to, A.V. Bhave and J.C. Kumarappa of *Sarvodaya*, Swami Shraddhananda of the *Aryasamaj* movement, Baba-ji of the *Mahalwari* (village-owned land) - *laukika* (creating a worldly dimension of social order) movements.

[16] See the McNamara-World Bank address of 1973, in IBRD's *The McNamara Years,* for his examination of the failure of aid.

[17] Schumacher, working with John Maynard Keynes, was largely responsible for The Keynes Plan, presented to the Bretton Woods conference, founding international mechanisms for multilateral financing; Schumacher's *Trade Policy and Full Employment,* and a Schumacher paper attributed to Sir William Beberridge *Full Employment in a Free Economy* both addressed the importance of free trade in achieving the British goal of full employment.

[18] *Does Economics Help? An Exploration of Meta-economics,* paper presented to the 1972 Annual Meeting of the British Association for the Advancement of Science, published in After Keynes, ed by J. Robinson (Oxford: Basil Blackwell, 1973:26-36

support and enhance local skills, knowledge and resources. ITDG[19] aimed development at the poorest, at small-scale and simple projects and supported the non-consumptive philosophy. Lacking the support of conventional development, Schumacher appealed to groups already marginalized by colonization and aid. Improving the efficiency of traditional tools, while re-investing in community economy and skills, fit village contexts and needs. Simple technologies, grassroots decision-making, local control of funds were ideas already known to some of the villagers. Schumacher's (quoted in Wood, 1984:329) aid popularized *sarvodaya* through his concept of aid being to 'Find out what the people are doing, and help them do it better.'

In the 1970's dissatisfaction with a singular concept for development came to a head. The persistence of poverty demanded the design of new tools and frameworks to meet the basic needs of Third World peoples. The search began for appropriate tools that could assist villager's in their quest to regain their self-sufficient. As Hoda stated in 1976:

> The present level of aid is only of marginal significance and comes with so many project conditions, tying of aid, foreign consultants and sophisticated technology that it saps the initiative and freedom of action of the developing world. The developed countries are only interested in selling their turn-key projects. Scientific and technological advances in the West are having an impact on the Third World countries *that is detrimental to their development prospects.* (Hoda in Jequier, 1976:149)

Confronting poverty through meeting basic human needs, reducing population growth and migration, redistributing income and stimulating growth in the poorest sectors offered legitimacy to groups supporting alternative forms of development. AT, as an already tested basic needs approach, received a great deal of attention. In particular, development planners were interested in AT's pluralistic concepts. Linking need and tool with context in a development problem, appealed to those who had seen large-scale or centrally-planned aid's failings. It was during this time in the 1970's that AT was provided with sufficient resources to test concepts and programs. An AT framework and its approach to underdevelopment, impoverishment and marginalization problems was designed. In addition, AT formulated development that supported traditional societies which operated outside western or industrialized socio-economic conventions (Brown, 1977:277-279).

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[19] Schumacher's group was named the Intermediate Technology Development Group; later the type of work undertaken by ITDG and its founding concepts were incorporated into AT.

2.3.3 The concept of Appropriate Technology

AT has no meaning in itself. *Appropriate,* as in the case of current use of the word *development,* has become a plastic word (Porsken, 1992:4). It is used freely to connote suitable methods and local ownership of change. Within the AT movement, *appropriate* demands to be defined by the context of any technology's use. AT can be "a collection of small-scale, simple tools or technologies," or "a radical, liberator philosophy" (Boyle in Willoughby, 1990:169). In its simplest definition, AT is a *Technology designed to best make use of a country's resources to achieve its development objectives.*[20] (Stewart in Stewart *et al.* 1990:5; Schutter, 1980:2). Emphasis is placed on the context in which a tool functions; the political, social, economic and environmental framework which presents opportunities and barriers for development. The context lessens ambiguity in AT, as it answers *appropriate for who?* and *appropriate where and when?* As Willoughby puts it:

> AT is a concept, a social movement or innovation strategy associated with a mode of technology-practice aimed at ensuring that the technology is compatible with its psycho-social and biophysical context. (Willoughby, 1990:44)

AT lacks a definitive statement in this need to place it in context. A project supporting medium-scale, complex machinery within a frame of labour-intensive production and participatory management can be AT. A simple plough as a part of an outside-directed aid project may not be AT. However, there are four key factors that help identify AT in practice.[21] The first is an agreed recognition of the existence of *inappropriate technology.* These inappropriate technologies are both the artifacts used (often large-scale, capital-intensive, highly-complex, or machinery-dependent industries) and their framework (dependence on technology-transfer, centralization of control, or a western-defined efficiency). The second factor is the recognition that *choice of technology* is central to development. The technology chosen strongly influences the path of local economics, health of social structures and distribution of local resources. The third factor recognizes that *the current pattern of human development cannot continue.* Biological and cultural survival depend on mitigating the damning effects of uncontrolled economic growth,

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[20] Development objectives vary radically, in some countris it is human, eocnomic and participatory-democratic growth, in others basic needs programs that emphasize redistribution of resources, or as an ethicval choice of wise-use of scarse resources in some 'developed' countries(Willoughby, 1990:169).

[21] For discussion, see Clark's *The Political Economy of Science and Technology,* McRobie's *Small is Possible,* Stewart's *Technology and Underdevelopment* and Willoughby's *Technology Choice: A Critique of the Appropriate Technology Movement.*

political disenfranchisement, ecological alienation, and loss of indigenous knowledge, adaptation methods and cultural diversity. Recognizing the value of pluralistic development may allow greater flexibility in societal change.

The final factor links the use of inappropriate technologies to the *foreclosure of options.* Options are lost when first, investments are made in inappropriate technologies. This tends to de-skill local people and remove local control. When this happens, future choices become more limited, which further impoverishes a village or group of people. Technology transfer is by far the greatest contributor to the foreclosure of options, repressing local innovation and economies, while encouraging an acceptance of psychological dependence. Underdevelopment follows foreclosure as context is removed from a technology choice, or policy is set and technology chosen *a priori* to exploring local possibilities (Willoughby, 1990:311).

2.4 Measuring appropriateness

It a case study of AT aid, it is important to have common, and specific criteria by which to measures results of AT work. It is still debated if AT is a fully developed theory, complete with testable hypotheses and methodology,[22] or simply a concept-as-practiced.[23] Within both concepts, there are specific lists of conceptual identifiers and specific variables that allow for the quantitative and qualitative analysis of programs.

2.4.1 AT conceptual identifiers

Appropriateness is central to the normative characteristics that identify AT. Within a given project, the following identifiers should be present:

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[22] The Delft University theory of AT states that AT consists of three elements. These are applicable *tools,* used to obtain the *means* of self-management, self-sufficiency and self-development in order to satisfy basic human *needs* within the context of a group's cultural and natural environment. Application of the political theory of the movement is used to describe the relationship between western technology and alienation, subordination and oversupply; and appropriate technologies with self-development, self-management and self-supply within locally-generated development frameworks. The hypothesis is three-fold: i) there exists a human goal of meeting basic physical and spiritual needs, ii) meeting of needs must be accomplished in a holistic manner and iii) economic dependence cannot exist within the effort to fulfill basic human needs. AT is seen as the tools and the process used to fulfill needs with methods of liberated people working together. See Riedijk in *Appropriate Development for Developing Countries,* 1984: Delft University Press, The Netherlands, 4-12.

[23] See evaluations of AT theory in Clark, T*he Political Economy of Technology,* de Schutter, *Fundamental Aspects of Appropriate Technology,* McRobie, *Small is Possible,* Stewart, et al. *The Other Policy,* Willoughby, *Technology Choice: A Critique of the Appropriate Technology Movement,*

i) *Technology is more than a tool,* it represents an evolutionary process of innovation, incorporating skills and experiences of people within their needs, the context of a given place and design that facilitate work (Schumacher, 1973:128).

ii) *Technology is not neutral* is reflected in Reddy's (1975:332) statement that "Technology is like genetic material: it carries the code of the society in which it was produced and survived and tries to replicate that society." Technology, as with needs, should be defined *in situ*[24] Tools should reflect place; local environment and institutions should not be re-defined to fit the tools.

iii) The *choice of technology* is crucial to the development of a place, indeed, it is fundamental to the development problem. Technological choice should open local options, encourage innovation, and create machines that serve people (Willoughby, 1990:313).

iv) *Technology creates linkages and relationships.* Technological choices, as with economic, social, political or spiritual choices, should be seen within the relationships, institutions and behaviour that govern community life. These relationships are unique in their context, while singular choices affect the functionality of the whole process. A single-blade plow, pulled by oxen, may be used not solely for the efficiency of the plow, but because of the effectiveness of the entire system of healthy linkages in which it works (Vacca, 1983:52), and

v) *Technologies are not static, but an important part of community development.* Endogenous innovation, adaptation and experimentation are vital to maintaining the health of the biophysical and psycho-social context of the community. Local technologies will best be adapted on a continuing basis (Pollard, 1983:34).

2.4.2 Evaluating AT

The normative characteristics form the foundation when evaluating AT programs. These can be quantified by answering four questions of any AT project. The questions are:

-Does it fulfill identifiable *needs*?

-Does it *reinvest knowledge* in the community?

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[24] Defined in broad parametres of social, economic, political, environmental and spiritual health.

-Can the program and tool be locally *maintained?*

-Does it *function* satisfactorily under operating conditions? (McRobie, 1981:39)

All these questions should be answered within the issue of encouraging self-reliance, while having positive, cross-sectoral impacts, and work within the local environmental constraints. Many AT evaluative frameworks are extraordinary complex. A simplified, four step evaluation can be used, which is much easier to understand, more easily duplicated for comparative evaluation, but looses some precision in its simplicity.

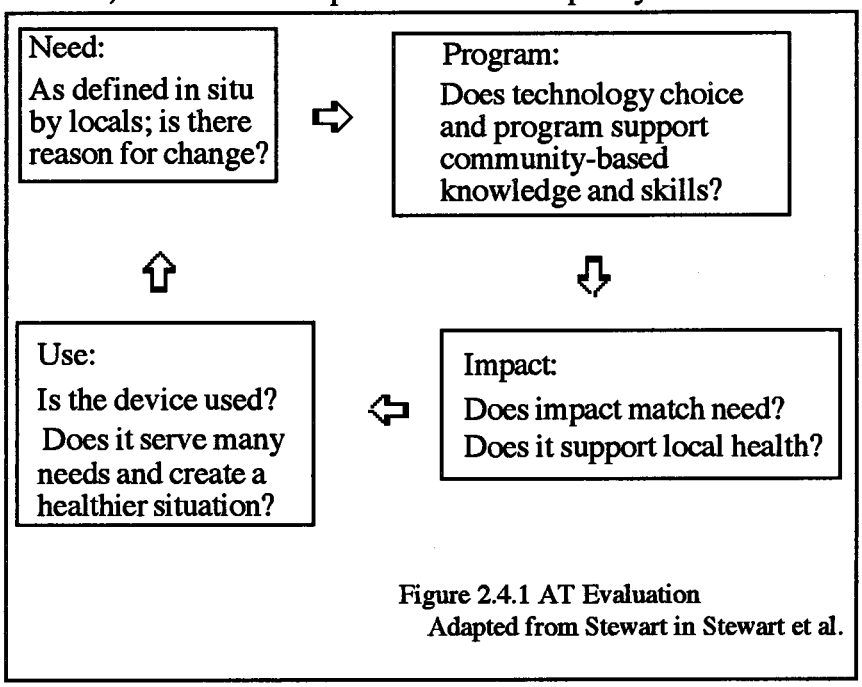

Figure 2.4.1 AT Evaluation
Adapted from Stewart in Stewart et al.

As a form of community development, AT programs result in far-reaching consequences. The nature of change in any society is complex. Inter-related impacts from an action can result in intentions not matching results in any of the program stages. AT evaluation maintains a structure to search out relational impacts to make these problems more apparent (Clark, 1984:184, Schutter, 1979:102, Stewart in Stewart *et al.* 1990:123). Programs are broken down into their component parts, and results examined. Then, the components are considered in their inter-relational impacts, and impacts on the context of the project. The components are then re-integrated into the project as a whole for consideration. Important to these steps is to include participants and programmers view equally, as perceived impacts can be very different between the two groups. Who is making the decisions, receiving benefits and feeling impacts is asked. (Clark, 1984:180; McRobie, 1981:2). In addition, development options used in the area, indigenous and imposed, should be included in an evaluation. Options of potentially more effective tools, or those with fewer

human and environmental constraints and greater potential in creating other developments (in options, contributions or knowledge creation) (McRobie, 1981:2; Stewart in Stewart *et al,* 1990:5). Finally, areas of technology investment should reflect the existing regional technology and knowledge of technological concepts. Adapting local technologies to changing objectives and conditions should be the foremost consideration (Singer, 1977:11).

The evaluation process is complete when one last variable is considered. Taken as a whole, these are the barriers and constraints on using ATs in a particular situation. This often takes the evaluation beyond the village to a national or international level; it wanders into realms of politics, culture, religion, economics and social organization.

2.4.3 Barriers and Possibilities

There are currently several key barriers to the adoption of AT. These barriers are also often contributors to failed AT. At the micro-level, an important barrier to acceptance is a strong feeling among users that they are being given a *second best technology.* ATs tend to be practical, affordable and localized in costs and benefits. This is in stark contrast to western technologies, which produce consumer goods within a market economy and have what can best be described as "pizzazz".[25] While a country's people are encouraged to export their resources (to be manufactured into western technologies for others), they are asked to adopt energy-efficient, sustaining tools. ATs are a daily reminder of the differences between Third World and modern tools (Ulrich in Sachs, 1992:284).

The barrage of advertising is one form of what some critics call the 'Trojan horse' entrance of technology into a culture. Jungk and Galtung (in Ulrich in Sachs, 1992:283) see the threat of technology as "more insidious than any other form of development aid." They note that technologies, appropriate or western, are often accompanied by a "catalyst" (an outside expert). The catalyst and tool introduce ideas that change local perceptions of time, space and culture. 'Trojan machines,' often intended to meet basic needs, undermine a culture from within. with their alien industrial work ethic, time rhythm, and changed relations in social systems. Some argue that no matter how well-intentioned the project,

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[25] These western goods are advertised in all forms of media; they quite often receive subsidies and can externalize a large share of their costs. With most desired western technologies, television, electricity, automobiles or refrigerators the real costs of production - mining, damming, low-paid labour, cultural marginalization - are not immediately seen or spatially felt.

evaluations will fail to recognize the insidious change sponsored by aid (Dube, 1992: 4; Ulrich in Sachs, 1992:278).

AT supports a *sarvodaya* approach to community health. This approach adheres to the belief that an established system of local decision-making is best able to protect natural resources and reject unsuitable technologies, techniques and goals (Dunn, 1978:7). Powerful political and economic barriers exist to self-sufficiency. Even if an AT program were technically and economically feasible, political constraints opposed to its grassroots structure may prevent adoption (Carr, 1985:45). As Stewart (1977:111) puts it in her critique of AT functioning within current systems of aid:

> AT can only be AT when it succeeds in benefiting the majority marginalized by an unjust system. The process of development supports that system. The power elite in the established socio-political system are without exception the losers in AT.

As there are political barriers to adopting AT, there are also coercive reasons to support these programs. AT can be used by those in power to placate people, as a temporary provision of basic needs, while forestalling the fundamental political changes necessary to deal with impoverishment (Kothari, 1982:42). Conventional aid's capture of the AT philosophy is seen as a way to perpetuate the structures that support the current scientific-materialist system.

AT's social change definitions challenge the very assumptions of the development concept. They make use of an Eastern sense of Dharmic "middle path" or the Vedic "balance of the cosmic world order"; change is not revolutionary, but works toward a synthesis of ideas that result in offering people the choice to create the kind of communities they need. These two belief systems support living in harmony with a place and its inhabitants, and life-goals of co-existence over dominance.

There is not yet sufficient evidence to determine if an AT path of development can work within a world of such rapid change. Past AT evaluations show that it can often work at the local level, where people have the desire and freedom to regain control of their own development. Where societies still living within spiritual-traditionalism exist, AT appears congruent with their concepts of change. As Rizvi (1983:115) put it:

> Only if it builds on a sure foundation - the wisdom of generations with its instinctive understanding of the importance of maintaining a balance between man and nature - can development fulfill its

> purpose of helping a people rooted in the past to face the inescapable challenge of the twentieth century.

In the Himalayan land of Ladakh, the Buddhist culture of the Tibetan Plateau supports a spiritual-traditional life system that has recently been subject to rapid change. Chapter Three looks at the ideologies that define Ladakhi society and sets the stage for the examination of how AT is implemented in a place where alternative development seems called for.

CHAPTER THREE
WHY LADAKH?

> If we develop good and considerate qualities within our own minds, our activities will naturally cease to threaten the continued survival of life on Earth (Tenzin Gyatso, the XIVth Dalai Lama, 1990:i)

Ladakh is a rugged and isolated land on the western-most edge of the Tibetan Plateau, which traditionally supported a small population on a sustainable basis.[26] Although for centuries it was the juncture of major Asian trade routes, exposing its people to outside influences, as a whole it developed its complex society in relative isolation. Due to its location, geography and lack of easily exploitable resources, it was not subject to the invasions and conquests so prevalent in other areas of Asia. While foreign powers were not particularly interested in Ladakh, Ladakhis, in turn, were not particularly interested in the outside world.

The culture that developed in Ladakh was one based on spiritual ecology. Dominated by a theology of Mahayana Buddhism, a sense of living in-place was embedded in every village. Compassion, as a religious belief, determined the day to day activities of people. Spiritual, rather than material growth was emphasized, and harmony was considered the goal of all household and village activities.

Life in Ladakh has changed radically in the past generation. Beginning in 1948, border conflicts resulted in the loss of over one-third of Ladakhi territory and the construction of a military road linking the district with greater India. As it became possible to develop the region by importing bureaucracy, infrastructure and development programs, the Centre[27]government felt compelled to do so. Projects within agriculture, health care, education, energy and resource exploitation were undertaken with little or no local consultation. Finally, in 1974, Ladakh was opened to tourism, and the *development* of Ladakh began in earnest.

Several small, alternative development projects have been established as a response to the effects of modernization in Ladakh. These projects question the wisdom of changing the

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[26] This description of Ladakh is taken from numerous sources, and from personal experiences. The sources include Mann, *The Ladakhi;* Norberg-Hodge, *Ancient Futures: Learning from Ladakh;* Palus, *Peaks and Lamas;* Rizvi, *Ladakh;* Snellgrove and Richardson, *The Cultural History of Ladakh;* and Sumi, Oki and Hassnain, *Ladakh: The Moonland.*

[27] The Centre refers to the national government in New Delhi

traditional Ladakhi society. Rather than a development that encourages trade with outside regions and dependency, they support development that supports local sufficiency.

Ladakhi values are founded on goals fundamentally different from those of most western societies. There is conflict between *development* and tradition. To understand this conflict, the following pages sketch the physical and cultural geography of Ladakh and its isolated development during the last several millennia, and the institutions that characterize the society.

3.1 Defining Ladakh: physical and cultural geography

Ladakh currently covers over 64,000 square kilometres[28] on the western-most edge of the Tibetan Plateau[29]. Present-day Ladakh consists of several *tahsils* (administrative districts) comprising 70% of the state of Jammu and Kashmir (J&K), India (Mann, 1986:1) (Illustration 3.1.1). It is a high-altitude desert in the rain shadow of the Himalayan mountains. Rainfall averages less than 50 mm per annum and temperatures range from +35° C in summer months to -40° C in the seven-to eight-month-long winter. Habitable regions range in altitude from 2,500 to 5,500 metres above sea level (Ahluwalia, 1980:5). It is an extremely rugged land, crossed by the Zanskar and Ladakh ranges, and sandwiched between the tallest mountains in the world. Its complex geography of high mountains and treacherous river valleys have largely isolated Ladakh from contact with its powerful Asian neighbours.

Ladakh was viewed as a 'moonscape' or 'desolate' land by marauding tribes, Asian powers and the first Europeans to explore the region[30]. As Mann (1986:3) states it was viewed as singularly poor in exploitable resources. Largely ignored by outsiders the area developed on its own terms. The vast majority of the land was suitable only to limited pastoral activities, the economic mainstay of the entire Tibetan Plateau for over four thousand years (OIIR, 1992:12). Contact with the outside world was because of its strategic location along several of the important trade routes linking the Arabic world to

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[28]Historic Ladakh covered almost 100,000 square kilometres. Almost one-third of Ladakhi territory is now under the control of Pakistan (Skardu/Baltistan) and Chinese-occupied Tibet (the Aksai Chin and Rumdok).
[29]The Tibetan Plateau is the largest high-altitude plateau in the world. With an average elevation of 4000 meters, it covers over 1.4 million square kilometers. In this text, Ladakh will be referred to as a part of the Western Plateau, that region of more rugged topography and less precipitation of western Tibet, Northeastern Pakistan and India lying between the Himalayas and Kun Lun mountains.
[30]See the journals of Cunningham, Franke, Hiu-Ch'ao, Moorcroft and the Tibetan Chronicles for early descriptions of Ladakh.

South Asia and China. Although not a major trading partner with these countries, Ladakh supplemented its subsistence-based economy with caravan trade-goods in exchange for pasturage, draft animals, labour and the fine pashmina wool of Ladakhi animals[31]. Along

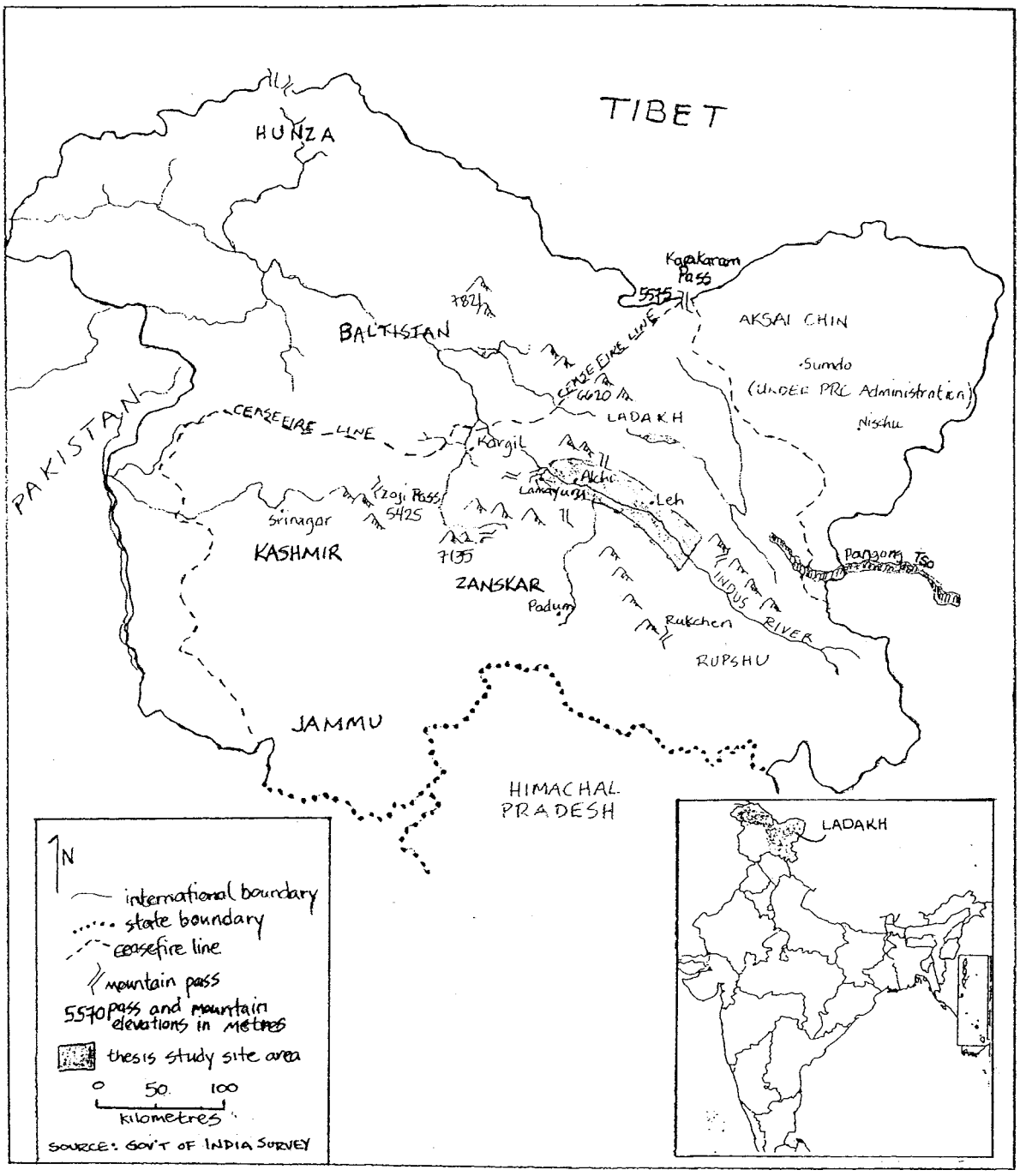


Illustration 3.1.1 A map of Ladakh, showing location in India, the occupied territories and study site area.

[31]Pashmina is the fine underwool combed from high-altitude animals such as goats, sheep, yaks, gazelle and antelope. Most pashmina used in South Asian goods is from the Tibetan Plateau.

with bartered goods, innovations, religious teachings and news reached Ladakh via these branches of the Silk Route. As in other Himalayan societies, the great mountain barriers and narrow mountain paths limited the amount and pace of outside influence and interchange (Fisher, 1989:iv). The evolution of Ladakhi social, religious, political, cultural and technological systems matched local goals; it was not imposed by outside powers through warfare or coercion (Dargyay, 1982:77; Rizvi, 1983:75).

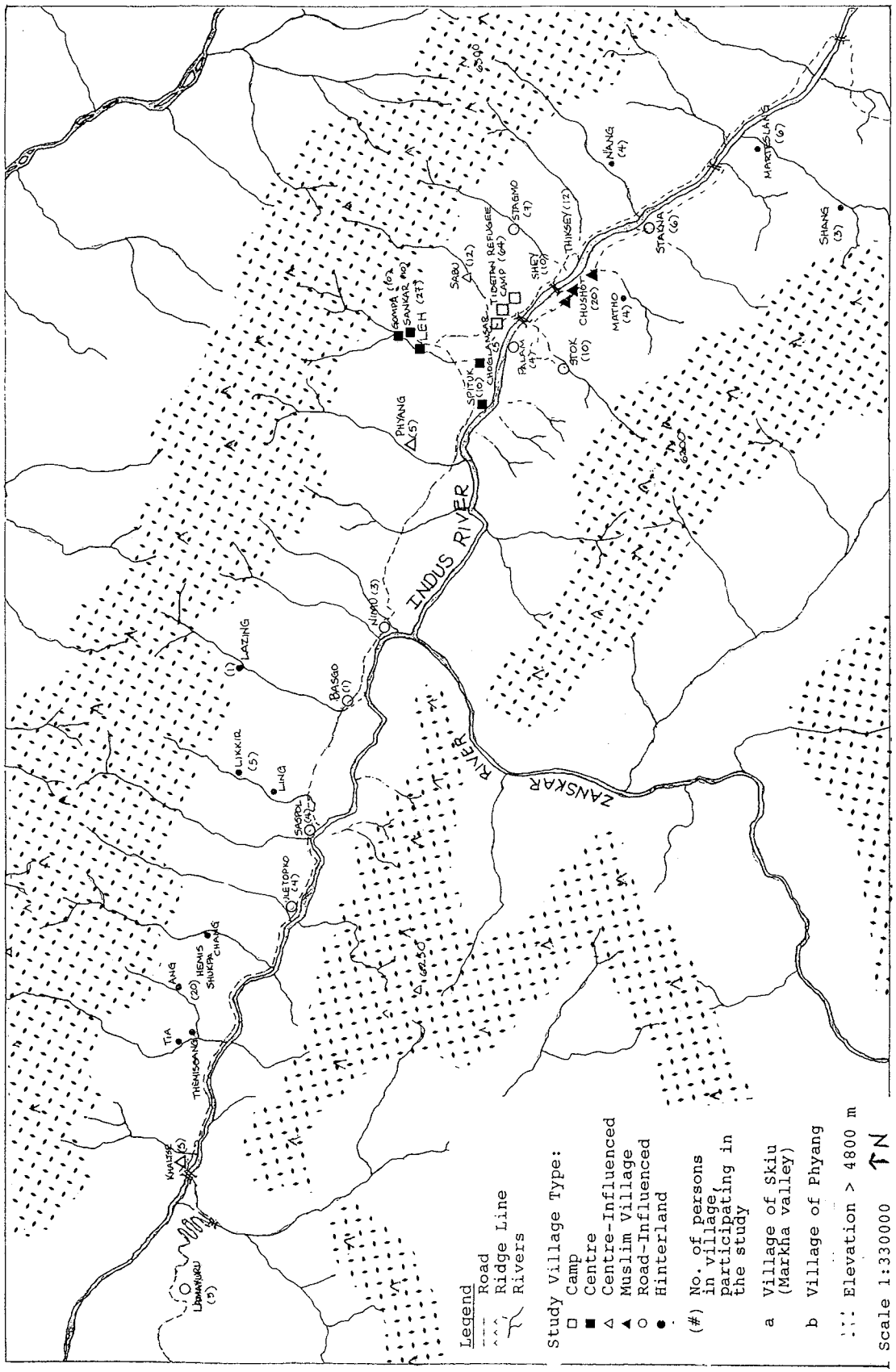
Today, the entire region supports a population of only 132,000 inhabitants[32]. Almost all live in semi-isolated villages (Illustration 3.1.2). Each consists of several kinship groups and is maintained through subsistence agro-pastoral activities. Leh, with about 8000 inhabitants, is the only major population centre. Most villages are models of self-reliance. Each family provides for itself the basic necessities of life. Specialists (doctors, astrologers, musicians, theologians and silversmiths) serve the community as a whole. Many routine tasks, such as shepherding and harvesting, are done on a cooperative basis. While the majority of people own their own land and animals, it is cooperation which ensures their survival.

Water is the most limited resource on the Western Plateau. Irrigation permits the creation of small oases of cultivated fields, spring-fed pastures and woodlots in this sparsely vegetated land. Most of Ladakh appears totally barren, although even graveled hillsides or steep scree slopes support native vegetation which can provide pasturage or be harvested for its medicinal properties. In spring and summer, the high-altitude pastures are verdant with growth from glacial melt waters, providing rich pasturage for herds. Villages are located where glacial run-off can be channeled into terraced fields of alluvial soils. Less than 0.002% of the land is forested and only 0.1% of the land cultivated (Mann, 1986:97). Intricate systems of irrigation channels abound in every village. Water is shared and conserved by all residents. For example, a cloudy spring means less glacial snow melt, therefore, less irrigation water. In consequence, each farmer will plant fewer fields so that each plant will have a good chance of survival (Osmaston, 1985:76).

Advocates of environmental determinism suggest that the Western Plateau illustrates a case where human life systems are controlled by their environment. But, although Ladakhis live in an extremely harsh environment, the people have demonstrated choice and creative manipulation in living here (Osmaston, 1990:141). Archaeological evidence suggests hu-

[32]1981 Indian Census at 130,000; estimates from Indian government records since that time.

Illustration 3.1.2. Map of Central Ladakh, bisected by the Indus River, and showing the study site area.



man habitation for almost 10,000 years, even though more attractive lands were available for inhabitation elsewhere (Ota, Dec. '91-May '92:49). The Ladakhi lifestyle developed over thousands of years as a result of experimentation and adaptation. This lifestyle does not rely on the expropriation of other's resources, long-distance transhumance or acceptance of extreme poverty within sectors of the population.

3.1.2 Living within a limited resource base

Goldstein (1981:6-7) used the term 'environmental encapsulation' to describe the limited potential of the Plateau ecosystem to support growing populations. The socio-economic, political and cultural organization adapted to a situation where there was little capacity for increased agricultural production. While vast tracts of pasture surrounded village agricultural lands, these pastures could not be cropped because of the lack of irrigation water. Additional factors limiting the expansion of cultivated land include poor quality soils, finite amounts of composted ash and nightsoil to improve tilth, steep slopes, north facing aspects, and limited labour. There was little competition among land uses, but rather complementary subsistence between valley-bottom and pastoral uses.

Within this environmentally-defined limitation, there are few options for social development. The Plateau people probably experimented with numerous tactics. Some herders and bandits expropriated other's resources. Some groups depended on circular migrations over large territories to live within ecological constraints. As Chatterji (1987: 217) observes, Plateau people responded by developing agro-pastoral and socio-economic institutions that 'achieved harmony with the natural environment.'

Research on the cultural ecology of the Tibetan Plateau shows the cultural, social and political responses to the high-altitude, limited-resource, mountainous environment. These responses are embedded in or expressed through the Plateau people's meta-philosophy or myth[33]. An adaptation of Chatterji's model of the Ladakhi religion-environment connection reveals the process of living 'in-place' (Figure 3.1.1).

The model suggests that Ladakhis (and most Tibetans) chose to live within limited resources. Agro-pastoral production developed and land health had to be maintained.

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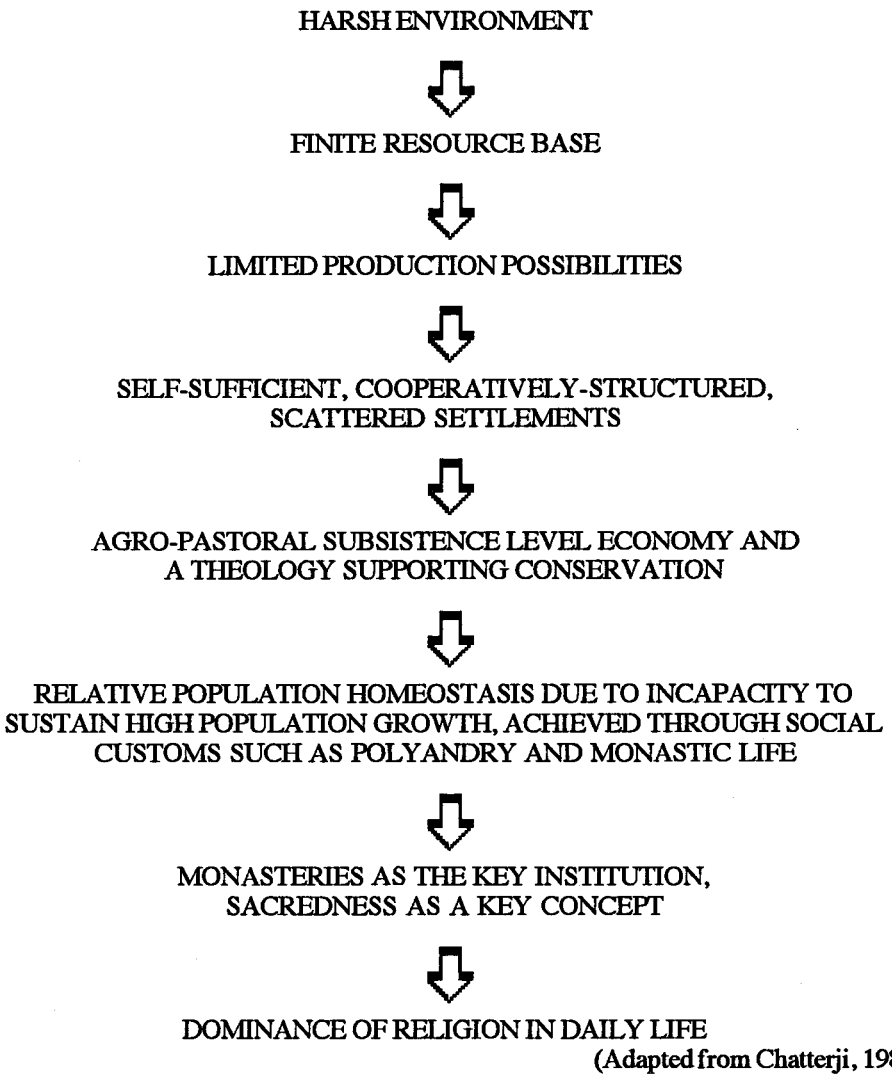
[33]See for example, Aziz, *Tibetan Frontier Families;* Ekval, *Fields on the Hoof: Nexus of Tibetan Society;* Guillet, "Toward a Cultural Ecology of Mountains: The Central Andes and the Himalaya Compared," *Current Anthroloplgy.*

Ladakhis created the mythology explaining their existence, and institutions that allowed the system to work. Their culture is revealed in location and size of their villages, the interactions between villages and nomadic communities, in economies which combine subsistence activities with barter-based markets and trade extensions. As the below model suggests, these patterns were institutionalized, but are also found within the philosophy of daily living. Whether Mahayana Buddhist[34] or Muslim, the Ladakhi meta-religious philosophy equates to a sense of living in-place.

Figure 3.1.1 People and place: manifestation of the Ladakhi religious connections to the land.



(Adapted from Chatterji, 1987:218)

[34] Buddhists comprise over 80% of the population in Leh and Zanskar in the Ladakh tahsil, and about 35% of Kargil tahsil, Shia and Suni Muslims represent about 15% of the Ladakh tahsil, with this population centred in Leh and Chushot villages, and about 60% of Kargil. Statistics from Kaul's interpretations of the 1981 census data. Census information was not gathered in the 1991 due to regional strife.

Harmonious living patterns established in Ladakh date back at least as far as the *Bon*[35] religion, which flourished for at least several hundred years prior to the introduction of Buddhism in 240 BCE (Ahluwalia, 1982:3). Although the Islamic faith does not share the same spirits of land, air and water, it participates in the reciprocal relationship between people and place. Islam is a recent arrival in Ladakh, beginning with raids into Baltistan around 1500 AD. In most areas of Ladakh, Islam has been practised for only several hundred years (Rizvi, 1983:44).

The manifestations of durable relationships are numerous in Ladakh. The complexity of life-patterns are best explained by the concept, structure and practise of spiritual ecology. Based within the harsh environment, and going beyond the bounds of any one of the religions of the Western Plateau, spiritual ecology reveals how Ladakhis created a balanced and compassionate society, structured institutions to govern communities, and practice their beliefs in daily life (Goldstein and Beall, 1990:48; Gokhale-Chatterjee, 1987:457; Miller, 1978:385; Rizvi,1987:434). These three areas will be briefly explored to provide an image of the Ladakhi world view.

3.1.2 Habitation patterns to conserve and improve the land

Altitude, latitude and topography combine to create a climatically-unique, semi-arid plateau in Ladakh. The climate, in turn, determines the flora, fauna, land use and habitation patterns within a system of altitudinally-derived life zones (Ekvall, 1968:5-6; Kantowsky, 1983:23). Dependent on a system of vertical zonation[36] the Ladakhis do not identify 'good' and 'bad' land (Illustration 3.1.3). Neither do they limit their concept of land-holding to the average one hectare of valley-bottom cultivated land. Rather, Ladakhis see each vertical zone as a component within a complicated, functional system (Illustration 3.1.4). An agro-pastoralist talks of any land as 'good' in terms of the use for which it is naturally suited. People recognize the need for a diversity of land types for production, valley-bottom fields, hillside woodlots, distant fuel- and medicinal plant- gathering areas, and high-altitude pasture (Kantowsky, 1983: 22; Osmaston, 1985:76-78). A 1981 Indian government survey designating over 87% of Ladakh's lands as "very poor quality, wasteland or glacial cover" (Sumi, 1983:148). However, the Ladakhi view of the importance of each component to the integrity of the entire system, and making optimal

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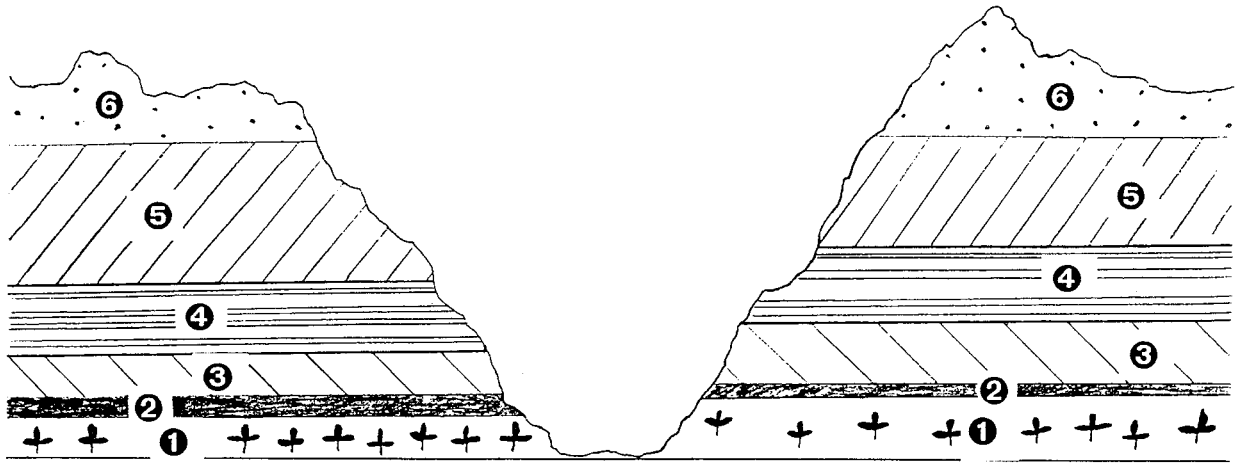
[35] Pre-Buddhist, animist religion of the Tibetan Plateau

[36] In India, this is often refered to as vertical habitation patterns.

Illustration 3.1.3 A profile of a typical Ladakhi village, showing the vertical zonation patterns and the percent of each land available for use. Adapted from maps of the village of Skiu and information on agro-ecology from the residents.



Vertical Land Use in Ladakh
A Profile of the Markha Valley at Skiu Village

6	'High pasture' Seasonal pastures	3	'Soil country' Irrigated fields & woodlots
5	'Neither soil nor pasture' High altitude pasture, juniper and fuel gathering area	2	'Village' Village, Gate-pastures, roads, construction woodlots
4	'Country' Improved pasture, brush, juniper and medicinal plant gathering, monasteries	1	'Deep valley' Irrigated, intensive agriculture and agro-forestry

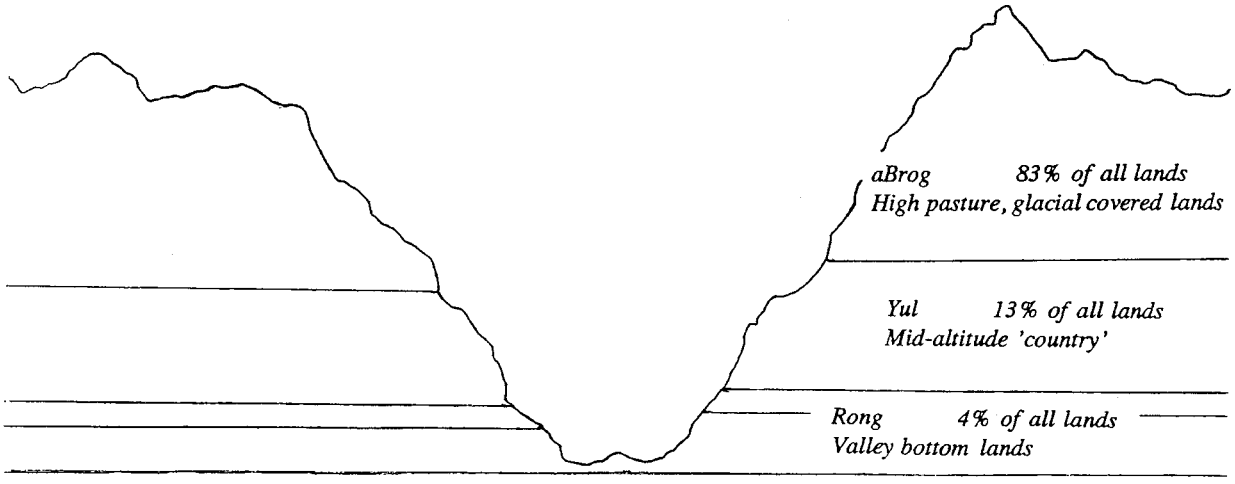
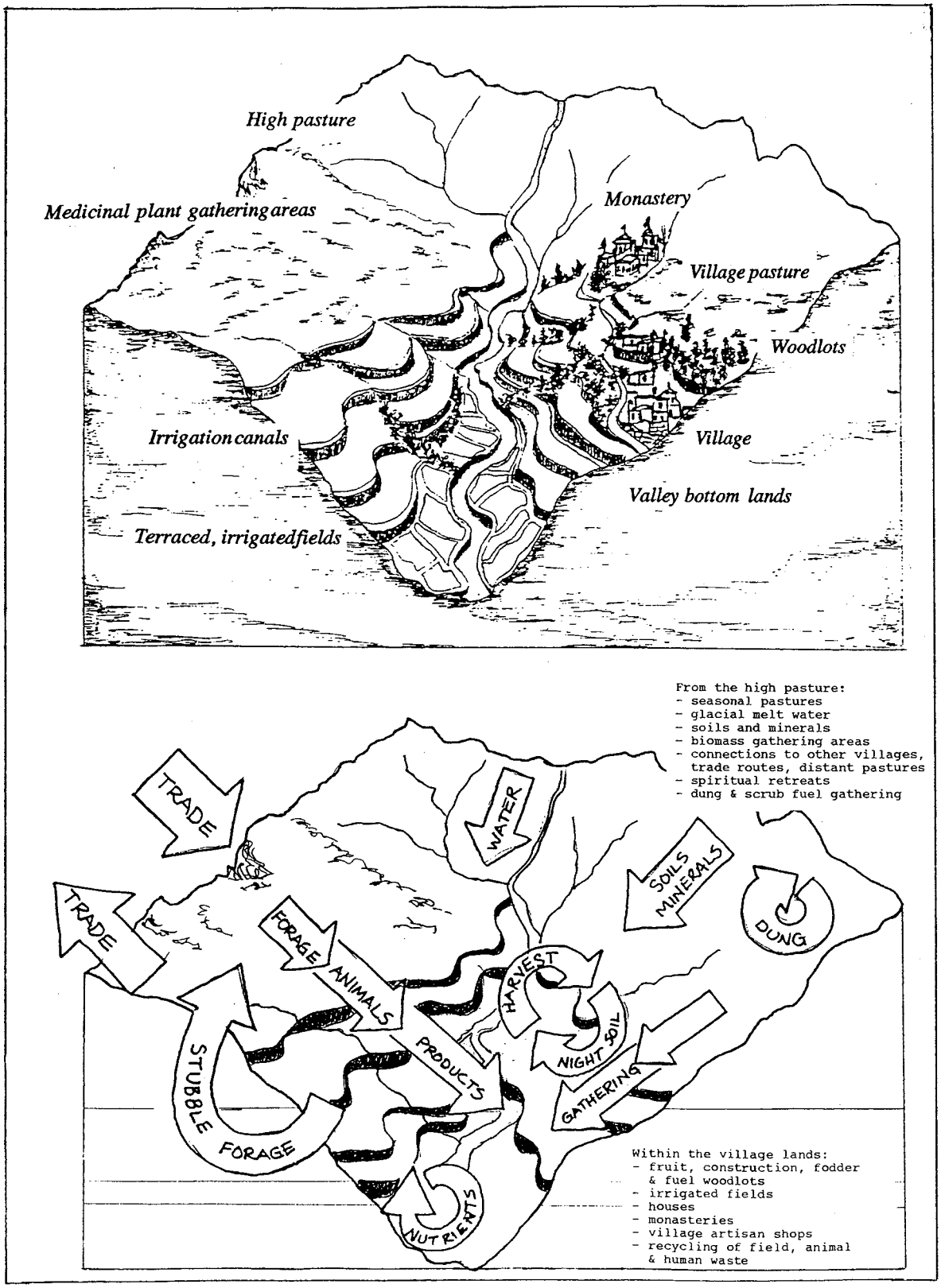


Illustration 3.1.4 A profile of a typical Ladakhi village, showing land use and the production, consumption and recycling systems. Adapted from maps of the village of Phyang and information on agro-ecology from villagers.



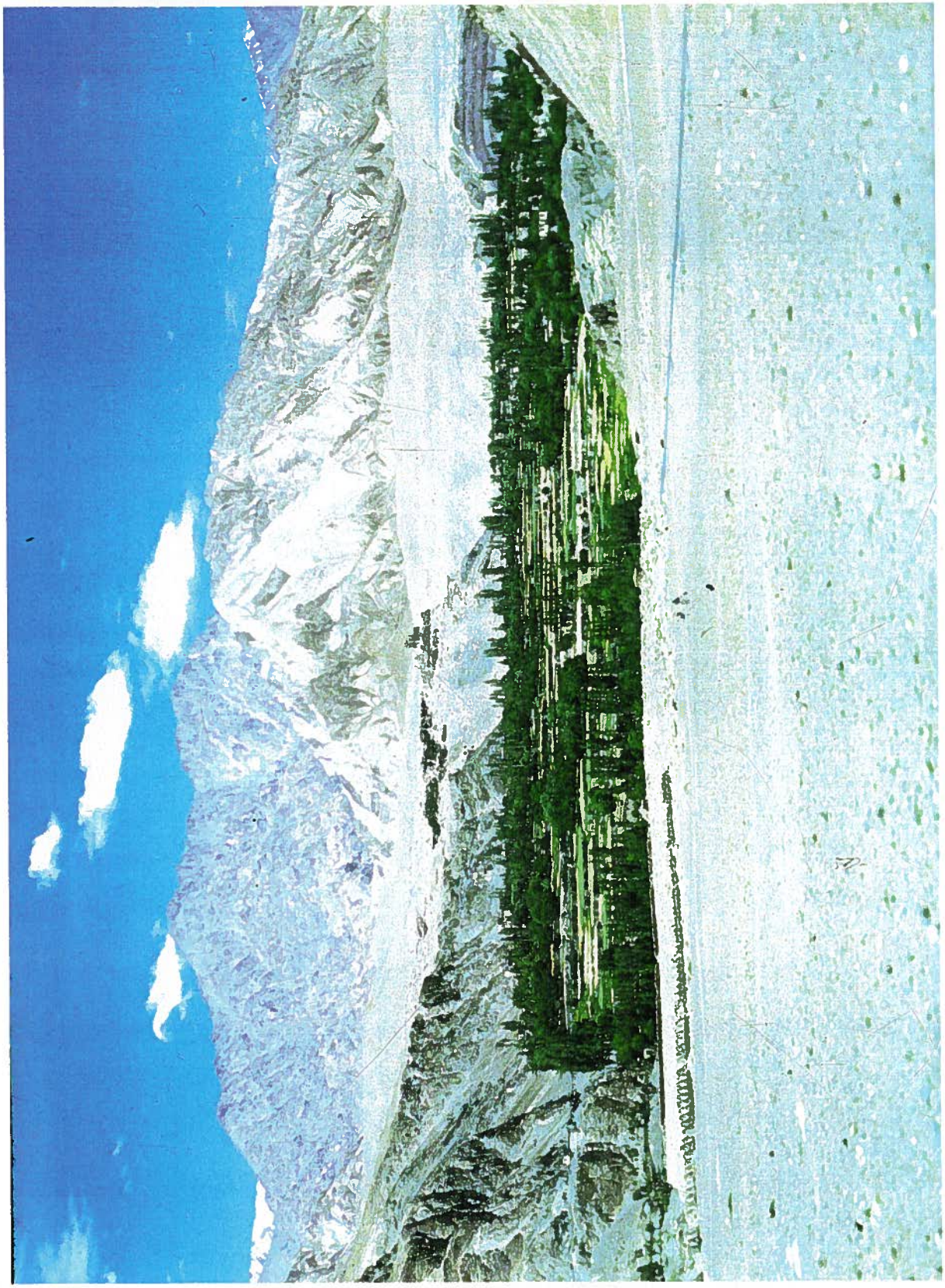
use of all land available to a community, allows for the support of a healthy, resilient population (Illustration 3.1.5).

3.1.3 Spiritual Beliefs: philosophy of cooperation within the wheel of life

The complicated relationships derived from vertical zonation reflect more than the environmental constraints of production in Ladakh. These relationships are encompassed within a greater belief in living in balance with the environment, and a compassionate treatment of and respect for all land and animals (Pallus, 1965:197). There is a singular absence of human dominance over their environment (Ekvall, 1968:80). This belief is expressed through many Himalayan religions, and practised within *ahimsa,* the principle of not destroying life. True *development* is four-fold: the valuing all life, a principle of reciprocity, commitment to people and place, and a primacy of valuing the sacred (de Silva, 1990:18-19; Regenstein, 1991:234). It creates an all-inclusive sharing, acknowledges responsibility and acceptance of the 'un-seen' and 'un-known' (Tucci, 1980:165). The dominant Buddhist and Bon faiths heighten these principles through their recognition of the existence of spirits inhabiting the land, air and water and who control production (Goldstein, 1987:61; Ekvall, 1968:81). In Islam, Muslims are called to care for all living communities as the "whole of the rich and wonderful universe belongs to God, not man." Man is no more than the *khalifa* (trustee) of God and will "render an account of how he treated the trust of God on the Day of Reckoning" (Regenstein, 1991:255).

The people knew that to disturb the soil or abuse the water of their extended ecosystem was to risk upsetting the delicate balance in their lives. Disrupting the *Sa b dag* or *kLu* (soil and water spirits) through tilling new soils or polluting or over-use of water could bring misfortune on an entire community (Ekvall, 1968:5-6; Snellgrove and Richardson, 1980:58-59; Ortner, 1978:278). Humans are *allowed* to gain sustenance from the environment by the greater powers (Vigoda, 1989:27). Spiritual ecology creates a system of rewards and controls in each community; production is optimized, balance and stability created, resulting in a greater degree of success over time within the social system. As in other mountain peasant societies, Ladakhis aim for security over risk in output, with a sense of responsibility toward all sentient beings (Guillet, 1983:570; Kantowsky, 1983:22). As Vigoda (1989:28) describes the meta-religious spiritual ecology of the region, "persistent spirit belief is an indication of the strength of the Tibetan's world view, combined with the sheer logic of their environmental taboos, and the congruence between Buddhism and ecology."

Illustration 3.1.5 A typical village in Ladakh. The edge of the village is defined by the extent of the irrigation canals; with 100% of farm lands irrigated. Glacial melt water feeds the fields and the high altitude pastures, used to graze animals.



The circular nature of life in most Ladakhi villages produces another form of care for all aspects of the life-system. Belief in rebirth reinforces the knowledge that all sentient beings are a part of a greater whole manifested in the desire to reach enlightenment. A bad rebirth could result as a life lived as an insect; hence the respect shown all life forms. The Tibetan term actually translates as 'mother sentient being' implying that any living creature could be your mother and therefore deserves respect and kindness (Dargyay, 1984:51; Gross, 1993:13).

3.1.4 Social Structures: A no-growth economy, polyandry and monasticism

These religious and ecological beliefs were manifested through Ladakh's social structures. Life was dominated by a no-growth belief: in both a village's population and it's economy (Dargyay, 1984:54-56). The economy supported a non-debtor, in-kind revenue system, with the concept of 'cash crops' virtually unknown. Even within the wool trade, most exchange was barter-based. The majority of trade consisted of intra-kinship group and inter-zonation exchange, trade served social, political, cultural, ecological as well as economic ends (Ekvall, 1968:18,70). A great deal of the trade occurring along the Silk Routes of Ladakh was in exchange for pasturage, draft animals or labour. Few Ladakhis experienced debt.

Individual material gain was not only subordinate to spiritual growth, but was considered the antithesis of community cohesion and functionality. The social fabric, which provided for most community needs, including identity, and reproduction, was strained by individualism. The monastery or mosque was the repository of excess production, the equalizer through redistributing wealth, and responsible for centering the village within its environmental constraints (Kaul, 1992: 56; Norberg-Hodge, 1991:77).

Social institutions provided for low population growth, an important contributor to ecological balance. Polyandry and monasticism both aided in limiting village growth (Ahluwalia, 1980:62). Although monogamy and polygamy also existed in Ladakh, fraternal polyandry was common throughout the Western Plateau. It is the key to the ability of the people to adjust to living within environmental constraints. As Goldstein (1981:11) states:

> it contributed to social stability by preventing the fragmentation of land...and by helping keep the population within limits.

Usually, the eldest son inherited the entire family's wealth; its house, land and animals, and was the male child who would marry[37]. If he and his wife agreed, other brothers, usually not more than three, would also become husbands in the marriage. This prevented the fragmentation of holdings while providing for a sufficient labour base in each home (Goldstein, 1981:11). The mono-marital principle, with only one male and one female reproducing per generation, population remained stable over centuries (Chatterji, 1987:218; Mann, 1986:56). Polyandry was a logical response to certain environmental constraints, but also became a social institution that supported the status of the women in a village (Norberg-Hodge, 1991:69).

Excess population was handled in various ways. Unmarried children could stay in their parents' home, or join their married siblings home as productive, needed and respected members of those families. They could also choose a life of spiritual practice and learning; a life that accorded more respect than other choices within a community (Gross, 1993:12). Somewhere between 10 and 30% of the people remained celibate and within the religious system (Alhuwalia, 1980:62). According to Vigoda (1989:32), monasteries were not simply repositories of excess population, but valuable contributors to the spiritual and physical health of the community. Here, village doctors and astrologers were often trained. The community's hereditary and financial wealth was stored in the *gompa,* and could be shared in time of need, and the *kushok* (reincarnate head monk) or *lamas* (monks) adjudicated village disputes as impartial outsiders (Mann, 1986:165-166).

Choice in life styles aids in dispelling the myth that traditional mountain societies did not offer people opportunities. Plateau women generally experienced more freedom than in other Asian societies. They could marry or choose not to, enter higher learning institutions, or control property. Women participated fully in family decision making, commonly controlled household incomes, enjoyed village festivals, drinking and dancing, side-by-side with the men. They had superiority over the junior husbands in a household or could inter-marry between Buddhist and Muslim communities (Dargyay, 1984:35; Mann, 1986:73-76). Young men and women who wanted to follow a life of religious dedication, did not need to severe ties to their family, often returning home to participate in family

[37]If the eldest son chose not to marry, either to pursue a religious life or for other reasons, another son would inherit the family holdings. If a family were without male heirs, the eldest daughter inherited and maintained ownership of the family holdings. Her husband would join the family as a *mag pa,* with the same rights as a woman joining a male heirs family. If a couple were childless, a male could take on another wife in order to produce children or the couple could adopt children (See Cunningham, Dargyay, Ekvall, Goldstein, Mann, Norberg-Hodge, or Pallis for ethnographic information on the Western Plateau).

festivals. Both had the opportunity to travel in pursuit of their religious studies, or could choose to leave the gompa if they discovered the religious life did not fulfill their needs. Characteristics of femininity, self-confidence strength and dignity were not deemed as uniquely male or female, encouraging equity (Norberg-Hodge, 1991:66).

3.1.5 The omni-presence of the sacred

In the Ladakhi world view, there was not a rock, a blade of grass, not a place on earth without spiritual essence. To Ladakhis, the earth was a living entity, full of the mythical, and they were interconnected in its existence. Religion was inseparable from life, as was belief from practice, resulting in an inescapable logic of living within their limited resource base (Norberg-Hodge, 1990:45). The system's checks, those of lack of economic and population growth, and community cooperation and identification, were not seen as forms of coercive control. These were benefits of a system which supported harmonious community relations, allowed for spiritual quests and encouraged coexistence with the sacred.

Inequity was not desirable in a society based on cooperation. Villages can be characterised by equity both within and between households. An illiterate farmer could be a *goba* (headman). Family decision-making included children, women and elders participating equally. Although classes existed, the rigid Indian caste system never penetrated the Himalayan barrier, and vast discrepancies in wealth were absent in most villages (Kaul, 1992: 152-153; Mann, 1986:17-22). Class distinctions involved a reciprocal relationship between nomads, agriculturists, merchants, artisans, monks and elites. Rarely was a person barred from a household on the basis of class or religious beliefs. Often, religious ceremonies were gatherings of all village members (Norberg-Hodge, 1991:48, Rizvi, 1983:70).

Because the rationale of their belief system was different made it no less valuable[38]. Reverence for all life resulted in a lack of will to exploit resources, desire to create hectic markets, or provide for an over-abundant material wealth. This belief supported the

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[38] Indeed, today, western scholars are beginning to recognize the important contribution made by the pressence of the sacred and support of tradition within a culture Journals such as *Alternatives, The Ecologist, In Context, and Resurgence* often support this view. In addition, see Alvares in Sachs, *The Development Dictionary;* Bhave, *The Intimate and the Ultimate;* Capra *The Turning Point;* Jones, "From Fragmentation to Wholeness: A Green Approach to Science and Society" in *The Ecologist;* Kothari, *Rethinking Development;* Shiva, *Staying Alive;* and Sale, *Dwellers in the Land.*

absence of inequity, poverty, competition and uncontrolled greed. Spiritual growth did not endorse the negative side effects seen in scientific-materialism, especially that of the Cartesian split of human-other[39], or the fatalism of environmental determinism (Gross, 1993:10). A wholeness in Ladakhi spirituality was reflected in individuals. Sound inter-personal relationships, individual mental health, introspective thought., and an encompassing system of social welfare resulted. Ladakhi life was generally filled with free time and laughter (Norberg-Hodge, 1991:76, 85, 136).

The kitchen and hearth serve as the focal point of Ladakhi family life (Illustration 3.1.6). In a land where winter temperatures often reach 40°C below zero and winter is eight months long, it is not difficult to understand the importance of the family hearth as a refuge from the cold. Nor is it difficult to understand the spiritual significance that would centre on this important space. Ladakhis believe that disruptions to the hearth, or more specifically, to the *kLu* (spirit) that abound in and near the hearth, will bring misfortune to the whole family (Rizvi, 1983:132). As the only heated room in the house, the kitchen naturally serves as a gathering place for the family.

Activities in the kitchen illustrate the need for cooperation within all tasks in Ladakh. Preparation of meals and maintenance of the fire requires the entire family's input. For example, the grandfather stirs the tea while seated beside the warm ash tin, the grandmother operates the bellows, without which the fire would die in the low-oxygen atmosphere. A daughter feeds the fire, while another family member prepares the food. One child grinds the spices, and one brings dippers of water to the soup pot. Someone churns the milk with a leather sash looped around a central utility pole. Each family member is an important contributor to, not just consumer, of a meal.

The kitchen is where family decisions are made, with discussions including, not excluding, the young children. Work and social skills are passed from generation to generation in an atmosphere of patience and joy. The stove and pots represent a source of family wealth. Stoves made of iron are decorated with religious symbols in copper and brass (Illustration 3.1.7). Behind the stoves, shelves of gleaming pots are on display. Behind the shelves, a storeroom houses at least four years' supply of *grim,* high-altitude barley, as a 'bank' against poor crop years. Windows are few, to better hold in heat in winter, but one or two allow easy communication with neighbours (Norberg-Hodge, 1991:13).

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[39] See, for example, Walter, "Scientific Materialism" *The Ecologist,* 1980; and Porritt, *Seeing Green.*

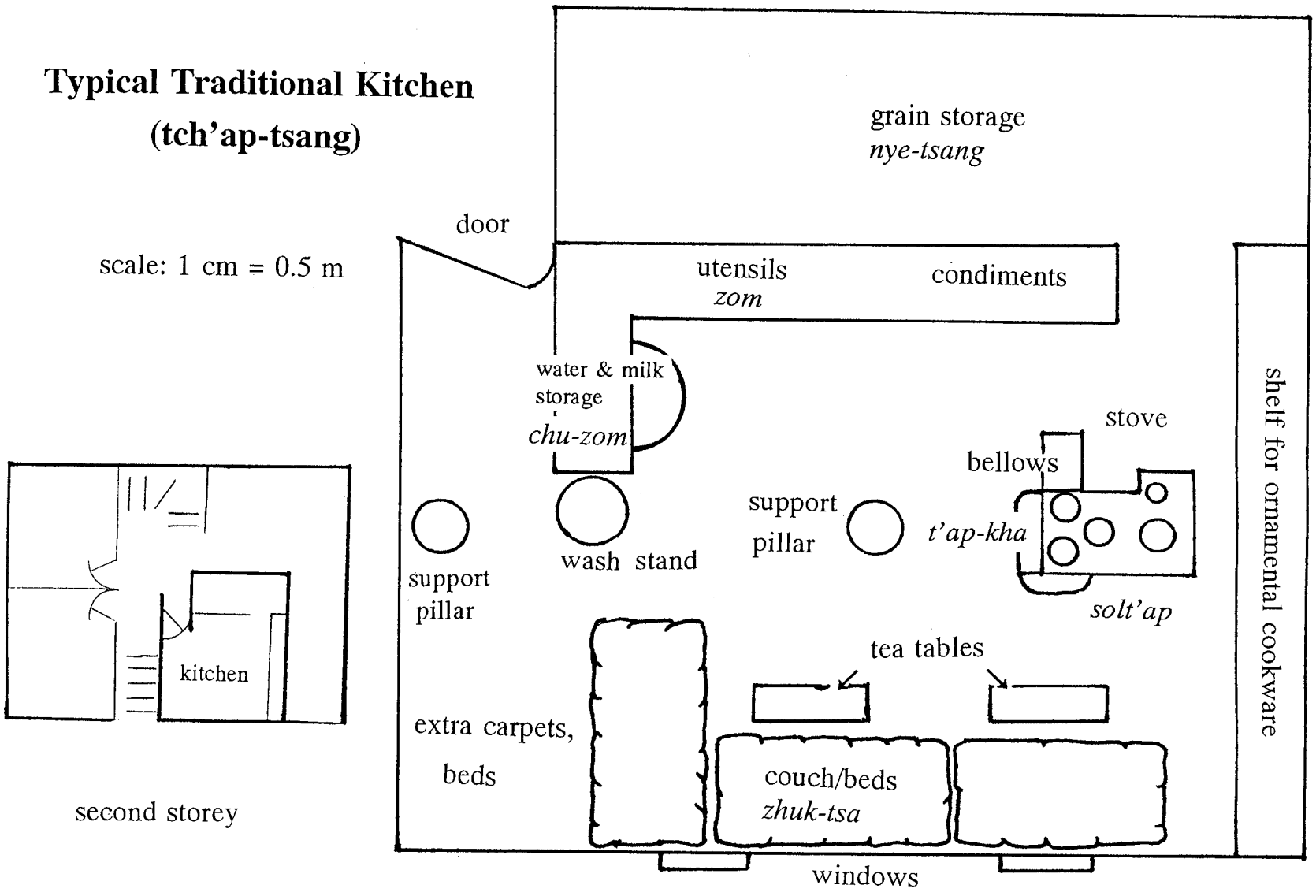

Illustration 3.1.6 Map of a traditional Ladakhi kitchen.

Illustration 3.1.7 Photograph of a traditional Ladakhi stove, showing the Buddhist symbols which decorate most hearths.

3.2 Ladakhi institutions and development

A traditional Ladakhi village, largely identified by its self-sufficiency and local control of institutions (Figure 3.2.1), functioned similarly to a cooperative business. The village, or more precisely the place, was the focus of identity; decision making was based on the health of the community as a whole (Gokhale-Chatterjee, 1987:458). Individuals were subordinate within 'departments,' such as the cooperative work groups of professionals or spiritual fraternities. This cooperation produced balance and a tremendous amount of village-based autonomy. Repeatedly, scholars characterized a healthy village as balanced, sufficiency-oriented, and ecologically sound[40].

Ladakhi habitation patterns of small, scattered villages, are almost universally determined by the environment. The great distances and geographic relief between villages have supported autonomous institutions. Inter-village interaction, and hinterland-centre activity were largely decided at the local level. Outside governance and religious imposition was limited, benign or supportive in nature. Villagers were 'taxed' through a feudal corvee system (labour constriction) on the trade route (Goldstein and Tsarong, 1987:446). The local *gompa* (monastery) belonged to a sect of religious lineage, linking *gompas* and villagers across the entire Tibetan plateau.

Due to the geography of Ladakh, decision making and control remained either at the village or household level[41]. Most resource use, structural adaptation and growth decisions and redistribution of wealth were made within village institutions. The village 'council' and religious leaders spent little time on dispute resolution - it was uncommon for differences to rise beyond informal *gyut, chaspun or chutso*[42] resolution. Production inputs and outputs were traded at the local level, village artisans and specialists village (astrologers, musicians, doctors, blacksmiths, butchers and carpenters) served almost all needs. The household was the level of production for food, shelter and clothing. Cash exchanges were kept to a minimum to avoid monetary inflation and inequity issues. Contacts with Leh (as

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[40] See Bray, Cunnignham, Franke, Goldstein and TSarong, Norberg-Hodge, Moorcroft and Rizvi

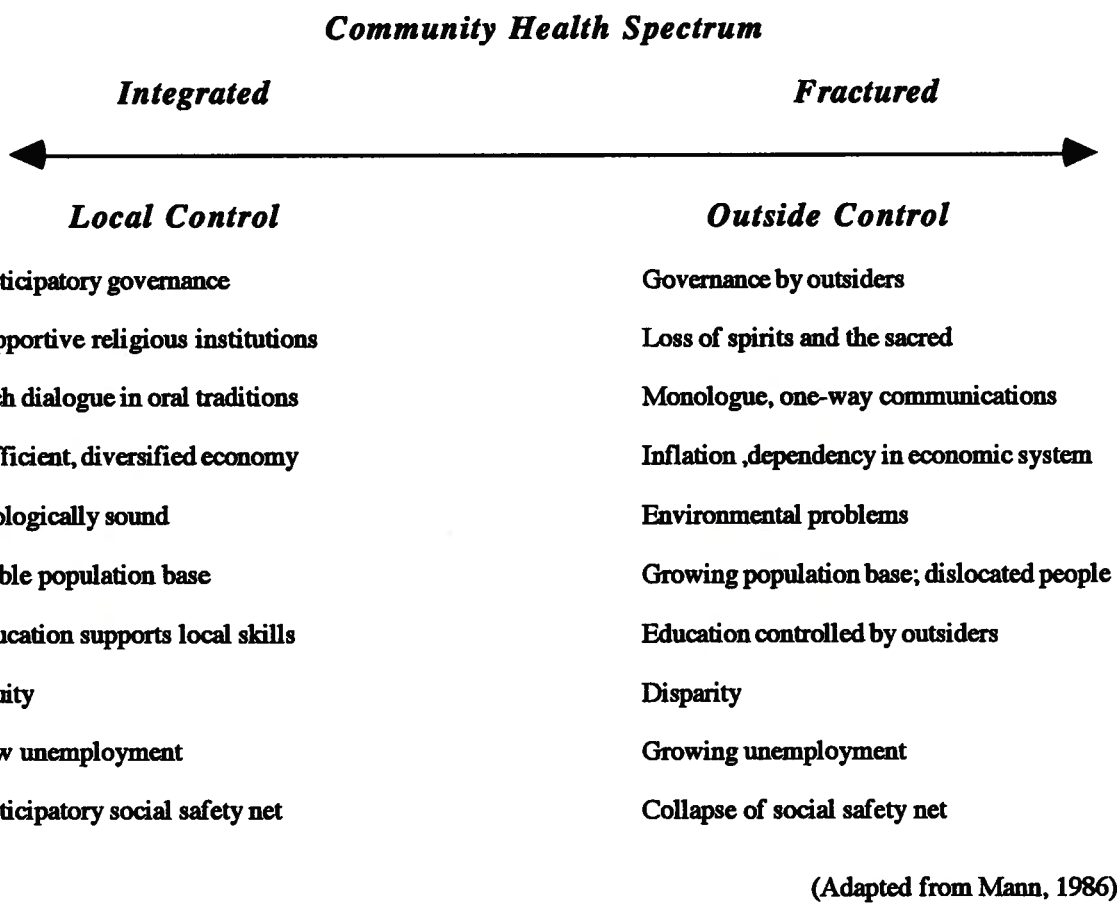
[41] This information draws from Aziz, Dargyay, Goldstein, Mann, Norberg-Hodge, and von Furer-Haimendorf.

[42] The *Gyut or Rigs* is a a bigger social group than a family; a group of people who trace descent from a common ancestor or ancestress; a *Chaspun* is an informal but important friendship formed between two people. The *Chutso* is a sub-group within a village that often has a 'representative' in the village council. All serve the purpose of and additional support system, to help with work, personal problems or dispute settlements. For example, if farmers are in dispute over irrigation water, a *gyut* member might work to facilitate agreeement. See Mann, 1986:48-54, Norberg-Hodge, 1991:52-53.

the trade centre) and the world at large were on a limited basis. Economic and governance activities based on mutual aid, occurred informally at all levels within the village. Education was also an informal and multi-disciplinary activity. Home training, apprenticeship and more formalized monastic training all blended to provide for complete, culturally-appropriate education. Institutions' central purposes were to maintain tradition through a balanced and equitable economy, harmony in resource use and conservation and dispute adjudication. The moral economy of the Ladakhi is a form of inclusive Buddhist economics.

Although the social system of a Ladakhi village appeared lose or casual, it was not (Goldstein and Tsarong, 1987:444-446). Social networks, the religious and friendship support groups, and hereditary and professional clans, all served the needs beyond the pur-

Figure 3.2.1 Ladakhi institutional characteristics



(Adapted from Mann, 1986)

pose or scope of the family unit. Village stability and risk reduction lay behind the system of social support and institutional function. While decisions were made in consideration of the health of a whole, they were generally not enforced upon the village by outsiders.

Ladakhi villages are not uniform. There have always been differences between hinterland communities and trade centres, and in upper and lower Ladakh. Today however, these differences are heightened, with many villages seeing the weakening of control by local institutions for the first time (Norberg-Hodge, 1989: 126) Change within these institutions coincides with the rapid modernization of the area[43]. A shift to the right in the Community Health Spectrum appears necessary to encourage economic growth and material consumption. A shift to the left would support spiritual traditionalism as seen in Ladakh, and possibly the aims within the AT movement. A villager's personal definition of health in the community will make an important statement on what form of development would be welcome and important in that locale.

3.3 Change and its impact

Change came to Ladakh in a rapid succession of events. Ladakh, as an independent Buddhist kingdom, was incorporated into India after the (Jammu) Hindu Dogra invasion in the 1830s. After Indian independence in 1947, Ladakh lost part of its Balti territory in an Indo-Pakistani border conflict. In 1950, the increasing severity of the Chinese occupation of Tibet severed emotional, cultural and economic links to the country that had often dominated Ladakh. The 1962 border conflict between the Indian and the Peoples' Republic of China (PRC) governments, resulted in the construction of the Srinagar-Leh road to transport troops and supplies. Change induced by external investments in energy subsidies, consumer goods, communications links, a new system of education, political structure and outsider presence (military, refugee, tourist, bureaucrat); arrived along side heightened Centre[44] interest in the region. Finally, in 1975, the region was opened to foreign tourists. A misleading view of the outside world and the process of *developing* Ladakh began in earnest. Ladakh's relationship, to itself and to the outside world, experienced change of unprecedented scope and pace (Rizvi, 1983:67-74).

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[43] Rapid change in traditional instituions is not unique to Ladakh; it is common place in most places that traditional cultures and development or modernization meet. For further reading, see The Ecologist, 1987?? and

[44] The Centre is the national government in New Delhi. Most development monies and decisions come from the Centre to the state, and then down to the district level within the state.

Because its inhabitants had lived within the limits of their resources, the Western Plateau had an abundance of unexploited natural wealth. As soil gods were not to be exploited, mining was almost unheard of. Copper, gold, silver, borax, and precious stones were all there for the taking (Chopra, 1981:195-9). The Plateau represented limitless space for the two most populous countries on earth. With seven of the eight great rivers of Asia arising from the mountains of the Plateau, then rapidly tumbling from its 4000 metre heights, these rivers represented the largest unexploited hydro-power resource in the world. In some areas, pastures seemed under-populated, agricultural lands expandable, and industry wholly underutilized(Goering, 1991990:22; OIIR, 1992: 5-12).

Development of the region was based on the ideology of modernization, seen in India since the time of its independence, emphasizing 'man's ascendancy over nature with a priority on production' (Viroda, 1989:33). With development, Ladakh became a 'backward' area, its lands were universally lumped into the category of wasteland, valueless to the Indian economy and the Ladakhis, who could not read nor write in either of the two national languages.

As a small minority Buddhist district governed by the Muslim-dominated Jammu and Kashmir state and a Hindu India, almost all decisions concerning Ladakh's future are made by non-Ladakhis. Locals have little representation in state and centre governments (one representative to each). Local administrators are largely outsiders, appointed for two to three year terms. This is particularly telling in the case of the Development Commissioner (DC), the centre-appointed administrator in charge of 'improving the conditions and integrating development' for the entire region (Dube, 1992:164). The DC oversees departments with vast differences in mandates and conflicting budget demands. He enforces nationally-defined programs, works in a language and within a culture he does not truly understand, in an area where over 80% of the population is defined as impoverished (Angorama, 1992).

In 1962, the government implemented the 20 Point Programme, designed to result in the betterment of all people, strengthening the nation as a whole and furthering the path of self-reliance (Bhattacharya, 1982:24). The program would lessen the cost of maintaining newly positioned bureaucracy and army troops through increased regional hydro-power production and making better use of sparsely populated lands (Hanif, 1992). Due to its strategic location, developing Ladakh in compliance with national policy, resulted in the majority of Centre funding being used to support government administrators and the army.

Two development programs receive the majority of the money and emphasis; infrastructure improvement (over 50% of all funds from the 1960s to the 1980s went toward road and bridge construction) and energy development (over 50% of funding since the mid-1980s) (Rizvi, 104; Angorama, 1992). Of particular interest to this study are the decisions made in energy investment.

3.4 Energy investments within development

While regional energy demands and dependence are growing, energy investments have skyrocketed in the past ten years (Angorama, 1992). Fossil fuel expenditures (which carry a national subsidy) and the 4 mW Stakna hydroelectric power project[45] represent a continual drain on government funds.

Ladakh's complex geography limits the effectiveness of hydroelectric transmission and imported fossil fuels. Currently, the multi-million dollar Stakna project provides electricity for about 40% of the villages around Leh, and it functions only about eight months each year (freezing temperatures and sediment build-up prevent year-round operation). Back-up power comes from diesel generators. Over 60% of the population have no access to electricity (compared with 20% nation-wide average). At great cost to the government, hydro-electric power is now available to about 20,000 Ladakhis and army personnel in the Indus valley (Hanif, 1992).

Although less than half of Ladakhis are dependent on fossil fuels for at least a portion of their heating and cooking fuels, there are growing fuel problems in the Leh area. Kerosene is the most commonly imported fuel. Coke, propane and fuelwood are also imported in large amounts over the dangerous Leh-Srinagar road (Goering, 1990:22). Subsidies for fossil fuels, which account for between 40-60% of the total expenditures of the national government, amount to more than 3.2 billion Canadian dollars per year[46] while end-use prices have increased 1400% since 1972 (*Times of India*, Sept. 16, 1992). Petroleum products used in army camps, in government establishments, and those available through the black market, receive government subsidies directly or indirectly representing 90% of their costs (Tripathi,1992). For the majority of the people living in Ladakh, fuels remain

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[45] Stakna construction began in the 1980s, and is ongoing. Located on the Indus River, about 30 kilometres upriver from Leh, it currently produces half its power potential.

[46] In 1992 dollars.

the traditional dung and scrub wood. For these people, centralized energy development has little value.

The most recent oil shocks from the Gulf War, an IMF-imposed austerity program, and a national goal of supplying electricity to all villages in India by the year 2020 suggest alternative energy development in the region (Chossudovsky, 1993:271). Extremely limited water sources, moisture deficits, and saline soils eliminate the possibility of fuelwood plantations. However, small, rapidly moving streams at the heart of each community, suggest potential for micro-hydro power. With the Himalayas blocking the monsoons and the thin atmosphere of high altitudes, Ladakh has a greater number of sunshine hours per year than any other place in India and the second highest global incident solar radiation[47] (Arun 1990:1490). Even in winter when temperatures plummet, the sun shines with regularity. Small scale, alternative energy devices suit decentralized use. This matches the pattern of scattered villages and household-centered energy use found in Ladakh. Solar energy flows freely, passive harnessing of solar energy requires only an initial equipment investment, and low maintenance costs.

Small scale energy projects allows investment to be localized at specific points of energy shortages and mitigates the social, environmental and economic impacts which accompany the use of fossil fuels and large-scale hydro electric projects. Small scale projects are best suited to serve the 80% of the Ladakhi people with limited cash or access to the market economy (LEDeG, 1988:9).

In both technical and economic terms, greater investment in renewable energy devices is an option for easing energy shortages in remote, mountainous areas. Yet in Ladakh, as elsewhere, almost all national and internationally-sponsored energy development continues to emphasize conventional large-scale sources. Objectives of these projects are to provide fuel and power to the army, outsiders and the powerful who could voice dissatisfaction with government. Development is intended to stimulate the local economy by providing jobs in large scale projects. Thousands of unemployed and impoverished residents find work on the big dams, irrigation works and road building projects. But most of these projects are located in a small section of Ladakh, near Leh and Kargil and the large army camps, where the outsiders and powerful live. Government feels compelled to invest in regions that can help maintain power. As Norberg-Hodge (1992:146) comments:

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[47] Only the Sahara desert has a higher incident solar radiation than the cold desert areas of the Tibetan Plateau.

> Development money flows freely into large-scale projects aimed at increasing market transactions...Yet when it comes to small-scale projects that truly promote self-reliance; such as village-scale hydro-electric installations or solar ovens and water heaters for the household, the question is immediately asked: 'can the people pay?'

3.4.1 The insidious nature of development

There are hidden costs to subsidizing only a segment of the population. In Ladakh, government policies have resulted in a recent population boom. Immigration represents most of the 35% population increase over the past thirty years. In a land with very limited potential to support this new population on a sustained basis, the immigrants develop a more mobile population, breaking the reciprocal relationship between people and place. The increase in the presence of outsiders amplifies other changes increased interpersonal conflict, pollution, inflation, insecurity, loss of identity and rapid drain of resources out of the district. The newcomers work within the formal market, and are accustomed to purchasing fuel, foodstuffs and clothing.

Two additional energy changes in Ladakh are having an important impact on the human-land relationship in the area. Communication links with the rest of India are an important consideration in government's investment in a steady source of electricity. Television and radio have had a dramatic impact on the indigenous population. For the first time, people in and around Leh can compare their society with the outside world on a daily basis. According to Norberg-Hodge (1991:96), the message they receive is that traditional life systems are inferior. This has been reinforced by the annual summer influx of between 10,000 and 15,000 western tourists, the second major, fuel-related change. The tourists exacerbate energy shortages with their demands to cook a wider variety of foods, heat water for bathing, electrify hotels and run the buses and taxis. These impacts radiate from Leh through popular trekking routes. There, fuelwood and dung are over-harvested and trekkers demand greater consumption of fossil fuels for light and cooking. Together, increased mass communication with the outside world and increased tourism precipitates change in Ladakhi villages unprecedented in history.

3.5 The impact of development on Ladakhi institutions

Traditional forms of development in Ladakh have induced major changes in the institutional structure of villages and in the reciprocal human-land relationship. Organizations that define Ladakhi communities, the monasteries and nunneries, the schools and health system, the governance forums and cooperative work and support groups, are in turmoil. Apparently less destructive, are alternative forms of aid such as appropriate technology, or more specifically the introduction of solar cookers to supplement supplies of traditional fuels. To assess the impact of this form of development aid on Ladakhi society, the introduction of solar cookers was studied in several villages.

3.5.1 Village institutions within the study

Twenty-six villages participated in solar technology programs whose objectives was to introduce solar cookers. Each village can be located along the community health spectrum (page 47) using villagers' perception of the health of their institutions as indicators. These twenty-six villages were placed in one of six categories of the spectrum (Fig. 3.5.1). These range from autonomous and healthy to fractured, although some of the villages exhibit characteristics of several categories.

3.5.2 The four intensive study site villages[48].

Four villages were studied more intensively in an attempt to document relationships between technology transfer, acceptance and institutional change. These four villages are the Tibetan refugee camp, the Centre town of Leh, the Muslim village of Chushot and the hinterland community of Hemis Shukpachang[49]. A brief description of these four villages, their institutions and relations to the larger world follows.

1. Refugee camp

The refugee community in Ladakh are *Drog-pa,* nomads, from western Tibet. Over 15,000 *Drog-pa* fled their native homeland as the Tibet - Peoples' Republic of China conflict in-

[48] Much of the information in this section comes from long discussions with villagers during the period of the field study.

[49] The community of Hemis Shukpachang was used to base hinterland studies from; solar surveys covered an area of about fifteen kilometres to include three other villages of Themisgang, Tia and Ang.

Table3.5.1 Village institutions within the case study

Village institutions:
Description, continuity and place of control in six village types within the Ladakh case study sites

	Refugee Camp	Centre	Centre Influenced	Muslim Village	Road Influenced	Hinterland
Governance	Exiled	Outside	Outside	Local	Local	Local
Religion	Disrupted	Disrupted	Declining	Intact	Declining	Intact
Economy	Cash	Cash	Mixed	Mixed	Subsistence	Subsistence
Market	Outside	Outside	Outside	Local	Local	Local
Commun-ications	Local	Outside	Outside	Local	Local	Local
Education	Outside	Outside	Outside	Outside	Outside	Mixed
Social Net						
-village-whole	Disrupted	Disrupted	Mixed	Mixed	Intact	Intact
-Family	Disrupted	Disrupted	Disrupted	Intact	Intact	Intact
-Inter-personal Relations	Disrupted	Disrupted	Disrupted	Disrupted	Disrupted	Changing
-Pop growth	Slow	Rapid	Rapid	Rapid	Slow	Slow
Environment						
-Quality	Very poor	Poor	Acceptable	Poor	Healthy	Healthy
-Relationship	Lost	Breakdown	Breakdown	Breakdown	Stable	Complete

(Compiled from Mann, Rizvi and Norberg-Hodge)

creased in the past 34-four years. They left behind family members, large herds of yak, goat and sheep, and, in many cases, their possessions. Suffering almost a 50% mortality rate as they came into exile, the refugees generally arrived impoverished and ill. The Indian government granted 400 hectares of Indus valley land to the refugees in 1963 (Illustration 3.5.1). Today, over 3500 people live in eleven camps[50], in crowded housing, on the wind-blown and saline land, with little access to water or sanitation facilities. Fierce sandstorms blow up the Indus in summer. Previously unsettled, because of its poor quality, the land has little ability to grow crops, or graze the animals which were an integral part of the *Drog-pa's* personal identification. As they lost their animals, the refugees lost

[50] An additional 2600 Tibetans occupy nine camps in Eastern Ladakh. These refugees maintain their herds, on land shared by Ladakhi nomads.

Illustration 3.5.1 The Tibetan refugee camp, looking across the Indus River valley to the Ladakh Range.

their means of sustenance, ability to trade, fuel (dung) and means of transport. Social crisis of physical and mental dislocation was thus compounded by poverty.

The refugees are Mahayana Buddhists, their religion is an integral part of their identity. Within the camps, they have constructed two small monasteries, but most young monks must leave to study religious teachings. Authority once nested within the nomadic household now rests in the Tibetan Government-in-Exile in Dharamsala, H.P. Local governance is supplied by Dharamsala's appointed chief representative while elected camp leaders facilitate action in each camp. Education is centralized in the main camp. The curriculum is prescribed in Dharamsala. People work as coolies on road gangs or construction sites, as teachers or in the market of Leh. Although a few of the refugees have become 'wealthy' by Ladakhi standards, average wages are $20 per month. Families have been broken and in consequence, there are numerous one-parent households, and orphaned children. Family life is also disrupted in homes where both parents must work. The social safety net, traditionally the extended family, has been replaced by a central relief committee and international aid agencies. With little access to dung, people depend on kerosene for fuel. More than 80% of the families have no access to any fuel other than kerosene. Between 50-75% of family incomes are spent on fuel. While conditions in the camps are harsh, the Tibetan arts and oral traditions thrive. As exiles, their own culture and the life they lead back in Tibet have become idealized and cherished. The refugees describe themselves as victims. Almost all want to return to their homeland after it regains independence (Vigoda, 1989:60). The camps in Ladakh are a temporary necessity.

2. Leh: the Centre

The town of Leh is the only population centre in the district. The population of 8000 permanent residents more than doubles in the summer months with an influx of tourists, bureaucrats and army personnel. It is located several kilometres off the Indus up a large side valley, at the junction of two important trade routes. Leh was the capital and trade centre of the kingdom of Ladakh for over three hundred years and is now the government administrative centre for the district. Its population has always been an interesting mix of people, as Yarklandis, Kashgaris, Tibetans, Indians, Turks and Kashmiris; Muslims, Buddhists, Christians and Hindus gathered to trade. For centuries, new ideas accompanied goods to this major stop along the Silk Road.

Leh is the focus of growth in Ladakh. The rate of change is so great that the relationship between people and land is disrupted. As described earlier, Ladakhis traditionally identify with place and the Buddhist philosophy of the middle path. This world view placed greater importance on balance than growth and on cooperation rather than competition or rivalry. Yet, development aid, government services and the cash economy replace these traditional values with competition and commerce. Today, there is a great deal of conflict in Leh over outside control of government and the market, the growing pollution and waste problems in the city, an education system that does not necessarily meet local needs, and growing religious tensions. The social safety net is disintegrating under the pressure of the market economy and an inter-generational schism is developing. According to Rizvi (1989:111) and Norberg-Hodge (1989:96), this conflict is directly tied to the loss of sense of identity with place.

Almost all residents of Leh depend on fossil fuels for at least part of their fuel needs and almost all homes are connected to the Stakna electric supply. Most people still gather or purchase dung for winter heating fuel, but kerosene and coke heaters are becoming common. Bottled gas is also available in Leh, with about 15% of the homes making use of propane for cooking. Fossil fuels are estimated to represent about 50% of the fuel used for cooking (Hanif, 1992).

3. Muslim village

Chushot, the largest Muslim village in upper-central Ladakh is located about 20 kilometers upstream from Leh. On the south bank of the Indus, and at an altitude of 3500 metres, the village of over 400 homes stretches for over five kilometres and is sub-divided into three smaller communities. Two bridges, one at each end of Chushot connect the village to the main road on the northern bank of the river. The road through the village has recently been upgraded from a track. Its proximity to Leh is deceiving. Bus service can be sporadic, and private vehicles are unheard of throughout Ladakh.

The Chushot villagers are Shia Muslims who followed their Queen from Baltistan into Ladakh in the 1600s. These original immigrants were, for all intents and purposes, assimilated into Ladakhi culture although they remain proud of their Balti heritage, and live differently than the strict Shia Muslims in the Kargil region and the Suni Muslims who

dominate in Leh (Rizvi, 1989: 124) As Balti Shia Muslims, they have differing forms of structuring their village institutions.

The Balti system is not based on a belief in *lhas*, as found in Buddhist communities. The land, hearth and water are not sacred, but a sense of spiritual ecology exists in an adaptation of the Islamic demand of stewardship of God's creation. Safeguarding, if not enhancing, the soil and water is an integral aspect of farming. Because they do not practice polyandry, lands are subdivided to be distributed among sons who marry. With recent reductions in mortality rates, and more children surviving into adulthood, farm-lots too small to support a family are becoming common. The Baltis, as late arrivals to Ladakh, settled on previously uninhabited and ecologically poor land. Although there is an ample supply of Indus River water for irrigation, the land is more saline and, therefore, not as productive as side-valley lands. Winds ranging up to 50 or 100 km/hour on most summer afternoons create dust storms which rob the soil of its moisture, lodging in barley fields and causing human and animal health problems. Combining the physical land quality with the human management system, Chushot agricultural and pastoral economy has never been as healthy as that of other Ladakhi villages.

The Chushot social safety nets consist of extended families, professional clans, caste groups, marriage connections (often to Buddhist women and their families) and the mosque. The Baltis maintain an arms-length relationship with outsiders in village decision making. As well, they maintain loose market and family ties to outsiders. Decision making is dominated by adult males within the mosque. Schools are strongly influenced by religious leaders. Traditional structures have remained largely intact, but many Baltis feel this is a consequence of their lack of attractiveness to outside settlement, investment, tourism and some amount of neglect from the government. Chushot has not changed greatly because outsiders don't see an opportunity for gain there (Khan, 1992).

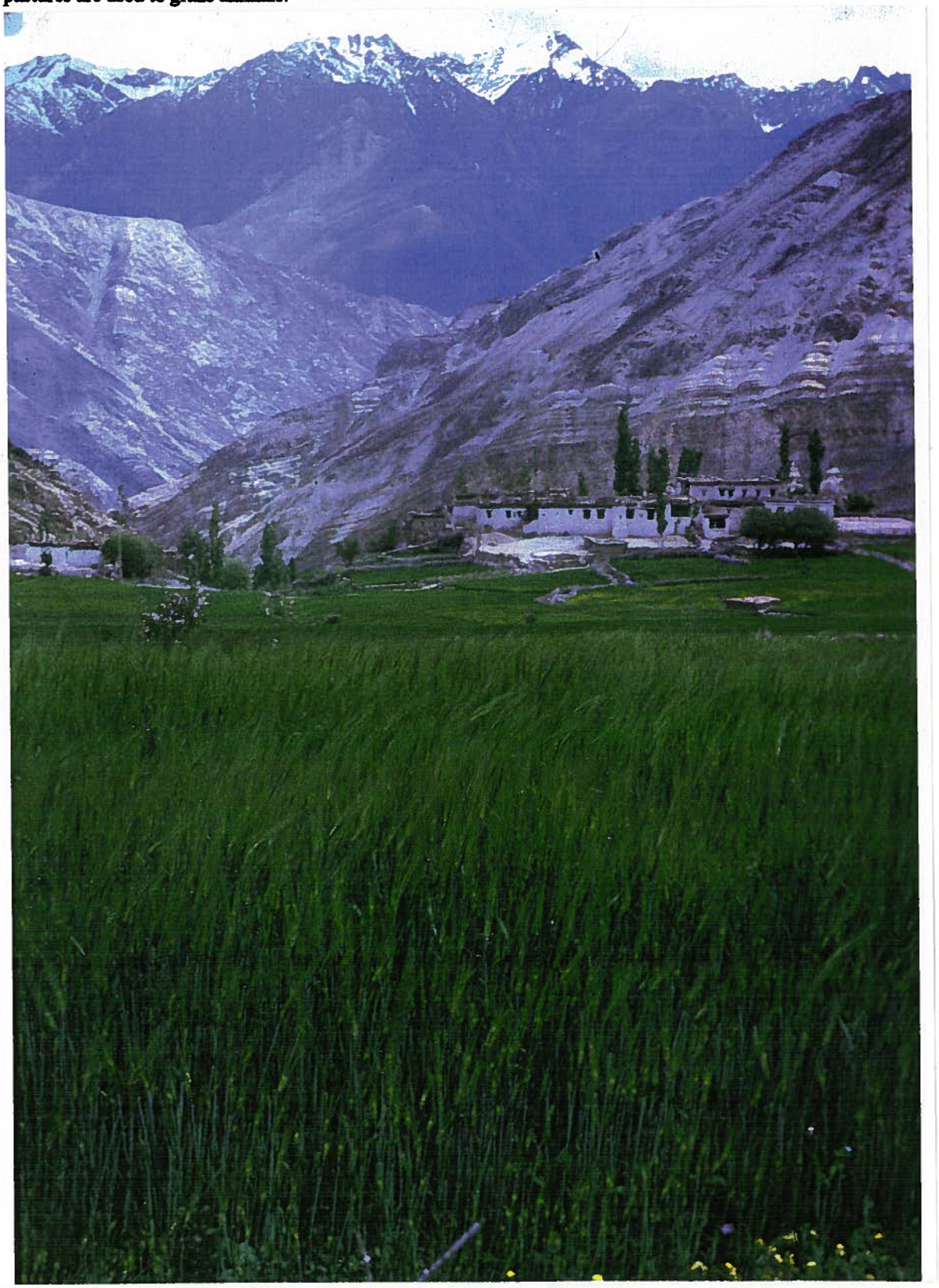
Recent rapid population growth on environmentally inferior land has impaired local sufficiency. Tuberculosis and dysentery are becoming a problem as a result of crowded living quarters. Fuel shortages are a growing worry, as is inflation, which impacts those Baltis involved in the market economy. There are feelings of growing disenfranchisement from Leh, government and their neighbours, due largely to the religious and separatist strife in Ladakh over the past five years, and locally perceived neglect of Chushot by the government.

4. Hinterland village

The hinterland community of Hemis Shukpachang lies at least a three hour uphill walk from the Leh-Srinagar road (Illustration 3.5.2). As with most off-the-road, hinterland communities in Ladakh, Hemis Shukpachang villagers are still largely in control of their institutions and the rate of change occurring in their communities. Interaction with the outside world is limited to trade excursions to Leh or Khalse, or traveling to festivals in neighbouring villages and monasteries. Otherwise, this village of about 60 houses, remains largely self-sufficient and independent. Village governance lies firmly in the hands of the *goba,* his *ghansum* (assistants), professional leaders (traditional doctors and astrologers). Each household participates in decision making on an informal basis. Consensus is almost always reached through ample discussion which often occurs along the footpaths and in the fields. The *gompa* still has a large input, especially in cases of difficult dispute resolution. Although Hemis Shukpachang has a state-sponsored medical and development office and Centre-sponsored schools, the medical office is often vacant school taught by locals. Participation in the formal economy is marginal, trade is primarily on a barter basis, supplemented by cash sales.

The people of the village all practice traditional professions, although some supplement their income through government postings or the tourist trade. Each home is at the centre of a traditional farm; with average holdings of one or two hectares. The village is wealthy in that it has a sufficient supply of irrigation water, several year-round springs of clear water, healthy soils within fairly flat or meticulously maintained, terraced fields, and large family woodlots and pastures. Even at an altitude of 3700 metres, the villagers produce high yields from their barley, potato, mustard, wheat and pea fields. Households have a 'bank' of up to an eight year supply of barley. Houses are large and well-kept. A winter barn is usually located on the first floor, kitchen and storage spaces directly above, and numerous bed, guest and alter rooms, and open space for drying on the roof. Some houses have incorporated a *shelkhang* (glassroom) as a solar-heated room into their homes. There is full recycling of nutrients in the village. Dung and fuelwood is burned in the kitchen. Some kerosene lanterns are used for light. Animal urine and human nightsoil is mixed with topsoil and ash, composted and returned to the field. Field stubble is grazed before it is turned over. Crops are rotated and seeds traded between farmers to aid in healthy crop production.

Illustration 3.5.2 Photograph of Hemis Shukpachang, a typical, remote Ladakhi village. Fields of barley cover the majority of the valley-bottom, villages perch on the edge of productive lands, high-altitude pastures are used to graze animals.



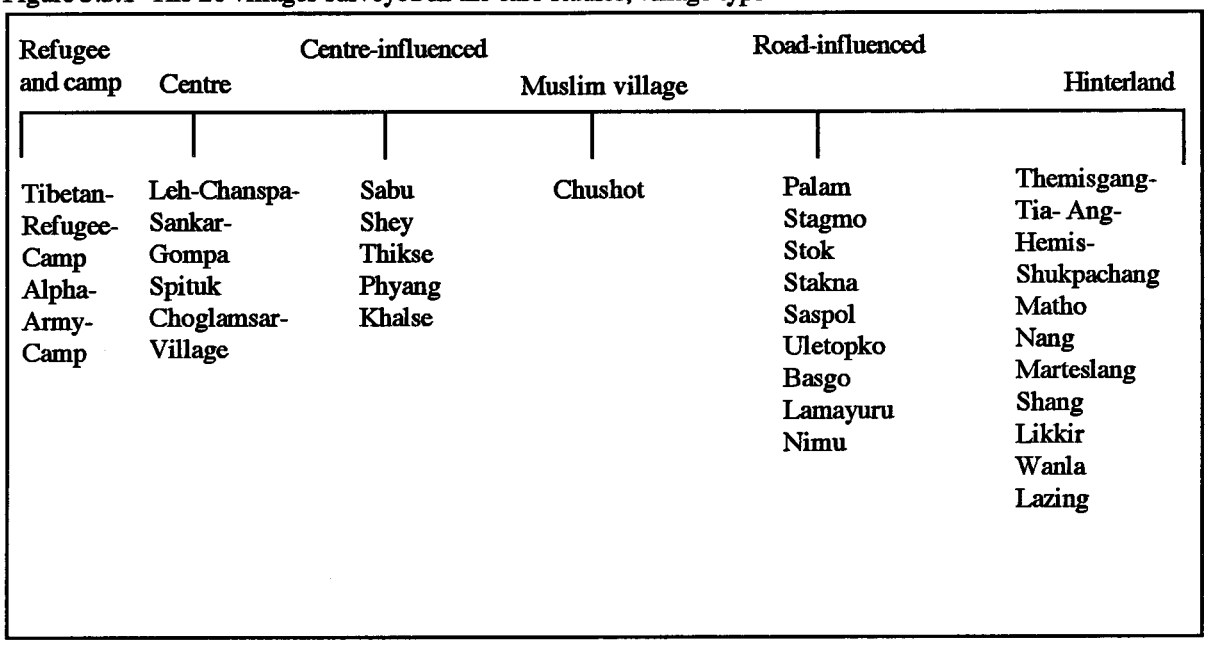
Inter-personal relationships are maintained through an intricate social web. People are not isolated or ostracized in times of need, celebration or daily living. Village harmony and balance guides decisions and actions, to upset this balance, for whatever purpose, is undesirable. It allows villagers to shrug off differences and forget difficulties, concentrating instead on the positive aspects of village health. Personal goals, even that of enlightenment, are subservient to collective goals. The Bodhicitta path to enlightenment that dominates in central Ladakh's hinterland villages is of a collective nature. Within Mahayana Buddhism, all sentient beings will reach enlightenment together.

In the hinterland communities, institutionalized education carries the greatest impact. Many children are sent away to school, in order to receive their Class Ten ticket. The current education system prepares children to join the service sector or continue their training, but not for a traditional life in their home village. Few children are exposed to schools that teach traditional as well as 'modern' education. A generation of children are ill-prepared to continue the spiritual-traditionalism of their parents. There are serious concerns that when these children reach adulthood, the social systems in villages will collapse.

3.5.3 Other villages: the importance of rapid change

Centre-influenced and road-influenced villages fall along the middle of the spectrum representing neither the severe disruption experienced in the refugee camps or the stability seen in hinterland villages. Although they still manifest strong traditions within the household, these are often overshadowed by outside influences. Villagers express feelings of being pulled away from their centuries old systems of ecological balance and social harmony, toward a modern, ego-centred life-pattern (Interviews in Shey, Khalse, Palam, Stok, 1992). People often feel ill-equipped for the change and therefore experience feelings of alienation and resistance (Norberg-Hodge, interview 1989). These impacts hit the younger generation and women particularly hard. The young are often distanced from their own heritage, or lose confidence in their village's traditional knowledge. As the system changes, women lose the status of being the single female in a home of several polyandrous husbands. They lose some of their power over household decision making and control of the 'purse.' Women may see an increase in their work-load as men move away from the home to work for cash. Inter-generational conflict emerges as identities are shaken, and inter-village or class conflicts can emerge with the loss of power (Mann, Goldstein and Tsarong 444; Norberg-Hodge,).

Figure 3.5.1 The 26 villages surveyed in the case studies, village type



The rapid change in Ladakh is occurring simultaneously with the opening of the area to the outside world and the advent of development. In some areas, this change is not welcome. In all areas within the study area, people expressed concern regarding the scope and scale of change. They question a development path geared toward modernization when they observe its influence on the institutions that have supported their lives for centuries. The deterioration of the monastery, system of governance, traditional education forums and social safety nets all reduce their level of self-reliance and control. In addition, Helena Norberg-Hodge (1991:139) notes that:

> An equally important factor in cultural breakdown is the sense of inferiority produced by contact with the modern world.

In response to growing awareness of the destructive aspects of conventional aid, alternative programs are designing and implementing development that supports social structures. The objective of these programs is to reinforce local security, increase material well-being and conserve the foundations of well-being in remote villages. They are intended to address the growing problem of loss of self-respect which is reinforced by conventional development's definition of the Ladakhi people as impoverished. Instead of targeting traditional institutions as culprits of backwardness, these programs attempt to build on local structures.

CHAPTER FOUR
THE CASE STUDY:
APPROPRIATE TECHNOLOGY IN LADAKH

> We used to hold change in one hand and tradition in the other. Then experts came from the outside and brought us development. But it was so big, we couldn't hold it. First we had to set aside our way of change. And then we had to set aside our tradition.
>
> -a Ladakhi man talking about development aid.

Development aid will have significant impacts on Ladakh. The people have unique definitions of human well-being and needs, that are not homogenous across the district. Alongside, and often in conflict with, a traditional society exists a booming tourist industry, a strong military presence, a rapidly growing and modernizing regional capital, a large refugee population and an internal political struggle. Rapid change, both led by and following behind modernization, is a new and threatening challenge to a culture based on balance. Attempts to *develop* the region with nationalized plans have largely not been successful while representing a significant cost to the Indian government[51]. How then can the Ladakhis balance change, development and tradition?

AT programs have been undertaken in Ladakh by government agencies, local grassroots groups and international aid agencies with the intent of better meeting local needs with limited development funds. This chapter examines data gathered in a case study of four AT programs which introduced solar box cookers to address growing energy and health problems in the region. The case study focuses on cooker users who participated in the four programs, and a group who purchased cookers on the open market. The case study covered users in 26 villages in central Ladakh.

Examined in this chapter are the results from the case study. First, the methodology used in this research is described. Then, results from performance tests of cookers used by the different programs are presented. The, results are used to determine the ability of programs

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[51] From an interview with the Development Commisionerof Ladakh, Mr. A Angorama, September, 1992. He stated that the failure of development was two-fold. First, the majority of the people living in Ladakh have been left out of the development process. Most hinterland villages still lack access to electricity, do not have functional schools or health clinics and have no easy access to raods and markets. At the same time, for many people involved in the development process, the provision of infrastructure has not resulted in significant personal gainas. He feels that for development to be successful, both personal well-being and the modernization of Ladakh must occur.

to correctly identify user's needs and willingness to use technologies. Information gathered from surveys and observations is used to examine the effectiveness of introduction programs, and the acceptability and impact of cooker use within the home. Finally, comparisons between different programs are made to help identify areas where cooker programs could be improved.

4.1 Aims of case study: research questions and objectives

Two related questions have developed from technology transfer theory that will be addressed to the case study in Ladakh. First, what components within AT programs contribute to or hinder the acceptance and use of a transferred technology? Second, does technology transfer work, and is it of value, when carried out within the framework of AT? These questions are addressed through the following research questions:

1. Are locally-defined *needs* in energy use patterns correctly identified and reflected in *methods used to address needs?*

2. Are the solar box cookers technically capable of functioning under the local conditions?

3. Are AT programs structured to facilitate understanding, do they result in positive impacts and encourage acceptance and use of solar cookers?

4. Is there a correlation between frequency of use of solar cookers and village-defined need, willingness to use, tool capability, the user's understanding of the tool, net positive impacts in villages, and ease of use? and

5. When results from the above examinations are compared, are there significant differences between villages or between AT programs in Ladakh with respect to solar cooker use?

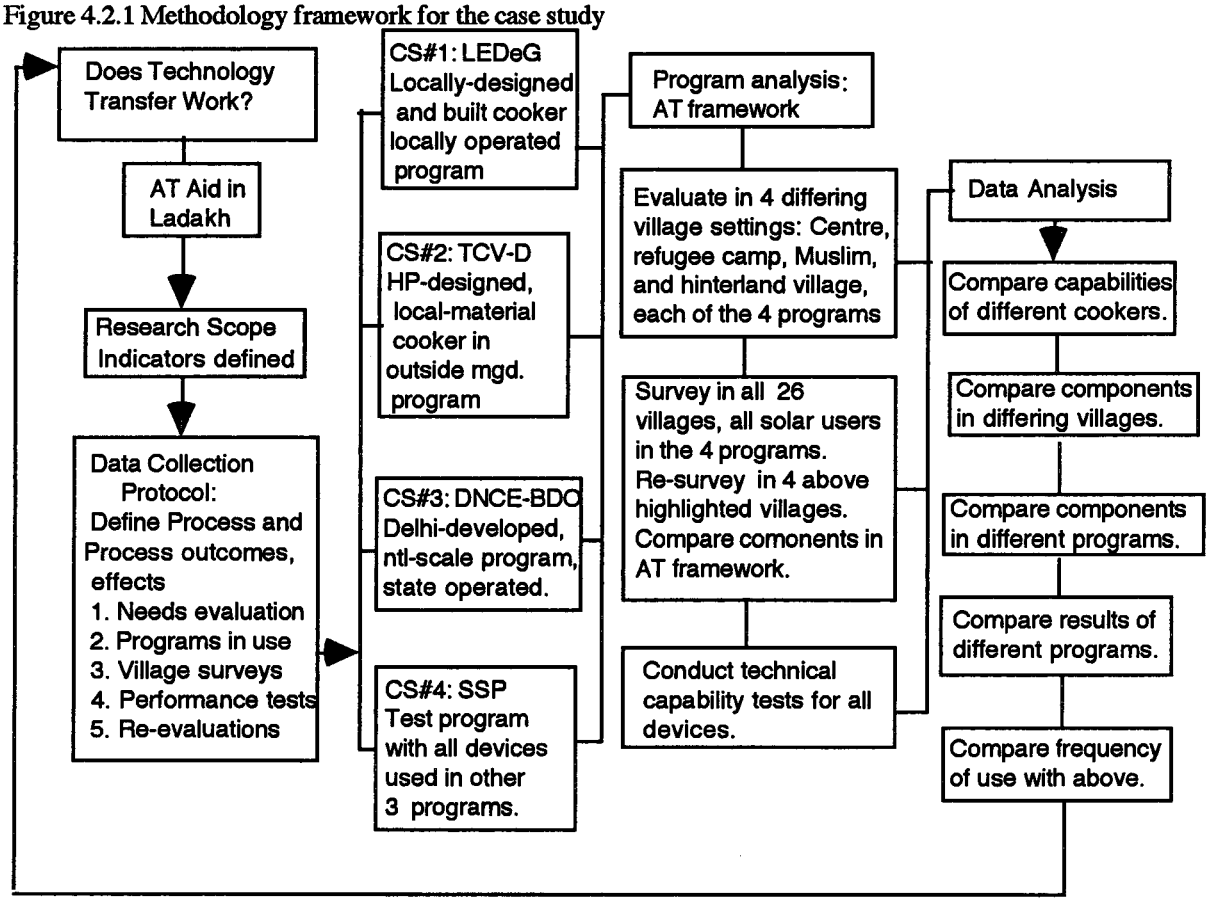
The objectives of this work are to use the case study to examine a form of AT as it is practised, to examine the relationship between components within each of the four AT programs and use of cookers, to compare differences between programs, and to suggest possible improvements in AT frameworks.

4.2 Methods

The study adopts the case study design because this is a commonly used mode of inquiry within planning, sociology and political science; all areas important to development

planning (Yin, 1981:14). The case study is particularly suited to examining and evaluating contemporary events within a real-life situation. The research questions are geared to discovering *why* people use cookers, *how* programs adapt to user demands and *what* components of a program impact use. In this particular case, there was little opportunity for control over actual behavioral events, and the study was interested in conducting "research on real, as opposed to stated, organizational goals" (Marshall and Rossman, 1989:44-46). First, a preliminary data collection stage was initiated, followed by a formal process, which is outlined in Figure 4.2.1.

Figure 4.2.1 Methodology framework for the case study



Data were collected using seven methods in this field work. First, archival research was undertaken in two program offices (LEDeG and DNCE). The LEDeG program supports a library with information on programs it undertakes and has kept a record of technology design, testing and use. In addition LEDeG maintains records on its solar projects, and many of the people who purchased solar technologies in the past. Although LEDeG did not

have a record of solar cooker purchases, information on other technology use assisted in finding owners of cookers.

The Block Development Office (BDO) supports the distribution of the DNCE cookers. The office has a record of most users of the various BDO services, including a fairly complete record of solar cooker purchasers outside the Leh-town area. The records helped locate SBC users. The BDO keeps records on introduction and follow-up program techniques, and user-surveys. These reports were used to help determine the process used and change in the process within the DNCE program.

Second, interviews and correspondence with the three AT program directors (TCV-D, LEDeG and DNCE) provided information on each program's goals, methods and achievements. The fourth program, SSP, was designed as a participatory research program to aid in the evaluation of the other three programs. Interviews were conducted with SSP technicians. Information from the archival search and interviews is aggregated in Table 4.3.2.

Third, surveys of 283 cooker users living in 26 villages were conducted. The surveys made use of four different interview types: structured, informal interview, and key-areas discussion[52]. The observation-based interview did not make use of an interpreter, while the others depended largely on local residents to act as interpreters. Interview structure was designed to match differing interpreter skill levels. The structured interview was largely developed by Solar Box Cookers International, of Sacramento, California. Results from these interviews were used within an international survey of solar cooker users, although the interviews were adapted to fit local data requirements. Informal interviews and key-areas discussion interviews were used when either interpreters could not precisely translate questions, or a more informal setting was preferred. The observation-based interview was used on occasions when an interpreter was not available, or for observation of previously-stated use and actually-observed use was desired. The surveys were tested in the first two months of field work; and data collection continued for the following five months. Table 4.2.3 shows the break down of surveys used.

Each of the surveys gathered answers to 25 questions[53] which covered information on:

- household data,

[52] Interviews placed in Appendix.

[53] Basic 25 questions appearing in the data base are placed in the Appendix.

- views on development or change in the village or area
- household fuel situations and need for alternative fuel sources and technologies,
- willingness to try a new technology
- the nature of the introduction and follow-up programs in the village and the perceived value of these programs to the user,
- benefits and impacts of use of the cooker,
- frequency of use of the cooker,
- likes and dislikes concerning use, design and cooker program,
- suggestions for changes either in the cooker itself or the introduction program.

In addition to the surveys, observation between stated answers to questions and what was actually observed about cooker use or demographic data was recorded. This added a fourth form of information gathering.

Data collection occurred in all villages where technologies could be located. In some cases, cookers distributed in programs in the 1980s could not be located. Attempts were made to contact all past and present solar users in each village; about 50% of all cooker users were contacted and surveyed[54]. In some instances, a neighbour, kinship group member, or relative was allowed to share use of a family cooker. If these persons were fairly frequent users, they were included in the study[55]. Participation in the survey was 100% of solar users contacted, although some users preferred not to address certain questions and asked to remain anonymous. In some instances, non-owner users offered information that owners seemed uncomfortable volunteering.

A fifth method of data collection was repeat visits in 13 villages, either to talk with cooker users not previously found, or to follow-up with users previously interviewed. In four villages, numerous visits and surveys were made. These intensive study sites were used to offer greater ethnographic information, gain the trust of participants, observe the actual use of cookers over several seasons of use, and test interview validity with repeat questioning. Project implementation (village programs), technology training programs and evaluation methods were observed whenever possible.

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[54] As two of the three agencies had incomplete records of the number of cookers sold or given away, the total number of cookers used in Ladakh can only be estimated. Out of approximately 354 cookers in Ladakh (in the three programs), 200 users, or 56%, were contacted.

[55] These 'non-owner' users were included when they stated they had tried using the cooker at least ten times, over two or more seasons, and held opinions on value, limitations and changes in fuel consumption represented by cooker use.

Table 4.2.3 Numbers of each survey used in field work, according to program participation.

Program	L*	Structured #	Informal #	Key discussion #	Observation #	Test Cookers #a*	L
TCV-D	1	20	10	0	0	4	TRC
LEDeG	1	0	7	0	0	5	TRC
	2	11	20	5	0	2	Chanspa
	3	3	4	7	0		
	4	2	0	0	0		
	5	3	14	16	6		
	6	8	4	6	4		
TOTAL		27	49	34	10		
DNCE	1	0	3	0	1	3	TRC
	2	6	11	2	0	2	Chushot
	3	1	15	8	0		
	4	13	5	0	0		
	5	0	9	5	5		
	6	3	1	7	11		
TOTAL		23	44	23	12		
SSP	1	11	19	0	0	2 (A)	TRC
	2	0	5	0	0	2 (B)	TRC
TOTAL		11	24				

Key:
= Number of interviews of each type in each village
#a= number of cookers tested in SSP experiment
L = Location: 1 Camps (army and Refugee)
2 Centre
3 Centre-influenced
4 Muslim village
5 Road-influenced
6 Hinterland
TRC = Tibetan Refugee camps
Chanspa = Near Leh
Chushot = Muslim village
A = SSP-LEDeG model, plastic
B = TCV-D model with 22°
If locations not listed, no interviews were conducted in that village type for that model.

A sixth form of information gathering was a 193 day experiment with all models of cookers used in the above four programs. Six variations of three basic models (the TCV-D, the LEDeG and the DNCE cookers) were tested for their technical capability, with a total of fourteen cookers included in the test (details on the experiment are found in the variables and measures section).

Finally, a participatory research project was added to facilitate the cooker capability testing, and to involve a group of local users in the design of cooker programs. This is the fourth AT program in the case study, the SSP project. The primary purposes of SSP were to i) undertake a capability test of each of the cookers used in the TCV-D, LEDeG and DNCE programs ii) use the cookers within an AT framework in the Tibetan refugee camps, iii)

actively involve users in framework design and evaluation of the program and iv) offer suggestions for change in cooker design and AT program framework.

4.3 The Programs

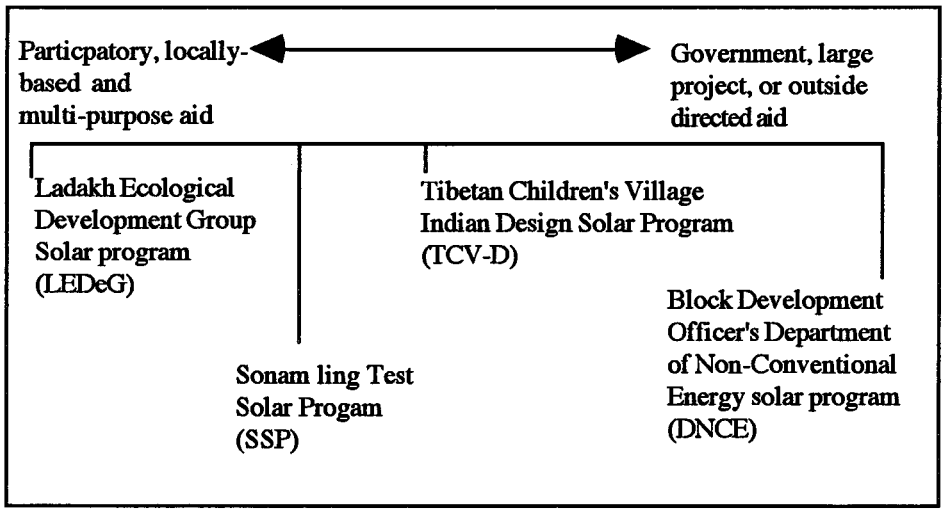
The four different solar cookers programs compared in this case study are the TCV-D, LEDeG, DNCE and SSP programs (Table 4.3.1). Each is a form of AT aid and complies with the general AT concepts in that a program:

- makes use of a proven technology,
- uses its tools to fulfill an identifiable, locally-defined need,
- uses tools to support and enhance local skills and knowledge and
- makes use of relatively simple and cheap tools, and can be sustained without outside aid after the end of an introductory period.

The programs range from indigenously-operated, local programs which stress village self-sufficiency, to government-sponsored programs that focus on technological efficiency and lowering fossil fuel use in impoverished homes (Figure 4.3.1) All four programs share important similarities in that they:

- work within the conceptual framework of development aid, making use of outside financing and technicians,
- work within the conceptual framework of AT by building on local technological experience,
- make use of tested technology, defined as 'appropriate,'
- offer subsidies of 50% or more of cooker cost to users,
- encourage local participation beginning at the planning stage of the project, and
- use introduction programs to encourage greater use of the technologies.

Table 4.3.1 Spectrum of AT program structure in Ladakh



The four programs that will be compared have their characteristics summarized in Table 4.3.2. A brief description of each program and its central emphasis is provided, followed by a discussion of the experimental program.

4.3.1 LEDeG Program

An international organization concerned with the impacts of modernization established the Ladakh Ecological Development Group (LEDeG) in response to the conflict between traditional Ladakhi societies and development. Started in 1984, LEDeG sponsors technology and cultural programs, supports vocational and handicrafts training, and works in inter-cultural education. Based out of its Ecology Centre in Leh, with a staff of between 40-50, LEDeG depends mostly on international aid and private funding.

LEDeG's mandate is to "demonstrate means by which the Ladakhi people can improve their standard of living without thereby suffering environmental or social imbalance" (LEDeG, 1987:46). Within this, their AT projects stress the best use of locally-available resources and materials, technology reproduction at the local level, and cooking technologies used to mitigate (not replace) fossil fuel use.(Dawa, 1992). The LEDeG AT introduction programs stress the context; supporting a healthy, local environment and culture is the purpose of the tool (Norberg-Hodge, 1992). LEDeG currently undertakes the construction, distribution and maintenance of almost a dozen solar, hydro and wind technologies. A design and testing program operates out of their Ecology Centre; with further testing done in homes. The solar cooker project is a small part of LEDeG's AT work (Dawa, 1992).

The LEDeG staff works with villagers who have expressed an interest in incorporating solar technologies into their homes. LEDeG uses this interest as the primary measure of need, as those expressing interest, should be are those with fuel needs and a willingness to use technologies. Staff visit the village for a discussion with potential users, or village leaders. Usually a local planning session or demonstration program precedes technology introduction. LEDeG also attempts to train locals in the maintenance and repair of technologies, offering them up to six month apprenticeships at the Ecology Centre. Follow-up programs were conducted in the earlier years of solar cooker introduction, but there was no systematic cooker evaluation (Dawa, 1992 and Tsering, 1992).

Component	Program characteristics			
	TCV-D Tibetan Refugee Camp	LEDeG Based in Leh	DNCE National program	SSP Evaluative program
AT framework	In H.P.*, full local participation in projects. In Ladakh, outside-directed directed dvpmt. aid	Full participation and investment in community, adheres to philosophy of AT	Decentralized energy projects, making use of small-scale techs, mandated to lessen fossil fuel dependence	Borrowed from other projects in the study evaluation to produce a framework for AT use.
Program emphasis	Fuel use	Cultural conservation, AT	Fuel use	Evaluation of AT programs
Financing	Intl and Indian donors	International donors	National ministry	International donors
Years in Ladakh	3 month program	14 years w/ parent org.	26	Less than 1 year
#staff	None in Ladakh	40-50	15	3
AT variety	Solar cookers only	Micro-hydro, ram pumps, wind, other solar	Pumps, pressure cookers, stoves	Other solar technologies
Other programs	Fuelwood conservation, job training	Cultural program, arts, handicrafts, voc. training	Village support program	Training and health
Location of villages	TCV only	Throughout Ladakh	Leh Block villages	Tibetan camps, near Leh
#villages served	1	91	25	4
Years w/ cookers	3	8	5	1
#cookers	54	150-200	80-100	30
Subsidy to user	100%	33-100%	25-50%	50-100%
Needs evaluation	Request from TCV director users not asked	Villagers come to Ecology centre, or pilot projects	Targeted at impoverished, input from village heads	100% evaluation as part of experiment to redesign programs
Participation	Little user participation in TCV; director's choice	R&D, construction and test with Ladakhi staff	State and Centre	R&D, construction, test, redesign with local staff
Intro order	Only cookers used	Dependent on request from villagers	Dependent on local needs	Dependent on local needs
Program: R&D	10 years in HP, many successful programs	ITDG + 14 years in Ladakh, many successful programs	19 years with DNCE, many successful programs	Less than 1 year
Local testing	none	All technologies	Limited	All technologies
Construction	Locals participate	At Centre or village	Outside (Jammu)	2 models on site
Staff make-up	HP w/ local help	Mostly Ladakhi	State and local	Mostly Tibetan
Training	On-site, use and repair	On-site or at Centre	On-site, use and repair	Some R&D, on-site use, repair
Program dvpmt	HP	Ecology Centre	Centre and state	Local
Introduction	70% info session 30% demonstration	70% information session 30% demonstration	50% information 50% demonstration	100% demonstration
Follow-up	Locally trained technician	Up to users unless use within a pilot project	25% surveyed program, some local technicians	100% surveyed, some redesign and training
Evaluation	None	Within pilot projects	User survey in some villages	User survey for all users

Table 4.3.2 Summary of information on each of the four AT programs included in the case study

4.3.2. TCV-D Program

The Tibetan Children's Village (TCV) program within the Tibetan refugee camp was based on a small, ten year solar cooker program operated in Himachal Pradesh (HP), India. Didi Contractor, the designer, and a small group of technicians experimented with solar cookers in response to local fuelwood shortages. The program addresses social and environmental consequences of fuel shortages, supports local cottage industry, encourages local problem-solving and appropriateness in development. As a small group, the project works only with cookers, but incorporates these into an AT program. Design research was undertaken for ten years at Ms. Contractor's Suni Cottage, in HP. Funding for the program is largely from grassroots movements and government subsidies. Forty locally-trained technicians aid in training and building of cookers, and offer demonstrations of cooking in HP (Contractor, 1992).

Ms. Contractor came to Ladakh to undertake a project at the request of the TCV director. The main kitchen at TCV was consuming over 200 litres of kerosene per day for the over 2000 people it serves. The director requested that solar cookers be built to lessen this fuel consumption. Ms. Contractor undertook the TCV-D project with the goals to i) provide each residential home within TCV with two cookers, ii) use these cookers for baking bread for the 2000 residents and staff, iii) lessen kerosene consumption, and iv) provide an example that could encourage further use of solar technologies. The TCV-D cooker was designed to be simple and cheap to build, largely from indigenous materials, and be easy to maintain and use (Contractor, 1992).

The TCV director did not consult with the 30 people expected to use the technologies. Several HP technicians worked in conjunction with Tibetan vocational training students to construct 54 cookers in the school compound. No locally-constructed, experimental cookers were constructed. A training program on the use and maintenance of the cookers was held for the houseparents and cook staff. When working in HP, this AT program inserts cookers into women's support groups or village self-sufficiency system (Contractor, 1992). In Ladakh, this was not done. The director asked for HP assistance for three reasons; to gain knowledge of solar energy, to obtain funds for cooker construction and because of their inability to acquire Ladakhi-based AT aid (Tenpa, 1992).

4.3.3. DNCE program

The Block Development Office (BDO) of the Leh district currently operates a Department of Non-Conventional Energy Sources (DNCE) sponsored alternative energy program. The BDO-DNCE mandate is to address the energy needs of the 80% of the Ladakhi people defined as impoverished, especially those in hinterland villages without access to fossil fuels (Hanif, 1992). The BDO makes use of alternative energy sources in order to achieve the goals of the (Centre-sponsored) 20 Point Program to provide adequate energy to all citizens by the year 2020. The BDO focuses its development programs on basic needs, over cultural support. The department supports the use of numerous technologies, irrigation and water services, and vocational training programs. The office is supported through national and state government grants, a small portion of which goes to alternative fuels. It has a staff of more than 15 people and serves 25 villages in the block (Angorama, 1992).

The DNCE cooker was tested within the national alternative-fuels program and has met with success when introduced elsewhere in India. Local testing was limited, usually with staff experimenting with local foods and introduction program frameworks. The BDO sponsors programs in villages where interest has been demonstrated, and in 'target' villages. Participants must be below the poverty line (earning less than 440 IR/month; about $17) and living in the Leh block, in order to receive a cooker. After a preliminary meeting with village leaders, a demonstration program is conducted in villages. Cookers are sold to villagers who participate in the introduction program. Local technicians are not trained. Follow-up and evaluation programs are mandated by the Office of Science and Technology, J&K government (Hanif, 1992).

4.3.4 SSP Program

The Sonam Ling Solar Project (SSP) was the experimental, participatory research project that ran in conjunction with other research for this thesis. Operated by the author, and funded through an international aid grant, SSP had three components. The first was to run independent tests on each of the cookers used in the other programs. These tests were carried out in the Tibetan refugee camp, under similar micro-environmental conditions and equal use. This was done to provide the basic information on technological capability, over a period of 193 days. The second purpose was to distribute and use cookers (of each model) within the refugee camp under a participatory AT program. In addition to elements

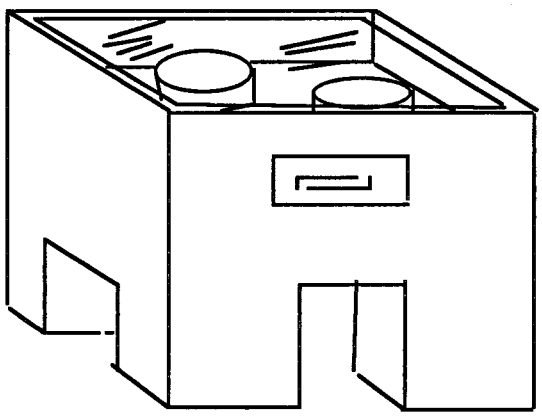
from other solar programs, a food subsidy was added to SSP. This allowed the refugees the freedom to experiment with cooking methods, without worry about their limited food budgets. The cookers were used for up to six months within the refugee camp, then the program and cooker performances were evaluated. Finally, evaluation information was used by participants to design a solar program useful to the refugees. This program borrowed elements from each of the other AT programs. Several villagers from Choglamsar (village), Chushot and Chanspa then joined the SSP program.

SSP was a participatory program, with the 35 recipients chosen by their demonstrated willingness to try new technologies and to offer feedback on performance. Users helped design the program, evaluated cooker capabilities, experimented with cooker design and use, and then participated in creating a program for further use in the refugee camp.

4.3.5 Cooker type

Six variations of the (three) models associated with the LEDeG, TCV-D and DNCE projects were tested in the case studies[56]: two variations of the TCV-D model, three of the LEDeG model and one DNCE model (Table 4.3.3). A brief description of each model follows.

Figure 4.3.1 TCV-D Adobe solar cooker

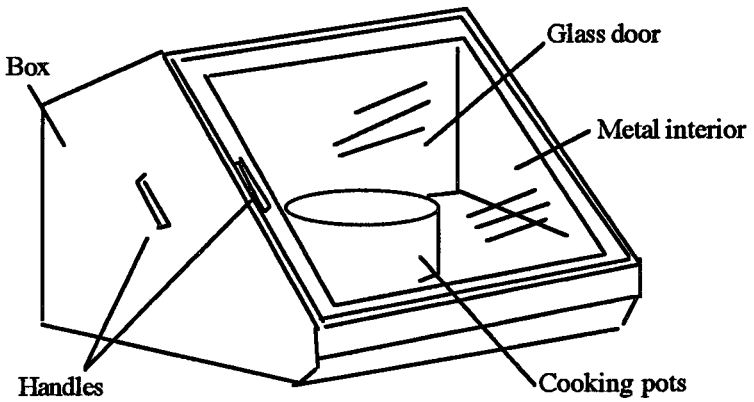


Fifty-four TCV-D cookers were constructed in 1989, all within the Tibetan Children's Village compound. The cookers are constructed of adobe brick, with a small amount of wood for framing. The hot box is lined in black-painted sheet metal, with straw insulation.

[56] Other models of SBCs are produced and used in Ladakh; but they are not common.

All cookers use double-paned glass, with a surface area of 1 metre by 0.6 metre. Forty-eight of the cookers are constructed on rooftops in communal homes at the village; six cookers are on ground level at a large dormitory. All the cookers are anchored on the roofs or ground; they are not portable and cannot be oriented to the sun. The cookers were originally constructed so that the glass is oriented at a 90° angle to the ground (variation 1) (Figure 4.3.1). In 1992, several of the cookers were rebuilt at a 22° angle (variation 2, reconstruction undertaken within the SSP program), in an attempt to capture more sun's rays for more of the year. The cookers have a capacity of six 1.5-litre bread pans. The door or hatch to the cooker is a small opening at the front of the cooker, so constructed that large water containers or pots cannot be inserted into the cooker.

Figure 4.3.2 The LEDeG solar cooker



The LEDeG cooker (and two of the three variations) is the result of many years of testing in the Leh area (Figure 4.3.2). The cooker has been used in dozens of communities throughout upper and central Ladakh; including the remote Nubra valley area. Between 150 and 200 cookers have been built and distributed since 1984[57]. All cookers are constructed of materials available in the local market. The box is made of plywood over a wooden frame. The interior of the hot box is sheet metal, and insulated with either coconut husk or straw. Most cookers use a single pane of glass (variation 3), with a surface area of 0.5 metre by 0.65 metre. Some double-paned cookers were constructed to test for greater heat retention (variation 2). (Through the SSP program, the LEDeG design with two 'panes' of a special ultra-violet resistant LDP film were tested for performance capability (variation 3). This model will be discussed under the SSP program.) The cooker is constructed so that it

[57] The Ecology Centre supports an AT office in Kargil as well as the office in Leh. The Kargil Centre also constructs and distributes solar cookers. It is unknown how many cookers are in use in this part of greater Ladakh.

Table 4.3.3 Solar cooker characteristics

	TCV-D	LEDeG	DNCE
Number in study	54	78	68
Number in Ladakh	54	150-200	80-100
Location	Refugee camps	Upper and central Ladakh	Upper and central Ladakh
Materials	Adobe brick, sheet metal, wooden frame, straw insulation, with glass top	Plywood, sheet metal, wooden frame, coconut husk insulation with glass door	Plastic, sheet metal, fiber-glass insulation, mirror, with double-paned glass door
% local materials	40%	0%	0%
% locally-available materials	100%	100%	80%
% local construction	100%	100%	0%
Glass surface size	0.6m square	0.325m square	0.3m square
Cooker size	1.5m x 1m x 0.75m	0.5m x 0.75m x 0.75m	0.6m x 0.6m x 0.25m
Capacity: litres food	9	12	6
Capacity: litres water	9	20	6
Cooker weight	approx. 100 kg	12 kg	14 kg
Primary function	Bread baking	Water heating, baking	Food cooking
Hatch	15 cm x 40 cm	38 cm x 52 cm	56 cm x 56 cm
Reflector	Not possible (adobe sidewalls)	Can be attached	Built in
Cover	Canvas cloth, can be insulated	Can use blanket, can be insulated	Built in cover, can be insulated

can be oriented toward the sun at either a 30° or 60° angle to the horizontal (while maintaining a flat interior surface) and to take advantage of summer and winter sun. The cookers are portable, weighing about 12 kilograms and measuring approximately 0.5 metre x 0.75 metre x 0.75 metre. The cookers were specifically designed to serve two purposes, to cook food and heat water. The entire front of the cooker functions as the hatch, so that 5 or 6- litre pots or a 20-litre jerrycan can easily be placed inside.

Cookers tested within SSP for use in the thesis:

Test cooker #	Model	# in field	Test cooker #	Model	# in field
1-2	TCV-D90°	48	7-8	LEDeG2x	125-150
3-4	TCV-D22°	6	9-11	LEDeG	25-50
5-6	SSP-LEDeG plastic	6	12-14	DNCE	100

The DNCE solar cooker (Figure 4.3.3) was developed at the solar energy centre in Haryana state, over a 10 year period of research and testing. The model is used nationally and must be reproduced to standard by state-sponsored manufacturing agencies; in J&K the agency is located in Jammu (city). Over 350,000 cookers have been distributed across India. There are approximately 100 cookers in use in 25 villages are throughout central

Ladakh[58]. The BBO-DNCE program has operated for four years, while previous state-sponsored programs made use of the same DNCE model. They are made of a heavy plastic box over a metal frame. The hot box is sheet metal, insulation is fiberglass. A double-paned glass top and a large reflector mirror, both measuring 0.5 metre x 0.5 metre, directs sun rays into the box. Weighing about 14 kilograms, and measuring 0.65 x 0.65 x 0.25 metres, the cooker resembles a large suitcase when closed. The entire glass top functions as the hatch or door, allowing easy access to the interior. The cooker's adjustable mirror allows for use in all seasons. The cookers are designed chiefly to cook food, with a capacity of 8 litres of food, in specially-made, shallow pots that are sold with the cooker. Water capacity is limited, and specially-designed containers must be manufactured. The cooker has an insulated lid that can be closed to allow heat retention for hours after the loss of direct sunlight, and allows the cooker to be moved easily and safely.

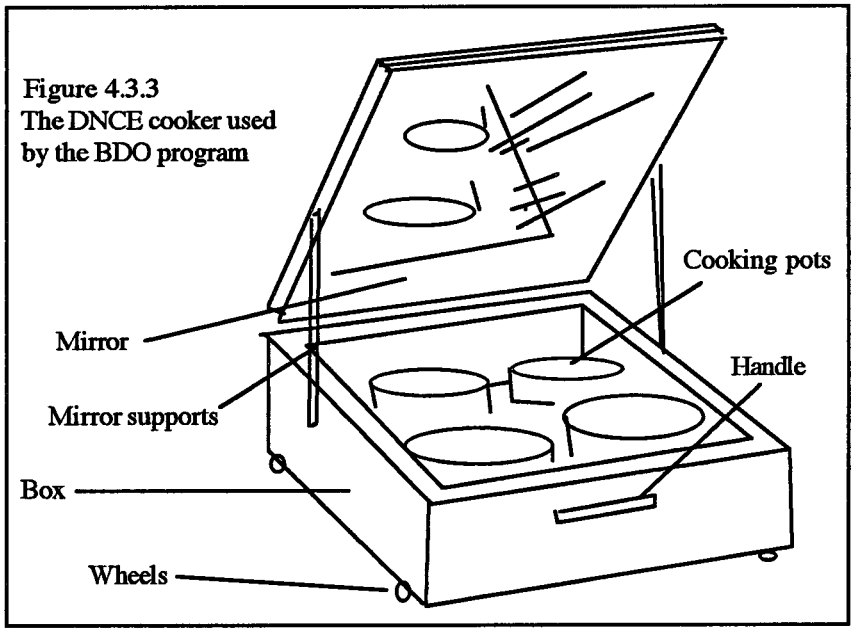


Figure 4.3.3
The DNCE cooker used by the BDO program

All of the above-mentioned cooker models are used in the SSP program. In addition, SSP designed and used one variation of the LEDeG and one of the TCV-D models. The SSP-LEDeG variation was one that used two 'panes' of UV-resistant LDP film. This film has proved a suitable replacement for glass, which is expensive and fragile, when used in other cooker programs in the equatorial region. The film had never been tested in temperate regions or at high altitudes. Several LEDeG models were fit with the LDP film and tested

[58] The BDO office in Kargil also operates a solar cooker program which was not evaluated in this study. The army makes use of the DNCE model, with between 50-200 cookers being used by army personell.

within a LEDeG program framework. The second SSP variation was the redesign of the TCV-D cooker, with a change in angle of the glass top of the cooker (from 90° flat surface, to a tilted 22° surface). This change was tested to see if the cooker-use season could be extended.

In total, SSP tested 14 cookers, of six variations, on a daily basis for the entire field study period. This fulfilled the need to record the technical capability of each of the above mentioned cookers. In addition, 21 other cookers were used in the program.

4.4 Variables and measures

Variables measured in the thesis are drawn directly from AT literature. According to McRobie, co-founder of ITDG (1981:39), *appropriate* tools and programs can be specifically identified. The tools should address locally-defined needs, invest in local knowledge and skills, and produce a situation where participants are more self-reliant. In addition, the tool is one that is fully tested before large-scale implementation is undertaken. The program should remain flexible in order to react to local change, and use evaluations as feedback to match needs with program results. These concepts directed the variables chosen, and were included in each of the surveys conducted in the field.

In conducting the study, and in presenting the results, the focus remained on the user's perceptions of how effectively cookers functioned. The user surveys covered information in the following conceptual framework:

1. frequency of use is related to
- *2. a local need and willingness to use a different cooking system,*
- *3. technical capability*
- *4. user's understanding of technology,*
- *5. functionality, and*
- *6. household and village benefits and impacts.*

In combination, the variables attempt to present a holistic picture of why users may or may not adopt a new technology (Table 4.4.1). Frequency of use will be used as the determinant of whether or not the program has been successful. Need and willingness are acceptable general measures of whether a change within a home will be considered. Technical capability is vital as people will stop using a cooker that does not work.

Knowledge of how the cooker works provides the comfort needed in making a technological change. Functionality, benefits and impacts contribute to ease of change within the home.

Concurrent with the user survey, a capability test on all models of cookers was undertaken. This *do the cookers work?* aspect of the research question makes use of a different format from the other variables. Fourteen SBCs, representing six variations of three models, were tested over 193 days and during spring, summer, autumn and early winter. The technologies were used under similar micro-climatic conditions and carried the same loads. The cookers were located within three kilometers of each other (in the Tibetan refugee camp), placed on the same desert-type surface, experienced the same outside air temperatures, degree of cloudiness or shade, and incident solar radiation. Each was maintained oriented toward the sun and hatch opening was limited (to retain internal heat as much as possible).

Table 4.4.1 Variables in the case studies

VARIABLE	TO INDICATE	PROBLEM DEFINED
1. frequency of use	if all other variables combine in a situation where benefits outweigh impacts	as a measure of success of a program, local adaptation of the technology or need so great, negative impacts not considered as important as fuel savings.
2. a. need	if there a fuel problem	is fuel defined as a problem?
b. willingness	technology acceptance	as cookers are an intrusive technology, will, a new technology be accepted by users?
c. ability	affordable technology	could the household afford a needed tech
3. technical capability	capability+ functionality	does the cooker used match defined needs, will it work in this context?
4. a. program intro	including those interested	did the program make learning easy, encourage further dissemination, carry out
b. follow-up	support understanding	problem checking, and establish a local support network?
c. comprehension	actual understanding	do users understand how cooker functions and are confident in using it?
5. ease of use	use problems	difficulties incurred in use
design	design problems	difficulties caused by design
6. impacts	net perceived gain (benefits)	did net gains make use of a new tech worth effort invested: economic, health and micro-environment, time, soil fertility, travel, control
	net loss (impacts)	did net loss make use of new tech dis-advantageous: socio-political changes, social/ household disruption, religious,

4.5 Results and discussion

Cookers were tested for i) maximum daily temperatures, ii) hourly temperatures, iii) load, iv) ability to cook specific kinds of food, v) ability to maintain heat during cloudy weather and after sunset and vi) ability to heat and pasteurize water. Outside temperatures, hours of solar radiation and percent clouds, were recorded in conjunction with cooker performance.

Min/max thermometres were used for maximum daily temperature readings, with thermometers always suspended in the air and centrally located in the cooker. Readings were taken at the end of each day, without opening the hatch to take readings. Thermometers were pre-tested and variance taken into account; the same thermometers were always used in the same cooker. Hourly temperature readings were made through the glass (without opening the door) and were taken on 17 out of the 193 days, and at least twice each month. Loads were measured in kilograms of raw food or litres of water loaded. Cloud cover was estimated by visual examination. On cloudy or stormy-weather days, cookers were uncovered and temperatures taken. Cookers (whenever possible) were re-oriented toward the sun on a bi-hourly basis; the glass was cleaned each morning.

Technical capability was primarily measured through the cooker test (operated in the Tibetan refugee camp). Secondary capability data came from the users, who were surveyed for their perceptions of how well the cookers performed. In some instances, when interviews coincided with cooker use, performance tests were run in villages.

4.5.1 Technical capability

Seven issues were addressed within the question *do the cookers work?* These components taken together answer:

- do the cookers achieve sufficient temperatures for sufficient periods to cook food?
- can they cook enough food of the local diet to feed the average Ladakhi family?
- are the cookers reliable enough to be functional on partly cloudy days?

Each of the seven questions will be discussed individually in order to answer *do the cookers work?* The results are displayed in Table 4.5.1 and outlined below.

The first question looked at the number of days the cookers achieved minimum cooking temperatures of 100°C (Column 1 in Table 4.5.1) and whether the cooker stayed above 100° for at least two hours in order to be able to cook food (Column 2 in Table 4.5.1)[59].

Table 4.5.1: Technical capability of all cookers; according to the temperatures they produce and according to the type and amount of food they can cook?

Does the solar box cooker work?
Experiments with six models used by four programs

Cooker ⇓	1. #Days T>100° /193	2. #Days T>100° >2 hrs/ 17	3. #Meals cooked /51	4. Time to cook 6 l food Bread	/Rice	/Meat	5. Max load F/W	6. Maintain T° in clouds	7. Cook food eaten?
1. TCV D-22° (2[a])	109 (56%)	10 (59%)	5 (10%)	5	6	0	9 - 6	30 min*	38%
2. TCV D-90° (2)	103 (53%)	7 (41%)	5 (10%)	5	6	0	9 - 6	30 min*	40%
3. SSP-LEDeGP (2)	86 (47%)	4 (24%)	5 (10%)	3.5	6	6	12-20	<1 hour*	35%
4. LEDeG Mod-2x (2)	153 (79%)	13 (77%)	19 (37%)	2.5	3.5	4	12-20	<2 hours*	72%
5. LEDeG Reg (3)	142 (74%)	12 (71%)	19 (37%)	3	4	4.5	12-20	<1.5 hours*	70%
6. DNCE (3)	180 (99%)	17 (100%)	44 (86%)	2	2.5	4	6 - 6	<2.5 hours	90%

1: Number of days temperature reached 100°C or more (total days 193)
2: Number of days temperature reached 100°C or more for more than two hours (total days 17)
3: Number of meals cooked out of a total of 51 on 17 days tested
4: Time required to cook 6 litres of food (bread, rice and meat soup) on 17 days tested
5: Maximum load cooker holds in food/water
6: Time taken for temperature to drop by 20% or below 80°C in partly cloudy weather, measurements on 3 days in 30% clouds, with outside temperature between 15-25°C.
7: Percentage of meals cooked that are foods within the local diet, of the total cooked in column 3
*with a blanket covering cooker
a: number of cookers tested; temperature differences between the cookers tested was less than 3°C

The tests show that all the cookers achieved temperatures sufficient to cook food, although there are great differences between the six models. The first three obtained sufficient temperatures between 44-57% of the days, while the last three showed that 74% or more of the time, sufficient temperatures were reached. The average maximum temperatures for

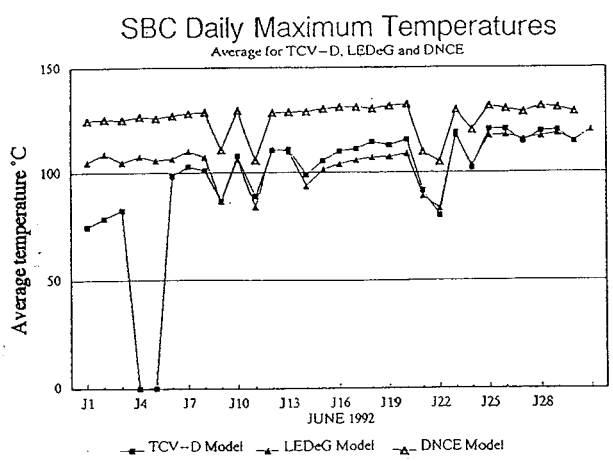
[59] Tests undertaken by the (Indian) government show that SBCs can *continue* to cook food at temperatures as low as 85°C once an initial temperature of 100°C is achieved and maintained for at least half of the cooking time (Tripathi, Oct. 8,1992 interview).

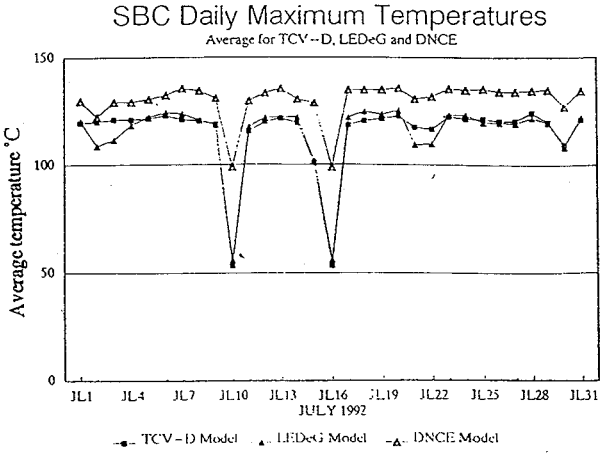
each model over the entire 193-day period is shown in Figure 4.5.1. Similar differences between the first and last three cookers is seen in their ability to maintain cooking temperatures (Column 2) with the DNCE cooker performing four times better than the SSP-LEDeG cooker. Average diurnal measurements for each model over the 193-day period is shown in Figure 4.5.2.

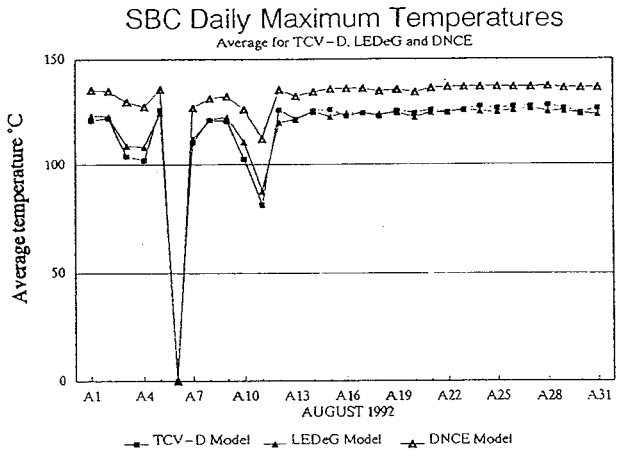
The second issue to be addressed is to test a cooker's ability to actually cook food. Hourly temperature measurements were taken on 17 days between June 1 and December 10, 1992, to determine how many meals out of a total possible of 51 (17 days at three meals per day, with temperatures reaching and maintaining 100°C for at least two hours for each meal) the cookers could produce (Column 3, Table 4.5.1). Results reveal a marked difference between the models' capabilities. The total daily output is determined by temperatures achieved, which in turn controls the amount of time needed to cook each meal. A comparison of times needed to cook bread, rice and meat stew in each model also reveals differences between capabilities (Column 5). Here it can be seen that cookers 1 and 2 on average took twice as long to bake bread than cookers 4, 5 and 6. The TCV-D cookers were not used to cook meat because they often did not retain high enough temperatures for sufficient time to fully cook meat. Cooking capabilities are also addressed by data in Column 7 which shows a record of the number of times on 17 days that the cookers successfully cooked foods representative of the local diet.

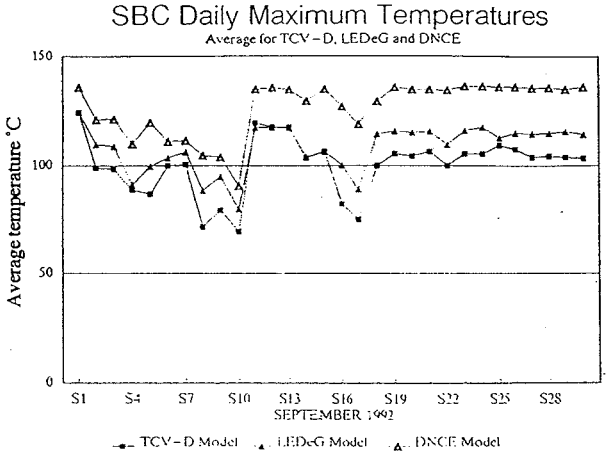
A third important issue concerns the different functions the cookers were designed for. The LEDeG cooker was specifically designed to heat water and to cook food. The interior oven space was designed large enough to hold jugs of water. The cooker can make use of utensils commonly found in Ladakhi homes. The 20-litre jerrycans which most families use to haul water from springs to their homes, fit within this cooker. Large five or six litre pots also fit easily inside. The DNCE cooker makes use of small pots, designed strictly for food preparation, supplied with the cooker. The cooker was designed with a small capacity to achieve high maximum temperatures, producing more meals per day, over a longer use-season (less than 50% of the time required by the other cookers). What it achieves in heat is lost in capacity per use; but its *per day* capacity is normally sufficient to cook for the average family. Heating water and cooking sufficient quantities of food for large families remains a problem. The TCV-D cooker is limited by its small oven space, its extremely small hatch for loading and its slow cooking speed. It cannot handle large or tall pots, nor water jugs. It was chiefly designed to bake bread and so only oblong loaf pans or small pots fit through its door.

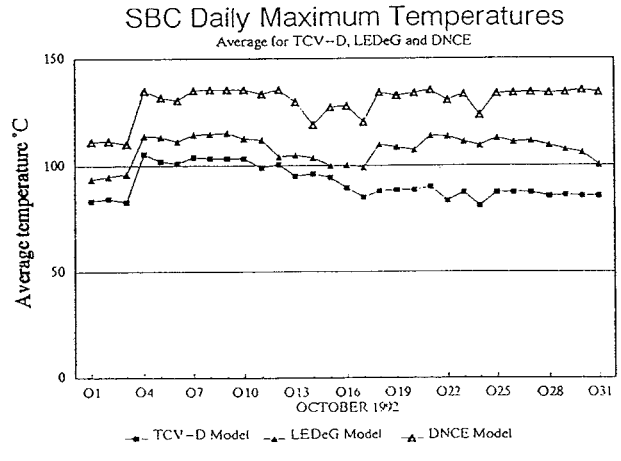
Figure 4.5.1 Daily maximum temperatures taken in 14 cookers over a seven month period; temperatures are averaged to cooker model.

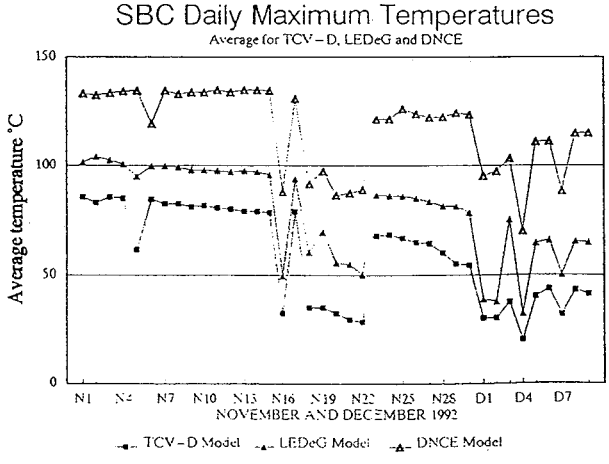












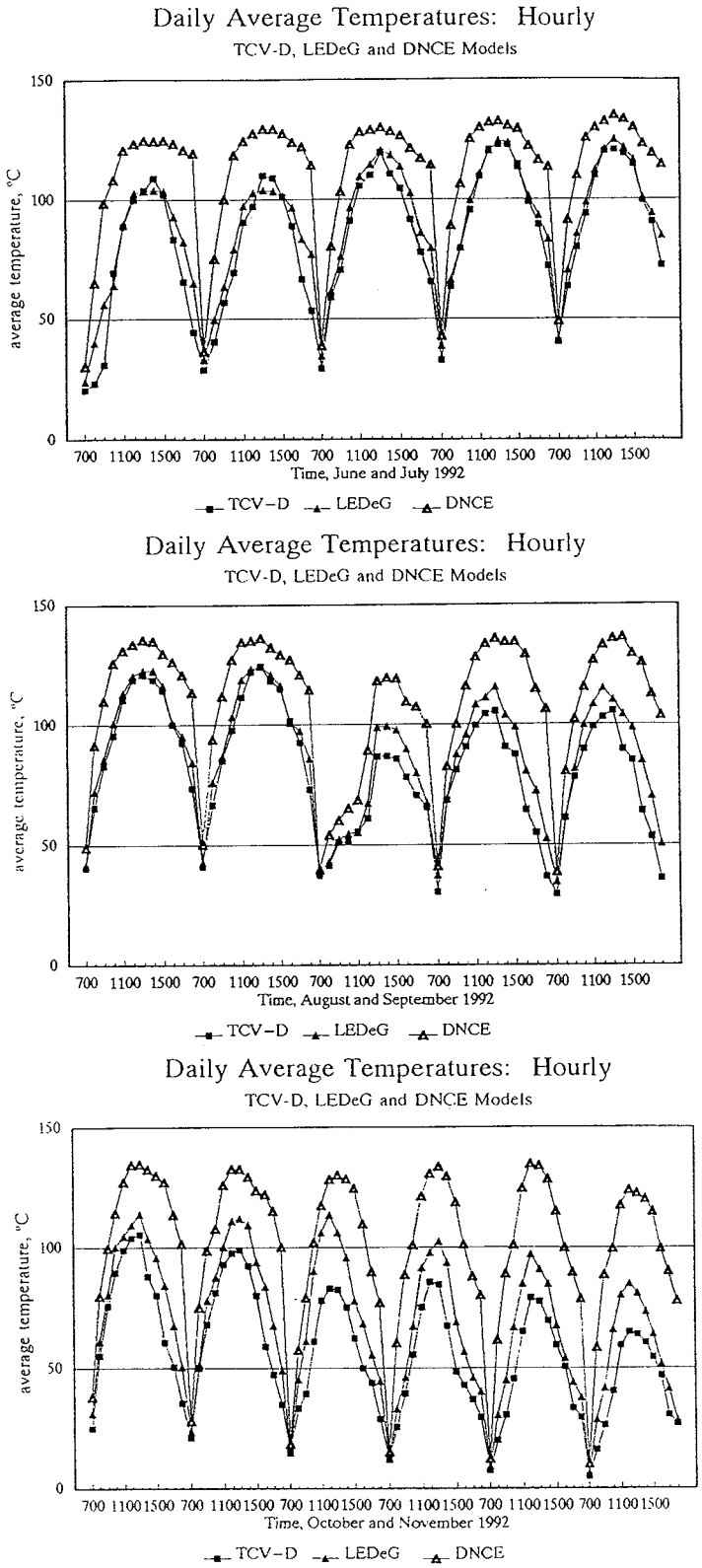
*cooker temperature differences of individual models were between 0.5°C and 3°C

All cookers were tested within the Sonam ling Solar project, cookers located at the TCV compound.

Total number of each model averaged:

TCV-D: 2 (90° model)
LEDeG: 3 (Regular model)
DNCE: 3

Figure 4.5.2 Diurnal temperatures taken on 17 days in 14 cookers, with temperatures averaged by cooker type.



* cooker temperature differences of individual models were between 0.5°C and 3°C

All cookers were tested within the Sonam Ling solar project, cookers were located at the TCV compound. Total number averaged for each model: TCV-D:2 (90° model), LEDeG: 3 (regular model), DNCE: 3.

Finally, the capability of the cookers to maintain temperatures was tested (Column 6). This is important on partly cloudy days, or when food is prepared in the late afternoon to be eaten in the early evening. Temperature measurements were taken on three days with at least 30% clouds, and on five days in the late afternoon, after direct sunlight was no longer entering the cooker. Time taken for temperatures to drop by 20%, or below 80°C, were recorded. As outside temperatures effect this, measurements were made when outside temperatures were between +15°C and +25°C. Only the DNCE cooker is constructed with an insulated lid that can be closed to maintain temperatures in the cooker. The LEDeG cookers maintain heat for at least an hour when a blanket is draped over the glass area of the cooker. The TCV-D cooker tends to lose heat rapidly.

The cookers also showed great variance in their technical capability at different times of the year (See Figures 4.5.1 and 4.5.2). All cookers performed well in August, when the sun is close to being directly overhead and the angle of incidence is high. The cookers' abilities varied greatly in the winter, when the sun's path was low along the horizon, outside temperatures were cold and hours of sunlight reduced. The TCV-D cookers function for two to four months per year because they are stationary models whose glass surface cannot be adjusted to changing sun positions. The LEDeG and DNCE cookers are adjustable for summer and winter positions; either by flipping the LEDeG box or adjusting the DNCE mirror. In the study, the LEDeG cooker obtained sufficient temperatures until November; the DNCE cooker continued to work until the end of the study in December. (Users report that the LEDeG cooker worked for between six and eight months each year, and that the DNCE cooker worked between ten months and year-round.)

In summary, all the cookers work at least part of the year, and perform well for different purposes. If summertime use alone is expected of the cookers, then each is functional. If the cooker is meant to function well as both a cooker and water heater, or if the cooker is meant to be a baking oven, then not all models can be labeled functional. Matching expectations, purpose for use, and cooker limitations and capabilities will be further explored in the next section where user's perceptions of capability are addressed in village surveys.

If year-round use is expected, it can only be said that the final three cookers (LEDeG-2x, LEDeG and DNCE) function well. These cookers produce at least four times more output in meals than the first three models tested, with the DNCE cooker functioning well throughout the entire test period. The DNCE cooker appears the cooker of choice;

however, if both water heating and food cooking are important, the LEDeG cooker works well. Although it appears that the first three cookers on the list (TCV-D90°, TCV-D22° and SSP-LEDeG-P) will not perform well enough to be classified as cookers that work, user surveys will assist in discovering if the cookers are liked under actual use conditions.

4.5.2 Village surveys

A. Do the cookers match village-defined needs and willingness to use?

In addition to technical capability, economic, cultural and social factors in each community also determine cooker use. Data from the village surveys were compiled to address the remaining variables in the model. The first four questions[60] address the users perceived need for change and the ability to purchase a cooker. They include a need for an alternative fuel and willingness and ability to adopt a new technology into the home. While these indicators are sufficient to determine if users wanted to try a solar cooker, qualifiers of need and willingness, along with differing program approaches to measure these indicators, will be further addressed in the discussion. Here, the results reflect the villagers' perceptions. Subsidy levels, ability to pay, and who was chosen to participate (or receive a subsidy) were explored [the cookers costing between IR400 and IR1000 ($15 to $37)].

It is an integral part of any aid program to address the question *is there a need for change?* All users were asked if they recognized fuel as a problem, and were asked to expand on the nature of that problem. Fuel use patterns were also recorded. Respondents are categorized first by locale, and then program participation (Tables 4.5.2 and 4.5.3). Each of the tables reveals interesting information on fuel problems.

Table 4.5.2 shows strong differences between the refugees (who are solely dependent on purchased fuel for their water heating and cooking) and the members of hinterland villages (who remain largely self-sufficient in providing for their fuel needs). Those living in areas where urbanization has led to fuelwood and dung shortages, and which have easier access to purchased fuel, respond affirmatively to fuel as a problem. Users further defined fuel as

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[60] The questions in this section are listed in the appendix. These three questions were: Do you have a fuel deficiency?, What percentage of your fule is fossil fuel?, are you willing to accept new technologies that have an impact on your kitchen into your home? Did the programs offer a subsidy, or was the cooker affordable?

a problem in terms of its environmental, social (health and time), economic and/or political aspects. For most hinterlanders using fuelwood and dung, fuel shortages (or time invested in gathering) were not seen as a problem. The exception was that winter fuel use (largely for heating, not cooking) was seen as a problem. From the spatial distribution of the perceived problem, it would appear there are areas where cookers could be helpful (Illustration 4.5.1). There are more users near Leh and this Centre area who state they have fuel shortages and that these are fossil fuel dependencies. Generally, movement away from the Centre or away from the road coincides with lower fuel problems.

Table 4.5.2: Fuel need, as categorized by village types

Is there a fuel problem?
Responses by village type

	Refugee Camp (65*)	Centre (65)	Centre Influenced (44)	Muslim Village (20)	Road Influenced (42)	Hinterland (44)
Fuel Prob?[a]	100%	66%	45%	50%	33%	4%
% Fossil f[b]	100%	35%	11%	12%	11%	0%

a: *Do you have a problem with fuel, either in deficiency, cost, scarcity, unreliability or time to gather or purchase? Responses show the percent of users who are in agreeement that they are experiencing a serious fuel problem.*
b: *What percentage of your fuel use is fossil fuel?*
**Total number of responses in each locale*

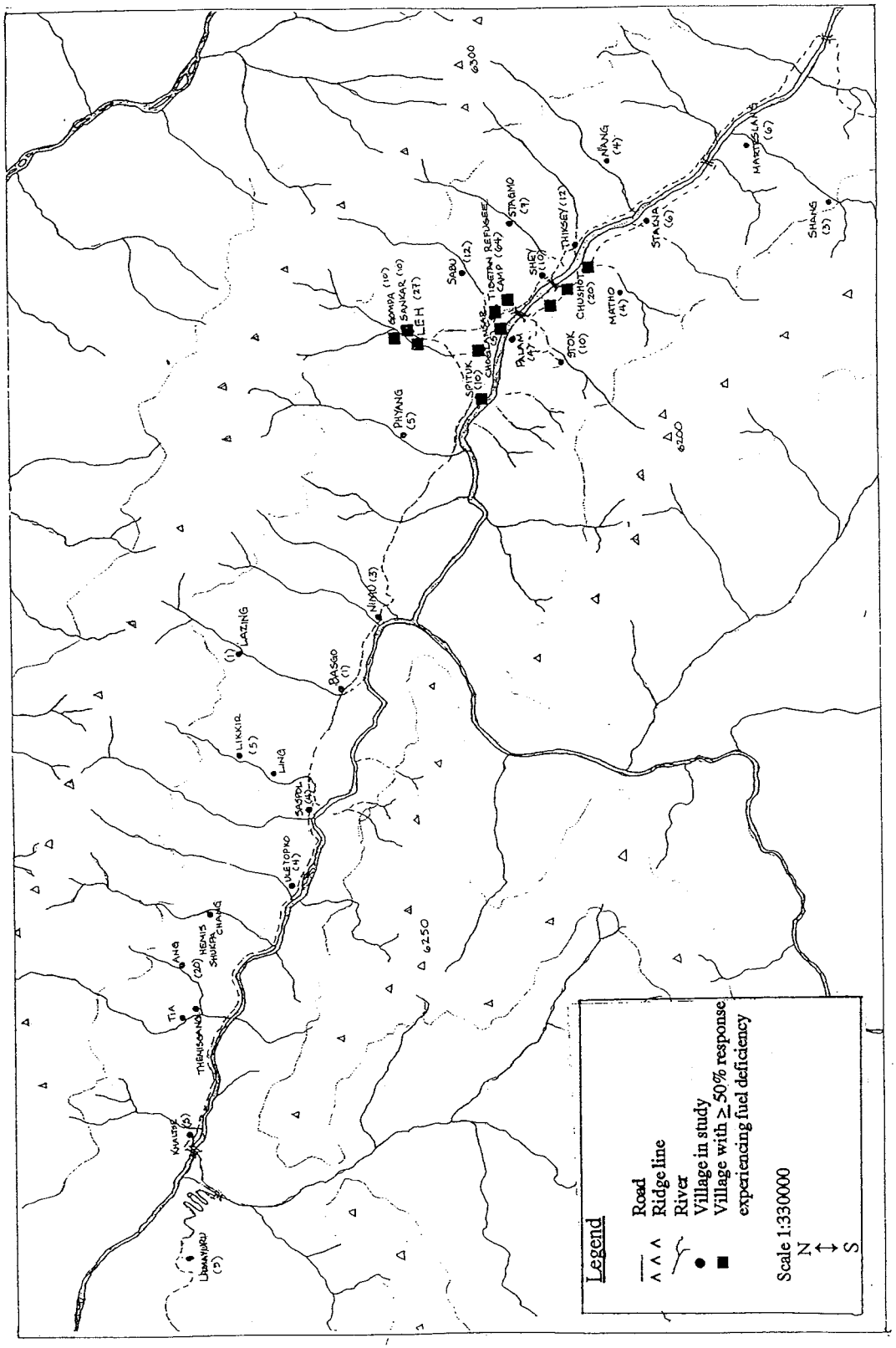
Table 4.5.3 Fuel need, as categorized by program participation

Is there a fuel problem?
Responses per program

	TCV-D (30*)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
Fuel Prob**	100%	37%	51%	100%	35%
%fossils f	100%	10%	16%	85%	29%

**Total number of responses in each program*
***Same questions asked as in Figure 4.5.4*

Illustration 4.5.1 Map of study area in Ladakh. Highlighted are areas where fuel was clearly defined as a problem.



When user response is categorized by program participation, patterns are not evident. The two programs concentrating on the refugee camps (TCV-D and SSP) showed a user-defined problem with fuels, with all participants experiencing dependence on fossil fuels. Respondents within the LEDeG and DNCE programs offered a mixed response in fuel deficiencies and dependencies in their homes.

In the concept of AT, diagnosing need is matched in importance by a user's willingness to accept new ideas into daily life. The solar cookers are not going into the kitchen, but they have impacts on this important (to the users) room. As discussed previously, the kitchen is not only the room where food is prepared and eaten, but it is the room where the family spends a large amount of time, where ideas are exchanged, inter-family relationships maintained and decisions made. It is the only heated room in the house during the long, cold winters and is usually heated by a traditional fuelwood-burning stove. It is through traditional kitchen practises, job assignments and gestures that many of the family relationships, accommodation and personal value are defined and maintained. To some extent, the cooker changes the purpose behind gathering in the kitchen, the timing of meal preparation and who is in charge of and aids in cooking. This change is not total: the cooker is only used for some meals, on some days, during certain seasons. However, due to the centrality of the kitchen to traditional Ladakhis, it is important that program participants are interested in trying a new technology that will impact their kitchen.

The results of this question are separated into responses per village type and responses per program (Table 4.5.4). Again, the users from the refugee camps responded overwhelmingly in the direction toward acceptance. They explained that their kitchens were no longer an important room in the house (or they lacked a kitchen). This response of unimportance was echoed in some of the homes from the Centre and Centre-influenced villages. For some users from the Centre, the significance of their kitchen had changed a great deal in the past ten years. They stated they were now more willing to adopt new technologies that affected this part of their lives. On the other hand, many people mentioned that they did not want to change their kitchen and the social habits associated with it. Those needing to supplement their cooking fuel were willing to try the technology. For those who felt the kitchen was a very important part of their lives (190 of the 282 participating in the survey), just 13% (or 26 persons) were willing to welcome new ideas into their kitchens. For almost 70% of these respondents, they did not want any change that would effect their kitchens.

Table 4.5.4 Willingness to use a new technology that effects the kitchen

	Willing to incorporate new technology into kitchen? Responses by village type					
	Refugee Camp (65*)	Centre (65)	Centre Influenced (44)	Muslim Village (20)	Road Influenced (42)	Hinterland (44)
Kitchen[a]	90%	30%	20%	0%	0%	0%

	Responses per program				
	TCV-D (30*)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
Kitchen	97%	13%	11%	80%	27%

a: *Are you willing to introduce new technologies into your home that impact your kitchen? those in agreement*
**Total number of responses in each area or program*

All four programs offered subsidies toward the purchase of their solar technologies, making cookers affordable to most people who participated in the cash economy. With these subsidies, cookers cost about the same amount as a 10 month supply of kerosene for a family of four who were dependent on fossil fuels for more than 75% of their cooking. Two programs limited the people qualified to participate in their program. The TCV-D program was a predetermined project, established to serve only those within the Tibetan Children's Village. Refugees outside the compound, and the general Ladakhi population, could not participate. In the DNCE program, any Ladakhi living in the Leh block could purchase a cooker, but only those people earning less than IR 440/month could receive a subsidy. Tibetans were not allowed to participate in this program because they are not permanent residents of Ladakh. The SSP program allowed anyone to participate in the program, due to with limited resources, the program covered only a few villages. The LEDeG program was the most inclusive. Anyone who came to their Centre asking for solar technologies, and willing to donate labour or local materials to construction, learning or installation, would receive a subsidy toward the purchase of a cooker.

More than 80% of the people in each program received a subsidy of 50% or more on their cookers. Of the non-owners who participated in the survey, 25% stated that they would like to purchase technologies but could not afford it. Many of these people earned slightly more than the DNCE upper limit or were refugees looking for a program that would offer them a subsidy. Additionally, 21% of respondents stated that subsidies went to people who could already afford the cookers.

In summary, some of the cookers were distributed in communities that did not have high responses to perceived need for change or willingness to use a new technology. In several communities, people stated that they had other reasons for purchasing a cooker, for example, some used cookers seasonally to heat food taken to the fields during busy planting and harvest times. Other persons were intrigued by technologies they saw in Leh and simply wanted to try them. In aggregate, 69% of the cookers went into villages where fuel was seen as a problem and there was willingness to try a new technology. However, 31% of the cookers were placed in villages where people did not perceive a serious fuel problem, and what fuel problems they were experiencing were shortages of fuelwood and dung[61]. In these communities, change was accepted in some aspects of their lives. However, traditional kitchen habits and practises remain culturally important, with people reluctant to accept change in the kitchen. The importance of raising, processing, cooking and eating of food is central to hinterland village life. The stated reluctance of using a cooker reflects, in part, this fact.

B Introduction and Follow-up: Do people understand their solar cookers?

Another important quality of AT is the ability to reinvest knowledge, power and wealth in the village. Investing in education programs that allow villagers to make informed decisions about technology choices is vital (McRobie, 1981:184). The third major question in the model is that of understanding. AT introduction programs in Ladakh are designed to result in the people understanding some basic concepts of solar energy, how to use cookers, and being able to adapt the technology to fit individual needs. These factors are particularly important in dealing with cookers, as they require changes in traditional cooking patterns. Understanding the basic principles of solar energy and technologies, and specifically, how cookers work, allows users to confidently determine how to adjust their cooking, when to use or not to use the cooker, and to be creative in adopting the cooker into their lives.

[61] This statement is an example of linkages between problems experienced in Ladakh, and the need to further explore fuel questions. Many respondents stated that their herd sizes were dropping, resulting in fuel shortages. Solutions to this problem might need to include animal husbandry, options,designing and placing acceptable fuel efficient stoves, and questioning if animals are being culled for use in the tourist trade.

This set of questions[62] examines the nature of introduction, follow up and maintenance programs, and to what degree users are confident in their use of cookers. All four programs use some form of introduction program, although they did not offer a program in every village where they placed technologies. Generally, if only one or two persons from a village express interest in solar technologies, those persons are asked to participate in another village's program, or attend a demonstration at a solar centre. Over half the cooker users stated they attended some form of solar training program in their own village (Table 4.5.5). In some villages, sponsors also undertook follow-up programs which included training a local person to then work as a technician. A village-based technician, trained to diagnose problems, carry out repairs and help users, was reported present by 30% of LEDeG participants, 51% of DNCE participants and 100% of SSP participants.

Table 4.5.5: Introduction, Follow-up and Understanding

Introduction and Follow-up Programs
Do people understand how to use their cookers?
Responses per program

	TCV-D (30*)	LEDeG (95)	DNCE (70)	SSP (35)	NONE** (52)
Intro[a]	76%	63%	95%	100%	31%
Follow[b]	53%	30%	51%	100%	25%
Understand[c]	16%	58%	87%	95%	40%
Comfortable[d]	0%	7%	26%	48%	4%

** Total number of respondents in each program.*
***Most respondents who did not identify their cooker with any particular program said they attended some other introduction program.*

a: *Did you attend an introduction program, held in your village, in a language you could understand, those in agreement*
b: *Did you participate in a follow-up program that helped trained a local person to maintain SBCs and help you use?*
c: *Do you understand how your cooker works and know what might be wrong when it doesn't work?*
d: *Do you understand your cooker's functioning well enough to try new recipes and explain solar cooking to friends?*

[62] These questions are listed in the Appendix. They are: Did you attend an introduction program, and how helpful was that program?, Did you participate in a follow-up program and how helpful was that program?, Did program participation help you in understanding the basic concepts of solar energy and how your cooker works? and Do you understand how to use your cooker well eneough to be creative in cooking, try new recipes and help friends learn how to use cookers?

Finally, Table 4.5.5 presents results of questions on impact of the introduction program. They ask if the users obtained a basic understanding of solar energy principles, sufficient information on how to use their cooker and a degree of confidence in cooker use. The majority of users responded affirmatively. However, in the TCV-D program there was a clear problem in communicating between deliverers and users. This lack of understanding is highlighted by the final question. Here, TCV-D users state they did not feel comfortable in their knowledge of cooker use. Indeed, all the programs appear to have had problems designing education programs that instill confidence in using this new technology. In the SSP program, a food subsidy was offered to purchase raw food and encourage experimentation during the first few weeks of ownership. This idea was stated as a large contributor to feeling comfortable with cooker use; it was not used in the other three formal programs.

In summary, while each of the programs undertakes introduction demonstrations, further exploration of the context, content and approach of these programs appears necessary in order to explain the lack of understanding. In the short term, understanding cooker function facilitates use, and to some extent, accrues benefits from use. For a program to continue and to spread to potential users in a village, understanding is vital. Low understanding rates revealed in the study suggest the need for further exploration of introduction program content and style.

C. Benefits and Impacts: what changes result from cooker use?

Probably the most difficult to measure, and possibly the most important among the variables, was exploring user-perceived benefits and impacts of cookers. The surveys included open-ended questions, allowing users to explain what aspects of the cooker and its use were liked or disliked. Generally, the respondents did not list a wide range of *likes* about the cookers, although many people experienced numerous benefits from use. Users were freer in listing some hindrances to use, and a list of 30 dislikes was compiled. When examining benefits and impacts by aggregate responses per program, the information appeared inconclusive. To clarify results, users were sub-divided into those who used their cookers frequently, at least six months (or a total of 60 days each year), and those who were infrequent users.

Benefits were closely linked to what people identified as needs in their area. In addition, the degree of benefits were circular in that the more the cooker was used, the greater the

benefits experienced, followed by greater use of the cooker. In the SSP program, for instance, fuel savings was identified as the most pressing need and seen as the largest benefit. The more people used their cookers, the more fuel savings occurred, which encouraged even greater use. This is seen in differing total benefits when between frequent and infrequent users (Figure 4.5.3).

All the frequent users stated one of three factors as the most important benefits of cooker use (Table 4.5.6). People did not generally identify one benefit from use. They stated that a combination of time savings, improved kitchen environment[63], ease of use, and fuel savings together was seen as the largest benefit of use. Fuel savings (both fuelwood-dung

Table 4.5.6 Benefits and impacts from cooker use, responses categorized by program.

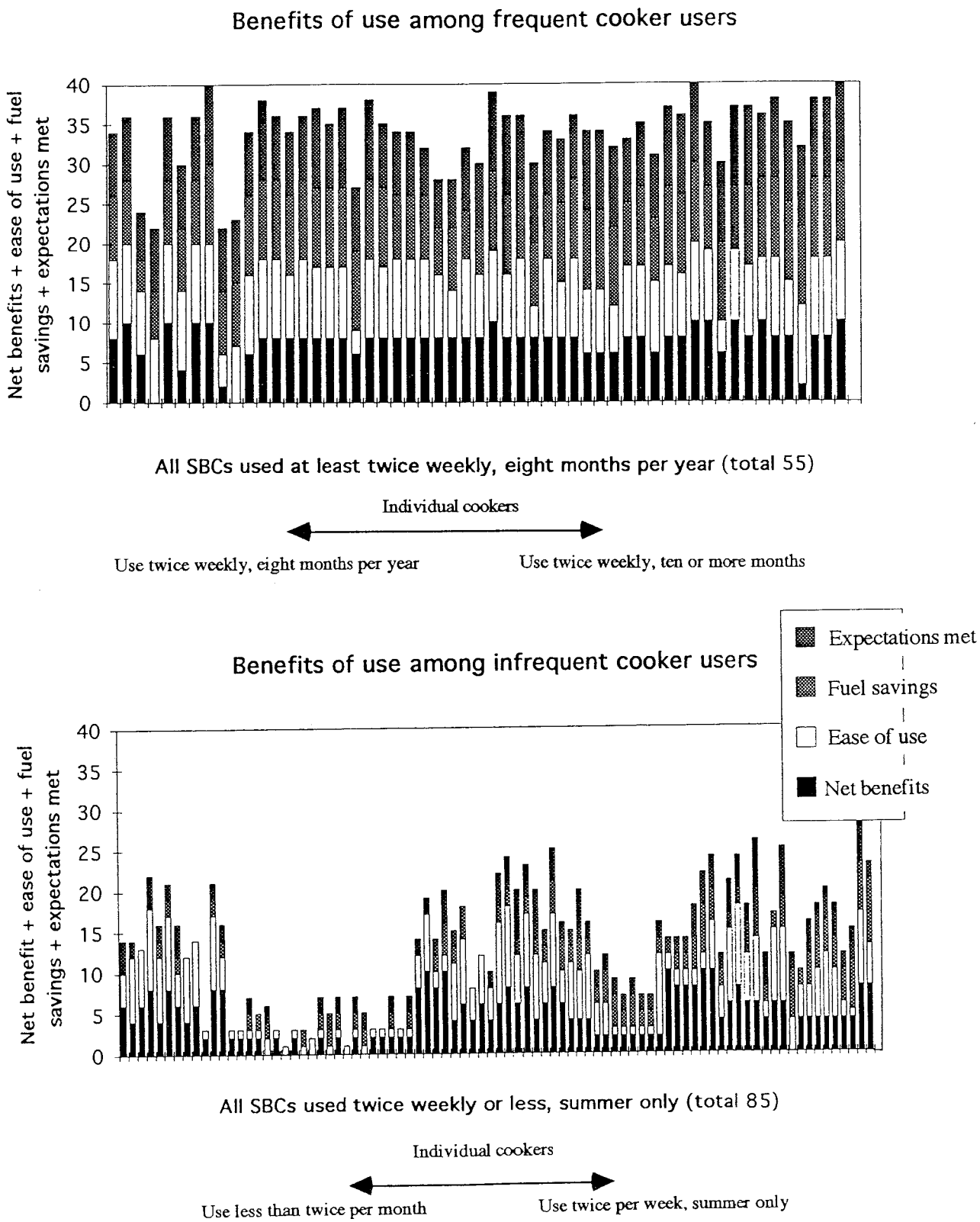
Benefits, impacts and most common dislikes of cooker use
Responses per program

	TCV-D		LEDeG		DNCE		SSP		NONE	
	I* (30)	F (0)	I (30)	F (65)	I (3)	F (67)	I (10)	F (25)	I (12)	F (41)
Socio-econ benefits[a]	0%	0%	23%	76%	100%	97%	0%	92%	33%	85%
Fuel Savings >10%[b]	0%	0%	0%	14%	0%	47%	0%	82%	0%	63%
Expectations met[c]	0%	0%	6%	27%	0%	65%	0%	80%	8%	56%
Least-liked:										
Functionality[d]	63%	0%	86%	12%	33%	1%	100%	8%	83%	5%
Design[e]	13%	0%	10%	2%	35%	12%	20%	14%	28%	6%
Performance[f]	13%	0%	33%	1%	100%	44%	50%	28%	41%	2%
General dislike[g]	20%	0%	66%	21%	100%	22%	50%	12%	83%	4%

**Total number of respondents in each program, categorized as infrequent and frequent users, those in agreement. Responses to benefits and impacts within the home were open-ended questions on the survey, where users listed up to four things they liked and did not like about the cooker.*
a: *Using the cooker resulted in fuel and time savings, improved kitchen environment,, was easy to use*
b: *Using the cooker resulted in at least a 10% fuel savings*
c: *The cooker worked at least as well as promised through the introduction program*
d: *The cooker was unreliable, extremely slow, and only worked a short time each year*
e: *The cooker was designed so that use was difficult, or its capacity was too small*
f: *The cooker did not perform as expected*
g: *The cooker does not cook the food we eat in this house, disrupts our kitchen, is uncomfortable to use*

[63] Household environment improvbements were a mixture of leessened smoke in the kitchen and less smell and mess from kerosene use.

Figure 4.5.3 Comparisons across cookers: Expressed positive benefits in a household between frequently, intermittently and infrequently used cookers.



and fossil fuel) and the associated economic benefits of reduced smoke or fumes, were other commonly stated benefits of use.

The third important factor was whether or not expectations were met. When the cooker's actual performance matched its promised performance, users expressed much greater satisfaction with the cooker, even without experiencing high fuel savings. Expectations not being met was sited as a dislike of the cookers. Many users described a major benefit in terms of what the cooker *was not;* in that it was not disruptive, or that there were not problems in the functionality of the cooker.

The one program clearly lacking user benefits was the TCV-D program. A telling statistic is that when pressed for positive impacts from cooker use, 89% of the respondents stated that they "had to use it." Part of the problem within the program is *who* benefited from use. These cookers functioned fairly well during the summer months, and resulted in some fuel savings for the central kitchen at the TCV compound. Users stated that while they did the work, the central kitchen received the benefits. In addition to this problem, users noted that their expectations were not met in the program, nor did they feel confident using the cooker in spring and autumn, when food might not fully cook.

Cooker design was seen as both a benefit and impact, because design has direct impacts on performance and portability. Among the infrequent users, functionality, a dislike of the cooker generally associated with its disruptive nature, and performance less than what was promised were the three most important impacts of use. Users cited slowness, seasonality and unreliability as the major cooker performance problems. Another impact (related to previously stated problems in education programs) was the inability to cook foods included in the local diet, discomfort in using the cooker and the waste of food improperly cooked. Disruptions of the traditional kitchen, through change in intra-familial relations, redefinition of jobs, change in diet, and altering spirit-worship practises, were associated with complaints about change in general. Within the household, the kitchen was one of two rooms[64] where traditions were socially and materially expressed. Changing the continuity of this tradition was disturbing. Outside the household, people showed a reserve for changing village political and social patterns. Many felt new technologies resulted in village power shifts, especially within the *paspan or chaspun,* where cooperation was vital.

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[64] The shrine room being the other tradtionally significant room, found in Buddhist homes.

Working and living within village norms remains key to a harmonious village: new technologies could set users apart.

When asked the open-ended question, *what do you dislike about using the cooker?* a long list of dislikes was given. The seven most frequent responses are given in Table 4.5.7. These dislikes reflect impacts previously discussed. For example, the most common complaint within the TCV-D program was that the cooker was slow, reflecting users dissatisfaction with the functionality of their cooker.

Table 4.5.7 Most frequently stated impacts of cooker use, categorized by program.

Common Complaints about cookers*
Responses by program

	TCV-D (30**)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
Can't cook food we eat	73%	23%	7%	15%	10%
Can't cook more than one meal/day	33%	21%	10%	33%	10%
They said it could work all year; not	23%	23%	16%	33%	20%
Temps° not what they said would be	66%	31%	13%	33%	20%
Its very slow	90%	37%	25%	25%	28%
Changes social patterns	6%	21%	16%	9%	21%
Like traditional way we cook	6%	20%	14%	9%	20%

**People were asked to list three complaints about their cookers. The total list covered 30 different complaints, each respondent listed up to four dislikes.*
***Total number of respondents per program*

D. Frequency of use

Finally, this information is considered in light of asking the users their frequencly of cooker use. This was accomplished with two questions. The first asked how many months each year the cooker functioned; while the second asked how many months each year the cooker was used (with an average frequency of at least twice each week). The TCV-D cooker was so constructed that it functioned on average two months each year, therefore,

none of the users could state they used it for six months each year. All the other programs had cookers that did function for at least six months each year; capability and use are compared in these programs. These results are summarized in Table 4.5.8.

Each of the other cookers were used less than they were technically capable of functioning. For respondents from the SSP program, two reasons were given for a frequency of use that closely matched technical capability. The first was need; users were experiencing severe fuel problems and clear and immediate benefits resulted from use of the cooker. The second reason given was that the users were not disappointed in the cooker, it performed as well or better than expected and this further encouraged use. The lower actual use in the DNCE program was often attributed to not using the cooker in the coldest of winter months, when a fire was often burning in the home, or not using on very windy days when the cooker could blow over[65]. Lower use was not directly associated with a complaint about the cooker, but with the environment in which the cooker functioned.

Table 4.5.8 Cooker capability and use

Are They Used?
Cooker use and solar acceptance
Responses per program

	TCV-D (30*)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
SBC function >6 mo/year[a]	0%	40%	97%	75%	79%
Frequency of use >6 mo/yr[b]	0%	33%	82%	71%	48%

**Total number of respondents in each program.*
a: *Does your SBC work for food preparation more than six month per year? (those in agreement)*
b: *Do you use your cooker for food preparation at least twice each week for more than six months each year?*

E. Did the cookers facilitate use of other solar technology

In creating a sustainable AT program, projects should result in the use of the cookers and a sufficient understanding of solar technology principles to encourage future investment in other solar use. This was accomplished in some villages and within certain programs more than others. SBC users were asked if they would be willing to use other solar technologies (Table 4.5.9). Many respondents were familiar with other models of cookers, water

65 The hinged mirror that projects up from the DNCE cooker makes the cooker unstable on very windy days. In gusty winds, the cooker can blow over and food in pots spill.

heaters, greenhouses, and *shelkhangs* (improved glass rooms within homes). The table shows that greenhouse and *shelkhang* technologies were popular additional technology choices throughout all village types[66]. Persons in the Muslim village and Road-influenced villages were users who liked their current cooker and wanted additional technologies. A telling response came from the refugee camp. Here, among the 30 users who owned cookers that did not perform well, who did not understand how solar energy technologies worked, and who did not experience benefits from use, reported that they believed solar energy technologies did not work well. Of these 30 users, 47% stated that they did not want to try any solar technology. The introduction of an insufficient cooker, within an insufficient program, in this case had broad impacts.

The results of this question may also suggest a different technology introduction order in villages. Greenhouses and *shelkhangs* are the most popular desired technology in every village type. In the hinterland villages, where the kitchen remains important and there is an unwillingness to incorporate new technologies that impact kitchen traditions, greenhouses and *shelkhangs* may be the best pioneer technology. In the refugee camps, there was also a

Table 4.5.9 Comparison of additional solar technology preferences between village types

	Refugee Camp (65*)	Centre (65)	Centre Influenced (44)	Muslim Village (20)	Road Influenced (42)	Hinterland (44)
Different cooker[a]	6%	12%	16%	15%	9%	11%
Water heater[b]	21%	2%	3%	1%	9%	13%
Greenhouse *shelkhang*[c]	38%	67%	70%	45%	51%	63%
I like mine plus others[d]	12%	19%	11%	35%	31%	13%
None[e]	23%	0%	0%	0%	0%	0%

**Total number of responses in each area.*
a: *Respondents stating that they would like to have a different model of cooker*
b: *Those who would like a solar water heater.*
c: *Those who would like a solar greenhouse or a shelkhang, a solar heated space or room in their home.*
d: *Those who stated they liked their present cooker and would lalso ike to try other solar technologies.*
e: *Those who stated that they do not want to use any solar technologies, including their current cooker.*

[66] In fact, the Department of Agriculture's greenhouse program (which offers subsidies for the construction of greenhouses) is very popular throughout Ladakh, with over a three year waiting list to reveive a greenhouse.

demand for solar water heaters over cookers. Non-disruptive technologies could have a higher net positive impact, and could be followed by a second solar technology, such as cookers, which have both positive and negative impacts.

F. Response from the solar programs: goals, impacts and use

The mandates of the four programs studied were used as the evaluation basis from the programmers viewpoint. Each director offered an opinion on the match between his or her program goals and actual impacts. Within the TCV-D program, the mandate was to reduce fuel consumption through the use of cookers[67]. Other AT components were not important in this program. The director stated that he was pleased with the result of the cookers, and would like to invest further in solar in the future. The fuel savings at the central kitchen were not specifically recorded, although fuel savings were experienced in the summer months[68]. The cookers provided about 33% of the kitchen's bread each day, and could be responsible for savings of up to 10 litres of kerosene per day (of a total use of 200 litres) in July and August. TCV continues to invest money in the maintenance of the current cookers. The director was interested in upgrading the cookers (to increase their use over several seasons, but this was not feasible due to cooker design. The cooker functioned for 56% of the days in the evaluative study (see Table 4.5.1, pg. 83). Use was reported to be about two months each year.

The LEDeG program mandate was the most encompassing of all four programs[69]. LEDeG goals stressed re-investing knowledge and control at the local level. The program emphasized local involvement in design, implementation and monitoring of programs. LEDeG supports technologies that serve multiple, locally-defined purposes. Their solar cooker was designed to function as a cooker and as a water heater. It could be reproduced in the community and was easily repaired. The cooker's function was to reduce fuel use, reduce health hazards from smoke, and to make use of locally-available energy sources.

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[67] Information from interviews with Mr. L. Tenpa, director of TCV.

[68] The central kitchen at TCV also made use of a solar water heater, which operated from May to October. This technology was thought to be a major contributor to fuel savings during these months. In the month of August, 1992, fuel use was recorded. The total savings averaged 30 litres per day, or 15% of total consumption. The solar water heater providied up to 800 litres of pre-warmed water to the kitchen each day.

[69] Information from interviews with Mr. S. Dawa, director, and Mr. L. Tsering, technical officer, for LEDeG.

The cooker was a small component of the overall LEDeG-AT program. In 1992, cookers were not the highest priority, nor the most functional tool offered by LEDeG. The program had not been fully evaluated by LEDeG, but the director stated he was generally pleased with response to solar technologies as a whole. The LEDeG model functioned reasonably well as a cooker, and very well as a water heater. Numerous users responded that cooker use resulted in fuel savings. There was a lessening demand for cookers (about 20 each year), while overall demand for new LEDeG technologies continued to rise. LEDeG has received feedback that the cookers do not perform as well as expected; it continues to work on improving the design and performance of the cookers.

The DNCE program worked within a broad BDO-mandate of improving the well-being of the poorest people throughout India[70]. The solar cooker program fit into this mandate. After successful programs elsewhere in the state, the local BDO decided to fund the cooker program in Leh block. The program's purpose was to reduce fuel use and the economic problems associated with dependence on fossil fuels. An introduction program facilitated household knowledge of use, repair and maintenance of the cooker. The program loosely adhered to the concepts of AT.

The program conducted evaluations on cooker use in some villages participating in the first two years of the program[71]. Users response was positive: cookers were used and fuel savings reported. Maintenance and repair costs remained low, few recipients discontinued use of the cookers. The director will expand the program in 1993 as the demand for cookers continues to slowly grow. Evaluations will assist in overcoming some of the difficulties experienced thus far, including a lower-than-expected cooker performance in winter, lack of recipe information, and insufficient number of villagers trained as technicians. One of the most serious reported program drawbacks is a continued lack of funding and staff, and the resulting lack of follow-up programs. Funding is dependent on the number of cookers placed in the field (not on the number of functional cookers). This places pressure on the BDO to put as many cookers as possible in the field, regardless of their effectiveness. Another drawback is the fact that the cooker cannot be replicated at the village level. The plastic shell of the cooker demands that it be imported from the manufacturer in Jammu.

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[70] Information from interviews with Mr. M. Hanif, Block Development Officer for Leh block, Ladakh.

[71] Other DNCE model cooker programs have been sponsored in the past in Ladakh. The current program is now in its third year.

The SSP program was an experimental program designed to blend the functional components of other programs into one AT cooker project[72]. Its primary purpose was to fully test cookers used by all the programs. Additionally, it was mandated to train technicians to design, build and install cookers, and to offer cookers to the neediest people in the Tibetan refugee camps and surrounding villages. The program completed the testing of all models in this study, and designed and tested several other models[73]. Experimental cookers did not function as well as expected, and user satisfaction was lower than expected, as was over-all program response rate. A participatory evaluation project resulted in suggested changes to make within the camps. These suggestions will be incorporated into future programs and, in turn, evaluated. The program did not place fully-trained technicians in the refugee camp, while it plans to continue training in 1993.

4.5.3 Comparison of program components

Valuable information can be gathered by comparing components of the AT equation between each of the programs. Each of the components will be briefly compared between programs in order to draw out differences in program results. Furthermore, the users within each program will be sub-divided into two groups: those who used the cookers with some frequency (at least sixty days per year) and those who did not use them frequently (See Table 4.5.10 for a list of frequent and infrequent users, and their village locations).

Technical capabilities and non-use of cookers

An important constraint common across programs was the technical capability of the cookers. Survey respondents who used cookers infrequently[74] listed technical capability as the biggest hindrance to use. Three of the models used within the survey functioned for less than three months each year (Models 1-3 in Table 4.5.10). For those people using these cookers, all responded that they did not feel it worked sufficiently well to merit use. Of the 40 respondents, all stated that unreliability (30%), a short use season (23%), extremely slow cooking times (37%), and inability to maintain heat on partly cloudy days (10%) resulted in their not using the cookers.

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[72] Information is from the director of the vocational training institute at TCV and the author.

[73] Also tested were hot boxes, a metal LEDeG cooker model and the Solar Box Cookers, International cardboard model.

[74] Less than two times each week, in summer only.

Table 4.5.10 Locations of cookers, the six models of cookers in the study, and their use

	Infrequently used solar cookers Listed by model						Frequently used solar cookers Listed by model						
Locations:	1*	2	3	4	5	6	1	2	3	4	5	6	T#
Refugee	30	6	4							7	8	10	(65)
Centre					4					2	32	27	(65)
Centre-influenced					5	1					15	23	(44)
Muslim											2	18	(20)
Road-influenced				1	17					1	13	14	(46)
Hinterland				4	11	2				2	4	20	(43)
Total	30	6	4	5	37	3				12	74	112	(283)

*Cooker models: 1: TCV-D90°
2: TCV-D22°
3: SSP-LEDeG-P
4: LEDeG2x
5: LEDeG
6: DNCE

The other three cooker models functioned more than four months each year; however, 19% of total of models 3-6 (33% of the LEDeG models and 3% of the DNCE model), were not often used. For the 45 respondents who did not use their cookers, the actual technical capability was a secondary issue. Perceptions were important; 42% (19) of the infrequent users of the LEDeG model responded that the cooker did not meet performance expectations. For these people, the failures experienced when food did not cook because of fluctuating or low oven temperatures made them lose confidence in their models. Two of the three infrequent users of the DNCE model stated that the cooker's limited capacity resulted in their perception that it was incapable of producing sufficient food to warrant changing cooking habits.

Technical capability was a significant factor in use. Also important was the user's perception of the technical capability of the cooker. For those users who experienced less-than-expected results, cookers were seen as limited in capability. Thirty-nine of the 45 (87%) infrequent users owned cookers that could function for six (or more) months each year. A sound design that matches either the single purpose of cooking, or the two-fold purpose of cooking and water heating, is important to the program. The response of the

infrequent users shows that it is also important not to promise more than the cooker will produce in actual use.

Social acceptance and non-use of cookers

Reasons for non-use among the remaining respondents varied. Of all of the 45 infrequent users, 60% responded that fuel was not perceived as a serious problem, and change was unwelcome in 64% of the users' kitchens. This response was found across programs, and was prevalent in villages away from the Centre. A lack of understanding of cooker use was second in frequency of responses (22%). People stated that education programs showed them how to load and unload the cooker, and to cook one or two meals. These users did not feel that the education programs taught them how to adapt cooking habits to match SBC cooking methods. Eight out of ten stating lack of understanding as a problem were in the TCV-D program (who had fuel problems). Finally, three of the infrequent users (7%) listed significant positive benefits from use of the cookers (savings in time and fuel); they did not use the cooker because it interfered with normal kitchen habits. In listing dislikes about their cookers, all but one of the 45 (98%) had complaints about the ease of use of cookers. Many of the users (26%) stated that they were not opposed to solar cooking *per se,* but that the benefits received were not worth the needed change in kitchen habits.

Among the forty-five infrequent users, a large number had a clearly stated need and willingness to adopt cookers into their home. Their resulting lack of cooker use revealed the importance of matching needs with technically-sound technologies. In the case of the Tibetan refugee camp, an 89% support for change in fuel and stove type was found. Yet many participated in a program that did not match this condition to a program that supported this change through technology, education and positive impacts.

Technical capability and frequent use of cookers

Among the frequent cooker users, each of the components in the AT model seemed important to encourage use. Fifty-five per cent of respondents stated the technical capability of the cooker was important to their continued frequent use of the cookers. However, frequent users were clearly divided into two camps. To many of the respondents, this seemed an odd area of discussion in the survey; they *assumed* the cookers would work well. For the 23% of the frequent users who were disappointed in the performance of the cookers, this was an important issue that needed addressing. The habit of daily use,

whether for cooking or for water heating, encouraged a higher frequency of use (18% of respondents). It became part of the users' daily routine, made them more comfortable with having a cooker associated with their kitchen, and increased the total benefits from cooker use.

Respondents, on average, used cookers less than actual technical capability. For the DNCE and the LEDeG-2x models, use was more in line with maximum capability. These two models can easily be used year-round for cooking and water heating. Whether used for bathing or cooking, water heating resulted in fuel savings and was seen as a valued use for the cooker.

Social acceptance and frequent use of cookers

The remaining components, those of need, understanding, benefits and ease of use, were also important in frequent cooker use. For the models that performed well, and had a high, year-round use rate, significant fuel savings were reported in homes. For those persons using cookers because they were experiencing fuel deficiencies, this type of immediate, positive impact encouraged use. For example, ten of the twelve (83%) LEDeG mod-2x model users lived in villages located in or near Centre villages listed fuel as a serious and growing problem, and all used their cookers at least six months each year. Among these users, those stating that they did not understand how to use the SBC to cook food in winter months, still depended on it to produce hot water. Seventy-four per cent stated they understood how cookers worked and grasped the basic principles of solar energy.

The majority (62%) of frequent users lived in or near Centre villages, in the areas where they were experiencing changes in their kitchens and fuel problems, and were more likely to see immediate benefits from use. Some of the users worked in the cash economy; these people stated that the cooker represented a time-saving device for them. To some users, time was a factor; while at work, they could prepare the noon-time or nightly meal. Fuel savings almost always resulted in more cash available within the household to spend on food, clothing or other items. Many of the people (54% of those frequent users in the Centre villages) stated their dislike for kerosene stoves. The stoves are subject to dangerous malfunctions, are smelly and smoky when burning, demand maintenance and break down with regularity. Preparing meals in the cooker meant less use of a disliked stove.

Each of the programs targeted one or more components within social acceptance to encourage persons to use cookers. The DNCE program specifically targeted people experiencing fuel problems, living a considerable distance from fossil fuel supplies, or those who could not afford to purchase fuels. They depended on an encompassing introduction program to convince this group to try cookers. Immediate benefits in fuel savings were noticeable in households with very limited incomes. While much of the success of this program can be attributed to the fact that the cooker performed very well, the DNCE program and target participants also facilitated success. The SSP program functioned similarly. Largely operating in the refugee camp, the base population was experiencing fuel problems; saving fuel was a major target. The program emphasized understanding cooker use through a food subsidy that allowed experimenting with use. It depended on user understanding (users helping users) to assist in spreading the program. The LEDeG program targeted users expressing a clear willingness to try a cooker. This was followed by introduction and follow-up programs in villages. The cooker design allowed several purposes to be served, making the cooker more adaptable.

Additional findings

The results of the surveys are generalized in Table 4.5.11 according to the program participated in, and in Table 4.5.12 according to village type. In comparing results across programs, differences are seen between programs, cookers and locations. A closer examination of specific instances in the four villages which had repeated surveys, and where the researcher spent more time in discussion with cooker users[75], highlights some of these differences.

In the Tibetan refugee camp fuel was seen as a serious problem. The refugees were heavily dependent on kerosene for cooking, while more than 50% of the population falls below the poverty line[76] and has difficulty purchasing fuel. Not only were the refugees economically impoverished, but the majority had lost their animals during their flight into exile. This left

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[75] Repeat surveys in these four villages were conducted for several reasons. First, return visits to the vilalges allowed the researcher time to become more familiar with cultural influences on technology choice. Second, repeat surveys assisted in validating information. In these four villages, when surveys were repeated, answers remained fairly consistent. If their were differences, respondents often attributed this to questioning the intent of the survey or the use of the data. Third, these visits helped to eliminate problems in the surveys to increase accuracy in other villages. Finally, it allowed for examination of some cookers outside of the SSP research program, while they were in use. When discrepencies were not explained, the first response was accepted and presented.

[76] The poverty line in India is measured along economic terms. It stood at IR 440 per month (or about $17).

them without the means to regain self-sufficiency[77], and without their chief fuel source. Two solar programs were conducted almost exclusively within the camp (TCV-D, making use of an adobe, horizontally-placed glass surface model, and SSP program, which experimented with all six models of cookers). The TCV-D program installed cookers that worked only two or three months each year and did not result in high fuel savings. Participants in the TCV-D program did not feel comfortable using their cookers nor did the program result in users understanding solar principles. The SSP program used three models that worked two to three months each year, and the LEDeG and DNCE models that functioned between six months and year-round. An introduction, follow-up and food subsidy program was included within the SSP project, which resulted in higher rates of understanding and cooker use being facilitated. Among the three models that functioned well, fuel savings (between 10-40%) and net positive impacts (time, fuel savings, less smoke, smell and mess from kerosene, less economic pressure within the home) were immediate for many users.

Along with a clear fuel need, a strong willingness to use new technologies existed in both programs. Within the SSP program, 10 of the 35 users were given cookers that did not function well. These 10 people participated in introduction programs, which eight out of ten stated resulted in their learning how to use cookers, and they received food subsidies to assist in experimenting with use. Use for cooking was low in these users from September to October, when the cookers were no longer capable of achieving temperatures above 100°C[78]. The remaining 25 persons used functional cookers. All 25 used their cookers more than six months each year, 96% stated they received positive benefits, 68% reported that the cooker and program facilitated use, and 100% reported that they liked their cooker and would like to try other solar technologies. Of those persons disappointed in the cooker or program, 16% stated that they thought the DNCE cooker's capacity was too small, another 16% said they had to re-orient the DNCE mirror toward the sun too often. Sixteen per cent were disappointed in the amount of fuel savings. Those using the LEDeG cooker generally had lower fuel savings than those using the DNCE cooker. Others complained that doors could be opened and heat lost, and one had the glass broken in the cooker.

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[77] Over 95% of the refugees were Drog-pa, nomads, from Western Tibet. Their job skills centred on tending their herds. Without pasturelands available in the camps, most of the refugees have become dependent on fossil fuels and wage labour. Over 50% of the refugees now work as coolies, building roads, buidlings and other infrastructure projects. Education is limited, and there is little immediate opportunity for re-training in order that they fill skilled jobs posts in Ladakh.

[78] Many of the users continued using the cookers for water heating.

In looking at these two programs operated in the refugee camp, some clear differences between use, and reasons for use can be seen. The SSP program resulted in higher rates of understanding, regardless of the cooker used. While beginning with lower rates of willingness, it had higher rates of use. Functional cookers and the program they operated within were credited by users as reasons for high rates of use.

Table 4.5.11 Summary of Information, which programs encouraged use, with response by program

	TCV-D (30)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
Need	100%	37%	51%	100%	35%
Willingness	97%	13%	11%	80%	29%
Understand	16%	58%	87%	95%	40%
+ Impacts	0%	60%	98%	68%	78%
Use facilitated	0%	33%	51%	48%	25%
Use> 6 mo.	0%	33%	82%	71%	48%

4.5.12 Summary of Information, which programs encouraged use, with response by village type

	Refugee Camp (65*)	Centre (65)	Centre Influenced (44)	Muslim Village (20)	Road Influenced (42)	Hinterland (44)
Need	100%	66%	45%	50%	33%	4%
Willingness	90%	30%	20%	0%	0%	0%
Understand	57%	76%	70%	90%	57%	36%
+ Impacts	41%	98%	79%	90%	63%	77%
Use facilitated	27%	43%	34%	60%	31%	20%
Use > 6 mo/yr	35%	54%	57%	90%	48%	32%

The Muslim village offers an interesting case. Most villagers (18 of 20) participated in the DNCE program. Here, fuel need was evident, but the people were initially reluctant to accept change in their traditional kitchens. Kerosene dependency, a growing problem in the village, coupled with limited incomes was resulting in economic hardship. Although

reluctant to try the cookers, attitudes changed after several months of cooker use. Users attributed this to immediate and dramatic positive benefits experienced in the household following use of the cookers. However, many respondents were clear to point out that they felt compelled to adopt cookers; if not for pressing fuel deficiencies, change would not have occurred. As a means of compromise, cookers were used as a supplement to the traditional fire; often it was carried to fields during planting and harvest seasons or used for noontime meals when people were working outdoors. Users did not make maximum use of their cookers, generally choosing to preserve the tradition of the hearth for morning and evening meals.

In the Centre village of Leh, people are experiencing rapid change. Fuel shortages and dependencies are only a small portion of this change. Modernization, an influx of tourists and outsiders, along with a breakdown in traditional institutions are contributing to both a feeling of insecurity and fuel problems in the Leh area. Dealing with such fundamental problems might be outside the scope of an AT program, yet in pockets within the Centre, program acceptance was high. One such area included eight homes where LEDeG introduced cookers. These homes were located on a footpath that LEDeG technicians traveled on a daily basis. With ready access to these people, the users gained a thorough understanding of solar principles, cooker abilities and limitations and how to repair and maintain the cookers. In an additional nine homes within close proximity and similar fuel needs, but without daily access to LEDeG technicians, use of cookers was dramatically lower. Indeed, in the homes along the path, all eight cookers were still in use several years after their introduction, in the homes off the path, seven of the nine cookers were no longer used.

In the hinterland community, most respondents stated that although they felt the cookers would result in lower dung and fuelwood consumption in their homes, they were reluctant to change kitchen patterns. The difference between this community and the Muslim community can be seen in the perceived fuel problem and the presence of *lhas* or spirits associated with the hearth. Not only were users reluctant to change important kitchen habits, but they did not perceive a pressing need to do so. Users were interested to try the new technologies, but once problems with the cookers were experienced, they did not make a significant effort to overcome these difficulties. It was not so much a dislike of solar technologies, as expressed when users were asked if they would be willing to try other technologies. It was a statement that as long as they did not have to change their kitchens, they would prefer not to. Therefore, they did not want to use cookers.

In some instances, the same cooker model, capable of producing the same results, and used by people with similar backgrounds, was viewed as having differing value. One cooker would be used and appreciated by a user; another user would state that the cooker was not worth the effort using it. A common difference found in surveys producing this result was differing expectations of cooker potential. If the cooker did not perform reasonably close to what was promised, then it was more likely to be disliked or not used. No new technology user liked being let down by actual performance, especially if an important change in habits was required. Programs that tended to over-estimate cooker capability often met with lower use rates.

Cooker-user mismatches could also result in not using the cooker. A large family might find the small capacity of the DNCE cooker a severe limit, whereas families which moved a cooker between field and home frequently might prefer this model. In the case of the cookers built at the Children's Village in the refugee camp, 48 of the 54 cookers were built on the roofs of the residential homes to reduce the potential of broken glass or cookers being opened and heat lost. The users, who are the housemothers at the homes, are almost all refugee *Drog-pa*, nomads from the Western Plateau. The women had lived most of their lives in tents; none of them were accustomed to climbing ladders. Cooker use demanded that they steep and unstable ladders, carrying heavy loads, in order to use the cookers. This was considered a major hindrance to use for the women.

4.6 Summary of findings

When comparing results by ranking summary responses according to the program and the village type, several differences can be seen (Tables 4.6.1 and 4.6.2). First, in looking at the results ranked by program of participation, a clear difference exists between programs in their ability to address need. The TCV-D did not provide a technologically sound cooker to address the highest fuel needs and willingness to adopt a new technology found in the study. The DNCE program provided a functional cooker, within a comprehensive program, and experienced the highest use and benefits of all programs. The other programs more closely matched needs with program results. Within the SSP program, the balance also corresponded with positive outcomes. Comparing this result with the result within the TCV-D program, it might suggest that a different cooker, and a more inclusive program might have resulted in different use patterns within TCV. Important in this issue, is the

statement made by 23% of the users within TCV-D that, based upon their previous experiences, they did not believe solar technologies worked. Recognizing this obstacle, and planning education approaches to deal with it, would have to be incorporated into the design of any future programs.

When categorized by total program results, the LEDeG cooker program ranks mid-level or lower. Looking at individual village results show that in many cases, positive results were achieved. For example, 42 out of the 65 (65%) cookers in the Centre village were LEDeG cookers (Table 4.6.2) These cookers were placed in homes where need for a supplement to fuels was needed and new technologies acceptable (42% and 28%), education programs resulted in a large percentage of understanding of cooker principles (54%), and use rates were high (87% used six months each year).

Table 4.6.1 Summary of Information, which programs encouraged use, with response ranked within programs

	TCV-D (30*)	LEDeG (95)	DNCE (70)	SSP (35)	NONE (52)
Need	1	3	2	1	4
Willingness	1	4	5	2	3
Understand	5	3	2	1	4
+ Impacts	5	4	1	2	2
Use facilitated	5	3	1	2	4
Use> 6 mo.	5	4	1	2	3

*Total number participating in the program
Ranking is by per cent of participants responding affirmatively, refer to Table 4.5.9.

When grouping the ranked responses according to village type, differences between response to programs within the refugee camp and the Muslim village stand out. While being reluctant to try a new technology that would impact traditional kitchens, and only half of the participants expressing the presence of fuel deficiencies, there was a high rate of use and benefits resulting from the program. TCV-D shows an opposite result; fuel problems and willingness to try a new technology were not matched by the program and tool.

Table 4.6.2 Summary of Information, which programs encouraged use, with response ranked by village type

	Refugee Camp (65*)	Centre (65)	Centre Influenced (44)	Muslim Village (20)	Road Influenced (42)	Hinterland (44)
Need	1	2	4	3	5	6
Willingness	1	2	3	4	4	4
Understand	4	2	3	1	4	5
+ Impacts	6	1	3	2	5	4
Use facilitated	5	2	3	1	4	6
Use > 6 mo/yr	5	3	2	1	4	6

* Total number of respondents per village type.
Ranking is by per cent of participants responding affirmatively, refer to Table 4.5.10

In summary, the data reveals three issues that are central to the success of programs according to the respondents. The first is that the cooker must work function well enough to encourage change. Cookers that functioned moderately well were as accepted as those that functioned very well when they were incorporated into introduction programs that did not oversell their capabilities. Different cookers performed well for different things; for example, the difference between water heating capabilities of the LEDeG and DNCE cookers. Second, initial unwillingness can be overcome in programs that match need to a technology that meets needs. Immediate benefits appear to offset a resistance to change. Finally, understanding facilitated use in the short term and might contribute to overcoming unwillingness to use.

CHAPTER FIVE
CONCLUSIONS

> Show me a man who has come to help, and I will run for my life.
> H. D. Thoreau

5.1 Development in Ladakh

There is no universally accepted definition of development. In western thought, development means inclusion in the cash economy and increased consumption. In other social contexts, as for example, that of Ladakh, development means living in harmony with people and place. In the western sense, development is *having;* in the Ladakhi sense, development is *being.* In the west, revered life-styles include competition, rivalry and material growth. In Ladakh, right livelihood encompasses cooperation, harmony, balance and spiritual growth.

Recognition of the above paradox by westerners within development aid was best captured in Schumacher's statement (in Wood, 1989:260) on his reaction to the Burmese people:

> If 90% of these people are impoverished according to global standards, then why are they so happy?

The concept of AT emerges from this recognition and, in general, seeks to solve locally-defined needs through the application of technologies that make use of local resources.

5.2 AT in practice

Rather than being a simple tool, AT is defined as a program that:

- employs a proven technology,
- uses that technology to address locally-defined needs,
- introduces the technology in a program that enhances and employs local skills and knowledge, and
- ensures that use of the technology persists in the absence of external subsidies.

AT literature states that these criteria must be present and balanced in an *appropriate* program. In situations where all of the above criteria were satisfied in Ladakh, cookers were accepted. In these instances, the results reveal that AT is a viable option in the development of Ladakh. In several villages, programs were successful with an imbalance

among, or even the absence of one or more of the criteria. In such a case programs worked but were not necessarily *appropriate.* Finally, the data reveal instances where the failure to use cookers can be linked with weakness in, or absence of one or more of the four components of AT. The results from the case-study suggest that while it is not possible to be predictive of program outcome, it is important to pay close attention to each component of AT, and the linkages between these components, in order to offer potentially *appropriate* programs. A brief look at the case study results highlights differences between AT in concept and AT in practice.

First, in programs where all criteria were present, the programs did work. This is shown within the SSP program, where people were experiencing severe fuel problems and showed a willingness to use a new technology. This was matched by a program that, to some extent, delivered functional cookers. In the portion of the SSP program where functional cookers were used (three out of the six models used in the program), fuel need was met with an appropriate tool. Even among users testing functionally-limited cookers, the introduction program resulted in a high level of understanding and a willingness to try other solar technologies. The program experienced the second highest use of cookers.

The DNCE program offers an example of a successful program that lacked what AT theory states is an important element. Although many of the users were reluctant to try a new technology that impacted the kitchen, this program had the highest positive impact, facilitated use and frequency of use. People adapted to the cooker, and adapted the cooker to better fit into their traditional kitchen practices.

The summarized, ranked outcomes of the TCV-D program reveal an instance where the failure to use cookers can be linked to weakness in, and absence of several of the components of AT (Table 4.6.1). This program was undertaken within the refugee camp, where fuel problems and willingness to try a new technology were the highest in the study. However, the program ranked last in delivery to users. The program can be compared to the SSP program which, working within the same base population with the same needs, had a greater level of success. There were two key differences between the programs. First, the cookers functioned well for 71% of the 35 people involved in SSP. Second, the SSP program used a participatory program framework that insured understanding of cooker use, encouraged feedback and inclusive evaluations, and remained sufficiently flexible to adapt to change. A valuable component within this framework was the use of a

food subsidy. Users stated that this food allowed greater experimentation with cookers, resulting in a broader understanding of the capabilities and limitations of their cooker.

Both predicting program outcome and looking for contributors to program success are more difficult when looking at the results grouped by village type (See Table 4.6.2). In the case of the refugee camp, a high need was not matched by high program results for all participants. In the Muslim village, there was a lack of willingness to use new technologies and just 50% of respondents defined fuel as a problem. However, this program had the highest use of cookers. The largest difference between the refugee camp and the Muslim village was the capability of the cookers used. Eighteen of the 20 respondents in the Muslim village were making use of a proven technology, while 61% of users in the refugee camp had cookers that had not functioned well. Further study into areas of fuel deficiencies may assist in determining contributors to the differences seen within the refugee camp, Center villages, Centre-influenced and the Muslim village.

5.3 Differing perceptions

There are evident differences between the impacts of the programs when viewed by program deliverers and recipients. This study concentrated on information from the users of a new technology. These are the people who must decide whether or not to use the cookers, and live with the impacts and benefits of that decision. Their perceptions of the value of the cooker will largely determine use, success and future potential of an AT program. By concentrating first on the user, and information gathered at the village level, program evaluators are more likely to be able to see impacts, benefits and barriers to use. Many aid evaluations are largely dependent on information derived from agency records and personnel, with brief field visits to determine project success. Conducting evaluations in this manner can easily mask actual results, resulting in inaccurate conclusions regarding individual programs.

Evaluations should not be undertaken with the intent of designing programs that can change traditions, but with the intent of changing misplaced perceptions of solar technologies. As seen in the case study, some users who had mal-functioning cookers perceived that all solar technologies did not work. In the future, program designers will have to take the history of solar programs in the area into account when designing new technology introduction models. Experiences with both functional and mal-functioning

cookers will have a strong impact on how technologies are received. Evaluation of past use is essential.

5.4 Barriers to AT

A fundamental criticism of AT is that it does not adequately address the political barriers to adoption that it faces within the development industry. AT philosophy is fundamentally different from that of conventional development aid, and from those who hold power and control money in international arenas. AT supports self-sufficiency and devolution of power; in general, international business, development aid and banks do not. For example, in both international aid and national programs in Ladakh, most research and money designated toward energy development programs are invested in large-scale, centralized projects. This results in development frameworks which concentrate on providing aid to population centres, support use of subsidized fossil fuels or large-scale energy systems, and depend on a top-down program delivery and management system. AT must come to terms with working within this arena as a form of development aid. It must recognize that in an era of rapid change, the acceptance of small-scale, grassroots, subsistence-based development is limited not solely by its own potential, but by the power held in other forms of development.

Barriers also exist at the village level. A gap exists between AT funders, often from a western world view, and aid recipients, who have a Ladakhi world view. Political, economic, social and cultural barriers can hinder the entrance of AT, the discovery of local needs and forms of problem-solving, and the creation of positive change. A final barrier to the use of any form of grassroots aid is the power of telecommunications as it permeates hinterland regions. The influence of media and advertising is one that hinders the support of cultural diversity and conservation of traditional heritage.

5.5 The option is no option

The case study reveals apparently-successful AT programs in many villages throughout Ladakh. This appearance can be validated only if a wide range of options to a given problem are considered with an AT chosen as the best option available. In the case of the SSP program within the refugee camp, many users gladly accepted and used new technologies. But it should also be noted that the only other option available was the continued use of kerosene stoves, a much less desirable choice. If the Tibetans were

offered *either* solar cookers or propane stoves, it cannot be said that participants would have chosen solar technologies. Outside the experience of the experimental SSP program, users were not offered a choice of several cookers, each program used only its model. Success then, is tempered by the knowledge that sometimes technology use represents a lack of options, not choice.

5.6 Recommendations

5.6.1 Inter-program cooperation

Cooperation between AT programs in Ladakh is important for many reasons, and should be actively fostered. First, by themselves, each of the AT projects in Ladakh is small and relatively powerless. They lack the staff and funds to individually deal with existing barriers and create a voice heard at distant planning centres. Working alone, or worse, in competition, they negate part of their potential impact to broach the entrenched barriers to alternative development aid.

Second, cooperation allows programs to make good use of scarce resources. The case study reveals impacts suffered from the lack of evaluations which are attributed to a lack of human and financial resources. Absence of evaluative feedback results in program continuation while impacts remain unknown, with one program's mistakes potentially repeated by another. Successful innovations can have limited impacts if they are not shared and widely dispersed. Most important, information sharing can increase the likelihood of success within individual programs, and enhance the reputation of AT as a whole.

There is a clear lack of cooperation among the four AT programs in Ladakh. Information is not freely available, staff and methods are not shared, and mistakes often repeated. Some of this is a result of distant funding agencies and their ability to dictate research and program implementation actions in the field. Some of it is a result of differing philosophies between programs, and some results from outright competition between them.

5.6.2 Matching needs, willingness and tools

Understanding needs and discovering locally-appropriate tools to address needs are fundamental to AT. Local people must be included in the discovery process as it is their definitions of need and willingness to use new tools that will determine program content.

Just as Ladakhi definitions of needs differ from Western needs, individual villages and households perceive problems differently. Cooker placements in homes where fuel problems are recognized but where there is an unwillingness to use a new technology should be reconsidered. A dilemma is presented within this suggestion: what if a person requests a cooker, yet there is evidence that the cooker will not be used? Or, as in the instance of the high frequency of use shown in the Muslim village in this study, should cookers be withheld from areas of strong unwillingness to try a cooker? Participation by all persons should be encouraged; but this should go hand-in-hand with introduction, education and follow-up programs that explore root causes of problems to better match local needs, willingness and tools. In villages where there is doubt about the match between need and use, a program may also consider trial periods, with the removal of unused technologies from the field.

5.6.3 Supporting a wide range of options

AT programs should be innovative in creating numerous problem-solving options. Programs must recognize there are instances where any change may produce benefits. In these cases, the tool offered is not necessarily the best choice, but simply better than existing conditions. This can be shown in the case of high rates of AT acceptance in the Muslim village. People were experiencing fuel shortages, but were also reluctant to accept a new technology into their traditional kitchens. Cookers eventually met with a high use rate and resulted in numerous positive impacts. Users stated that they were happy with their cookers. However, they also stated they would have included an option for improved *chulas* (fuelwood stoves) had they been more involved in design of the program. AT programs operating in Ladakh should develop and support a sufficient range of options in problem solving, increasing choice at the local level. Numerous options can better ensure that technologies chosen will match local needs, result in long-term use, and support innovation.

5.5.4 Investing in local knowledge and skills

AT mandates creation of locally-sustainable programs. This is accomplished in several steps. The first investment is an introduction program that results in user understanding of the cooker and solar principles. This enhances use frequency, aids in dissemination of the cookers throughout the community, and supports expansion of use into other solar technologies. The second investment is providing a local technician to assist in user

problems, maintenance and reproduction of technologies. Through this, solar cookers, or other technologies, are adapted to fit local conditions and employment opportunities enhanced. Finally, investment in local decision making supports the village system of adaptation to change and adoption of new ideas. Reinvesting control in the community provides needed tools for the community to deal with other issues surrounding modernization.

5.5.5 Need for better testing and evaluation

Only thoroughly-tested tools are considered *appropriate* in AT philosophy. Technology testing and evaluation programs should be a vital component of each of the programs. Testing could have limited the negative impacts experienced within some of the four programs in Ladakh. For example, the LEDeG program undertook testing at its Centre (and staff homes) prior to field tests. Cookers that performed well at the Centre were then tested in the field. Cookers should then be tested for their ability to function in the local environment and culture. A careful evaluation of the technical capability and social acceptability of the cookers should follow. Construction of large numbers of cookers should follow only carefully operated and evaluated pilot programs. Otherwise, a loss of valuable time, money and human resources, and a foreclosure of options can result. To avoid a high number of un-used cookers, and the ensuing belief that solar technologies do not work, testing programs can limit the scope and scale of mistakes.

None of the three regularly-operating programs in the case study invested in encompassing evaluations of cookers. The participatory research project in the Tibetan refugee camp explored the potential of numerous cookers, and dependent on local suggestions for change in project and tool design. The opinions of both those designing technologies and those using them on a daily basis offer valuable information to AT programs. Both views together would best maintain program flexibility, and therefore, the ability to adapt to changing needs within Ladakh.

5.5.6 AT, development and tied aid

AT depends on working at the village level, within small, flexible, locally-operated and locally-controlled programs. It may be difficult for the Ladakhi AT programs to balance philosophy, operation and the mandates of external funding agencies. One result of the tying of aid in the case-study programs was an apparent need to get as many technologies

in the field as possible. This number was used to justify continued funding from donors. Numbers of technologies distributed took precedence over high use rates among distributed technologies. This compromises the underlying philosophy of the programs, and contributes to the existence of discarded technologies in villages. Whenever possible, autonomy from funder dictates of quantity over quality is preferable.

5.5.7 The nature of the beast: the Trojan Horse

A. K. N. Reddy stated that no technology is neutral. Technologies bear the imprint of the society that produces them. The change that is ushered into a community through the introduction of a new technology can be likened to the tale of the Trojan Horse. Unknown impacts are delivered to the heart of a village in the benign guise of novelty. In a village lacking a stated need for change, the introduction of a solar cooker may mark its user as different from other community members. In traditional Ladakhi society, material superiority and individuality is not necessarily considered beneficial. Instead it could lead to damage of important social connections in the village. Change, for the sake of change, may not be a welcome event in such a case.

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Appendices

INTERVIEWS WITH PROGRAM DIRECTORS, INDIAN GOVERNMENT OFFICIALS, AND SOLAR ENERGY TECHNOLOGY EXPERTS

LEDeG
Sonam Dawa
Lobzang Tsering
Helena Norberg-Hodge

DNCE
M. Hanif
A. Angorama
S. Rafiq
S. Dawa
Noor Shah

TCV D
Leshik Tenpa
Didi Contractor
Phuntsok
Tenzin Dorje
Lodoe Gyaltsen

Solar Energy, General
Matin Tak, Leh
Angchuk Kalon, Leh
Taric de Villers, Belgium
Paul Mirmont, Paris
Tsering Norbu, Chushot
Nam Tsering, Stagmo
Sonam Wangchuk, Leh
Arul Singh, Leh
Wazir Mohammed Ali, Leh
Dr. Phuntsok, Leh
Beverly Blum, Sacramento, CA
Brigadeer Vombtkare, Leh
J.L. Trivedi, Delhi
K. Triparthi, Delhi

Survey Questions in Database

Village # and name		Interview ID
1.	Choglamsar Tibetan Refugee camp	A-RRR
2.	Leh-Chanspa Sankar-Gompa	A-UU
3.	Themisgang-Tia-Ang-Hemis Shukpachang	A-T
4.	Chushot	
5.	Spituk	A-T
6.	Palam	A-J
7.	Sabu	A-F
8.	Stagmo	A-M
9.	Stok	A-G
10.	Shey	A-J
11.	Thikse	A-J
12.	Stakna	A-L
13.	Matho	A-F
14.	Nang	A-D
15.	Marteslang	A-D
16.	Shang	A-F
17.	Phyang	A-C
18.	Alpha A	A-E
19.	Alpha B	A-E
20.	Likkir	A
21.	Saspol	A
22.	Uletopko	A-D
23.	Basgo	A-C
23.	Lazing	A
24.	Khalse	A
25.	Lamayuru	A-D
26.	Nimu	A-D A-B

Village type

1. Refugee camp
2. Centre
3. Centre - influenced
4. Muslim village
5. Road- influenced
6. Hinterland

Religion

1. Buddhist-Refugee
2. Buddhist
3. Muslim
4. Other

Program

1. TCV-D
2. LEDeG
3. DNCE
4. SSP
5. None

SBC Model

1. TCV-D22°
2. TCV-D90°
3. SSP-LEDeG-P
4. LEDeG-2x
5. LEDeG
6. DNCE

Use

1. Past
2. Present
3. Non-owner, use neighbours

% Subsidy

0. NA
1. 0-24%
2. 25-49%
3. 50-74%
4. 75-100%

#Years used

0. < 1 month
2. < 6 months
4. < 1 year
6. < 2 years
8. 2-3 years
10. > 3 years

Did you want? Did you seek out solar?

0. Not mine
2. No choice
4. Asked to test it
6. Neighbour had, or liked how it looked
8. After the intro program, I wanted
10. Went out looking for it

Kitchen Description

2. Traditional kitchen: Ladakhi stove, biomass fuels, hearth seats, *lhas* honoured, local diet

4. Mixed kitchen: Ladakhi and fossil fuel stoves, biomass and ffuels, hearth seats, *lhas* honoured, mixed diet

6. Mixed kitchen: Ladakhi stove, possibly with fossil fuel stove, either fuels used, traditions important, no *lhas*, largely traditional diet, (Muslim or Christian)

8. Modern kitchen: fossil fuel stove, ffuels used, no hearth seats, *lhas* honoured, mixed diet (refugee)

10. Modern kitchen: fossil fuel stove, ffuels used, traditions unimportant, no *lhas*, mixed diet

Survey Questions in Database (continued)

Kitchen Importance

0. No response

2. The kitchen helps identify ourselves, we spend a lot of our time there, I don't want it to change

4. Its important to use, we like our kitchen a lot, change unwelcome

6. Its changed a lot in the past ten years, now less important

8. Its never been that important to us

10. Our kitchen is a depressing room, we spend as little time as possible in there, we want to change our kitchen, we don't have a kitchen

Fuel 2: % Fossil fuel use

0. 100% biomass

2. no ffuels for cooking

4. 80/20 biomass/ ffuel

6. 50/50 biomass/ ffuels

8. 20/80 biomass/ ffuels

10. >80% ffuels, a lot of our money

New Ideas: acceptance of technologies

0. I don't like new tech's in kitchen

2. New tech is okay, not in my kitchen

4. Change and tech's are okay, I don't like SBCs

6. We need SBC, but like our fire

8. New tech's okay, we'll accept if we need

10. No problem with new tech's in kitchen

Fuel 1: Is there a fuel deficiency

0. No problem

1. Only a problem in non-cooking use (lighting)

2. Rarely a problem

3. Only in non-cooking (heating in winter)

4. A problem in worst of winter

5. Takes time to gather, and/or its becoming more difficult

6. No access to ffuels, long way to purchase

7. Ffuel scarcity or unreliability

8. Don't like smoke, smell, mess; health, environment concerns

9. Money to purchase a problem

10. Money to purchase a large concern, it makes us poor

Introduction Program

0. Did not have

2. Brief discussion in Leh

4. Demonstration in Leh

6. Came to our village, not a good program

8. Agency representative talked with village leaders, then had village demo

10. Same as above and gave us food subsidy and cookbook

Follow-up Program

0. Did not have

2. Did not have, friends helped

4. Had to go to Leh for help

6. Came to our village, not of great help

8. Came to our village at least once, of great help

10. Trained local technician to help

Do you Understand how to use solar?

0. Never understood

2. Explained, but I don't really understand

4. It doesn't work the way they explained, I don't know what to do

6. Can't explain how it works, but I can fix it and use for conventional cooking

8. Don't understand enough to try new things, but I understand how solar works

10. I can explain solar, try new things and show friends

Impact 1: General benefits

0. Don't like, family makes me use

2. We need to use for $fuel savings

4. Its good to use in summer, during planting or harvest

6. Positive outweighs negative in use

8. Saves fuel

10. Positive economic, environmental, and time impacts without negative side effects

How well does your cooker work?

0. Not well

2. Good 2-3 mo/yr

4. Cooks 4 mo/yr, hot water 4 mo/yr

6. Cooks 6 mo/yr, hot water 4 mo/yr

8. Cooks 6 mo/yr, sometimes 2 more mo/yr, hot water 4-6 mo/yr

10. Cooks 8 mo/yr, sometimes all year and hot water 2-4 mo/yr

Impacts 2: What do you like about solar?

0 Not to use it

1. We have to

2. Asked to try it

3. Like new gadgets

4. Its not difficult to use, easy

5. Its safer with children

6. Less smoke inside, health benefits

7. Kerosene is stinky, messy or smoky

8. Saves time which I can re-invest

9. Saves dung

10. Saves fuel and money

Does solar work in general?

0. No

2. Not mine

4. Other solar does, not SBCs

6. Yes, but SBCs have limited ability

8. Other SBCs do, mine is just okay

Survey Questions in Database (continued)

10. Mine and other solar works

Neg Impacts: what do you least like?

0. None

1. It doesn't work

2. It doesn't fit into our social system in home

3. Can't cook the food we eat

4. Promises made but not kept: esp. it is slow and seasonal in use

5. Its unreliable on cloudy days, wastes food

6. Needs planning, adjust-ing, watching

7. Food not ready when we eat

8. Pots or design wrong

10. Light a fire anyways or it doesn't save enough fuel

Fuel Savings

0. None

2. Negligible

4. Less fuel, less time

6. 5-10% and some time

8. 11-40% and some time

10. >40% and time

Frequency of Use

0. Didn't use, doesn't work

1. Summer only, 1x/mo

2. Summer only, 2-4x/mo

3. Summer only, at least 2x/wk

4. 6 mo/yr, < 2x/wk

5. 6 mo/yr, at least 2x/wk

6. 4-5 months/year, almost daily

7. 6 mo/yr, daily

8. 8mo/yr, at least 2x/wk

9. 8 mo/yr, daily

10. At least 10 mo/yr, at least 4x/wk

Would you like a second solar?

0. No solar, it doesn't work

2. Propane stove or electric lights

4. SBC if its free

6. Other solar (esp. *shelkhang* or greenhouse)

8. A reliable SBC

10. I like this one, and *shelkhang* or grhouse

Expectations met?

0. No

2. <25% expectations

4. I use only for water heating

6. Okay, 50% of what I hoped for

8. Yes, all met

10. It works better than they told me

Ease of Use: what use problems do you have?

0. Can't use often enough to make a difference

1. Unreliable, don't feel confident using it

2. Disrupts our kitchen and traditions

3. Can't cook the food we eat in this house

4. Sometimes food doesn't cook, throw it away

5. Food doesn't taste right

6. Takes too long, food not ready when we usually eat, disruptive

7. Need pots, parts or help maintaining

8. Need more info, demo or recipes

9. Want more help answering Q's, but I like it

10. Like it very much

Design Ease: what design problems do you have?

0. Design doesn't work for our needs

1. Need money for repairs and maintenance

2. Design only works 1-2 hours each day

3. Cloudy or dusty hours effects heat loss

4. Doesn't capture early morning, late afternoon or winter sun

5. Wrong size to fit our needs

6. Too heavy or immobile

7. Need lock or cover

8. Want it to be near my kitchen

9. Pots not right, need to hold more

10. Like it very much

I would like...

0. Not to use

1. Not SBC, other solar

2. Different style or size SBC

3. Make my cooker work all year

4. Someone local trained to help

5. More education

6. Recipes in my language

7. Repair info and help

8. Its too much work, need info on making it less work

9. Financial support, maybe SWH also

10. No problems, I like design and way it works

Survey Questions in Database (continued)

Complaints or Expectations not met: It does not...

1. Save time and work in kitchen

2. Save money

3. Save fuel

4. Cook the food we eat

5. Cook/bake more variety

6. Cook more than it can, more than one meal per day

7. Work all year

8. Temps are not what they said they would be

9. Be safer with children

10. Reduce smoke

11. Keep kitchen cool

12. Help household environment

13. Be easy to maintain and repair

14. Last more than 5 years

15. I would get follow-up help

16. I would get recipes in my language

17. Takes too long to cook, longer than they said

18. We were asked to try, but won't buy ourselves

19. We got one because our neighbor said it was good, but its not that good

20. We got one as we were told this was good by workers

21. We don't really have a fuel problem so we don't use like we should

22. Need to heat the room anyway, SBC can't do that

23. Said it would be easy to learn

24. Pay for itself in one year

25. Need to adjust mirror or oven too often

26. Not disrupt our family patterns and it does

27. I don't like new technologies

28. It wasn't offered to the people who need it in this village

29. Techs are second best, westerners don't use

30. I would like a propane stove

Database 1: Village Surveys

Database from User's Survey

VILLAGE	VIL#	C/H	PRO	INT	MOD	PPN	SUB	WTD	REL	KIT 1	KIT 2	FUEL	FUEL 2	fuel	YRS	IDEAS	INTR	FOLL	UND?	IMPCT	EOUS	USED	fsav	exp	SR WK	slrw	FREQ	2NDS?	NOT 1	NOT 2	NOT 3	NOT 4	INTV#
Choglamsar	1	1	1	A	1	2	4	2	1	8	10	9	10	2	6	4	0	0	4	2	1	1	0	0	4	0	2	0	7	6	17		A
Choglamsar	1	1	1	B	1	2	4	2	1	8	10	10	10	2	8	2	8	8	6	2	4	9	2	2	4	2	3	8	8				B
Choglamsar	1	1	1	C	1	2	4	2	1	8	10	9	10	2	8	4	8	6	6	2	1	1	0	0	2	2	2	8	20				C
Choglamsar	1	1	1	D	1	2	4	2	1	8	10	9	10	2	8	4	8	2	4	2	1	1	2	2	2	2	2	0	6	7	8		D
Choglamsar	1	1	1	E	1	2	4	2	1	8	10	9	10	2	8	6	8	3	2	2	1	5	2	0	2	0	2	2					E
Choglamsar	1	1	1	F	1	2	4	2	1	8	10	10	10	2	8	4	8	6	0	0	2	3	2	2	0	2	2	0	17	6			F
Choglamsar	1	1	1	G	1	2	4	2	1	8	10	10	10	2	8	10	8	6	6	2	4	5	4	2	2	2	3	8	7	20			G
Choglamsar	1	1	1	H	1	2	4	2	1	8	10	9	10	2	6	4	0	3	2	2	1	1	0	0	0	2	2	0	8				H
Choglamsar	1	1	1	I	1	2	4	2	1	8	10	7	10	2	6	10	8	3	2	0	1	1	0	0	2	2	2	0	7	6	17		I
Choglamsar	1	1	1	J	1	2	4	2	1	8	10	9	10	2	8	6	8	8	2	2	1	1	0	0	0	0	2	2					J
Choglamsar	1	1	1	K	1	2	4	2	1	8	10	9	10	2	6	10	0	3	4	0	1	3	2	0	2	0	2	4					K
Choglamsar	1	1	1	L	1	2	4	2	1	8	10	9	10	2	6	4	8	3	4	0	2	9	0	0	2	2	2	0	8	17			L
Choglamsar	1	1	1	M	1	2	4	2	1	8	10	8	10	2	8	4	0	0	0	2	1	1	2	2	0	2	2	0	6	7			M
Choglamsar	1	1	1	N	1	2	4	2	1	8	10	9	10	2	8	4	0	0	2	0	1	3	2	2	0	2	2	4	8				N
Choglamsar	1	1	1	O	1	2	4	2	1	8	10	7	10	2	8	6	8	6	4	2	1	5	2	2	2	2	2	0	6	17			O
Choglamsar	1	1	1	P	1	2	4	2	1	8	10	9	10	2	8	2	8	6	4	2	1	3	0	0	2	0	1	0	7	17			P
Choglamsar	1	1	1	Q	1	2	4	2	1	8	10	9	10	2	8	2	8	8	0	0	1	5	0	0	2	0	2	4	8				Q
Choglamsar	1	1	1	R	1	2	4	2	1	8	10	9	10	2	6	6	0	0	2	2	1	3	2	2	2	2	2	4	6	17	20		R
Choglamsar	1	1	1	S	1	2	4	2	1	8	10	7	10	2	8	10	8	2	2	0	1	8	2	2	2	2	2	4	7				S
Choglamsar	1	1	1	T	1	2	4	2	1	8	10	7	10	2	8	4	8	2	2	2	1	5	0	0	0	2	2	0	16				T
Choglamsar	1	1	1	U	1	2	4	2	1	8	10	9	10	2	8	4	8	2	2	2	1	9	0	0	2	0	2	0	6	2	17		U
Choglamsar	1	1	1	V	1	2	4	2	1	8	10	7	10	2	8	2	8	8	2	2	1	1	2	2	2	2	2	4	6	17			V
Choglamsar	1	1	1	W	1	2	4	2	1	8	10	10	10	2	6	6	0	6	4	2	1	1	0	0	2	2	2	0	16	20			W
Choglamsar	1	1	1	X	1	2	4	2	1	8	10	7	10	2	8	10	8	6	4	2	1	3	2	2	0	2	2	0	8	17	6		X
Choglamsar	1	1	1	Y	1	2	4	2	1	8	10	9	10	2	8	10	8	8	4	2	1	5	4	2	8	4	3	4	25				Y
Choglamsar	1	1	1	Z	1	2	4	2	1	8	10	10	10	2	8	10	8	6	2	2	1	9	2	2	2	2	3	6					Z
Choglamsar	1	1	1	AA	1	2	4	2	1	8	10	10	10	2	8	10	8	2	4	2	1	5	4	2	4	4	3	0					AA
Choglamsar	1	1	1	B8	1	2	4	2	1	8	10	10	10	2	8	10	8	8	6	2	1	1	2	2	4	2	3	0	13	17			88
Choglamsar	1	1	1	CC	1	2	4	2	1	8	10	10	10	2	8	10	8	8	4	2	1	1	2	2	4	2	3	2					CC
Choglamsar	1	1	1	DD	1	2	3	8	1	8	10	10	10	2	8	10	8	8	6	2	10	3	2	2	4	4	3	2					DD
Choglamsar	1	1	4	EE	2	2	3	2	1	8	10	9	10	2	4	4	8	8	6	10	2	1	0	2	8	2	3	6					EE
Choglamsar	1	1	4	FF	2	2	3	2	1	8	10	9	10	2	4	2	8	8	8	8	4	1	0	2	8	4	2	6	8	17	20		FF
Choglamsar	1	1	4	GG	2	2	3	2	1	8	10	8	10	2	4	4	8	8	6	8	2	3	2	2	8	2	3	6	7	17	6	20	GG
Choglamsar	1	1	4	HH	2	2	4	2	1	8	10	9	10	2	4	2	8	8	4	10	7	4	0	2	8	2	2	6	7				HH
Choglamsar	1	1	4	II	2	2	3	2	1	8	6	10	10	2	4	10	8	8	4	8	2	4	2	2	8	2	3	8					II
Choglamsar	1	1	4	JJ	2	2	3	2	1	8	6	10	10	2	4	10	8	8	6	8	2	5	2	2	8	2	2	6	8	17			JJ
Choglamsar	1	1	4	KK	3	2	3	4	1	8	10	8	10	2	4	4	8	8	6	8	2	4	4	4	8	2	3	6	8	20			KK
Choglamsar	1	1	4	LL	3	2	4	4	1	8	10	7	10	2	4	2	8	8	8	10	2	1	6	4	8	2	3	6	7	17	6		LL
Choglamsar	1	1	4	MM	3	3	3	4	1	8	6	9	10	2	4	10	8	8	6	10	2	1	4	4	8	2	2	6	25				MM
Choglamsar	1	1	4	NN	3	3	3	4	1	8	10	10	10	2	4	10	8	8	8	10	6	4	4	4	8	2	3	6	18				NN
Choglamsar	1	1	4	OO	4	2	4	4	1	8	10	10	10	2	4	4	8	8	10	10	9	7	8	8	6	8	5	8	17	8			OO
Choglamsar	1	1	4	PP	4	2	4	4	1	8	10	9	10	2	4	4	10	8	10	10	6	5	8	8	10	8	7	6	13	20			PP
Choglamsar	1	1	4	QQ	4	3	4	4	1	8	6	8	8	2	4	4	10	8	10	10	8	6	6	6	10	8	5	8	6	8	17		QQ
Choglamsar	1	1	4	RR	4	2	3	8	1	4	4	10	10	2	4	10	10	8	10	10	10	6	8	8	10	10	5	10	8	6	17	20	RR
Choglamsar	1	1	4	SS	4	2	4	8	1	4	4	10	10	2	4	10	10	8	8	10	10	7	8	8	10	8	7	8					SS

Database 1: Village Surveys

Database from User's Survey (continued)

VILLAGE	VIL#	C/H	PRO	INT	MOI	PPN	SUB	WTD	REL	KIT1	KIT2	FUEL	FUEL2	fuel3	YRS	IDEAS	INTR	FOLL	UND?	IMPCT	imp2	imp3	fsav	expc	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
Choglamsar	1	1	4	TT	5	2	3	4	1	4	6	8	8	2	4	6	8	8	10	10	6	7	6	6	10	8	5	6					TT
Choglamsar	1	1	4	UU	5	2	3	8	1	8	10	9	10	2	4	10	10	8	10	8	8	5	8	8	10	8	5	6	6	7			UU
Choglamsar	1	1	4	VV	5	2	3	8	1	8	10	8	10	2	4	10	10	8	8	8	10	6	8	8	10	8	8	6	13	20			VV
Choglamsar	1	1	4	WW	5	3	4	4	1	8	10	9	10	2	4	6	10	8	10	10	10	5	8	8	10	8	8	6	17				WW
Choglamsar	1	1	4	XX	5	3	3	4	1	8	10	9	10	2	4	6	10	8	10	10	8	7	10	8	10	10	9	6	8	17			XX
Choglamsar	1	1	4	YY	6	2	3	4	1	8	10	9	10	2	4	10	10	8	10	10	10	9	8	8	7	8	8	6	7	8	6		YY
Choglamsar	1	1	4	ZZ	6	2	3	4	1	8	10	10	10	2	4	10	10	8	10	8	10	7	10	10	10	10	9	10	25				ZZ
Choglamsar	1	1	4	AAA	6	3	4	4	1	8	10	10	10	2	4	10	10	8	6	8	7	6	10	10	10	10	9	6	17	20			AAA
Choglamsar	1	1	4	BBB	6	3	4	4	1	8	10	10	10	2	4	10	10	8	10	4	10	9	8	8	6	8	8	10	17				BB8
Choglamsar	1	1	4	CCC	6	2	4	8	1	8	10	10	10	2	4	10	10	8	10	10	10	9	8	8	6	8	8	6	6	8	17		CCC
Choglamsar	1	1	4	DDD	6	2	3	10	1	8	10	9	10	2	2	10	10	8	10	10	10	9	10	10	10	8	8	6	18	20			DDD
Choglamsar	1	1	4	EEE	6	3	4	10	1	8	10	9	10	2	2	10	10	8	10	2	4	6	8	8	10	8	8	6	7	20			EEE
Choglamsar	1	1	4	FFF	6	2	4	8	1	4	10	10	10	2	4	8	10	8	10	0	7	6	8	8	6	10	8	10	6	7			FFF
Choglamsar	1	1	4	GGG	6	2	4	8	1	4	10	10	10	2	4	8	10	8	6	2	10	3	10	10	10	10	9	10	8	17	20		GGG
Choglamsar	1	1	4	HHH	6	2	3	8	1	4	10	10	10	2	4	8	10	8	8	6	10	0	10	8	10	8	8	6	17	20			HHH
Choglamsar	1	1	2	III	5	1	3	8	1	8	10	9	10	2	6	10	4	4	6	8	10	4	6	6	6	6	5	6					III
Choglamsar	1	1	2	JJJ	5	1	3	8	1	8	10	10	10	2	6	10	4	4	8	4	10	4	6	6	6	6	5	6					JJJ
Choglamsar	1	1	2	KKK	5	3	0	8	1	8	10	9	10	2	4	10	4	4	6	4	7	4	4	6	10	4	4	6	17				KKK
Choglamsar-	1	2	2	LLL	5	3	0	8	1	8	10	9	10	2	4	10	4	4	4	6	7	5	6	6	6	6	5	6					LLL
Choglamsar-	1	2	2	MMM	5	1	3	8	3	6	6	8	6	2	6	10	6	4	6	8	10	3	6	6	6	6	5	8					MMM
Choglamsar-	1	2	3	NNN	6	1	3	8	2	6	6	7	8	2	6	10	6	4	6	6	10	6	8	6	10	8	5	8					NNN
Choglamsar-	1	2	3	OOO	6	1	3	8	2	4	4	8	6	2	6	8	6	2	8	8	10	9	6	8	10	8	5	6					OOO
Choglamsar-	1	2	3	PPP	6	1	3	8	2	4	4	8	6	2	6	8	6	0	6	8	2	6	8	6	10	8	7	6					PPP
Choglamsar-	1	2	5	QQQ	5	3	0	8	2	4	4	7	6	2	6	6	0	0	4	6	10	2	2	8	6	6	4	6					QQQ
Choglamsar-	1	2	5	RRR	6	3	0	8	2	4	4	8	6	2	6	6	0	2	4	8	10	4	6	8	4	6	5	6					RRR
Leh-C-S-G	2	2	2	A	5	1	3	8	2	4	6	4	4	1	6	8	2	4	4	6	9	5	4	2	8	4	4	6	4	7	8	14	A
Leh-C-S-G	2	2	2	B	5	1	3	6	2	4	8	4	4	1	6	8	2	0	6	6	2	0	2	8	10	6	4	6	6	7	17	14	B
Leh-C-S-G	2	2	2	C	5	1	2	8	3	4	6	9	4	2	6	8	2	4	6	6	9	7	4	2	8	4	4	6	8	5	17	20	C
Leh-C-S-G	2	2	2	D	5	1	1	4	3	10	6	2	8	1	8	10	8	0	6	6	10	0	6	6	10	6	5	10	17				D
Leh-C-S-G	2	2	2	E	5	2	4	8	2	4	2	4	4	1	10	6	8	0	6	6	6	5	4	2	10	4	4	6					E
Leh-C-S-G	2	2	2	F	5	2	4	8	2	10	4	8	4	2	8	6	6	0	8	6	8	7	6	8	10	6	5	6	25				F
Leh-C-S-G	2	2	2	G	5	1	3	6	2	4	6	9	6	2	4	6	2	0	8	6	7	2	6	6	4	6	5	6	20				G
Leh-C-S-G	2	2	2	H	5	1	1	8	2	4	4	2	6	2	6	10	2	0	6	8	8	2	4	4	4	4	4	6					H
Leh-C-S-G	2	2	2	I	5	2	4	8	2	10	4	2	4	1	10	10	2	8	6	8	8	4	4	2	4	4	4	6	8	17	20		I
Leh-C-S-G	2	2	2	J	5	2	4	6	2	10	4	2	6	2	8	10	2	10	6	6	7	7	6	8	8	6	5	8	7	17			J
Leh-C-S-G	2	2	2	K	5	2	4	6	2	10	4	2	6	2	8	10	2	8	6	8	7	8	6	6	8	6	5	8	16				K
Leh-C-S-G	2	2	2	L	4	2	4	10	2	10	4	2	4	1	6	8	8	10	6	8	10	7	4	8	10	6	5	6	8	17	6		L
Leh-C-S-G	2	2	2	M	5	1	4	6	2	10	4	2	4	1	6	8	2	2	4	8	4	4	6	8	4	6	5	6	8	7	6	15	M
Leh-C-S-G	2	2	2	N	5	1	4	10	2	4	4	4	2	1	6	6	2	0	2	6	9	10	6	6	8	6	5	6	16				N
Leh-C-S-G	2	2	2	O	5	1	3	6	3	4	4	4	2	0	4	8	2	0	2	6	9	5	4	4	8	4	4	8	1	4	8	17	O
Leh-C-S-G	2	2	2	P	5	2	4	6	3	2	2	5	4	2	6	6	6	2	4	8	10	2	4	2	4	4	4	6	7				P
Leh-C-S-G	2	2	2	Q	5	1	3	8	2	4	2	4	2	1	6	8	2	2	2	6	9	3	2	4	6	2	3	6	7				Q
Leh-C-S-G	2	2	2	R	4	1	4	4	2	4	4	5	4	1	4	6	2	4	4	8	9	8	6	8	8	6	5	6	7	17			R
Leh-C-S-G	2	2	2	S	4	2	4	4	2	4	6	9	6	2	6	6	4	4	8	6	10	8	8	8	10	8	7	6	8	7			S
Leh-C-S-G	2	2	2	T	4	2	4	4	2	4	6	4	2	1	8	6	6	2	8	6	9	4	6	8	4	6	5	6	6	17	14	24	T

Database from User's Survey (continued)

VILLAGE	VIL#	C/H	PRC	INT	MOC	PPN	SUB	WTD	REL	KIT1	KIT2	FUEL	FUEL2	fuel3	YRS	IDEA	INTR	FOLL	UND?	IMPC	imp2	imp3	fsav	exp(	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
Leh-C-S-G	2	2	2	U	5	2	4	8	2	4	2	4	4	1	8	8	6	2	6	8	6	2	6	8	4	6	5	6	20	16			U
Leh-C-S-G	2	2	2	V	5	2	4	4	2	4	4	9	4	2	8	4	6	2	4	8	4	3	6	6	6	6	5	6	5	8	21		V
Leh-C-S-G	2	2	2	W	5	2	3	6	2	4	2	5	4	2	8	6	6	10	6	8	10	0	2	4	10	2	3	6					W
Leh-C-S-G	2	2	2	X	5	2	3	6	2	4	2	9	4	2	8	6	6	2	6	8	6	6	4	4	10	4	4	6					X
Leh-C-S-G	2	2	2	Y	5	2	4	8	2	4	4	5	2	1	8	6	6	8	4	8	9	7	4	4	10	4	4	6					Y
Leh-C-S-G	2	2	2	Z	5	2	4	10	2	4	4	9	6	2	6	8	6	2	10	8	8	9	10	8	10	8	7	8					Z
Leh-C-S-G	2	2	2	AA	5	1	3	6	2	4	2	6	4	1	6	6	2	2	4	6	7	2	4	6	10	6	4	6	25				AA
Leh-C-S-G	2	2	3	BB	6	2	2	4	2	4	4	5	6	2	6	6	8	8	6	8	10	9	8	8	10	8	5	6	16	25			BB
Leh-C-S-G	2	2	3	CC	6	2	2	8	2	4	4	5	6	2	6	8	2	0	10	8	10	9	10	10	10	10	8	10					CC
Leh-C-S-G	2	2	3	DD	6	2	2	6	2	4	4	6	4	2	6	8	2	0	6	8	9	9	8	8	8	8	5	6	16				DD
Leh-C-S-G	2	2	3	EE	6	3	2	6	2	4	4	6	4	2	4	8	8	10	10	8	9	7	8	6	8	6	5	6					EE
Leh-C-S-G	2	2	3	FF	6	2	3	8	2	2	2	7	4	2	6	8	8	8	6	8	10	9	10	8	10	10	8	10	3	4	6	14	FF
Leh-C-S-G	2	2	3	GG	6	2	1	6	2	4	2	9	4	2	6	8	6	4	8	8	8	9	10	8	10	8	8	10	6	13	14		GG
Leh-C-S-G	2	2	3	HH	6	3	4	0	2	4	2	5	2	2	4	6	6	6	8	8	9	7	8	6	8	6	5	6	16	14			HH
Leh-C-S-G	2	2	3	II	6	2	4	6	2	2	4	9	4	2	6	8	6	4	8	8	10	10	10	8	10	10	8	10	20	7	17		II
Leh-C-S-G	2	2	4	JJ	6	2	3	10	3	6	8	5	2	2	6	10	10	8	10	6	7	10	8	6	6	6	5	6	20	5			JJ
Leh-C-S-G	2	2	4	KK	6	2	3	10	2	2	2	9	4	2	6	10	10	10	10	8	9	2	10	10	10	10	8	10					KK
Leh-C-S-G	2	2	4	LL	6	2	3	4	2	4	4	7	2	2	6	6	8	8	6	6	8	10	8	8	10	6	5	6	6	17	8		LL
Leh-C-S-G	2	2	4	MM	6	2	3	8	2	4	4	8	4	2	6	8	8	8	8	8	9	2	10	8	10	8	8	6	23	21	18		MM
Leh-C-S-G	2	2	4	NN	6	3	3	0	2	4	4	7	4	2	4	6	8	8	6	8	9	2	10	10	10	10	8	10	1	18	23	21	NN
Leh-C-S-G	2	2	5	OO	6	2	2	6	2	10	6	2	8	1	2	10	0	0	8	6	3	3	8	8	6	6	5	6	17				OO
Leh-C-S-G	2	2	5	PP	6	2	2	6	2	10	6	2	8	1	2	10	0	0	10	6	4	6	8	8	6	6	5	6	7	6	8		PP
Leh-C-S-G	2	2	5	QQ	6	2	2	8	3	4	8	7	8	2	6	10	0	0	8	6	3	6	10	8	10	10	8	10	17	7			QQ
Leh-C-S-G	2	2	5	RR	6	2	2	8	3	4	8	7	8	2	6	10	0	0	6	8	10	9	10	10	10	10	8	10	19	20	18		RR
Leh-C-S-G	2	2	5	SS	6	2	3	8	2	4	8	7	8	2	6	8	0	2	6	6	6	9	8	6	8	6	5	6	6	7			SS
Leh-C-S-G	2	2	5	TT	6	3	2	0	2	10	4	9	4	2	6	8	0	2	6	8	9	7	10	8	10	10	8	10	5	8	20	7	TT
Leh-C-S-G	2	2	5	UU	6	2	1	8	2	4	4	2	6	2	2	10	0	0	8	6	4	0	4	6	10	4	4	6	6				UU
Leh-C-S-G	2	2	5	VV	5	1	2	4	2	6	8	4	6	2	4	8	0	2	6	6	7	4	8	8	6	6	5	6	7				VV
Leh-C-S-G	2	2	5	WW	5	1	4	6	3	6	8	2	6	1	4	8	0	2	4	4	8	5	4	6	6	4	4	6	7				WW
Leh-C-S-G	2	2	5	XX	5	2	4	0	3	6	8	2	6	1	4	8	0	2	6	4	8	5	6	6	8	4	4	6	17				XX
HShuk-Th-T	3	6	3	A	6	3	3	6	2	2	2	1	0	0	6	4	2	2	4	8	9	2	2	2	4	2	1	6	8	5			A
HShuk-Th-T	3	6	3	B	6	3	3	6	2	2	4	0	0	0	6	4	2	2	2	8	4	7	2	2	4	2	1	6	17	8			B
HShuk-Th-T	3	6	2	C	4	1	3	4	2	4	4	3	0	0	6	8	4	2	8	4	4	2	2	2	2	4	3	8	22	23			C
HShuk-Th-T	3	6	2	D	4	1	3	4	2	2	4	1	0	0	6	4	4	2	0	4	8	3	0	2	4	2	0	4	8	24			D
HShuk-Th-T	3	6	3	E	6	2	2	6	2	4	4	5	2	1	4	8	2	2	4	8	9	3	4	6	6	6	4	6	17	8	7		E
HShuk-Th-T	3	6	2	F	6	2	2	8	3	2	4	4	0	0	4	4	2	2	8	8	9	3	4	6	8	6	4	8	8	20	5	24	F
HShuk-Th-T	3	6	2	G	5	1	2	8	2	2	4	3	0	0	4	6	2	2	4	4	8	6	2	2	4	2	0	6	4	6	7	20	G
HShuk-Th-T	3	6	2	H	5	1	4	4	2	4	2	5	4	1	6	8	6	0	4	6	4	2	4	4	6	4	4	6	7	17			H
HShuk-Th-T	3	6	2	I	5	2	4	6	2	4	2	5	0	0	6	6	8	0	2	8	9	3	4	4	4	4	2	6	20	25			I
HShuk-Th-T	3	6	2	J	5	2	4	8	2	4	2	1	0	0	8	4	8	0	4	8	9	4	2	2	4	2	0	6	6	1	22		J
HShuk-Th-T	3	6	2	K	5	3	3	8	2	2	2	5	0	0	6	2	8	6	4	6	4	2	2	4	6	4	0	0	24	5			K
HShuk-Th-T	3	6	2	L	5	3	3	10	2	4	4	6	4	1	6	4	8	6	4	6	2	3	4	6	8	6	4	4	13				L
HShuk-Th-T	3	6	2	M	5	3	3	8	2	2	4	4	0	1	6	2	8	8	4	6	4	5	4	2	4	4	2	2	20				M
HShuk-Th-T	3	6	2	N	5	1	3	10	2	4	4	0	0	0	6	4	6	8	0	4	8	2	0	0	4	2	0	6	8	17	5		N
HShuk-Th-T	3	6	2	O	5	1	3	6	2	4	4	1	0	0	8	4	6	8	2	4	7	6	2	2	4	2	2	2	5	26			O

Database 1: Village Surveys

Database from User's Survey (continued)

VILLAGE	VIL#	C/H	PRC	INT	MOC	PPN	SUB	WTD	REL	KIT1	KIT2	FUEI	FUEL2	fuel3	YRS	IDEAS	INTR	FOLL	UND?	IMPC	imp2	imp3	fsav	exp	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
HShuk-Th-T	3	6	5	P	5	3	3	6	2	2	2	6	0	1	4	4	0	2	2	6	8	2	0	0	2	0	0	6	5	8			P
HShuk-Th-T	3	6	5	Q	4	1	4	8	2	2	4	1	0	0	4	2	0	0	0	6	7	5	0	0	4	0	0	6	4	1			Q
HShuk-Th-T	3	6	5	R	4	1	3	4	3	4	4	0	0	0	6	2	0	0	4	4	7	4	2	2	4	2	2	6	6	7	4		R
HShuk-Th-T	3	6	5	S	5	1	4	8	2	2	2	3	2	0	6	2	0	0	4	4	6	2	4	6	2	2	2	8	27				S
HShuk-Th-T	3	6	5	T	5	1	3	6	2	2	2	3	2	0	6	4	0	0	4	4	8	2	2	2	4	0	2	8	7	6	8		T
Chushot	4	4	3	A	6	2	2	8	3	8	2	4	2	1	6	2	8	6	8	8	9	6	8	8	4	6	5	10	22				A
Chushot	4	4	3	B	6	2	2	4	3	8	4	6	4	2	6	8	6	0	8	10	7	0	8	8	10	6	5	10	22				B
Chushot	4	4	3	C	6	2	2	2	2	4	2	5	0	1	6	8	8	0	10	10	9	9	8	8	10	6	6	8	25				C
Chushot	4	4	3	D	6	2	2	8	3	4	4	4	0	0	6	6	8	6	6	10	10	9	6	6	10	6	4	8					D
Chushot	4	4	3	E	6	2	2	10	2	4	4	6	4	2	6	6	6	6	6	8	10	0	8	8	6	6	5	8	15	25			E
Chushot	4	4	5	F	6	3	0	8	2	4	4	7	4	2	6	8	6	6	8	6	8	9	10	10	10	10	8	6					F
Chushot	4	4	3	G	6	2	3	8	2	4	4	7	4	2	6	8	6	6	8	8	7	0	10	8	10	10	8	6					G
Chushot	4	4	3	H	6	2	3	8	3	6	4	5	4	2	6	10	6	6	4	6	6	9	8	6	10	6	5	10	8	17	14	7	H
Chushot	4	4	5	I	6	3	0	8	3	6	4	5	4	1	6	10	6	6	4	6	7	9	8	8	10	6	5	10					I
Chushot	4	4	3	J	6	2	3	6	3	8	4	9	4	2	6	10	6	6	10	8	10	0	10	10	10	10	10	10	7	8	17		J
Chushot	4	4	2	K	5	1	3	2	2	4	2	4	0	1	8	6	0	0	6	4	6	9	6	6	8	6	4	6					K
Chushot	4	4	2	L	5	2	3	10	2	4	4	4	0	1	4	6	0	0	6	6	4	9	6	6	6	4	4	6					L
Chushot	4	4	3	M	6	2	3	6	3	4	4	5	0	1	6	8	6	6	8	6	7	9	8	8	10	6	6	10	22	6			M
Chushot	4	4	3	N	6	2	2	6	3	2	2	9	6	2	4	6	8	6	10	8	10	7	10	8	4	8	8	6	25				N
Chushot	4	4	5	O	6	3	0	8	3	2	2	9	6	2	4	6	8	6	10	6	6	7	10	10	8	10	8	6					O
Chushot	4	4	3	P	6	2	3	8	2	4	2	5	0	1	4	8	8	6	8	8	9	7	6	6	8	6	4	6	22				P
Chushot	4	4	5	Q	6	3	0	8	2	4	2	5	0	1	4	8	8	6	8	6	8	6	6	6	8	6	4	6					Q
Chushot	4	4	3	R	6	2	3	6	2	4	4	7	4	2	6	8	8	6	10	6	8	9	10	10	10	10	8	10	16				R
Chushot	4	4	3	S	6	2	3	6	3	4	2	5	0	1	4	6	8	6	6	8	6	6	8	6	10	6	5	6	16				S
Chushot	4	4	5	T	6	3	0	6	3	4	2	5	0	1	4	6	8	6	6	6	9	9	8	8	8	6	5	6					T
Spituk	5	2	2	A	5	2	3	4	1	4	2	5	1	2	10	8	8	2	8	8	9	2	6	6	8	6	5	6	7	20	6		A
Spituk	5	2	2	B	5	2	3	4	2	4	2	7	2	2	8	8	8	4	8	8	9	6	6	6	8	6	5	8	17	19			B
Spituk	5	2	2	C	5	1	3	6	2	4	2	7	1	2	8	6	8	2	6	4	4	3	4	4	6	4	4	6	8	17	7		C
Spituk	5	2	2	D	5	2	3	6	2	6	4	7	2	2	6	4	2	2	4	6	9	3	4	4	6	4	4	6	20	7	8	17	D
Spituk	5	2	2	E	5	1	4	6	2	0	4	2	2	0	8	6	8	2	8	6	6	1	4	2	4	2	3	8	7	20			E
Spituk	5	2	2	F	5	2	2	6	2	0	4	2	1	1	6	4	0	0	4	6	8	2	6	6	4	2	3	6	26	6	7		F
Spituk	5	2	2	G	5	2	3	6	2	6	4	5	2	2	8	4	2	2	4	6	4	6	6	6	8	6	5	6	7	17	19		G
Spituk	5	2	5	H	6	2	4	4	4	8	10	3	3	1	10	10	8	8	8	8	10	9	8	8	10	8	8	10	20				H
Spituk	5	2	5	I	6	2	4	4	4	8	10	3	3	1	10	8	8	8	10	8	10	7	8	8	10	8	8	10	20				I
Spituk	5	2	5	J	6	2	1	10	4	8	6	2	3	1	8	8	2	2	6	10	10	9	8	8	10	8	5	10	20				J
Palam	6	5	3	A	6	2	2	8	2	4	4	6	4	1	8	10	6	2	6	8	9	9	8	8	8	8	8	10	2	4	6	8	A
Palam	6	5	3	B	6	3	0	8	2	4	4	6	4	2	8	10	6	2	6	8	9	7	10	8	10	8	8	10					B
Palam	6	5	3	C	6	2	2	8	2	2	4	7	4	2	8	8	6	2	6	6	9	6	8	8	8	8	8	10	7	6	4	20	C
Palam	6	5	3	D	6	3	0	8	2	2	4	7	4	1	8	8	6	2	6	8	9	6	10	10	10	10	8	10					D
Palam	6	5	2	E	5	1	3	4	2	4	4	6	2	1	6	6	6	0	4	4	4	1	2	0	6	0	3	8	15	16			E
Palam	6	5	2	F	5	1	3	6	3	6	4	6	4	2	4	4	6	0	4	4	8	1	0	0	6	0	4	6	15				F
Sabu	7	3	3	A	6	2	3	8	2	2	2	3	2	0	8	10	8	2	8	6	9	2	6	6	6	6	5	6	1	7	4	2	A
Sabu	7	3	3	B	6	2	3	8	4	6	6	7	4	2	6	10	8	2	8	8	10	6	8	6	10	8	8	6	17	1	4	6	B
Sabu	7	3	3	C	6	3	0	8	4	6	6	7	4	2	6	10	8	2	8	8	8	6	6	6	8	6	8	6					C
Sabu	7	3	2	D	5	2	3	6	2	4	4	4	2	1	6	10	8	2	10	4	4	4	4	4	8	2	4	6	16				D

Database from User's Survey (continued)

Database 1: Village Surveys

VILLAGE	VIL#	C/H	PRC	INT	MOD	PPN	SUB	WTD	REL	KIT1	KIT2	FUEL	FUEL2	fuel3	YRS	IDEAS	INTR	FOLL	UND?	IMPCT	imp2	imp3	fsav	exp	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
Sabu	7	3	2	E	5	2	4	8	2	4	4	4	2	1	8	10	10	0	10	4	8	10	8	6	6	4	5	10					E
Sabu	7	3	2	F	5	2	3	8	2	4	4	3	2	0	8	10	10	0	8	6	9	5	0	0	4	0	5	8	1	2	24	19	F
Sabu	7	3	2	G	5	1	3	6	2	2	4	2	2	1	4	4	2	2	4	4	2	1	2	4	4	2	3	6	7	4	16		G
Sabu	7	3	2	H	5	2	4	6	2	4	4	4	2	1	8	4	8	2	2	6	5	3	4	6	4	4	4	6	17				H
Sabu	7	3	2	I	5	3	4	0	2	2	2	2	2	0	6	4	2	2	0	6	9	2	2	0	4	2	3	8	19	17	5	6	I
Sabu	7	3	2	J	5	3	4	0	2	2	2	4	2	1	6	8	0	0	6	6	9	8	4	6	6	2	3	10	17	24			J
Sabu	7	3	2	K	5	3	4	8	2	2	2	7	6	2	4	2	0	0	4	6	8	3	4	6	6	8	8	4	3	1	2	10	K
Sabu	7	3	2	L	5	3	3	0	4	6	6	5	4	2	6	8	0	0	6	6	8	8	4	0	4	0	2	10	2	1	6		L
Sabu	7	3	2	M	5	3	3	8	4	4	6	7	4	2	4	2	8	4	6	6	10	4	6	8	6	6	7	6	7	6	17		M
Stagmo	8	5	2	A	5	1	3	4	2	2	2	2	0	0	8	2	8	8	8	4	4	1	0	0	4	0	2	6	13	14	6		A
Stagmo	8	5	2	B	5	1	4	4	2	2	2	2	2	0	10	4	8	8	4	6	6	1	0	0	4	0	2	2	1	12	10	4	B
Stagmo	8	5	2	C	5	1	3	8	2	2	2	4	0	1	10	8	10	10	6	4	2	8	8	5	8	7	20	24					C
Stagmo	8	5	2	D	5	1	4	8	2	2	2	4	0	1	10	8	8	2	4	6	5	6	8	8	10	8	5	10	13	4	21	20	D
Stagmo	8	5	5	E	5	3	4	6	2	2	2	6	2	1	6	6	2	8	6	2	6	4	6	6	10	6	5	8	6	17	8	26	E
Stagmo	8	5	5	F	5	3	4	0	2	2	2	5	2	1	6	4	2	10	6	4	4	2	4	4	4	4	3	6	1	8	4	5	F
Stagmo	8	5	5	G	5	3	3	0	2	2	2	3	0	0	6	2	2	10	6	4	4	1	0	2	2	2	2	6	3	6	14	13	G
Stok	9	5	5	A	5	2	3	10	2	2	2	0	2	0	10	4	2	2	4	0	8	2	6	4	6	6	4	6	23	17	8	7	A
Stok	9	5	5	B	5	2	3	8	2	4	4	7	4	2	10	10	2	2	4	6	2	6	2	8	8	8	5	10	14	18			B
Stok	9	5	2	C	5	3	4	4	2	4	4	6	4	2	8	6	8	2	6	4	4	7	6	4	4	6	4	6	16				C
Stok	9	5	2	D	5	3	4	6	2	4	4	2	2	0	6	6	0	2	4	4	6	3	4	4	2	4	3	2	18	16			D
Stok	9	5	5	E	5	2	3	8	2	2	2	7	4	1	8	4	4	2	4	6	8	5	6	4	6	6	4	2	7	6	4		E
Stok	9	5	2	F	5	1	3	6	2	2	2	4	2	1	2	2	8	10	4	4	8	2	4	4	2	4	3	4	4	18			F
Stok	9	5	2	G	5	1	3	6	2	4	4	4	2	1	4	6	8	2	4	4	6	3	4	4	4	4	3	6	2	4	14		G
Stok	9	5	5	H	4	1	3	4	2	2	2	4	2	1	4	4	2	10	4	6	8	6	8	8	8	8	5	8	4	8	5		H
Stok	9	5	2	I	5	2	3	6	2	2	4	5	2	1	4	6	8	10	8	4	2	4	4	2	4	4	3	4	3	7	1	17	I
Stok	9	5	2	J	5	1	3	4	2	2	4	7	4	2	6	4	8	10	8	4	4	5	6	4	4	6	4	2	7	4	22		J
Shey	10	3	3	A	6	2	3	8	2	2	2	4	2	1	8	4	8	8	4	8	5	3	8	2	4	6	3	10	21	6	7	24	A
Shey	10	3	3	B	6	2	3	8	2	4	4	6	4	2	8	10	8	8	8	8	6	6	8	6	8	8	8	10	7	14	27		B
Shey	10	3	3	C	6	2	3	8	3	4	6	6	4	2	8	8	8	6	10	8	10	9	6	8	10	6	8	6	25				C
Shey	10	3	3	D	6	2	3	8	3	4	6	2	2	1	6	6	8	8	6	8	9	7	8	6	6	8	4	6					D
Shey	10	3	2	E	5	1	4	6	2	4	4	4	4	1	6	4	2	2	4	0	4	1	6	2	2	4	3	8	26				E
Shey	10	3	2	F	5	1	3	6	2	4	4	7	4	2	6	8	2	4	10	0	8	8	6	8	6	8	8	8	25				F
Shey	10	3	3	G	6	3	3	0	2	2	2	6	4	2	4	4	8	2	6	8	10	9	10	8	8	8	5	6	1	20	21		G
Shey	10	3	3	H	6	3	3	0	2	4	4	8	4	2	4	6	8	2	10	8	8	6	6	8	10	10	8	6	26				H
Shey	10	3	2	I	5	3	4	0	2	4	4	8	4	2	6	4	2	0	6	2	6	4	6	6	6	6	5	6					I
Shey	10	3	2	J	5	3	3	0	2	4	4	7	4	2	6	4	0	0	6	2	4	3	6	8	4	8	5	6	25				J
Thiksey	11	3	3	A	6	2	3	8	2	2	2	4	2	1	6	8	8	8	6	8	9	6	8	8	10	8	5	6	1				A
Thiksey	11	3	3	B	6	2	2	6	2	4	4	6	2	2	6	6	8	8	6	8	9	5	8	8	10	8	5	6					B
Thiksey	11	3	3	C	6	2	3	8	2	2	2	3	2	0	6	10	8	8	6	8	9	9	8	8	10	8	5	6	17				C
Thiksey	11	3	3	D	6	2	3	8	2	2	2	6	2	1	6	8	8	2	10	10	9	0	10	10	10	10	8	6					D
Thiksey	11	3	3	E	6	2	3	8	3	4	4	9	6	2	6	10	8	2	10	8	8	9	10	10	10	10	8	8	14	17	24		E
Thiksey	11	3	3	F	6	2	2	6	3	4	4	9	4	2	6	8	8	0	8	8	10	9	10	8	10	10	8	8	19	27			F
Thiksey	11	3	2	G	5	2	3	8	2	4	4	3	2	1	8	6	8	8	8	4	4	3	8	6	8	4	4	8	25				G
Thiksey	11	3	2	H	5	2	3	8	2	4	4	4	2	1	8	4	8	8	4	6	8	4	8	8	8	4	4	6					H
Thiksey	11	3	3	I	6	3	2	0	2	4	2	4	2	0	4	6	8	6	4	8	8	2	6	6	6	6	4	6	17				I

Database 1: Village Surveys

Database from User's Survey (continued)

VILLAGE	VIL#	C/H	PRC	INT	MOI	PPN	SUB	WTD	REL	KIT1	KIT2	FUEI	FUEL2	fuel3	YRS	IDEA	INTR	FOLL	UND?	IMPCT	imp2	imp3	fsav	exp	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
Thiksey	11	3	5	J	6	3	2	0	2	4	2	4	2	1	4	6	8	6	4	10	9	10	6	6	6	6	4	6	17				J
Thiksey	11	3	3	K	6	3	0	0	2	4	4	4	2	0	4	6	8	0	6	8	9	9	8	8	6	6	4	6					K
Thiksey	11	3	5	L	6	3		0	2	4	4	4	2	1	4	6	8	0	4	8	9	6	8	8	10	6	4	6					L
Stakna	12	5	3	A	6	2	3	8	2	2	4	5	4	1	8	8	8	10	10	8	10	7	10	10	10	10	10	10					A
Stakna	12	5	3	B	6	2	3	10	2	2	4	6	6	2	8	10	8	10	10	10	10	9	10	10	10	10	10	10					B
Stakna	12	5	3	C	6	2	3	10	2	2	4	4	2	0	8	10	8	10	8	10	9	6	10	10	10	8	5	6	25				C
Stakna	12	5	5	D	6	2	0	10	2	2	4	4	2	0	8	10	8	10	8	8	9	7	8	8	8	8	5	6					D
Stakna	12	5	3	E	6	2	3	6	2	2	4	4	2	0	6	6	8	10	6	10	9	9	8	8	8	8	5	10	25				E
Stakna	12	5	5	F	6	2	0	6	2	2	4	4	2	0	6	6	8	10	6	8	9	6	8	8	8	8	5	10					F
Matho	13	6	2	A	6	2	3	6	2	2	4	6	4	1	6	6	8	8	6	8	6	10	8	8	10	8	5	6	7	8			A
Matho	13	6	3	B	6	2	3	6	2	2	4	4	2	1	6	6	8	8	6	6	8	10	6	6	6	6	5	8	8	24	14	17	B
Matho	13	6	3	C	4	3	4	6	1	6	4	6	4	1	4	6	8	8	6	6	4	1	6	6	6	6	4	10	17				C
Matho	13	6	2	D	4	2	4	4	2	4	4	6	2	0	6	6	8	8	6	4	8	4	6	6	6	6	4	10	17	23			D
Nang	14	6	3	A	6	2	3	8	2	2	2	6	2	1	6	6	8	0	6	10	9	7	8	8	10	8	8	6	25				A
Nang	14	6	5	B	6	2	3	8	2	2	4	6	2	0	6	6	8	0	6	6	4	9	10	10	10	8	8	6	16				B
Nang	14	6	5	C	6	3	3	0	2	2	2	4	2	0	6	4	0	0	2	6	6	2	8	8	6	6	4	6					C
Nang	14	6	3	D	6	3	3	0	2	2	2	4	2	1	6	4	0	0	2	8	9	3	8	8	6	6	4	6					D
Marteslang	15	6	3	A	6	2	3	8	2	4	2	5	2	1	6	8	8	0	8	10	9	9	8	10	10	8	8	10	16	18			A
Marteslang	15	6	3	B	6	2	3	8	2	2	2	6	2	1	6	6	8	0	10	8	9	10	10	10	10	8	8	10	16				B
Marteslang	15	6	3	C	6	2	3	8	2	4	2	6	2	1	6	4	8	0	6	8	9	9	8	6	8	6	5	6	16				C
Marteslang	15	6	5	D	6	2	0	0	2	2	2	6	2	0	4	4	0	0	6	8	9	2	8	6	8	6	5	6					D
Marteslang	15	6	5	E	6	3	0	0	2	2	2	4	2	0	6	4	0	0	8	6	6	3	6	6	6	6	4	6					E
Marteslang	15	6	5	F	6	2	0	0	2	2	2	4	2	0	4	4	0	0	6	6	4	6	8	10	6	6	5	6					F
Shang	16	6	3	A	6	2	3	8	2	2	2	5	2	1	6	6	8	0	6	8	9	10	8	6	6	6	5	10					A
Shang	16	6	5	B	5	3	3	0	2	2	2	4	2	0	6	4	0	0	0	8	9	2	6	6	6	6	3	6	17				B
Shang	16	6	5	C	6	3	3	0	2	2	2	3	2	0	6	4	0	0	2	10	9	3	6	6	6	6	4	6	16	25			C
Phyang	17	3	3	A	6	2	3	4	2	2	2	3	2	0	6	6	8	6	6	8	9	6	8	6	8	6	5	6					A
Phyang	17	3	3	B	6	2	3	8	2	4	4	9	4	2	6	8	8	6	10	8	4	9	8	10	10	8	8	6					B
Phyang	17	3	3	C	6	2	3	6	3	4	6	9	4	2	6	8	8	4	10	8	10	7	8	8	10	8	8	6	16				C
Phyang	17	3	5	D	6	3	3	6	2	4	4	9	4	2	6	6	0	2	4	8	4	3	8	6	8	6	5	6	16				D
Phyang	17	3	5	E	6	3	3	6	2	2	2	5	2	1	6	4	0	2	4	6	8	9	8	8	8	8	4	6					E
Alpha A	18	5	3	A	6	3	3	0	4	8	10	8	8	2	8	10	8	8	10	10	10	0	10	10	6	10	8	10	16	15			A
Alpha B	19	5	5	A	5	3	4	0	2	6	4	7	6	2	4	8	6	2	4	8	10	4	2	4	5	2	2	6	8	7	17		A
Likkir	20	6	5	A	6	2	3	8	2	4	4	5	2	1	6	4	8	8	4	8	9	9	6	8	3	8	5	6					A
Likkir	20	6	5	B	5	2	3	6	2	4	4	5	2	1	8	6	0	2	2	6	6	5	8	4	4	6	4	6	7	1	4		B
Likkir	20	6	2	C	5	3	3	6	2	4	4	5	2	1	8	4	0	2	4	6	4	4	8	4	4	6	4	6	17	8	5		C
Likkir	20	6	3	D	6	3	3	4	2	4	4	7	4	2	6	4	0	2	4	6	1	0	8	8	8	8	5	6	16	25			D
Likkir	20	6	3	E	6	3	3	4	2	4	4	7	4	2	6	4	8	8	4	6	1	9	6	8	2	8	5	6	17	16			E
Saspol	21	5	2	A	5	2	4	4	2	4	4	4	4	1	8	6	8	4	6	6	4	4	6	4	3	6	5	6	17	8			A
Saspol	21	5	2	B	5	1	4	6	2	4	4	6	4	1	8	6	8	2	6	4	4	4	6	4	1	6	4	6	18	20	21		B
Saspol	21	5	2	C	5	3	3	0	2	4	4	7	6	2	8	6	8	2	4	4	0	3	6	4	4	6	3	6	24	17	18	20	C
Saspol	21	5	2	D	4	1	4	6	2	4	4	4	4	1	8	6	8	2	2	6	4	5	0	4	1	6	0	6	19				D
Uletopko	22	5	2	A	5	1	4	8	2	4	4	8	4	2	6	8	8	2	4	6	8	5	6	4	4	6	4	6	4	7	6	18	A
Uletopko	22	5	5	B	5	3	4	0	2	6	4	8	6	2	4	6	6	2	4	6	10	4	2	4	4	2	2	6	18	20			B
Uletopko	22	5	5	C	5	3	4	0	2	6	4	8	6	2	4	6	6	2	0	8	10	1	0	4	1	0	0	6	8	23			D

Database 1: Village Surveys

Database from User's Survey (continued)

VILLAGE	VIL#	C/H	PRC	INT	MOI	PPN	SUB	WTD	REL	KIT1	KIT2	FUE	FUEL2	fuel	YRS	IDEA	INTR	FOLL	UND?	IMPC	imp2	imp3	fsav	exp	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#
Basgo	23	5	3	A	6	2	3	8	2	2	2	6	2	1	6	6	8	2	8	6	1	2	8	8	2	6	5	10					A
Lazing	23	6	3	B	6	2	0	8	2	2	2	6	2	1	6	6	8	2	8	6	6	2	8	8	2	6	5	10	16				B
Khalse	24	3	2	A	5	2	3	6	2	2	2	4	4	1	8	6	8	8	6	4	10	5	6	6	3	4	4	6	8	17	27		A
Khalse	24	3	2	B	5	2	3	0	2	6	4	7	6	2	8	8	8	8	6	6	6	6	8	8	9	6	5	6	8				B
Khalse	24	3	5	C	5	3	3	0	3	6	6	8	6	2	8	6	2	2	6	6	10	5	6	6	5	4	4	6	5	7			C
Khalse	24	3	5	D	5	3	3	4	3	6	6	8	6	2	8	8	2	2	2	2	6	10	4	6	6	6	4	4	6	4	7		D
Lamayuru	25	5	2	A	5	2	3	6	2	2	2	4	2	0	6	4	8	8	4	6	6	6	2	6	7	2	2	6	13	14	24		A
Lamayuru	25	5	2	B	5	1	4	6	2	2	2	3	2	0	8	4	6	8	2	8	9	1	2	4	1	2	2	6	4				B
Lamayuru	25	5	2	C	5	1	4	4	2	4	4	2	2	0	8	4	2	2	2	4	8	2	2	6	3	2	2	6	4	17	6		C
Lamayuru	25	5	2	D	5	1	3	4	2	4	4	7	4	2	8	8	2	2	4	4	1	2	2	4	3	6	4	6	19	18	17	12	D
Lamayuru	25	5	5	E	5	3	4	0	2	4	4	3	2	1	8	6	0	2	2	6	5	2	2	2	8	2	2	6	20	22			E
Nimu	26	5	3	A	6	2	3	8	2	6	4	7	6	1	6	10	8	8	10	8	8	9	10	10	9	10	8	10	25				A
Nimu	26	5	3	B	6	2	3	8	2	4	4	6	6	1	8	10	6	2	10	8	8	0	10	10	9	10	5	10	25				B
VILLAGE	VIL#	C/H	PRC	INT	MOI	PPN	SUB	WTD	REL	KIT1	KIT2	FUE	FUEL2	fuel	YRS	IDEA	INTR	FOLL	UND?	IMPC	imp2	imp3	fsav	exp	SR WK	amtT	FREQ	2NDS?	NOT1	NOT2	NOT3	NOT4	INTV#

SURVEY FORMAT #1
1992 SOLAR BOX COOKERS INTERNATIONAL SOLAR SURVEY

STRUCTURED INTERVIEW
INDUS RIVER VALLEY - SONAM LING STUDY 1992

1992 SOLAR COOKING QUESTIONNAIRE INTERVIEW #__ __-__-___

ORGANIZATION

COMMUNITY _____ DATE _____
INTERVIEWER _____

PERSON INTERVIEWED _____
ADDRESS _____

Purpose: To survey the person who does the most cooking in the household. The questions are about cooking. Of special interest are awareness and interest in solar cooking, especially about people's experience building and using solar cookers and problems they have encountered.

TO INTERVIEWERS:

PART I: EVERYONE INTERVIEWED SHOULD COMPLETE
PART II IS FOR ALL WHO HAVE SEEN A SOLAR COOKER WORK AND/OR EVER TRIED SOLAR COOKING
PART II IS FOR THOSE WHO ARE USING SOLAR COOKERS

For statistics purposes, please estimate the following:
Age of person interviewed:
____ under 20 ____ 20+ ____ 30+ ____ 40+ ____ 50+

Please also estimate the general family income compared to others in the community
____ lower ____ average ____ higher

PART 1 FOR ALL

1. What time of the day do you serve hot cooked food or hot beverages?
____ morning
____ noon
____ evening
____ other

2. For how many people usually?
_____

3. Which cooking fuels do you use MOST?
(check up to 4)
____ wood
____ charcoal
____ kerosene
____ butane/bottled gas
____ electricity
____ solar energy
____ other: _____

For only those checked above:
WOOD:
If you buy wood, compared to last year it
____ cost more
____ costs less
____ costs the same
If you gather wood, compared to last year do you have to walk
____ farther
____ less far
____ the same distance
Do you have a special stove to burn wood?
____ no ____ yes. What type?
CHARCOAL - compared to last year does it cost
____ more
____ less
____ the same
KEROSENE - compared to last year does it cost
____ more
____ less
____ the same
BUTANE/BOTTLED GAS - compared to last year does it cost
____ more
____ less
____ the same
ELECTRICITY - compared to last year does it cost
____ more
____ less
____ the same

4. Do you have any problems with cooking fuels? (Check all that apply)
____ none
____ expense
____ time/distance to get fuel
____ scarcity, unreliability
____ smelly, smoky
____ other: _____

5. How many hours each week do you spend gathering or buying fuel? _____

6. How many hours each day do you spend cooking? _____

7. As the one who does most of the cooking, are you

____ mostly at home or
____ mostly away from your house during the day?

8. For you, what is the hardest part about cooking family meals?

9. Do you have an area near your house which is mostly sunny several months of the year?
____ yes ____ no

10. How long ago did you first hear about solar cooking?
____ just now
____ less than a year ago
____ 1-2 years ago
____ 3_4 years ago
____ more than 4 years

11. Have you ever seen food cooked in a solar cooker?
____ yes
____ no: Would you like more information about solar cooking on sunny days?
____ yes
____ no.

END OF PART 1. THANK YOU VERY MUCH.

PART II: IF YOU HAVE SEEN A SOLAR COOKER WORK AND/OR TRIED ONE

12. How long ago did you first see a solar cooker work?
____ less than a year
____ 1-2 years
____ 3-4 years
____ more than 4 years

13. What did the solar cooker(s) look like?
a. ____ b.____ c. ____

14. What do you see as the main advantages of solar cooking on sunny days?

15. What do you see as the main disadvantages of solar cooking?

16. If you have ever tried to cook in a solar cooker yourself what was your experience?
____ tried one or twice, didn't like it
____ use for awhile, didn't like it
____ liked it, but I don' use anymore
____ still using - SKIP TO 19.

17. What are the main reasons you don't use a solar cooker on sunny days?
____ don't have a cooker
____ cooker is broken
____ cooker was hard to use
____ need more information : (describe)
____ couldn't cook food right:

which foods?

____ cooking outside is a problem because

____ other: Please describe:

18. Would you want to try solar cooking again someday?
____ no. Why not?

____ yes. What would help?
____ recipes for solar cooking
____ a cooking demonstration
____ someone to answer questions
____ an affordable cooker
____ help/parts to repair
____ other. Describe:

END OF PART II. THANK YOU VERY MUCH.

PART III. IF YOU STILL USE A SOLAR COOKER

19. What is the solar cooker made of ?
Outside of cooker:
____ Cardboard
____ Adobe
____ Wood
____ Baskets
____ Metal
____ Other: describe:

Cooker window:
____ Glass
____ Other: describe:

Insulation
____ Newspaper
____ Rice hulls
____ Other: describe:

20. Compared to last year do you use a solar cooker
____ more
____ less
____ about as often as last year?

21. How long have you been solar cooking?
____ less than one year
____ 1-2 years
____ 3-4 years
____ more than 4 years: how many? _____

22. How often do you solar cook?
____ most sunny days

____ several times a month
____ several times per year

23. About what time do you usually put food in the solar cooker to cook?
_____

24. Do you often have to worry about dusty, cloudy or rainy weather?
____ yes. Which months? _____
____ no

25. What foods do you solar cook most often?

26. What foods come out best in your solar cooker?

27. What foods haven't cooked right in your solar cooker?

Were they
____ under cooked
____ over cooked
____ poor taste or texture
____ other: describe:

28. for foods that didn't cook right do you think it was because of
____ not enough sunshine
____ time of day
____ type or amount of food?
____ didn't use dark, covered pots
____ I need special recipes
____ other. describe:

29. About the slower cooking time - would you say
____ it's nice because I don't need to watch or stir
____ it's a problem to plan ahead and put food in the solar cooker early in the day
____ other: describe:

30a. When you use your solar cooker do you notice that you use less cooking fuel?
____ no
____ yes
b. Does using a solar cooker save you money?
____ no
____ yes

31. Does solar cooking take less time and work for you while the food is cooking?
____ no
____ yes

32. What do you like <u>least</u> about solar cooking compared to your other cooking methods?

33. What do you like <u>most</u> about solar cooking?

34. Do any of the following describe your cooker?
____ durable?

____ flimsy?
____ too light?
____ too heavy?
____ easy to carry?
____ immovable?
____ attractive?
____ not attractive?
____ none of the above
____ other: describe:

35. Have you had any problems with the cooker itself?
____ no
____ yes. Please give details

36. Have you had any solar cooking problems that you found solutions for?
Problem:

Solution:

37. Have you found other uses for a solar cooker besides cooking ?
____ no
____ yes: describe:

38. How did you get a cooker?
____ I borrowed one
____ It was a gift: from whom?

____ I bought myself
____ I built myself
Any problems building?
____ no
____ yes

39. What do you think are the main reasons more people haven't built solar cookers?
____ instructions aren't clear, too complicated
____ hard to find materials needed
____ materials needed are too expensive
____ they would rather buy one

40. How many other people do you know who have a solar cooker?
_____ (number)

41. About how many people do you know who use their solar cooker sometimes?
_____ (number)

42. Have you told other people about solar cooking?
____ no
____ yes: about how many? _____

THANK YOU VERY MUCH FOR HELPING US

SURVEY FORMAT #2
INFORMAL INTERVIEW
INDUS RIVER VALLEY - SONAM LING STUDY 1992
TROMBE WALLS, GREENHOUSES, IMPROVED SHINGSAK, COOKERS, WATER HEATERS

Interview # Date
Community House # or name
Interviewee name
Family names
Note on why these people are being interviewed: observed solar at house, told by villagers, LEDeG notes, LNP notes

Number of persons in home
Ages/relations
Place of origin
Years/generation in camp
Buddhist____ Muslim____ Ladakhi____ Tibetan____ NOTA____
Profession of TWO heads of home
Other working family members
Education in home (all)
Formal economy pay: monthly summer
winter
agriculture/animal sales
informal trade
self-sufficiency: home_____ clothes_____ food_____
% informal
savings? purpose

Home ownership
land ownership
land description
animals
pasture rights
range
who tends?

Fuel use

COOKING: kerosene_____ propane_____ coal/coke_____
fuelwood_____ fueldung_____
Amt. summer
Amt. winter

HEATING: kerosene_____ propane_____ coal/coke_____
fuelwood_____ fueldung_____
Amt. winter
MONTHS

Est. budgets each
who gathers
where
problems in recent years
Solar in kitchen OK?

STOVE SYSTEMS IN HOME

stove type
other stoves
stove pipe: straight _____ elbow _____
noticeable smoke in kitchen
CO2 measurement of chula
temp at stove
temp: corner _____ ceiling _____ floor_____
time of day meals cooked
who
time needed

SMOKELESS CHULA USERS

when built
cost subsidy?
who built
why purchased
repair/maintenance
changes in time cooking
changes in smoke
changes in fuel use
health improve
who?
CO2 measure

SOLAR USERS

solar type(s)
general condition
when installed
cost subsidy?
by whom
why purchased
where did you hear of /see solar
repair/maintenance
any monitoring
by who
education program
cooking lessons
help in repair
solar q/s taken to what group

general problems
local innovations

1. cookers
what food cooked
what doesn't
water warmed amts. s/w
months/year used
meals/day
who uses
any fuel savings
dislikes

2. Water heaters: (YP)
capacity fills/day
months/year used
used for: preheating cooking _____ preheating washing _____
pasteurizing water _____
who uses
any fuel savings
dislikes
likes

3. Trombe wall Improved shinksak
effect in winter
effect in summer
inside temps taken
Today's temps: at wall _____ floor _____ ceiling _____
far corner_____ adjacent room wall_____ ceiling_____
air circulation vents
air closed at night
how clean is glass
who cleans
still using stove in room
any fuel savings

4. Greenhouse SIZE
months used
plants grown: summer
winter
purpose of growing: bedding plants for farm
bedding plants for sale
winter foods
Other uses (animals)
glass _____ plastic _____ polyethylene _____

FOR ALL USERS OF APPROPRIATE TECHNOLOGIES:

neighbors using solar
neighbors using smokeless
who told you about solar/smokeless
what improvements would you like
what would make you use

GENERAL OBSERVATIONS

Are these people well off
innovative thinkers
any equality
community status
clean home
involved in tourism
family health
outhouse
water supply
who gathers how far
food storage

SURVEY FORMAT #3
KEY AREA DISCUSSION - SHORTENED FORM
INDUS RIVER VALLEY - SONAM LING STUDY 1992
TROMBE WALLS, GREENHOUSES, IMPROVED SHINGSAK, COOKERS, WATER HEATERS

Interview # Date
Community
Interviewee name
Family names
Note on why these people are being interviewed: observed solar at house, told by villagers, BDO, LEDeG, LNP, HA-TCV

Go to town
Why
number trips/year
Information from neighbors: Well-being

Education
Village position

Connections: DAg, LEDeG, BDO, LNP

Solar use

OBSERVATIONS ON ARRIVAL
Dooryard: cleanliness, barn, walls

number of animals and keep
fields: where, number, soil, water
Trees: wood, fodder, fruit, construction

Tools
Grain bank
Outhouse
Water supply
Involved in tourism

House
Orientation/windows
Composting toilet
Roof
LoSar/Lhas (spirits present)
16 book pole (measure of affluence)

INSIDE HOME
number persons
Ages/relationship
Place of origin
Years in camp
Buddhist ____ Muslin____ Ladakhi____ Tibetan____ NOTA____
Shrine
Work
Any in school
Informal economy %
Home/Land ownership
Pasture rights
who tends

KITCHEN
dowry
windows
food
traditional furniture
Stove
Cleanliness
Solar in kitchen OK?

FUEL USE
cooking winter
heating
supplies

HEALTH
nutrition
age
smoke
M/F or age problem

SOLAR USERS (Solar Box Cookers, Solar Water Heaters)
solar types
condition
who installed
when
cost subsidy
LIKE NOT LIKE
Use record

OUTSIDE SOLAR
trombes
greenhouse
function/condition

ALL SOLAR
Follow up by Subsidizers
REPAIRS
local innovations

NEIGHBORS AND SOLAR
who what

COMMUNITY SOLAR
type
condition
who funded
when
cost subsidy
labour by whom

Interviewee participation
perception of value

does family use?

Village

GOMPA/ANI GOMPA (monastery/nunnery)

WATER TESTS
HISTORY

SURVEY FORMAT #4
SOLAR TECHNOLOGY, OBSERVATION-BASED, WITHOUT INTERPRETER

TOPICS COVERED:

Dooryard: animals
fields
wealth?

House: size
16 book pole
windows
orientation

Family: generations
class
education
farmer?
connections in Leh, government, tourist trade, health promotion

Solar technology: SBC
SWH
GH
TR
Other technologies

Questions about use of SOLAR TECHNOLOGY

1. From whom? Subsidy?
2. Fuel a problem
3. Cooker and kitchen - any problems?
4. How did they learn to use?
5. Impacts: months/year
   type of food
   water
   fuel savings
   take to field
   time savings
   chichoen
   lhas
   ajos
   smoke
6. Likes/dislikes
7. Cooks/can't cook
8. Who told you about solar? Neighbours with solar? Others wanting solar technology?

Database from Technological Capability Testing

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
J1	10.5	8	1	73	1	0	2	76	1	0	74.5	3	110	1	2	4	110	1	2	110
J2	10	12	1	78	1	0	2	79	1	0	78.5	3	108	1	2.5	4	109	1	2.5	108.5
J3	9.5	16	1	83	1	0	2	82	1	0	82.5	3	108	1	2.5	4	109	1	2.5	108.5
J4	4.5	60	1	0	0	0	2	0	0	0	0	3	115	1	2	4	114	1	2	114.5
J5	4	64	1	0	0	0	2	0	0	0	0	3	111	1	2	4	110	1	2	110.5
J6	4	64	1	98	1	3	2	99	1	3	98.5	3	110	1	2	4	110	1	2	110
J7	5	56	1	104	1	2.5	2	102	1	2.5	103	3	114	1	2	4	114	1	2	114
J8	5	56	1	100	1	2.5	2	102	1	2.5	101	3	107	1	2	4	108	1	2.5	107.5
J9	3	76	1	86	1	0	2	87	1	0	86.5	3	88	1	0	4	89	1	0	88.5
J10	6.5	44	1	108	1	2.5	2	108	1	2.5	108	3	110	1	2	4	111	1	2	110.5
J11	2	84	1	90	3	0	2	88	3	0	89	3	94	3	5	4	92	3	5	93
J12	6	50	1	110	3	3	2	111	3	3	110.5	3	111	3	3	4	112	3	3	111.5
J13	6	50	1	110	3	3	2	112	3	3	111	3	112	3	3	4	112	3	3	112
J14	5.5	44	1	99	3	0	2	99	3	0	99	3	106	3	5	4	104	3	5	105
J15	6	50	1	105	3	5	2	106	3	5	105.5	3	102	3	5	4	105	3	5	103.5
J16	10	16	1	110	3	4	2	110	3	4	110	3	107	3	4	4	109	3	4	108
J17	10	16	1	110	3	4	2	112	3	4	111	3	113	3	3	4	114	3	3	113.5
J18	10	16	1	115	3	4	2	114	3	4	114.5	3	116	3	3	4	115	3	3	115.5
J19	10	16	1	113	3	4	2	113	3	4	113	3	116	3	3	4	116	3	3	116
J20	12	0	1	115	3	3	2	116	3	3	115.5	3	120	3	3	4	121	3	3	120.5
J21	5.5	66	1	90	3	0	2	93	3	0	91.5	3	90	3	0	4	91	3	0	90.5
J22	3	82	1	80	3	0	2	80	3	0	80	3	81	3	0	4	80	3	0	80.5
J23	8	32	1	118	3	3	2	120	3	3	119	3	120	3	3	4	120	3	3	120
J24	4	64	1	102	3	5	2	102	3	5	102	3	104	3	5	4	105	3	5	104.5
J25	10	16	1	120	3	3	2	121	3	3	120.5	3	121	3	3	4	121	3	3	121
J26	7.5	44	1	120	3	3	2	121	3	3	120.5	3	121	3	3	4	121	3	3	121
J27	6	50	1	115	3	4	2	114	3	4	114.5	3	117	3	3	4	118	3	3	117.5
J28	8	32	1	121	3	3	2	118	3	3	119.5	3	119	3	3	4	120	3	3	119.5
J29	8	32	1	120	3	3	2	120	3	3	120	3	119	3	3	4	119	3	3	119
J30	6	50	1	115	3	4	2	114	3	4	114.5	3	117	3	3	4	117	3	3	117
JL1	8	32	1	119	3	3	2	120	3	3	119.5	3	120	3	3	4	120	3	3	120
JL2	3	72	1	120	3	3	2	120	3	3	120	3	120	3	3	4	121	3	3	120.5
JL3	4	64	1	121	3	3	2	121	3	3	121	3	122	3	3	4	121	3	3	121.5
JL4	6	50	1	121	3	3	2	121	3	3	121	3	122	3	3	4	121	3	3	121.5
JL5	8	32	1	122	3	3	2	121	3	3	121.5	3	123	3	3	4	121	3	3	122
JL6	10	16	1	123	3	3	2	123	3	3	123	3	123	3	3	4	123	3	3	123

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
JL7	12	0	1	121	5	5	2	121	5	5	121	3	123	5	5	4	122	5	5	122.5
JL8	10	16	1	121	5	5	2	120	5	5	120.5	3	122	5	5	4	122	5	5	122
JL9	6	50	1	119	5	5	2	119	5	5	119	3	121	5	5	4	119	5	5	120
JL10	2	84	1	52	0	0	2	55	0	0	53.5	3	50	0	0	4	52	0	0	51
JL11	4	64	1	115	5	6	2	116	5	6	115.5	3	115	5	6	4	116	5	6	115.5
JL12	8	32	1	120	5	5	2	120	5	5	120	3	121	5	5	4	121	5	5	121
JL13	8	32	1	121	5	5	2	122	5	5	121.5	3	121	5	5	4	121	5	5	121
JL14	6	50	1	119	5	6	2	120	5	5	119.5	3	118	5	6	4	118	5	6	118
JL15	4	64	1	102	0	0	2	100	0	0	101	3	97	0	0	4	99	0	0	98
JL16	2	80	1	52	0	0	2	55	0	0	53.5	3	50	0	0	4	54	0	0	52
JL17	6	50	1	118	5	5	2	119	5	5	118.5	3	121	5	5	4	122	5	5	121.5
JL18	8	32	1	121	5	5	2	120	5	5	120.5	3	121	5	5	4	121	5	5	121
JL19	8	32	1	121	5	5	2	122	5	5	121.5	3	121	5	5	4	123	5	5	122
JL20	12	0	1	123	5	5	2	123	5	5	123	3	123	5	5	4	123	5	5	123
JL21	6	50	1	118	5	5	2	117	5	5	117.5	3	118	5	5	4	120	5	5	119
JL22	6	50	1	116	5	5	2	117	5	5	116.5	3	118	5	5	4	120	5	5	119
JL23	10	16	1	122	5	5	2	123	5	5	122.5	3	121	5	5	4	122	5	5	121.5
JL24	10	16	1	122	5	5	2	121	5	5	121.5	3	121	5	5	4	121	5	5	121
JL25	9	24	1	121	5	5	2	122	5	5	121.5	3	122	5	5	4	121	5	5	121.5
JL26	8	32	1	120	5	5	2	121	5	5	120.5	3	121	5	5	4	121	5	5	121
JL27	7	40	1	120	5	5	2	121	5	5	120.5	3	121	5	5	4	122	5	5	121.5
JL28	10	16	1	125	5	5	2	124	5	5	124.5	3	126	5	5	4	125	5	5	125.5
JL29	7	40	1	120	5	5	2	120	5	5	120	3	121	5	5	4	122	5	5	121.5
JL30	3	72	1	110	5	6	2	109	5	6	109.5	3	110	5	6	4	110	5	6	110
JL31	10	16	1	121	5	5	2	121	5	5	121	3	121	5	5	4	120	5	5	120.5
A1	10	16	1	121	5	5	2	121	5	5	121	3	121	5	5	4	122	5	5	121.5
A2	10	16	1	122	5	5	2	122	5	5	122	3	122	5	5	4	124	5	5	123
A3	8	32	1	104	5	6	2	104	5	6	104	3	107	5	6	4	110	5	6	108.5
A4	4	64	1	102	5	6	2	102	5	6	102	3	104	5	6	4	104	5	6	104
A5	7	40	1	126	5	5	2	126	5	5	126	3	126	5	5	4	126	5	5	126
A6	1	92	1	0	0	0	2	0	0	0	0	3	0	0	0	4	0	0	0	0
A7	8	64	1	110	6	7	2	111	6	7	110.5	3	112	6	6	4	113	6	6	112.5
A8	8	32	1	121	6	6	2	121	6	6	121	3	121	6	6	4	121	6	6	121
A9	8	32	1	120	6	6	2	121	6	6	120.5	3	121	6	6	4	122	6	6	121.5
A10	4	64	1	102	0	0	2	103	0	0	102.5	3	110	6	7	4	112	6	7	111
A11	2	84	1	80	0	0	2	83	0	0	81.5	3	80	0	0	4	84	0	0	82

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
A12	12	0	1	126	6	6	2	126	6	6	126	3	126	6	6	4	125	6	6	125.5
A13	5	54	1	121	6	6	2	122	6	6	121.5	3	122	6	6	4	123	6	6	122.5
A14	7	40	1	126	6	6	2	125	6	6	125.5	3	126	6	6	4	127	6	6	126.5
A15	10	16	1	126	6	6	2	126	6	6	126	3	126	6	6	4	126	6	6	126
A16	8	32	1	123	6	6	2	123	6	6	123	3	124	6	6	4	125	6	6	124.5
A17	11	8	1	125	6	6	2	124	6	6	124.5	3	125	6	6	4	125	6	6	125
A18	8	32	1	123	6	6	2	123	6	6	123	3	124	6	6	4	125	6	6	124.5
A19	8	32	1	126	6	6	2	125	6	6	125.5	3	126	6	6	4	125	6	6	125.5
A20	9	24	1	124	6	6	2	125	6	6	124.5	3	125	6	6	4	125	6	5	125
A21	11	8	1	126	6	5	2	126	6	5	126	3	125	6	5.5	4	126	6	5	125.5
A22	11	0	1	125	6	5	2	125	6	5	125	3	125	6	5.5	4	126	6	5	125.5
A23	11	0	1	126	6	5	2	126	6	5	126	3	127	6	5	4	127	6	5	127
A24	11	0	1	127	6	5	2	128	6	5	127.5	3	127	6	5	4	127	6	5	127
A25	11	9	1	126	6	5	2	127	6	5	126.5	3	126	6	5	4	124	6	5	125
A26	11	9	1	127	6	5	2	128	6	5	127.5	3	128	6	5	4	128	6	5	128
A27	11	9	1	127	6	5	2	128	6	5	127.5	3	128	6	5	4	127	6	5	127.5
A28	10	9	1	128	6	5	2	128	6	5	128	3	128	6	5	4	128	6	5	128
A29	10	0	1	126	6	5	2	127	6	5	126.5	3	126	6	5	4	126	6	5	126
A30	10	0	1	124	6	5	2	125	6	5	124.5	3	124	6	5	4	123	6	5	123.5
A31	10	0	1	126	6	5	2	127	6	5	126.5	3	127	6	5	4	125	6	5	126
S1	9	18	1	125	6	5	2	124	6	5	124.5	3	126	6	5	4	125	6	5	125.5
S2	2	81	1	99	0	0	2	99	0	0	99	3	100	0	0	4	98	0	0	99
S3	2	81	1	99	0	0	2	98	0	0	98.5	3	98	0	0	4	96	0	0	97
S4	3	72	1	88	0	0	2	90	0	0	89	3	86	0	0	4	89	0	0	87.5
S5	4	63	1	87	0	0	2	87	0	0	87	3	89	0	0	4	90	0	0	89.5
S6	2	82	1	100	3	6	2	100	3	6	100	3	101	3	6	4	100	3	6	100.5
S7	2	82	1	100	3	6	2	101	3	6	100.5	3	100	3	6	4	100	3	6	100
S8	1	91	1	71	0	0	2	72	0	0	71.5	3	69	0	0	4	71	0	0	70
S9	1	91	1	79	0	0	2	80	0	0	79.5	3	80	0	0	4	80	0	0	80
S10	0	100	1	69	0	0	2	70	0	0	69.5	3	69	0	0	4	70	0	0	69.5
S11	11	0	1	119	3	4	2	120	3	4	119.5	3	118	3	4.5	4	119	3	4.5	118.5
S12	10	9	1	117	3	4	2	118	3	4	117.5	3	115	3	4.5	4	114	3	4.5	114.5
S13	10	9	1	117	3	4	2	118	3	4.5	117.5	3	115	3	4.5	4	115	3	4.5	115
S14	5	54	1	104	0	0	2	103	0	0	103.5	3	104	0	0	4	102	0	0	103
S15	5	54	1	106	3	6	2	107	3	6	106.5	3	109	3	6	4	110	3	6	109.5
S16	3	81	1	82	0	0	2	83	0	0	82.5	3	80	0	0	4	80	0	0	80

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
S17	2	81	1	75	0	0	2	75	0	0	75	3	75	0	0	4	77	0	0	76
S18	4	63	1	100	0	0	2	100	0	0	100	3	99	0	0	4	99	0	0	99
S19	11	0	1	105	0	0	2	106	3	6	105.5	3	103	3	6	4	104	3	6	103.5
S20	6.5	40	1	104	0	0	2	105	3	0	104.5	3	100	0	0	4	101	0	0	100.5
S21	8	27	1	106	0	0	2	107	3	6	106.5	3	102	0	0	4	103	0	0	102.5
S22	5	54	1	100	0	0	2	100	0	0	100	3	97	0	0	4	98	0	0	97.5
S23	10	9	1	105	0	0	2	106	0	0	105.5	3	97	0	0	4	97	0	0	97
S24	10	9	1	105	0	0	2	106	3	0	105.5	3	103	0	0	4	104	0	0	103.5
S25	10	9	1	110	3	6	2	109	3	6.5	109.5	3	104	0	0	4	105	0	0	104.5
S26	10	9	1	107	3	6	2	108	3	6.5	107.5	3	103	0	0	4	104	0	0	103.5
S27	10	9	1	104	3	7	2	104	3	0	104	3	98	0	0	4	99	0	0	98.5
S28	10	9	1	105	3	7	2	104	3	0	104.5	3	100	0	0	4	100	0	0	100
S29	10	9	1	104	3	0	2	104	3	0	104	3	100	0	0	4	99	0	0	99.5
S30	9	18	1	103	3	0	2	104	3	0	103.5	3	97	0	0	4	98	0	0	97.5
01	2	80	1	83	0	0	2	84	0	0	83.5	3	79	0	0	4	79	0	0	79
02	2	80	1	84	0	0	2	85	0	0	84.5	3	78	0	0	4	79	0	0	78.5
03	2	80	1	83	0	0	2	83	0	0	83	3	81	0	0	4	83	0	0	82
04	10	0	1	107	1	0	2	104	0	0	105.5	3	100	0	0	4	99	0	0	99.5
05	6	40	1	102	0	0	2	102	0	0	102	3	94	0	0	4	95	0	0	94.5
06	6	40	1	102	0	0	2	100	0	0	101	3	92	0	0	4	91	0	0	91.5
07	10	0	1	104	0	0	2	104	0	0	104	3	90	0	0	4	92	0	0	91
08	8	20	1	103	0	0	2	104	0	0	103.5	3	90	0	0	4	92	0	0	91
09	10	0	1	103	0	0	2	104	0	0	103.5	3	90	0	0	4	90	0	0	90
010	10	0	1	103	0	0	2	104	0	0	103.5	3	86	0	0	4	87	0	0	86.5
011	7	30	1	99	0	0	2	99	0	0	99	3	86	0	0	4	87	0	0	86.5
012	10	0	1	101	0	0	2	100	0	0	100.5	3	80	0	0	4	81	0	0	80.5
013	6	40	1	95	0	0	2	95	0	0	95	3	82	0	0	4	82	0	0	82
014	4	60	1	96	0	0	2	96	0	0	96	3	80	0	0	4	81	0	0	80.5
015	6	40	1	94	0	0	2	95	0	0	94.5	3	76	0	0	4	77	0	0	76.5
016	6	40	1	90	0	0	2	89	0	0	89.5	3	77	0	0	4	77	0	0	77
017	5	50	1	85	0	0	2	85	0	0	85	3	72	0	0	4	75	0	0	73.5
018	8	20	1	88	0	0	2	88	0	0	88	3	80	0	0	4	82	0	0	81
019	9	10	1	88	0	0	2	89	0	0	88.5	3	82	0	0	4	84	0	0	83
020	8	20	1	88	0	0	2	89	0	0	88.5	3	82	0	0	4	82	0	0	82
021	9	0	1	90	0	0	2	90	0	0	90	3	82	0	0	4	84	0	0	83
022	6	33	1	83	0	0	2	84	0	0	83.5	3	78	0	0	4	79	0	0	78.5

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
O23	9	0	1	87	0	0	2	88	0	0	87.5	3	80	0	0	4	81	0	0	80.5
O24	4	55	1	80	0	0	2	82	0	0	81	3	76	0	0	4	78	0	0	77
O25	8	11	1	87	0	0	2	88	0	0	87.5	3	79	0	0	4	79	0	0	79
O26	9	0	1	87	0	0	2	88	0	0	87.5	3	78	0	0	4	80	0	0	79
O27	9	0	1	87	0	0	2	88	0	0	87.5	3	78	0	0	4	78	0	0	78
O28	9	0	1	85	0	0	2	86	0	0	85.5	3	77	0	0	4	78	0	0	77.5
O29	8	11	1	86	0	0	2	86	0	0	86	3	77	0	0	4	78	0	0	77.5
O30	9	0	1	85	0	0	2	86	0	0	85.5	3	75	0	0	4	75	0	0	75
O31	8.5	7	1	85	0	0	2	86	0	0	85.5	3	72	0	0	4	74	0	0	73
N1	8.5	6	1	85	0	0	2	86	0	0	85.5	3	70	0	0	4	71	0	0	70.5
N2	8	11	1	83	0	0	2	83	0	0	83	3	70	0	0	4	71	0	0	70.5
N3	8	11	1	85	0	0	2	86	0	0	85.5	3	69	0	0	4	70	0	0	69.5
N4	8	11	1	85	0	0	2	85	0	0	85	3	66	0	0	4	68	0	0	67
N5	4	55	1	61	0	0	2	62	0	0	61.5	3	51	0	0	4	52	0	0	51.5
N6	8	11	1	84	0	0	2	85	0	0	84.5	3	64	0	0	4	65	0	0	64.5
N7	8	11	1	82	0	0	2	83	0	0	82.5	3	65	0	0	4	65	0	0	65
N8	9	0	1	82	0	0	2	83	0	0	82.5	3	62	0	0	4	64	0	0	63
N9	8	0	1	81	0	0	2	81	0	0	81	3	62	0	0	4	63	0	0	62.5
N10	8	0	1	81	0	0	2	82	0	0	81.5	3	62	0	0	4	64	0	0	63
N11	8	0	1	80	0	0	2	81	0	0	80.5	3	60	0	0	4	62	0	0	61
N12	8	0	1	80	0	0	2	80	0	0	80	3	59	0	0	4	61	0	0	60
N13	8	0	1	78	0	0	2	80	0	0	79	3	60	0	0	4	61	0	0	60.5
N14	8	0	1	79	0	0	2	79	0	0	79	3	59	0	0	4	60	0	0	59.5
N15	8	0	1	78	0	0	2	79	0	0	78.5	3	59	0	0	4	60	0	0	59.5
N16	2	72	1	33	0	0	2	33	0	0	33	3	20	0	0	4	21	0	0	20.5
N17	8	0	1	78	0	0	2	80	0	0	79	3	59	0	0	4	60	0	0	59.5
N18	3	60	1	35	0	0	2	36	0	0	35.5	3	25	0	0	4	25	0	0	25
N19	4.5	42	1	35	0	0	2	36	0	0	35.5	3	29	0	0	4	30	0	0	29.5
N20	2.5	66	1	33	0	0	2	33	0	0	33	3	20	0	0	4	21	0	0	20.5
N21	2.5	66	1	30	0	0	2	30	0	0	30	3	24	0	0	4	25	0	0	24.5
N22	2	70	1	28	0	0	2	30	0	0	29	3	20	0	0	4	21	0	0	20.5
N23	7	0	1	68	0	0	2	68	0	0	68	3	51	0	0	4	52	0	0	51.5
N24	7	0	1	68	0	0	2	69	0	0	68.5	3	52	0	0	4	52	0	0	52
N25	7	0	1	67	0	0	2	67	0	0	67	3	49	0	0	4	48	0	0	48.5
N26	7	0	1	65	0	0	2	65	0	0	65	3	48	0	0	4	48	0	0	48
N27	7	0	1	64	0	0	2	65	0	0	64.5	3	42	0	0	4	44	0	0	43

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 1&2	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 3&4
N28	7	0	1	60	0	0	2	60	0	0	60	3	40	0	0	4	41	0	0	40.5
N29	5	28	1	55	0	0	2	55	0	0	55	3	40	0	0	4	40	0	0	40
N30	7	0	1	54	0	0	2	55	0	0	54.5	3	35	0	0	4	36	0	0	35.5
D1	3	56	1	30	0	0	2	31	0	0	30.5	3	20	0	0	4	20	0	0	20
D2	3	56	1	30	0	0	2	31	0	0	30.5	3	20	0	0	4	21	0	0	20.5
D3	4	42	1	38	0	0	2	38	0	0	38	3	28	0	0	4	30	0	0	29
D4	1	84	1	20	0	0	2	21	0	0	20.5	3	15	0	0	4	16	0	0	15.5
D5	5	28	1	40	0	0	2	41	0	0	40.5	3	31	0	0	4	30	0	0	30.5
D6	6	14	1	44	0	0	2	44	0	0	44	3	31	0	0	4	30	0	0	30.5
D7	3	56	1	32	0	0	2	33	0	0	32.5	3	26	0	0	4	25	0	0	25.5
D8	7	0	1	44	0	0	2	43	0	0	43.5	3	28	0	0	4	28	0	0	28
D9	7	0	1	42	0	0	2	41	0	0	41.5	3	27	0	0	4	26	0	0	26.5
D10	0	0	1	0	0	0	2	0	0	0	0	3	0	0	0	4	0	0	0	0

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 5 & 6	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 7 & 8
J1	10.5	8	5	98	1	2.5	6	100	1	2.5	99	7	105	1	2	8	105	1	2	105
J2	10	12	5	100	1	2.5	6	100	1	2.5	100	7	110	1	2	8	109	1	2	109.5
J3	9.5	16	5	99	1	2.5	6	99	1	2.5	99	7	110	1	2	8	107	1	2	108.5
J4	4.5	60	5	100	1	3	6	98	1	3	99	7	115	1	2	8	112	1	2	113.5
J5	4	64	5	99	1	3	6	97	1	3	98	7	110	1	2	8	110	1	2	110
J6	4	64	5	98	1	3	6	98	1	3	98	7	110	1	2	8	109	1	2	109.5
J7	5	56	5	97	1	3	6	99	1	3	98	7	112	1	2	8	111	1	2	111.5
J8	5	56	5	100	1	2.5	6	103	1	2.5	101.5	7	110	1	2	8	111	1	2	110.5
J9	3	76	5	84	1	0	6	83	1	0	83.5	7	89	1	0	8	90	1	0	89.5
J10	6.5	44	5	90	1	4	6	91	1	4	90.5	7	110	1	2	8	111	1	2	110.5
J11	2	84	5	78	3	0	6	77	3	0	77.5	7	85	3	0	8	85	3	0	85
J12	6	50	5	98	3	5	6	100	3	5	99	7	111	3	3	8	113	3	3	112
J13	6	50	5	99	3	5	6	99	3	5	99	7	111	3	3	8	113	3	3	112
J14	5.5	44	5	90	3	0	6	89	3	0	89.5	7	106	3	3.5	8	105	3	3.5	105.5
J15	6	50	5	90	3	0	6	90	3	0	90	7	111	3	3	8	114	3	3	112.5
J16	10	16	5	96	3	5	6	95	3	6	95.5	7	119	3	3	8	119	3	3	119
J17	10	16	5	98	3	5	6	97	3	5	97.5	7	116	3	3	8	115	3	3	115.5
J18	10	16	5	100	3	5	6	99	3	5	99.5	7	115	3	3	8	116	3	3	115.5
J19	10	16	5	99	3	5	6	99	3	5	99	7	116	3	3	8	117	3	3	116.5
J20	12	0	5	100	3	5	6	101	3	5	100.5	7	118	3	3	8	117	3	3	117.5
J21	5.5	66	5	86	3	0	6	85	3	0	85.5	7	90	3	0	8	92	3	0	91
J22	3	82	5	80	3	0	6	81	3	0	80.5	7	88	3	0	8	89	3	0	88.5
J23	8	32	5	100	3	5	6	100	3	5	100	7	119	3	3	8	120	3	3	119.5
J24	4	64	5	90	3	0	6	91	3	0	90.5	7	106	3	3.5	8	105	3	3.5	105.5
J25	10	16	5	104	3	4	6	105	3	4	104.5	7	118	3	3	8	118	3	3	118
J26	7.5	44	5	102	3	5	6	105	3	4	103.5	7	119	3	3	8	118	3	3	118.5
J27	6	50	5	102	3	5	6	102	3	4	102	7	121	3	3	8	120	3	3	120.5
J28	8	32	5	104	3	4	6	105	3	4	104.5	7	120	3	3	8	121	3	3	120.5
J29	8	32	5	104	3	4	6	106	3	4	105	7	121	3	3	8	122	3	3	121.5
J30	6	50	5	100	3	5	6	102	3	4	101	7	117	3	3	8	118	3	3	117.5
JL1	8	32	5	99	3	5	6	100	3	5	99.5	7	121	3	3	8	122	3	3	121.5
JL2	3	72	5	95	3	5	6	90	3	0	92.5	7	108	3	4.5	8	110	3	4	109
JL3	4	64	5	88	3	0	6	85	3	0	86.5	7	119	3	3	8	118	3	3	118.5
JL4	6	50	5	104	3	4	6	105	3	4	104.5	7	122	3	3	8	120	3	3	121
JL5	8	32	5	104	3	4	6	105	3	4	104.5	7	122	3	3	8	122	3	3	122
JL6	10	16	5	105	3	4	6	106	3	4	105.5	7	124	3	3	8	125	3	3	124.5
JL7	12	0	5	107	5	6	6	107	5	6	107	7	124	5	4	8	125	5	4	124.5
JL8	10	16	5	104	5	6	6	106	5	6	105	7	122	5	4	8	125	5	4	123.5
JL9	6	50	5	105	5	7	6	100	5	0	102.5	7	122	5	4	8	122	5	4	122
JL10	2	84	5	39	0	0	6	41	0	0	40	7	55	0	0	8	57	0	0	56
JL11	4	64	5	97	0	0	6	97	0	0	97	7	116	5	5	8	116	5	5	116
JL12	8	32	5	106	5	6	6	106	5	6	106	7	121	5	4	8	121	5	4	121
JL13	8	32	5	106	5	6	6	107	5	6	106.5	7	123	5	4	8	124	5	4	123.5
JL14	6	50	5	101	5	0	6	101	5	0	101	7	121	5	4	8	121	5	4	121

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 5 & 6	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 7 & 8
JL15	4	64	5	86	0	0	6	88	0	0	87	7	102	0	0	8	103	0	0	102.5
JL16	2	80	5	40	0	0	6	42	0	0	41	7	55	0	0	8	59	0	0	57
JL17	6	50	5	106	5	6	6	106	5	6	106	7	121	5	5	8	121	5	4	121
JL18	8	32	5	109	5	6	6	110	5	6	109.5	7	122	5	5	8	123	5	4	122.5
JL19	8	32	5	110	5	6	6	111	5	6	110.5	7	123	5	5	8	123	5	4	123
JL20	12	0	5	107	5	6	6	107	5	6	107	7	125	5	5	8	125	5	4	125
JL21	6	50	5	107	5	6	6	107	5	6	107	7	109	5	6	8	111	5	5	110
JL22	6	50	5	89	0	0	6	89	0	0	89	7	108	5	6	8	110	5	5	109
JL23	10	16	5	88	0	0	6	90	0	0	89	7	123	5	4	8	125	5	4	124
JL24	10	16	5	108	5	6	6	108	5	6	108	7	123	5	4	8	125	5	4	124
JL25	9	24	5	110	5	6	6	111	5	6	110.5	7	122	5	4	8	122	5	4	122
JL26	8	32	5	107	5	6	6	107	5	6	107	7	121	5	4	8	121	5	4	121
JL27	7	40	5	108	5	6	6	110	5	6	109	7	120	5	4	8	121	5	4	120.5
JL28	10	16	5	114	5	5	6	112	5	5	113	7	126	5	4	8	127	5	4	126.5
JL29	7	40	5	108	5	6	6	109	5	6	108.5	7	120	5	4	8	122	5	4	121
JL30	3	72	5	98	0	0	6	99	0	0	98.5	7	111	5	6	8	111	5	6	111
JL31	10	16	5	110	5	6	6	110	5	6	110	7	123	5	4	8	125	5	4	124
A1	10	16	5	112	5	6	6	113	5	6	112.5	7	126	5	4	8	126	5	4	126
A2	10	16	5	115	5	5	6	111	5	6	113	7	126	5	4	8	126	5	4	126
A3	8	32	5	100	5	6	6	100	5	6	100	7	109	5	5	8	111	5	5	110
A4	4	64	5	99	3	7	6	100	3	7	99.5	7	108	5	5	8	109	5	5	108.5
A5	7	40	5	113	5	5	6	114	5	5	113.5	7	125	5	4	8	125	5	4	125
A6	1	92	5	0	0	0	6	0	0	0	0	7	0	0	0	8	0	0	0	0
A7	8	64	5	99	3	7	6	100	3	7	99.5	7	115	5	5	8	114	5	5	114.5
A8	8	32	5	114	5	6	6	115	5	6	114.5	7	121	5	4	8	121	5	4	121
A9	8	32	5	113	5	6	6	113	5	6	113	7	121	5	4	8	121	5	4	121
A10	4	64	5	98	3	7	6	99	3	7	98.5	7	114	5	5	8	114	5	5	114
A11	2	84	5	78	0	0	6	80	0	0	79	7	91	0	0	8	90	0	0	90.5
A12	12	0	5	116	5	6	6	117	5	5.5	116.5	7	125	5	4	8	125	5	4	125
A13	5	54	5	112	5	6	6	112	5	6	112	7	121	5	4	8	121	5	4	121
A14	7	40	5	116	5	6	6	116	5	6	116	7	125	5	4	8	125	5	4	125
A15	10	16	5	118	5	5	6	119	5	5	118.5	7	125	5	4	8	126	5	4	125.5
A16	8	32	5	111	3	5	6	112	3	5	111.5	7	124	5	4	8	124	5	4	124
A17	11	8	5	118	5	6	6	116	5	6	117	7	125	5	4	8	125	5	4	125
A18	8	32	5	111	3	5	6	111	3	5	111	7	124	5	4	8	125	5	4	124.5
A19	8	32	5	116	5	6	6	115	5	6	115.5	7	125	5	4	8	126	5	4	125.5
A20	9	24	5	118	5	6	6	119	5	6	118.5	7	124	5	4	8	126	5	4	125
A21	11	8	5	117	5	6	6	118	5	6	117.5	7	124	5	4	8	126	5	4	125
A22	11	0	5	117	5	6	6	119	5	6	118	7	126	5	4	8	127	5	4	126.5
A23	11	0	5	119	5	6	6	119	5	6	119	7	126	5	4	8	127	5	4	126.5
A24	11	0	5	118	5	6	6	119	5	6	118.5	7	126	5	4	8	127	5	4	126.5
A25	11	9	5	119	5	6	6	119	5	6	119	7	126	5	4	8	128	5	4	127
A26	11	9	5	118	5	6	6	119	5	6	118.5	7	127	5	4	8	128	5	4	127.5
A27	11	9	5	120	5	6	6	118	5	6	119	7	127	5	4	8	128	5	4	127.5

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 5 & 6	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 7 & 8
A28	10	9	5	114	5	6	6	114	5	6	114	7	127	5	4	8	128	5	4	127.5
A29	10	0	5	115	5	6	6	116	5	6	115.5	7	124	5	4	8	126	5	4	125
A30	10	0	5	112	5	6	6	112	5	6.5	112	7	125	5	4	8	126	5	4	125.5
A31	10	0	5	111	5	6	6	112	5	6.5	111.5	7	125	5	4	8	127	5	4	126
S1	9	18	5	111	5	6	6	112	5	6.5	111.5	7	126	5	4	8	127	5	4	126.5
S2	2	81	5	90	0	0	6	90	0	0	90	7	109	5	6	8	110	5	5.5	109.5
S3	2	81	5	90	0	0	6	89	0	0	89.5	7	108	5	6	8	110	5	5.5	109
S4	3	72	5	85	0	0	6	86	0	0	85.5	7	91	0	0	8	93	0	0	92
S5	4	63	5	90	0	0	6	90	0	0	90	7	106	3	3.5	8	105	3	3.5	105.5
S6	2	82	5	89	0	0	6	92	0	0	90.5	7	104	3	3.5	8	106	3	3.5	105
S7	2	82	5	89	0	0	6	89	0	0	89	7	107	5	6	8	108	5	6	107.5
S8	1	91	5	80	0	0	6	81	0	0	80.5	7	89	0	0	8	90	0	0	89.5
S9	1	91	5	85	0	0	6	86	0	0	85.5	7	98	3	6	8	98	3	6	98
S10	0	100	5	70	0	0	6	71	0	0	70.5	7	81	0	0	8	81	0	0	81
S11	11	0	5	104	3	5	6	107	3	5	105.5	7	120	3	3.5	8	121	3	3.5	120.5
S12	10	9	5	101	3	5	6	103	3	5	102	7	121	3	3.5	8	122	3	3.5	121.5
S13	10	9	5	101	3	5	6	102	3	5	101.5	7	121	3	3.5	8	122	3	3.5	121.5
S14	5	54	5	82	0	0	6	85	0	0	83.5	7	109	3	4	8	110	3	4	109.5
S15	5	54	5	85	0	0	6	88	0	0	86.5	7	110	3	4	8	111	3	4	110.5
S16	3	81	5	75	0	0	6	75	0	0	75	7	100	3	4.5	8	101	3	4.5	100.5
S17	2	81	5	70	0	0	6	72	0	0	71	7	92	0	0	8	95	0	0	93.5
S18	4	63	5	88	0	0	6	89	0	0	88.5	7	115	3	4	8	116	3	4	115.5
S19	11	0	5	100	3	6	6	100	3	6	100	7	119	3	4	8	120	3	4	119.5
S20	6.5	40	5	96	0	0	6	98	0	0	97	7	115	3	4	8	117	3	4	116
S21	8	27	5	99	0	0	6	100	0	0	99.5	7	117	3	4	8	119	3	4	118
S22	5	54	5	94	0	0	6	94	0	0	94	7	110	3	4.5	8	111	3	4	110.5
S23	10	9	5	99	0	0	6	100	0	0	99.5	7	118	3	4	8	119	3	4	118.5
S24	10	9	5	100	3	6	6	101	3	6	100.5	7	118	3	4	8	119	3	4	118.5
S25	10	9	5	101	3	6	6	101	3	6	101	7	119	3	4	8	120	3	4	119.5
S26	10	9	5	103	3	6	6	104	3	6	103.5	7	118	3	4	8	119	3	4	118.5
S27	10	9	5	101	3	6	6	101	3	6	101	7	118	3	4	8	119	3	4	118.5
S28	10	9	5	103	3	6	6	104	3	6	103.5	7	119	3	4	8	119	3	4	119
S29	10	9	5	103	3	6	6	105	3	6	104	7	119	3	4	8	119	3	4	119
S30	9	18	5	100	3	6	6	101	3	6	100.5	7	116	3	4	8	118	3	4	117
O1	2	80	5	90	0	0	6	90	0	0	90	7	98	0	0	8	99	0	0	98.5
O2	2	80	5	89	0	0	6	90	0	0	89.5	7	98	0	0	8	99	0	0	98.5
O3	2	80	5	92	0	0	6	91	0	0	91.5	7	98	0	0	8	98	0	0	98
O4	10	0	5	103	3	6	6	104	0	0	103.5	7	118	3	5	8	118	3	5	118
O5	6	40	5	101	0	0	6	100	0	0	100.5	7	116	3	5	8	115	3	5	115.5
O6	6	40	5	0	0	0	6	100	0	0	50	7	114	3	5	8	115	3	5	114.5
O7	10	0	5	0	0	0	6	100	0	0	50	7	118	3	5	8	118	3	5	118
O8	8	20	5	0	0	0	6	99	0	0	49.5	7	116	3	5	8	117	3	5	116.5
O9	10	0	5	0	0	0	6	100	0	0	50	7	118	3	5	8	117	3	5	117.5
O10	10	0	5	0	0	0	6	98	0	0	49	7	117	3	5	8	118	3	5	117.5

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 5 & 6	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 7 & 8
O11	7	30	5	0	0	0	6	94	0	0	47	7	114	3	5	8	116	3	5	115
O12	10	0	5	0	0	0	6	96	0	0	48	7	114	3	5	8	114	3	5	114
O13	6	40	5	95	0	0	6	95	0	0	95	7	110	3	5	8	111	3	5	110.5
O14	4	60	5	96	0	0	6	95	0	0	95.5	7	110	3	5	8	110	3	5	110
O15	6	40	5	95	0	0	6	95	0	0	95	7	109	3	5	8	110	3	5	109.5
O16	6	40	5	92	0	0	6	94	0	0	93	7	106	0	0	8	106	3	6	106
O17	5	50	5	92	0	0	6	94	0	0	93	7	102	0	0	8	101	0	0	101.5
O18	8	20	5	100	0	0	6	101	0	0	100.5	7	110	3	5	8	111	3	5	110.5
O19	9	10	5	100	0	0	6	101	0	0	100.5	7	111	3	5	8	112	3	5	111.5
O20	8	20	5	100	0	0	6	99	0	0	99.5	7	110	3	5	8	110	3	5	110
O21	9	0	5	101	0	0	6	102	0	0	101.5	7	115	3	5	8	116	3	5	115.5
O22	6	33	5	100	0	0	6	103	0	0	101.5	7	115	3	5	8	116	3	5	115.5
O23	9	0	5	101	0	0	6	101	0	0	101	7	115	3	5	8	115	3	5	115
O24	4	55	5	92	0	0	6	93	0	0	92.5	7	110	3	5	8	111	3	5	110.5
O25	8	11	5	100	0	0	6	101	0	0	100.5	7	114	3	5	8	115	3	5	114.5
O26	9	0	5	100	0	0	6	105	0	0	102.5	7	111	3	5	8	112	3	5	111.5
O27	9	0	5	99	0	0	6	102	0	0	100.5	7	114	3	5	8	113	3	5	113.5
O28	9	0	5	99	0	0	6	100	0	0	99.5	7	114	3	5	8	115	3	5	114.5
O29	8	11	5	98	0	0	6	100	0	0	99	7	114	3	5	8	115	3	5	114.5
O30	9	0	5	98	0	0	6	100	0	0	99	7	111	3	5	8	111	3	5	111
O31	8.5	7	5	95	0	0	6	97	0	0	96	7	108	3	5	8	109	3	5	108.5
N1	8.5	6	5	97	0	0	6	98	0	0	97.5	7	106	3	5.5	8	107	3	5	106.5
N2	8	11	5	97	0	0	6	97	0	0	97	7	106	3	5.5	8	107	3	5	106.5
N3	8	11	5	96	0	0	6	97	0	0	96.5	7	105	3	5.5	8	106	3	5.5	105.5
N4	8	11	5	96	0	0	6	97	0	0	96.5	7	101	3	6	8	101	3	6	101
N5	4	55	5	81	0	0	6	83	0	0	82	7	98	0	0	8	95	0	0	96.5
N6	8	11	5	94	0	0	6	95	0	0	94.5	7	104	3	6	8	105	3	6	104.5
N7	8	11	5	95	0	0	6	95	0	0	95	7	104	3	6	8	104	3	6	104
N8	9	0	5	94	0	0	6	95	0	0	94.5	7	100	3	6	8	101	3	6	100.5
N9	8	0	5	94	0	0	6	95	0	0	94.5	7	100	0	0	8	100	0	0	100
N10	8	0	5	94	0	0	6	95	0	0	94.5	7	100	0	0	8	100	0	0	100
N11	8	0	5	94	0	0	6	95	0	0	94.5	7	100	0	0	8	101	0	0	100.5
N12	8	0	5	95	0	0	6	95	0	0	95	7	101	0	0	8	102	0	0	101.5
N13	8	0	5	93	0	0	6	94	0	0	93.5	7	102	0	0	8	103	0	0	102.5
N14	8	0	5	90	0	0	6	91	0	0	90.5	7	103	0	0	8	103	0	0	103
N15	8	0	5	90	0	0	6	91	0	0	90.5	7	102	0	0	8	103	0	0	102.5
N16	2	72	5	46	0	0	6	44	0	0	45	7	52	0	0	8	52	0	0	52
N17	8	0	5	86	0	0	6	86	0	0	86	7	95	0	0	8	96	0	0	95.5
N18	3	60	5	58	0	0	6	58	0	0	58	7	62	0	0	8	62	0	0	62
N19	4.5	42	5	62	0	0	6	62	0	0	62	7	70	0	0	8	71	0	0	70.5
N20	2.5	66	5	51	0	0	6	50	0	0	50.5	7	59	0	0	8	59	0	0	59
N21	2.5	66	5	45	0	0	6	42	0	0	43.5	7	57	0	0	8	58	0	0	57.5
N22	2	70	5	47	0	0	6	47	0	0	47	7	51	0	0	8	52	0	0	51.5
N23	7	0	5	83	0	0	6	84	0	0	83.5	7	90	0	0	8	91	0	0	90.5

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 5 & 6	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 7 & 8
N24	7	0	5	83	0	0	6	81	0	0	82	7	90	0	0	8	90	0	0	90
N25	7	0	5	84	0	0	6	84	0	0	84	7	91	0	0	8	91	0	0	91
N26	7	0	5	84	0	0	6	80	0	0	82	7	87	0	0	8	88	0	0	87.5
N27	7	0	5	80	0	0	6	80	0	0	80	7	88	0	0	8	89	0	0	88.5
N28	7	0	5	74	0	0	6	74	0	0	74	7	84	0	0	8	85	0	0	84.5
N29	5	28	5	73	0	0	6	72	0	0	72.5	7	76	0	0	8	76	0	0	76
N30	7	0	5	74	0	0	6	74	0	0	74	7	83	0	0	8	85	0	0	84
D1	3	56	5	36	0	0	6	35	0	0	35.5	7	50	0	0	8	51	0	0	50.5
D2	3	56	5	36	0	0	6	36	0	0	36	7	50	0	0	8	51	0	0	50.5
D3	4	42	5	68	0	0	6	68	0	0	68	7	78	0	0	8	79	0	0	78.5
D4	1	84	5	30	0	0	6	31	0	0	30.5	7	35	0	0	8	36	0	0	35.5
D5	5	28	5	62	0	0	6	63	0	0	62.5	7	69	0	0	8	69	0	0	69
D6	6	14	5	62	0	0	6	61	0	0	61.5	7	69	0	0	8	69	0	0	69
D7	3	56	5	48	0	0	6	48	0	0	48	7	52	0	0	8	52	0	0	52
D8	7	0	5	63	0	0	6	64	0	0	63.5	7	65	0	0	8	66	0	0	65.5
D9	7	0	5	62	0	0	6	63	0	0	62.5	7	64	0	0	8	65	0	0	64.5
D10	0	0	5	0	0	0	6	0	0	0	0	7	0	0	0	8	0	0	0	0

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 9, 10, 11
J1	10.5	8	9	105	1	2	10	105	1	2	11	104	1	2	104.7
J2	10	12	9	110	1	2	10	109	1	2	11	108	1	2	109.0
J3	9.5	16	9	105	1	2	10	104	1	2	11	105	1	2	104.7
J4	4.5	60	9	110	1	2	10	105	1	2	11	108	1	2	107.7
J5	4	64	9	108	1	2	10	104	1	2	11	105	1	2	105.7
J6	4	64	9	108	1	2	10	106	1	2	11	106	1	2	106.7
J7	5	56	9	110	1	2	10	111	1	2	11	110	1	2	110.3
J8	5	56	9	107	1	2	10	108	1	2	11	107	1	2	107.3
J9	3	76	9	85	1	0	10	87	1	0	11	88	1	0	86.7
J10	6.5	44	9	105	1	2	10	108	1	2	11	106	1	2	106.3
J11	2	84	9	84	3	0	10	83	3	0	11	85	3	0	84.0
J12	6	50	9	110	3	3.5	10	111	3	3.5	11	112	3	3	111.0
J13	6	50	9	109	3	3.5	10	110	3	3.5	11	111	3	3	110.0
J14	5.5	44	9	93	3	0	10	94	3	0	11	94	3	0	93.7
J15	6	50	9	100	3	4.5	10	100	3	4.5	11	104	3	4	101.3
J16	10	16	9	102	3	3.5	10	105	3	3.5	11	105	3	3.5	104.0
J17	10	16	9	106	3	3.5	10	105	3	3.5	11	106	3	3.5	105.7
J18	10	16	9	109	3	3.5	10	106	3	3.5	11	106	3	3.5	107.0
J19	10	16	9	109	3	3.5	10	107	3	3.5	11	106	3	3.5	107.3
J20	12	0	9	110	3	3.5	10	109	3	3.5	11	108	3	3.5	109.0
J21	5.5	66	9	88	3	0	10	90	3	0	11	90	3	0	89.3
J22	3	82	9	85	3	0	10	81	3	0	11	84	3	0	83.3
J23	8	32	9	118	3	3	10	117	3	3	11	119	3	3	118.0
J24	4	64	9	103	3	3.5	10	103	3	4	11	104	3	4	103.3
J25	10	16	9	118	3	3	10	116	3	3	11	118	3	3	117.3
J26	7.5	44	9	119	3	3	10	118	3	3	11	117	3	3	118.0
J27	6	50	9	115	3	3	10	116	3	3	11	116	3	3	115.7
J28	8	32	9	115	3	3	10	118	3	3	11	118	3	3	117.0
J29	8	32	9	117	3	3	10	118	3	3	11	120	3	3	118.3
J30	6	50	9	113	3	3	10	116	3	3	11	115	3	3	114.7
JL1	8	32	9	120	3	3	10	121	3	3	11	120	3	3	120.3
JL2	3	72	9	110	3	4	10	108	3	4	11	108	3	4	108.7
JL3	4	64	9	112	3	3	10	112	3	3	11	111	3	3	111.7
JL4	6	50	9	118	3	3	10	116	3	3	11	121	3	3	118.3
JL5	8	32	9	121	3	3	10	124	3	3	11	122	3	3	122.3
JL6	10	16	9	124	3	3	10	124	3	3	11	125	3	3	124.3
JL7	12	0	9	124	5	4	10	124	5	4	11	124	5	4	124.0
JL8	10	16	9	120	5	4	10	121	5	4	11	121	5	4	120.7
JL9	6	50	9	118	5	4.5	10	119	5	4.5	11	119	5	4.5	118.7
JL10	2	84	9	55	0	0	10	55	0	0	11	58	0	0	56.0
JL11	4	64	9	117	5	4.5	10	117	5	4.5	11	119	5	4.5	117.7
JL12	8	32	9	122	5	4	10	121	5	4	11	123	5	4	122.0
JL13	8	32	9	122	5	4	10	121	5	4	11	123	5	4	122.0
JL14	6	50	9	122	5	4	10	122	5	4	11	123	5	4	122.3

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 9, 10, 11
JL15	4	64	9	100	0	0	10	102	0	0	11	103	0	0	101.7
JL16	2	80	9	55	0	0	10	55	0	0	11	59	0	0	56.3
JL17	6	50	9	122	5	4	10	122	5	4	11	122	5	4	122.0
JL18	8	32	9	125	5	4	10	125	5	4	11	125	5	4	125.0
JL19	8	32	9	124	5	4	10	122	5	4	11	125	5	4	123.7
JL20	12	0	9	126	5	4	10	126	5	4	11	125	5	4	125.7
JL21	6	50	9	109	5	6	10	109	5	5	11	110	5	5	109.3
JL22	6	50	9	108	5	6	10	110	5	5	11	111	5	5	109.7
JL23	10	16	9	122	5	4	10	123	5	4	11	125	5	4	123.3
JL24	10	16	9	122	5	4	10	123	5	4	11	125	5	4	123.3
JL25	9	24	9	120	5	4	10	119	5	4	11	121	5	4	120.0
JL26	8	32	9	119	5	4	10	120	5	4	11	120	5	4	119.7
JL27	7	40	9	119	5	4	10	120	5	4	11	119	5	4	119.3
JL28	10	16	9	121	5	4	10	122	5	4	11	123	5	4	122.0
JL29	7	40	9	119	5	4	10	120	5	4	11	120	5	4	119.7
JL30	3	72	9	108	5	6	10	107	5	6	11	110	5	5	108.3
JL31	10	16	9	122	5	4	10	122	5	4	11	122	5	4	122.0
A1	10	16	9	122	5	4	10	124	5	4	11	124	5	4	123.3
A2	10	16	9	123	5	4	10	123	5	4	11	123	5	4	123.0
A3	8	32	9	108	5	5	10	110	5	5	11	109	5	5	109.0
A4	4	64	9	108	5	5	10	108	5	5	11	109	5	5	108.3
A5	7	40	9	124	5	4	10	125	5	4	11	125	5	4	124.7
A6	1	92	9	0	0	0	10	0	0	0	11	0	0	0	0.0
A7	8	64	9	111	5	5	10	112	5	5	11	113	5	5	112.0
A8	8	32	9	121	5	4	10	121	5	4	11	122	5	4	121.3
A9	8	32	9	122	5	4	10	123	5	4	11	123	5	4	122.7
A10	4	64	9	110	5	5	10	110	5	5	11	112	5	5	110.7
A11	2	84	9	87	0	0	10	88	0	0	11	89	0	0	88.0
A12	12	0	9	120	5	4	10	120	5	4	11	120	5	4	120.0
A13	5	54	9	121	5	4	10	122	5	4	11	121	5	4	121.3
A14	7	40	9	124	5	4	10	125	5	4	11	126	5	4	125.0
A15	10	16	9	123	5	4	10	122	5	4	11	123	5	4	122.7
A16	8	32	9	124	5	4	10	125	5	4	11	124	5	4	124.3
A17	11	8	9	124	5	4	10	124	5	4	11	125	5	4	124.3
A18	8	32	9	124	5	4	10	124	5	4	11	124	5	4	124.0
A19	8	32	9	124	5	4	10	125	5	4	11	124	5	4	124.3
A20	9	24	9	122	5	4	10	122	5	4	11	123	5	4	122.3
A21	11	8	9	124	5	4	10	126	5	4	11	124	5	4	124.7
A22	11	0	9	124	5	4	10	125	5	4	11	125	5	4	124.7
A23	11	0	9	126	5	4	10	125	5	4	11	126	5	4	125.7
A24	11	0	9	125	5	4	10	125	5	4	11	125	5	4	125.0
A25	11	9	9	124	5	4	10	125	5	4	11	125	5	4	124.7
A26	11	9	9	125	5	4	10	126	5	4	11	126	5	4	125.7
A27	11	9	9	126	5	4	10	127	5	4	11	127	5	4	126.7

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 9, 10, 11
A28	10	9	9	125	5	4	10	125	5	4	11	125	5	4	125.0
A29	10	0	9	124	5	4	10	126	5	4	11	126	5	4	125.3
A30	10	0	9	123	5	4	10	124	5	4	11	125	5	4	124.0
A31	10	0	9	123	5	4	10	124	5	4	11	124	5	4	123.7
S1	9	18	9	124	5	4	10	124	5	4	11	125	5	4	124.3
S2	2	81	9	109	5	5.5	10	110	5	5.5	11	110	5	5	109.7
S3	2	81	9	109	5	5.5	10	108	5	5.5	11	110	5	5	109.0
S4	3	72	9	90	0	0	10	91	0	0	11	93	0	0	91.3
S5	4	63	9	99	0	0	10	100	0	0	11	100	0	0	99.7
S6	2	82	9	104	3	4	10	104	3	4	11	103	3	4	103.7
S7	2	82	9	106	3	4	10	106	3	4	11	107	3	4	106.3
S8	1	91	9	88	0	0	10	89	0	0	11	89	0	0	88.7
S9	1	91	9	95	0	0	10	94	0	0	11	96	0	0	95.0
S10	0	100	9	80	0	0	10	80	0	0	11	80	0	0	80.0
S11	11	0	9	118	3	4	10	118	3	3.5	1	116	3	3.5	117.3
S12	10	9	9	118	3	3.5	10	118	3	3.5	11	116	3	3.5	117.3
S13	10	9	9	118	3	3.5	10	117	3	3.5	11	117	3	3.5	117.3
S14	5	54	9	105	3	4	10	104	3	4	11	104	3	4	104.3
S15	5	54	9	107	3	4	10	107	3	4	11	106	3	4	106.7
S16	3	81	9	100	3	4.5	10	101	3	4.5	11	100	3	5	100.3
S17	2	81	9	89	0	0	10	90	0	0	11	89	0	0	89.3
S18	4	63	9	113	3	4	10	115	3	4	11	115	3	4	114.3
S19	11	0	9	115	3	4	10	116	3	4	11	116	3	4	115.7
S20	6.5	40	9	115	3	4	10	115	3	4	11	116	3	4	115.3
S21	8	27	9	115	3	4	20	116	3	4	11	116	3	4	115.7
S22	5	54	9	110	3	4.5	10	109	3	4.5	11	110	3	4	109.7
S23	10	9	9	115	3	4	10	116	3	4	11	117	3	4	116.0
S24	10	9	9	117	3	4	10	118	3	4	11	118	3	4	117.7
S25	10	9	9	112	3	4	10	113	3	4	11	114	3	4	113.0
S26	10	9	9	114	3	4	10	115	3	4	11	116	3	4	115.0
S27	10	9	9	114	3	4	10	114	3	4	11	116	3	4	114.7
S28	10	9	9	114	3	4	10	115	3	4	11	116	3	4	115.0
S29	10	9	9	115	3	4	10	116	3	4	11	116	3	4	115.7
S30	9	18	9	113	3	4	10	114	3	4	11	116	3	4	114.3
O1	2	80	9	95	0	0	10	91	0	0	11	95	0	0	93.7
O2	2	80	9	95	0	0	10	96	0	0	11	94	0	0	95.0
O3	2	80	9	96	0	0	10	96	0	0	11	96	0	0	96.0
O4	10	0	9	113	3	5	10	114	3	5	11	115	3	5	114.0
O5	6	40	9	112	3	5	20	115	3	5	11	113	3	5	113.3
O6	6	40	9	111	3	5	10	111	3	5	11	112	3	5	111.3
O7	10	0	9	114	3	5	10	115	3	5	11	114	3	5	114.3
O8	8	20	9	114	3	5	10	114	3	5	11	116	3	5	114.7
O9	10	0	9	114	3	5	10	116	3	5	11	116	3	5	115.3
O10	10	0	9	114	3	6	20	112	3	6	11	112	3	6	112.7

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 9, 10, 11
O11	7	30	9	111	3	6	10	112	3	6	11	113	3	6	112.0
O12	10	0	9	104	0	0	10	105	0	0	11	104	0	0	104.3
O13	6	40	9	105	0	0	10	105	0	0	11	105	0	0	105.0
O14	4	60	9	103	0	0	10	104	0	0	11	104	0	0	103.7
O15	6	40	9	100	0	0	10	100	0	0	11	100	0	0	100.0
O16	6	40	9	100	0	0	10	101	0	0	11	100	0	0	100.3
O17	5	50	9	99	0	0	10	100	0	0	11	99	0	0	99.3
O18	8	20	9	111	3	6	10	109	3	6	11	110	3	6	110.0
O19	9	10	9	109	3	6	10	108	3	6	11	109	3	6	108.7
O20	8	20	9	107	3	6	10	107	3	6	11	108	3	6	107.3
O21	9	0	9	114	3	6	10	114	3	6	11	114	3	6	114.0
O22	6	33	9	113	3	6	10	114	3	6	11	114	3	6	113.7
O23	9	0	9	111	3	6	10	111	3	6	11	112	3	6	111.3
O24	4	55	9	109	3	7	10	110	3	6	11	109	3	6	109.3
O25	8	11	9	113	3	6	10	113	3	6	11	113	3	6	113.0
O26	9	0	9	111	3	6	10	110	3	6	11	112	3	6	111.0
O27	9	0	9	111	3	6	10	112	3	6	11	112	3	6	111.7
O28	9	0	9	109	3	6	20	109	3	6	11	110	3	6	109.3
O29	8	11	9	107	3	6	10	108	3	6	11	108	3	6	107.7
O30	9	0	9	106	3	6	10	106	3	6	11	106	3	6	106.0
O31	8.5	7	9	100	0	0	10	101	0	0	11	100	0	0	100.3
N1	8.5	6	9	103	0	0	10	101	0	0	11	101	0	0	101.7
N2	8	11	9	104	3	6	10	105	0	0	11	104	0	0	104.3
N3	8	11	9	102	0	0	10	103	0	0	11	103	0	0	102.7
N4	8	11	9	100	3	6	10	101	0	0	11	101	0	0	100.7
N5	4	55	9	95	0	0	20	95	0	0	11	95	0	0	95.0
N6	8	11	9	98	0	0	10	100	0	0	11	101	0	0	99.7
N7	8	11	9	99	0	0	10	100	0	0	11	100	0	0	99.7
N8	9	0	9	99	0	0	10	99	0	0	11	100	0	0	99.3
N9	8	0	9	98	0	0	10	97	0	0	11	99	0	0	98.0
N10	8	0	9	98	0	0	10	97	0	0	11	99	0	0	98.0
N11	8	0	9	98	0	0	10	97	0	0	11	98	0	0	97.7
N12	8	0	9	98	0	0	10	95	0	0	11	98	0	0	97.0
N13	8	0	9	98	0	0	10	97	0	0	11	98	0	0	97.7
N14	8	0	9	98	0	0	10	97	0	0	11	96	0	0	97.0
N15	8	0	9	97	0	0	10	95	0	0	11	95	0	0	95.7
N16	2	72	9	50	0	0	10	49	0	0	11	50	0	0	49.7
N17	8	0	9	93	0	0	10	95	0	0	11	94	0	0	94.0
N18	3	60	9	60	0	0	10	61	0	0	11	61	0	0	60.7
N19	4.5	42	9	69	0	0	10	70	0	0	11	70	0	0	69.7
N20	2.5	66	9	56	0	0	10	56	0	0	11	55	0	0	55.7
N21	2.5	66	9	55	0	0	10	55	0	0	11	55	0	0	55.0
N22	2	70	9	50	0	0	10	51	0	0	11	50	0	0	50.3
N23	7	0	9	86	0	0	10	87	0	0	11	87	0	0	86.7

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 9, 10, 11
N24	7	0	9	85	0	0	10	86	0	0	11	87	0	0	86.0
N25	7	0	9	87	0	0	10	85	0	0	11	86	0	0	86.0
N26	7	0	9	85	0	0	10	85	0	0	11	85	0	0	85.0
N27	7	0	9	83	0	0	10	82	0	0	11	85	0	0	83.3
N28	7	0	9	81	0	0	10	82	0	0	11	81	0	0	81.3
N29	5	28	9	81	0	0	10	80	0	0	11	83	0	0	81.3
N30	7	0	9	78	0	0	10	78	0	0	11	79	0	0	78.3
D1	3	56	9	39	0	0	10	40	0	0	11	39	0	0	39.3
D2	3	56	9	38	0	0	10	38	0	0	11	39	0	0	38.3
D3	4	42	9	76	0	0	10	76	0	0	11	75	0	0	75.7
D4	1	84	9	32	0	0	10	33	0	0	11	33	0	0	32.7
D5	5	28	9	65	0	0	10	64	0	0	11	65	0	0	64.7
D6	6	14	9	66	0	0	10	66	0	0	11	66	0	0	66.0
D7	3	56	9	50	0	0	10	51	0	0	11	50	0	0	50.3
D8	7	0	9	65	0	0	10	66	0	0	11	66	0	0	65.7
D9	7	0	9	64	0	0	10	65	0	0	11	66	0	0	65.0
D10	0	0	9	0	0	0	10	0	0	0	11	0	0	0	0.0

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 12, 13, 14
J1	10.5	8	12	124	1	1.5	13	125	1	1.5	14	125	1	1.5	124.7
J2	10	12	12	125	1	1.5	13	125	1	1.5	14	126	1	1.5	125.3
J3	9.5	16	12	125	1	1.5	13	125	1	1.5	14	125	1	1.5	125.0
J4	4.5	60	12	126	1	1.5	13	126	1	1.5	14	128	1	1.5	126.7
J5	4	64	12	125	1	1.5	13	126	1	1.5	14	126	1	1.5	125.7
J6	4	64	12	126	1	1.5	13	127	1	1.5	14	128	1	1.5	127.0
J7	5	56	12	128	1	1.5	13	126	1	1.5	14	130	1	1.5	128.0
J8	5	56	12	128	1	1.5	13	128	1	1.5	14	130	1	1.5	128.7
J9	3	76	12	109	1	2	13	109	1	2	14	114	1	2	110.7
J10	6.5	44	12	128	1	1.5	13	130	1	2	14	130	1	1.5	129.3
J11	2	84	12	105	3	2	13	105	3	2	14	107	3	2	105.7
J12	6	50	12	128	3	2	13	127	3	2	14	130	3	2	128.3
J13	6	50	12	128	3	2	13	128	3	2	14	130	3	2	128.7
J14	5.5	44	12	129	3	2	13	128	3	2	14	130	3	2	129.0
J15	6	50	12	130	3	2	13	130	3	2	14	131	3	2	130.3
J16	10	16	12	131	3	2	13	131	3	2	14	131	3	2	131.0
J17	10	16	12	131	3	2	13	130	3	2	14	132	3	2	131.0
J18	10	16	12	130	3	2	13	130	3	2	14	131	3	2	130.3
J19	10	16	12	130	3	2	13	131	3	2	14	134	3	2	131.7
J20	12	0	12	129	3	2	13	132	3	2	14	136	3	2	132.3
J21	5.5	66	12	108	3	2	13	110	3	2	14	111	3	2	109.7
J22	3	82	12	103	3	3	13	106	3	3	14	106	3	3	105.0
J23	8	32	12	129	3	2	13	129	3	2	14	131	3	2	129.7
J24	4	64	12	120	3	2	13	120	3	2	14	121	3	2	120.3
J25	10	16	12	129	3	2	13	131	3	2	14	135	3	2	131.7
J26	7.5	44	12	129	3	2	13	129	3	2	14	133	3	2	130.3
J27	6	50	12	128	3	2	13	128	3	2	14	130	3	2	128.7
J28	8	32	12	129	3	2	13	131	3	2	14	135	3	2	131.7
J29	8	32	12	129	3	2	13	130	3	2	14	133	3	2	130.7
J30	6	50	12	128	3	2	13	128	3	2	14	131	3	2	129.0
JL1	8	32	12	129	3	2	13	130	3	2	14	131	3	2	130.0
JL2	3	72	12	120	3	2	13	121	3	2	14	126	3	2	122.3
JL3	4	64	12	128	3	2	13	129	3	2	14	131	3	2	129.3
JL4	6	50	12	129	3	2	13	129	3	2	14	130	3	2	129.3
JL5	8	32	12	129	3	2	13	131	3	2	14	132	3	2	130.7
JL6	10	16	12	130	3	2	13	133	3	2	14	135	3	2	132.7
JL7	12	0	12	135	5	3	13	136	5	3	14	136	5	3	135.7
JL8	10	16	12	134	5	3	13	135	5	3	14	135	5	3	134.7
JL9	6	50	12	131	5	3	13	131	5	3	14	132	5	3	131.3
JL10	2	84	12	98	0	0	13	99	0	0	14	100	0	0	99.0
JL11	4	64	12	129	5	3	13	130	5	3	14	131	5	3	130.0
JL12	8	32	12	133	5	3	13	133	5	3	14	135	5	3	133.7
JL13	8	32	12	135	5	3	13	136	5	3	14	136	5	3	135.7
JL14	6	50	12	130	5	3	13	131	5	3	14	131	5	3	130.7

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 12, 13, 14
JL15	4	64	12	128	5	3	13	129	5	3	14	130	5	3	129.0
JL16	2	80	12	98	0	0	13	98	0	0	14	100	0	0	98.7
JL17	6	50	12	135	5	3	13	135	5	3	14	136	5	3	135.3
JL18	8	32	12	135	5	3	13	135	5	3	14	136	5	3	135.3
JL19	8	32	12	135	5	3	13	136	5	3	14	135	5	3	135.3
JL20	12	0	12	136	5	3	13	136	5	3	14	136	5	3	136.0
JL21	6	50	12	130	5	3	13	133	5	3	14	130	5	3	131.0
JL22	6	50	12	129	5	3	13	134	5	3	14	133	5	3	132.0
JL23	10	16	12	135	5	3	13	136	5	3	14	136	5	3	135.7
JL24	10	16	12	135	5	3	13	136	5	3	14	135	5	3	135.3
JL25	9	24	12	135	5	3	13	136	5	3	14	136	5	3	135.7
JL26	8	32	12	135	5	3	13	135	5	3	14	133	5	3	134.3
JL27	7	40	12	135	5	3	13	133	5	3	14	135	5	3	134.3
JL28	10	16	12	133	5	3	13	136	5	3	14	136	5	3	135.0
JL29	7	40	12	135	5	3	13	135	5	3	14	136	5	3	135.3
JL30	3	72	12	126	5	3	13	127	5	3	14	129	5	3	127.3
JL31	10	16	12	133	5	3	13	136	5	3	14	135	5	3	134.7
A1	10	16	12	135	5	3	13	136	5	3	14	136	5	3	135.7
A2	10	16	12	135	5	3	13	136	5	3	14	135	5	3	135.3
A3	8	32	12	129	5	3	13	131	5	3	14	130	5	3	130.0
A4	4	64	12	124	5	3	13	129	5	3	14	130	5	3	127.7
A5	7	40	12	136	5	3	13	136	5	3	14	136	5	3	136.0
A6	1	92	12	0	0	3	13	0	0	0	14	0	0	0	0.0
A7	8	64	12	125	5	3	13	129	5	3	14	127	5	3	127.0
A8	8	32	12	131	5	3	13	133	5	3	14	131	5	3	131.7
A9	8	32	12	132	5	3	13	133	5	3	14	133	5	3	132.7
A10	4	64	12	125	5	3	13	128	5	3	14	126	5	3	126.3
A11	2	84	12	110	5	3.5	13	114	5	3.5	14	113	5	3.5	112.3
A12	12	0	12	135	5	3	13	137	5	3	14	135	5	3	135.7
A13	5	54	12	132	5	3	13	133	5	3	14	133	5	3	132.7
A14	7	40	12	135	5	2.5	13	135	5	2.5	14	134	5	2.5	134.7
A15	10	16	12	136	5	2.5	13	137	5	2.5	14	135	5	2.5	136.0
A16	8	32	12	136	5	2.5	13	137	5	2.5	14	136	5	2.5	136.3
A17	11	8	12	136	5	2.5	13	137	5	2.5	14	136	5	2.5	136.3
A18	8	32	12	134	5	2.5	13	136	5	2.5	14	135	5	2.5	135.0
A19	8	32	12	135	5	2.5	13	136	5	2.5	14	136	5	2.5	135.7
A20	9	24	12	134	5	2.5	13	134	5	2.5	14	135	5	2.5	134.3
A21	11	8	12	136	5	2.5	13	137	5	2.5	14	137	5	2.5	136.7
A22	11	0	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0
A23	11	0	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0
A24	11	0	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0
A25	11	9	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0
A26	11	9	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0
A27	11	9	12	137	5	2.5	13	137	5	2.5	14	137	5	2.5	137.0

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 12, 13, 14
A28	10	9	12	136	5	2.5	13	138	5	2.5	14	138	5	2.5	137.3
A29	10	0	12	136	5	2.5	13	137	5	2.5	14	137	5	2.5	136.7
A30	10	0	12	136	5	2.5	13	137	5	2.5	14	137	5	2.5	136.7
A31	10	0	12	136	5	2.5	13	137	5	2.5	14	137	5	2.5	136.7
S1	9	18	12	135	5	2.5	13	136	5	2.5	14	137	5	2.5	136.0
S2	2	81	12	120	5	3	13	121	5	3	14	122	5	3	121.0
S3	2	81	12	121	5	3	13	121	5	3	14	122	5	3	121.3
S4	3	72	12	110	5	3.5	13	109	5	3.5	14	111	5	3.5	110.0
S5	4	63	12	118	3	3	13	120	5	4	14	121	5	4	119.7
S6	2	82	12	110	3	3	13	111	3	3	14	112	3	3	111.0
S7	2	82	12	111	5	4	13	112	5	4	14	112	5	4	111.7
S8	1	91	12	103	3	3	13	105	3	3	14	106	3	3	104.7
S9	1	91	12	103	3	3	13	103	3	3	14	106	3	3	104.0
S10	0	100	12	90	3	4	13	91	3	4	14	91	3	4	90.7
S11	11	0	12	135	5	3	13	135	5	3	14	136	5	3	135.3
S12	10	9	12	135	5	3	13	137	5	3	14	135	5	3	135.7
S13	10	9	12	134	5	3	13	135	5	3	14	136	5	3	135.0
S14	5	54	12	129	5	3	13	130	5	3	14	130	5	3	129.7
S15	5	54	12	135	5	3	13	136	5	3	14	135	5	3	135.3
S16	3	81	12	126	5	3	13	128	5	3	14	127	5	3	127.0
S17	2	81	12	119	5	3	13	120	5	3	14	118	5	3	119.0
S18	4	63	12	128	5	3	13	130	5	3	14	130	5	3	129.3
S19	11	0	12	135	5	3	13	137	5	3	14	136	5	3	136.0
S20	6.5	40	12	135	5	3	13	135	5	3	14	135	5	3	135.0
S21	8	27	12	135	5	3	13	135	5	3	14	135	5	3	135.0
S22	5	54	12	133	5	3	13	135	5	3	14	136	5	3	134.7
S23	10	9	12	136	5	3	13	137	5	3	14	137	5	3	136.7
S24	10	9	12	136	5	3	13	137	5	3	14	137	5	3	136.7
S25	10	9	12	135	5	3	13	137	5	3	14	137	5	3	136.3
S26	10	9	12	136	5	3	13	137	5	3	14	136	5	3	136.3
S27	10	9	12	135	5	3	13	135	5	3	14	137	5	3	135.7
S28	10	9	12	135	5	3	13	136	5	3	14	137	5	3	136.0
S29	10	9	12	135	5	3	13	136	5	3	14	135	5	3	135.3
S30	9	18	12	136	5	3	13	136	5	3	14	137	5	3	136.3
O1	2	80	12	110	3	3	13	111	3	3	14	113	3	3	111.3
O2	2	80	12	112	3	3	13	111	3	3	14	112	3	3	111.7
O3	2	80	12	110	3	3	13	110	3	3	14	111	3	3	110.3
O4	10	0	12	135	5	3	13	134	5	3	14	135	5	3	134.7
O5	6	40	12	130	5	3	13	131	5	3	14	134	5	3	131.7
O6	6	40	12	130	5	3	13	131	5	3	14	130	5	3	130.3
O7	10	0	12	134	5	3	13	136	5	3	14	135	5	3	135.0
O8	8	20	12	134	5	3	13	136	5	3	14	136	5	3	135.3
O9	10	0	12	135	5	3	13	136	5	3	14	135	5	3	135.3
O10	10	0	12	134	5	3	13	136	5	3	14	136	5	3	135.3

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 12, 13, 14
O11	7	30	12	131	5	3	13	134	5	3	14	134	5	3	133.0
O12	10	0	12	135	5	3	13	135	5	3	14	136	5	3	135.3
O13	6	40	12	128	5	3	13	130	5	3	14	130	5	3	129.3
O14	4	60	12	117	5	3.5	13	120	5	3.5	14	120	5	3.5	119.0
O15	6	40	12	126	5	3	13	128	5	3	14	127	5	3	127.0
O16	6	40	12	126	5	3	13	128	5	3	14	129	5	3	127.7
O17	5	50	12	120	5	3.5	13	121	5	3.5	14	120	5	3.5	120.3
O18	8	20	12	132	5	3	13	135	5	3	14	135	5	3	134.0
O19	9	10	12	131	5	3	13	132	5	3	14	134	5	3	132.3
O20	8	20	12	131	5	3	13	135	5	3	14	135	5	3	133.7
O21	9	0	12	135	5	3	13	135	5	3	14	135	5	3	135.0
O22	6	33	12	124	5	3	13	133	5	3	14	134	5	3	130.3
O23	9	0	12	131	5	3	13	132	5	3	14	136	5	3	133.0
O24	4	55	12	122	5	3.5	13	123	5	3.5	14	125	5	3.5	123.3
O25	8	11	12	132	5	3	13	134	5	3	14	134	5	3	133.3
O26	9	0	12	132	5	3	13	134	5	3	14	135	5	3	133.7
O27	9	0	12	133	5	3	13	134	5	3	14	135	5	3	134.0
O28	9	0	12	132	5	3	13	134	5	3	14	135	5	3	133.7
O29	8	11	12	134	5	3	13	135	5	3	14	133	5	3	134.0
O30	9	0	12	134	5	3	13	135	5	3	14	136	5	3	135.0
O31	8.5	7	12	134	5	3	13	134	5	3	14	134	5	3	134.0
N1	8.5	6	12	133	5	3	13	133	5	3	14	134	5	3	133.3
N2	8	11	12	132	5	3	13	133	5	3	14	133	5	3	132.7
N3	8	11	12	133	5	3	13	134	5	3	14	134	5	3	133.7
N4	8	11	12	134	5	3	13	134	5	3	14	135	5	3	134.3
N5	4	55	12	134	5	3	13	135	5	3	14	135	5	3	134.7
N6	8	11	12	119	5	3.5	13	119	5	3.5	14	120	5	3.5	119.3
N7	8	11	12	134	5	3	13	135	5	3	14	135	5	3	134.7
N8	9	0	12	132	5	3	13	133	5	3	14	134	5	3	133.0
N9	8	0	12	133	5	3	13	134	5	3	14	135	5	3	134.0
N10	8	0	12	132	5	3	13	135	5	3	14	135	5	3	134.0
N11	8	0	12	135	5	3	13	135	5	3	14	135	5	3	135.0
N12	8	0	12	134	5	3	13	134	5	3	14	134	5	3	134.0
N13	8	0	12	134	5	3	13	136	5	3	14	135	5	3	135.0
N14	8	0	12	135	5	3	13	135	5	3	14	135	5	3	135.0
N15	8	0	12	134	5	3	13	135	5	3	14	135	5	3	134.7
N16	2	72	12	87	0	0	13	88	0	0	14	89	0	3	88.0
N17	8	0	12	130	5	3	13	131	5	3	14	132	5	3	131.0
N18	3	60	12	91	0	0	13	92	0	0	14	92	0	0	91.7
N19	4.5	42	12	96	3	3	13	97	3	3	14	99	3	3	97.3
N20	2.5	66	12	85	0	0	13	87	0	0	14	87	0	0	86.3
N21	2.5	66	12	87	0	0	13	88	0	0	14	87	0	0	87.3
N22	2	70	12	88	0	0	13	89	0	0	14	90	0	0	89.0
N23	7	0	12	121	3	3	13	123	3	3	14	121	3	3	121.7

DATE	Hrs Sunshine	% cloud cover	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	SBC #	max temp	load (L)	cooking time	average max temp 12, 13, 14
N24	7	0	12	121	3	3	13	121	3	3	14	123	3	3	121.7
N25	7	0	12	125	3	3	13	128	5	4	14	126	5	4	126.3
N26	7	0	12	122	5	4	13	125	5	4	14	125	5	4	124.0
N27	7	0	12	120	3	3	13	123	5	4	14	124	5	4	122.3
N28	7	0	12	121	5	4	13	123	5	4	14	124	5	4	122.7
N29	5	28	12	124	5	4	13	124	5	4	14	125	5	4	124.3
N30	7	0	12	122	5	4	13	124	5	4	14	125	5	4	123.7
D1	3	56	12	95	0	0	13	96	0	0	14	95	3	4	95.3
D2	3	56	12	98	3	3	13	96	0	0	14	98	3	3	97.3
D3	4	42	12	103	3	3	13	103	3	3	14	104	3	3	103.3
D4	1	84	12	69	0	0	13	70	0	0	14	72	0	0	70.3
D5	5	28	12	110	3	3	13	111	5	4	14	112	5	4	111.0
D6	6	14	12	110	3	3	13	112	5	4	14	112	5	4	111.3
D7	3	56	12	87	0	0	13	89	1	3	14	89	0	0	88.3
D8	7	0	12	115	3	3	13	115	5	4	14	115	5	4	115.0
D9	7	0	12	114	3	3	13	116	5	4	14	115	5	4	115.0
D10	0	0	12	0	0	0	13	0	0	0	14	0	0	0	0.0