INNOVATION IN SEABUCKTHORN PROCESSING TECHNOLOGIES IN LADAKH

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DECLARATION

This is to certify that the thesis entitled, "**Innovation in Seabuckthorn Processing Technologies In Ladakh**" submitted by **Mohd Ali,** Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal NehruUniversity, New Delhi – 110067, India, in partial fulfillment of the requirements for the award of the degree of **Master of Philosophy (M.Phil.)** is his original work and has not been previously submitted for any other Degree of this or any other University .

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CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.

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15th July, 2017 Mohd Ali

CONTENTS

ABBREVIATION

AYUSH	Ayurveda, Yoga, and Naturopathy, Unani, Siddha and Homeopathy
CAD	Computer Aided Design
DIHAR	Department of Industrial and High Altitude Research
DRDO	Defense Research Development Organization
FDI	Foreign Direct Investment
FRL	Field Research Laboratory
GDP	Gross Domestic Product
KMS	Potassium Metabisulphite
LAHDC	Ladakh Autonomous Hill Development Council
MOEF	Ministry of Environment and Forest
NGO	Non Governmental Organization
NSI	National System of Innovation
OECD	Organization of Economic cooperation and Development
R&D	Research and Development
RIS	Regional Innovation System
SCOT	Social Construction of Technology
SME	Small Medium Enterprises
SST	Social Shaping of Technology

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CHAPTER ONE

INTRODUCTION

1.1 Background and Motivation

Seabuckthorn is one of the economically important plants, which has received the attention of scientists, industrialist, academicians, and government bodies including common people worldwide in recent times (Beveridge *et al*., 1999). In India this plant occupies an area of 30,000 hectares most of which (11500 hectares) is in Ladakh (Singh et al., 2004) The people of Ladakh have been aware of health promoting effects of this plant since ages (Kaul and Ali, 2015). 'Amchi system of medicine'[1] which is quite prevalent in Ladakh utilises almost all parts of this plant. However little attention has been paid to translate the knowledge of Amchies into a sustainable industry. Although, Seabuckthorn has been used in medicinal formulations since ages but processing of Seabuckthorn for different product formation starts very recently.

Earlier Seabuckthorn was processed in Ladakh by cooperatives and households at small scale using simple tools[2] (Singh et al., 2012). But the scenario changes when Department of Industrial and High Altitude Research (DIHAR)[3] designed innovative technology. This new technology is patented and currently being used by DIHAR itself. The same patented technology was also given to the firms and cooperatives for berry processing (Stobdan et al., 2012). Thus there are different methods[4] for Seabuckthorn processing existed today in Ladakh. The present research gives an ample scope to undertake a comparative study of different methods used for berry processing in Ladakh, including the innovation[5] visible in these methods in terms of technique and technology.

[1] Amchi system of medicine is one of the centuries old medicinal systems and is the only alternative to formal system of medicine in Ladakh. Plant, animal derivatives are used in this system of medicine.

[2] Like commonly using pestle and mortar, pan, glass bottles and sieve

[3] DIHAR was established by Defense Research Development Organization (DRDO) in the year 1962, to carry out agro-climatic research in Cold Desert of Ladakh.

[4] Local and non-local methods of berry processing.

[5] One of the most accepted definition of innovation was propounded by Schumpeter (1975) who believes that innovation is far beyond in producing new products using new production methods. If a new market is open up in a region, also comes under the ambit of innovation.

Due to the less availability of research publications on berry processing in Ladakh it, we have relied more on field survey. According to Zhou et al. (1989) there are less number of publications written on Seabuckthorn processing globally. In literature most of the information is available on biochemical and botanical aspects of the plant. This gap in literature gives us research scope in the concerned research area.

1.2 Research objectives

In accordance with the research scope and motivation stated above, the objectives of the research are stated below.

1. To identify the key factors responsible for the beginning of Seabuckthorn processing in Ladakh and the different techniques and methods used in this regard.
2. To understand the correlation between Seabuckthorn processing and RIS, including the socio-cultural factors shaping the technology in Ladakh.

1.3 Research Questions

The broad research questions that this research effort is to seek answer of the following:

1. How Seabuckthorn processing activity begins and what are the factors which played key role in establishing Seabuckthorn processing industry in Ladakh region?
2. What are the different methods used by firms and cooperatives with respect to Seabuckthorn processing in Ladakh?
3. What are the stages of innovation at in Seabuckthorn processing? What is the pattern of its development?
4. What is the kind of linkages found among the different stakeholders in the industry? To what extend the innovation taking place are related to the regions, knowledge innovation and different actors related to the industry?
5. How innovative technology in Seabuckthorn processing has been shaped by socio-cultural factors and what is the people's response towards this new technology in Ladakh?

To answer these questions both primary and secondary data have been collected. Research Scientists at DRDO, firm owners, Cooperatives as well as households were interviewed at different places in Ladakh. The processing of berries was experienced personally by spending time at processing sites. A history of berry processing was constructed by looking at secondary sources, as well as interviewing different stakeholders in order to identify significant changes in technique and technology. To construct the history, secondary sources like journals, research papers, websites, patent records and government reports were consulted.

1.4 THE ORGANISATION OF THE THESIS

Chapter one introduces the research scope and motivation of the study. Research questions and objectives are outlined to get a better understanding of the research area.

Chapter two discusses the conceptual framework so that the present study can be designed in order to accomplish the objectives of the research. Concepts like region, innovation, system, technology are discussed in great detail. This theoretical framework gives an opportunity to understand how technology is shaped by the socio-cultural factors and how innovation and technology can facilitate and influence the human beings.

Chapter three exclusively deals with the literary review of the research area. Broadly it talks about the methods used in Seabuckthorn processing and the diversity of products available in Ladakh. This chapter also touch broad contours of ecological and economic value of Seabuckthorn plant.

Chapter four is about the research methodology that was followed for the research purposes. The study uses quantitative and qualitative analysis.

Chapter five of the thesis entitled “Socio-technical aspects of Seabuckthorn plant-Observation and Analysis” encompasses the overall picture of Seabuckthorn processing in Ladakh and analyses the significant changes in processing methods including the effects of these changes on people.

Chapter six concludes the thesis by summarising the research findings and offers further scope for future research.

CHAPTER TWO

REGIONAL INNOVATION SYSTEM AND SOCIAL SHAPING OF TECHNOLOGY

2.1. Introduction

Regional innovation system (RIS) and Social Shaping of Technology (SST) has strong bearing to the present research area. We have explored the literature on RIS because Seabuckthorn and its related business are specific to a particular region. The technological development and methods of Seabuckthorn processing (both local and non-local) is specific to Ladakh region. It is also observed that institutional set up of Department of Industrial and High Altitude Research (DIHAR) and its industrial set up for product formation is geographically specific to Ladakh. However it is important to explore the local and non-local manufacturing, therefore response enterpreneurs and people become important to study. With this logic theoretical framework of RIS and SST (Social Shaping of Technology) are been used in present study. Thus RIS and SST both are important to review. Regarding RIS it is important to understand different concepts like innovation, innovation system, historical accounts and characterization of regional innovation system. As it is intended to focus on technology, its characterization, function and shaping in the society this chapter is also emphasizing that how society and technology is connected and what are the consequences of such interactions. Innovation has different sets of definition and from time to time understanding towards innovation has been considerably changed. Earlier focus of innovation was only at the national level (national innovation system), and scholars like Lundvall (1992) have specially focused much on such innovation. Later on and more recently the understanding of innovation has been significantly changed. Since then innovation has also been focused at regional level. Thus the concept of regional innovation system (RIS) has been emerged. Scholars like Cooke (1997) have credited for the creation of concept of regional system of innovation. RIS is described in first half of the chapter.

In second major part of this chapter, social shaping of technology has been discussed. Technology encompasses several meanings, phenomena, implications, ideas and concepts. Dusek (2006) characterizes technology as rules, hardware and system. We are going to

conceptualize a framework to understand the various aspects of technology, the interaction between society and technology as well as adoption and diffusion of technology. The various socio-cultural factors help in shaping the technology. Within first half of the chapter, Regional innovation system is discussed under several definitions around regions, system, innovation; structure and types of RIS. Various potential deficiencies of RIS and policy approaches to remove these deficiencies are also covered. With these intentions, this chapter is organized, in accordance with following ten sections namely definition of the concept of regional innovation, evolution of the regional innovation Concept, Structuring of Regional Innovation System, Types of regional innovation system (RIS), Criteria and Issues related to regional innovation system, Problems with regional innovation system, Innovation strategies and policy approaches for different problems and challenges, Social Shaping of Technology, Technological Determinism, SST Perspective : A Model of Social Shaping. Each section describes major areas and has been further divided into subsections. First we are going to review the literature and discuss regional innovation system.

2.2. Regional Innovation System

The concept of Regional Innovation System (RIS) was for the first time used in a paper (Regional Innovation Systems: Competitive Regulation in the New Europe) published by Philip Cooke (1992) and reviewed similarly on the subject in 1998 and 2004. This concept has been constructed on Lundvall's (1992) and Nelson's (1993) National Innovation System. Regional Innovation System is a new concept, to analyze and understand the importance of regional clusters, their working, how these clusters form networked innovation architecture in the region (Cooke, 1998). The author argues that RIS is an important tool to bring development at regional level, where the firms in different clusters interact with one another that leads to diffusion of knowledge, skills and best practices in a specific geographical area. According to Rosenfeld (1997), regional innovation system refers to the clusters present within a separate geographical boundary and the firms present in those clusters are independent.

RIS refers to the clusters present within a region and the supporting organizations are present surrounding those clusters. RIS is primarily constituted of two important actors including the relationships among them. (Asheim and Isasken, 1997). Firms are the first actors which are present in region having industrial clusters including the support industries. The second actors comprises of institutional infrastructure that include research institutes, universities,

technology transfer institutes, financial institutions, business associations, vocational training organizations etc. and are competent enough to support regional innovation. Thus for the development of innovative system from a regional cluster may require (1) formal collaboration between the firms in a cluster (2) strengthening of institutional infrastructure which means more number of knowledge providers (both national and regional level) are the prerequisites in formulation of innovation system. Before heading our discussion, it is important to define *region, innovation and system* to get clarity on their meaning within the context of *regional innovation system.*

2.2.1. Regions

They are evolved along different lines through combination of economic, political and cultural forces (Cooke et al., 1997). In other words it can be defined as all such territories which are smaller geographically as compared to their state having the ability to govern supralocally[6] which can differentiate that territorial region from other regions (Cooke et al., 1997). From the evolutionary point of view *regions* are in the process of residual or may have emergence as *nations*. For example Quebec and Belgian have supremacy related to some crucial activities within their regions after Second World War. On the other hand Sicily as compared to the former kingdom ruled autonomously now became residual.

Conceptually regions are designated by two important processes. First, the *regionalization* process (Hadijmichalis, 1986). Here superordinate body like a state is delimited fro supralocal territory. According to Harvie (1994) *regionalism* is the second process. It refers to the mobilization of regions due to the state negligence, discrimination and, as a result it creates new form of governance. This causes to varied extent establishment of new values, norms and routines among the actors and they trust one another in the process.

2.2.2. Innovation

In conventional terms innovation is "the process by which firms master and put in to practice the product design and manufacturing process that are new to them" (Nelson and Rosenberg, 1993-4). But this definition is limited to the industries could be questioned when we are

[6] Supralocally means regions having the power and capacity and the required resources to govern.

talking about the firms which can offer only services or in other words whose final product is not a tangible good. According to some scholars who gave their contribution to make National System of Innovation (NSI) known to large number of people, innovation is not restricted to handful of firms. Keeping this logic at the fore front these authors study and focused on broader context of innovation orienting their research on National Innovation System through an "orientation that is not limited to the behavior of firms at the forefront of world's technology, or to institutions doing the most advanced scientific research, although in some countries the focus is here, but is more broadly on the factors influencing national technological capabilities" (Nelson and Rosenberg, 1993). However one can understand innovation in a broader sense. One of the most accepted definition of innovation was propounded by Schumpeter (1975) who believes that innovation is not only restricted to the product formation and techniques to produce those products, rather it may also referred to the new market open in a new region. Innovation is "the introduction of new goods, new methods of production, the opening of new markets, the conquest of new source of supply and the carrying out of a new organization of any industry" (Schumpeter, 1975) .

Technological change is not merely a technical change, it goes beyond than that. It encompasses change in organization, behavior and the interactions among different agents in a system etc. Thus using systemic perspective to understand innovation is more holistic approach, giving the clear picture of innovation in a system. With respect to Regional innovation System (RIS), changes in institution are also an innovation (Pavitt and Patel, 1988; Dalum et al., 1988; Edquist and Jakobsson, 1988). As technological need parallel change in organizational work and production, in a similar way if there is a change in habit or change in culture the possibility of technical change is widen? Or we can say, it is not sufficient to have institutional change in the production world rather in the field of society and consumption also.

2.2.3. System

Lundvall (1992) asserted that system comprises of a various discrete elements and the interactions among them. In more comprehensive way the 'systems' regarding RIS constituted of important elements of organization and interactions among them. Research centres, university research, technology diffusion agencies, organizations involved in skill development, consultants, funding agencies, small and large firms including non firm

organisations related to innovation are the essential elements. The kind of linkages between these elements includes flow of knowledge, flow of authority and flow of funding. Beside these there could be informal arrangements like clubs, fora, network and partnership.

2.3. Evolution of the Regional Innovation

In the past few years understanding towards the nature of innovation process has been changes and several new things have been added. Major role has been played by systems of innovation approach in this regard. The earlier concepts of innovation like those of Schumpeterian one is or linear model of innovation has been overtaken by new concept of systemic innovation. This new approach (systemic innovation approach) should be taken as evolutionary, complex, interactive process and nonlinear needed interactions among academic institutions, industry associations and financial bodies (Edquist, 1997, 2001, 2005).

The innovation concept initially at the beginning was used at national level (Lundvall, 1992; Nelson 1993; Niosi et al., 1993; OECD, 1999). In literature National Innovation System has shown large variance among nations in attributes like institutional set up, economic structure, R&D base and institutional innovation performance (Edquist, 2010). During the 1990s also new trend of innovation and specifications have been emerged: Carlson (1994), Carlson and Jacobson (1997), Carlson and Stankiewicz (1991) have studied, analysed and came up with ‘’technological system’’. They argued systemic interactions are unique to the area of technology. There are other group of authors focussing on ‘sectoral approach’. Their main emphasis is to look after, that in what ways firm groups manufacture and come up with sector specific products and how these firms utilises the various sector specific technologies (Breschi and Malerba, 1997; Malerba 2002; Mowery and Nelson, 1999).

In the recent times there has been an emergence of growing interest in regional system of innovation (Autio, 1998; Bathelt and Depner, 2003; Braczyk et al., 1998; Cooke et al., 2000; dela Mothe and paquet, 1998; Dolerux, 2002; Fomahl and Brenner, 2003; Howells, 1999; Mytelka, 2000). These groups of authors accepted the importance of national and international including sectoral and technological factors, but at the same time they argued that regional factor is quintessential one. There are several reasons in support of this view. First, industrial specialization pattern and innovation performance differs region to region (Breschi, 2000; Howells, 1999; Pasci and Usai, 2000), secondly, the knowledge spillover that

plays a very crucial role in the process of innovation are often place specific (Anselin et al., 1997; Audertsch and Feldman, 1996; Bottazzi and Peri, 2003). Finally the issue of tacit knowledge as it has gaining importance nowadays (Polanyi, 1996) needs to be mentioned. The exchange of tacit knowledge requires in depth personal and trust based interactions which are made possible by geographical (Maskell et al., 1998; Morgan, 2004; Storper, 1997). Lastly the issue of institutions and policy competence are partly associated to territories which are subnational (Cooke et al., 2000).

2.4. Structuring of Regional Innovation System

Autio (1998) has come up with diagrammatic illustration of RIS. Fig. 1 is the depiction of that. A regional innovation system is constituted of two subsystems: *knowledge generation and diffusion subsystem* and the other is *knowledge application and exploitation subsystem.*

Knowledge application and exploitation subsystem is constituted of firms, their clients, suppliers. These groups are often called as firm cluster of a particular region. These manufacturing units are ideally connected by vertical and horizontal networking. The second subsystem is comprises of several organizations which are involved in knowledge and skill generation including their diffusion. Key components include agencies which are facilitating technology to the public, work force mediating bodies as well as institutions providing education (like universities, polytechnic institutes, vocational training institutions, etc.). . these are found in Autio's original model but later o Todtling and Tripp (2004) additionally incorporated policy dimensions at the level of regions which is not visible in model given Autio. At this juncture actors involved in policy making can play a vital role in grass root level innovation by shaping it subject to that there is handsome capital at regional level to formulae and implement policies related to innovation (Cooke et al., 2000; Cooke and Memedovic, 2003).

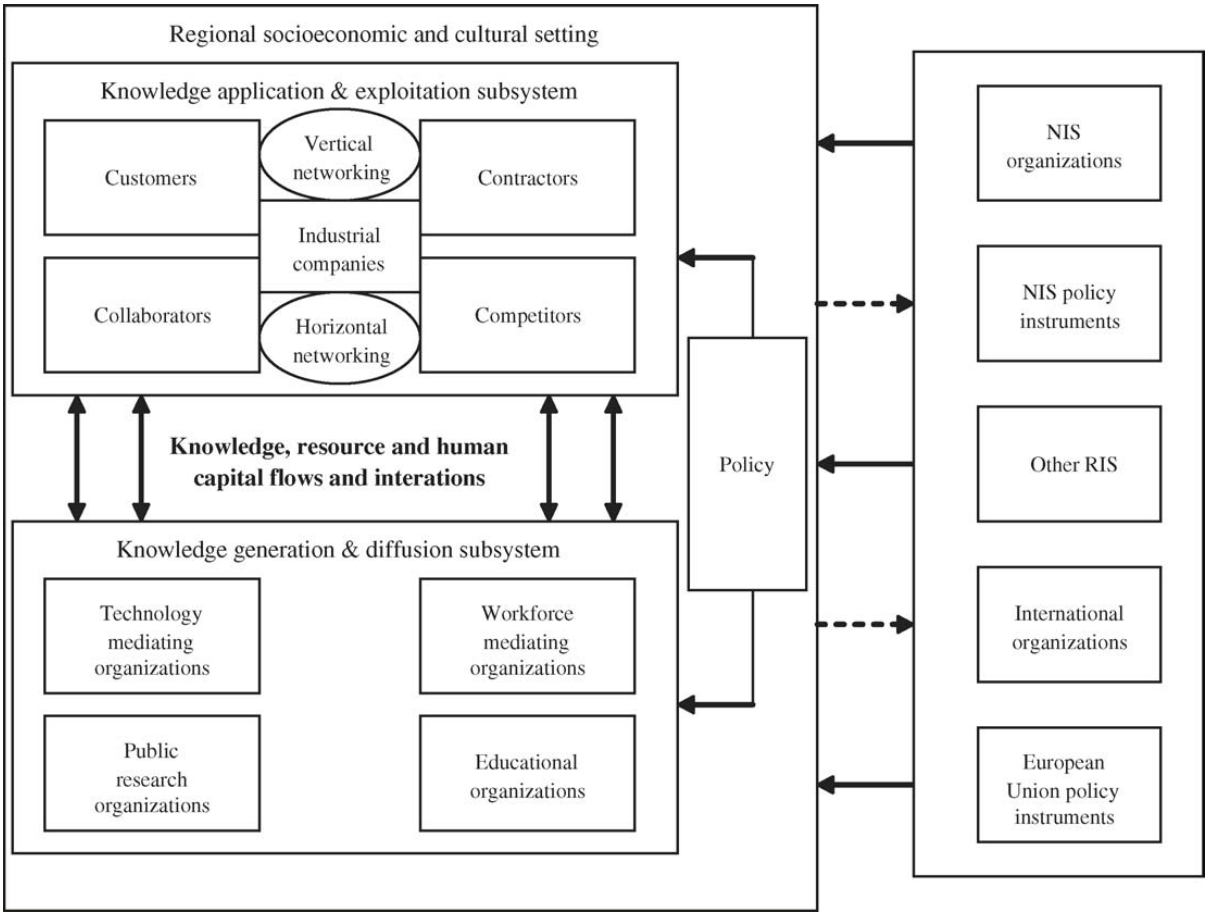

Fig 1: Structure of Regional Innovation System. *Source*: Todtling's and Trippl's (2005) modification of Autio (1998): 134.

Ideally there are several interesting and deepen relationships between these subsystem at intra or inter level showing transfer of human capital, knowledge and resources. However there are various problems and failures in RIS like deficits related to institutions and organisations including absence of interactions and relations between the subsystems. These problematic issues will be discussing ahead in this chapter.

This should be reminded that RIS are miles away from acquiring the status of self sustaining bodies (Todtling and Trippl, 2005). The current understanding is that these RIS they have several connections with actors, agencies, organisations of national as well as international. In this context we may differentiate two significant distinguish dimensions: One is, there is a wide spread consensus now a days regarding network of innovation of firms that innovativeness cannot be sustain by mere local connections. At the time of huge competition at international level and unbelievable change in technology, contacts and connections with outside the region which can accelerate the efficiency and complement with the local ones are quintessential and of key significance (Bunnel and Coe, 2001; Camagni, 1991; Mytelka,

2000; Oinas and Malecki, 1999, 2002). Another issue is related to intervention from public side it becomes well known that multi level governance is imperative for the proper functioning of the RIS. Thus regional, national and European policy actors and institutions can play a vital role in shaping development and dynamics of regional innovation system (Todtling and Tripp, 2004).

In Fig.1, Todtling and Tripp (2004) has added the policy dimensions and the interactions of regional innovation system with national and international systems, thus giving the clear picture with respect to RIS structuring. After giving a comprehensive illustration of structuring of regional innovation system, it is apt to discuss typology of RIS.

2.5. Types of regional innovation system (RIS)

It is important to divide RIS in different types, analytically as well as politically. Asheim (1998) came up with three main groups of RIS (Table 1), which resembles with the classification of Cooke (1998). These are:

1) Territorially embedded regional innovation network

In this type innovation activity based mainly on localised or limiting learning process guided by various factors like socio-cultural factors without having significant interactions and relationships with knowledge mediating organizations. *Sunmore*[7] is one of the fine examples of this type. This type of RIS is closely similar to "grassroots RIS" proposed by Cooke (1998).

2) Regional networked innovation system

This system is characterises by presence of organizations and firms which are restricted to particular region and have limited and localised learning. But type is not only restricted to the localised learning, the system have a proper planning characterised by strengthening of the regional organisational and institutional infrastructure, i.e., more vocational training institutions, R&D-organizations including other local organizations are actively involved in industry's and firm's innovation process. This system is sometimes called ideal and typical regional innovation system. Another name is "network RIS" proposed by Cooke (1998). This

[7] Sunmore is a industrial place in Norway, where shipbuilding industry is located

type of RIS gives a picture of an endogenous development model to stimulate and increase innovation activity through policy which is having public approach. For Small and Medium Enterprise, in particular, there is a requirement to supplement the informal, localised and tacit knowledge with R&D activities and competence in order to achieve more radical innovations. It is an obvious thing that in a long term basis firms simply cannot depend on localised learning, rather it should have access to more comprehensive, codified, universal knowledge like that of national innovation systems (Asheim and Isasken, 1998). To some extent *Jaeren*[8] is the probable example of this type of RIS.

Table 1: Three main RIS and some of their characteristics (Asheim and Isasken, 2002).

Main type of RIS	The location of knowledge organisation	Knowledge Flow	Important stimulus of cooperation	Examples
Territorially embedded regional innovation network	Locally, however, few regional knowledge organisation	Interactive	Geographical, social and cultural proximity	Sunnmore
Regional networked innovation systems	Locally, a strengthening of (the cooperation with) knowledge organisation	Interactive	Planned, systemic networking	To some extent historically at Jaeren
Regionalised national innovation systems	Mainly outside the region	More linear	Individual with the same education and common experiences	Horten

[8] Jaeren is an industrial centre for mechanical engineering in Norway

3) Regionalised national innovation system

This type is quite different from the previous two in many ways. Firstly, there is an integration of national and international innovation systems with parts of firm and the institutional infrastructure. This means innovation in firms can be realised when there is integration between firms and actors from outside the regions. Thus this system is look like exogenous development model. This type is what Cooke (1998) calls "dirigiste RIS"'. Electronics industry in *Horten*[9] represents one o the fine examples, where knowledge providers responsible for innovation activity mainly found outside the region. Secondly, as far as the collaboration is concern, it is based on linear model to a large extent.

2.6. Problems with Regional Innovation System (RIS)

So far we have discussed the RIS in detail. Being one of the important instruments to realise development at regional level and to ensure innovation at grass root level, RIS being the focal point in recent times in many parts of the world especially in Europe. Despite of being the instrument of development RIS is not devoid of potential deficiencies and drawbacks. In the ongoing discussion we try to find out these deficiencies and look for appropriate policies to bridge this gap.

First, the reason for failure of the system is due to the problems infested in institutional and organizational set up. Presence of inappropriate elements or missing of the essential elements has negative effects on the innovative potentials of the region. These problems and deficiencies ranges from restricted innovative potentials of the region to cluster level. At cluster level the problems can be of twofold: one is, regions may suffer due to no cluster present almost in the region. At the same time there is outdated technologies and overspecialisation in traditional industries are responsible for region's innovation deficiencies. Innovation problems can also arise due to the missing or presence of inappropriate organisation in the area.

Second problem is related to the interactions between the actors and between organisations. One of the major RIS deficiency is the inappropriate relations and interactions among the various actors and organisations engaged in innovation. The bad innovative performance may

[9] Horten, is a place in Norway, where electronic industry is located

be due to the absence of cooperation and communication among RIS elements. Another reason for low innovative performance is the result of strong ties and interactions between innovation related organisations. This could lead to serious lock-in effect and severely affects the innovation potential. These two types of network problem could be seen within the two RIS subsystem or between them.

Finally, as mentioned before, that merely the presence of regional networking is not sufficient for the effective functioning of the system, rather international collaboration is of utmost significance to realise the sustainable innovativeness of the region. If international collaborations are weakly developed, the respective regions could be devoid of international resources and knowledge.

In the ongoing discussion we will deal with various RIS failures, deficiencies and region we wise discuss the respective types. To get a comprehensive understanding of these failures RIS deficiencies could be assigned to particular problems regions like peripheral regions characterised by organizational thinness; old industrial regions (lock-in) and few metropolitan regions characterised by fragmentation (Todtling and Trippl, 2005). Fig 2 tries to figure out these barriers.

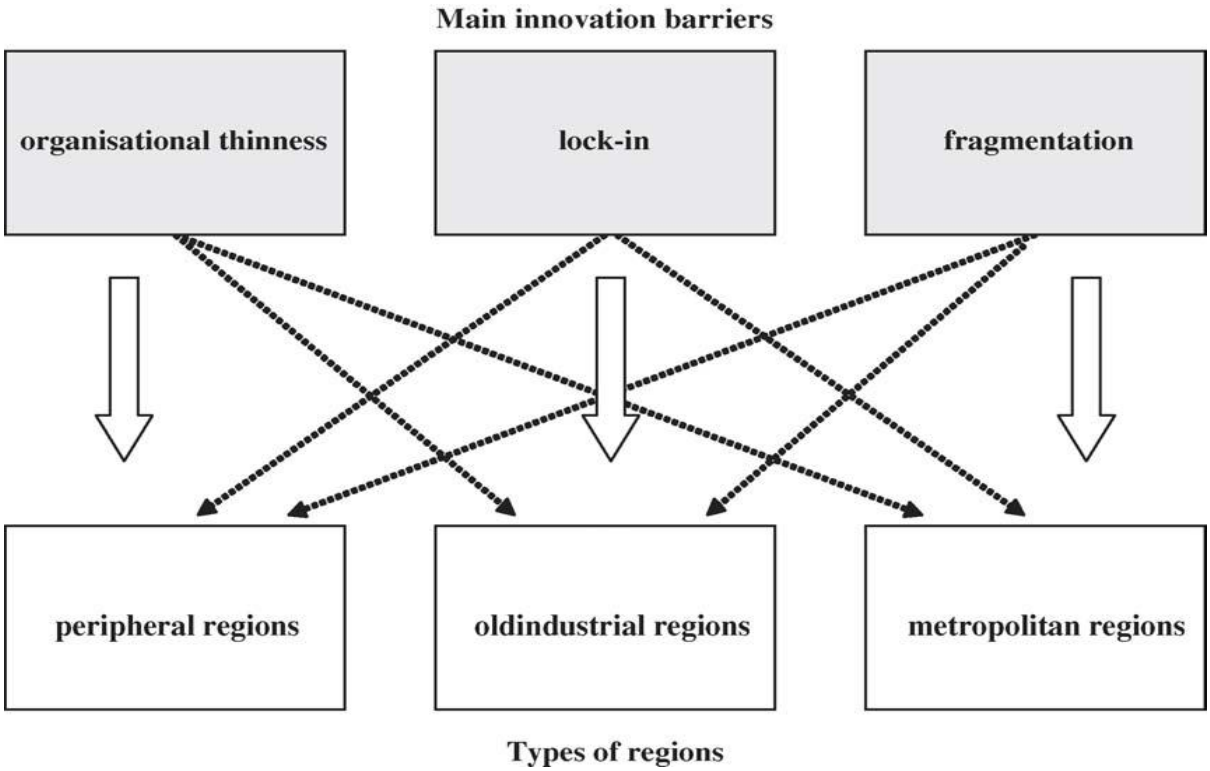

Fig. 2: RIS deficiencies and type of problem regions (Todtling and Trippl, 2005)

Todtling and Trippl (2005) asserted that there is no specific relationship among the various types of innovation problems and the regional types. In reality there are mixture of these problems and deficiencies at many instances. In the ongoing discussion a comprehensive analysis of the important systemic innovation and the type of problems in these regions will be focussed. Table 2 summarise for each type of regions, their potential deficiencies and characteristics.

Table 2: Problem areas and regional innovation deficiencies (Todtling and Trippl, 2005)

Problem dimensions		Type of region		
		Peripheral regions(organisational thinness)	Old industrial regions (lock-in)	Fragmented (meatapolitan regions)
Firm and regional cluster	Cluster characteristics/problems	Clusters often missing or weakly developed SME dominance	Often specialised on mature industries Large firm dominane	Many industries/services but high profile and knowledge based clusters often missing
	Innovation activities	Low level of R&D and product innovation, emphasis on incremental and process innovation	Mature technological trajectories, domination of incremental and Process innovation	R&D in headquarters of large firms and in high-tech companies, product innovation and new firm formation often below expectations
Knowled	Universities/researc		Often oriented on	Many and high

ge generation and diffusion	h organisations	Few or low profile Emphasis on low to medium level qualifications	Traditional industries/technologies	quality, but often weak industry links
	Education/training		Emphasis often on technical skills; managerial skills and "modern" qualifications often missing	Large variety of schools and Other educational Organisations

	Knowledge transfer	Some services available but in general "thin" structure; lack of more specialised services Often too little orientation on demand	Often too little orientation on demand	
Networks	characteristics/problems	Few in the region due to weak clustering and "thin" institutional Structure	Often characterised by Technological and/or political lock-ins	Market links dominate, often few cluster and innovation Related networking

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2.6.1 Peripheral regions

Here the pre-requisites of RIS are poorly developed, as there are no dynamic clusters present and lack of support organisation ("organisational thinness"). Innovation activities in such regions are at lower and primitive level in comparison to the areas which are more central and agglomerated (Feldman, 1994). The SMEs are dominating in such regions. Another central feature is the below average level of R&D activities, innovation and patenting in such regions. There is a dominance of SMEs and/or branch plant, in particular patenting, R&D activities and product innovations new for the market are usually below average level. Other key features are put in the table. 2.

2.6.2. Old industrial regions

This type of region represents another problem area, which is characterised by insufficient learning and innovation in spite of recovery in last few years (Cook, 1995; Rehfeld, 1999). In comparison to the Peripheral regions, old industrial region is characterised by too strong clustering as the mature firms exhibits overspecialised clusters (Tichy, 2001; Ttrippl, 2004). Such region is characterised by a highly specialised and developed knowledge production and diffusion system but it is usually oriented towards technology fields and traditional industries (Cooke et al., 2000; Kauffmann and Todtling, 2000).In such regions SMEs demand hardly met and interactive learning is achieved rarely (Asheim et al., 2003).

2.6.3. Fragmented metropolitan regions

Metropolitan regions are often referred to as hotspots of innovation. Such region is charecterised by the presence of notable research organizations, high tech companies, financial headquarters, universities etc. (Keeble and Wilkinson, 1999). This is the reason that R&D activities, product innovation and patenting are usually above average or more than other two regions. (Brower et al., 1999). But the problem is that not all the regions are hotspots or centre of innovation. Some regions are lacking in dynamic clusters of innovative companies. These regions are normally having good and efficient public research organizations including huge knowledge diffusion.

The problem faced by such region is the n ‘fragmentation’ problem i.e. the lack of interactive learning ad network to constitute major innovation barrier. The two RIS subsystem tend to operate independently as its generally seen that firm-university interactions are usually minimal including the innovation networking within local firms may be poor (Fritsch, 2003b). As a result the new technological development and the coming up of new companies are usually marginal. For example agglomerations like Vienna (Todtling, 2002), Frankfurt (Schamp, 2001) demonstrate some of the above mentioned features.

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So far we have discussed the multiple problems and challenges in different regions with respect to innovations, product development, patenting etc. Now we are going to discuss the appropriate and possible policy approaches and innovation strategies in brief as a panacea to these problems.

2.7. Innovation strategies and policy approaches for different problems and challenges

As we have seen from the detail analysis of different regions and their problems, that there is no general policy possible to address them. In other words there is no “universal practice” of innovation policy approach appropriate for all the problems. Rather a plea for “tailor-made” innovation policy approach has to be made in order to address the different sets of problems and challenges. First let us focus on some of the issues infested with new innovation policy paradigm, prior to discuss innovation strategies specific to three regional types so far we have discussed.

1. There is an emergence of new thinking with respect to the policy making. As innovation process is shaped by interorganizational arrangements (innovation systems, clusters and networks) and that can sustain compete in global market, a complete change from traditional company oriented perspective, in the direction of a better system oriented policy is the need of the hour (Amin and Tomaney, 1998)

2. A comprehensive view of innovation process is essential when it comes to design political initiatives feasible to push learning process. Thus focussing only on technological aspects of innovation and R&D is usually not enough (Asheim et al., 2003; Cooke and Memedovic, 2003; Lagendijk, 2000; Lundvall, 2004).

3. It is often being the centre of discussion that a rethinking of the method of policy intervention and the policy actor's role is of great significance. The associational forms of governance and interactive modes of state intervention are observed as being superior to traditional top-down policy approach (Cooke and Morgan, 1998

4. Regarding the selection of the projects, detailed policy scheme is required. This will be a possible move towards competitive bidding (Dohse, 2000, 2003).

5. Further, the importance of better coordination and cooperation within the political system is focussed. It means linking of different policy arenas (horizontal coordination) (Mytelka, 2000) as well as collaboration and coordination between regional, national and European policy hierarchies a (vertical coordination, Cooke et al., 2000).

So far we have discussed the key issues of new innovation policy paradigm, now we are going to focus issues of three regional types and the specific innovation strategies to address the various problems discussed before. What type of innovation policies can be suggested for the problems and challenges of above mentioned regions? An overview of the differentiated approach and their key elements is given in the Table 4. The policy recommendations proposed in Table 4 are important guidelines derived from the different RIS problems discussed above. They have to be further modified, developed and adapted according to the context of specific local problems (Todtling and Trippl, 2005).

2.7.1. Peripheral regions

The main policy approach for peripheral regions usually is to increase and boosting the regional economy. Innovation policy should give a high priority to innovative organisational activities, process and product technologies. The policy framed specific to SMEs and the concerned innovation weaknesses (Asheim et al., 2003; Todtling and Kaufmann, 2001). According to Landabaso and Mouton (2003) this also implies behavioural changes e.g. stimulation of innovation attitudes.

Table 3: Types of problem regions and innovation policy approaches (Todtling and Trippl, 2005)

	Types of regions		
	Peripheral regions (organisational thinness)	Old industrial regions (lock in)	Fragmented metropolitan Regions
Strategic orientation of regional economy	Strengthening/upgrading of regional economy	Renewal of regional economy	Improve position of regional economy in global knowledge economy
Innovation strategy	New organisational practices, product and process technologies Improve strategic and innovation capabilities of SMEs	Innovation in new fields/ trajectories Product and process innovation for new markets	Science based and radical innovation, new ventures Enhance interaction between industry and knowledge providers
Firms and regional Clusters	Strengthen potential clusters in the region Link firms to clusters outside the Region Attract innovative companies	Support clusters in new/related industries or technologies Restructuring of dominant industries Diversification New firm formation; attract cluster related FDI	Support emerging clusters related to region's knowledge base Develop specialisation advantages to achieve synergies and international visibility Attract cluster related FDI Support start ups and

	New firm formation		spin-offs in knowledge based industries
Knowledge providers	Attract branches of national research organisations with relevance to the regional economy	Set up research organisations and universities in new relevant fields	Expand and set up high quality universities and research organisations in relevant fields
Education/skills	Build up medium level skills (e.g. technical colleges, engineering schools, management schools)	Build up new skills required (technical colleges, universities)	Set up universities/schools for highly specialised qualifications and skills required
Networks	Mobility schemes (e.g. "innovation assistants" for SMEs) Link firms to knowledge providers and transfer agencies inside the region and beyond, demand-led approach	Attract new skills Stimulate networking with respect to new industries and technologies on regional, national and international levels	Promote regional networks among firms, encourage local research-industry interfaces

- The low level of innovativeness may be overcome by strengthening the potential clusters in the region (Lagendijk, 2000; Rosenfeld, 2002, 2003). To attract the innovative companies from outside and link them to the cluster or the RIS is often an important and key element to enhance the endogenous potential. This does not mean

that policy makers should only rely and dependent on inward investment as a motor of growth and innovation. It is important to support new formation of new firms and increase the potentials and capacities of existing firms. Its often experienced that combination of both exogenous and endogenous elements seems to be useful. This encompasses the attraction of innovative companies from abroad and makes an inter-linkage between regional companies to knowledge sources and business partners both inside and outside the areas.

- By taking the help of innovative support organisations, peripheral regions could be made stronger. In order to improve the knowledge infrastructure of the region, branches of important research organisations and universities which can match and influence the regional economy, could be attracted? With respect to education and training, focus on medium level skill enhancement provisions (e.g., by establishing technical colleges, management colleges etc.) including mobility schemes (like innovation assistance for SMEs) seems to be appropriate for such regions (Todtling and Trippl, 2005).

- Finally, the different policies to improve the network dimensions and to increase the social capital are indispensable (Landabaso and Mouton, 2003; Morgan and Nauwelaers, 1999). There is a need of active support and atrong relationships between the firms with knowledge suppliers and transfer agencies (Asheim et al., 2003).

2.7.2. Old industrial regions

The various development measures need to be undertaken for the renewal of regional economy. Innovation policies in this respect is about encouraging transition to new fields and trajectories and taking important steps towards process and product innovation for new markets (Hassink and Lagendijk, 2001; Lagendijk, 2000; Maskell and Malmberg, 1999, Wolfe, 2002). Key elements and policy measures of an innovation strategy specified in this way are as follows:

- Regarding the initiatives for cluster formation, central issues for policy include both the restructuring or revitalisation of already existing industries and the development and of clusters in new or related industries and technologies (Grote westrick and

Rehfeld, 2003; Todtling and Trippl, 2005). Hardly there is any existing evidence so far that old industrial areas can leapfrog into high tech sectors (Cooke, 1995; Braczyk et al, 1998). The innovative policies might support formation of new firms including the modernisation diversification and modernisation activities of the already existing firms (Cooke, 1995; Rehfeld, 1999). But the above mentioned endogenous approach may be insufficient to realise structural changes in such regions. Thus policy approach should be oriented to attract more and more foreign direct investment (Cooke, 1998; Lagendijk and Charles, 1999) bringing new and complentary knowledge into old and new clusters.

- Innovative policies efforts might aim and oriented at bringing institutional change within the RIS subsystem of knowledge generation and diffusion. For example support organisation, institutions and the formation of new ones. To establish and formation of research centres, uuniversities, backing business activities in new technological and industrial fields and to develop providers of new skills (technological colleges, universities etc.) are some of the important initiatives to rebuild the knowledge base of the region (Heinze et al., 1998; Todtling and Trippl, 2005).

- Finally, the challenge which policy makers face in old industrial region is to induce and support the transformation network structure of the regions (Morgan, 1997; Morgan and Hendwrson, 2002). This is a tough and complicated task, aiming at opening up and renewal of already existing network (traditional networks) as well as the rise of new ones(Grabher, 1993; Rehfeld, 1999; Trippl, 2004). Thus innovative policies targets networking with respect to new industries and technologies not only restricted to the regional level but also on national and international level.

2.7.3. Fragmented metropolitan regions

The main development goal in such regions is to overcome the poor integration level and to position themselves in the international economy. With respect to this innovation policy can be of significant and powerful tool provided that it based on three core factors: First, it is focussed on formation of new business entities and radical innovations in science based

industries might constitute a primary priority. Second, fragmentation problem need to be tackle by the policy makers in an efficient way by improving the communication and cooperation among firms and between knowledge providers and companies. Third, it's very important for the metropolitan RIS to be well connected with the information centres international knowledge providers (Brower et al., 1999; Simmie, 2003).

- The adoption of an explicit cluster strategy thought to be a key step in this context (Cooke, 2002; Todtling, 2002). New policy is to be taken to address the newly emerging regional complexes of the firms and to promote their growth and development. The capability and efficiency of emerging clusters can be improved by attracting innovative firms and global companies. But at the same time endogenous potentials should be enhanced and strengthened by giving support and assistance to business start-ups in the region (Todtling and Trippl, 2005).

- Regarding the knowledge generation and diffusion of RIS subsystem, policy should be designed and focussed at further improvement of institutional infrastructure. Setting up of educational institutions which could provide high level of skills in the economic and technological areas and establishing research organisations with high level of expertise become crucial task in this respect (Trippl, 2004)

- Finally, the key role of policy makers in such regions is to improve the systemic innovation capabilities of the RIS. As fragmented metropolitan region has low level of learning, policy initiatives geared to foster innovation networks among companies and stimulating industry-local university partnerships are of key significance (Todtling, 2002).

Although RIS can substantiate the issue of innovation at regional level but it cannot cover the effects of innovation and technology on people and the feedback mechanism which play a crucial role in shaping a particular technology. To address these important phenomena, the present research has also undertaken another theoretical framework i.e. social shaping of technology (SST). In the following section we are going to discuss SST in detail.

2.8. Social Shaping of Technology

This is the second major part of the chapter, which encompasses the interaction between society and technology in shaping technology, including its adoption and diffusion. How social, economic and technical consideration fostering the design and implementation of technology? Social shaping of technology brought together researchers, who are very much critique of traditional conceptions of technology, such as 'linear models'[10] of innovation, that severely restricts the scope of social enquiry into technology to assessing its impacts. SST offers better and more profound comprehension and furthermore possibly broadens the technology policy agenda. Before going into the details of social shaping of technology, it is apt to define the term 'technology' first.

2.8.1 Technology

Technology signifies different phenomena, meaning, implications, idea, intentions and concepts. It is difficult for us to offer a single consolidated definition of technology. In social sciences it's a tough and challenging task to offer a concrete and consolidated definition to understand technology. Thus a universally accepted definition of technology is hardly possible which satisfy everyone. This range of differences among the people regarding the definition of technology gave us scope to look for an appropriate definition which will suit to this present research on sociological and technological perspective of Seabucthorn plant.

It is very important to give a rational definition of technology. According to B.F Skinner, all human activities are included in technology (Dusek, 2006:31). But this definition leaves no scope further to understand what technology is. Thus there is no well defined boundary by this definition to characterise technology. It is a very basic thing to have boundary while we are talking about a specific technology.

To a common man or so to say for a lay person, technology refers to different kind of tools, equipment, machines, and applied scientific knowledge (Gana and Feutens, 2206). The term

[10] "linear models: conceived the idea of innovation as involving a one-way flow of information, ideas and solutions from basic science, through research and development (R&D), to production and the diffusion of stable artefacts through the market to consumers" (Williams and Edge, 1996)

technology is comprises of three important elements: technique, knowledge (usually being considered as 'technology'), an organization of production, and the product (Li Hua, 2009:19). Mackenzie and Wajckman propose three different sets of meanings to technology. First technology comprises of physical sets of objects, secondly human activities and objects and thirdly, what people know and what they do. According to Kline (2003), technology refers to manmade eyeglasses, refrigerators, cycles, rifles which cannot formed naturally on earth. In engineering field, normal we call manufactured articles as 'hardware', in Anthropology, we call them 'artifacts'. Even another common usage of technology is the practice of manufactured hardware which include the manufacturing of equipment, and sometimes it also include the people who operate the equipment. He further added by saying that technology encompasses methodology, technique or know-how. Many sociologist and philosopher try to apply the law of nature in social arena during nineteenth century. Miles (1995), defined technology from positivist angle, which it is a means to which we put on our understanding of the natural world to the way out of every day problems. Technology is a union of 'software' (knowledge, experience, skills together with proper institutional, and organisational arrangements) and 'hardware' (equipment, plant, buildings) (Li Hua, 2009 :19). Hickman (1995:207) look for historical account of the technological concept. It exhibits two focal points. First what has happened or is going on in the domain of hardware such as machines, tools, structures and even items of personal use. Second, they have concerned with themselves what were or are the 'attitudes' that led to the invention, improvement, development, or usage of such hardware such ancillary considerations have included the cultural milieus that made such development and inventions possible and the cultural consequences of the service. One of the ways that historians have conveyed this difference of emphasis has been to identify the stock of hardware available for use throughout a given historical period as its 'tools', or civilisation, and its institutions and ideas as its 'culture'. According to Gana and Feutens (2006 :437) people make choices in a world which is sustained and interrelated by technology. Thus people have to reflect that technology is subject to interpretation and analysis because human design it with varied experiences, histories and cultures.

Arnold Pacey (1990) tries to understand technology in a different way. He try to observe different aspects of technology distinct from the traditional mechanical conceptualisation, such as organisational and cultural factors. Gana and Feutens (2006) concludes by saying that innovation can be seen as a result of a cycle begin with radical organizational change or a

technical idea, but with either one there will be an interaction with other factors as the innovation matures. Thus technology is not merely a technique or tool; rather it is a system which encompasses the entire stakeholder as mentioned above. After going through the length and breadth of the definition of technology, we are going to discuss the social shaping of technology (SST) in the coming section

2.8.2. Social Shaping of Technology (SST)

This theory was proposed at time when there was a general perception, that technology impacts the society at great length and the social behaviour is determined by this technological impact. But this perception was later on changed and people realise that technology itself is influenced ors. Now there is no longer a dispute whether technology determines the social behaviour or social factors determine technological development. It is the matter of comparative discussion between the technological division of labour (job roles determine the technology) versus the social division of labour (job functions and technology determined by the desire of owners and managers to control the workers) (Schaff and Dusek, 2003 :7). According to Feenberg (2009 :146), technologies are not isolated from society but are adopted to specific socio political system. Hence we can say that technologies are not neutral rather they are in connection with the socio-political order they serve and contribute in shaping. The critiques of 'technological determinism' make strong argument that socio-cultural factors immensely impact the technological design and form and hence technology is shaped according to the will and demand of the socio cultural milieu (Williams and Edge, 1996 ; and Mackenzie and Wajcman, 1985). This theory emerged as social shaping of technology which is based on the principle that factors like social, economic and political forces helps in shaping the technology.

Issue of Economics has an important bearing on social shaping of technology. Economics play a crucial role in technological change and it cannot be ignored while discussing the social; shaping. Bhaduri (1983) point out towards the social relations in East Indian agriculture vary from those fully developed in capitalist farming and the way technology is shaped by economic consideration and thus differ (Mackenzie and Wajcman, 1985). Hence we can say that economic shaping of technology is, indeed, the social shaping of technology.

Before heading further it is apt to through some light on technological determinism, which is actually the critical point from where the ideas of social shaping of technology emerge. In the next section technological determinism is discussed in b

2.9. Technological Determinism

According to Edge (1998), the social shaping perspective emerged from a long standing critique of crude forms of technological determinism, which held:

a) That the nature of technologies and the direction of change are unproblematic or pre-determined (perhaps subject to an inner 'technical logic' or economic imperative).

b) That technology had necessary and determinate 'impact' upon work, upon economic life and upon a society as a whole: technological change thus produces social change.

Thus technological determinism is relied upon the fact that technological setup and design is predetermined and there is no say of socio-cultural and political forces in shaping technology. Rather socio-cultural and political milieu of is determined by the technology.

Technological determinism was related to opposition to ideologies of ''technological imperative'', was prevalent during 1970s and 1980s in British government and industry. This ideology was based on the fact that particular path of technological change were inevitable (William and Edge, 1996).

But the SST perspective was not merely a response to the public rhetoric of technology; it was also against the general perceptions of technology among academicians too. Social scientists too had this perception that technology impacts society and they took technology for granted and merely acccept the idea of technological impact and busy in assesing the amount of impact (William and Edge, 1996). The same idea and perception of academicians was shared by critical theorists, such as many writers from the labour process perspective (Mackenzie and Wajcman, 1985). They put a pessimistic angle to this by saying that how information technology would degrade work, replace and displace work force, skills and increase managerial efficiencies. They treated and conceived technologies such as robotics,

computer numerical control and computer aided design (CAD) in an abstract manner, as if they were finished and homogenous objects, uniform in their design and stable over time (Fleck et al., 1990). They live with this assumption that technology that technology is the complete and perfect vehicle to bring organisational change, and ignored the other side of the story, by overlooking the challenges and difficulties in implementing the same, including their frequent failure to deliver predicted and desired outcomes.

Besides technological determinism, there is another concept proposed i.e. social construction of technology (SCOT), which although talks about technology and social factors, but this approach is not devoid of deficiencies and drawbacks. SST is build up on critique of both technological determinism and SCOT approach. We will discuss SCOT in briefly in the coming paragraphs.

2.10. Social Construction of Technology (SCOT)

This approach was extended to study the technological artefacts. The proponents of SCOT sought to identify instances where technologies could be designed in more than one way, having choices between different technological options and also explained why one way of artefact designing is successful and triumphed. This is although a technical issue but it is shaping is affected by the type of environment, or in other words social factors definitely play a role in shaping the technology. This approach has been presented as offering a 'new sociology of technology', summed up by the phrase social construction of technology (SCOT) (Pinch and Bijker, 1984). SCOT writers have also been strongly influenced by actor-network theories, particularly by the research programme led by Michel Cailon and Bruno Latour (see e.g. Bijker et al., 1987; Pickering, 1992). But the SCOT approach has difficulty in accounting for closure. Because the technical options are many in SCOT, thus the possibilities of interpretative flexibility seem endless.

The above discussion draws a clear picture, how technology was perceived by the lay man as well as well academicians and intellectuals. Now we are going to look for SST perspective, and make a comparative account with the earlier theories and understandings regarding technology and society. In the next section we are going to discuss this.

2.11. SST Perspective: A Model of Social Shaping

The foundation of SST lay upon stream of social and economic analysis. William and Edge (1996), have beautifully drawn a picture of SST perspective. According to them, the SST research investigates the ways in which economic, social, institutional and cultural factors have shaped:

1) The direction as well as rate of innovation ;
2) The form of technology : the content of technological artefacts and practices ;
3) The outcome of technological change for different groups in society.

This highlights that SST goes beyond traditional approaches concerned merely to assess the impacts of technology, to examine what shapes the technology, which is having these impacts, and the way in which these impacts are achieved (Mackenzie and Wajcman, 1985). SST allowed people to get inside science and technology themselves (Latour, 1986, Latour, 1988). It offered opportunity of looking for more proactive role of technology, rather than restricted to defensive and reactive responses of technology.

SST originates from criticism of conventional 'linear model' of invention (William and Edge, 1996). This model describes technology in traditional sense as 'applied science', emerging through a sequential flow from basic science, through applied R&D to commercial production and use/ consumption: it follows the cycle of invention-innovation-diffusion as separate stages in an essentially linear process (Pinch and Bijker, 1984; Edge, 1988; Fleck, 1988b). This model presumed technology as 'fixed' or black-boxed at the 'invention' stage, then it is diffused through the market place to have impacts upon the society. However empirical studies came up with serious limitations of this linear model of technological development. To be very specific, SST research emphasis feedback from the later stages of innovation to the upstream sites (see, e.g. Edge, 1988). With this brief discussion of linear model of innovation and the severe flaws, we are going to discuss SST, (also known as 'interactive model') (Mackenzie and Wajcman, 1985; Williams and Edge, 1996) in a great detail: First the *technology/organisation relationship*, second *consumption of technology* finally *Gender and technology*. The rationale behind describing all these work is to

understand, that technological change as *social processes.* Next section of this chapter will discuss these interrelations.

2.11.1 The technology / organisation relationship

According to Mckenzie and wajcman (1985) and Edge (1988), technology and organisation cannot be treated entirely as separate entities. Organisational social settings shape technologies just as much as vice versa: the mutual relationships become more apparent between the two. Thus it is clearly wrong to treat technologies and their social contexts as separate phenomena. The definition of technology itself must incorporate the social arrangements within which it emerges and embedded (Hill, 1981; Clark et al., 1988).

This implies the abandoning of the pre set idea that technology is just equipment alone, rather we require a comprehensive framework, which acknowledges all those institutions, artefacts (technological product) and arrangements within which the adoption, configuration and use of those technologies takes place including knowledge and expertise which are significant in creating in creating technologies and are embedded within them (Dosi, 1982). Thus we can conclude that technologies are inclusive phenomena. Their development includes the interaction of various social and technical elements. These different elements cannot be separated from one another, but are in constant mutual tension. As there is no linear affects of technological effects upon society, in a similar way conditioning of technologies by social factors is not a simple one-way process. Once technology is developed and implemented, not only it react back upon their environment for new information to generate further new kind of technology, but it also generate new environments (Clark and Staunton, 1989 ; Fleck, 1993, Fleck, 1995 ; Webster and Williams, 1993).

2.11.2. Social shaping of consumption and the role of markets

SST research approach often started from the design of technology, this interactive model also highlights the need to look at Whole ‘circuit of technology’ (Cockburn and Furst-Dillic, 1994, p.3),ranging from design and production through to consumption and use, so as to comprehend how technologies and social implications are shaped.

These attract our attention towards the interactions among various actors involved in innovation and the creative tension between supply and consumption. Few groups, such as marketing personnel, may occupy the crucial interfaces. Hence Webb (1992) has analysed their role in the relationship among the suppliers and user companies in a variety of new products. She stresses that product development is not restricted to the question of deploying technical know-how, but also involves several other types of expertise, such as in marketing. Product design and choice is influenced by variety of social interaction among particular occupational groups within and between companies, their culture and orientation.

Green (1992), has examined this kind of interaction across a broader network of players. He studies the commercial exploitation of monoclonal antibodies in biotechnology to create techniques as well as products to be used in medical diagnosis. He notices that for a new technology to accomplish and realise its 'commercial potential', where there is no existing market, ''the 'market may have to be created to go with the technological product'' (Green, 1992, p.165). Green observed that those biotechnology firms engaged in manufacturing products of incremental innovation of the existing products were relatively successful in selling those products in the market as compared to those products which are the outcome of more radical innovation. The new product of radical innovation face number of institutional as well as technical problems and made less headway. Walsh (1993) in a separate study reaches the similar conclusion.

The biotechnological work of Green draws our attention to the different form of 'coupling' (Freeman, 1984) that may found between suppliers and users of technology. In emerging product regions where markets and products are developing with fast pace, accompanied with high level of uncertainty, close form of coupling or interaction is likely, including collaborative development (Green, 1992; Walsh, 1993). Thus technological products are consumed according to the type of market and consumers perception and understanding. Hence feedback from the market and consumer decides the design and form of technological products.

2.11.3. Gender and technology

Gender is one of the significant social factors that shapes technology as well as influenced by the any technological change. Issue of gender is an important one and any SST model must

accommodate it (Wajcman, 1991; Sorensen, 1992). Much of the socio-economic research on technology, including research on social shaping found to be 'gender-blind' (Liff, 1990). The exclusion of women from most areas of technological research and design, and the fact that it principally men that shape modern technology often largely be ignored (Williams and Edge, 1996). Within the SST had specific problems in addressing this sexual division of labour; there analyses begin from the actors involved directly in innovation, and facing the problem in explaining that why some actors are excluded or marginalised. Their preoccupation with the leading and powerful groups has led to the exclusion and neglect of sub-ordinate and marginalised groups (Russell and Williams, 1988; Radder, 1992). Another sad story is that we have focussed largely on the masculine world of technology design, but the predominance of men been unremarked. Moreover they have failed to observe women's involvement in production and in the consumption of several technologies (Cockburn, 1993; Winner, 1993).

During the era of 1980s, the focus of interest of feminist extended from science to the field of technology, and also the position of women in professions related to technology, such as the gendered nature of technology, and role of women in the production and consumption of technology including its design. Feminist approach has considerably drawn our attention to the mutual shaping of gender and technology (Cockburn and Furst-Dilic, 1994).

A number of studies show exclusion of women in particular areas. Hence Cockburn (1985) and Hacker (1990) consider the systematic exclusion of women from the area of technological know-how including maleness of certain profession (such as skilled printing craft and engineering) and their associated technologies.

By extending gender and technology analysis further, it was argued that men and women have significantly different relationships in fundamentally, hence men more actively involved in construction and design of technology and women primarily on the receiving ends of technological products at-at work and home (Cockburn and Furst-Dilic, 1994), and even the intimacy of giving birth (Faulkner and Arnold, 1985).

The writings of feminist initially bend towards a pessimistic feeling with respect to the implications of technological change for women. The exclusion of women from technology was mainly seen as the imbalance of power and material benefit between men and women. This kind of research, overt serious issue of lack of regard to women's need and priorities in technological design and innovation. Today such serious interpretation of technology as

patriarchal, have been criticised (Wajcman, 1991). The contemporary writings highlight and point towards the difficulties of making direct link between (e.g. gendered) social values and the content of science and technology, and between the latter and social outcomes (Sorensen, 1992). Some researcher from the feminist circle has insisted upon the potentials of even remote and marginalised users/consumers of technologies to be actors (Berg, 1994a, p. 95).

Despite of difficulties, the interaction between feminist research and SST appears to have been mutually fruitful. Feminist Perspectives have strong bearing on technology and have made immense contribution to SST. It has broadened the range and number of actors under consideration. SST has been an important platform to analyse the complex relationship between (gendered) technology and (gendered) society, which has improved the understanding of human intervention.

2.12. Summary

The concept of regional innovation system was proposed at the time when the concept of national system of innovation was prevalent in the literature and there was no talk of innovation at the grass root level. When regional innovation was proposed and it was accepted in most of the regions of the world, then grass root level innovation got its identity. Philip Cook was one of the pioneers of regional innovation system. He defined regional innovation system as a new concept, to analyze and understand the importance of regional clusters, their working, how these clusters form networked innovation architecture in the region, as well as a tool in policy making to create system of innovation in support of business competitiveness on a regional scale. The author argues that RIS is an important tool to bring development at regional level, where the firms in different clusters interact with one another that leads to diffusion of knowledge, skills and best practices in a specific geographical area. According to Rosenfeld (1997), RIS may be delimited by first defining geographical clusters that are geographically bounded and there are interdependent firm.

Although RIS is one of the backbone of development at regional level, but it is not devoid of deficiencies. But these deficiencies and problems can be treated with various strategies from time.

Interaction between the society and technology determines technological development. The various socio-cultural factors decide the form and design of technology. Type of market and demand of the people determines how technology should be. Even if an innovative

technology is produced but if it is the outcome of radical innovation, then people will resist buying and using it, thus it makes less head way as compared to the product of incremental innovation (Green, 1992).

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CHAPTER THREE:

SEABUCKTHORN PLANT: ITS ECOLOGICAL, ECONOMIC AND SOCIO-TECHNICAL ASPECTS

3.1. Introduction

The chapter is an attempt to collect all the relevant material, information and knowledge of the proposed research field. The objective of the chapter is to make an effective review of the literature over the concerned research area. Review of literature is done to reach the overall aim of the research. By doing so I could explore the research questions and accordingly shape my research objectives.

Literature reviewed includes books, journals, research papers and articles, written on Seabuckthorn plant and its processing, including its ecological and economic importance. Also government reports, papers and websites are explored to make an effective review of the research area. Relevant information was also gathered on regional innovation system and social shaping of technology.

The reason behind including the ecological and economic importance of Seabuckthorn is obvious. Seabuckthorn is processed because of the necessary nutrients and bio-chemicals present in different parts of the plant. It is very logical that before processing the plant, first we must know the economic value of the plant. With this objective literature is reviewed on economic importance too. Similarly ecological importance of the plant is also necessary to include in the literature review, due to the significant role played by this plant. Ranging from preventing soil erosion to support biodiversity, this plant is very crucial to the inhabitants of Ladakh. It is the major source of food and habitat for wild animals. But the present berry harvesting method for Seabuckthorn processing pose serious threat to berry plantation. During ‘berry harvesting’ (which is the first step of Seabuckthorn processing), Seabuckthorn plant get seriously damaged. It is through literature survey we come to know about the serious implications of Seabuckthorn processing. With this objective ecological role of the of Seabuckthorn plant is also included in this chapter.

The chapter has five sections including the introduction section. Section 2 outlines broad contours of morphology[11] including ecological and economic importance of the plant. Section 3 gives comprehensive account on socio-technical aspects of Seabuckthorn. Here different methods of Seabuckthorn processing have been discussed. This section gives an idea how innovation, technology and socio-cultural factors[12] are inter-related to each other. Section 4 describes Seabuckthorn products produced out of Seabuckthorn processing along with their patent numbers. Here it is important to mention that the photographs of the products shown in this section are specifically of those developed by DRDO. There are several firms and cooperatives including households working in this area and they have their own products with different names and labels. Section 5 gives brief account of important research papers on Seabuckthorn processing, regional innovation and social shaping of technology.

3.2. Morphology, Diversity, Nature and Geographical extent of the plant

Seabuckthorn is a spiny, dioceous[13] and wind pollinated shrubby plant (Jeppsson et al., 1999; Rousi, 1971). A deciduous (shed their leaves in one season), thorny shrub with copious leaves and powerful root system which can retain the soil from erosion. The female plant bears red, orange, or yellow berries on two year old thorny bush.

This wild plant is found in Eurasian land mass but in India it grows abundantly in trans-Himalaya, like in Uttarakhand, Himachal Pradesh (Lahul-Spiti and Kinnaur district), Jammu & Kashmir (Kargil and Leh districts), and Sikkim ((Rongsen, 1990; Subedi, 2007).

Seabuckthorn is scientifically known as *Hipphophae* which is classified in '*Species Plantarum'* by Karl Von Linnaeus in 1753. This plant belongs to the plant family Elaegnaceae (Rajchal, 2009).The term *Hippophae* is derived from two Latin words, 'Hippo' which implies horse and 'Phae' means to shine, which reflects its uses in ancient Greece whenever the horses gained weight and earned shiny coat after using Hippophae as fodder (Subedi and Adhikari, 2001). It is locally called Chharma, Sutz, Tirkug, Chasterlulu, Sarla or Pilickcha, in Himachal Pradesh; Tsemarang and Chasterlulu in Ladakh.The genus *Hippophae* have seven species, *viz. Hippophae salicifolia , Hippophae rhamnoides,Hippophae Tibetans*,

[11] Morphology: Study of external features of an organism (plant/animal)
[12] Socio-cultural factors shape technology (Mackenzie and Wajcman,1985)
[13] Dioecious: Having the male and female sexes on different plant

Hippophae neurocarpa, *Hippophae gyantsensis*, *Hippophae goniocarpa* and *Hippophae litagenesis* (Rousi, 1971).

In India, three different species of *Hippophae* L. (viz. *H. rhamnoides*, *H. salicifolia* and*H.tibetana*) are naturally distributed in high altitude areas of HimachalPradesh, (Lahul Spiti, parts of Chamba, Kinnaur, Kullu, Shimla and Kangra), geographical regions of Jammu and Kashmir (Leh and Kargil) and in smaller portion of Uttar Pradesh (Singh et al., 1995)

In Ladakh, studies conducted using satellite imagery has shown that the plant occupies 11500 hectares of land (Dwivedi et al., 2001). This plant can grow at an altitude of 1200-4500m, but in some areas also grow in planes. The shrubby plant can withstand temperature ranging from -43 degree Celcious to 40 degree Celcious (Li, 2002) and thus considered drought resistant. These features make Seabuckthorn an ideal plant to grow in cold desert. Seabuckthorn has been reported to grow in low humidity (15%), wet areas, different soil conditions, hills, and mountain slopes, riverside with brown rust scaly shoots (Rongsen, 1992; Banjade, 1999; Bashishtha et al 2002). Seabuckthorn species are fast growing (Rongsen, 1992). They can withstand at low precipitation (300mm), ready to grow in soils with pH of 9.5, salts 1.1% (Rongsen, 1990). The whole Seabuckthorn plant (fruits, leaves, stem and roots) are economically vital (Rongsen, 1992).

In China, this plant has been extensively cultivated but in Ladakh no cultivation practice has been reported in the past. Recently, Ministry of Environment and Forest (MOEF) and the Defence Research and Development Organisation (DRDO), Government of India have launched a noble initiative to cultivate this ecologically and economically important plant in high altitude, cold desert ecosystem (Kaul and Ali, 2013). The objective is to bring million of hectares of land under cultivation by 2020 with an initial corpus of Rs.25 crore in 2011. This initiative will definitely help to increase the area of Seabuckthorn, and also open employment opportunities to the locals.

In Ladakh grows without much human interference. No systematic plantation and standard practices are followed in Ladakh, as a result Seabuckthorn of Ladakh origin are ‘wild harvest’ (Stobdan et al., 2013). This is the reason behind that Seabuckthorn berries in Ladakh are free of synthetic chemical and pesticides and fetch premium prices in the market.

3.2.1. Ecological role of the of the plant

Seabuckthorn plant has enormous ecological role to play. As they have strong root system they can prevent soil erosion. Since 1954 Seabuckthorn has been planted at a gross scale to prevent soil erosion in hilly areas of China (Rongsen, 1992), which has similar geographic and climatic conditions to Cold Desert of Indian Himalayan region. Therefore Seabuckthorn makes a perfect choice for the afforestation programme and greening of Ladakh region. This plant has symbiotic[14] relationship with nitrogen fixing bacteria known as *Frankia* in its root nodules (Rousi, 1971). As per the estimation Seabuckthorn can fix 180kg of Nitrogen per hectare per year. Besides the cold and drought resistant Seabuckthorn can grow in any fallow and barren land. Soil fertility and moisture content can be improved by establishing Seabuckthorn plantation which can lead to shrub-grass community of thick forest within 4-5 years (Stobdan et al., 2012).

Ladakh being a cold desert and hilly topography is characterised by high wind speed prompting ecological degradation. Windbreaks made of Seabuckthorn are viable at counteracting speedy wind in open areas. In 10–12 year old bush, the root extends horizontally up to 537 cm and vertically 127 cm deep, thus acting as an ideal plant for soil binding (Chengjiang and Daiqiong, 2002). The extensive and strong root system enables Seabuckthorn to be used for plantation along streams and water channels to prevent soil erosion. in this way Seabuckthorn control surface runoff. Plantation of Seabuckthorn enhances soil physical characteristics and fertility, thus improves water holding capacity of the soil. It has been noticed that soil moisture in Seabuckthorn plantation areas is 3–4 % higher than outside the forest (Chengjiang and Daiqiong, 2002). Similarly, Seabuckthorn forest has 10–20 % higher humidity then outside the forest. The plantation of Seabuckthorn around agricultural field for fencing immensely helpful to enhance soil fertility. It has been practised in Nubra valley that less fertile fields are added with soil taken from Seabuckthorn fields to enhance soil fertility. Growing of Seabuckthorn for fencing around agricultural fields is known to improve soil fertility

Plantation of fruit trees like apricot, apple and timber trees like popular, cupressus, willow is an important activity in Ladakh. The cuttings and saplings during its initial periods need enormous care especially from the stray animals. To keep away these animals from harming

[14] Symbiosis: interaction between two different organisms living in close physical association, typically to the advantage of both.

and damaging the plants the thorny Seabuckthorn cuttings are tight around the saplings to act as a tree guard. This method is proves effective in increasing survival of the plants during their initial years. However, there in recent times the traditional use of Seabuckthorn is declining and is replaced by empty tinned food packaging materials.

It is a common observation that large number of wildlife species feed on Seabuckthorn stem, branches, leaves, fruits and seeds. It has been observed that a number of wildlife species depend for their food on Seabuckthorn fruit, seed, leaf and branches. Seabuckthorn berry is generally called *Chepayzanma* i.e. 'food of birds' in the region (Stobdan et al., 2013). The highly acidic fruits stay on the bushes all winter, unlike other plants where fruits fall off the plant at maturity. Thus it act as main source of food for birds and other animals during winter season. Seabuckthorn berries act as life giver during the severe cold winter to the endangered double humped camel, wild sheep wild ass etc. Seabuckthorn thus provides lots of benefits by maintaining the ecological harmony, equilibrium and improving biological environment.

3.2.2. Economic Importance of Seabuckthorn

Traditionally the whole plant is being used in Ladakh for a number of uses such as firewood, fencing, wind break, tree guard building construction, medicine, nutritional supplement, soil fertility enhancement etc. (Stobdan et al., 2013a). This plant is a repository for researchers within the field of biotechnology, pharmaceuticals, neutraceuticals, cosmetics and environmental sciences (Xu, et al., 1994). Recent scientific advancement in pharmacology and therapeutic potential of Seabuckthorn has been reviewed (Geeta and Gupta, 2011; Kanayama et al., 2013).

Since decades this plant has been used by the locals[15] traditionally for various uses due to the scarcity of resources[16]. Every part of the plant viz. stem, roots, leaves are being used by the locals as nutritional supplement, medicine, fuel and fence (Stobdan et al., 2011). These uses are further described in detail as follows:

[15] Locals: inhabitants of Ladakh or community with the region
[16] Resources like fuel, food and medicine

Seabuckthorn and Medicine

Seabuckthorn is widely used in ancient Tibetan system of medicine that is normally followed here in Ladakh. As early as eighteenth century the medicinal value of Seabuckthorn has been recorded in the Tibetan medicinal book as *rGyud* Bzi (Four Medical Tantras). The three noteworthy species of Seabuckthorn has been set up in Tibetan medicine as Sa-sTar for *H.tibetiana*, *Bar-sTar* for *H.rhamnoides* and *Nam-sTar* for *H.salicifolia* Sa-sTar for *H. tibetana*, *Bar-sTar* for *H. rhamnoides* and *Nam-sTar* for *H. Salicifolia*. The characterization depends on plant stature. The "Sa" signifies 'ground', "Bar" signifies "centre" while "Nam" signifies 'sky'. Of these, Bar-sTar is the most usually utilized species in Tibetan prescription. In Ladakh area, even today Amchies[17] frequently endorsed preparations from Seabuckthorn for treatment of health related problems like gastritis, heartburn, throat disease, bronchitis, gynaecological issue, ulcer, acidity, diarrhoea, hypertension, blood issue, fever, tumour, gallstone, hack, frosty, food poisoning and so forth (Zhao et al., 1987). Current research facility and clinical reviews affirm the viability of Seabuckthorn for its restorative properties for treatment of vaginal mucositis, cervical disintegration, skin ulcers, oral mucositis malignancy, duodenal ulcers slow assimilation, stomach disorder, neoplasia, thrombosis, hepatic harm, ligament and tendon wounds and so on. Present day logical progression in restorative and remedial capability of Seabuckthorn has as of late been looked into.

Antiviral, antifungal antibacterial, activity of Seabuckthorn:

"Hiporamin" which is one of the important phytochemical compounds extracted from seabuckthorn leaves have found to be effective antimicrobial compound (Kripkova et. al., 2008). Seabuckthorn fruit extracts is found to have potent inhibitory antiviral activity against Herpes viruses and Influenza (Shipulina et. al., 2005). One of the significant use of extract from Seabuckthorn fruit is its anti HIV properties (Suryakumar and Gupta, 2011). In a similar way extract from Seabuckthorn leaf is effective against dengue infection (Jain et al., 2008). The aqueous extract from seeds of Seabuckthorn also showed antibacterial activity (Chauhan et al., 2007). In other studies extract from seed and leaf extracts also found to have effective against gram positive bacteria and seed oil extract showed anti-fungal activity (*Mucor* and *Tilletia*) (Gupta et. al., 2011). One of the study revealed that the aqueous and hydroalcoholic leaf extracts of Seabuckthorn showed growth inhibiting result against *Enterococcus faecalis,*

[17] Amchies: Neighborhood customary specialist

Staphylococcus aureus, Bacillus cereus and *Pseudomonas aeruginosa*, (Upadhyay et al., 2010)**.**

Seabuckthorn as an antioxidant, immunomodulatory and anti-cancer agent:

Use of Seabuckthorn on gross scale in numerous oriental and conventional medicinal practices for the treatment of various inflammatory problems and immunomodulatory issues has experimentally demonstrated its utilization. Seabuckthorn has anti-aging, anti-inflammatory and immunomodulatory effects (Geetha et al., 2005; Mishra et al., 2011). Glial[18] cells are protected from oxidative damage by the use of leaf extract (Narayanan et al., 2005). Similar studies have found seed oil of Seabuckthorn have potent scavenging activities (Ting et al., 2011). Several studies conducted on Seabuckthorn revealed that extract from the plant prohibits oxidative stress of nicotine on rat liver and heart (Gumustekin et al., 2010). In similar studies of seed oil, it has been found Seabuckthorn showed effective inhibition of oxidative damage on mice (Padwad et al., 2006).

Nutritional Supplements

Characteristics of Seabuckthorn meet dietary necessities in high altitude are very much perceived. Berries of Seabuckthorn are very acidic and people generally avoid its direct use, unlike other edible fruit. In any case, children frequently consume the berries when they are ripe. Seabuckthorn is rich in several vitamins like Vitamin C, Vitamin E, Vitamin K, Folic Acid, Flavonids, carotenoids, Omega fatty acid, Organic acid etc. (Xiao, 1980; Anderson, 2009; Suryakumar and Gupta, 2011; Pradhan et al., 2012). Being a cross pollinated plant; there exist ample amount of variations in Seabuckthorn population. Kids recognize and check the plants bearing moderately sweeter and ripe fruits. Seabuckthorn leaf is highly antioxidant in nature, and for this reason it is regularly utilized as tea in Ladakh region. It has been confirmed through investigation leaf of Seabuckthorn is rich in antioxidant and phenolic substance (Korekar, et al., 2011). However the use of Seabuckthorn tea is declining in recent times due to the better alternatives tea available in the market. Recently the nutritional attributes of Seabuckthorn has been investigated and reviewed (Koreka et al., 2010).

[18] Gilial cells: cells surround neurons and support them

3.3. Socio-Technical aspects of Seabuckthorn

So far we have discussed the ecological and economic importance of Seabuckthorn. We get a clear idea how much this plant is important to the natives of the region and adhered to their lives for several purposes. Because of the innumerable benefits of Seabuckthorn, it has been the eye catching for scientists, industrialist, academicians and government bodies. In Ladakh this plant is socio-culturally bind to their lives since time immemorial. Amchies processed this plant for various medicinal preparations. In factAmchisystem of medicine was the only alternative available to the people especially during winter season till recently.

In fact importance of this plant was known to the people especially to theAmchipractioners since time immemorial. However this plant becomes the focus point to Ladakhis[19], when Seabuckthorn processing was started years ago. Firms have been established and several products are produced like berry juice, berry jam, tea, omega-7 fatty acids etc. Today Seabuckthorn is being processed using local as well as non-local (DRDO designed technique and technology) methods. In the following discussion we will outlined these processing methods and technologies mentioned in the literature and also try look for different products produced using these methods.

After a thorough literature survey it has come to the notice, that there are only few papers available on local method. These research papers are mainly written on local methods practiced in Ladakh (Jammu and Kashmir) and Kullu-Manali (Himachal Pradesh). The integrated researches in these two regions of different states are carried on by different researchers. It is due to the fact that socio-cultural aspects of both these regions are quite similar. However, regarding the non-local methods there are ample amount of research papers available. Now we will see, how local and non-local methods are outlined in literature.

3.3.1. Local method of Seabuckthorn Processing

Following steps are involved in Seabuckthorn processing: Harvesting of berries, Berry cleaning, crushing of berries, juice extraction, separation of pulp fro juice, use of pulp for other purposes like tea formation etc.

[19] Ladakhis: inhabitants of Ladakh

Berries are harvested using hand and beating the branches with stick (Singh et al., 2003). The fallen berries are cleaned by picking leave, damaged berries, and any other debris manually. Berries are then washed in pan and crushed. Juice is extracted and then sugar is added (Singh et al., 2012). After inducing a preservative, juice is packed in sterilised bottles. Now it is ready for consumption. The whole processing method is done manually (Chauhan et al., 2001). Women groups are actively engaged in the whole process (from collection of berries to processing) of product development. The whole process of product development is simple to adopt. Major food products are pulp, jam, tea and wine (Lebeda, 2005).

3.3.2. Non-local method

The total number of publications available describing processing of Seabuckthorn berries is rather limited (Zhou and Chen, 1989; Liu and Liu, 1989; Liu et al., 1989; Chen et al., 1995). However the overall steps involved in processing include the following:

1) *Berry harvesting*

It is done by the local people manually. Harvesting is done by beating the branches of the plant with the help of stick. The fallen berries are collected in a bucket. Then they are taken to the processing units in 10 kg capacity food grade plastic tray. As majority of the Seabuckthorn plantation is on land under the executive control of Government (Forest Department), strict regulation is made regarding method and time of berry collection. Berry collection is allowed only during morning hours when it is easy to harvest without damaging the shrub. Prior permission is required for berry collection from the Forest Department in the area under its jurisdiction (Singh et al., 2012). The mean annual berry harvest from 2004 to 2013 is 201.8 ± 76.8 MT which is less than 5% of the total available Seabuckthorn resource in the region. There is no significant increase in quantity of berry harvested during the 10 years study period. This is largely due to short harvesting season. Moreover berry harvesting period coincide with that of other crops including unorganized plantation, which restrict harvesting of only a part of the available resource. Berry harvesting is done for a short period of 20-30 days in September unlike many other places. In Ladakh Overripe berries are generally not harvested. However, in Himachal Pradesh, berry harvesting is done from September to December (Singh *et al*., 2012). The mean percent share of berry processed by

private players is 48.6% as against 51.4% by the Cooperative Society during the period of 2004-2013. (Stobdan et al., 2013). However, with the coming of more private firms, the trend is changing and private players are now processing more quantity of berry than the Cooperative Society.

2) Berry Cleaning

In local method berry cleaning is done manually, but in case of no-local method this process is somehow mechanised. Specially designed berry cleaning device is used designed by DRDO (Stobdan et al., 2013). Berry cleaning is an important step to remove damaged berries, leaves, twigs, and other debris collected in harvesting period. The first step in cleaning is done by rolling the berry on a these specially designed aluminium sheets having wet surface. The device is placed at particular angle so that berries can easily roll over the sheet. The damaged berries and leaves stick to the wet surface and are removed manually. Twigs and other debris that does not stick to the wet surface are removed by manually. The berry is then washed in water and the remaining leaves and damaged berries that float on the surface are skimmed away with a sieve. Water is drained from the berry before juice extraction (During cleaning process, it has come to the notice that a loss of 4.73±0.89% berries during rolling and 8.45±2.46% during washing was recorded, which together constitute 13.18±3.0% (Arimboor et al., 2006.)Large quantity of damaged berries, twigs, leaves and other debris in the harvested berry is primarily due to the crude method of berry harvesting. Whether it is local or non-local method, berry harvesting is still done with beating the bush method. Thus it amounts a huge loss to the berry plant There is a need to develop mechanical harvester and plantation of Seabuckthorn need to be done systematically to ensure sustainable exploitation of berries during harvesting (Beveridge *et al*., 1999).

20 *Extraction of Juice*

Juice extraction from Seabuckthorn berry is done in a DRDO designed pulper[20]. After the cleaning step, berries are fed into the pulper. As a result pulp (73.82 ± 3.33%) and cake (24.14 ± 2.96%) having unbroken seeds are obtained (Chauhan et al., 20010). The extracted juice is collected in food grade 50 kg capacity container (drum) and KMS (potassium

[20] Pulper: extraction or crushing machine

metabisulphate) is added as preservative. The pulp is the main marketable component and in the year 2012-13 fetches Rs 70-105 per kg. Sometimes the pulp is further processed by passing through filtration unit to get cake and a clear aqueous solution (pH 2.7). The cake is then packed in 50 litre capacity drum for sale. But the clear aqueous solution remains unused. Finally, cake containing seed is sun dried and by rubbing the dried residue with hands seed get separated from the hull. Both seed and hull is of great economic importance and can be used for oil extraction (Singh et al., 2012).

Although leaves and fruits are also used for making other products like tea, jam, oil etc.
Both local and non-local firms as well as cooperative societies are engaged in Seabuckthorn processing. The technology designed by DRDO is used by these firms and cooperatives for the production of different products. We are going look for various products developed by DRDO Leh using this newly designed technologies. These products are also developed by firms and cooperatives but with different label on the products. Although these firms and cooperatives made their own product, but they are tested and approved by DRDO before marketing (Stobdan et al., 2013).

Photo1: Berry Juice

Source: DRDO (Aromboor et al., 2006; Stobdan et al., 2015)

In the following subsection we are going to look for DRDO based products along with their patent number. The reference to these products are taken from various research papers written by DRDO based Scientists at Leh.

3.4. SEABUCKTHORN PRODUCTS

DIHAR (Department of Industrial and High Altitude Research), a research wing established by DRDO Leh, is the first in Jammu and Kashmir to commercialise Seabuckthorn and its products. After many years of research DIHAR is able to produce various products of Seabuckthorn which include juice, herbal tea, jam, pickle, sauce, wine, nectar (Kaul et al., 2013). These products are:

3.4.1. Berry Juice

One of the significant achievements of DIHAR regarding Seabuckthorn is the manufacturing of Berry Juice. This has been granted patent with the patent[21] number 231773 (Arimboor *et al*., 2006 and Stobdan et al., 2015). The given image of berry Juice is taken from a research paper written by the above cited authors. This has been commercialised in Indian market. Using the technology developed by DRDO, berries are being processed and extract juices out of it. Under the brand name of 'Leh Berry', 'Ladakh Berry' or Powder Berry' it is currently available in the Indian market (Stobdan et al., 2012). Defence Research Development organisation (DRDO). Seabuckthorn juice is one of the important product developed from the fruits of Seabuckthorn berries, is very significant commercially now adays. The juice is rich in nutrient contents such as vitamins especially in vitamin C and Carotenoids. It also contains fatty acids, and elemental components. These components substantially vary among individuals, populations, species or subspecies. The presence of various chemicals and other important nutritional constituents in berry juice and from the scientifically comprehensive knowledge it is clear that Seabuckthorn can be used as an alternative source of nutrition in commercial market. The demand for Seabuckthorn is increasing day by day and its market is

[21] Patent: a government authority or license conferring a right for a set period especially the sole right to exclude others from making, using and selling an innovation

expanding. Industrialist and enterpreneurs have shown keen interest in the shrub. Seabuckthorn fruit of worth Rs 14 crore has been sold in Leh distrct of Jammu and Kashmir which increase the capital of the region as well as increase the employment opportunities.

3.4.2. Seabuckthorn Tea (Herbal Tea)

Photo 2: Herbal Tea

Source: DRDO (Kumar and Stobdan, 2015)

This is again one of the important achievements DIHAR, the research unit of DRDO. Herbal tea has been granted patent under the patent number 242959 **(**Arimboor *et al*., 2006 and Stobdan et al., 2015) and is being commercialised**.** Both seeds and leaves are used to formulate tea out of Seabuckthorn plant. According to professor Kaul (2016) Seabuckthorn leaves are better substitute for green tea due the presence of various constituents like flavonoids. Quality wise Shade dried leaves of Seabuckthorn are as good as green tea and they can be sold in commercial market. Fresh leaves of Seabuckthorn contain less amount of flavonoids on as compared to the shade dried leaves of Seabuckthorn. This is attributed to difference in age of the leaves or plants or time of collection (Gupta and Kaul, 2016). Due to its high antioxidant property Seabuckthorn leaves are used as tea. The antioxidant potential and Phenolic content of Seabuckthorn has been investigated and it is found to be rich source **(**Korekar et al., 2011). For making tea, mostly leaves from male plant are used than female

this is due the lesser amount of biochemical constituents in female leaves. The leaves are first dried under shade for around one week. When the leaves are completely dried, 3-4 leaves are put in one cup of water and then boiled for around 3-4 minutes.

3.4.3. Berry Jam

Photo 3: Berry Jam

Developed by DIHAR, Seabuckthorn has been granted patent with the **patent number 195059** (Kumar and Stobdan, 2015). It is being commercialised in Indian market. It is again one of the important by product of Seabuckthorn. Berries are used for this purpose. There are several jam products with the brand name such as 'Berry Jam

Source: DRDO (Kumar and Stobdan, 2015)

3.4.4. Seabuckthorn Oil

This is again developed by DIHAR. Patent has been filed with the **patent number 1430/DEL/2011** (Kumar and Stobdan, 2015). Seabuckthorn oil is yellow in colour and is rich in Vitamin E. Presence of Vitamin E is responsible for its antioxidant nature. Vitamin E content varies both in seed and berries. It possesses desirable physical and feasible to be used in tropical cosmetics, neutraceuticals, Cosmoceuticals (Bveridge et al., 1999). It is used as natural sunscreen absorber as it absorbs strongly in the UV-B range (290-320nm) (Beveridge et al., 1999). Carotenoids impart yellow colour, as it is present in higher concentration. It is used to protect the skin from sun burn and other skin disorder. High concentration of Vitamin E is thought to have minimised fat breakdown, maintaining tissue integrity and reducing wrinkling and skin toughening.

3.4.5. Wine Preparation

Buddhist dominated regions of Ladakh particularly in Leh district wine is offer in festive seasons especially during winter times. Mostly wine is prepared from barley grains but now a day's Seabuckthorn is also used for the same purpose. Although it is not practiced in a large scale but in some pockets of Ladakh as well as in state of Himachal Pradesh local people prepared wine using local method (Singh et al., 2012). Fresh fruits of 10kg weight are gathered in a pan and are thoroughly washed. Fruits are then crushed and added with fermenting agent (enzyme of yeast available in the market) of 200-400g is added in to the mixture. Around 4-6 months it is kept for fermentation. Warm cloth is covered over the pot during the time of fermentation. When the fermentation period is over, sweet wine gets ready to use which is famously called as 'Chang' by the locals (Singh et al., 2012). Chang is then offered on occasions especially during winter to warm up from severe

Photo 4: Seapricot

3.4.6. Seapricot beverage

Source: DRDO (Arimboor et al., 2006; Stobdan et al., 2015)

This was developed by scientists at DIHAR situated in Leh. Patent has been filed under patent number 635/DEL/2009 (Arimboor *et al*., 2006 and Stobdan et al., 2015). It is currently being commercialised in different parts of India.

3.4.7. Antioxidant Herbal Supplement

Developed by DIHAR, patent has been filed with the patent number 635/DEL/2009 (Kumar and Stobdan, 2015). This is again commercialised and is one of the nutritional supplement.

3.4.8. UV protective oil

This is one of the important products developed by DIHAR and is quite useful against sun burn and other skin disorders in

cold desert of Ladakh. Patent has been filed by DIHAR with the patent number 91/DEL/2010 (Kumar and Stobdan, 2015).

3.4.9. UV protective Cream

This can be used against intensive radiations in high altitude regions. Especially in Ladakh UV cream can effectively protect skin from sun burn. This is again developed by DIHAR and patent has been filed with the patent number 2919/DEL/2014 (Kumar and Stobdan, 2012).

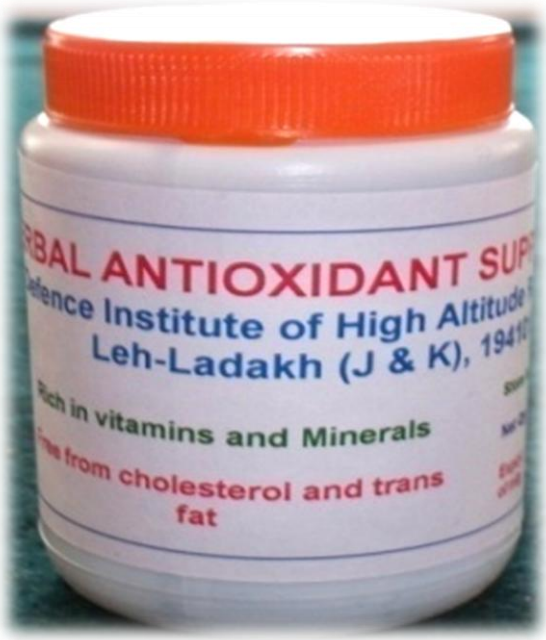
3.4.10. Food Supplement

Natives of high altitudinal regions require enough calories in their body due the harsh climatic conditions. Food Supplement is developed with the objective of additional supplement along with their routine food. Developed by DIHAR, patent has been filed with the patent number 1000/DEL/2014 (Kumar and Stobdan, 2015).

Photo 5: Antioxidant Supplement

3.4.11. Antioxidant Herbal Supplement

Developed by DIHAR, patent has been filed with the patent number 635/DEL/2009 (Kumar and Stobdan, 2015). This is again commercialised and is one of the nutritional supplements.



Source: DRDO (Kumar and Stobdan,2015)

3.4.12. Adaptogenic appetiser

This product has been developed by DIHAR, and patent has been filed with the patent number 987/DEL/2012 (Kumar and Stobdan, 2015)

Photo 6: Adaptogenic Appetizer

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Source: DRDO (Kumar and Stobdan, 2015)

3.5. Areas of Seabuckthorn explored or work done on Seabuckthorn

Seabuckthorn, being an important and promising plant especially in the area of Pharmacology and food industry has attracted the attention of scientists, and academicians. This plant is known to mankind since centuries but it has been recently explored at high rate by the researchers and scientists.

Throughout the research survey it has been come to my observation, that most of the work was done on scientific aspects like morphology, anatomy, genetics, cell biology, phytochemistry, including pharmacology of Seabuckthorn. There is less documentation available on Seabuckthorn processing and technology involved in it, especially in India. Although China has developed sophisticated technology to process Seabuckthorn and the plant has been domesticated on a large scale. Seabuckthorn was planted at 1,038,000 hectare (28%) of land in 1990 and the total value of Seabuckthorn products sold by China was US$ 20 million in 1990 (Rongsen, 1992). In 2004 1.5 million ha (60%) of Seabuckthorn plantation was recorded in China including 200 processing units (Dharmananda, 2004)[22].

[22] http://www.itmonline.org/arts/seabuckthorn.htm

3.6. Documentations or research papers available in literature on Seabuckthorn Processing Technique, Regional Innovation and Social Shaping of Technology

Several research papers and literary works available in literature on Seabuckthorn processing and technology associated with it. Some of them are:

1) *Seabuckthorn In Trans-Himalyan Ladakh : Primary Processing and Income Generation*

This paper was the outcome of work done by Stobdan et al. (2013) on Seabuckthorn in Leh based research unit known as DIHAR established by DRDO. In this paper they thoroughly described how berries are harvested, collected, washed and processed further to form Seabuckthorn Juice and other products. This paper also talks about the rate of collection of berries and the percentage of berries processed by cooperative societies and private firms.

2) *Seabuckthorn in Ladakh*

This paper was written by OP. Chaurasia and others in the year 2012. In this paper they beautifully described the patented technology developed by DRDO in Leh.

3) *Indigenous Techniques of Product Development and Economic Potential of Seabuckthorn : A Case Study of Cold Desert Region of Himachal Pradesh, Indi**a***

Although the area of research was mainly in the state of Himachal Pradesh, but they also include Leh district of Ladakh region in their study. Kullu district of Himachal pradesh and Ladakh has cultural similarities and natives of both the places use Seabuckthorn in their daily life. This research paper was written by Singh and Butola and others in the year 2012. Title of the paper reveals the local methods employed for processing of Seabuckthorn. Methods of processing for the formation of different Products like ‘berry Juice’, ‘Wine preparation’, ‘Jam preparation’, ‘Tea ‘are described in detail

4) *Development of Seabuckthorn Mixed Fruit Jelly*

This paper was accomplished by Selvamuthukumarn and others in 2006. Mixed fruit jelly is prepared by using Seabuckthorn, papaya and watermelon.

5) *Seabuckthorn Products : Manufacture and Composition*

Tom Beveridge and others has written this paper in the year 1999. Here the details of Seabuckthorn processing have been given. How berries are harvested, cleaned and processed to form Seabuckthorn beverages are been discussed in great detail. With the help of table and charts the paper has explained in detail the nutrient content of Seabuckthorn Juice.

6) *Regional Innovation System: Institutional and organisational dimensions*

This paper was written by Phillip Cooke in the year 1997, explores the issue of Regional Systems of Innovation. This paper acknowledges the major contribution of scientific research on National Innovation Systems. With evolutionary economics standpoint, the paper specifies the concepts of 'region,' 'innovation' and 'system'. This paper ends up by advocating strengthening of regional level capacities for promoting both interactive innovation and systemic learning.

7) *Regional Innovation Systems Clusters and the Knowledge Economy*

This paper was written by Phillip Cooke and others in the year 2001. Following the discoveries of innovation analysts, economic geographers and regional scientists they beautifully present the idea and content of regional innovation system. This paper concludes by advocating wide spread public innovation support system with strong organizational and innovational support from the private entities**.**

8) *Regional Innovation Systems: The integration of Local 'sticky' and Global 'Ubiquitous' Knowledge*

This paper systematically examines the regional innovation system in three places in Norway dominated by Ship building industry, mechanical engineering and electronic industry. This paper emphasised how firms in these respective places are using local resources as well as external-world class knowledge to increase their competitiveness**.**

9) *One size fits all? Towards a differentiated regional innovation policy approach*

This paper was written by Todtling and Trippl in the year 2005. Here the focus is made on innovation, especially on regional system of innovation. They argued from the last few decades regional innovation system is playing a great role to bring development from the grass root level. This paper argues by proposing various innovation related policies depending the region concerned.

10) *The Social Shaping of Technology*

This was written by Mackenzie and Wajcman in the year 1985. Then series of editions published further like in 1987, 1988, 1990, 1992, 1993, 1994, 1996, and 1999. This paper outlined the broad contours of social shaping of technology, like origin of the concept of social shaping of technology, economics of social shaping and gender and social shaping. This paper talks about 'technological determinism' which was seriously criticised. As a result of this critique of technological determinism, concept of social; shaping of technology emerges. This paper makes special focus by outlining the issue of gender and economics as important factors in social shaping.

11) *The social shaping of technology*

This paper reviews the previous researches accomplished on 'social shaping of technology'. Written by Williams and Edge in the year 1996, this paper explores how the design and implementation of technology are patterned by range of socio-economic factors. This paper levels a sharp criticism on linear model of innovation (discussed in detail in chapter second) and support social shaping of technology instead. This paper argues by saying that SST offers a SST offers a deeper understanding and also potentially broadens the technology policy agenda.

Based on the literature review, it was found that none has worked on the socio-technical perspectives of Seabuckthorn in Ladakh. The people's behaviour towards the technologies were never been explored and the way these technologies would have shaped the local manufacturing never been focused. Moreover region specific industrial development, linkages between various actors like Government, DRDO, firms, households and Amchies have been completely untouched. Therefore, following research objectives and research questions will be studied.

3.7. Research objectives

1. To identify the key factors responsible for the beginning of Seabuckthorn processing in Ladakh and the different techniques and methods used in this regard.
2. To understand the correlation between Seabuckthorn is processing and RIS, including the socio-cultural factors shaping the technology in Ladakh.

3.8. Research Questions

1. How Seabuckthorn processing activity begins and what are the factors which played key role in establishing Seabuckthorn processing industry in Ladakh region?
2. What are the different methods used by firms and cooperatives with respect to Seabuckthorn processing in Ladakh?
3. What are the stages of innovation at in Seabuckthorn processing? What is the pattern of its development?
4. What is the kind of linkages found among the different stakeholders in the industry? To what extend the innovation taking place are related to the regions, knowledge innovation and different actors related to the industry?
5. How innovative technology in Seabuckthorn processing has been shaped by socio-cultural factors and what is the people's response towards this new technology in Ladakh

CHAPTER FOUR

METHODOLOGY

4.1. Introduction

The present study undertakes case study as a research methodology under the Regional Innovation System and Socio-technical Framework, to reach the overall aim of the research. Through these frameworks we are trying to understand the nitty-gritty of processing techniques when local methods and DRDO based techniques are used. Both secondary and primary sources have been used. For secondary sources, literature review is undertaken. In this way, a complete framework of Seabuckthorn processing is outlined. Through the literature survey and historical account of this case study, research questions and research objectives are designed. The logic behind using case study method is that the present work is looking for understanding the local and non-local methods using for Seabuckthorn processing. To accomplish this both qualitative and quantitative approach has been taken. But mostly I have relied on qualitative approach. Moreover, based on that different sets of questionnaire were prepared to interview firm, household and Amchi practioners by involving them in discussion. Direct observation of the techniques and methods used by the above mentioned stakeholders was also carried out. Based on these activities data is collected. They are analysed and inference is carved out to reach the overall aim of the research. Analysis is done in Chapter Five.

This chapter is categorised into following three sections: Section 4.2 outline the study site; Section 4.3 enlisted the data sources and data collections under which primary and secondary sources have been discussed ; Section 4.3 is all about methods employed for the present research.

4.2. Study Site

The study was conducted in trans-Himalayan Ladakh region, which is famously known as ‘cold desert’, due to its harsh weather. Ladakh is one of the three major divisions of Jammu

and Kashmir State, covering an area of more than 80,000 square kilometer. The winter temperature can be as low as minus 40 degree Celsius. Human habitations are found in areas of over 3,000m above the sea level. The recorded mean maximum and minimum Temperature during 2001-2011 at an altitude of 3,235 m mean sea level was 18.9 ± 9.5 degree Celsius -5.8 ± 9.8 degree Celsius respectively, , while the mean maximum and minimum relative humidity was 35.5 ± 7.3 % and 25.0 ± 3.7 %, respectively. The annual precipitation during the same period was below 200 mm, of which more than 70 % was in the form of snowfall (Korekar, 2013).

Present study is carried out in different parts of Ladakh, mainly focussed on those areas, where Seabuckthorn plant is processed. Ladakh region has two districts, one is Kargil and other is Leh. Areas like Leh town, Chuchot, Nyoma, Nubra in Leh district and Sankoo, Panikhar, Zanskar and Drass in Kargil district are focussed. However the major study was carried out in Leh district, where the possibility of Sea buckthorn processing unit is more.

Ladakh consists majorly of tribal population and their life style is environmentally viable, and mostly dependent on naturally endowed resources like plants and animals for their survival. Majority of the plants are medicinal in nature, and the same is used by the local 'Amchi practitioners' for medicinal preparation. Seabuckthorn is one of the important plants, which is used by the natives of Ladakh as source of food as well as medicine. This plant is socio-culturally adhered to the lives of thousands of Ladakhis. Seabuckthorn processing has effectively changed their lives of Ladakhis. The present study is to look for various processing units in Ladakh, in the areas mentioned above.

4.3. Sources of Data and Data collection

In order to study the Seabuckthorn processing through local and DRDO techniques, secondary and primary sources of data are used. These are explained briefly in the coming sub-sections. Data collection is made for both, local methods as well as modern DRDO based modern technology and techniques of Seabuckthorn processing.

4.3.1. Secondary Sources

Secondary sources are collected from books, journals, research papers, articles, government reports and documents, academic institutions and their reports including online materials and

information have been used. As already mentioned, literature review is put together with the aim of making a consolidated study on Seabuckthorn processing. Online information and materials have been collected from several articles, papers and official websites of government organisations and institutions. The secondary sources were fruitful to build up the background, argumentative links, and information including effective analysis in the study.

Online sources

Several online websites are visited for literature survey. These sources are extremely helpful during the course of my study. Online sources provide huge opportunity to get acquainted with the recent updates and information. In my study, several government websites and portals have been focussed. It is apt to give an account of government websites.

Government websites

The logic behind using government websites is their reliability. Following are the list of websites used for literature survey.

1. **Defence Research Development Organisation (DRDO)**

DRDO is one of the leading organisations under the Ministry of Defence. DRDO has established Defence Institute of High Altitude Research (DIHAR) with the motive of making R&D efforts and become world class leader in the area of cold arid agro-animal technologies. This institute was formerly known as Field Research Laboratory (FRL) and was established in 1962. The information on Seabuckthorn and its processing were accessed by using the website www.drdo.gov.in. Information regarding Seabuckthorn plant, processing and products are mentioned in the website.

2. **Research Gate**

The information can be accessed by using the website researchgate.net. It is the authentic and most reputed site for scientists and researchers to share scientific work, papers, ask and answer questions. By using this website, several research papers and articles on Seabuckthorn

processing and techniques were accessed. These papers are extremely helpful as they were very specifically produced on Seabuckthorn processing. Through researchgate, one of the senior research scientists working at DIHAR (Leh), cooperated us in understanding the processing techniques of Seabuckthorn. The research scientist is from the native of Ladakh, thus immensely helpful during the course my study at DRDO, Leh.

4. **Website of Ladakh Autonomous Hill Development Council (LAHDC)**

In Ladakh, the concept of Hill Development Council was first came in 1995, when district Leh of Ladakh region was able to convince the central government for devolution of power at grass root level. It was patterned on the basis of Darjeeling Hill Development Council. In district Kargil, it was introduced in the year 2003. Information regarding both the LAHDCs can be accessed at both the districts which can be accessed at leh.gov.in and kargil.gov.in. Data and information regarding the socio-cultural milieu of Ladakh region are available, including the use of Seabuckthorn plant by the natives. Much of the information regarding processing techniques are not available on the respective sites, although it was useful to know the lifestyle and utilisation of naturally endowed plants, including the plant of my case study.

5. **Ministry of AYUSH**

The information can be accessed by using the website ayush.gov.in. The relevance of my research with AYUSH can be justified on the ground that it talks about 'Sowa-Rigpa'[23] orAmchiSystem of Medicine. This medicinal system is centuries old and has been practiced in Ladakh since time immemorial. Seabuckthorn is used by the local Amchies, as a source of medicine. Raw material of this plant is processed by using localAmchimethod for making different formulations.

[23] Sowa-Rigpa or Amchi system of medicine is a centuries old traditional medical system that employs a complex approach of diagnosis, incorporating techniques such as pulse analysis and urinalysis. It utilizes natural materials such as plants and minerals and physical therapies such as Tibetan acupuncture to treat diseases.

6. **DRDO Publications on Seabuckthorn**

Regarding Seabuckthorn processing technique, several research papers are published. The techniques are described in great detail in these papers. Through these papers we come to know about the R&D efforts by DRDO to maximise the benefits of Seabuckthorn especially for the local people. Another interesting thing about these publications is there focus on Innovations brought by the research scientists at DRDO regarding the processing techniques of Seabuckthorn. These innovations are of immense help for me to make a comparative study of local methods and innovative processing techniques in Ladakh.

4.3.2. Primary sources

During the course of my study, 'semi-structured open-ended' interviews were conducted. Besides this, 'direct observation' was also made to get the first hand data and information on my case study. The reason behind using semi structured interviews is that I can pre-establish a set of questions to know more information about the research problem. If new issues come across, that were not originally part of the interview, I could have enough liberty and flexibility to add or remove questions from the schedule based on the results of each interview. Interestingly, semi-structured interviews give us the opportunity to probe for more detailed information by asking the respondent to give more clarification to his answer, and the same have been experienced in field during the course of my study.

Different firms, organisations (like DRDO), government cooperatives as well as Amchi shops were studied at different places in both Leh and Kargil. Sample was studied at 4 distinct places viz. Leh town, Chuchot, Nyoma, Nubra in Leh district; and 4 in Kargil district viz. Sankoo, Panikhar, Zanskar and Drass. The logic behind selecting these places in particular is because of the better prospects of getting information and data as compared to others. In Leh district, there several firms both local and non-local engaged in processing of Seabuckthorn. The same district has research organisation i.e. DIHAR, under the control and regulation of DRDO. Around fourteen firms have been enlisted in Leh, including DIHAR and government cooperatives, and accordingly fourteen interviews were conducted. Beside this ten Amchies were also interviewed to give their account on different uses of Seabuckthorn, as well as the procedure of medicinal preparations. Although they responded to the queries regarding the uses of Seabuckthorn, but were reluctant to answer the queries regarding the techniques of

medicinal preparations. Eight households were also interviewed in Leh district, to know, how locally Seabuckthorn is processed. Thus total of thirty two interviews were conducted in Leh district. In my survey I do not come across any existing firm in Kargil district engaged in Seabuckthorn processing; although there are several Amchi practioners in Kargil too. Seven of the Amchi practioners were interviewed in Kargil. Beside this, eight households were also interviewed at different places in Kargil. Thus total of fifteen interviews were conducted in Kargil district of wild Seabuckthorn plantations. Out of the four places mentioned above, three individual in each was interviewed.

Three sets of questionnaire were prepared, due to the different kind of stakeholders involved. One set is for the manufacturing units or firms. Another set is for Amchi practitioners and households. The questionnaire is semi-structured and open-ended.

The questionnaire with respect to the firm level, were divided into following sections:

1) *Basic profile of the firm*

Questions related to the socio-cultural and historical factors associated with the firms were asked to them. These questions give an insight of the prospects of Seabuckthorn processing in Ladakh. Qualification of the firm owner give an idea about the strength and integrity of the firm, meaning if people with good qualifications and professional backgrounds are owning these firms, then we can think of better prospects of the concerned firm. Similarly questions regarding R&D and investments are helpful in understanding the research potential, production capacity and prospects of research and innovation in the firm. Question regarding annual sales turn over give an idea about the demand of Seabuckthorn products in the market. It also tell us about the adoption of new technology to increase the production of these products.

2) *Use of Seabuckthorn plant for processing*

These set of questions give an idea of the economic importance of the plant. Making of different product is heavily affected by the type of plant being used for their manufacturing; For example berries are more in demand than leaves for making nutritional drinks, jam etc. while leaves are hardly used for making tea only or used as fodder. This question also give an idea of the level of exploitation and anthropological threat to this plant, meaning if the whole is used then it may be uprooted, leading to the destruction of whole plant and heavily affected the environment and biodiversity.

3) *Technologies and techniques used by firm*

These questions are asked s to get an idea of the processing techniques employed by different firms. Also it gives an insight, whether the firm is industrially more creative and innovative with respect to the technology they are employing. Similarly it also point towards inter firm innovation. The level of awareness to entrepreneur or firm owner regarding innovation or innovative technology may increase the chance of more success to the firm and increase the production to many fold.

4) *Shaping of technology*

The set of questions were asked is to get information regarding the influence of technology over the common people. This would reflect the influence of this technology on local people and whether the response of the people is positive or negative. According to the people's response, firms may change the formulation and adoption of technology.

5) *Research activities*

Response to these questions would quantify the novelty of the firm or organisation. It gives an idea of the research conducted by the firm/ organisation. The research may be either conducted by the firm on their own or with collaboration. Qualification and expertise of the research personnel would give an idea of effectiveness of the research activity.

Another set of questions are framed and asked to the Amchi practioners and households:

1) *Parts of the plant using for preparation, formulations and product formation*

These questions give an insight about the perception of the people towards its use and economic importance. These questions check the awareness of the people about its nutritional content and other health benefits. Similarly, these questions throw some light on historical accounts of this plant.

2) *Local methods employed for formulations and product formation*

These ranges of questions are asked with the aim of getting information and data regarding local method of Seabuckthorn processing, range of products produced, popularity of the plant and its products among the common household, level of advancement and weaknesses of local method as compared to the DRDO based technology. These questions are also asked to understand the impact of modern technology on local methods and its future course.

Direct observation

This type of observation implies that the observer watches and listens to events directly. The observation can be guided through a set of questions that an investigator attempts to answer (Thomas, 2003).

Patton (2002) identified several advantages of using the direct observation method. This technique enables the observer to: understand and capture the setting within which people interact; see and discover things that people in the location have not paid any attention to; get things that people will be reluctant to talk about in an interview, i.e. critical issues; go beyond the selective views of people (i.e. participants in interviews); being open, inductive and discovery-oriented to help the observer to obtain great experience about the phenomenon

During my survey of different firms, organisations, Amchi shops and different households, there have been lot of factual things I have observed. Machines used by these firms are personally observed. My visit to local Amchi shops and household was immensely helpful to give an account of the plant and its processing by using the indigenous or local method. How things have been changed with the establishment of DIHAR and the patented technology and techniques provided by DRDO was also possible with direct observation.

4.4. Method

By using the direct observation method and interviews, the data collected are huge and vast. The collected data is categorised into variables. Analysis of the data is both qualitative and quantitative. Conceptual qualitative methods are emphasized in the study.. Based on the collected data, some flow charts and tables are generated containing the useful information on the number of firms, households and Amchi practioners.

4.5. Research objectives

- To identify the key factors responsible for the beginning of Seabuckthorn processing in Ladakh and the different techniques and methods used in this regard.
- To understand the correlation between Seabuckthorn processing and RIS, including the socio-cultural factors shaping the technology in Ladakh.

2.6. Research Questions

1. How Seabuckthorn processing activity begins and what are the factors which played key role in establishing Seabuckthorn processing industry in Ladakh region?
2. What are the different methods used by firms and cooperatives with respect to Seabuckthorn processing in Ladakh?
3. What are the stages of innovation at in Seabuckthorn processing? What is the pattern of its development?
4. What is the kind of linkages found among the different stakeholders in the industry?
5. To what extend the innovation taking place are related to the regions, knowledge innovation and different actors related to the industry?
6. How innovative technology in Seabuckthorn processing has been shaped by socio-cultural factors and what is the people's response towards this new technology in Ladakh?

CHAPTER FIVE

SOCIO-TECHNICAL ASPECTS OF SEABUCKTHORN PLANT: OBSERVATION AND ANALYSIS

5.1. Introduction

This chapter is an attempt to put all the observed facts and data which I have collected during field work. It has been a worthy experience to see the manufacturing of Seabuckthorn infield. Being a student of botany till my post graduation, I enjoyed the Seabuckthorn plantations including their processing. During the interview with different stake holders I came to know the history of Seabuckthorn processing and the contemporary practices firms and cooperatives are following. Roughly there are three stages of Seabuckthorn processing in Ladakh if we go by history. In the first stage, Amchi practitioners played a vital role. In the second stage few local firms and cooperatives come on the scene. In the third stage DRDO based technology and method revolutionizes the Seabuckthorn processing industry.

Seabuckthorn processing industry in Ladakh represents the 'territorially embedded regional innovation network' type of RIS. This type is quite similar to what Cooke (1998) referred to as "grassroots RIS". Among the type this is a 'peripheral region' with organizational thinness and less institutional support. Among the three stages of Seabuckthorn processing, third stage is the advanced one. The first two stages have several challenges and problems associated with them. Third stage is characterized by the intervention of DRDO/DIHAR. In this stage production was increased many fold. There is also increase in the diversity of products. But this stage is also not devoid of challenges and problems.

The chapter is divided into divided into eleven sections. First five Sections is the 'Observation' part of the chapter and next six sections included the 'Analysis' part 5.1 is introducing the chapter; Section 5.2 with the title of 'processing of Seabuckthorn plant in Ladakh: An observation'; Section 5.3 with the title processing of Seabuckthorn plant; Section 5.4 describes the perspectives of the people; Section 5.5 discusses the environmental implications of Seabuckthorn processing in Ladakh; Section 5.6 with the title 'Seabuckthorn

processing: A RIS and SST perspective; Section 5.7 describe first stage of Seabuckthorn processing; Section 5.8 describes second stage of Seabuckthorn processing; Section 5.9 describes third stage of Seabuckthorn processing; Section 5.10 discusses the knowledge diffusion and linkages between different actors; Section 5.11 is a debate on women and Seabuckthorn processing in Ladakh.

5.2. Processing of Sea buckthorn plant in Ladakh: An Observation

It has been a wonderful journey to observe the processing of Seabuckthorn plant, which has lot of economic and ecological importance. Almost whole of the plant is being used by the natives for different purposes. Berries and fruits are processed for making different products both at the level of firm and households including by Amchi practioners. Seabuckthorn products have unbelievably changed the lives of thousands of Ladakhis, by acting as a supplement of food, medicinal preparation for various diseases as well as source of income.

During the course of my survey at different places in Ladakh, I came to know the formal beginning of Seabuckthorn processing. During the interview and discussion with one of the retired officers of Cooperative department and several firm owners, who have years of experience in Seabuckthorn processing told the history of processing of this plant. Earlier people consume raw berry just for the taste and no processing method was available to convert these raw berries into products like juice and jam. For the first time a non-local firm named as ‘Ladakh Foods Limited’ starts processing this plant in 2004 and earned huge profit. But the same firm indulged in scam and later on it was shut down.

The local administration Ladakh Autonomous Hill Development Council (LAHDC) at Leh took the cognizance and completely banned that firm on the basis of fraudulent activities. LAHDC Leh, then assumed the whole control of Seabuckthorn processing and its related activities. Later on Cooperative Department was given the charge of the Seabuckthorn collection and processing. Local people formed different cooperative societies including the women-cooperatives to process this wonderful plant. Women participation in this job gives a clear picture of gender division of labor, where women population is too engaged in income generating activity. These cooperative societies with the help of NGOs learned how to process different parts of this plant especially berries and leaves. But the rate of processing and product formation was not that high, because the various stages of processing were done manually and mechanization was hardly at their disposal. The locals called this processing technique as local technique or local method. However the local method is too standardized

and regulated under the guidance of government officials specially those of Horticultural Department.

But the revolution in Seabuckthorn processing began, when DRDO (Defense Research Development Organization) establishes DIHAR[24] (Department of High Altitude Research) at Leh. After the years of research by scientists at DIHAR on Seabuckthorn, an innovative technology was invented. The technology was patented and later on given to the firms and local people in the region. A proper processing technique is also proposed. Scientists at DIHAR developed several products using this new technique. This newly designed technology and technique is being used by almost all the firms in the region for processing.

There is range of technologies used for Seabuckthorn processing in Ladakh. These include the local technology and techniques used by households and local cooperatives. Secondly, firms majorly use DRDO based technology and techniques. It is important to mention here, that during primitive time, people were aware of the significance of this plant and have been used by local Amchi practioners for medicinal preparations. But there was no technique and technology available to them for the processing of Seabuckthorn. This was mentioned in one of the interview that people used to pluck the berries and ate them raw. However, its sour taste made it non-palatable.

5.3. Processing of the Seabuckthorn plant

As it is already mentioned, that this plant is economically and ecologically useful. All the parts of this plant are used by the natives of Ladakh. However, fruits, seeds and leaves are processed at the level of firms, cooperatives and by Amchi practioners, for the formation of different products and formulation. Berries of the plant are processed, due to the high quantity of nutritive substances like Vitamin A, C, E, K, proteins, carotenoids, flavonoids and organic acids, steroid (Rongsen, 1992). Seeds are processed due the availability of Omega-7 in oil extraction of the seeds which is useful for the prevention and treatment of many diseases. Capsules of Omega-7 are manufactured using the seeds of this plant by different firms.

[24] DIHAR: earlier named as Field Research Laboratory (FRL). It was established in the year 1962 by DRDO

5.3.1. Methods of processing

As I mentioned in the previous section, that Seabuckthorn is processed at different levels: first at the level of firm, second at the level of households and cooperatives, finally at the level of Amchies. These include local method, DRDO based technique, technology and method used by Amchies for medicinal preparations. In the following sections, these methods are described in detail.

5.3.1.1. Local method

This method is used by households, women cooperative societies, for the formation of different products. Berries, seeds as well as leaves are used for this purpose. The range of products formed using local method includes: berry juice, jam and tea. Here we are going to discuss preparation of berry juice first, using local method.

a) **Preparation of Berry Juice**

Following are the stages involving in juice preparation:

1. *Berry Harvesting*

   Harvesting of the berry is done by using 'beating the bush' method in the month of September. For this purpose polythene sheet is spread on the ground just below the canopy of Seabuckthorn plant. With one hand tip of a tender branch is held and the branch is beaten with other hand. Berries are then collected from the polythene sheet in a bucket.

Photo 7: Berry Harvesting

Source: Research Paper[25] (URL retrieved on 10/04/2017)

Berries are harvested in the morning, as advised by the experts and special instruction from the forest department, with the objective of easy harvesting of the berries without damage to the shrub. Over riped berries are not generally harvested. Local communities require the permission of Forest Department in the under its jurisdiction. This step is common in both local method as well as non local method (DRDO designed technological method).

One of the serious issues with this method of berry harvesting is, that beating the bush seriously damaged the tender branches. In China, where Seabuckthorn is processed at a very large scale, and berry harvesting is done with specially designed machines, which could easily harvest the berries without damaging the plant.

Looking at the seriousness of the issue, LAHDC Leh, recently requested DIHAR to invent berry harvesting machine, so that damages to the Seabuckthorn plant can be avoided.

[25] http://www.researchgate.net/publicarion/262298423

2. *Berry cleaning*

This is an important step to remove damaged berries, leaves, twigs and other debris collected during harvesting time. This is simply done by hand picking and no special machine or technology is used. But for advanced and non-local method there is a special technology for berry cleaning. We will discuss that in the coming sections. Fresh fruits gathered in a pan are thoroughly washed with the running water.

Photo 8: Pruning of leaves and damaged berries

Source: internet[26] (URL retrieved on 10/04/2017)

[26]https://www.google.co.in/imgres?imgurl=https%3A%2F%2Fpermies.com%2Ft%2F13986%2Fa%2F8916%2FCollecting-seabuckthorn

3) Follow on steps

Fresh fruits are then put in a jar and are thoroughly crushed and sieved with the help of a sieve. The seeds and pulps are separated. The extract is sun dried and subsequently used for making tea. According to the quantity and amount of juice, sugar is added with the juice. KMS (potassium metabisulphite) powder is added in the range of 0.25-0.30 g/liter. KMS is a preservative and preserve the juice for at least two years. Then it is stored and sterilized in a cool place.

Photo 9: Local women making Seabuckthorn Juice

Source: Internet[27] (URL retrieved on 12/06/2017)

b) **Preparation of Jam**

[27] **http://www.thehindu.com/thehindu/yw/2003/10/04/stories/2003100400020200.htm**

First step is the harvesting of berries and their subsequent collection. This step is similar to that of preparation of berry juice, which we have discussed before. Fresh berries are then collected in a pan and washed with clean water. Berries are then crushed and extraction of juice is made with the help of sieve. The residue formed in the form of seed and pulp is later on processed for tea preparation. On an average every 2.5 kg of fresh berries produce 1.5 liter of juice. Subsequently 0.5kg of sugar is added to the juice and boiled till the formation of jam. KMS powder is added as preservative. The jam is stored in sterilized bottles and kept in cool places.

c) **Preparation of Tea**

Tea can be prepared either from leaves or from fruit pulp.

Leaves

Mainly leaves from the male plant are used for this purpose. Leaves from the female plant are usually avoided, because of the lesser amount of biochemical constituents present in them. The leaves are then dried for a week under shade. 3-4 completely dried leaves are added in one cup of water and then boiled for 4-5 minutes. Then one tea spoon Sugar is added. Thus tea is ready.

Fruit pulp

This is again a simple method in which residues of pulp is obtained while extracting juice. This is also used for making tea. The residues are sun dried and packed in paper bags as Seabuckthorn tea. Preparation of 2 cup of tea, require 2 cup of water and 1 tea spoon of dried pulp residue, small amount of ordinary tealeaves including 2 spoon of sugar. Then the mixture is boiled for around 10 minutes. Thus tea is ready.

5.3.1. 2. Non-local method (DRDO designed technology and technique)

This method is based on the technology invented by DRDO few years ago. As mentioned before in this chapter that this method has revolutionizes the Seabuckthorn industry. The amount of Seabuckthorn product formation was increased many fold since then. The patented technology was given to government cooperatives, local and non-local firms. The research

scientists at DIHAR also designed innovative methods for the manufacturing of different products. Today the entire existing firm is using non-local method in one or the other way. The range of products formed by using this method includes: Berry Juice, Berry Jam, Tea, Omega-7 fatty acids.

a) Preparation of Berry Juice

The following steps involved in juice preparation:

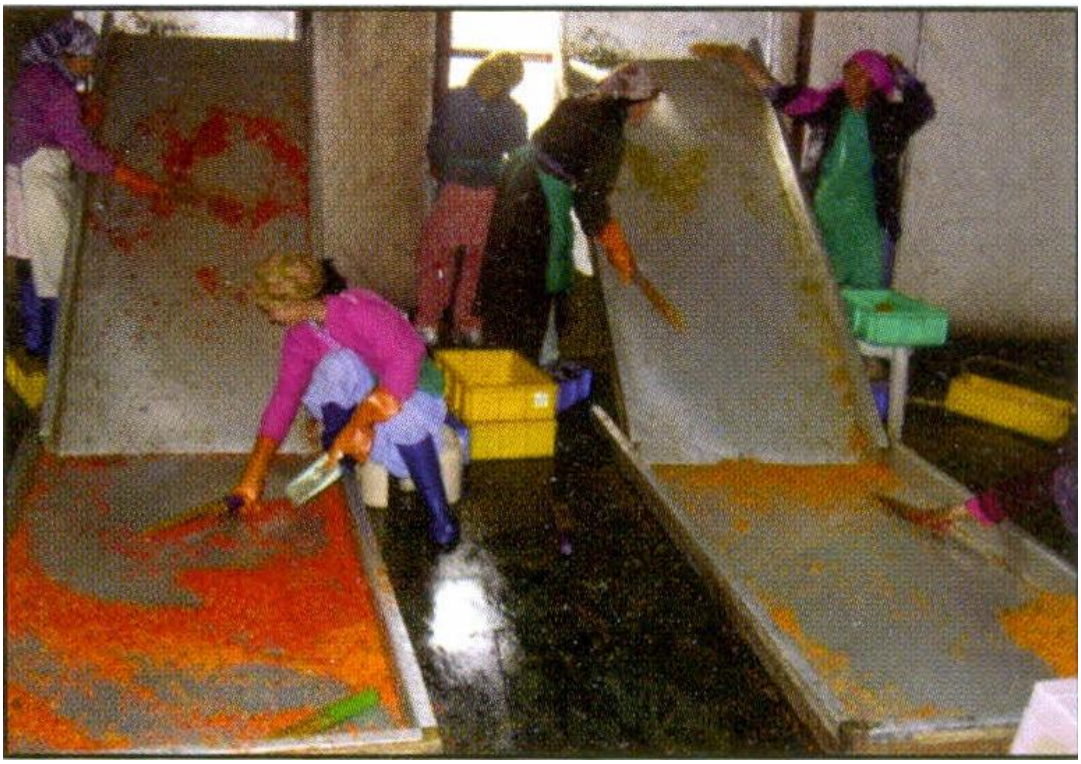
1. Harvesting of Berries

This step is similar to that of local method. But the amount of berry collection is more, because of its use at firm level and for the reason of commercial motive. Berry harvesting is done for a shorter period of around 30 days in the month of September. In Ladakh overripe berries are generally not harvested. In an interview with one of the government official, private firms are harvesting 48.6% as compared to the Cooperative Society whose share is 51.4%. However the situation is changing as more and more firms and private players are taking interest in Seabuckthorn processing.

1) Berry Cleaning

Berry cleaning is an important step, in which damaged berries, leaves, twigs and other debris collected during berry harvesting is removed. The first step involved here is that of rolling the berries on a specially designed rolling sheet of aluminum having the size of L×W: 7’6" × 3’, at an angle of 40-50°. The surface of aluminium sheet is kept wet. The damaged berries, leaves and other debris stick to the wet surface and subsequently they are removed. The leaves, damaged berries and other debris that does not stick t to the surface are removed by hand. The berries are then washed in a specially designed container. The damaged berries and leaves pop on the surface and they are skimmed away with a sieve water is drained and the berries are ready for the next important step of Juice extraction.

Photo 10: Berry Cleaning Technique



Source: Research Paper (Chaurasia et al., 2012)

Photo 11: workers cleaning berries using container, designed by DRDO

Source: Field Work

2) Juice Extration

Extraction is done in a pulper. It is again designed by DRDO, having main body and two ends. Main body of this machine contains the motorable parts. From one end berries are feed to the pulper. Berries are crushed and juice is extracted from other end of the pulper. With the use of this specially designed pulper, juice extraction is easy process as compared to the local method, where this is done manually by using pestle and mortar and is cumbersome. In my observation-cum interview at the site of juice extraction, the firm owner reveals that during the extraction process, 73.82 ± 3.33% pulp and 24.14 ± 2.96% cake containing unbroken seeds are obtained.

Photo 12: juice extracting machine or Pulper

Source: Field Work

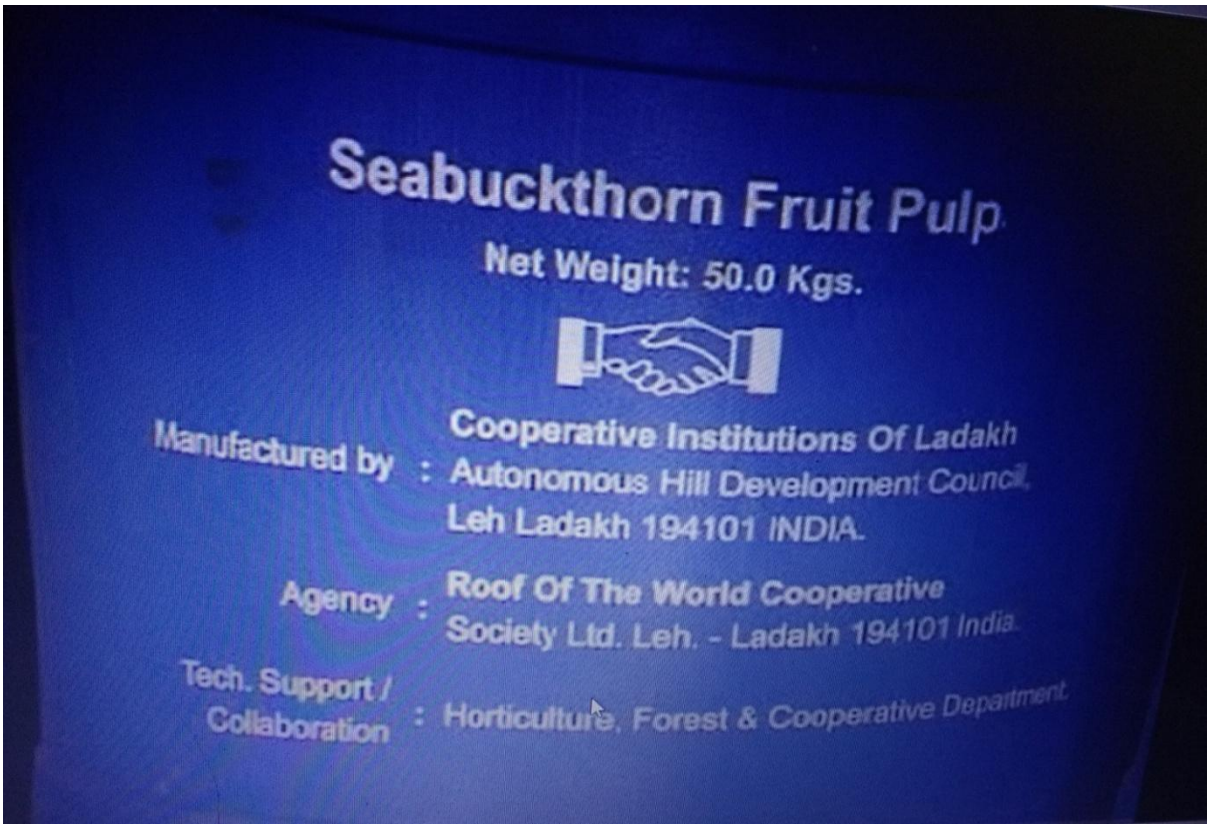
Photo 13: Side view of the pulper

Source: Field Work

3 *Packaging*

This is the final step, in which the extracted juice is collected in food grade 50 kg capacity Drums. Then potassium metabisulphite (KMS) is added into the juice as preservative. The pulp is the main marketable component which fetches the value of around 60-110 kg. Sometimes pulp is then put into the filtration unit to get cake. The resulting cake is also packed in drums of 50 litres for sale. Cake is then sun dried and seed is separated by rubbing it with hand to get seed and the hull. Both of them are the source of valuable oil.

Photo 14: Seabuckthorn pulp storage drum



Source: Field Work

Flow chart of Seabuckthorn processing is shown below:

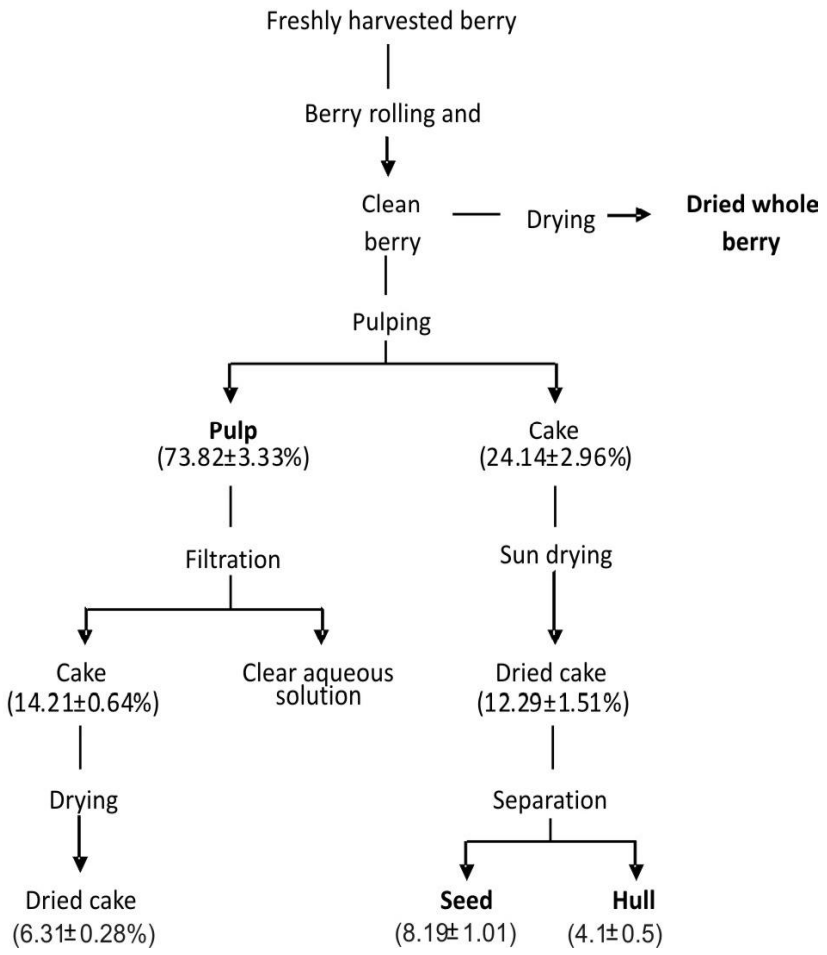


Fig 3: Processing of Seabuckthorn berry. Values in bracket show the percentage of various components obtained from processing of 100kgof clean berry (Source: Research paper; Stobdan et al., 2015)

2) Preparation of Jam

After the harvesting and cleaning steps, berries are partially crushed in specially designed mixer grinder gradually at low speed. Then seeds are separated manually and then partially crushed berries at higher speed to get the coarse pulp. Through stainless steel fine pulp is separated by filtering the coarse one pulp. Fine Pulp is heated to boil for 10-15 minutes in a

container. Add required amount of sugar as per the quantity of pulp and again boil for 10 minutes. Small amount of carrageenan[28] is then added after mixing them with remaining amount of sugar. Again boiled for 15-20 minutes. Now the jam is ready to fill in pre-sterilised glass bottles. Then it is allowed to set for 2-3 hours. Finally store at temperature of around 23 degree Celsius.

Photo 15: Seabuckthorn Jam

Source: Field Work

[28] Carrageenan is a carbohydrate, extracting from algal plant. They are widely used in the food industry for their gelling, thickening and stabilising properties

5.4. Amchi practitioners and techniques they are employing

Amchies or traditional health practioners uses Seabuckthorn for different medicinal preparations. In fact Amchies were aware of the health benefits of Seabuckthorn and they are using it since time immemorial. Upon visiting their Shops for the purpose of interviewing them, they initially hesitate to respond, but later on answered some of the questions. Although they tell us the importance of Seabuckthorn in medicinal preparation and cure of several diseases, but they could not respond to the questions regarding techniques of medicinal preparations.

So far we have touching almost all the contours of Seabuckthorn processing techniques and the technologies involved there in. Both local as well as non-local techniques are followed in Ladakh, thus immensely helping the natives of this remote region of India by meeting the demands of food, health as well as benefiting them commercially. It is important to mention here that Omega-7 fatty acids, which is one of the important by-product of Seabuckthorn is not usually prepared by the existing firms in Ladakh. Seabuckthorn seeds are exported within country from Ladakh, especially in Kerala, where seeds are further processed to manufacture this wonderful product.

5.5. Perspective of the people

People of Ladakh lives in an environment where living life is at nature's mercy due to the harsh climate prevailed over for most of the year. Seabuckthorn being one of the important plants in the region is a great hope for them meeting the demands of food, health, and also become a source of income in the recent years (ibid). With the increase in awareness about this shrub, people are getting attracted towards its processing. They are generating income out of it. Various technologies are being used in processing. The diversity of methods as we have discussed in the earlier section of this chapter, being practised by the people have different implications for them. There is no doubt that processing techniques and technologies are immensely helpful for them. However there are several implications with respect to the socio-cultural and environment aspects. Following sections will reveal the

people's response to processing techniques and technologies being used with respect to Seabuckthorn in Ladakh, including their ecological implications.

5.5.1. Response to Processing Techniques

When there was no technique and method available to process Seabuckthorn, and when there was no awareness and information available to the people regarding its nutrient contents, this plant was in oblivion state to the natives of Ladakh. Except the Amchi practioners using this plant for different medicinal preparations, majority of them were consuming the raw berry whenever they are passing from the dense population of Seabuckthorn in wild. People are not planting or growing Seabuckthorn till recent and we can imagine from this fact that processing of this plant starts only recently. As it is mentioned in section 1of this chapter that it was NGOs and government bodies who made the locals aware of the importance of Seabuckthorn and also guide them how to process this economically important plant. Initially the response to the processing of this plant was meagre, because it was new to them. People practiced this method at their houses and later on formed small cooperatives to process it. With the passage of time people come to know more about the value of this plant as a result more and more people get attracted in Seabuckthorn processing. But the kind of technology they were using was simple. Pestle Mortar, glass bottles, commonly using container in houses (locally called 'Zansbu' and 'silver') were used. This commonly practicing method using the simple tool is known as local method. One the important characteristic of this method is that processing is made at a very small scale. Despite of this it has benefitted the households and cooperatives because firm level competition was not there. When new technology was designed and firms were come up in this field, Seabuckthorn processing increases many fold. This new technology and technique has revolutionizes processing of the plant and increases the GDP of the region also.

5.5.2. Response to Innovative Technologies

In the midst of time when there was no innovative technology available at their disposal and people were practising local method for processing of Seabuckthorn, DRDO invented new technology to process it. This new technology was patented and given to cooperatives and firms to process Seabuckthorn. DRDO also designed new method for this purpose (ibid).

With the participation of cooperatives and firms Seabuckthorn processing and the production of various products increases many fold.

Although this new and innovative technology has been welcomed by the people, but it seems that all is not well at the level of household. Earlier households and small cooperatives were getting maximum benefit and good income, but with the adoption of this innovative technology by firms and their participation in processing of Seabuckthorn things have changed completely. Now local method is ignored by most of the stakeholders and adoption of new technique and innovative technology has been increased. In an interview, Sonam (owner of one of the house hold in Leh town) narrates "earlier I use to process Seabuckthorn and manufacture berry juice at home, now I have left the practice few years ago".

It is not the sad side of the story, because the new technological method has not left these households for none. This is because new technology has not been randomly given to few firm and few people. It is under the complete regulation of LAHDC (the local administrative body in the region). People are allowed to form cooperatives to process this plant. During the interview with members of a cooperative, it has come to know that this method has facilitated rather than making obstruction. As a result more and more people participating in the processing activity. Thus they are been provided with a better alternative where processing activity is not a cumbersome and production is more. This is an interesting fact that participation of people has enormously increased with the coming of new technology. Importance of Seabuckthorn has been sensed in remote corners of Ladakh and people are taking huge interest in Seabuckthorn including its processing. This all happens due to the onset and coming of new method. More and more cooperative societies and firms are coming up and more people are absorbing in the Seabuckthorn processing. Thus it has opened up more and more employment opportunities.

5.5. Environmental implications

Whether it is local or advance method of Seabuckthorn processing, environment is always on losing side in Ladakh. Although government has taken the control and regulating the processing activity, but there is no plan of afforestation or planting Seabuckthorn trees.

During the harvesting period, 'beating the bush method' is seriously damaging the plant. Sometimes they are plucking out the whole branch of this plant. Thus Seabuckthorn has been exploited at unsustainable rate which is a serious issue for environment lovers. It has been come to the notice that in remote corners of Ladakh, people are uprooting the whole plant. This practice may is not healthy. Thus it is the high time for all the stakeholders to think seriously on the issue, so that this plant could be saved and remain augur well for everyone.

Based on the above observations we are going to make analysis of the findings, so that the research questions could be answered and the objectives of research could be accomplished. In the following section we are focussing on analysis part which is the gist of present study.

ANALYSIS

5.6. Seabuckthorn Processing: A RIS and SST perspective

From the whole discussion of Seabuckthorn and its processing in various chapters, and the observations which were made during field study, several facts and findings have evolved. These findings are linked up with theoretical framework that substantiates uniqueness of the present study. These findings beautifully answer the research questions and meet the objective of research. Analysis of the observations and findings are made under several headings, so that it can be presented with more clarity and detail. As we know that Seabuckthorn processing is centuries old in Ladakh region, but from time to time the processing technique has been considerably changed. Thus Seabuckthorn processing evolves over a period of time which can be explained three stages.

5.7. First Stage of Seabuckthorn processing: The beginning of knowledge generation

Amchi processing technique is the representative of this stage. Amchies were the first in the history of Ladakh when Seabuckthorn was processed for the first time. Although their focus was on medicinal formulations but it was the beginning of Seabuckthorn processing. Amchies were using the traditional knowledge which was passing from generation to generation. So the knowledge sharing process in Ladakh region with respect to Seabuckthorn processing is very primitive. As 'Amchi system of medicine' is based on traditional

knowledge, the type of method they are using is still local one, meaning it is non-mechanical, where simple tools like pestle and mortar are being used. However this indigenous knowledge of Amchies were never translated into an industrial set up till date, which can otherwise be changed into a well established Amchi medicinal industry.

However local government extended its support in recent times to give it a proper organizational structure, so that it could be made an effective alternative system of medicine. In this stage of Seabuckthorn processing we are observing the kind of linkages established between Amchies and people with respect to knowledge sharing. Diffusion of knowledge and information from Amchies to the common people helped immensely to aware them about the importance of this wonderful plant. This knowledge sharing of Amchies made them understood that Seabuckthorn is not an ordinary plant. Amchies laid a fertile ground for the future, where people can use this knowledge and benefitted in several ways. In other words we can say that first stage of Seabuckthorn processing is the foundation for rest of the stages where we can see firm level development in processing and more knowledge diffusion, including more linkages between different actors namely Amchies and local people. The decade following the year 2000, has marked change in the Seabuckthorn processing which forms stage two as discussed below.

5.8. Second Stage of Seabuckthorn processing: An interaction among local actors

The second stage is characterised by the establishment of cooperative bodies and few local firms in the region to process Seabuckthorn plant. As we have seen in the observation part of this chapter, that knowing the importance of this plant, local government in Ladakh took special interest and also undertaken the responsibility to aware the locals with the aid of NGOs about the importance of this plant as well as its processing. This linkage and knowledge sharing between the government and people was an important and crucial step at this juncture for the future of Seabuckthorn processing in Ladakh region. Now there is a new phase of Seabuckthorn processing begun. In this phase Seabuckthorn was processed for the formation of different products unlike medicinal formulation by Amchies. Products like berry juice, tea, jam etc. were the outcomes of Seabuckthorn processing. Establishment of firms and cooperatives for Seabuckthorn processing and the role of government plus NGOs was an innovation in Ladakh region. This innovation was region (Ladakh) specific. As we have discussed in chapter two that a RIS is constituted of two subsystems embedded in a common

regional and socioeconomic and cultural setting: one is *knowledge application and exploitation subsystem*, other is *knowledge generation and diffusion subsystem*. Here in this second stage of Seabuckthorn processing, government and NGOs acting as the knowledge generation and diffusion subsystem, on the other hand, firms and cooperatives act as knowledge application and exploitation subsystem. Many actors involved in this stage of Seabuckthorn processing and there is a linkage between them. These actors are local government, NGOs, firms and cooperatives. This diffusion of knowledge between different actors is crucial for the sustenance of these firms and cooperatives involved in Seabuckthorn processing. But there is no cluster formation and R&D support base here. Firms are few and that too in a nascent stage of production. Lack of investment and lack of diffusion of technology is the root cause of backwardness, as they were using simple techniques and tool for Seabuckthorn processing. Although the method of processing was simple and only few products were formed in this stage of processing. But the contribution of this stage was significant because for the first time Seabuckthorn was processed for producing products other than medicinal formulations.

There is a an absence of organizations (in the research field, education, technology transfer) as well as major focus on strong orientation of existing institutions towards the traditional technological and economic structures that could lead to serve innovation problems. Another set of problems in this stage of Seabuckthorn processing was the lack of creativity among the actors. For example cooperatives and firms were not planning for something new; they were simply using the knowledge and information passed on by the government and NGOs. The reason could be lack of qualified and professional persons in these Seabuckthorn processing units. Also there is a lack of proper interactions and feedback system between different actors involved. Although government was making them aware of the importance of Seabuckthorn processing but there is no further push from the government regarding the technology transfer or allocating professionals in these firms and cooperatives to make them innovative or more productive.

Finally there is a complete lack of interactions and support from outside actors, meaning there is no collaboration between these regional firms and cooperatives with firms and organizations of outside state and no collaboration and support of international organizations. If external links and international collaborations are poorly developed, the respective regions could be devoid of international resources and knowledge. Use of potassium metasulphite

(KMS) was a significant feature of this stage. It is because of the interaction and knowledge diffusion between government and local people which could help in use of KMS as a preservative. Despite of the problems cited above, this stage of Seabuckthorn processing had contributed a lot in product formation.

However a government research body was established in 1962, known as Field Research Laboratory (FRL), now DIHAR for studying Seabuckthorn and developing the product and process. But its activity can be marked after 2000. With this third stage of Seabuckthorn begins. This stage is crucial for Seabuckthorn processing which cannot be understand without the first two stages as DIHAR has directly or indirectly acquired a lot of knowledge which has passed through these many years.

5.9. Third Stage of Seabuckthorn Processing: Advancement in technological innovation

This stage is characterised by the establishment of more formal organizational setup. Here the role of DRDO played a crucial role. Through its research laboratory at Leh, known as DIHAR, innovative technology was developed and patented. This patented technology was then given to the firms and cooperatives. As a result of this diffusion of technology, several local firms mushroomed in the region thus formed cluster. Since in the second stage of processing, firms and cooperatives were already established, DRDO played a role of value addition in third stage. Besides local firms, non-local manufacturers also increase in number. As we know that few non-local firms already stepped in and started manufacturing Seabuckthorn products in Ladakh region. Now the number of actors also increases in Seabuckthorn processing. The patented technology of DRDO played a revolutionizing role in Seabuckthorn processing as the manufacturing process becomes ‘mechanical’.

At this stage, we can say that it is a territorially embedded regional innovation system with institutional and R&D support through DRDO. This type of RIS is quite similar to what Cooke (1998) called as “grassroots RIS”. It means innovation at the bottom level where the common people can be benefitted more compared to the national level innovation where common people may not be benefitted often. As we have said earlier that the first two stages laid a perfect ground for the third stage which can easily thrive and more effectively benefitted the different stakeholders. Due to its rich local resources and the traditional

knowledge including the diffusion of knowledge from DRDO, Seabuckthorn processing at this stage in Ladakh region goes a mile away. There is a cumulative effect of knowledge at this stage which results in the success of Seabuckthorn processing and increases the regional economy. There is a participation of outside actors as DRDO is not a regional organization.

The current understanding of regional innovation systems (RIS) is that RIS should have several links with national and international actors, agencies, organizations and innovation systems. In this sense, third stage of Seabuckthorn processing is closely furnishing the criteria of successful RIS. Although international collaboration, knowledge sharing and funding is not visible here but DRDO is almost filling this gap, because the DRDO personnel are the reputed scientists whose expertise are definitely benefitting the Seabuckthorn processing industry in Ladakh region today. DRDO itself has national and international collaborations, thus it could have bring international expertise indirectly in Ladakh with respect to Seabuckthorn processing. Scholars like Bunnel and Coe (2001) believes that in the arena of international competition and tremendous technological change, extra regional contact which can accelerate the efficiency and compliment with the local ones are quintessential and of key importance. Another eye catching feature of this stage is the multi level governance which is important for the proper functioning of the Seabuckthorn industry in Ladakh. As we have seen that both local government as well as DRDO is governing the Seabuckthorn processing in Ladakh. Government is making a proper regulation for the time of harvesting of berries and the allocation of rights to process Seabuckthorn, meaning that one cannot harvest the berries and process Seabuckthorn at their will. Rather they have to take the formal approval from the government to do so. Government has formed several cooperative bodies to process Seabuckthorn, so that common people can get the employment opportunity in these processing units. DRDO is governing the Seabuckthorn processing by ensuring the proper use of its patented technology allocated to several firms and cooperatives. Also Seabuckthorn products manufactured by different firms and cooperatives are finally tested by research laboratory of DRDO i.e. at DIHAR. Hence several Scholars like Todtling and Trippl (2005) believes that multi level governance is imperative for the proper functioning of the RIS. The linkages between different actors and diffusion of knowledge among them including the presence of well developed institutions like DRDO made Seabuckthorn processing industry in Ladakh a successful one. The handsome expenditure and investment by DRDO as well as by the local government in Seabuckthorn processing has upgraded the regional economy. The innovation strategy developed new technology like the patented technology by DRDO helped

in developing new organizational practices, products, process and strengthened innovative practices of SMEs. This results in the strengthening of potential clusters in Ladakh region.

Although this is an advanced stage of Seabuckthorn processing in Ladakh. However there are several challenges and problems visible in this stage too. There is no dynamic cluster present which can bring innovation activities at their own. These clusters are directly or indirectly using the technology developed by DRDO and no efforts have been taken by these firms in this direction. In fact one reason could be lack of capital. There is a dominance of SMEs and R&D activities and product innovations new for the market are below average level. During the field survey it has come to my observation that most of the firms are producing two or three products like berry juice, tea and jam. The only difference visible is the packaging and labelling of products of different firms. Another factor which hampers the innovativeness of these firms is the low and medium level qualification of the firm owner and their workers. Also there is a weak networking developed with knowledge suppliers like universities and research organizations.

Despite of these challenges and problems, third Stage of Seabuckthorn processing is no doubt an advanced stage of Seabuckthorn processing in Ladakh region. DRDO and other actors have contributed a lot in flourishing this industry. These firms and cooperatives have opened up employment avenues to the people even though they are unskilled or less skilled. This absorption of people in firms undoubtedly increases the per capita income of the households and upgraded the regional economy in the process.

5.10. Knowledge diffusion and linkages among different actors: An integrated perspective

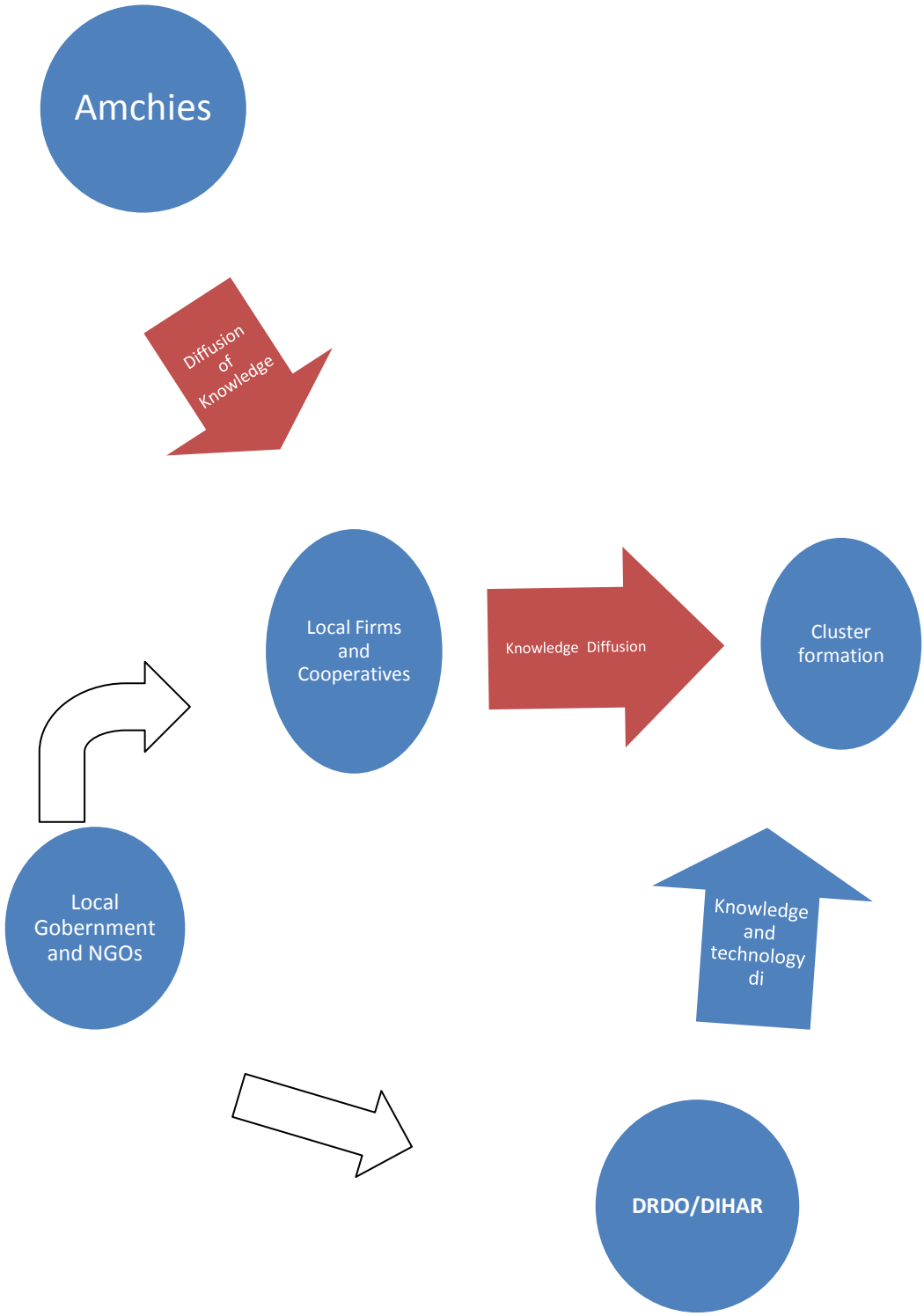
As we have seen that there are several actors and linkages among them in all the three stages of Seabuckthorn processing. Although there are several stages of Seabuckthorn processing but that does not mean they are separated altogether. In fact there is an integration and diffusion of knowledge among these actors of different stages. Because of this integration the shared knowledge keep on accumulating and finally helped in forming a successful Seabuckthorn processing industry. It is because of the demand of the people and their feedback that results in the formation of advanced technology and advanced method for Seabuckthorn processing. Although it was DRDO who invented the new technology but the

idea to go for this invention was the requirement and demand of the people. Thus socio-cultural factors definitely played a crucial role in shaping the technology. With the help of a diagrammatic representation we are going to comprehend these linkages and knowledge diffusion in fig. 4.

5.11. Response to innovative technologies

Innovation in Seabuckthorn processing has always been welcomed by the people. Although new technology has affected those firms using local method. However this new technology helps in mushrooming of firms, because more and more new firms were coming up and using the innovative technology. Doing so the overall production of Seabuckthorn products has been increased considerably. This innovative technology was not randomly given to the people, rather it was first given to the government cooperatives. Later on firms were also given this new technology under the governance of government and DRDO. Local method is cumbersome because the whole processing is done manually. New technology has completely changed the face of Seabuckthorn processing, where most of the processing steps are done by machines. New technology has considerably changed the Seabuckthorn processing industry in Ladakh, where not only production has increased but the diversity of products also increased considerably. Due to this new technology number of firms has been increased. As a result more and more employment opportunities are coming up in Ladakh region. Thus people are immensely benefitted by this new technology.

Fig 4: Diffusion of knowledge and linkages between actors of different stages



Source: Researcher's work

CHAPTER SIX

CONCLUSION

The research work was an attempt to understand the Seabuckthorn processing in Ladakh. In this study the emphasis was made on different processing techniques evolved from time to time. We discussed the different concept like technology, innovation, system etc. Region specific innovation and socio-cultural factors shaping the technology is majorly focussed in this study. Within the ambit of regional innovation system we found that Seabuckthorn processing in Ladakh is an example of 'territorially embedded type of RIS' which is also named as 'grassroots innovation'. Although Seabuckthorn processing was practiced in Ladakh since centuries by Amchies in 'Amchi system of medicine', but the indigenous knowledge of Amchies were never translated into an industrial set up till date. We found that Amchies only used Seabuckthorn for medicinal formulations but the actual beginning of Seabuckthorn processing begun only when local government took an initiative of knowledge sharing and informed the locals about the importance of this plant. It does not mean that Amchies played no role in establishing the modern Seabuckthorn processing in Ladakh. We have seen that in Ladakh there is a cumulative effect of knowledge sharing; meaning knowledge and information were passed on from Amchies to the people which act as precursor in establishing modern Seabuckthorn industry in Ladakh. Fig. 8 is an attempt to show how linkages between different actors helped in diffusion of knowledge to accomplish modern industrial setup of Seabuckthorn processing in Ladakh.

During the course of study, we found that Seabuckthorn processing has an evolutionary development. There are several stages of Seabuckthorn processing. Each stage has its own significance and role in shaping the Seabuckthorn processing industry. Amchies are the representatives of first stage, where processing was only restricted to medicinal formulations. At this stage people were benefitted by the knowledge diffusion from Amchies. In second stage few local firms and cooperatives began their journey in Seabuckthorn processing. The prime feature of this stage was that Seabuckthorn was now used for product formation other then medicines. Berry juice, berry tea and berry jam were some of the products produced at

this stage. For the first time natives of Ladakh were introduced with such products. In third stage which is the most recent and modern one is characterised by the production of diversity of products, which are not only consumed in the region but has also exported in other parts of the country.

The study indicates that there are several methods used in Seabuckthorn processing, ranging from 'local' to non-local methods. Local method is characterised by absence of machines, thus it becomes non-mechanical. While as non-local method is characterised by the use of machines, thus it becomes mechanical. The first two stages of Seabuckthorn processing is non-mechanical in nature, while as the third stage is mechanical in nature. However berry harvesting in Seabuckthorn processing is still manual or non-mechanical in third stage also.

It is manifested that People's perspective towards the innovative technology used in Seabuckthorn processing is interesting. Adoption of new technology has increased the production level and more and more people come forward in Seabuckthorn processing business. Thus increases the employment avenues and reducing the unemployment rate. But at the same time competition among the firms increases. Although technology has immensely benefitted the whole region but environment is severely affected. As we have seen that in Ladakh Seabuckthorn has been exploiting at an alarming rate and the method of berry harvesting is harming the berry plantation severely. Berry harvesting is done in wild and no step has been taken by the government for berry plantation. If the same method scenario continues than Seabuckthorn could be fall in endangered category soon in this cold desert region.

One of the significant findings of the present study is the women participation in Seabuckthorn processing. Women presence is more apparent in berry harvesting, sorting and cleaning of berries. This shows that women workforce is mostly restricted to manual work as compared to their male counter parts who are mostly dealing with the mechanical work. This point towards one of the important issue i.e. women are less skilled than men in Ladakh with respect to Seabuckthorn processing. The reason could be that education for girl child was a taboo till recently, as a result the present working women population in Ladakh with respect to Seabuckthorn processing is unskilled or less skilled. Thus they are assigned only the manual work by their employers in Ladakh. But today parents are ready to provide better education to their girl child also.

The findings point to one of the important feature, that most of the research works have been carried on phytochemical and botanical aspects of Seabuckthorn plant. In specific with Ladakh region there is no research work existing to understand the socio-technical perspectives and regional innovation with respect to Seabuckthorn in Ladakh. Thus the present study has able to find out the research gap and it was an attempt to fill this gap.

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ANNEXTURE

QUESTIONNAIRE FOR FIRMS, COOPERARIVES, AMCHIES AND HOUSEHOOLDS LEVEL INTERVIEWS

The questionnaire with respect to the firms and Cooperatives are as under:

I. Basic profile of the firm

1. What is the name of your firm?
2. In which year your firm has been established?
3. Where your firm is located and what is the reason behind selecting specific location?
4. When and how did you first think of becoming a Seabuckthorn entrepreneur?
5. What motivates you to establish a Seabuckthorn processing unit?
6. What is your qualification and professional background?
7. How many females employed in your firm?
8. How much monetary investments you have made in R&D?
9. What is the annual sales turnover of your firm

I. Use of Seabuckthorn plant for processing

1. For how long Seabuckthorn plant has been used for processing?
2. Which part of the plant do you think is more useful in terms of making maximum sales in the market?
3. Whether the young plant is selected or mature plants as a source for making different products ?

II. Technologies and techniques used by firm

1. What are the techniques used for processing Seabuckthorn plant?
2. Whether the technology for processing is self created by the firm or procured?
3. How your technique and technology is different from that of other firm ?
4. Do you heard of innovation?
5. Do you believe that your technology is innovative then other's, how?

III. Shaping of technology

1. What are the factors which led to the formulation and adoption of technology being used by your firm?

2. Does socio-cultural milieu plays any role in determining the kind of technology which you are adopting?
3. Is there any possible effects of technology on the lives of people in Ladakh regarding Seabuckthorn processing

IV. Research activities

1. Does your firm/ organisation carried out any research activity ?
2. What are the qualifications of research personnel?
3. Would you like to share any research breakthrough regarding Seabuckthorn processing?

Questionnaire with respect to Households andAmchiPractitioners

V. Parts of the plant using for preparation, formulations and product formation

1. Do you know about any local method for Seabuckthorn Processing?
2. What are the different products produced using the local method?
3. Whether DRDO has helped in Seabuckthorn processing at local level?
4. Do you find any major change in method of processing between local and DRDO based technique?
5. Whether DRDO based technology has helped or harmed the local methods and product formation?
6. Which method do you like to adopt in future for product formation?
7. Whether technology is good or bad?
8. Whether the whole plant or any part of it is being used?
9. Do you think the plant is useful in terms of food, health and medicine?
10. For how long you have been using the plant?
11. Which part of the plant is mostly used for formation of different products?
12. Whether the products are consumed in the household or sold in the market?
13. What are the different products/ formulations produced using Seabuckthorn?

VI. Local methods employed for formulations and product formation

1. What are the factors which led to the formulation and adoption of technology being used by your firm?
2. Does socio-cultural milieu plays any role in determining the kind of technology which you are adopting?

3. Are there any possible effects of technology on the lives of people in Ladakh regarding Seabuckthorn processing?

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