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**Landwirtschaftlich-Gärtnerische Fakultät**

**"Livestock Utilisation in Cholistan - Ecological and Socio-Economic Impacts  
of Development Interventions"**

Diplomarbeit in der Studienrichtung: Internationale Agrarwirtschaft

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Berlin, den 20.12.2007



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# Contents

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<b>List of Abbreviations.....</b>	<b>v</b>
<b>List of Figures.....</b>	<b>v</b>
<b>List of Tables.....</b>	<b>vi</b>
<b>1 Introduction.....</b>	<b>1</b>
1.1 Background and Relevance.....	1
1.2 Objectives of the Study and Working Hypotheses.....	4
1.3 Structure of the Thesis.....	6
<b>2 The Target Area.....</b>	<b>7</b>
2.1 Physiography.....	7
2.1.1 Localisation and Palaeogeography.....	7
2.1.2 Contemporary Climatic Conditions.....	13
2.1.3 Soils and Topography.....	15
2.1.4 Water Sources.....	18
2.1.5 Vegetation.....	19
2.1.6 Land Degradation.....	23
2.2 Infrastructure.....	27
2.2.1 Water Supply.....	27
2.2.2 Transport Facilitation.....	29
2.2.3 Marketing Systems.....	31
2.2.4 Veterinary Services.....	34
2.3 Characteristics and Dynamics of local Farming Systems.....	35
2.3.1 Origins of Mobile Pastoralism in Cholistan.....	35
2.3.1.1 The Process of Domestication.....	36
2.3.1.2 The Great Transition of the 3rd Millennium B.C.....	41
2.3.2 Forms of Mobile Animal Husbandry.....	45
2.3.3 Livestock Resources.....	50
2.3.3.1 Livestock Breeds and Diseases.....	50
2.3.3.2 Size and Composition of Livestock Herds.....	52

2.3.4	Livestock Products and Market Orientation.....	54
2.3.5	Social Organisation and Resource Tenure.....	56
<b>3</b>	<b>Focussed Development Interventions.....</b>	<b>60</b>
3.1	Conceptual and Institutional Framework.....	61
3.2	Details of the Different Efforts.....	63
3.2.1	Rainwater Harvesting and Storage.....	63
3.2.2	Pumping of Useable Groundwater.....	65
3.2.3	Drinking Water Pipelines.....	65
3.2.4	Transport Facilitation.....	67
3.2.5	Colonisation of Government Land.....	68
3.2.5.1	Historical Background of Land Tenure in Pakistan.....	70
<b>4</b>	<b>Methodology.....</b>	<b>73</b>
4.1	Farming Systems Approach.....	73
4.2	Information Base and Critical Evaluation of Data Quality and Representativeness.....	76
4.2.1	Primary Data Generation.....	77
4.2.1.1	Selection of Research Localities and Interview Participants.....	79
4.2.1.2	Interviewing Herders.....	81
4.2.2	Data Processing and Analysis.....	83
<b>5</b>	<b>Results and Discussion.....</b>	<b>85</b>
5.1	Recommendation Domains.....	85
5.2	Analysis of Impacts on the Farming Systems.....	90
5.2.1	Impacts of the Development Interventions on Migration Patterns.....	90
5.2.1.1	Water Supply Developments.....	90
5.2.1.2	Agricultural Colonisation.....	94
5.2.2	Impacts of Acquiring Land on Pastoral Farming Systems.....	96
<b>6</b>	<b>Summary and Conclusions.....</b>	<b>100</b>
<b>7</b>	<b>Bibliography.....</b>	<b>103</b>
<b>8</b>	<b>Annex.....</b>	<b>110</b>

## List of Abbreviations

acc.	according to
a.o.	among others
approx.	approximately
avg.	average
e.g.	for example (lat. <i>exempli gratia</i> )
esp.	especially
i.e.	that is (lat. <i>id est</i> )
n.a.	not applied
PRs	Pakistani Rupees (currency of Pakistan)
sc.	so-called

## List of Figures

<b>Figure 1:</b> General map of Cholistan.....	8
<b>Figure 2:</b> Palaeo-channels of the Indus-Sarasvati drainage system.....	11
<b>Figure 3:</b> Climate diagram of Dingarh station (PCRWR) in Cholistan.....	13
<b>Figure 4:</b> Rain map of Thar/ Cholistan.....	14
<b>Figure 5:</b> Map of transport facilities in the district of Bahawalpur.....	30
<b>Figure 6:</b> View (near closing) on the weekly small-ruminants market in Yazman.....	32
<b>Figure 7:</b> Simplified evolutionary classification of systems of animal exploitation.....	36
<b>Figure 8:</b> Map of northwestern South Asia, showing archaeological sites.....	37
<b>Figure 9:</b> Yearly movement pattern of pastoralists in Cholistan.....	46
<b>Figure 10:</b> Migration spaces practised by different livestock species.....	47
<b>Figure 11:</b> Drinking water pipelines in Cholistan.....	66
<b>Figure 12:</b> Percentage distribution of survey participants involved in interventions....	86
<b>Figure 13:</b> Percentage distribution of survey participants among wealth groups.....	89
<b>Figure 14:</b> Increased stocking density around improved water supply (clustered).....	92
<b>Figure 15:</b> Routes to drought season areas disturbed by colonisation schemes.....	95
<b>Figure 16:</b> Proportions of respondents telling interest to acquire irrigated land.....	97

**Figure 17:** Proportions of respondents interested to keep more livestock (clustered)...98

## List of Tables

<b>Table 1:</b> Exemplary water intake of a fine textured soil in Cholistan.....	16
<b>Table 2:</b> Carrying capacity per year of Cholistan.....	22
<b>Table 3:</b> Extent and parameters of land degradation in Cholistan .....	23
<b>Table 4:</b> Livestock population and forage demand in Cholistan.....	24
<b>Table 5:</b> Annual demand and supply of dry matter forage in Cholistan.....	24
<b>Table 6:</b> Average annual flows of Sutlej.....	29
<b>Table 7:</b> Reported livestock population in Cholistan.....	52
<b>Table 8:</b> Average livestock holding per species in Cholistan.....	53
<b>Table 9:</b> Areas allotted under various schemes in Cholistan.....	69
<b>Table 10:</b> Wealth groups of households in Cholistan defined by livestock holding.....	88
<b>Table 11:</b> Average livestock holding per species of the surveyed farming systems.....	89

# 1 Introduction

## 1.1 Background and Relevance

Drylands cover 41 % of the earth's land area and are home to more than 2 billion people, "a third of the human population in the year 2000" (MA, 2005: 1), of whom at least 90 % live in countries suffering under the poorest living conditions.<sup>1</sup> Drylands are characterised by low annual mean and extreme fluctuations of rainfall, with droughts as an intrinsic part of the system. Thus fluctuating provisioning of ecological goods and services is normal, but when the "resilience of a dryland ecosystem is impaired and does not return to a sustainable level after the stress is removed, a downward spiral of degradation may occur" (MA, 2005: 4). This is caused by a combination of factors, indirect (population pressure, socio-economical and political, international trade) and direct (land use pattern and practises, climatic processes), that change over time and location. Recent evaluations, such as the Millennium Ecosystem Assessment completed in 2005, clearly demonstrate that desertification has emerged as an environmental crisis of global proportions. The persistent reduction in the capacity of ecosystems to provide services such as food, water and other necessities is leading to "a major decline in the well-being of currently estimated 100 to 200 million people in drylands, but threatening the lives and livelihoods of a much larger number" (UN, 2007: 5). The resulting loss of income is estimated at US\$ 65 billion annually.<sup>2</sup> This is relevant to Pakistan, as it is a country with a predominantly arid to semi-arid climate and around 30 million ha rangelands, of which approx. 85 % (acc. NAP, 2002: 3) have been classified as degraded, including the target area of the thesis in hand, the Cholistan Desert.

Pastoralism or mobile animal husbandry is the prevalent form of land use in fragile dryland areas and has traditionally achieved a maximum adaptation of the human living pattern and their production to the spatial and temporal disequilibria of water and feed for livestock. "It represents a complex form of natural resource management, involving

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<sup>1</sup> as compared with the OECD countries the GNP of such dryland countries is exceeded almost in order of magnitude; the average infant mortality rate (about 54 per 1,000) for all economically less developed dryland countries exceeds that of non-dryland countries by 23 % and more, the difference is even higher (10 times) when compared with the rate in industrialised countries (MA, 2005: 7) -the relatively low rate of water provisioning in drylands limits the access to clean drinking water and adequate sanitation, thus leading to poor health

<sup>2</sup> whereas it does not include the difficult to measure but extremely important social and environmental costs to the current and future generations (GEF and GM, 2006 cited in UN, 2007: 5); FAO (1994) is summing provisional estimates of costs of cumulative effects of human-induced land degradation in South Asia per year and comes to a order of magnitude of US\$ 10 billion annually

the direct interaction between three systems in which pastoral people operate", i.e. the natural resource system<sup>3</sup>, the resource users system<sup>4</sup> and the larger geo-political and macro-economic system<sup>5</sup> (D.J. Pratt et al., 1997: 3). Mobility is a highly efficient way of managing the sparse vegetation and relatively low fertility of dryland soils. "It depends on the presence of temporarily utilised lands, knowledge of ecosystem productivity potentials (and constraints), and capacities to negotiate or enforce access to these resources" (M. Nori et al., 2005: 8).

But during historical processes these (risk avoiding) practises have been disturbed. In many dryland countries, mobile pastoralists are large and often ethnic minorities. Despite this, mobile pastoralism is increasingly under threat from legal, economic, social and political disincentives and barriers to mobility of livestock. Pastoralists are usually adversely affected by the demarcation of political borders, often drawn through their traditional territories, and become segmented minorities and marginalised to remoteness. In the national-political context and governance structures, they experience great difficulty to articulate and represent their interests. This leads to tensions between the central state authorities and local pastoral groups about imported concepts of land use and local traditions. Basis development initiatives like land tenure reforms and the implementation of water development schemes are often the cause of disputes.

Before it, the colonial authorities were much interested in seizing pastoral lands and livestock and sought to control and tax their subjects while moving pastoralists off of prime arable lands. To control the resources of pastoralists, they instrumentalised group differences through 'divide-and-rule' strategies. The minor political power of the pre-nation-state regency in present-day Pakistan during the colonial era under the Britons marginalised the influence of the Cholistani pastoralists on plans for land use and distribution, so they have been inadequately represented in running the affairs of the area.<sup>6</sup>

Policies of neglect or of forced integration have continued to further marginalisation in most post-colonial states, as well as after the partition of India and Pakistan in 1947 and

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3 "rangelands with productive and diverse natural vegetation represent the fundamental resource for pastoral livelihoods"; "drylands are interdependent with other external or adjacent ecosystems, thus have opportunities for resource extraction across different ecological niches" (M. Nori et al., 2005: 6)

4 "ruminants are the link between range resources and the livelihoods by converting widely-dispersed biomass into protein and products"; "food is produced, stored and moved by strategically composited/ diversified herds"; "flexibility and reciprocity are vital elements between pastoral communities and play a critical role in range resources access" (M. Nori et al., 2005: 8)

5 "includes the relationship with the state, neighbouring land users, market forces and international development community" (M. Nori et al., 2005: 10)

6 the former state of Bahawalpur was not so strong at the time of Nawab Amir Sadiq Mohammed Khan Abassi V. (tenure between 1907- 1955), thus e.g. the Maharaja of Bikaner was favoured by the Britons during their plans to extend irrigation areas, and the alternative plan to protect Bahawalpur's interest was denied



the merging of Cholistan into the province of Punjab. Due to placing the emphasis on easing administration and service-delivery rather than maintaining mobility and integrity of seasonal grazing areas, states often favoured urban and fixed rural populations, with agricultural and food policies addressed to the needs of urban and village consumers, distorting markets through subsidies, barriers and taxation.<sup>7</sup>

These efforts, which failed to appreciate the fundamentals of pastoralism, resulted in the deterioration of environmental, economic and social conditions for many pastoral communities. "Pastoral marginalisation is also the result of global processes, involving structural adjustment, policy modernisation and economic liberalisation" (M. Nori et al.: 2005: 11). Because aid has flowed to central governments and not to local structures to assist community-based development, one can say that "the external assistance usually determines the extent to which the state actually intervenes in pastoral areas" (D.J. Pratt et al., 1997: 7). Market forces and commodisation of the pastoral economy are also relevant aspects of pastoral vulnerability<sup>8</sup>. Generally favourable terms of trade for pastoral goods and services are no longer providing adequate compensation in times of need, during long dry seasons or periods of drought, when livestock conditions and prices deteriorate and costs for necessary staple purchases increase. The social and cultural value of livestock is not monetarised on international markets. But the growing market integration leads to changing nutritional patterns, migration routes, and relationships for resource management and social support which are based preconditionedly on monetary payments rather than on traditional reciprocity exchanges. This leaves space for exploitation, creates stress of social differentiation and insecurity and potentially fuels conflicts and violence.

This political and economic instability is part of the causal chain of desertification. The two primary driving forces are limited land resources and an increase in rural population (expansion of cultivator populations at the expense of herders), which combined produce land shortage and consequently poverty. The latter both together lead to non-sustainable land management practises (e.g. overgrazing, deforestation), which is the direct cause of degradation. The response is lower land productivity or a higher input need to maintain yields and farm income, which is equal to land shortage and thus completes the vicious circle.<sup>9</sup>

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<sup>7</sup> only in a handful of countries, out of about 40 where extensive pastoralism is practised, do pastoralists command automatic political and economic priority; and even then, ethnic rivalry and a weak economy may intervene (D.J. Pratt et al., 1997: 6)

<sup>8</sup> refers to a person's state and relationship to its environment, is the susceptibility to physical or emotional injury or attack, commonly applied in relation to hazards or disasters (Wikipedia)semantische suche

<sup>9</sup> in addition to productivity losses and increasing poverty, desertification results in significant reductions of carbon storage in soils,

With the rationale to prevent desertification the question comes up, how to develop opportunities to manage dryland resources sustainably, or better, how to empower pastoralists to do that and to satisfy their needs for nourishment, health, education, social interaction and other non-farm commodities.<sup>10</sup> Therefore, the intention of the present study is to determine on the basis of sustainability if the responses of developmental institutions to the complex challenges of desertification and poverty in Cholistan led or will lead to an increase in the quality of ecology and livelihoods. The recent passed drought<sup>11</sup> pointed out that current farming systems and the infrastructural frame in Cholistan are not in a position to cope with such complex hardships. Following appearance of financial assistance for responsible institutions was provoked by this inevitable statement. But thereby the value of project plannings, the progress towards achieving development objectives and the effectiveness of resource use after implementation is not yet assured. Furthermore it is important to address skills and expectations of the local population and use traditional knowledge as well as scientific approaches to find solutions that associate development of human welfare with sustainable use of the natural environment. If one aspect remains neglected it could come to erroneous measures and thus the ecosystem could become further damaged in long term. It should be compulsory to regularly legitimise the targets of intervention projects by monitoring the activities and effects and evaluating the cornering predictability of the strategy.

## **1.2 Objectives of the Study and Working Hypotheses**

The study seeks to investigate impacts of development interventions on the socio-economic and ecological conditions of the Cholistan Desert. It is aimed at identifying changes of the utilisation patterns of livestock on the rangelands and the causative constraints and potentials. It will provide an analysis of the relevant reasons and motivations of the inhabiting mobile pastoral farm households for possibly changing their resource management and land use.

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thus contributing to global warming and in loss of biodiversity

<sup>10</sup> actually, this brings up further questions, about philosophical issues of progress, growth and development, and society, wealth and freedom, and natural capital and economy; a possibly necessary shift in the angle of vision of adequately provisioning the global community makes it necessary to tackle these, if one is optimistic to avoid the ecological collapse; but the status quo is another and for the present study it was not possible to make a difference in that range

<sup>11</sup> "the most severe drought on national scale [...] which occurred from 1999- 2000 prolonging up to 2002" (IWMI, 2004: v)

A consideration of impacts implies the occurrence of entities with at least some causal relationship. So here the development interventions are conceptualised as potentially causing the changing context that forces effects in aspects of the behaviour of farming systems and thus indirectly in the natural environment. The study is exploring this by asking, according to what logic is the socio-economic situation of the mobile pastoral farming systems changing if their exogenous or endogenous resource base is affected by the intervention projects? The possible ecological impacts are ascertained by asking, how the changing farming systems regard their relations to the natural environment?

The study hypothesises that locations in the desert with improved infrastructural facilities attract pastoralists, causing them to change their migration pattern. Herds become possibly more concentrated there, so that grazing pressure on the natural vegetation rises and conflicts about the realised tenure of basic production resources occur.

A pull factor for modifications of farming systems is supposed by the allotment of irrigable land to the pastoralists. If acquiring land ownership agronomic practises attract more interest for the livelihood of the families, so increasingly they wish to reallocate their resources outside of pastoral production.

The research into these questions addresses, based on principles and laws of the socio-economics, the causations between development interventions, changing set-up of the farming systems and the natural environment. In this framework, statements are deduced as to whether the strategies behind the implementation are beneficial for welfare and prospects of the local population and prevent further desertification in Cholistan. The study strives to attain a locally valid, scientific contribution to an wider research effort into the environmental impact assessment of the concerned development schemes, and how a effective dynamic approach of livelihood improvement could be drawn up. Perhaps this could stimulate funding donors, government policy-makers, research institutions, military and NGOs for continuative research and development activities. As far as possible the work inspires further discussions about the meaning of progress and concepts of provisioning (pastoral) societies with globally dwindling running sources of natural capital. The potential to bring the general descent into ecological decline, social chaos and war to a halt depends on this.

### 1.3 Structure of the Thesis

The thesis is structured in six chapters. After the introduction to the objectives of the study, chapter 2 describes the target area, chapter 3 details the development interventions focussed on, chapter 4 addresses the design and implementation of the research concept, chapter 5 works on the discussion of the results and chapter 6 contains a concise summary and the conclusions about detected impacts.

The second chapter is made up of three sections, which include information about the physiography, infrastructure and farming systems of the target area. That provides a basic understanding of the conditions of natural resources and land degradation, of the range of physical and social infrastructure inventory on regional and local level, and of the animal husbandry practises, resource tenure and social organisation of the pastoral population.

The third chapter outlines the respective development projects with emphasis on the aims and objectives of responsible governmental research and development institutions. After, it goes over to illustrate the technical details and potential improvement of each component.

The fourth chapter establishes the theoretical basis (Farming System Approach) of the present research concept and develops the general scale, main target and detailed procedure from it. Data generation and analysis methods are subjected to a critical evaluation of quality what puts the basis for the later decisions about generalisability of inferences.

The fifth chapter continues at this point. It makes the field activities transparent and examines the validity of data base first. By account for this, it uses the results of the field work to discuss the causal relations in the hypotheses and deduce from this explanations of the reality.

The sixth chapter summarises all that to provide a concise statement of the problem and the research objectives, the general procedure and the limitations of the study's scope. The basic findings are restated for expanding them by conclusive remarks.

## 2 The Target Area

Cultural, economic, institutional, natural and technological factors of the environment in the Cholistan Desert are primarily shaping the livelihood of the families there. This chapter depicts basically the relationship of the farming systems with their living space and disaggregates therefore from the ecosystem and region to the land use system and community level to the households with their animal husbandry practises. It presents the physiogeographic conditions, outlines the infrastructural inventory and describes the focussed pastoral farming systems. Particular reference is made to the palaeogeographic and (pre-) historical context of water sources in the region and of pastoralism and its sustaining water harvesting techniques.

### 2.1 Physiography

This section provides information about the ecological zone and the regional configuration of land use systems. Therefore it covers first general aspects of the target area's geological development and sets its geographic borders. Then it presents the conditions of the natural environment and issues of land degradation.

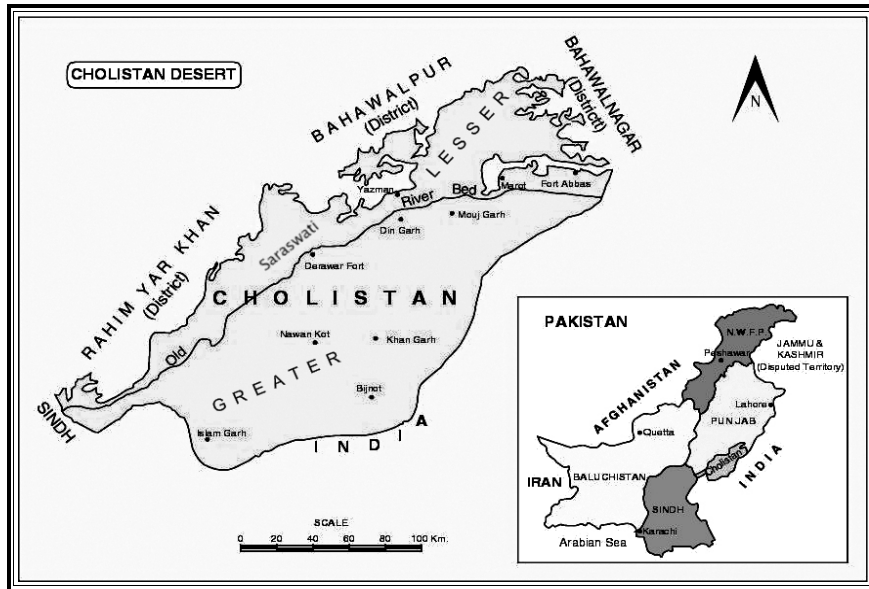
#### 2.1.1 Localisation and Palaeogeography

Cholistan is the arid area that extends over the southern 2/ 3 of the area of the three southern districts<sup>12</sup> of the Pakistani part of the province of Punjab, which is partitioned with India. It is located between latitudes 27° 42' and 29° 45' North and longitudes 69° 52' and 75° 24 ' East. The length of the desert is about 480 km and breadth varies from 32 km to 192 km with an area covering about 26,000 km<sup>2</sup> (acc. Akhter & Arshad, 2006: 210). Often in contemporary literature, it is described as being bounded in the north and west by the irrigated areas which are fed by the Sutlej River, to the south by the district of Sukkur in the province of Sindh<sup>13</sup>, and to the south east it is separated from India by

<sup>12</sup> Rahim Yar Khan, Bahawalpur, Bahawalnagar; these three districts were referred to as Bahawalpur Division until the decentralising local government reform in year 2000

<sup>13</sup> the parts of the Great Indian Desert in this province are named Tharparkar, Nagarparkar, Nara, depending on district or locality

the national transboundary. It should be emphasised that the latter is not an acceptable parting line for this ecosystem, as the districts of Jaisalmer and Bikaner of the Indian state of Rajasthan lie adjacent to the Bahawalpur District on the Indian side of the Thar Desert<sup>14</sup> and have at least similar physiographic features (see Figure 4). Anyhow, the political environment sets borders as can be seen in the following map.



**Figure 1:** General map of Cholistan (Source: Akhter & Arshad (2006: 211), modified by the author)

Cholistan is part of a larger geosystem, it is the north-western extension of the Great Indian Desert also known as the Thar Desert. This is, together with its surrounding semi-arid and dry sub-humid drylands and fertile corridors providing rivers, part of the vast Indo-Gangetic Plain which comprises large alluvial areas in the northern, north-eastern and north-western parts of the Indian subcontinent, a great tectonic trough<sup>15</sup> which lies between the West-Asian Plateau, the Himalayan hills and the Central Indian uplands, an ecological contrast zone, also referred to as the Greater Indus Region. A wider differentiation considers the Thar Desert as part of the Afro-Asiatic desert belt, which also comprises semi-arid drylands or steppes. This extends almost continuously from the Sahara in North-Africa, then in north-eastern direction across the Red Sea and Arabia, Syria and Anatolia, through long stretches of the Iranian Plateau where it splits in two branches, one to the north to the Aralo-Caspian basin, the deserts of Kizil-Kum and Kara-Kum, the Balkash regions, thence broadening out in Eastern Turkistan into the

<sup>14</sup> 20 % on Pakistani and 80 % on Indian areas; largest North- South extension 900 km, East- West 600 km

<sup>15</sup> originated in the middle Tertiary epoch as a result of upheaval of the Himalayas in the north and the concomitant receding of the sea in the south

Takla-Makan Desert of the Tarim Basin and the Mongolian desert of Gobi, and the southern branch through Balochistan, across the Indus Basin into the Thar Desert. The arid zone of the earth's northern hemisphere has arisen as a reaction of the Pleistocene Ice Age with widespread desiccation by worsening of glaciation in the last phase of this epoch.

Supposedly the Thar Desert or the whole currently arid areas in the northern extratropics had been, as N. Brooks (2006: 33) mentioned for the Sahara, "largely uninhabited away from the river valleys and overall of greater extension during that time".<sup>16</sup> The Pleistocene was characterised by changing wet and dry periods of which the contemporary Holocene is probably just the last Inter-glacial<sup>17</sup>. The enormous advancing (stadial) and retreating (interstadial) ice-sheets and glaciers during the glacial and inter-glacial periods had strong meteorological influence on the region immediately to the south of it. This gave rise to pluvial periods in these temperate and subtropical lands, thus supersaturating the soils and sub-soils which produced in them a deep weathered zone and disintegration of subjacent rocks. In the last glacial episode of the Pleistocene (in Europe known as Weichselian), which reached its maximum extent about 18,000 B.C. (acc. Wikipedia) the consequent drying up of the formerly rain-swept, heavily logged regions exposed the thick layers of rotted rocks to atmospheric forces, winds and storms sorted out the material into clay, loess and sand.

It is supposed that, when the Holocene emerged, displacements in the earth's orbital parameters resulted in the far more north penetration of the northern hemisphere summer insolation than its current northernmost position and increased the climatic seasonality (warmer summer and lower winter temperatures). During the early Holocene, "this was associated with the retreat of glaciers of the preceding epoch, with warmer ocean surface temperature, greater atmospheric moisture availability, intensified monsoon system and winter precipitation" (N. Brooks, 2006: 31). The climatic optimum of the Holocene was a period in which the global climate became 0.5- 2°C warmer than today. However, the warming was probably not uniform across the world, it appears to have a south to north pattern, with southern latitudes displaying maximum warming a few millennia before the northern hemisphere. Now the Greater Indus Region became characterised by numerous water bodies, abundance of surface and rainfall water and

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<sup>16</sup> former extent of the Thar could have been made up the whole Punjab, as such that the current, north-westerly Thal Desert is a relict from that time

<sup>17</sup> the term inter-glacial denotes the absence of massive glaciation on global scale, conversely a glacial is often called an ice age, as it is a geological phenomenon in which massive ice sheets form in the Arctic and Antarctic and advance toward the equator

humid-climatic flora and fauna thus providing better sustenance for the resulting expanding human population.

But responses to these climatic changes have been different in the Thar and its margins. "In an initially arid area like the western Thar, precipitation increases led to the extension of tributaries through formation of gullies, and sediments flushed out into the main valleys during local storms" (B. Allchin et al., 1978: 64). On the other hand, in an initially semi-arid area like the eastern Thar, a rather different situation arose when rainfalls increased. The strength of the vegetation cover increased to an extent that there has been less run-off, sediment outflow decreased and alluvial aggradations formed in situ.

But anyhow reviews of aeolian sedimentation records of Thar dunes, of lacustrine or fluvio-lacustrine depositions (e.g. Sambhar<sup>18</sup>, Didwana, Lunkaransar<sup>19</sup>), of the alluvium in the Indus Basin floodplains and the Arabian Sea show predominantly a stabilisation of the sandy landscape in a phase of optimal climatic conditions with relatively stable rainfall and moderate evapo-transpiration rates, and also the Sarasvati River still flowed through the area of today's Cholistan.

In (pre-) historical times, the area over that is currently extending the desert has played an important role in relations between the agriculturally rich regions which surrounded it, the Indus Valley, the Ganges Plains, the Malwa Plateau and the plains of Gujarat. "All land communications, all movements of people and animals had to go round it or cross it at their peril" (ibid.: 1). Any increase or decrease in aridity which has caused the desert to extend or retreat must have profoundly affected the relationship of the sub-continent to e.g. the West-Asian cultures.

Around 4000 B.C., the area of current Cholistan was a cradle of an ancient, advanced civilisation, the Indus-Sarasvati Civilisation (see 2.3.1). S.P. Gupta (1996: 3), a well-known Indian archaeologist and art historian having done extensive studies, concludes about related excavations that "with more than 650 sites on the Sarasvati River and its tributaries and not even 100 sites on the Indus and its tributaries, we can hardly ignore the claim of the Sarawati in the nomenclature". This already denotes the importance of the river systems for economic and social developments in the Greater Indus Region, esp. of the Sarasvati also called *hakkra* or *ghaggar* (depending on language, considered point in time or trace/ segment of river channels), whose today dried out bed passed

<sup>18</sup> the largest palaeo-lake in the Thar with 233 km<sup>2</sup> area; these lakes have been a major factor in the utilisation of the area since the lower Pleistocene by human beings

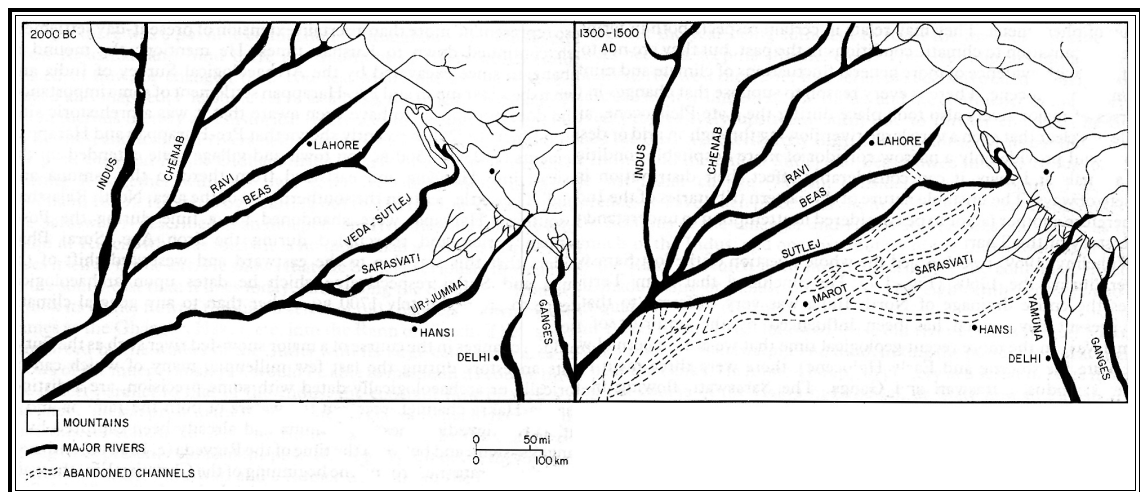
<sup>19</sup> a small, closed, dry basin surrounded by dunes at the northeastern margins of the Thar Desert



directly through the target area from north-east to south-west.<sup>20</sup>

But also for the ecological conditions, N. Lahiri (Ed., 2000: 213) refers back to old Vedic scriptures<sup>21</sup> where "the Saraswati, rising from the Siwalik Range<sup>22</sup>, is said to have been a mightier<sup>23</sup> river than even the Indus", considerably enforced by the rivers Sutlej and Yamuna (in the following figure referred as Ur-Jumma) as main tributaries with large catchments from the glaciers of the inner Himalayas, "thus having been able to maintain a perennial flow through the Thar into the Rann of Kutch with a course roughly parallel to that of the Indus".

It is seen as relatively assured that a chain of neotectonic<sup>24</sup> events (in North Rajasthan and in South Haryana) diverted the Sutlej westward (now joining the Indus) and the Yamuna south-eastward (now joining the Ganges) thereafter the course of the Saraswati moved north-west, the bed became successively narrower, indicating the dwindling water supply which led to it no longer reaching the sea (Figure 2).



**Figure 2:** Palaeo-channels of the Indus-Sarasvati drainage system (Source: B. Allchin et al. (1978: 20), modified by the author)

According to information from B. Allchin et al. (ibid.) and N. Lahiri (ibid.), the date at which the river dried up ranges between 2000 B.C. and 1500 A.D.. This long time span is possible as the historical and physiographic observations of a river in the area are related to terminal channels of the former Sarasvati. When Akhter & Arshad (2006:

20 studies of the palaeo-channels of the river have been carried out by Landsat pictures, mostly vegetation patterns on their beds bring them out

21 Rgveda (approx. 1000 B.C.), the oldest surviving record in any Indo-European language

22 the southernmost and geologically youngest foothills, running parallel to the main Himalayas, extending 1,600 km, with 900 m to 1,200 m altitude

23 N. Lahiri (ibid.: 221) mentions 6- 8 km expanse of the bed

24 (Greek) by W.A. Obrutschew affected term for still currently proceeding tectogenetic motions (Meyers Neues Lexikon, 1963)

211) report that the Sarasvati dried up about 600 years ago then this is most possibly marking the final disappearance of river water. Very interesting for the contemporary groundwater sources of pastoralists in Cholistan is what N. Lahiri (ibid.: 223) reports about a subsidence around the localities Marot and Beriwala (see Figure 2), which was "perhaps" also a result of the mentioned tectonic incidents. The Sarasvati may have vanished in this area in a large lake, which may have charged the sweet groundwater stock pumped up today (see 2.1.4 and 3).<sup>25</sup> For Cholistan the impact of tectonic factors on the hydrologic conditions is overwhelmingly important, but it seems that climatic changes have also played a subordinate role for its desiccation.

For the middle Holocene between the 5th and the mid of the 3rd Millennium B.C., N. Brooks (2006: 32) reports about "one phase of gradually increased aridity" and "increased variability of the important monsoon rains", that gave feedback to destabilisation of the surfaces of the dunes, increased sedimentary records in the lakes and more sand transport in the rivers.<sup>26</sup> E.g. lake "Lunkaransar did not dry between the beginning of the Holocene and the middle of the 4th Millennium B.C." (N. Brooks, 2006: 39), when siltation and evapo-transpiration first time suppressed the water table below the ground. Also the vegetation system had been weakened (or even collapsed as supposed by Brooks for the Sahara) which probably retroacted on the monsoon dynamics over the area which became more sensitive, and thus promoted desertification.

So when the Sarasvati flowed through Cholistan in a southwesterly direction, it was flowing against the sand advance which was blown towards the north east by monsoon winds from the Thar Desert. It can be concluded, therefore, that the Sarasvati, after the weakening of its tributaries could no longer overcome such a sand advance and hence it started drifting north and run dry. The main source of water for the once fertile area were the rivers, now it turned over centuries into a desolate, arid and inhospitable "sandy monster" which got the names *rohi* or Cholistan.

For further remarks on anthropogenic factors of desiccation and the cultural response to these (paleo-) environmental changes see subsection 2.3.1.

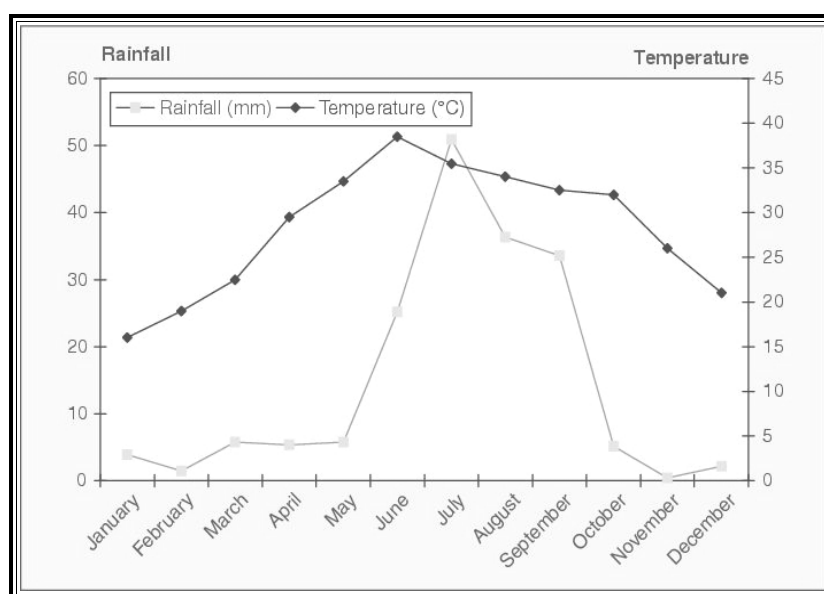
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<sup>25</sup> around Marot there are numerous places with the suffix "toda" which can be translated as "seaside"; also mentioned should be numeral forts built between the 11th and 18th century along the old riverbed, which used this groundwater what is obvious by higher number of wells there

<sup>26</sup> as reason Brooks mentions gradually declining summer insolation and a collapse of a north-polar ice-sheet which led to sea surface cooling in the North Atlantic which led to lower atmospheric moisture content thus possibly inhibiting of rain-bearing convection systems

### 2.1.2 Contemporary Climatic Conditions

The climate of Cholistan is of arid, sub-tropical continental type, characterised by low and sporadic rainfalls, high temperatures, low relative humidity, high rates of evaporation<sup>27</sup> and strong summer winds.<sup>28</sup> The mean annual rainfall is low between 100-250 mm and shows, as many dry areas of the world, considerable spatial, seasonal and interannual variability.<sup>29</sup> Further it can be characterised as erratic, so some areas receive extremely high falls in a very short period leading to great flooding and erosion. Prolonged droughts are common once every 10 years.



**Figure 3:** Climate diagram of Dingarh station (PCRWR) in Cholistan (Source: Akhter & Arshad (2006: 211))

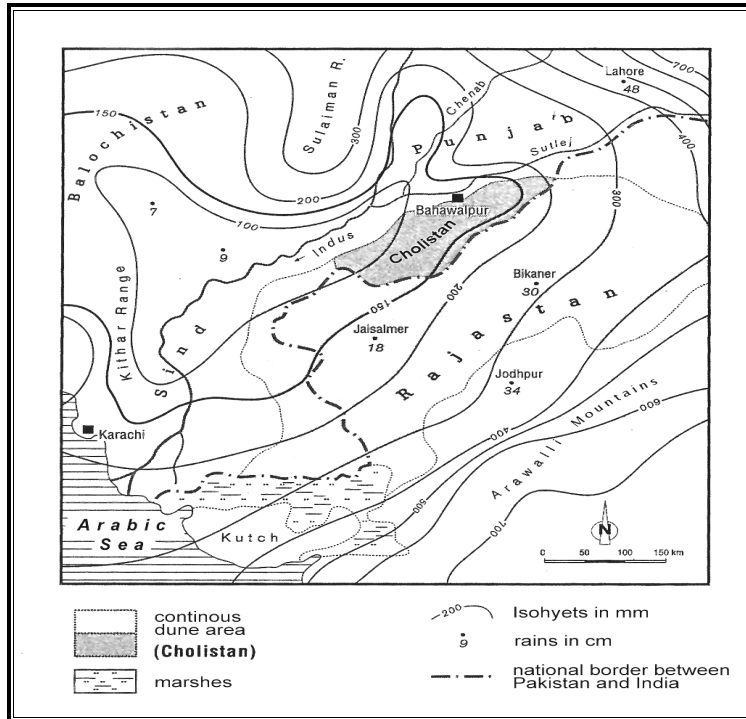
Looking at the following rain map of the northwestern area of the Indian subcontinent (Figure 4) one can find a tendency for the rainfall to increase from west and north-west to east and south-east. Cholistan, as the northernly and north-westernly adjacent area to the Indian districts Jaisalmer and Bikaner receives some of the lowest mean annual rainfalls of the ecosystem. Most is received as showers during the monsoonal months from mid June to September, but even within this period with huge variability, some also falls in winter.<sup>30</sup>

<sup>27</sup> the evaporation rate stands at 3,000 mm/ a, more than 10 times the rate of rainfall (F. Ahmad, 2001); but this detail provides a discrepancy to Allchin et al. who reported about annual rates of potential evapo-transpiration in Jaisalmer and Bikaner of around 1,530 mm/ a

<sup>28</sup> BWh climate (acc. Köppen -Geiger classification)

<sup>29</sup> B. Allchin et al. (1978: 30) speaks about maximum variation coefficient of more than 70 % in Jaisalmer District and adjoining areas

<sup>30</sup> being a measure of this can be details of maximum monthly precipitation or highest records over 24 hours in district Jaisalmer-



**Figure 4:** Rain map of Thar/ Cholistan (Source: F. Scholz (1997: 245), modified by the author)

Just as the rainfall varies seasonally so does the temperature, where in the Thar in the hot season there is a constant increase of temperatures north- and westward. Cholistan falls under one of the driest and hottest areas in South Asia, with very hot summer with rapidly rising temperatures from April onward. The mean summer temperature is 34-38°C and occasionally exceeds 51.6°C in late May and June.<sup>31</sup>

During this period hot dry winds occur throughout the day and air humidity usually falls below 32 %. The general pattern of wind movement is dominated by monsoon winds blowing from sea to land in summer and from land to sea in winter. During the summer months (May- October) the temperature of the landmass of Asia rises, the air above heats and low pressure areas are formed in contrast to high pressure areas over the Arabian sea and the Bay of Bengal. The predominant wind direction during summer is therefore from south, south-west and south-east.

In the winter months (November- April) the temperature of the Asian landmass decreases and a high pressure area is created above the Indian subcontinent resulting in land winds blowing towards the south and south-west. The summer winds are as

66 mm and 135.4 mm (B. Allchin et al., 1978: 29)

31 there is always an abrupt fall in temperature in the nights; the mean winter (December- January) temperature is about 15°C, with the lowest falling between 2°C and -2°C, also frost may occur at few nights in winter usually in December (acc. Forestry Department, 1974)

stronger, with average velocities ranging from 1.8- 10.5 km/ h, as the winter winds with speeds of 0.37- 7.0 km/ h, thus creating dust storms esp. in the early and middle summer.

There was not a single meteorological observatory in the whole Cholistan area until July 1989, which was established at Dingarh by PCRWR, and has since been regularly providing data on rainfall, max. and min. temperature, wind speed and relative humidity.

### 2.1.3 Soils and Topography

Based on topography, parent material, soils and vegetation, the Cholistan Desert can be divided into two geomorphic parts (see Figure 1). The northern sc. Lesser Cholistan covers 7,700 km<sup>2</sup> (~30 %) and consists of large alluvial flats (*dahar*) which are mainly level to nearly level to gently sloping with hummocks of loose fine sand. It comprises all the area north of the old riverbed of the Sarawasti and the desert margins, which include an irrigation zone of 280,000 ha (acc. Akhter & Arshad, 2006: 211). But only a small part is actually irrigated (see 2.2.1). Greater Cholistan, the land south of the riverbed which lies 2- 4 m higher, covers 18,130 km<sup>2</sup> (~70 %) and is predominantly characterised by windresorted old river terraces (*doab*)<sup>32</sup> and large<sup>33</sup> sand dunes which have undulating to rolling topography and less interdunal flat areas.

The soils in Cholistan are formed from two types of parent material, river alluvium<sup>34</sup> and aeolian sands. Actually, the transition zone from the alluvium of the Indus Basin and the aeolian derived eastern and southern areas of the Thar runs in between Cholistan.

The alluvium consists of mixed calcareous material which was derived from the igneous and metamorphic rocks of the Himalaya and was deposited by the Sutlej and the abandoned Sarasvati during different stages of the Pleistocene and subrecent<sup>35</sup> periods. These contributing rocks are composed of granites, schists, gneisses and slates in the

32 local appellation for the alluvial affected areas between two rivers, it derives from *do* = 2 and *ab* = water, or the land between 2 waters; the Indus Basin is notably divided in *doab*(s), these can be composed of several levels - *hithar, utar, bar*

33 Akhter & Arshad (2006: 211) write that dunes reach an average height of about 100 m in Greater Cholistan and about 30 m in Lesser Cholistan

34 the Indus alluvium like that of Gujarat rivers is thick, reaching between 300- 600 m; the Indus delta is thought to have been extended 80 km in the last 2,000 years; excavations indicate that there has been 10 m aggradation in the floodplains in the last 5,000 years (acc. B. Allchin et al., 1978: 16)

35 characterises the period of shift between prehistorical and current epochs, actual from Pleistocene to Holocene and further to today's conditions

Higher Himalaya and calcareous sandstones, shales and clays in the Lower and Middle Himalayas.<sup>36</sup>

The alluvial material having been deposited during different stages of the Pleistocene, is predominantly sandy and covers the central and major part of the area.<sup>37</sup> Following the deposition, the material underwent severe windresorting and was transformed into a series of differently aligned sand ridges and hollows. The soils developed by this material are nearly level to gently sloping, characteristically moderate to coarse in texture, very deeply to deeply homogenised, excessively to well drained, moderately to strongly calcareous and yellowish brown to dark brown in colour. The transitional zone between hollows and ridges are occupied by loamy fine sands or fine sands which at the base of the windward slopes can be covered with *kankar*<sup>38</sup> (Calcrete), thus stabilising the soil structure and dunes. All these soils are non-saline and non-sodic with pH values of 8.0- 8.5.

The alluvium deposited during the more humid Holocene epoch prominently in the western part of Cholistan consists mainly of clayey material and contains a higher proportion of material derived from the Lower Himalayan formations. The soils are mostly level, generally fine to moderately fine in texture, homogenised to moderate depths (30- 90 cm) and moderately to strongly calcareous, redder in colour than the former, and either saline or saline-sodic with pH values ranging from 8.2- 9.6. Most of these soils are generally porous and presently barren due to strong salinity and lack of moisture. But gypsum, which is contained in some areas of the subsoil, could make it possible to reclaim the soils if water were be available in sufficient quality and quantity. Parts of these alluvial soils are dense and do not contain gypsum.

**Table 1:** Exemplary water intake of a fine textured soil in Cholistan (in cm)

Time in minutes								
5	10	20	30	45	60	90	120	Sum (cm)
0.66	0.13	0.1	0.1	0.2	0.2	0.3	0.4	2.09

Source: reproduced from PCRWR (2005: 28)

<sup>36</sup> the Lower Himalayas -the southern most ranges- do not rise to great heights (600 - 1,200 masl); the Middle Himalayas lie to the north of the Lower Himalayas and rise to 1,800 - 4,600 masl; the Higher Himalayas are located north of the Middle Himalayas; they attain snowy heights (of more than 4,600 m) (acc. UNEP, 1998: 15)

<sup>37</sup> the stages have been recognised in form of two distinct terraces, one as Hafizabad stage, the other as Wazirabad stage; the Wazirabad terrace is higher and older than that of Hafizabad and its soils are brighter in colour, more deeply homogenised and contain more lime content

<sup>38</sup> soil layer of calcareous concretions on old erosion surfaces, alluvium and sand dunes, thickness may attain 30 m and more

They are poorly to imperfectly drained and rain water percolates in them only up to 5- 8 cm from the surface. Such soils are very important for the water harvesting techniques of the pastoralists. Around 4,400 km<sup>2</sup> (~17 %) of the desert are formed as such.

The southern and eastern confines of the area are occupied by aeolian sands which are quite different in mineralogical composition from the alluvial sands.<sup>39</sup> The former is postulated to have been derived mainly from the Rann of Kutch and the sea coast and partly from the lower Indus Basin. A small proportion of these sands is contributed by the weathered debris of the Aravalli mountains and its offshoots in the east of the Indian part of the desert. The sands have been carried from there inland by the strong south-western coastal winds, also underwent wind resorting and were transformed into high ridges and broad hollows of long wave length. The characteristics of these dune land are very excessively drained, coarse in texture, structureless fine sands with pH values between 8.0- 8.2. Parts of the dunes are stable (21 %) due to the presence of enough vegetation and *kankar* on the surface while some are mobile (79 %). B. Allchin (1978: 21) reports about the distribution of dune land and flats, "even in the heart of the desert, dunes are frequently absent" and "in many of the world's deserts, including the Sahara and Arabian deserts, sand cover only amounts to 20- 30 %, so that the Thar Desert is in no way exceptional". Whereas Cholistan as part of the Thar comprised of around 44 % (acc. PCRWR, 1986) of sand dunes.

#### 2.1.4 Water Sources

"Prime source of Pakistan's freshwater resources is the river drainage system of the Indus Basin" (UNESCO, 2000: 30).<sup>40</sup> More than half<sup>41</sup> of the total geographical area of Pakistan (796,095 km<sup>2</sup>) is classified as arid to semi-arid and receives annual rainfall of up to 250 mm, and approx. 110,000 km<sup>2</sup> of this consists of the main deserts<sup>42</sup> including Cholistan (acc. FAO, 1997).

It is apparent that natural sources of water for production and consumption in the deserts are only temporally useable surface water and groundwater. As described in the sections before, climatic and edaphic factors like low rainfall, high rate of evaporation and water

<sup>39</sup> most predominant component is Quartz, but also Feldspar, Hornblende and calcareous grains

<sup>40</sup> other important hydrological regions are the Kharan Closed Basin and the Makran Coastal Basin

<sup>41</sup> details range from 51 % (acc. PCRWR, 2003: 1) to 68 % (acc. FAO, 1997)

<sup>42</sup> namely Tharparkar (43,000 km<sup>2</sup> in Sindh), Thal (23,000 km<sup>2</sup> in Punjab), Chaghi-Kharan, D.I. Khan desert and other smaller (10,000 km<sup>2</sup>)

infiltration prevent the natural accumulation of surface water, so there are no permanent natural bodies in existence.<sup>43</sup> Anyhow, rainwater is the cheapest of all the sources, thus techniques for the use of it are common in almost all parts of Pakistan.

Detailed hydrogeological investigations about groundwater have been carried out by WAPDA in Cholistan in 1986.<sup>44</sup> Generally this water is not useable for human consumption due to its very poor, brackish to saline quality, with salinity ranges (total dissolved solids, TDS) of below 1,000 mg/ l in the canal fed areas of Lesser Cholistan to exceeding 30,000 mg/ l in the far southern part (acc. FAO, 1992: 6).<sup>45</sup> But even so it is used for drinking due to the absence of alternatives in the area, such as rivers or canals. The depth to the water table varies usually between 15- 90 m and the yields are typically 10- 50 m<sup>3</sup>/ hour, while water columns range 1.20- 5 m (acc. PCRWR, 2005: 24). It lies as deep due to the absence of recharge by a canal or river system and because rainwater is negligible for this. Groundwater is therefore a very precious resource which should only be utilized very efficiently.

It is reported about two major aquifers which have useable, moderately saline groundwater and are surrounded by saline water. These coincide with the abandoned bed of the Sarasvati River, thus it is quite possible, that these originated by non-saline lakes in the Thar during the geological period when the Sarasvati River has been blocked by sand depositions. The first aquifer extends for 80 km from Fort Abbas towards Marot and Mojgarh, and is from 10- 15 km wide and lies between 40 and 100 m below the surface. The second has its centre about 20 km north-west of Derawar Fort. It occupies an area of 50 km<sup>2</sup>, has a maximal thickness of 100 m and lies about 25 m below the surface. There are further isolated lenses of useable groundwater, but with salinity content barely tolerable by animals.<sup>46</sup> Akram and Sheikh (2000, cited by UNDP, undated) estimate the total quantity of useable groundwater in Cholistan at about 9,867.84 million m<sup>3</sup> with recharge of about 2 mm per annum. "Of the aquifers available in Pakistan, by far more productive are the Quaternary alluvial aquifers of the Indus Basin" (British Geological Survey, 2002).<sup>47</sup>

Water is the most limiting factor of arable agriculture, it is not sufficient to grow crops,

43 except the Patisar Lake in the Lal Suhanra Biosphere Reserve- approx. 1,900 ha wetland site built for wintering of waterfowls

44 WAPDA- Water And Power Development Authority; they undertook in cooperation with the Federal Institute of Geoscience and Natural Resource of Germany an interdisciplinary groundwater survey in Cholistan during 1986- 1991

45 most of the groundwater resources are alkaline in reaction causing precipitation of Ca<sup>2+</sup>, SO<sub>4</sub><sup>2-</sup> and CO<sub>3</sub><sup>2-</sup> -ions and increasing the ionic balance of Na<sup>+</sup> and Cl<sup>-</sup> in water

46 at Bhai Khan, Ghunnianwala, Islamgarh, Lakhewala, Renhal- all near the border to India

47 sediments in the river plains are yielding groundwater typically around 100- 300 m<sup>3</sup>/h, groundwater table is typically 20- 30 m below surface, but also down to 150 m (ibid.)



forests or fruit plants. Endemic scarcity of drinking and irrigation water is also a main factor of the area's low livestock production potential, which forces the adaptation to it by emigration of the local pastoralists.

### 2.1.5 Vegetation

Life on the planet earth depends directly or indirectly on the presence of vegetation, thus it is the most important of all natural resources. Much of Cholistan is covered by sandy conditions, thus a wide range of nutritious and drought-tolerant species of grasses, herbs, shrubs and trees had to adapt to exist in this territory.<sup>48</sup> The sparse vegetation is dominated by bush forming perennial shrubs and scattered small trees as well as hardy grasses. Also a large number of annual and ephemeral species appear after monsoon rains, but when aridity intensifies along with gradual decrease of temperature to the winter they complete their life cycle and dry up after dispersing seeds.<sup>49</sup> Especially the herbaceous plants have very short lifetimes and are affected when less soil moisture is available.

The vegetation is adapted to the arid conditions with a strong root system, thus holds the soil and protects it from wind erosion and conserves water. Root studies on adapted trees and shrubs indicated, that "apart from the main root which goes deep down in the ground, extensive lateral roots occur in the upper soil" (I. Prakash, 1987, Ed.: 113). The same appeared for hardy grasses which have higher root numbers and vertically and horizontally wide spreading root systems. Most of the shrubs and trees are leafless or have reduced and modified, leaflike structures to lower the rate of transpiration.<sup>50</sup> Due to absence of leaves, stems of many species are green for carrying the physiological function. They have a remarkable capacity to regenerate even after severe desiccation,<sup>51</sup> also their seeds have a hard, resistant coating to survive multiple years of drought. Further adaptations are osmotic adjustment<sup>52</sup>, foliar absorption of moisture from light showers, inhibition of companion vegetation<sup>53</sup>.

Basically, the distribution and diversity of vegetation is controlled by edaphic and

48 128 species are belonging to 33 families, and phytogeographically to the Nubo-Sindhian Province of the Sudanian Region; typical for arid regions, these are mainly Xerophytic but also Halophytic (acc. Akhter & Arshad, 2006: 212)

49 grasses and some shrubs dry up partially while forbs do so completely

50 also by thickening of cuticles to check excessive water loss

51 the shoot apexes remain active despite drying of foliage during the rainless period

52 e.g. plants can reduce the pressure in the Xylem to buffer the external gradient of dry conditions

53 leaf litter can contain germination and growth inhibitors to restrict the establishment of other vegetation (e.g. *Prosopis juliflora*)

climatic factors. "Lesser Cholistan is dominated by several species of shrubs and perennial grasses dotted by few species of small trees" and "in Greater Cholistan trees are generally lacking, shrubs are sparser and species diversity is poor" (Akhter & Arshad, 2006: 212). Vegetation cover is more pronounced towards the eastern arid parts (~200 mm rain) due to better moisture conditions than in the hyper-arid south and west (~100 mm/ a) (see Figure 4), but generally it is poor on sand dunes (shrubland), and unstable sand dunes are devoid of any vegetation. Some interdunal areas have better vegetation (shrub-grassland) depending on the water retention capacity of the soil, e.g. in swales where a thick layer of sand overlies a relatively impermeable loam or clay stratum. The long-lasting work of regional research institutions (esp. AZRI, CIDS, PCRWR; see list in the Annex) created a list of major forage plants and corresponding characteristics, use and grazing animals. Moreover, it defined vegetation communities associated with their typical availability in distinct habitats<sup>54</sup>. A description of these would include excessive detail here. For further information, see the work of Rubina Akhter and Muhammad Arshad.

The most important function for human beings is as forage for livestock, shade for resting, thatching rooftops with branches of trees and shrubs, or using them as fences around animal enclosures or as firewood and timber. Some species also have medicinal value.

A range unit is considered as "in excellent conditions when the present vegetation cover and plant composition is as near to climax as possible, whilst it is considered to be poor when markedly different from the local climax type" (PCRWR, 2005: 55). Akhter & Arshad (2006: 212) state up to 60 % vegetation cover in some areas depending on sufficient rainfalls. Composition and production of browse and herbaceous forage vary between range types and characterise the suitability to support grazing animals. In the best ranges, herbaceous forage yields 60- 70 % whereas browse yields 30- 40 % of the total forage production. In moderate ranges, herbage production varies from 35- 45 % and browse from 55- 65 %. In poor ranges, herbage yields less than 20 % and browse more than 80 %.

Almost all the herbaceous forage is utilised during monsoon and post-monsoon season, whilst green browse is available in the area throughout the year. As seen before, the winter rains are very scarce so spring vegetation is generally poor, represented by few

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<sup>54</sup> beside the before noted, saline plains or during rainy season periodically flooded dry water-courses; mentioned for the latter is the huge amount of palaeo-channels of the Sarasvati River in which vegetation growth is facilitated (see Figure 2)

annual species of grasses and forbs providing very little biomass for grazing. The feed requirements of camels and goats in the winter and pre-monsoon summer are provided by green browse of common shrubs while cattle and sheep suffer severe nutritional deficiencies (see 2.3.2).

Rangeland use with livestock in an opportunistic mobile manner depends on the arid environment with its high climatic variability (monsoon, drought) and proportional variable plant production. For ecologically desirable land use the carrying capacity of range units "should be calculated on the basis of the level of vegetative growth of drier years and not by the average years" (S.R.A. Khan, 1992: 45). This statement is based on the interest in balancing the regeneration of plants and the pressure from livestock grazing.

The carrying capacity marks the maximum number of animal units (AU)<sup>55</sup> which can be supported by a range throughout the year without resource depletion. A range is characterised by its spatial and temporal variable forage production. Annual primary production can be assessed by "measurement of standing biomass (normally at the end of the growing season), remote sensing, prediction methods or more complex physiographic relationships" (J. Dijkman, 1999: 3).<sup>56</sup> Forage requirements of animals are estimated on the basis of dry matter intake per percentage of liveweight. The carrying capacity is calculated by relating the forage requirement per animal unit to the available forage production of the range. For practical considerations carrying capacities should not be used as a quantifiable measure, because their assessment is static, whereas the reality is much variable and unpredictable, which thus produces biases.<sup>57</sup> Anyhow, it can be used as a management and planning tool for interventions in pastoral societies, e.g. on infrastructure such as slaughterhouses.

PCRWR also approached the assessment of total forage production from the natural vegetation in Cholistan during their early desertification monitoring and land capability mapping activities. This led to numbers of animal heads which could be sustained in winter and monsoon season and per year. Numbers of the latter are presented in the

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<sup>55</sup> the concept of animal units is based on reference to the standardised characteristics of a livestock species (mostly cattle); here used is the approximate forage requirement; 1 AU-is the grazing area required to support e.g. 1 mature cattle with required dry matter per day (~ 7 kg/ d); other species are considered by a substitution ratio which is founded on their own forage requirements in relation to the reference species

<sup>56</sup> for calculations not the total yield can be used, because of proper conservative use and grazing efficiency, often 30 % to 2/ 3 consumption is estimated; the consumption is depending on palatability and digestibility of type and state of vegetation -seasonal quality (crude proteine) and quantity (dry matter)

<sup>57</sup> bias can result by quantifying the influence of occurrences of rainfall, fire, climatic variability, not taking in account the production objectives, not attending the grazing pressure by selective grazing of animal species and the influence on the range yields during the objected period (time of defoliation)

following table. The results should not misleadingly be added up as the (realistically, species-wise cumulating) carrying capacity of the entire area is here stated for each species at a time.<sup>58</sup>

**Table 2:** Carrying capacity per year of Cholistan

Area (km <sup>2</sup> )		Cattle	Camels	Sheep	Goats
	No. of heads	632,357	371,975	2,529,432	2,107,859
26,000		379,414	379,415	379,415	379,415
1	AU	14.59			

Source: No. of heads by PCRWR (2005), AU calculated with conversion factors from Sarwar et al. (2002)

These numbers are only calculated tendencies. This is due to previously mentioned bias of quantifying the range yields, but also because the data originate from different dates and the authors in some cases applied partly differing conversion factors (No. animal heads to AU, feed intake of species) which thus distorts the comparability. This has to be regarded also in the following section, when considering the forage demand and supply.

#### 2.1.6 Land Degradation

Serious land degradation, if not tackled by addressing sustainable development, leads to the irreversible process of desertification. "It is a phenomenon of reduction or loss of the biological or economic productivity and complexity of rainfed or irrigated cropland or range, pasture, forest or woodlands in arid, semi-arid and dry sub-humid areas on global level resulting from a process or combination of processes including environmental, climatic and human activities" (UNCCD, 1994: 5).

In Cholistan, this is reality and consequence of two major factors, the severe climatic conditions and the land use of the area.

PCRWR is active in desertification assessment and mapping since the 1980s and provided comprehensive reports about the processes in Cholistan (see Table 3).

<sup>58</sup> a factor for adjusting the carrying capacity downwards is set up with regard to proper conservative use and the fact that the numbers of sustainable animal heads taken from PCRWR come from the year 1986, what is some old, thus the land degradation processes have been continuously reduced it

Categorisation of desertification is not hard and fast, nevertheless, Cholistan can be classified in three categories on the basis of international indicators.<sup>59</sup> The largest part with 81 % (~20,794 km<sup>2</sup>) of the total area is characterised by poor to moderate<sup>60</sup> vegetation cover (5- 20 %, e.g. *phog* (*Calligonum polygonoides*) and *jand* (*Prosopis cineraria*)) on topography of rolling to moderately steep sand dunes and sandy soils. These areas are classified under severe desertification, with severe wind erosion, severe salinity/ sodicity and problematic slopes, whereby wind erosion is the major problem. The mainly barren, saline-sodic clayey *dahar*(s) comprise 17 % (~4,419 km<sup>2</sup>) and support only poor vegetation cover (<5 %), locally with little scrubs and some salt bushes like *khar* (*Haloxylon recurvum*) and *lani* (*Salsoal foetida*). The reported very severe desertification occurs in small scattered patches exceedingly in north and north-eastern (Lesser) Cholistan (e.g. at Lal Suhanra, Mojgarh) with very severe salinity/ sodicity and very severe soil compaction, but only slight wind erosion problems. By far the smallest part, 2 % (~587 km<sup>2</sup>) of the total area is covered with moderate to good (20- 50 %) vegetation, comprising mainly shrubs and some grasses like *dhaman* (*Cenchrus ciliaris*), *sewan* (*Lasiurus indicus*) and *chimber* (*Eleusine compressa*), lying in the southern (Greater) Cholistan. Here desertification is classified as moderate, the serious problems are wind erosion, poor vegetation cover, sodicity and severe soil compaction.

**Table 3:** Extent and parameters of land degradation in Cholistan

Soil types	Desertification class	Extent (ha)	%	Wind erosion	Vegetation cover
Loamy soils	Moderate	58,700	2.0	Moderate	Moderate to good
Sandy dunes/ soils	Severe	2,079,400	81.0	Severe	Poor to moderate
Saline sodic clayey	Very severe	441,900	17.0	Non or slight	Poor

Source: reproduced from PCRWR (2005)

Wind erosion<sup>61</sup> is active in areas with low rainfall and caused by over-exploitation of forage vegetation through heavy stocking densities of animals, more precisely by overgrazing, lopping of foliage feeds, collecting of grasses from higher dunes where

<sup>59</sup> major desertification parameters are soil fertility, biodiversity (vegetation cover/ animal species and density), wind erosion, water resources, land capability, land carrying capacity and overall desertification

<sup>60</sup> the canopy cover could be classified as "good" if the density of perennial plants would justify that, but overgrazing and cutting affected severely

<sup>61</sup> the removal of fine soil particles by high velocity winds

animals can not reach to, burning of scrubs and other vegetation with lower forage quality. Also the intensity with which already scarce woody bushes and trees are cut for fuel or potash<sup>62</sup> and seed collection is made for direct human consumption, must be estimated as seriously affecting the vegetation cover and regeneration potential.<sup>63</sup>

**Table 4:** Livestock population and forage demand in Cholistan (L/s Census 2000)

Species	Population (No. of Heads)	Population (AU)	Dry matter intake per day (kg/ head)	Annual forage demands (tons)
Cattle	447,591	447,591	7	1,143,595
Camels	29,340	49,878	12	128,509
Sheep	440,854	110,214	1.75	281,595
Goats	203,848	61,154	2.10	156,249
Total	1,121,633	668,837		1,709,949

Source: reproduced from Akhter & Arshad (2006); AU conversion factors and dry matter intake from Sarwar et al. (2002)

In the target area, "pastoralists have increased their herd sizes in many range areas without considering the carrying capacity" (UNESCO, 2002: 59), the stocking densities continuously exceed it. This problem of overstocking and grazing pressure can be illustrated by the rough estimated difference between the carrying capacity for livestock in Cholistan, mentioned in Table 2, of ~15 AU per km<sup>2</sup> and the stocking density of ~26 AU per km<sup>2</sup> (Table 4), calculated based on the Livestock Census 2000.

**Table 5:** Annual demand and supply of dry matter forage in Cholistan

L/s population (AU)	Annual forage demand (tons)	Forage available (tons)			Deficit (tons)
		Lesser Ch.	Greater Ch.	Total	
668,837	1,709,949	55,962	61,934	117,896	1,592,053

Source: reproduced from Akhter & Arshad (2006); L/s population and annual forage demand recalculated by the author

62 or to prepare crude soda (Na<sub>2</sub>CO<sub>3</sub>) for washing clothes or curing hides; for the production of potash are used nearly unexceptional slowly growing bushes and shrubs which are important feed of animals; there are official contractors which get permission from the Forestry Department to cut and burn the natural vegetation in the desert to make potash, mostly they are financially potent Punjabis; but there are also numerous of poor local people who find no other livelihood as to do the same in 'illegal' manner and have to attempt a bribe of the forestry officers; this severe intervention in the nature leads to huge disrobement of the soil surface (F. Scholz, 1998)

63 the decline in natural forage sources reduces the litter accumulation, alters the surface-soil structure and plant composition, reduces the presence of leafy, high-quality forage plants and promotes plants that sequester nutrients in armed and toxic parts, reduces the total plant cover and can eventually lead to soil loss

The calculated total annual forage demand of livestock kept in Cholistan (1,709,949 tons) and the comparison of this with the annual available dry matter forage supply of 0.12 million tons (acc. Akhter & Arshad, 2006: 216) reveal again the immense excess of the stocking density (see Table 5). Thus the rangelands of Cholistan are under severe threat of degradation because of overgrazing. A more concrete evaluation is left out here, because the displayed details do not warrant this.

By uncontrolled practised sc. open grazing the desirable vegetation degrades and for animals less palatable plant species prevail and spread. Consequently, grass coverage, height and yields are declining. To exemplify such process, it is said of the "famous *sewan* grasslands of the Jaisalmer region" that "today such excellent cover exists as islands only in the most inaccessible parts of the arid zone, where lack of watering points restrict the incidence of grazing" (I. Prakash, Ed., 1987: 21). Livestock movement (trampling) on devegetated sandy soils pulverises their surface and transforms them into shifting sand, which marches progressively in direction of the prevailing winds. The problem of wind erosion in the study area is severe particularly around the "habitations where complete depletion of the vegetation has resulted in the transformation of once stabilised sand ridges into actively moving sand" (PCRWR, 1986: 63). There can be severe loss of vegetation within an extensive radius around a water point with gradual improvement further away.

The direct<sup>64</sup> and indirect<sup>65</sup> human population pressure is posing a serious threat to the natural resources, as under the restricted natural conditions the pastures have limited carrying capacities for the increasing numbers of livestock. It should be remarked that rangelands are not degraded everywhere, or always in the same way. The relationship between wind erosion and overgrazing is strongly dependent on precipitation. After the monsoon, the range remains green for a short period and vegetation can cover up to 60 % in some areas. In years with lower rainfall, grazing can quickly lead to degradation. Important factors affecting wind erosion are texture, structure, density of particles, moisture content and surface roughness. The soils in Cholistan have high contents of soluble salts as a consequence of soil formation over centuries. Low rainfall, not sufficient to leach them out, and the high evaporation may have made the salts rise to near the surface by capillarity, thus reducing the soil fertility. Salts in the soil increase the efforts by plant roots to take in water, because of the concentration gradient, many

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64 a.o. the extension of land use by increasing the numbers of animal heads in the area

65 a.o. by the extension of agronomy, graziers become displaced to areas where thus rises the risk of land degradation

salt ions are recognised as a large amount of water. But the opposite is the case: a high salt content has a similar effect to dryness in that it makes water less available for uptake. Thus these soils are mostly barren or support sparse salt-tolerant vegetation.<sup>66</sup>

Badly compacted soils (e.g. overgrazed pastures, playgrounds, *kaccha* roads) are accompanied with inhibited movement of air, reduced root development, low infiltration and thus reduction in plant growth. Rain drops hit the soil surface with considerable mechanical force and rapidly destroy the structure of the upper soil creating a hard crust. This crust seals the surface and reduces the depth of water penetration and aeration. In coarse textured soils the capillarity is low, so the top layer acts as an insulator from desiccation, but in lower depths higher moisture contents can be found which can be reached by the roots of xerophytic plants.<sup>67</sup> It is possible that through afforestation this moisture dwindles due to its use by vegetation.

Droughts occur frequently in the areas affected by desertification and are generally a feature of the natural climate there. Climatic changes or changes of frequency and severity of droughts are both a consequence and a cause of desertification. Degradation of natural vegetation cover in dry areas affects the topsoil temperature and the air humidity and consequently influences the movements of atmospheric masses and rainfall. The recent drought having been prolonged for 4- 6 years from 1998 must be interpreted as a multiplier of the kinds of land degradation mentioned above and thus of the causes for future drought incidents.

Another ecological implication of overgrazing by domestic livestock is the non-availability of foraging material for wild ungulates. This competition for the desert's natural resources contributes to the loss of biodiversity, as a result of habitat degradation as well as unsustainable hunting mammals, birds and reptiles have to be listed as endangered species. The Blackbuck suffers most because of its almost identical grazing habitat with that of cattle and sheep and was virtually extinct. But the species has been re-introduced in Lal Suhanra National Park within large enclosures, together with the Chinkara Gazelle, Nilgai Antelope, Hog Deer, Charcoal Cat, Indian Rhinoceros and migratory ducks. I. Prakash (1987, Ed.: 185) from the Indian part of the Thar reported that "the Chinkara, which is mainly a browser, is capable to survive in regions of less than 100 mm rainfall in Jaisalmer District", remote areas where cattle and sheep would

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66 the salt sediments got concentrated by evaporation of the water which accumulated in such basins (potential water harvesting) in the wet season

67 Gupta (1979) cited by I. Prakash (1987, Ed.: 74) reported values of near field capacity moisture below 30 to 60 cm depth through out the year in dunes kept free of vegetation



not survive. A further threat that domestic livestock pose to the health of wild ungulates are parasites and microbes which cause periodic decimation of wildlife.

These statements should provide sufficient understanding of the physiographic conditions of the target area to put the study in the basic context of the ecosystem.

## **2.2 Infrastructure**

This section outlines infrastructural components and attempts to clarify the differing inventory and to draw attention to the extremely poor facilitation of the pastoral farming systems in Cholistan. Water supply, roads, marketing systems and veterinary services are described one after another.

### **2.2.1 Water Supply**

The status and kind of water resources in the desert has already been explored in subsection 2.1.4. This section continues with the ways in which surface and groundwater are commonly (traditionally) made accessible for purpose of drinking of livestock and pastoralists.

Rainwater run-off is received in reservoirs locally called *toba* and *kund*, while groundwater is obtained through open dug-wells and tubewells.

The details about the number of *toba*(s) (picture in the Annex) differ in the available literature. PCRWR (2005: 22) quoted more than 1,500 while CDA states once 598 and elsewhere 800. These can be natural depressions in the ground or man-made ponds, which are used by the desert dwellers for collecting and storing the run-off from catchment areas on flats, as mentioned in subsection 2.1.3, of dense clayey soils with very low infiltration rates. If these are dug then the earth is thrown away to only one side whereas the other sides are left for the rainwater to enter from these directions. The size usually ranges from 30- 60 m long and 20- 40 m wide, and with a depth of up to 2 m. Major losses of water result due to seepage and evaporation. They use it rapidly, as it can not be used for long periods, depending on the year for three to four months. Beside this, the collected rainwater already contains different pollutants, animals enter the

ponds and deposit their urine and feces and decomposed plant material comes during run-off, thus further polluting the water.

*Kund(s)* are tanks in the ground constructed by using bricks plastered with cement, with a concrete bed and roof, which are capable of storing harvested water for long periods, but with comparable small storage capacities. Problem is that the water can become smelly and provides favourable environment for mosquito breeding, which can cause Malaria. The number of *kund(s)* ranges between 100 and 200 (acc. PCRWR, 2005: 23).

The rainwater collected in the *toba(s)* is preferred compared to wells because of the problematic saline quality of the groundwater. The water from wells is used when rainwater in ponds is exhausted. The water from the more than 300 open dug-wells in Cholistan is drawn by big leather buckets attached with rope made by goat hair or leather strips and pulled by camel or tractor (picture in the Annex). Also tubewells, which comprise of a pump and a suction pipe, are in use in the area. 16 turbine pumps<sup>68</sup> have been installed up to 2001, but the number of handpumps remains uncounted.

*Toba(s)* are scattered all-over the rangelands, whereas *kund(s)* and wells are mostly situated at one of about a dozen semi-permanent centres<sup>69</sup> which have some obvious concentration along the bed of former river Sarasvati.

Depending on season and locality, a similarly important drinking water source for the Cholistan herds are the canals and the rivers<sup>70</sup> in the northerly adjacent area. But this facility has to be put in the context of irrigation capacities and agronomy, as the access to the canal lands is to some extent dependent on land ownership, but more because their function is primarily dedicated to supplying water for cultivation. Since rainfall is too low for dryland agriculture, cropping is an option only for those households who have received irrigated plots. For the surveyed district the Trimmu-Sidhnai-Mailsi-Bahawal link canal systems is the main supplier of irrigation water, further subdivided is the stock by smaller branches<sup>71</sup>. Three barrages (Sulaimanki, Islam, Punjnad) along the rivers Sutlej and Chenab and one link canal from the river Ravi provide the capacities. About 4 % or 113,500 ha (not quite actual numbers by FAO, 1992: 7) of Cholistan is commanded by canals. Owing to water-political disparities with India<sup>72</sup> and

68 a turbine well is a submerged centrifugal pump driven through a rotating shaft connected to a motor at the surface

69 the availability of wells makes these settlements inhabitable for longer or even the whole year; each is equipped with a series of wells and tanks

70 the river channels (creeks) of the Sutlej constituted traditionally the most important water source for the pastoralists of Cholistan

71 AB- Ahmadpur East Branch, BC- Bahawal Canal, DB- Desert Branch, DNB- Dera Nawab Branch, Eastern Sadiqia Canal, Abassia Canal and further link canals

72 the Indus Water Treaty, is a water sharing treaty, signed in Karachi on September 19th 1960; it gives India, with minor exceptions, exclusive use about the three eastern rivers of the Indus System- Sutlej, Beas and Ravi (and their tributaries)- before the point where these enter Pakistan; similarly, Pakistan has exclusive use of the three western rivers- Indus, Jhelum and Chenab

climatic variability, water by the Sutlej has been lacking in recent years and canal water is not available all year round. The average flow data of the Sutlej are illustrated in the following Table 6. These have been collected at Sulaimanki Barrage for the 40 years before the Indus Water Treaty, ten years after and recent years. For the latter has to be remarked, that these have been collected during drought conditions.

**Table 6:** Average annual flows of Sutlej

(1922- 1961)	(1985- 1995)	(2001- 2002)
litre/ s	litre/ s	litre/ s
547,000	140,000	780

Source: data acquired from Indus River System Authority

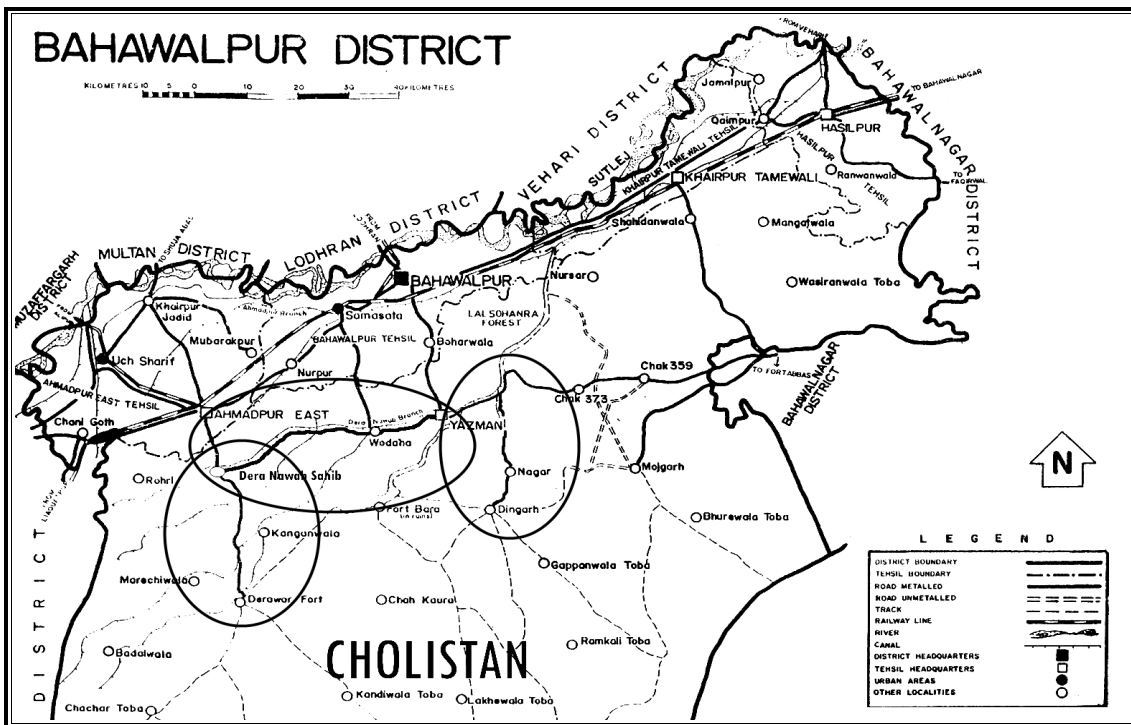
Because of these emerging shortages the cultivable area is reduced to the half of the amount. The canals providing water to the irrigable areas in Cholistan have been designed for non-perennial irrigation or, more specifically, to provide water supplies for about 10 weeks, during and immediately after the monsoon (July- August) when high river levels allow this. This supply is highly unreliable and depending on the position in the canal network, and is virtually only sufficient for irrigating parts of the land holdings of the families. Thus in many settlements in Lesser Cholistan a large part of the cultivable land is left fallow. E.g. in the district of Rahim Yar Khan, there is a reasonably large equipped irrigated area that was abandoned in the 1930ies when the water of the Sutlej was allocated to an area currently within the Indian district of Bikaner.

### 2.2.2 Transport Facilitation

The National General Trunk Road (NGTR)<sup>73</sup> and the railway linking Karachi, Lahore, Islamabad and Peshawar pass along the north of Cholistan, medial through irrigated areas, until they reach Bahawalpur where they turn north and cross the Sutlej. A important extension of the main road network is the southerly laying road between

<sup>73</sup> the GT Roads are South Asia's oldest and longest major road axes; for several centuries, these have linked the eastern, central, western and southern regions of the Indian subcontinent, running from Bengal, across north India, into Peshawar in Pakistan and to Goa or Madras

Ahmedpur- East and Yazman, which was upgraded by BRDP (see Figure 5).



**Figure 5:** Map of transport facilities in the district of Bahawalpur (Source: Federal Bureau of Statistics Bahawalpur (1981); modified by the author)

The access to this traffic and trade veins, interesting for economic activities, is possible from the fringes of the rangelands by only few metalled roads. In the district focused on here, these roads come from Derawar Fort, Dingarh or Marot, enter the scattered lying edges of irrigated desert and come to smaller market centres like Yazman<sup>74</sup>, Kudwala or Dera Nawab Sahib in the formerly irrigated land. From here to a series of urban settlements along the NGTR, the availability and adequacy of main roads is partially better developed, but the road surfaces and foundations of link roads and farm market roads can be in very poor state and have often to carry traffic loads well in excess of their structural quality.<sup>75</sup> Minibuses and motorbuses are in use for public transport, but often the traffic is somewhat chaotic and precarious because of the mixed nature and speeds of the various vehicles.

In the interior parts of the desert, the route is much more troublesome. The 3,000 km (acc. CDA: 2005) jeepable tracks (*kaccha* roads; dashed in Figure 5) are simply defined by the direction towards settlements and a experienced sense of orientation. On foot or

<sup>74</sup> capital of the similarly named *tehsil* (the second-lowest administrative unit in Pakistan) south of Bahawalpur

<sup>75</sup> BRDP is working here on improving road connections, they have improved 425 km from 1997 to 2003 and plan further 600 km up to 2011; road access does not mean that in front of every house there is a metalled road, but that in distance below 1 km at least one-way driving is possible, the core of the villages can be accessed, but due to the scattered settlements not every house

packing on camel or donkey carts, with motorbike, tractor-trolley or Jeep, one has to move the purpose.

### 2.2.3 Marketing Systems

"The income of the farming systems generated from sales is a function of the efficiency of the market system. The more efficient the markets work, the higher the level of farm production will be" (R. Wachholtz, 1996: 157). In order to develop an understanding of this impact, general information about the marketing systems (channels and infrastructure) for live animals and livestock products are described here.

The system in Pakistan is dominated by the private, informal sector and run by a chain of *beopari(s)* (middlemen). This applies especially to the dairy sector, which is the least commercialised but also the most important enterprise of the livestock sector.<sup>76</sup> More will be said about this after looking at the live animal marketing.

As stated in the section before, the irrigated tracks are reasonably well served by roads and a widespread distribution of weekly and bi-weekly markets which provide households adequate opportunity to market their products. Marketing of livestock and livestock products from outside of these areas, from Lesser or Greater Cholistan, poses some problems. In general livestock are sold both ex-farm to fellow herders, traders or butchers and in weekly and bi-weekly livestock markets which are held in or at the fringes of the irrigated areas. In addition, annual *urs mela(s)*<sup>77</sup> of one to three days are held at selected sites. The annual *mela* at Channan Pir<sup>78</sup> lasts two month with 50,000 to 70,000 heads of livestock sold (acc. NRSP, undated). Different types of livestock are marketed at various market levels. The district of Bahawalpur makes up the catchment area of two animal markets, for small ruminants in Yazman each Saturday (see Figure 6) and for large ruminants in Bahawalpur each Tuesday. The marketing of breeding stocks is an important feature of these district markets. The trading unit on district or local markets is mainly on a per-head basis.<sup>79</sup> The animals kept on rangelands are usually not brought there by the owner himself. Middlemen travel to take the animals

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<sup>76</sup> formal organised milk collection, processing and marketing represents only about two percent of the total urban dairy market (acc. FAO, 2003: 10)

<sup>77</sup> local term for animal shows

<sup>78</sup> a holy place with a tomb pulling every year pilgrims from all-over Cholistan; is situated north -west of Dingarh and south of Yazman; a visit is believed to be associated with a high probability of rain

<sup>79</sup> on markets for slaughter or export the basis is per kilo live weight

with jeeps or trucks from the places where the pastoralists stay to the market. E.g. at Yazman livestock market, 100 % of the sellers are small businessmen (NRSP, undated).



**Figure 6:** View (near closing) on the weekly small-ruminants market in Yazman  
(Source: by the author)

The processes at the market place have several actors. The key actor is the market contractor or commission agent. He has to have the license for holding the market from the district government, for which he pays around 3- 5 % of prospective commission, calculated on basis of the last years market potential. His role is to organise the auctions as a middleman and to guarantee transparency of transactions between buyers and sellers. His remuneration consists of a commission paid by the sellers. At the certain place, the sellers come together with purchasers from other markets, e.g. Faisalabad, Lahore, Sheikhpura, Sialkot or with local retail meat sellers (butchers), possibly arranged by brokers as a further instance.

The infrastructural facilitation of markets varies widely and can be of well-developed stores and space for handling, storing, packing, loading and unloading. There will be differences between those for grains, vegetable, fruits and those for live animals. Yazman, as the example used above, is just a central place connected by a road, with some trees, mobile shops for catering of the participants, a regular date and the market commissioner.

The milk market channels are more informally and still traditionally organised. Middlemen (*dodhi*)<sup>80</sup> collect the milk from the producers in Cholistan. Unprocessed milk can only be sold from pastoralists in parts of the desert or in the irrigated areas which the middlemen can afford to travel to daily. Information about the number of middlemen, the extent of milk collected from Cholistan and distributed in nearby cities is not available. Every milkmen has 5 to 7 clients. Usually they go on bicycle or motorbikes early in the morning to the ponds.<sup>81</sup> The payment for the milk to the pastoralists is made at the next day, to check the quality of milk (possible mixing of cattle milk with water or camel milk). But from that point the channel can be very different. It could be that they bring it to the milk collector, to the wholesaler or already to shops, tea stalls, hotels, bakers, home consumers or army messes. Milkmen usually receive their payments also with a delay of one day, or sometimes on weekly, fortnightly or monthly bases.<sup>82</sup> This system is relatively stable as the milkmen, moving daily between rural and urban areas, also provide some services to the producers, e.g. they bring market goods, provide credit or transport people.

A few years ago, processor companies (Haleeb Foods Ltd., Nestlé Milkpak Ltd.) have started operating milk collection systems in the irrigated areas all-over Punjab. The system of Nestlé, established partially at the fringes of Cholistan around Yazman and Marot, consists of several points with chilling tanks and two mobile units with jeeps. The price is paid on the basis of fat contents (relative to 3.5 % rate) not per litre.

The marketing of *desi ghee*<sup>83</sup> takes place mainly by the producers themselves outside the desert or near urban centres.

Wool shearing and sale is carried out on contractor basis. *Beopari(s)* and wool shearing crews (locally called *katray*) visit Cholistan bi-annually, firstly in the months of March and April and secondly during the months of September and October. "They set up shearing places with up to 10 shearers for around 40 days" (F. Scholz, 1997: 252). They take the wool and pay on per head basis rather than on wool weight in the next season, when they know which price they could obtain.

<sup>80</sup> common title given by villagers to middlemen of milk sector; can be further distinguished between the rural milk trader (*kacha dodhi*) and the highway collector (*pacca dodhi*)

<sup>81</sup> "as the producers tend to meet their domestic milk needs from the evening milk, virtually no middlemen go on a second collecting tour each day, although more milk would be available (Rangekar & Thorpe, Eds., 2002)

<sup>82</sup> some middlemen are reported extracting cream before marketing it; in summer, mixing of ice in the milk is allowed to prevent deterioration by lowering the temperature, this can lead to 10- 20 % dilution (acc. Rangekar & Thorpe, 2002, Eds.); sometimes other preservatives are used, such as hydrogen peroxide

<sup>83</sup> is a regular and principal dairy product in Cholistan; it is clarified butter oil or pure butter fat non-industrially processed for longer shelf life w/o chilling; 1st lactose is extracted from whole milk by making *dahi* (yogurt-like) by adding lactic acid bacteria, then this is churned until butter precipitates and leaves behind whey, the butter is heated to 110°- 120° C until the moisture has evaporated and the molten butter fat can be recovered; normal yield is 1 kg *ghee* from 20 kg milk (acc. FAO, 1990); the smoky burnt flavour of the *desi ghee* is preferred by a huge section of consumers

In addition to the livestock markets, the smaller centres like Yazman provide markets for feed-stuffs and in some cases for household items, food, textiles, clothing, shoes and energy products. Also workshops are found for all sort of repairs of tractors, engines and vehicles.

These are the prevalent marketing structures. The information presented here must be seen in connection with farm products and marketing behaviour of the pastoralists, considered in more detail in subsection 2.3.4.

#### 2.2.4 Veterinary Services

Traditionally, reasonable know-how for diagnosing diseases is available among the herders on the rangelands. However, the indigenous treatment capabilities of sick animals are very limited to some home-made herbal preparations. "Most of the time in minor illnesses, the local remedies work quite well" (PCRWR, 2003: 58).

However, the extension of veterinary services is principally the duty of the Livestock and Dairy Development Department. Its basis administrative unit is on district level. In the district of Bahawalpur, their aims are the treatment of sick animals and control of parasites and diseases (vaccination), pre- and post- slaughter observation in the slaughterhouses of Yazman and Ahmadpur-East, artificial insemination (A.I.), breed and product quality improvement, and market arrangements and price monitoring, with monthly report to the provincial department in Lahore.

For the district of Bahawalpur, there are two listed veterinary centres, 14 veterinary dispensaries (located in the irrigated tracks) and around 10- 12 mobile veterinary dispensaries (by which the desert areas should be covered), which are manned by veterinary officers, veterinary assistants, attendants and drivers (acc. Livestock Department). There is not one proper veterinary hospital in the whole district available.<sup>84</sup>

The coverage with vaccinations is estimated at 10- 20 % (acc. personal enquiry).<sup>85</sup> The situation of public veterinary service facilitation must be placed in a context of budget shortages of the department. A lot of staff positions are vacant because of low salary.

<sup>84</sup> Yazman, Head Rajgan or Channan Pir, as centrally situated market centres at the fringes of the desert, have been mentioned as feasible locations for improvement of this concern of the pastoralists

<sup>85</sup> due to the low production capacity of the nationwide vaccine research institute (VRI) in Lahore, and hesitancy of farmers as result of sometimes costly doctor visits and maltreatments



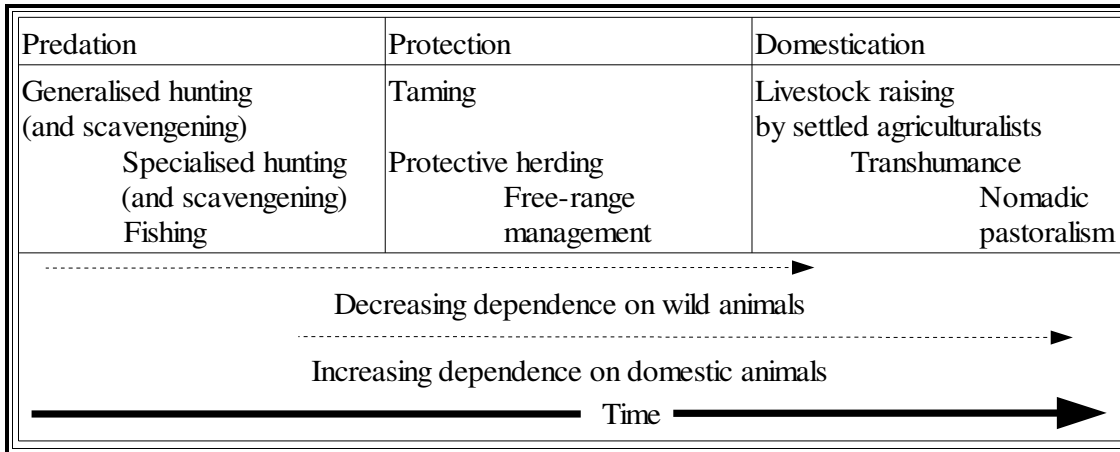
The rangelands are additionally disadvantaged, because the petrol is lacking for sufficiently frequent field visits.

### **2.3 Characteristics and Dynamics of Local Farming Systems**

The following section is a description of the prevailing farming systems and their links to the environment in Cholistan. The central intention is to develop a basic understanding of how these operate within the specific production environment or how the given resources are used to accomplish their main farm household activities. It is not aimed at presenting a complete record of the systems' defining parameters and conditions. It comprises the animal systems (micro level) with the mobility behaviour and grazing and feeding management, with the conditions of the livestock resource base, with the products use and farm market orientation and with the structure of the pastoral society and traditional rights of access to resources in the desert (institutions on communal level). Beside livestock, the two most important endogenous resources of pastoral households, labour and land, are only covered nominal here. Prependend is a subsection about the origins of pastoralism in the region.

#### **2.3.1 Origins of Mobile Pastoralism in Cholistan**

"The naïveté of much development literature concerning even the recent past is a rich source of error in the present" (R. Blench, 2001: 17). Although this thesis is basically an account of the present situation of pastoralists, it makes sense to refer to (pre-) historical processes. This is worth mentioning as input for discussions about the human dimension of environmental change and future paths of farming systems. But it would go far beyond the aim of this section to depict the processes of the development of pastoral land use (Figure 7) in Cholistan slightly more comprehensive or to show all the different facets and partially opposite corresponding theories of the mode of spread of agriculture.



**Figure 7:** Simplified evolutionary classification of systems of animal exploitation  
(Source: reproduced from D.R. Harris (Ed., 1996: 4))

The following considerations summarise in simple manner the developments in the larger region containing the target area.

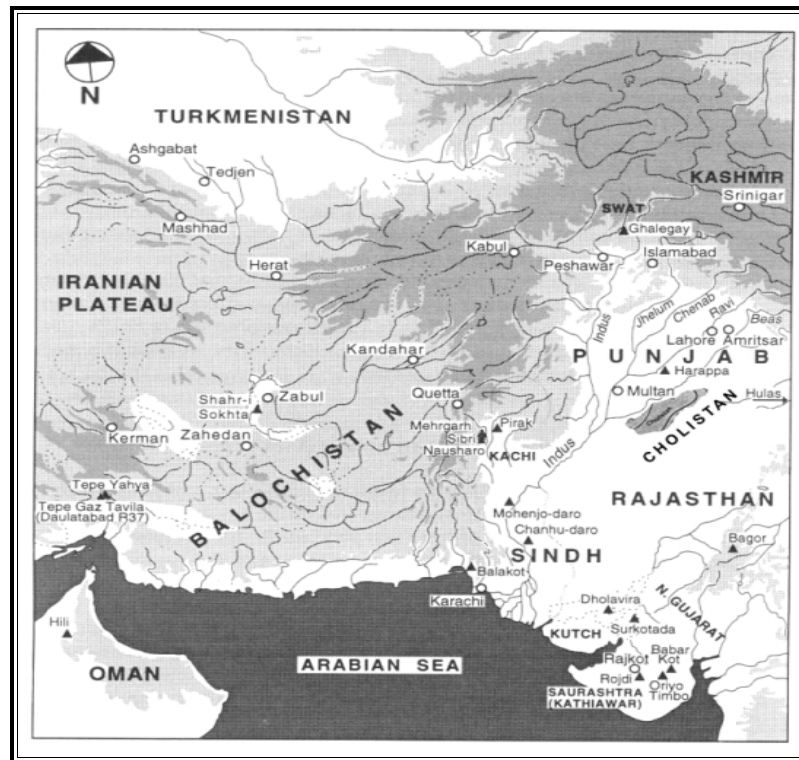
### 2.3.1.1 The Process of Domestication

Throughout the tropical and subtropical areas of southwestern and southern Asia, northern and central Africa and Central America, a major shift of the subsistence strategy of human beings occurred. It was the shift from food quest, the primal adaptation to nature, of naturally occurring vegetation, fruits, nuts, carrion and game animals, to food production, agriculture, by domesticated crops and livestock.

In the conference edition about early agriculture and pastoralism in Eurasia, D.R. Harris (1996: 569) concludes in a "provisional synthesis" of distinctive and multidisciplinary perspectives<sup>86</sup> that leaves "vast gaps in our knowledge", that "the evidence best fits a model of very few -possibly only two- independent loci in which pristine transitions to dependence on the systematic cultivation of domesticated crop plants took place". He goes on, that "first seed-crop agriculture based on cereals and pulses developed in western Southwest Asia during the 8th Millennium B.C., associated in the 7th Millennium with the raising of domesticated goats and sheep, and, secondly, that seed-crop agriculture based on millets and rice, with domestic pigs and chicken, developed in

<sup>86</sup> social, ecological, genetic, linguistic, biomolecular, epidemiological, geographical from archaeology, anthropology, biology, geography and others

East Asia, by, or possibly before, the mid of the 7th Millennium B.C."



**Figure 8:** Map of northwestern South Asia, showing archeological sites (Source: R.H. Meadow (in D.R. Harris, Ed., 1996: 394), modified by the author)

In Figure 8 can be seen that Cholistan is located at the conjunction of the Thar Desert (Rajasthan), the Indus Basin (Punjab, Sindh) and the Iranian Plateau (Balochistan), as was previously summarised as the Greater Indus Region. Here, earliest agro-pastoral farming settlements are known from the easternmost margins of the south-west asian Iranian uplands (namely Mehrgarh Culture in Balochistan)<sup>87</sup> since 7000 B.C. (acc. Wikipedia, 2007). R.H. Meadow (in D.R. Harris, Ed., 1996: 399) remarked, that "interaction with the regions to the northwest, west and southwest was continuous, although of varying intensity, provided the means of the introduction of new plants, people and animals". D.R. Harris (Ed., 1996: 563) concludes further, that "wheat and goats, and probably barley and sheep, were introduced from Southwest Asia, whereas cattle (*Bos primigenius* f. *indicus* or f. *namadicus*) may well have been domesticated locally", and that "agro-pastoralism had become established in the lowlands adjacent to the southeastern edge of the Iranian plateau by approx. 6000 B.C."

The transition to agriculture in different parts of the world at approximately the same

<sup>87</sup> situated at the northern Kachhi plain on the Bolan River with an elevation above the sea level of 150 m

time (within about one millennium) has led to the theory that climatic changes between geological periods set the (paleo-) environmental context, that is "providing opportunities for and constraints [drivers] on social, cultural, economic and technological innovations" (N. Brooks, 2006: 30). This human technological development, the Neolithic Revolution<sup>88</sup>, corresponded with the more wet conditions of the early Holocene epoch which lasted, with significant regional variations and also climatic fluctuations, from the 8 Millennium B.C. to the 3. Millennium B.C. (N. Brooks, 2006: 31). The effects of this humid phase showed themselves on the (mesolithic) pre-agrarian hunter-gatherer subsistence economies through changes in the distribution and composition of wild plant-foods, particularly wild-cereals<sup>89</sup> but also woodland-steppe and woodland and faunal<sup>90</sup> populations became increasingly available. During the course of adaptation hominids and their descendants must have, by trial and error, "learnt about the characteristic features, specially behaviour pattern and habits, of the animals which constituted their food supply and reserve, as well as about the edible qualities and desirability of almost all available plant resources" (R.S. Negi in B. Saraswati, Ed., 1998). "The increased greenery and diverse vegetation during the early Holocene enhanced human's awareness and sensitiveness towards nature", and we "became more curious to learn about the traits and usefulness of plants and vegetation for their subsistence" (A.K. Gupta, 2004: 56).

G. Hillman (in D.R. Harris, Ed., 1996: 192) concludes, that in ecological favourable but geographically restricted areas such increased carrying capacity led to "rapid population growth"<sup>91</sup>, so that the rising demographic pressure necessitated "small incremental increases in any existing practise of food storage and winter sedentism". A massive increased availability of food (calories per unit area) was associated with higher birth rates and reduced rates of human infant mortality. The human population increased progressively and periods of sedentary settlement could rise to the point that some family members (esp. pregnant women, young children) could remain in just one base camp all year round. After some generations possibly emerging stress on local food resources (also game animals) around these earliest villages was accompanied by

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88 term for the human-technological shift to agriculture, describing the transition from hunting and gathering to plant cultivation and pastoralism

89 due to their annual character, needing a dormancy period, facilitated by conditions of higher climatic seasonality since the late Pleistocene

90 the major source of animal protein of human beings have been e.g. moufflon (Bovidae), deer (Cervidae), wild ass (Equidae), rabbits (Leporidae), fish, mollusks; on the other hand it is reported about extinction of megafauna like mammoths, mastodons, glyptodons, ground sloths, predators like sabre-toothed cats and short-faced bear

91 a.o. by influx of many humans heavily dependent on storage and occupying particularly favourable locations with water supply and woody fuel

experimentation by the hunter-gatherers with destroying the natural vegetation, breaking up the soil, diverting water and sowing seeds of certain selected plants, what led to altered exploitative techniques<sup>92</sup> by which the required greater intensity of production could be sustained- cultivation<sup>93</sup>. The availability of stone and metal tools helpful in clearing fields and crop harvesting may have also helped the domestication of wild plants and beginning of agriculture.<sup>94</sup>

H.- P. Uepermann (ibid.: 233) sees "this ability to generate sufficient plant-protein foods as the preceding condition for herbivore domestication" (nursing hypothesis).<sup>95</sup> "It enabled the necessary nursing of tamed young animals that only could have led to reproduction in captivity and had made it probable that the proto-neolithic hunters and cereal gatherers/ cultivators realised the economic potential of founding domestic herds" (ibid.). The environmental context considered above fits to places of discovery of neolithic cultures in north-western South Asia like Mehrgarh, which is mentioned by S.P. Gupta (1996: 16) as the "nuclear zone" of cultivation and pastoralism in the region. Here has been "the formative period of the later highculture with change from cave dwellings to upcoming mudbrick houses, expanding family compounds, introduction of pottery and later on of copper, incipient domestication and increasing production and storing (granaries) and diversifying burial/ ceremonial practises and arts" (ibid.). F. Hole (in D.R. Harris, Ed., 1996: 272) locates those villages at sites "well drained by rivers", in the "classical dry-farming zone" where cereals and pulses might have grown naturally, "rather than or only little in the floodplains where tree fruits and the availability of wild caprine herds dominated the diet".

But to understand the reasons for the development of mobile pastoralism in the larger region focussed upon here, one has to be aware that the overall more wet conditions of the early Holocene have been fluctuative.<sup>96</sup> On the one hand the humans had to develop animal management, because formerly open pasture areas became segmented by the spread of forests in the more wet periods and because wild animals became endangered

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92 gradually upcoming propagation (burning, seeding/ planting or controlled breeding), protected growth (by weeding and manuring, or controlled feeding e.g. by transhumance) and organised harvesting or culling (C. Renfrew in D.R. Harris, Ed., 1996: 77)

93 C. Renfrew (in D.R. Harris, Ed., 1996: 77) refers to the capacity of simple and non-intensive agriculture as to be 50 times more productive than mobile hunter-gatherer economies; "whatever the total human population was at the beginning of the Holocene, just before the beginnings of agriculture and animal breeding it is likely to have been near saturation for the prevailing hunter-gatherer technology, so that population pressure was probably an important stimulus to innovations in food production" (Cohen, 1977 cited by L. Luca Cavalli-Sforza in D.R. Harris, Ed., 1996: 51)

94 "at Mehrgarh wheat and barley were cultivated from the beginning of agriculture, also jujube, date palms and grapes" (A.K. Gupta, 2004: 57)

95 he excludes several species from the process of domestication during the Neolithic Revolution by factors like body size, rate of growth, rude and territorial behaviour, thus only sheep and goat remain as animals suited to companionship with humans as lambs or kids for later reproduction; dogs were the first to have been domesticated around 12000 B.C.

96 could be "punctuated by severe decadal to centennial droughts" (N. Brooks, 2006: 38)

by heavy winters in the uplands, both led to fluctuating biomass of wild animals.<sup>97</sup> On the other hand emerging arid episodes were each time associated with degrading the provisioning of the inhabiting communities with food. There were coexistent groups at this time, some of which had adopted new technologies with cultivable plants and others which remained in nomadic hunting and gathering. Probably most realistic is that these gave way to another. For both, kept animals would have added a more predictable source of nutrition.

In order to protect or enhance continued availability of animals, the communities "embarked on a strategy of food resource management" by "elimination of predators, culling of non-productive animals (selective hunting), enhancing the growth of pasturage, providing supplementary forage and implanting animals into depleted or vacant habitats" (F. Hole, *ibid.*: 276). F. Hole (*ibid.*: 277) assumes, that "the communities among which seasonal mobility had been essentially ceased developed exploitable opportunities" by taking the increased climatic seasonality<sup>98</sup> "as incentive to resume [vertical] transhumance from lowlands or submountainous regions to summer pastures in the upland sites". Successful pastoralism depended on the availability of pasture thus mobile animal husbandry had to be organised.

These are the primary benefit related triggering factors for animal domestication and pastoralism.<sup>99</sup> The practises experienced rapid spread in spatial distribution during arid crises of provisioning, as herders were forced to move farther in search of new pastures. Depending on aridity of a specific habitat, for establishing animal husbandry different livestock species would have been preferred, as sheep and goats are more tolerant to heat than cattle. When considering the sequence of domestication and adaptation of immigrated practises in the Greater Indus Region, one should be aware of the probable diffusion from "one of the most important" (S. Legel, 1989: Bd. 1: 32) domestication zones, the Fertile Crescent in West Asia. "Initially, animals like sheep and goats were kept for the purpose of meat provision, but subsequent husbandry of larger animals was probably for their use in agriculture, irrigation and conveyance, and for milk, wool and fuel" (A.K. Gupta, 2004: 56). Once dairying was established, herding would have become an increasingly attractive option.

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97 during the late Pleistocene higher elevations had been unexploitable; "as the climate warmed, vast regions of pasturage enjoyed by the caprines in the mountains today have just been opening to potential colonisation" (F. Hole in D.R. Harris, Ed., 1996: 277)

98 pushed by the holocenic summer depletion of lowland pastures and pulled by new upland pastures colonised by wild animals- thus humans followed there

99 Keith Dubney (2007) speaks about a further impulse for domestication, that wild animals have been drawn to humans and human settlements by the "enormous advantage" of having access to different and more foods, and that the human presence may have kept away other predators

Up to this point, parts of the population with pastoral pattern of life kept seasonally moving from the highland to the lowlands and the developing village communities had established a winter cropping pattern (*rabi*)<sup>100</sup>.

### 2.3.1.2 The Great Transition of the 3rd Millennium B.C.

However, it should be considered that such cultural shift can not only be seen as being motivated by utilitarian purposes, rather animals "often fulfil important and culturally distinct symbolic and ritual roles" (Ilse Köhler-Rollefson, in D.R. Harris, Ed., 1996: 283). The importance of the new socio-economic element, agriculture, in the cultures rose to identifying bred animals as gods or as female gods, due to their assignment with fertility. A.K. Gupta (2004: 57) writes about the accompanying religious element, that the relation between humans and animals in India since the beginning of domestication has been "very friendly and complementary", and "worshipping of different components of nature (both animals and plants)" already during the pre-vedic polytheism indicates what they thought to be important for their survival and "many Indian sages turned wild animals as their pets".<sup>101</sup>

Through domestication and agriculture, the transformation from food collection to nature exploitation and (surplus) food production, the culture and consciousness of mankind changed. The reciprocal, non-hierarchical and egalitarian social structure of mobile hunter-gatherers gave way to systems based politically on leadership of clan chiefs and in larger communities of kings and economically on the redistribution or ownership of resources. The development of settled life and the long transition of village communities culminated in the emergence of the first urban highcultures in some parts of the Afro-Asiatic desert belt and northern South-America.<sup>102</sup> From the 3rd millennium B.C. the Indus-Sarasvati Civilisation<sup>103</sup>, with high number of localities in Cholistan, flourished, which is "remarkable for its uniformity and standardisation in weights, measures, ceramics, architecture, town planning and in arts and crafts, though

100 this is a adaptation to the hardships of a heavy but fluctuating monsoonal precipitation regime; wheat and barley are winter crops

101 it is often possible to find analogies between ancient mythologies and religious traits of current cultures, e.g. the sacred cow is a cultural link between historical times and current India; a lot of terracotta cattle figurines, bullock carts and cattle motifs have often been found at Harappan sites; regarding relation to animals, e.g. in the ancient Egypt evolved a cattle cult, "a association between the goddess and the king" (M. Brass, 2002: 108)

102 central Sahara, Egypt, Mesopotamia, South Asia, northern China and coastal Peru, during 4th and early 3rd Millennium B.C.

103 some authors prefer to call it Harappa Culture, after the site where it was first noticed

there is variation in ceramics, town plans, and perhaps religious beliefs", "over more than a million square kilometre an area more than that of Pakistan today" (D.P. Agrawal, undated).

It came about at the end of the early (middle) Holocene when, as already noted under 2.1.1, a climatic shift led to reduced global temperature averages and in the tropics to a more arid environment. N. Brooks (2006: 39) considered this at fluctuations of the water table of a.o. lakes in the Greater Indus Region, "a major and unprecedented (within the context of the Holocene) environmental change led to an abrupt fall in lake levels around 4400 B.C. and the lake was completely dry by around 3500 B.C."

N. Lahiri (Ed., 2002: 236) proposes, that until this point, "winter precipitation contributed to a larger scale to the hydrological conditions of the local rain-fed cropping systems and eliminated the fluctuations of the monsoon".<sup>104</sup> But now it was coming to a critical change, the recovery of the natural resources of the region after the event was at best partial. S.P. Gupta (1996: 25) describes a reaction to this drying period as "many groups of people moving down the Baluchi hills along the Kirthar and Suleiman ranges into the river basins of the Indus, Sarasvati, Ravi", also more south to Sindh and Gujarat new villages were established. There, "water resources have been more reliable and environmental variability more predictable, resulting in greater food security" (N. Brooks, 2006: 39). This preceded the rise of the (mature) urban highculture by 800 to 1,000 years (from 2600- 2000 B.C.).

N. Brooks (ibid.) suggests that the "expansion of farmers and herders eastwards from Baluchistan into the Punjab" went so far that herders appeared even at the eastern fringes of the Thar Desert. "The pastoralists had to penetrate deeper into the riverine and adjacent desertic zones in search for pasture during this stage" (Possehl, 2002 cited by N. Brooks, ibid.). The interactions of the humans with the environment of the Greater Indus Region are not as clear as for Egypt or Mesopotamia. There came about a significant increase of the population density at the rivers of the drainage systems of Indus and Sarasvati, possibly also to conflicts between (migrant) groups arriving in the valleys and the existing population, but also to cooperation. The responses to the water scarcity led to a highly complex society with a specialised urban population and stratified state-level organisation.

The ability to sustain the provisioning of all the people was a result of innovations in

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<sup>104</sup> it is also mentioned, that possibly until then the monsoon activity left over water sufficiently to crop in the winter season



cultivation and animal husbandry practises.<sup>105</sup> A.K. Gupta (2003: 46) hypothesises modifications of the "dwelling environments by adapting new strategies to optimise the utility of available water by harvesting rain". Since the peak of the wet conditions of the Holocene were over (6th millennium B.C.) "simplest earthworks originated in the Thar Desert" (ibid.: 48), which in the passage of time have been advanced to *toba(s)* and *kund(s)*. The expanding demand of urban centres encouraged cooperation between the crop and animal farming systems, as we could find in the region until the more recent, pre-colonial past and as is (just partially) existent today (see 2.3.2). The mobile pastoralists adapted to those needs or benefits and to the seasonal feed supply by organising (horizontal) transhumance in the plains between the vast rangelands and the cultivated, sedentary settled and riverine areas.<sup>106</sup>

The basis for this system and the advanced civilisation was the Greater Indus Region. A contrast zone of mountains, alluvium and desert with different ecosystems with different cycles of seasonal availability, where processes of intensification and specialisation of agriculture could occur by the suitability to transfer plants and animals and knowledge about cultivation and husbandry from initial habitats to new ecological niches of greater primary productivity.<sup>107</sup> But the proceeding climatic change, environmental desiccation and degradation by over-use problems through population pressure of the mainly cultivating Harappan people, and the aforementioned loss of the important Sarasvati River affected the decline of the civilisation. "The evidence points a precarious economic situation as a significant reason of the downfall of the third of the world's earliest civilisations" (N. Lahiri, Ed., 2000: 262). Singh et al. (1974 in N. Lahiri, Ed., 2000: 243) comments on the effect of aridity, that "this dry period (2000 B.C.- 1000 B.C.) was perhaps responsible for the wide cultural gap between the decline of the Harappan culture and the beginning of the succeeding culture, tentatively associated with the colonisation of impoverished land".<sup>108</sup> L. Luca Cavalli-Sforza (in D.R. Harris, Ed., 1996: 56) supposes around this time, "a possible expansion of pastoral nomads across Iran, Afghanistan, Pakistan and India who probably originated in the region of

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105 in the interaction zone, where Egyptian dynasties have been formed, different groups reacted differently, some became more settled and intensified the exploitation of local resources, others increased the mobility of pastoralism involving large-scale year round movements (N. Brooks, 2004: 3)

106 the cultivators modified their production systems too, whereas, they also introduced new water related techniques, but specially did they change the cropping pattern in the floodplains to summer season crops (*kharif*) with rice, sorghum, millets, whereby they were now relying more on monsoon rains and irrigation technics as before on sufficient winter rains

107 reasonable transfer of plants adapted to seasonal stress from marginal habitats to richer areas (A. Sherratt in D.R. Harris, Ed., 1996: 134)

108 A.K. Gupta (2003: 48) reports a major weakening of the SouthWest monsoon, with increased and persistent aridity, and between 1000- 600 B.C., migration of people eastward from early settlements along the Indus and Sarasvati to the Ganga Plain and Ganga-Yamuna *doab*

the Kurgan Culture<sup>109</sup> in Central Asia". The value of the culture of these incoming nomads (who are supposed to be the origin of the elusive Aryans), with their remarkably powerful economies, which were also adapted to the increasing desertification, must have been relatively high for the land use in the expanding Thar or developing Cholistan and around the semi-arid river *doab(s)* of the north-western Indian subcontinent. They contributed technically to the land use but also to the formation of the "unique social system, that of the Indian castes" (*ibid.*), successfully sustained by specialisation in logistics and warfare through their long seasonal migrations.<sup>110</sup>

"The process of expansion of pastoral nomads shows major differences from that of farmers, because nomads are adapted to marginal desert environments and their way of life is based mainly on a small range of domestic animals, so they cannot reach high population densities" (L. Luca Cavalli-Sforza, *ibid.*: 56). "Their agricultural activities can only be minimal, due to necessary extensive seasonal movements they rely on settled farmers for agricultural supplies, and the most efficient way to guarantee such supplies is to dominate the farmers politically" (*ibid.*). "The most successful example of symbiosis between them is perhaps that generated in the Indian subcontinent, the origin of which can be traced back at least to the 2nd Millennium B.C. in what is today Pakistan" (*ibid.*).

D.P. Agrawal (undated: 7) believes that during these processes of agricultural transformation (by the mid of the 2nd millennium B.C.), also the camel (supposedly *Camelus bactrianus*), the horse (*Equus caballus*) and the donkey (*Equus asinus*) also found their place in areas of northwestern South Asia. These new means of animal-based traction, transport and communication (and raiding and warfare) made the reoccupation of areas which had been aridified during middle Holocene period possible. I. Köhler-Rollefson (in D.R. Harris, Ed., 1996: 288) states, that "the first definite reference to the dromedary in the Indian subcontinent appears to be in connection with the Muslim conquest" (Muhammed bin Quasim, 717 A.D., in Sindh). It is important to recognise the "pan-Indus integration of the Greater Indus Region" by "several interaction routes" (N. Lahiri, Ed., 2002: 383) which were dependent on these domesticated animals and brought together various cultures which interacted or learned

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109 cultures closely east of the Volga-Don region are believed to have originated expansions to south and south-east, thus transmitted the Indo-Iranian branch of Indo-European languages to South Asia; "by about 1500 B.C. when the Harappan civilisation was already in decline there are archeological signs of another, more modest, culture of people who lived outside the cities, probably pastoral nomads who later spread to India" (*ibid.*)

110 A.K. Gupta (2003: 48) states here the origin of the Rigvedic pastoral economy; "the Aryan invasion of India was not a single concerted action, but one covering centuries and involving many tribes, perhaps not all of the same race and language" (N.Z.A. Auj, 1991: 40)

(trade) from one another and so contributed to the complex social-cultural system existent today.

Our understanding of the origins and spread of pastoralism in the target area has been advanced by the previous sections. Even if concepts like the centres of origin of cultivated plants and the "Neolithic Revolution" just lead to "provisional interpretations and generation of models partly with regional uncertainties and insufficient comparisons made with evidences from other areas" (D.R. Harris, Ed., 1996: 2).

### 2.3.2 Forms of Mobile Animal Husbandry

Referring to the distribution of the prevalent agricultural land use over the administrative districts comprising parts of the Cholistan area, it is possible to identify areas which are primarily in use for livestock rearing or for crop farming. When examining ecological and socio-economic sustainability of the rangelands of Cholistan, the focus must be on the households which are primarily earning their livelihood (subsistence, cash, capital) as graziers, characterised by a array of mobile pastoral production systems.

The survival of the animals is strongly associated with the amount, time and frequency of rains in the desert and by this also with the supply of vegetation there. Obviously climate carries immense significance and importance for the pastoralists. For sedentary life unfavourable natural environmental conditions have already been described (2.1), thus for survive, families had to adopt a system of mobility, which is a kind of adjustment process of human and livestock numbers to the spatially and temporally alternating carrying capacity of the area. The livestock management depends heavily on grazing pastures and the availability of water in *toba(s)* and *kund(s)*.

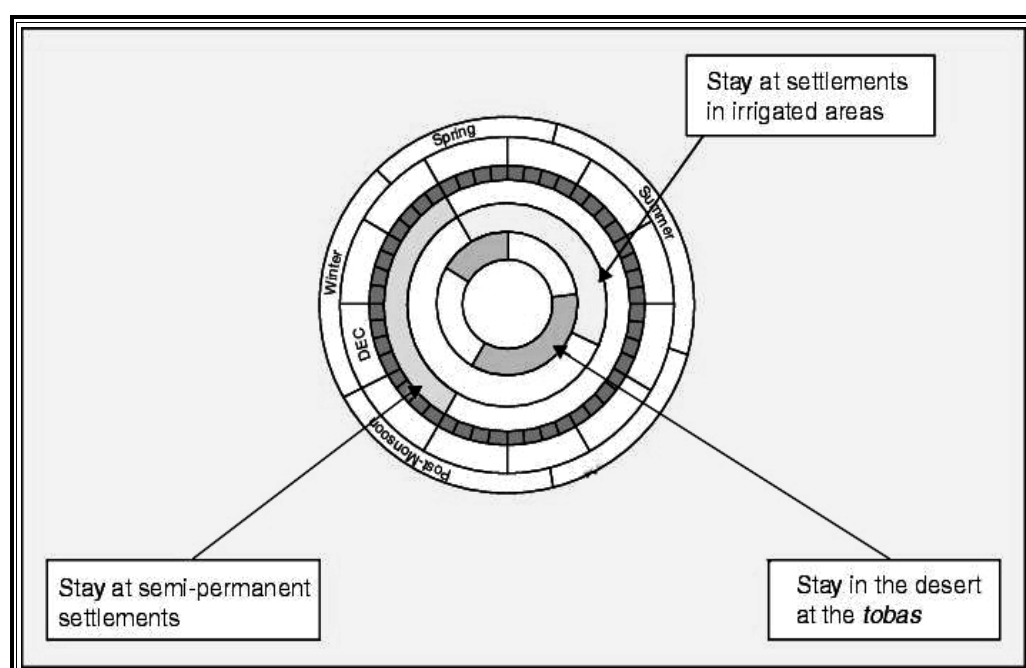
By the information given in subsection 2.3.1, it can certainly be assumed that traditionally the Thar Desert or Cholistan and the *doab(s)* north of it are pastoral nomadic living spaces. By today's practised seasonal-regional migration behaviour<sup>111</sup>, three groups of mobile pastoral livestock systems can be differentiated.<sup>112</sup> Those traditionally living "nomadic pastoralism" (acc. H.E. Jahnke, 1982: 67) remain

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111 "the most common categorisation of pastoralism is by the degree of movement" (R. Blench, 2001: 11)

112 concerning the use of pastures in Cholistan should also be mentioned the herds of sedentary pastoralists or mixed farmers; there is also a kind of joint herding arrangement which can be found between agro-pastoral and sedentary pastoralists, the latter leave their animals to be cared with the owners of larger herds

throughout years of sufferable seasonal land degradation within the desert. Other households traditionally practise "horizontal transhumance" (acc. R. Blench, 2001: 12), whereby the spaces between which they oscillate, from the rangelands to irrigated or riverine areas, are originally conditioned by the traditional land tenure system (see 2.3.5). Below termed agro-pastoralism are systems of "crop farming with limited transhumance" (acc. W. Doppler, 1991: 64). These are systems of recent origin and are practised by land-owning pastoralists or by tenant farmers of the irrigated areas. Akhter & Arshad (2006) find the differences mainly dependent on kept animal species, landholding and available feed resources. If necessary these are addressed in the following.



**Figure 9:** Yearly movement pattern of pastoralists in Cholistan (Source: Akhter & Arshad (2006))

The description of the pattern of seasonal migration starts at the water holes in the desert in the rainy season (July- August), when these get filled by rain water run-off and vegetation sprouts and provides grazing opportunities for livestock in relatively proximity (radius ~1 km) (see Figure 9).

In September, most of the families settle on their traditionally occupied pastures in the desert. The agro-pastoral farming systems bring their animals only with some family members or even hired labourers, while parts of the family remain in permanent

homesteads in their traditional villages or *chak(s)*<sup>113</sup>. Dwellings<sup>114</sup> of all the herders are situated nearby one up to three *toba(s)*, often within a 2- 4 km radius. Feeding of livestock is exclusively dependent on natural grazing and watering on the rainwater collected in ponds.

In the post-monsoon season (October- November) the ponds begin to dry. The people and herds start to move therefore to other ponds or wells and tanks, with the latter situated primarily at semi-permanent settlements all over Cholistan. The daily grazing tracks can increase in their distance to around 15 km now.

Cattle and sheep are more susceptible to hunger and thirst, therefore, if the (agro-) pastoralists have good relationships to the northerly, irrigated areas, where they, the extended family or other acquaintance may own a certain amount of land, they take them to these areas already, whilst dromedaries, dry cows and goats are left on the rangelands (Figure 10).

		Lesser Cholistan	Fringes	Canal Colonies	Sutlej Belt
Cattle					
Camels					
Sheep					
Goats					

**Figure 10:** Migration spaces practised by different livestock species (Source: BRDP (1999), modified by the author)

Some of them also move towards the irrigated areas (*abadi*) to graze on cotton stubbles in the same month, where women and children had already been sent for cotton-picking<sup>115</sup>. These groups have to go back to Cholistan in December (onset of winter) when wheat cultivation is under way and the farmers push the livestock out of their fields.

<sup>113</sup> during expansion of canal irrigation schemes newly founded villages; houses are mostly made of brick masonry and metal-beared roof top

<sup>114</sup> temporal settlements/ encampments; housing, sanitation and drinking water supply are all of an extremely rudimentary nature; in Lesser Cholistan types of mud huts, in Greater Cholistan made of leaves, branches, covered in with cloth

<sup>115</sup> an exclusively female activity, daily wages are customarily 1/ 16 of what is picked, or paid in cash about 25- 50 Rs/ 40 kg picked cotton

Except camel and goats which can survive on evergreen browse and are mainly kept in the nomadic system<sup>116</sup>, the herds have slowly retreated from the deeper locations in the desert to wells and *kund(s)* in Lesser Cholistan, mainly around the semi-permanent centres along the Sarasvati depression, during January and February.

In March and April (spring), most herders tend to move their milking cows and sheep towards the irrigated areas along the fringes of the desert, while the other animals are left back around water sources, which are scarcer by this time. They try to find unskilled labour in the towns or they engage in wheat harvesting there to earn supplementary money or grains for family consumption. In the days after wheat has been harvested<sup>117</sup>, the animals can stay for stubble grazing (in exchange for livestock droppings on the fields) until the ground has to be prepared for the following crop, or they are partly fed on dried forage from vegetation along canal banks, roadsides, on dryland between irrigated patches or wastelands and partly by purchased fodder<sup>118</sup> and *vanda*<sup>119</sup>.

In May and June, when the hot summer season or drought period rises, they tend to move on towards irrigation areas, to the riverine belt of the northerly Sutlej and to the Lal Suhanra National Park.<sup>120</sup>

AZRI (undated) remarks regarding herds size that "the smaller the herds the earlier they are reaching the irrigated areas", because during migration and around cultivated fields, it takes more labour effort by the males, when they must closely watch their animals to keep them from damaging the crops. Hauling water from wells and watering animals during the dry months are beside grazing and milking<sup>121</sup> main contributions of the males to the pastoral economy.

In this time when the environment for maintenance of animals becomes severe, the agro-pastoralists can return to their land in the irrigated tract. They can try to keep the animals there, as throughout the year remaining dairy and draught animals, water them by comparatively more comprehensive sources (canals, wells) and feed them with self grown fodder crops and crop residues.<sup>122</sup>

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116 comprising almost all larger camel herds (95%) and about half of the goats population (acc. FAO, 1992: 16); natural grazing is the exclusive nutritional source for these animals

117 activity of the whole family, including children, paid in cash or kind of about 40- 100 kg wheat per acre wheat harvested

118 green fodder crops esp. Berseem (*Trifolium alexandrinum*) and dry roughages esp. wheat straw

119 special feed for animals, concentrates like very common cotton seed cakes (Bahawalpur lies in the wheat- cotton- belt) plus minerals

120 F. Scholz (1997) writes, that it is said but not assured, that during harsh periods, some dromedary keepers even take the troublesome track along roads to the Thal Desert, some hundred km north to the Sutlej

121 this is usually performed twice a day, i.e. before departure of the herds for grazing and after their arrival from the rangelands

122 if this is not possible due to number of animals or cropping season, than they have to bring the animals, as their pastoral colleagues, to common areas at the river or irrigation canals

The reverse movement towards the water points in the desert begins with the onset of the monsoon rains. This is the ideal season for the male pastoralists, because open grazing is practised on the huge space of the rangelands, with cattle moving out daily (or at night<sup>123</sup>) guided by a leader cow and coming back to the pond for watering in the evening, thus male labour input is minimal. This can extend up to only collecting the dromedary herds annually in November for selecting them. But small ruminants with shorter grazing range are attended by shepherds, as they are vulnerable to attacks of predators (jackal). With these flocks, separated from the adults, mostly the young stocks of large ruminants are sent for grazing, or they are kept in pens or tied near to the dwelling cared for by family females, to prevent them to suckle milk from their mothers. Generally, the children and women accompany the males in this time, because greater milk production demands their contribution to process large quantities of dairy (see 2.3.4).<sup>124</sup> The boys as young as five years accompany the shepherds in their daily routines to learn the livestock related skills<sup>125</sup>.

Such practices can vary between the households. The distances covered range from 10 to more than 100 km.

This relatively simple description of the mobility pattern of pastoralists is of course more variable in reality, as the point in time, distances, duration, routes and herds composition of migration and the grouping of the families depend on the climate of the year and natural resource conditions. Livestock husbandry and human life in Greater Cholistan would be almost impossible without access to adjacent better watered land during the driest and hottest season as is made available in Lesser Cholistan. On the other hand, Lesser Cholistan has limited opportunities for free grazing. One can say that drought intensifies the magnitude and momentum of migration from Cholistan while rains work other way round and mitigate the frequencies and scale of migration. For example during the prolonged drought between 1998 and 2003, most of the herders barely moved south, some stayed only a few days or a few months before being compelled to return.

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123 night grazing is usually done in areas with emergence of the Warble fly, which is a name given to the genus *Hypoderma*, common species are *H. lineatum* and *H. bovis*; the large, hairy, bee-like and brown, orange or yellow in color flies are parasitic on cattle and deer; the fly lay eggs on the foreleg of the affected cattle, these are ingested by licking and swallowing or the larvae is burrowing into the skin of the host animal, causing Myiasis; internally they are passing of the oesophagus muscles and spinal cord before subcutaneous re-emerging; their presence is causing damage to livestock, like reduced milk yield, lower daily weight gain, hides rendered worthless

124 women contribute substantial to the livestock management activities

125 grazing methods, types of vegetation, medicinal plants, veterinary diseases

### 2.3.3 Livestock Resources

Mobile animal husbandry represents the main on-farm activity of the families in Cholistan. "Livestock is a special production factor that is not defined as capital in the classical sense. It can be transferred to capital and, in return, can be obtained by capital" (W. Doppler, 1991: 59). "The value of livestock for individual herders is characterised by a combination of the genetic reproductive potential, the size and composition of herds" (A.M. Abdullahi, 1990: 28).

#### 2.3.3.1 Livestock Breeds and Diseases

Indigenous livestock species are lean and hardy and, in terms of meat and milk, relatively unproductive. These characteristics are closely interrelated to the environment in which the herds and flocks develop. Occurring periods of droughts, famines and diseases mean that only the hardiest animals remain.

The people predominantly herd cattle (Cholistani, *desi*<sup>126</sup>), dromedaries (Brela, Marecha), sheep (Cholistani, Khadali, Sipli) and goats (Jattal). The modest numbers of buffaloes, added for people with landholding and settlement in the irrigated areas, and donkeys are not contemplated in the following.

The cattle in Cholistan are commonly named Cholistani. "It is a medium sized<sup>127</sup>, multi-purpose breed for meat, milk and draught power" (I.L. Mason, 2002) with a weight at maturity of ~240 kg (acc. PCRWR: 2005: 128). These Zebus (*Bos Indicus*) are usually white with red, brown or black speckles. Milk yields of up to 8 kg per day are mentioned (acc. M.S. Khan, undated) which decreases in the later stages of the 5- 9 months lactation period.<sup>128</sup> "It is a breed of recent origin, thought to have been derived from crossing of Sahiwal<sup>129</sup> with local cattle" (I.L. Mason, 2002). The animals are highly heat-tolerant and have high resistance to endo- and ecto-parasites (e.g. ticks). Because of continuous inbreeding and lack of selection of animals with desirable traits the breed characteristics and production have declined. So most of the animals are more

<sup>126</sup> is a term used for a nondescript local cattle; Punjab Livestock Census stated 80 % of provincial cattle as *desi* type (acc. Livestock Department, 2000)

<sup>127</sup> male height \* length - 135 cm \* 150 cm

<sup>128</sup> avg. milk production ~1,500 kg per lactation, milk fat content ~4.3 %, avg. calving interval ~520 days (acc. PCRWR, 2005: 128)

<sup>129</sup> one of the best dairy breeds in India and Pakistan



of *desi* type.

The both dromedary breeds common in the region have some different characteristics. The Marecha is an excellent riding animal, typical in the desert, with milking capacity of up to 6 litres per day (acc. M.S. Khan, undated). Due to modern communication and mechanisation its value for riding and transporting is declining. The light to dark brown coloured animals with a slim body and strong and fine legs can reach speed of 13- 16 km/ h and walk 8- 10 h (ibid.) at a stretch. The almond coloured Brela is a more heavy type with good production of milk and meat, typical for the riverine tracts of Punjab. With prominent milk veins it provides up to 10 litres per day, stall fed even up to 20 litres (ibid.), in lactation periods of 6- 12 months (acc. AZRI, undated).

The most typical sheep breed in the central desert area, the Cholistani, has small stubby ears, is hence locally called '*buchi*'<sup>130</sup>. It is a medium sized, thin tail, mutton and wool type, with female adult weight of ~39 kg (acc. M.S. Khan, undated). "The wool is considered to be the best carpet type", with a annual wool production of 3.5 kg (ibid.). Their body colour is white with dark-brown head and ears. It is reported (M.A. Khan et al., undated), that due to cross-breeding with the Lohi breed from central Punjab "the stress tolerance is reduced and thus animals become less productive with successive generations."<sup>131</sup>

The Cholistani goats are of stubby, *desi* type. Usually there is no pure breed found in the area. Sometimes Jattal is mentioned as typical breed. Their body colour is grey to dark, male adult weight is of ~23 kg and can provide daily milk yield of 0.5 kg. They can tolerate heat and drought and have long mohairs with a average hair production of 4 kg per head and year (acc. M.A.A. Quraishi, 1993: 133).

In general, reproductive performance is poor. Birth rates are low and mortality rates high, among cattle alone they range from 5 to 60 % (acc. Akhter & Arshad, 2006: 216). Pastoralists report a high incidence of animal health problems which evolve from a combination of nutrition and water (drought) and disease problems. The major diseases for large ruminants (cattle, dromedary) are Haemorrhagic Septicaemia, Black Quarter, Foot and Mouth Disease, Anthrax, Mastitis, Babesiosis, Camel Pox, Trypanosomiasis, Endo- and Ectoparasites. For sheep and goats these are Enterotoxaemia, Sheep and Goat Pox, Pleuropneumonia and Endo- and Ectoparasites.

<sup>130</sup> the term, common in Sindhi but also Seraiki language, means 'without ears'

<sup>131</sup> Lohi rams were distributed among the pastoralists to improve the genetic potential of local breeds for which no breeding programmes are established

### 2.3.3.2 Size and Composition of Livestock Herds

"Herd ownership patterns are socio-economic key indicators of prime importance and consequently differences in the wealth status or in ownership may explain different production objectives of pastoral households" (A.M. Abdullahi, 1990: 28)

The livestock numbers in Cholistan constitute only a small proportion of the livestock of the whole Punjab.<sup>132</sup> The exact population of livestock is unknown as the estimates reported by various agencies (such as Forestry Department<sup>133</sup>, National Livestock Census, Agricultural Census, Livestock Department of Bahawalpur) differ largely from one another (Table 7).

**Table 7:** Reported livestock population in Cholistan

Species	1976	1981	1986	1992	1997	2000	2001
Cattle	46,747	49,787	55,858	73,048	407,550	447,591	192,464
Camels	17,730	22,003	22,703	16,510	20,777	29,340	12,616
Sheep	171,741	169,518	202,375	147,429	650,558	440,854	189,567
Goats	31,167	33,658	37,080	53,680	275,277	203,848	87,655
Buffaloes	2,300	3,005	n.a.	n.a.	13,165	11,577	4,978
Total Heads	269,685	277,971	318,016	290,667	1,367,327	1,133,210	487,280
Total TLU	151,485	160,466	178,884	173,304	815,981	752,257	323,470
Total AU	131,473	142,674	156,171	154,076	701,259	680,414	292,578
details in number of heads							

Source: 1976- 1997 acc. AZRI (undated); 2000 acc. Livestock Department (2000); 2001 calculated by 43 % drought reduction; AU calculated with conversion factors from Sarwar et al. (2002)

It is notoriously difficult to get reliable numbers, because herd-owners can be somewhat hesitant to present real numbers to avoid head tax. That is why the estimates of the year 1996/ 97, which are taken from the livestock census of the Livestock Department of Bahawalpur are about five times higher than the estimates of the Forestry Department for the year 1992. Such a large increase in livestock within 5 years appears incredible. Keeping in view the estimates for previous periods (1976 to 1992) the data indicate an

<sup>132</sup> based on the livestock census of 1996, 13.1 mill. buffaloes, 9.38 mill. cattle, 6.14 mill. sheep, 15.3 mill. goats, and 2.37 mill. other animals were found in the Punjab Province

<sup>133</sup> the estimates of the Forestry Department are based on head tax collections from the Cholistani herders

average annual herd increase of 2.7 % for cattle and of 3.4 % for goats. Whatever the degree of accuracy of these estimates, it is clear that cattle and sheep are the most frequent livestock species in the area, moreover cattle numbers are increasing and camel population is declining.

When considering these numbers, one should not forget the impact of the severe drought, which recently overcame Cholistan. FAO/ WFP (2001) estimated, in a time when the recent drought was forceful in the third consecutive year, the percentage of livestock on provincial level of Punjab affected (mortality, production loss and distress sales<sup>134</sup>) by the drought at 43 %. With species-specific differences this factors can certainly be assumed for herds from such a remote area as Cholistan, because they had no possibility of escaping while even the dry season areas had been much in trouble with feed and water shortages. The projected animal numbers of 2001 on the basis of the numbers from 1997 show the dramatic losses.

The size of herds and herds composition (livestock holding) are determined by various factors, such as the productivity of the animals, their tolerance to harsh environments, the intensity of care required, resistance to diseases, size and composition of the farm family (labour), risk aversion behaviour of the decision-makers and market prospects of livestock and by-products.

The following table shows the average livestock holding of households in the target area, depicted species-wise in numbers of animal heads.

**Table 8:** Average livestock holding per species in Cholistan

	Cattle	Camels	Sheep	Goats	Buffaloes	Donkeys
No. of heads per household	58	7	60	18	0.5	0.5

Source: reproduced from AZRI (undated)

It shows that cattle are the most important livestock species in Cholistan and on average each household owns about 58 heads.<sup>135</sup> The average among dromedary in a herd is about 7 heads. Sheep ownership averaged 60 heads. The average incidence of goats in a herd is about 18 heads. Buffalo is the least frequent species among the large ruminants and is confined to the irrigated areas of Lesser Cholistan. A few herders also keep

<sup>134</sup> when the need arises to sell sizeable number of stock to purchase of foods

<sup>135</sup> people tend to raise it in herds ranging from 10- 200 animals in some cases even more (personal enquiry)

donkeys. A more detailed account of the distribution of herders making their living with various farming systems and combinations of livestock species and animal types<sup>136</sup> is not covered here.

#### 2.3.4 Livestock Products and Market Orientation

With this stock of animals the herders are trying to sustain their families. Livestock serves as wealth, source of income, nutrition, fuel, means of transport and as a status symbol. The most important farm products from the livestock species described above are meat, milk, *desi ghee*, wool and hair. The conditions and localisation (channels) of the marketing systems of the different products have already been described under subsection 2.2.3.

According to W. Doppler (1991: 19), the decision behaviour of the pastoralists is "most influenced by the degree of orientation of farming systems to markets". The degree of the market orientation is an indicator for the impact of monetary incentives on the decisions about the family's management of endogenous resources. "The measure for the degree of market orientation is the portion of the farm production, valued by market prices, which is sold to market" (ibid.).<sup>137</sup>

AZRI (undated) mentioned that the main objectives of cattle keeping are the sale of young stock, dairy products, adult animals and home consumption. Camels are kept mainly for travelling and transporting. Large herds of camels are mainly kept for sale of young stock, of adults and for domestic milk consumption. The leading objectives for keeping sheep and goats are the sale of young stock and adult animals, production of wool or hair, sale as sacrificial animals and for home consumption.

As becomes more clear from the following details, the production objectives of the farming systems in Cholistan are on average subsistence and market oriented.

The majority of households sell live off-take for slaughter and surplus animal products. Admittedly, "the herders in Cholistan generally have no intention to sell their animals unless some urgent monetary need arises" (ibid.). So the prevailing sale pattern of live animals are irregular or need based sales and annual herd clearance sales.<sup>138</sup> As a major

<sup>136</sup> breeding males, dry females, lactating females, young stocks, etc.

<sup>137</sup> thereafter W. Doppler (1991) differentiates farming systems in three groups; subsistence oriented systems are marketing over several years less than 10 % of their production, subsistence and market oriented systems are marketing between 10 % and 90 %, market oriented systems above 90 %

<sup>138</sup> others could be monthly, quarterly, bi-annually

portion of herds stays most of the time in areas far away from livestock markets, animals are often sold to the middlemen. Also, many animal sales happen when the transhumant herds stay in the irrigated areas, because here the access to markets is easier, which is why herders sometimes keep postponing the sale of animals until they migrate to the north. But this is also due to an increased monetary need for buying supplementary feed-stuffs during that time of seasonal emigration. A further notable sale reason are prolonged drought conditions, emergency sales, when the herders try to adjust the herd's size to the resource supply and to reduce the risk of losing their assets completely. The supply and demand forces are active, as such that in summer when lots of the herds migrate to the irrigated areas the market prices for animals decline, whereas the prices for feed-stuffs increase. This exceptionally occurs when drought conditions aggravate the pressure to sell animals of deteriorated health conditions.<sup>139</sup> Best prices are obtained in the time of religious occasions like *id-ul-azha*<sup>140</sup> and *id-ul-fitr*<sup>141</sup>. For instance, a healthy 1–2 years old goat with not more than two teats could bring at the market in year 2005 normally 6,000 PRs but during *id(s)* price could rise to 10,000 PRs (acc. personal enquiry). Thus the nominal prices had increased as compared to 1992 when the prices for goats ranged between 800 and 1,000 PRs (acc. FAO, 1992: 23).<sup>142</sup>

Cattle are the major milk-producing animals in Cholistan. Milk can be used for home consumption, fed to infant and young stock as food supplement, and processed and/ or sold. Total milk production of farming systems depends on the number of lactating cows and average milk yields. The milk yields per cow have wide variations around (post-) monsoon and winter seasons.<sup>143</sup> The stage of lactation, availability of water and vegetation, nature of foliage and feeding pattern may be of major impact. The average daily milk yield is estimated by AZRI (undated) as 4 and 2.3 litres per animal respectively. "Regarding herds size categories, irrespective of the season, the average milk yield per cattle is negatively correlated with herds size" (ibid.), whereas for agro-pastoral farming systems the yields are relatively higher. The survey by AZRI (ibid.) found overall, that in (post-) monsoon 9 % of the daily milk production is used for domestic consumption, 56 % is processed into *desi ghee*, 6 % is fed to infant animals and 29 % is sold as fresh milk. During winter when daily milk production is lower, the

139 AZRI (undated) reported about price divergences between good and severe seasons of 30- 70 %

140 commemorate the order of Allah to Ibrahim to sacrifice whatever is dearest to him, for that he took one of his sons (Isaak, Ismael)

141 celebrating the end of fastening at the end of the holy month

142 to come to the price the herders get, the here not specifiable margin of the middlemen must be subtracted

143 the milk yield ranges from 1- 13 litres/ day and 0.5- 10 litres/ day respectively (acc. AZRI, undated)

proportions of milk consumed by the family and that sold raises to 16 % and 31 % respectively, whereas the proportion of other usages decline. This implies that the quantity of milk consumed and sold do not decline proportionately to the decrease of other uses. The "nominal milk prices in Pakistan rose by 40 percent between 1996 and the first quarter of 2003. However, real milk prices have remained virtually unchanged" (FAO, 2003: 7). Apart from quality discrepancies, the price obtained by the middlemen selling to the urban buyers increased from ~10 PRs to ~14 PRs per litre milk (acc. *ibid.*).<sup>144</sup>

The higher amount of milk processing during (post-) monsoon may be attributed to higher daily milk yields, to the localisation of the herds deeper in the desert, where opportunities to sell are rare (lower milk price due to less competition between middlemen), to the relative ease of transport compared to milk, and to higher temperatures which increase the risk of spoilage. That is why pastoralists are found to process almost double the amount by agro-pastoralists, in numbers 21 kg/ month and 10 kg/ month respectively (acc. AZRI, undated). Making ghee is a completely female activity. Cholistani *ghee* is said to have a special purity and medical value. The daily produce is gathered in canisters (standard 16 kg). It is possible to carry these during migration to the irrigated areas and the markets there, where it is sold directly to buy e.g. foodstuffs. The price for *desi ghee* around the year 2002 was in average on 140 PRs per kg (acc. AZRI, undated).

Wool (and hair) are other principal marketed products. The wool price varies and is lower in spring than in post-monsoon season, in numbers ~23 PRs/ head and ~29 PRs/ head respectively (*ibid.*), but depends generally upon length of wool, cleanliness and degree of curliness.

### 2.3.5 Social Organisation and Resource Tenure

The population of Cholistan is comprised of more than 120,000 people (acc. CDA, 2005). The permanent population of Greater Cholistan is extremely low and estimated at only 2,000. Most of the population (98 %) live at least for part of the year in Lesser Cholistan, of which 67 % have homebases in the irrigated areas (acc. FAO, 1992: 9).

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<sup>144</sup> the ex-farm price can be estimated by subtracting a margin of the middlemen of ~4 PRs

For the most part (80 %), they are members of a larger ethno-linguistic group, the Seraiki<sup>145</sup> speaking culture of the central Indus Valley (the other 20 % are Punjabi). This has "some dialectical distinction to the northern Punjabi language thus can be easily identified, but also use words of the Marwari dialects of Rajasthan and Sindhi languages" (N. Z. A. Auj, 1991: 54). As described under 2.3.1, the direction of the flow of population into the Indus Valley was from Baluchistan and lower Sindh to the upper part of the valley or what is now the western Punjab. "Important tribes of Cholistan like Baluchi, Bhutta, Sumra, Kalhora, Dauadpotra have migrated from Baluchistan and Sindh" (ibid.).<sup>146</sup>

"The predominantly Muslim population<sup>147</sup> is divided into distinct social groups called *qaom* [clan or caste]" (F. Ahmad, 2001: 76). Traditionally, the life of Cholistan is governed largely by the institutions of *qaom*(s). Due to the lack of literature it can not be specified, how rigidly the institutions of social organisation and tenure determine currently the social, political, economic and ritual status of the inhabitants and the inter-group relationships, as is expressed in the caste system of the Indian subcontinent.<sup>148</sup> The early islamisation of the historic population of the target area leads us to believe that its influence was not so great (Quranic egalitarianism). But, due to the huge displacements of religious groups during the partition of 1947, Muslims who possibly had a stricter sense of social hierarchy were brought from other areas.<sup>149</sup> Also sectarian divides could be issues then.

"Members of each *qaom* differentiate themselves from others by tracing their identity to a common descent.<sup>150</sup> Groups boundaries are maintained by strict adherence to the rule of endogamy which prohibit marriage outside of one's *qaom*. *Qaom*(s) further maintain a sense of unity by sharing resources in moments of scarcity and by adhering to the rules of reciprocity" (ibid.). "Each *qaom* is divided into a number of *biraderi*(s)<sup>151</sup>, each consisting of a number of patrilineal extended families" (Ch. Alff, 1997: 77). "Extended

145 "an Indo-Aryan language and is spoken in large parts of Central Pakistan once attributed to camel-driving Jats and Baluchi tribes" (N. Z. A. Auj, 1991: 54)

146 further known in Cholistan are Bhatti, Buhar, Gujjar, Jat, Lohari, Penwar and Sheikh

147 a small minority of Hindus (2 %) remained after partition; a first wave of islamisation passed into the southern Punjab in the early 8th century A.D., led by Muhammad bin Qasim; it was stopped in the Battle of Rajasthan, which put the commencement of the Rajput period

148 criterion for the grading of castes and their members are the purity of their occupation and the physical proximity to higher ranked castes; status differentiation implicit in the caste system finds expression in restrictions on marriage and eating together

149 in the literature it is spoken about two Muslim categories, Ashraf (have a superior status from their claim of a foreign Arab ancestry) and Ajlaf (with a lower status, indigenous population assumed to be converts from Hindus), which show further hierarchical separation between occupational divisions, what can be meaningfully compared with the caste system

150 "people from the same lineage and clan share generally a recent common ancestor, no such ancestry is observed at tribal level, thus a tribe might be a conglomerate of clans who subsequently invented a mythical ancestor to strengthen group unity" (R. Chaix, 2004)

151 literally brotherhood; it expresses the economic and political solidarity between members of a *qaom*; e.g. one can be expelled from it

families are formed when sons marry and share the kitchen with their parents" (F. Ahmad, 2001: 76) and "graze their livestock as part of one herd" (ibid.: 85).<sup>152</sup> Considering family living patterns, both separate and joint family systems are present in Cholistan. The exact proportion of these patterns are not yet known, because Cholistanis "feel proud of telling large family sizes and living jointly", but however, "when they apply for household dependent benefits from government they separate the family system" (AZRI, undated). The father is the principal decision-maker of the household, the provider, whose dominance is guaranteed by the gender-discriminatory ownership and inheritance rules. Females share rarely more than some decisions related to family matters of children's marriage and visitations.<sup>153</sup> They are not empowered to establish a proportional economic role in their households and community.

Each *qaom* has customary leaders, consisting of some respected elders and a formal leader called *siana(s)* and *wadda*<sup>154</sup> respectively. Their social and political status is maintained by their ability to respond to people's expectations in reconciling tenure issues of rangelands and water sources and internal conflicts and day to day interpersonal disputes.<sup>155</sup> They are also used to arrange marriages and make decisions about regional migration.<sup>156</sup> Movement of herds and households, belonging to the same *biraderi*, occur simultaneously, generally in groups of 3- 4 households. Decisions of a *wadda* are not challenged, but a dispute over obeying his words could lead to fissure of the groups.

The authority of the *wadda* in a *qaom* has been replaced by the *numberdar* (also known as *lambardar*). "The *numberdari* system was established in the old state of Bahawalpur based on the Mughal administrative system in 1869 during the reform of the state's Revenue Department" (AZRI, undated). It was adopted by the British colonialists to extract taxes (e.g. *tirni*- head tax on livestock), land revenue from arable lands and communicate new laws with the local communities. The *tirni* system was withdrawn in 1974 but was again re-established in 1993. Today, a *numberdar* is still responsible for collecting taxes, registering marriages, and making statistics on the number and

152 even when sons decide to establish their own household, it is common that brothers continue herding their livestock together  
153 marriage transactions in Cholistan are very different to many parts of the Indian subcontinent; here the groom's family has to transfer wealth to the bride's family or exchange a bride for a bride; it is reported, that most females suffer protein-malnutrition; women perform hard tasks of domestic and informal sector work (food preparing, washing clothes and dishes, cleaning up, water carrying, collecting firewood, spinning and weaving); the restricted access to health services, including birth control, limits the women's ability to control their reproduction

154 the Seraiki term means big or large; it is equal to *wadera* in Sindh, *chaudry* in Punjab, *malik* in Pashtunistan and *sardar* in Baluchistan

155 these local law enforcement arrangements, common in the rural areas of South Asia, are called *panchayat*; it means literally assembly (*yat*) of five (*panch*); these are chosen and accepted by the community; the *panchayat* system regulates the *qaom*, e.g. it expels from the *biraderi*

156 they also keep record of gift-giving during each marriage to ensure that no household is slighted when it holds a marriage



composition of livestock owned by each household. His position does not have as great an intra-group importance as that of the *siana* but is more based on the relationship between the government and each *qaom* and between herders and farmers. In the past, *numberdar(s)* were selected from locally powerful families, but today, they are selected by the local branch of the Forestry Department and must be approved by the CDA before taking up their position. Three percent of taxes are given to a *numberdar* for his activities.

The primary governmental institutions of Pakistan are Union Councils. The elected representatives of the Union Councils constitute the District Councils, which are the most important element of government decision-making at the local level.<sup>157</sup> Although Cholistan has been given a distinct administrative status, these structures operate throughout the area. The rangelands of Cholistan are state-owned. The government of Pakistan has vested the responsibility of its management to the Forest Department which collects annually the charges for grazing.<sup>158</sup>

In traditional practise, the access for use of water sources and of pasture around and of migration routes is regulated by tenure arrangements between *qaom(s)*. They have established customary rights to specific *toba(s)*, *kund(s)*, wells, *dahar(s)* and grazing areas, and named them after their ancestors (or constructors of the facility)<sup>159</sup>, *qaom* leaders or important nearby areas. No other group is allowed to graze their animals there without permission. Right to a *toba* means the right to camp there and use its water for self and livestock drinking as well as grazing in the surrounding areas. These rights were originally established by excavating and regular desilting the facility. Right to wells and *kund(s)* means the right to build structures in the larger catchment area, although these areas are usually treated as common lands and different groups can use them by joint watering and grazing. In some cases the groups keep a own range as dry season reserve near to these facilities. As every area could once be stricken by a drought spell, there is solidarity and outsiders are allowed to come if their land is scarce and it is a mutual understanding not to refuse permission for grazing and watering of migrating herds crossing the area of another, residentiary community.<sup>160</sup>

Beside the *qaom* affiliation, the social hierarchy of the pastoral society is largely defined

157 the executive commissioner is supported by district representatives of all line ministries or departments, such as agriculture, livestock, forests, irrigation, roads, education and health

158 details of the present tax rate: PRs 3 per sheep/ goat, PRs 6 per cattle, PRs 12 per buffalo, PRs 18 per camel (acc. personal enquiry)

159 so the the suffix 'wala' means as much as 'made'

160 due to the limited capacity of a *kund* there is one limitation, that herders/ travellers but not their animals are allowed to drink the water

by the livestock holding. Economically powerful *qaom(s)* with large population and much livestock have claim over many *toba(s)* that can accommodate their herds. Their superior position is endorsed by permitting other, poorer *qaom(s)* to use their resources if needed, while these provide services, e.g. shepherding, repairing, etc.. "Despite the economic and social hierarchy, an ideology of equality formed the underlying basis of the social system. This ethos was upheld through cultural mechanisms of wealth equalisation and social welfare. Institutions such as *hadiara*<sup>161</sup> were among ways by that *qaom(s)* ensured the survival of their impoverished members" (F. Ahmad, 2001: 134). In the event of an epidemic or drought, small herd-owners could rely on their relatives and friends whose larger herds may be prevented from total decimation. Based on mutual agreements, they lend some female livestock to the poor herders to help to build up their new herds. "Reimbursement could be in instalments, and borrowers usually sell the male offspring and divide females between themselves and their benefactors", and "sometimes labour is exchanged for getting new reproductive animals" (ibid.). Regardless of the arrangement, the devastated and impoverished households were taken care of by the better off ones of the *qaom*.

In principle, the concerns of tenure here can be taken over for the irrigated areas. Subsection 3.2.5 proceeds with the history and development of tenure there.

### **3 Focussed Development Interventions**

Prepended to the following description of the focussed development interventions is the conceptual and institutional framework of these. First the physical infrastructure projects are covered and then the land colonisation. The latter is ultimately based on the development of physical infrastructure in the particular area. For a better placement of colonisation in the political context of development is appended a subsection about the history of land tenure in Pakistan or southern Punjab since beginning of the British colonial era. This can be seen as complement to the already under subsection 2.3.5 depicted traditional resource access on the rangelands.

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<sup>161</sup> giving gifts or lending livestock

### 3.1 Conceptual and Institutional Framework

Land degradation is strongly interrelated to a huge range of environmental and socio-economic issues, which make up the intense need to address the impacts of those. Therefore, a strategy with "the overall objective to improve the living conditions of the people" (PCRWR, 2003: 4-7) and "to uplift the Cholistan people" (CDA, 2005) has been integrated into plans for development. The activities in Cholistan focussed on by the present study are partly short-term measures to alleviate the recent drought but mainly included in long-term plans to minimise desertification effects and to resolve socio-economic issues, i.e. to increase the potential for pastoral households to be able to sustain themselves.

Above these plans stands the National Action Programme to Combat Desertification (NAP), which has been developed by local experts and the Government of Pakistan (ratified the UNCCD in 1997). Its purpose is to identify the factors contributing to the process of desertification in Pakistan and suggest practical measures and strategies, as the guideline/ framework for implementation of action programmes, formulating policy and conducting research. It is conceived that research and development (R&D) institutions integrate conservation and improvement of Pakistan's natural resources with national development plans. This should be facilitated by making their structures effectively operational in a coordinated bottom-up approach.

Actions to strengthen infrastructure and services in less developed areas have often been supported by the Federal Government and aid agencies but implemented by the provincial governments through specially formed development authorities. A decisive role for the technical implementation and supervision in the target area is played by the Cholistan Development Authority (CDA) and the Pakistan Council of Research in Water Resources (PCRWR).

The field of work of PCRWR's regional office in Bahawalpur is dedicated to "conducting site-specific, development oriented research on various aspects of water, land and plant resources of deserts, for making them productive and sustainable" and "controlling of desertification for developing a stable and sustainable environment" (ibid.: 5-2). They submit their project proposals to the Pakistani Ministry of Science and Technology. Important for the present thesis is the Mitigation of Drought Disaster in Cholistan Desert (MDDC) Project, which was initiated in March 2001 at a total cost of

PRs 152,620,000 for a four-year period. It is an expanded project of former field research activities, aimed at providing safe drinking water throughout the year in the desert for humans and livestock, by collecting rainwater in water ponds and tanks and pumping useable groundwater via wells.

The CDA's scope of activity is the development and administration of Cholistan, for which it was founded in 1976. The authority functions under the supervision and control of the provincial (Punjab) Planning and Development (P&D) Department. There are a large number of aims and objectives mandated to and thus activities required to be undertaken by the CDA. Therefore it consists of two main wings, the engineering (physical development) wing and the colonisation wing. Whereas "no development funds and engineering staff had been provided by the Government of Punjab till 1987-88" (CDA, 2005), when the engineering wing with today 20 personnel was created. The most prominent issues having been executed by the engineering wing during the three years until 2005 are related to water supply (water ponds and tanks, wells, water pipelines) and transport facilities (roads, bridges). For this development plan, an amount of PRs 1102.121 millions has been allocated to the CDA, half of it under the Drought Emergency Relief Assistance (DERA I) programme financed by the World Bank and the Drought Impact Mitigation and Recovery Component (DIMRC) programme financed by the Asian Development Bank, the other half from the federal and Punjabi governments. The purpose of the colonisation wing is the allotment or lease of government land. As assigned in the establishing act of 1976, the CDA has the functions to "grant land to any person on any conditions it thinks fit" (Punjab Government, 1976: § IV- 15- b). This is executed in schemes by the about 190 personnel including general administration.

For both organisations these are only parts of their past and present work in the area. The intensification of water supply related projects since around the millennium shift has been caused and enabled by the already mentioned severe drought, from which large parts of Central and South Asia suffered at that time, and its devastating effects on the living conditions of the inhabitants. It has to be kept in mind that interventions similar to those considered have already been applied before this. That is why it is not absolutely possible to divide the activities in the framework of the aforementioned projects from those previous to the drought. But the present study relates to the comparatively huge amount of activities since the drought, which directed decisively more attention and

financial resources to the area's civil sector. This is the reason for focussing on both these organisations, despite the fact that there are further organisations which are, in the broader sense similarly, active in the field of research and development in Cholistan. The formers' mandates, resources and activities are recently most extensive and concentrated on development of the local physical infrastructure.

## **3.2 Details of the Different Efforts**

### **3.2.1 Rainwater Harvesting and Storage**

"Improved water supply, reduction of water losses, more efficient use of water and development of new techniques are the main concerns in Cholistan" (PCRWR, 2003: 6-3). As mentioned under 2.3.1 water harvesting in Cholistan is a technique which has been used for a very long time for collecting precipitation from a prepared or natural watershed. It can be used to supply water as drinking water for human, livestock, wildlife, afforestation and crops. The carrying capacity of marginal desert lands is limited more by drinking water than by feed, therefore, rainwater can play a important role as a source of water development, if it is harvested and conserved properly.

PCRWR (2005: 22) delineated that the water points "are mostly not at appropriate places because the sites have not been identified by scientific information prior to construction, e.g. contour survey, soil physical characteristics, infiltration rate, soil porosity", and further, "they are not designed effectively, as well as the desilting is not been done regularly". Therefore it is the goal to develop the means and ways for harvesting rainfall run-off, to ensure the availability of water for a longer period.

Run-off depends on the quantity of precipitation and characteristics of soils.<sup>162</sup> By the explorative activities of PCRWR on land capability mapping it was possible to identify 17 % of the extent of Cholistan as having suitable soils for generating maximum run-off after absorbing minimum water, best catchments for rain water collection. Water intake characteristics of these soils are characterised by slow to very slow water infiltration rates due to very poor porosity (Table 1). Data about annual rainfall recorded by the PCRWR at Dingarh station from 1989 to 2001 and the potential run-off over these

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<sup>162</sup> depending beside the soil type, on the slope (flat,  $\sim 1 \cdot 10^{-3}$  % are capable) and vegetation cover (less than 10 % are capable)

catchments show that sufficient rains are received for harvesting and collecting water in ponds and tanks. The average run-off per year available was 387 million m<sup>3</sup> (acc. PCRWR, 2005: 31).<sup>163</sup>

For newly excavated/ constructed ponds the technology has been improved (see picture in the Annex). The run-off has been increased substantially by putting macro and micro ditches between the lowest points of a larger catchment area (20- 50 ha), and by clearing hummocks and vegetation, which could cause obstacles to the flow of rainwater. These are interconnected with a main channel that leads to a small pond to settle soil material before reaching the big pond. The purpose of the ditches and channels is to collect run-off promptly during and after rain, which reduces the losses in form of evaporation and infiltration. Seepage is minimised by spreading polyethylene on the bed of ponds covered with a 15 cm thick dense impervious clay layer and clay mud coating on the sides. The water to the ponds can be cleaned from clay, silt and suspended material to make it drinkable for human beings by filtering it through sand filters. The storage capacity of the ponds ranges widely between about 2,100 and 15,000 m<sup>3</sup>.

Beside constructing new ponds with these technological improvements, the desilting of existing ponds and the construction and repair of tanks have to be mentioned here. For the latter it was not possible to get more technical details than those shown under 2.2.1, but the mentioned improvements of catchment areas are certainly some similar here.

The following list does not distinguish between achievements of CDA<sup>164</sup> or PCRWR:

- Construction of ponds	131
- Desilting of existing ponds	102
- Construction of tanks	30
- Repair of existing tanks	25

The operation and maintenance costs of implemented project components are on the side of the community (beneficiaries). Thereby the tenure is also cleared, as is explained under 2.3.5, the title of a new pond is allocated to the community of the specific area. The localities of the new facilities are spread over the entire Cholistan, whereas the identification is mainly related to high demographic and livestock pressures and

<sup>163</sup> net potential run-off = 75 % to 90 % of annual rainfall \* 4,400 km<sup>2</sup> - 37 % water losses in form of seepage, evaporation and not approachable

<sup>164</sup> for the CDA it is reported, that they have constructed 284 *toba*(s) and 110 *kund*(s) since their engineering wing was made up, in a period of more than 20 years until 2001; but these have mostly been on small scale and unscientific for what there long-term sustainability is questionable

accessibility to them by the overwhelming population during disaster periods.<sup>165</sup> This should result in a more even spatial distribution of livestock on the range. Data about the situation of the vegetation are not involved in the plans.

### 3.2.2 Pumping of Usable Groundwater

As noted under 2.1.4, groundwater is the second water source in Cholistan. Fresh and useable groundwater quality is available only at few locations in the desert. A objective of the above projects is to increase the access potential, for the limited use of drinking for humans and livestock during periods when collected rainwater is exhausted. Pumping can be reasonable mainly from the confined aquifers under the dried up bed of the Sarasvati. These reservoirs have been targeted for further exploitation.

22 tubewells with turbine pumps have been installed by the combined efforts of CDA and PCRWR up to May 2005.<sup>166</sup> These are mainly low capacity pumps driven by diesel engines with an yield of 50 m<sup>3</sup>/ hour (= 0.5 cusec). The depth drilled for the tubewells varies between 150 and 320 meters, more frequent between 180 to 210 meters. In addition, an undated number (~ 20) of open dug-wells with brick masonry has been sunk in other areas.

The costs for operation of tubewells (diesel) are on the side of the users. The site selection for the installation has been made depending on factors like groundwater quality, population of human and livestock, area not property of any individual, approachable from surrounding areas, existence of grazing land around the turbine site, approachable for governmental institutions and NGOs.

### 3.2.3 Drinking Water Pipelines

A further component of water supply development is the provision of water to different settlements across Cholistan through the technique of pipelines. The pipeline project has been implemented to reduce the drought issue and shortage of drinking water in general, as it can provide water without loss to the delivery points. In the view of the CDA, the

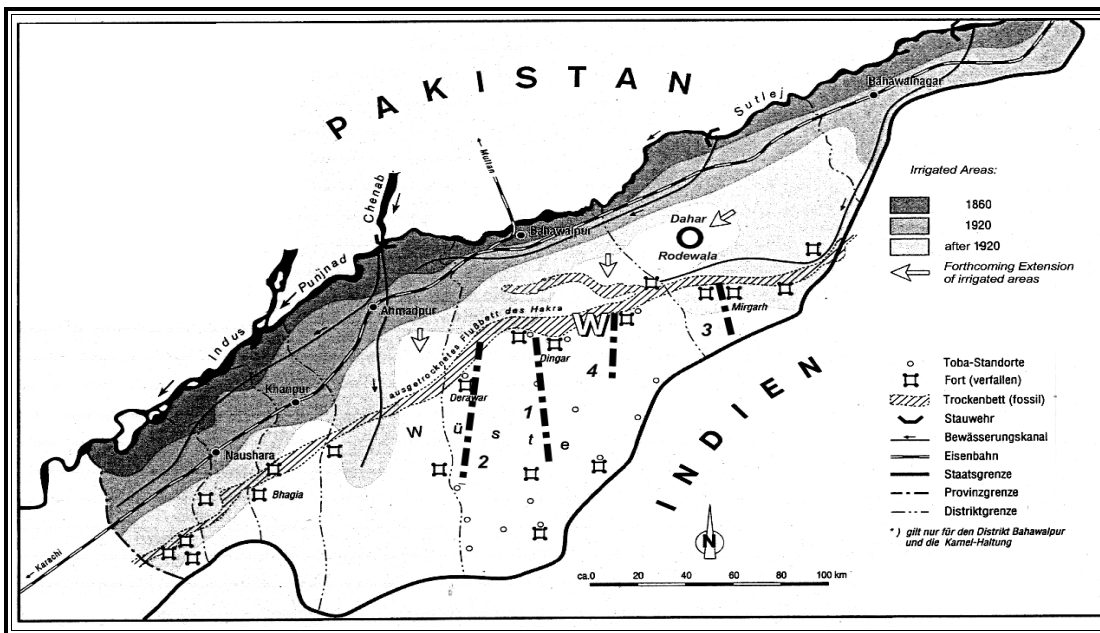
<sup>165</sup> PCRWR (2003: 36) suggests to develop a network of big ponds appropriately located every 10 to 15 km<sup>2</sup>

<sup>166</sup> 23 more are proposed by the CDA

pipeline project is "playing an important role in the water supply round the year, with the result that migration of the Cholistan population and its livestock can be diminished considerably" and "by multiplication of livestock heads the living standard of the people of Cholistan would be upgraded".

A total length of 248 km divided into four pipelines has been laid, covering different segments of the Cholistan area. The pipe systems begin at the source where each line is supplied by tubewells with turbine pumps.

There are two lines which start in canal irrigated areas, i.e. in Chak 107/ DB and Chak 111/ DNB. The first (in Figure 11 tagged by 1) is fed by 6 shallow tubewells installed up to a depth of 42 m north along the Desert Branch. It extends to 83.29 km to Khairwala. For the latter (in Figure 11 tagged by 2) have been installed 4 shallow tubewells up to the same depth along the Dera Nawab Branch. This one extends to 89.00 km to Nawakot. Both lines are fed with water that is at least partially recharged by seepage from the respective canals.



**Figure 11:** Drinking water pipelines in Cholistan (Source: F. Scholz, 1997; modified by the author)

The pipeline from Mirgarh to Churi (in Figure 11 tagged by 3) is fed by 4 deep (up to 100 m) tubewells with low capacity turbine pumps (50 m<sup>3</sup>/ h). Its length is 34.00 km. Water is pumped into the pipeline from Khuthri Dahar to Tufana (in Figure 11 tagged by 4) by 3 deep tubewells with low capacity turbine pumps and it is 42.00 km long.



Both lines are fed with water from the confined, already by other tubewells being explored, aquifers which were already mentioned in sections before.

Water from all these wells of the pipelines is pumped to a nearby ground storage tank from where it is pumped through PVC- pipes to delivery points (see picture in the Annex). The two longer lines are additionally divided with ground storage tanks on its distance, so that from each the further way is pumped (booster pumps).<sup>167</sup> From source to end point, there are a number of delivery points roughly every 10 km. Every point gets a surface tank of 90 m<sup>3</sup> capacity, a battery of taps to serve the human population and watering troughs for large or small livestock.

At the time of the study, water through the pipelines was provided free of charge by the CDA. There are following projects proposed (DERA II) in which it is planned to enlarge and branch the pipelines deeper and more evenly to Cholistan. More information about the pipeline project, e.g. data of groundwater, could not be obtained from the development authority due to their account for the interest of military and intelligence service.

### 3.2.4 Transport Facilitation

Transport or mobility play a important role in the economic and social life. Marketing of farm products, access to health services or education (public transport) are dependent on the availability of transport facilities. Objectives of this project component, mentioned by the CDA, are "the provision of communication network for taking the urgent actions efficiently and effectively in case of any future calamity" and "the extension of the road network into Lesser and Greater Cholistan".

As denoted under 2.2.2, a reasonable improvement of routes would be from the more developed, northerly irrigated areas to the interior parts of the desert. Such a "arterial route" is from Channan Pir to Bijnot in the far south of Cholistan. But also the linking of localities in the desert is important to develop alternative east-west routes (Figure 5).

In May 2005, the CDA stated existing 304 km metalled roads, of which 206 km had already been completed by 2001. An additional 80 km was achieved in the following three years. It has to be kept in mind that the realisation of this number of improved

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<sup>167</sup> these additional tanks function as rescue tanks if water is not available from the source wells

roads is divided between the irrigated fringes and the rangelands of Cholistan. Admittedly, the missing link roads between settlements in the irrigated area and bridges crossing different canals were given priority over the connexion of the rangelands.

Such roads are classified depending on their length as Farm-to-Market roads or link roads. Both are usually single lane (3 m) with a paved carriageway.

The CDA remarks that the plans of the road schemes have been formulated on the demands of elected representatives including Members of Provincial Assembly (M.P.A.) and Union Council *nazim(s)*<sup>168</sup>.

### 3.2.5 Colonisation of Government Land

About aims and objectives of the activities described in the following, only little information could be acquired. This is because the CDA, to which these activities are mandated, has been quite hesitant to reveal details to the author about this important part of their work and of the interventions in this field. There are no detailed publications from official sources available.<sup>169</sup> Regarding the work of the colonisation wing, it is remarked in collected papers on Cholistan that "for smooth working it is proposed that the Discipline Rules may be followed by the CDA as and when the same is revised/ notified by the Government".

Anyhow, based on the CDA act of 1976, its function is to "promote health, well-being and prosperity of the residents of Cholistan and their cattle heads" (Punjab Government, 1976: § IV- 15- 1). This statement and overall objectives of the CDA already mentioned under section 3.1 and the specific purpose of its colonisation wing lead to the consideration of the activities described following as part of a strategy for drought mitigation and socio-economic improvement, as development intervention.

The logic of the CDA is to "create incentive for cultivation among Cholistanis by allotting them land under various schemes" (CDA, 2005). Pastoralists, who gain access to irrigable land, could sell livestock to finance the reclamation, shift their farming system to agronomy and thus reduce the grazing pressure on the rangelands. During times of drought, they could go there with their animals, possibly produce their own feed-stuffs and thus remain there with less pressure of price for feed and stress with the

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<sup>168</sup> *nazim* is the appellation of the person heading it

<sup>169</sup> this attitude is probably connected to the corruption reproaches to local authorities in quite critical newspapers articles

cultivators, compared to landless herders. On the other hand, it is supposed that higher prices for feed-stuffs could cause pastoralists to give up or sale of livestock and so reduce the animal number in Cholistan.

The colonisation or development of irrigation is associated with allotment of land to individual owners and settlement. As was considered in different sections before, the area of Cholistan is state-owned since the princely state of Bahawalpur became incorporated into the state of Pakistan in 1947, and towards the north and north-west of the rangelands are areas which have been reclaimed from the desert for irrigated cultivation or have an edaphic potential to be reclaimed for arable use (see Figure 11). The CDA and its preceding bodies have surveyed the desert area and notified parts of that to be available for allotment.<sup>170</sup> But the distribution of land alone makes no sense, if access is not provided to additional resources such as Farm-to-Market roads, water supply and equipment for reclamation. The engineering wing of the CDA is active therefore in the irrigable fringes of Cholistan, and even, as mentioned before for the transport facilitation, with priority over the rangelands. Pastoralists could benefit from the access to land in these areas, because these are partially better equipped with infrastructure (alone the distances to facilities). The following enumerates the areas allotted under various schemes in Cholistan by the government or the CDA since Pakistan's foundation.

**Table 9:** Areas allotted under various schemes in Cholistan

Name of scheme	No. of allotments	Allotted land (ha)
Shahi Muzarian scheme 1950- 51	91	2,300
Grow More Food scheme 1959- 60	2,091	12,416
20 years lease scheme 1970- 71	2,038	10,190
15 years lease scheme 1977- 78	11,431	58,584
Land Reforms 1977	1,790	8,950
Total	17,441	92,440

Source: FAO (1992) and CDA papers

These allotments were officially based on the fulfilment of four criteria:

- the person must be permanent resident/ dependent of Cholistan prior to 1947
- the individual must be verified as a Cholistani by the *numberdar* of the area
- the individual must possess a national identity card

<sup>170</sup> the surveying is done to find out the direction and degree of the area's slope, by that could be defined the course of main canals and distributors

- the Forestry Department also verify that he/ she is paying *tirni*

But land allotment is a contentious issue. There are complaints of illegal transfer of these lands either by renting/ sharing out or selling out to non-Cholistani.

### 3.2.5.1 Historical Background of Land Tenure in Pakistan

Agricultural colonisation is a continuous process to the present. The allotments of the last 60 years are a continuation of the methods of operation of the British colonial administration to expand irrigation land (in Punjab since 1885) for commodity production and export- capitalist agriculture.<sup>171</sup> This is strongly influential for the current socio-cultural, economic and agro-structural situation of the target area.

The farmers in the Bahawalpur Division only used traditionally the fields along the banks of the Sutlej which had been flooded seasonally (locally called *mahal*). A first significant change resulted from the extension of irrigation of the northern *doab*(s) of the Sutlej since 1886 and the implementation of the Sutlej Valley Project since 1924, which brought southward, higher elevated areas (*bar*) under irrigation use. This was coupled with the foundation of new settlements, sc. *chak*(s) (canal colonies) through allotment of land on certain conditions, which were not consistent at all.<sup>172</sup>

According to Imran Ali (1988), professor at the Lahore University of Management Sciences, "land was granted to indigenous communities under various schemes, such as offering land grants to raise horses that could then be acquired by the British cavalry". In fact, Cholistani pastoralists and ancestral agricultural groups got land but "well-chosen and precious agriculturalists of adjacent over-populated districts" and of submountainous areas (sc. *abadkar*) had been privileged by amount and quality, as well as "retired army officers and merited civil bureaucrats [sc. capitalists] were rewarded" (Ch. Alff, 1997: 68). Lots of these larger landholders (landlords, locally called *zamindar*<sup>173</sup>, with more than 60 ha irrigated land) did not settle down here, they were

171 the Britons introduced money-taxes which directed agri-production to cash crops, and they initiated the conversion of land to private property instituted by the Permanent Settlement Act of Bengal 1793; land became subject to the payment of revenue/ rent/ tax; it was now required to purchase land first and then start the cultivation, what led to a land market -before land had belonged to the emperor (*badshah*), who ruled feudal vassals locally know as *jagirdar*, like the last Nawab (prince) of Bahawalpur Sadiq Muhammad Khan Abbasi V.

172 before the purchase was a phase of 5- 15 years of tenancy, partially with the right of the British crown to cancel the contract without reasons; the smaller colonists were committed to settle in the new villages, whereas the 'capitalists' were exempted from that

173 *zamin* is the local term for land; *zamindar*(s) occupied a intermediate position between the rulers and *jagirdar*(s) on the one hand and the peasantry on the other

more interested in absorbing yields by renting out the land for cultivation, usually under the *batai*- system<sup>174</sup> which was replaced by cash payments under the Britons.

This 'absentee landlordism' has its origins already in the period of the Mughal Empire (1527- 1707). It found expansion despite apparent disadvantages, e.g. low cropping intensity and reinvestments (levelling, reclamation, improvement), and "made up the source of prestige and economic power, which, again, put the basis for the political power of this landed aristocracy" (Haider & Kuhnen, 1974).

Failure to increase of productivity of labour and to pay taxes and debts made the system susceptible to speculation of urban and non-agricultural groups.<sup>175</sup> M.S. Kamdar (1996: 109) stated that "agriculturalists were driven to money lenders to raise cash, and many sank into debt" and that "the inflexible demand on land revenue widened the income inequality within agrarian classes". The Britons had created a bourgeois property right on land which was, by the logic of the land revenue system, not providing security of (subsistence) tenants because it made the landless dependent on the owners of the land.<sup>176</sup>

In order to protect the agrarian production by easing the burden on the peasantry<sup>177</sup>, the British rulers instituted the Punjab Alienation of Land Act in 1900 (Punjab Government, 2004). However, "this law had a feudal underpinning and was based on perpetuating various local social classes that would guarantee the interests of the imperial masters" (A. Siddiq, 2006). The granting of land as "gift made in good faith for a religious or charitable purpose " (Punjab Government, 2004, § 3- 2- 2a) was not sanctioned, so in order to appease local chiefs and gain their favour and to avoid any uprising against their rule, the Britons awarded certificates or conferred titles all over India. M.S. Kamdar (1996: 103) argues about the political consequences of the Indian rebellion of 1857, that these "acted as pressure (in the British mind) for a need to maintain friendly and cooperative relations with *jagirdar(s)/ zamindar(s)*". Between "1924 and 1939 fewer and fewer rich peasants and large landlords concentrated more and more land" (Geocities, 2004), and the number of very small peasants increased markedly.

174 feudal rent system, with rent paid in kind of a certain proportion of the produce (share-tenancy); grain had acted as a medium of exchange since pre-historical times

175 "by 1890 approximately 42 percent land in Sindh was in the possession of usurers and by 1900 a landless agricultural proletariat emerged in what is today Pakistan" (Belokrenitsky, 1991 cited by Geocities, 2004); prior to the British rule, Hindus were involved in financing agricultural activities of landlords and peasants, had a trading network throughout South Asia and had made the industry dependent in this way

176 the pre-British land right had no direct right over landownership, as the area of the vassals was transferable by the emperor; thus "local ruler did not alter the system of production because their relation with the state remained external" (M.S. Kamdar, 1996: 108)

177 in pre-British times, "all other classes -state, religious hierarchy, landlords and agricultural traders- lived entirely upon the industry and hard labour of peasants", therefore "whenever the peasant found himself in trouble of any kind, it was a convention amongst landlords that they would provide all the aid they could" (M.S. Kamdar, 1996: 68)

"In the decade following the creation of Pakistan, the political and economic power of landlords increased" (ibid.).<sup>178</sup> But a integrated policy framework for agriculture development was not prepared, consequently, it grew at a slower rate than the population and the industrial production (food deficit and lack of raw materials). Most landlords were able to side-step a first land reform in 1959, which declared a ceiling of 200 ha of irrigated land, and retained their holdings.<sup>179</sup> This update of British laws had been under the rule of military president Mohammad Ayub Khan. But the practise remained in the colonial logic, as it did little to better distribute the lands.<sup>180</sup> It was also the advent of the Green Revolution in the late 1960s, which favoured "the business-minded, commercial and capitalistic", larger landholders, who thus could "improve their economic situation and strengthen their traditional political power, with that they succeeded in ensuring the continuation of landlord-biased agriculture policy" (Haider & Kuhnen, 1974: 57). Implemented by the Pakistan People's Party (PPP) under prime minister Zulfikar Ali Bhutto in 1972, followed another land reform. It declared the ceiling on 60 ha holding of irrigated land and distributed the land free to tenants and landless peasants. But it was unlikely that the law resulted in large-scale transfers because the right to select the land for surrender was vested with the landlords, so the land available for allotment to tenants was often not fit for farming because of the high costs of its reclamation. As Haider and Kuhnen (1974: 60) write, it had an "important psychological and political effect", but less than the "more radical land reform program" (Geocities, 2004) instituted by the Pakistan Peoples Party (PPP) in 1977, with a ceiling of 40 ha holdings of irrigated land. But the government was overthrown in a military coup led by General Zia-ul-Haq and the decision for the land reform was quashed.

"Therefore, the differentiation that could be seen between 1924 and 1939 continued with the Green Revolution" (Geocities, 2004), which can be traced through the Agricultural Censuses till 1990.

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178 e.g. "very large landlords won 80 % of the seats in the 1951 provincial elections in Punjab", and 0.1 % of the landowners owned 15 % of the land of Pakistan, at the same time the poorest 64 % of the landowners owned another 15 % (ibid.)

179 e.g., they simply transferred land to dependants on paper, or handed over the worst quality land at their disposal; or the price of the land was set so high that resumed land was later auctioned back to military officials and rich farmers, what underscored their power

180 a major problem was that the ceilings were fixed on individuals rather than families, thus large landholder could manage to keep their land within an extended joint family system, or to give up only some marginal, not very productive lands

## 4 Methodology

This chapter concentrates on the design and implementation of the research concept and addresses therefore details of the theoretical framework as well as of the exploratory and analytical elements.

### 4.1 Farming Systems Approach

"Farming system analysis is based on the system philosophy and related to the development of farming in general" (W. Doppler, 1991: 9).<sup>181</sup> "Farming system research is aimed at identifying options for improving the well-being of rural households in specific local environments" (M. Upton, 1996: 217).<sup>182</sup> The farming systems are considered in the context of both the private and societal goals and of the given potentials and imposed constraints of determining factors.<sup>183</sup> "It is based on the development principles of improving productivity, increasing profitability, ensuring sustainability, and guaranteeing an equitable distribution of the results of production" (FAO, 1995). "Farms are considered here as economic units, and the relations of the farm system with the environment are consequently expressed in economic terms" (H. Ruthenberg, 1980: 2). Ideally this approach considers the farm households holistically, that means it concerns the whole system with sub-systems (family, farm, household) in its environment and the interdependencies rather than individual elements of it.<sup>184</sup>

The boundaries of a system are locally specific and relate to the resource base and the management practises. But farming systems are open systems with relations to other systems in their environment, whereas "with the development from traditional to modern forms usually the opening increases" (W. Doppler, 1991: 12).<sup>185</sup> That is why extended perspectives are important and should be part of the study, such as links with

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181 contrasts with the classical philosophy of reductionism which has as its subject a single part; a system is the order or set of a number of phenomena or elements which are interacting or are related to at least one other; any object which has no relation to any element of the system is not part of it, but rather of the system environment; a sub-system is a set of elements which is a system by itself and part of the whole system

182 there are many perspectives of defining systems in rural areas, e.g. watersheds (hydrology), regions (geography), villages or families (sociology), farms (agriculture science)

183 use of family's labour, land and capital; risk distribution of farm activities and use of the family's management capacity

184 research principally may be used to identify improvements in all these areas- M. Upton (1996: 217) mentions improvements like, new farm-level technology, rural social infrastructure (roads, market-places, health and education facilities, water and electricity supplies), off-farm employment opportunities, assured farm inputs supplies and farm products markets, price incentives

185 more market-oriented systems have developed a automotive in their decision-making about gathering information on technical progress

rural services<sup>186</sup>, issues of natural resource conservation and management, off-farm and non-farm activities (livelihood dimension) and the institutional setting<sup>187</sup>. Within this framework of complex relationships and progressive understanding, one can develop more or less realistic models by using techniques which address either a large or a small number of variables in the system.

"Any farm is part in a hierarchy of systems, belonging first to the larger system of the rural area and consisting, secondly, of various activities, which are systems themselves" (H. Ruthenberg, 1980: 3).<sup>188</sup> Depending on the objectives of the research and resources available to it is possible to concentrate on sub-systems of a farming system, e.g. the pastoral production system. To approach the latter incorporates intra-system study of rangeland ecology, animal husbandry, pastoral society and household economy. A multidisciplinary analysis of natural, social and technical sciences is needed, to explain the physical relationship between inputs and outputs of farms or to understand how (structural perspective) and why (functional perspective) resource allocation decisions of pastoralists are integrated under the current socio-economic and environmental conditions, in order to develop acceptable recommendations about methods and products of rural change and development. The Farming Systems Approach consists of a sequence of four fundamental stages (descriptive/ diagnostic, design, testing, dissemination) but the detailed procedure can differ considerably by the executed general scale and timing.<sup>189</sup>

The present research on farming systems with mobile pastoral production in Cholistan is based methodologically on this approach. The initial point is the consideration of pastoralists of different socio-economic categories occupying living spaces in Cholistan which are either equipped with well-developed or improved physical infrastructure; which lack one or the other facility; or least developed, remote areas. The focus is set on the objectives of the families and the design of their basic livelihood sustaining activity (livestock production), whereas relationships with other system parts (cultivation) and with environmental entities (natural, economic, social) are also involved. The main target is a qualitative descriptive explanation<sup>190</sup> of possible cause-effect relations of

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186 agricultural extension (information), credit, input delivery, product markets

187 e.g. land tenure, taxation system, labour laws, community structure, norms and beliefs, development policy, and already mentioned rural services

188 also inputs such as non-family workers, soil micro-organism, animals or road network are systems with rather distinct boundaries integrated in the hierarchy

189 "the entire research programme of a organisation maybe planned for several years along these lines, or the procedures are used for a series of relatively short studies", "on-farm research projects that seek to improve whole farm performance through manipulation of the linkages between all enterprises are few" (FAO, 1995)

190 constructed on a realist view and deductive reasoning and accordant methods of data generation



constraints and potentials resulting from recently carried out development interventions, of the decision-makers' reasoning and managing (socio-economic) and of their interactions with the natural environment (ecological).

The basis must be to develop an understanding of how the pastoralists are operating within their environment, by identifying external and internal conditions, their underlying relationships and the interactions with the pastoralists' resource management.<sup>191</sup> Exogenous resources, of which status and development are important for the farming systems, are agro-ecological conditions (physiography, land degradation), availability and adequacy of (social, technical) infrastructure and market system, and kind and intensity of norms and rules of the pastoral society (resource tenure, conflict resolution).<sup>192</sup> These are beyond the direct influence of the families' decision-making but can be transformed, depending on endogenous resources (livestock, labour) and the management of these, into output (energy, foodstuffs, products) and income (product marketing).

The analysis consists in technical innovations of exogenous resources (water supply, roads) and expanded endowment with endogenous resources (irrigable land) and the interactions of these with the farm management (attitudes and desires, motivations, production objectives and decisions) and resource use (production activities) and with the functioning of the ecosystem (awareness of proper/ problem conditions, perceptions, observation of status), characterised by qualitative parameters. According to thereon applied explanatory logic grounded on the constructed reality of the stated hypotheses an interpretation of the considered features of the research population and area is attempted with the purpose of achieving statements about the existence of socio-economic and ecological impacts of the innovations in Cholistan.

The required multi-subject enquiry makes it difficult to be precise with choosing essential information and creates the risk to collect unnecessary data. However, the relatively narrow frame of the work limits the complexity and scale of the approach (detail and reality accuracy of the system consideration). Problem areas or areas of under-utilized potential and important issues of sustainable rural development can be identified and discussed only initially. Cost-benefit impacts on farming systems and ecological conditions are not assessed empirically. The livelihood assets affecting

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191 causal connexions which result from mobility of labour, capital, miscellaneous resources, products and services

192 others would be administrative, institutional and political set-up (communal, national), agriculture policy (road map, world trade relationships), research and development (whole socio-economic framework), services (social, veterinary), off-farm employment (military, public sector)

linkages between the household survival strategies and the institutional setting remain largely rudimentary in the analysis. Geological and historical processes essentially affect the contemporary ecological and socio-economic conditions, but these are addressed here only at a glance. That is why the necessity for further in-depth research by specifying important parameters is underlined here.

The scope and questions of the research given in chapter 1 and the approach formulated here represent a large part of the study and provide implications for the practical procedure.<sup>193</sup> The representativeness of the analysis (generalisability) depends on the validity of the internal cause-effect construct and the validity of the data generation<sup>194</sup> and analysis methods. Judgement of the validity of data fed into the analysis and of the data analysis depends on the accuracy and reliability of the applied methods and techniques, i.e. on the question as to whether these and the data sources are well<sup>195</sup> chosen and conducted to answer the research questions. The operational steps of primary data generation and of analysis of data are therefore demonstrated therefore in the following sections.

## **4.2 Information Base and Critical Evaluation of Data Quality and Representativeness**

The primary data generation comprises qualitative methods such as field survey and interviews of local key informants and observations, and the complementary collection of secondary data<sup>196</sup> by meetings with locally active institutions, in most instances involved in agriculture research and extension (see the list in the Annex). The connexion of this with the data processing and interpreting facilitates the discussion of the results in the light of the research questions and establishes the conclusions of the study. By subjecting the choice and application of the methods to a critical evaluation of accuracy and reliability it may be ascertained that the analysis proceeded systematically

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193 the essence of the enquiry is expressed by the system perspective to reality (ontology) and the theory of empirical acquisition of knowledge and evidence (epistemology) which both are the underlying assumptions of the exploratory concept (methodology) of the explanatory logic (analysis)

194 J. Mason (1996: 36) uses this term rather than e.g. "collection" because she thinks that "most qualitative perspectives reject the idea that a researcher can be a completely neutral collector of information about the social world" instead of the researcher is seen as actively constructing knowledge

195 J. Mason (1996: 146) mentions terms like thorough, careful, honest and accurate to be more appropriate expressing the quality of qualitative research than true and correct

196 unfortunately, elaborate and in other papers already cited development plans of the leading governmental organisation CDA were not made accessible to the author; that are CDA– Master Plan (1986), CDA– A Brief of Cholistan (2001)

and under reasonable assumptions, and thus enabled sound and well-founded inferences (empirical<sup>197</sup>, theoretical<sup>198</sup>). Making the research process transparent is completed in section 5.1 by presenting the detailed data of relevant variables.

#### 4.2.1 Primary Data Generation

"The most common methods" of generating primary data in farming system research "are surveys, observations and direct measurements" (FAO, 1995). A number of methodological factors and analysis objectives influence the choice of methods, whereas "no one method of data collection is basically superior in minimizing operational constraints", that is why normally "a combination of methods is used" (ibid.). A indication of methods by FAO (1995) shows that (exploratory) field surveys are quite feasible ways of assessing impacts or adoptions with the required accuracy of data for a qualitative descriptive and diagnostic research as attempted here.<sup>199</sup>

The analysis approach is aimed at investigating the impacts of the development interventions on the pastoralists' reasoning and actions. The explanations are constructed on understanding in complexity the individual decision-maker's perceptions and objectives, constraints, indigenous technology and decisions, what can be attained much deeper through "effective consultative and collaborative (participatory) interaction with the target population" (C. Conroy, 2005: 81).<sup>200</sup> This can be enabled by direct contact between the researcher and the target group rather than in full-scale random sample socio-economic surveys<sup>201</sup>, which are often conducted through enumerators, because responses may not be clearly formulated in the participants' minds in a way which they can simply articulate to short standardised questions.

During the stage of planning the research frame of the thesis, these assumptions and the emphasis of the costs of field work (financial and time) delivered the justification that semi-structured interviewing of herders during a one-shot survey serves appropriately

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197 empiricism is a "central concept of science", it is "dependent on evidence that is observable by the senses", "refers to the use of working hypotheses that are testable using observations or experiments" (Wikipedia, 2007)

198 is related to the theory of the researched phenomenon in reality constructed in the approach

199 also if attempting feed-back to planners or preparing more in-depth investigations

200 however, "in many situations farmer participation in research is beneficial, but it is not always absolutely necessary" (ibid.) and "the debate continues about the degree of farmer participation that is desirable and feasible" (M. Upton, 1996: 226); "direct measurement and observation are likely to yield the most accurate results in more complex systems" (e.g. year-round farming is more complex than seasonal) (FAO, 1995)

201 "with formal questionnaires, regular visiting and possibly even direct measurement of plot areas, yields or dietary intake for instance" (M. Upton, 1996: 223)

the purpose.<sup>202</sup> It consists of selecting the research localities and interviewing participants and the practical interviewing in the field.

Additionally, key informant interviews with Union Council *nazim(s)*, market protagonists and responsible persons of departments, research institutes and development organisations should gather relevant information and knowledge about further particulars and more complex issues of the research localities and communities.<sup>203</sup> To complement, observation, the most simple and direct empirical method to gain insights into processes of a subject, took place everywhere. It was carried out by taking notes immediately or if customs or the situation prevented, e.g. at formal meetings when authority officials attended, memorised observations were written down in the evening of the very same day. Observations took place during the entire study project to enhance learning esp. when conducting field work. This relatively unsystematic gathering of information provided preliminary data as a necessary basis for refining the field work (objectives-related), developing better relationships with the stakeholders (socially, e.g. local terms) and for interpreting the interview data.

#### 4.2.1.1 Selection of Research Localities and Interview Participants

"Representativeness is usually the most important criterion for selection of a research area" (FAO, 1995). It must be representative of the target area with respect to, "relatively similar" (ibid.), environmental conditions (bio-physical, economic, social) and practised farming systems (socio-economic, technological), with both setting the recommendation domains.

The selection of research localities was undertaken in order to get valid data of certain conditions and situations of the research population. The adopted approach defines those localities by an infrastructural differentiation of the research area. This was enabled by a preceding review of earlier obtained notices<sup>204</sup> and secondary sources. During the first days of field work, it was improved by general guidance of the CIDS, conducting a group discussion with local farmers in the regional office of the WWF<sup>205</sup>, and by informally consulting agents from AZRI, CDA, L. & D.D. Dept. and NRSP (see

<sup>202</sup> the research project is conducted within the scope of achieving the author's post-graduation

<sup>203</sup> the contact to them was always made by resource persons from institutions in Pakistan facilitating the research procedure

<sup>204</sup> first preparations and topic selection during the author's four-month internship funded by the German Academic Exchange Service (DAAD) in 2004

<sup>205</sup> they have an office in Bahawalpur and work with farmers on ecological cultivation practices

the list in the Annex). All these meetings provided details about the spatial distribution of infrastructure and development interventions over the research area, and the seasonal localisation of Cholistanis and their herds. On the basis of this, it was attempted to assure a selection of localities representing a reasonable cross-section, so that the team was able to propose where<sup>206</sup>, when<sup>207</sup> and how<sup>208</sup> to move to the field.

It was clear from the beginning to delimitate the selection of research localities to the district of Bahawalpur. This was only a small restriction for the representativeness, as this district comprises the largest parts of land area and grazing animals of the target area Cholistan (acc. personal enquiry). But due to the military sensitive proximity of the interior parts of the desert to the international border with India, and under the prevalent security issues due to the current global political tensions, a huge tract of the researched geographic territory was unauthorised for visitation ("not below the blue line", which refers to areas south of the dried up river bed). A grave hindrance which resulted from difficulties to get adequate intelligence clearance.

In the plannings with logistic facilitators of daily routes to permitted parts of the research area, some further trade-offs are supposed between the interest of the study team to approach the most representative localities and the facilitators' or resource persons' preferences. E.g. the governmental development agency was possibly interested in presenting successful results of their previous or continuous activities, and the team in the field guiding veterinary staff partially recommended localities in their usual area of operation. For the latter must in return be concerned that the staff in their known area could provide more background information and had good rapport with the pastoralists. The operational step after differentiating the research area and selecting the concrete localities of field work is to identify individuals to be interviewed. As suggested before, for the selection of survey participants a purposive approach is likely to be more feasible than completely random sampling. In the present work, it was important to be sure that a representative socio-economic cross-section is chosen out of the population of mobile herders of the research area, because different livelihoods or production systems "may have different constraints and may require different interventions to remove those constraints" (C. Conroy, 2005: 28). "The identification of different sub-groups should be one of the first activities of any situation analysis" (ibid.).

A wealth grouping of the households was used to ensure this further assumption. By

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206 routes, water holes, wells, settlements and dwellings, locations with interventions

207 dates, time of day

208 by the help of which institution, kind of vehicle, drink & food requirement

definition of ILCA (1990) "a household is often defined as a group of people (normally related to one another) who live together and share the same resources and tasks of production (agricultural and non-agricultural)" and "the output produced is also normally shared between its members". ILCA (1983) suggests "that the single most important parameter for stratifying within a community is wealth rank" and continues about the pastoralists' concept of wealth that "livestock holdings represent a close approximation of wealth". It should be remarked that in the present approach this applies also to pastoralists owning or leasing irrigable land. So the livestock holding of a household, i.e. animal species and apparent herds size, was used for the selection of respondents. A prior understanding of the socio-economic composition of the target population was required to avoid bias. Therefore again preparatory notices and secondary data played a part. During the practical field work, selecting participants was generally reliant on the experienced judgement of resource persons from local institutions which were facilitating the study.<sup>209</sup> On the go sighted herds and thus the keeping households were classified and it was decided if the one could contribute to broaden the collected data.

C. Conroy (2005: 21) concerning trade-offs, "users of participatory methods have generally been less systematic in their approach to selecting a sample", what "can be a major weakness of survey findings". However, a bias is already in the simplification of participant selection by only herds size as wealth parameter, because wealth is in reality more complex when considering that animal keepers are also active in on-farm crop production or as non-farm labourers. Additionally it must be remarked that this is just economically differentiating wealth. But particularly in smallholder communities, social and institutional parameter carry immense relevance and influence for a positive self-perception and wealth. For more precise and participatory research the community members should be involved in wealth ranking "by identifying those criteria that they consider to be the most important and relevant for this purpose, and identifying a number of wealth categories on the basis of them" (Czech Conroy, 2005: 25). A possibly important bias is temporally justified. While wealth ranking ensured a representative sample regarding herd ownership patterns, the sample could be of little value if the situations of the selected herders were themselves very special and not representative of the locality. This is quite possible as the field work was conducted in

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<sup>209</sup> a typical phrase while browsing through the field with a jeep: "we got a cattle man, so we need another small sheep and goat man"

the peak of seasonal outmigration of pastoralists to the irrigated areas, leaving only few of them behind. A bias in reliability is that interviewed males may sometimes have not been the appropriate or even no member of the households. Such cases were accepted because even these could provide information and it may give an additional impression of the pastoral production and society.

Generally, the limited time frame (limited number of interviews) and the cost-effectiveness of the administrative and logistical effort (restriction to travel to remote areas, only one-day field trips) for this qualitative descriptive study contributed to the deficits of representativeness of the locality and participant samples to the research area and population respectively.

#### 4.2.1.2 Interviewing Herders

Interviewing herders is the core exploratory element of the research procedure. "In situations in which you won't get more than one chance to interview someone, semi-structured interviewing is best" and "it has much of the free-wheeling quality of unstructured interviewing, and requires all the same skills, but semi-structured interviewing is based on the use of an interview guide" (H. Russell Bernard, 2000: 191). On the other hand it requires an attitude by the researcher "towards a greater willingness to accept and learn from farmers' opinions" and needs special staff with field experience to derive a proper understanding of a farming system on the basis of a single interview (M. Upton, 1996: 224).<sup>210</sup> The purpose of the semi-structured interview is to generate information by the means of leaving the development of an interview to the interviewed individual and his or her personal experience. "Interview guides are built up from informal and unstructured interview data" (ibid.: 205).

This applies also for the present study, which is based on a quite comprehensive, around 50 questions including, interview guide (see Annex). These were developed during the preparation<sup>211</sup> phase in Germany and were consolidated with the kind help of resource person with experience in farming system analysis during the first part of the three-month research period in Pakistan. A pre-testing was not used but the structure of the

210 "some critics doubt whether it is possible to identify farmers' objectives simply by asking questions" (ibid.); employment of senior scientists in field work is again more costly

211 beside literature review the author attended a language course in Urdu (Pakistani national language) at the Institute of Asian and African Studies

guide was continuously refined during the field work by rephrasing or specifying the content.<sup>212</sup>

Due to the deductive approach of research, with working hypotheses, the structure of the interview guide is predetermined to a greater degree than it is usual for semi-structured, qualitative interviewing. The structure of the guide comprises a combination of open-ended and closed questions, with the majority being open-ended questions or sometimes with response options. It is divided into six parts. The first part starts with general questions about the respondent's family and household structure and the available infrastructure at their rangeland areas and the participation on development interventions. Then it moves on to more specific questions about the household's income-generating activities and expenses, endogenous resources and marketing of livestock products, always with a focus on possible problematic situations. After, it comes to more open-ended questions to encourage the respondent to become more descriptive. These address the household's herd composition and mobility, tenure and conflicts, and the feeding practises and the individual's awareness regarding land degradation and its causes. The final part is concerned with future expectations and needs for wealth development.

Thereby, and with the logistic support of the institutions already mentioned, the team went out to the field and carried out interviews with 27 herders at 17 localities. The selection of respondents has been described before. In their well known area, the resource persons/ guides brought the team directly to the pastoralists' homestead, dwelling, water point, *gopa*<sup>213</sup> or asked them to come to a place where a relaxed meeting could be arranged, e.g. veterinary dispensary, shop. Another way was to find them on the go and try to have contact during herding. Respondents were always males, mostly herd owners, sons of the extended households, but also employees. Two of the three interviewed Union Council *nazim*(s) were heads of areas in Cholistan. The resource persons made the contact and told the pastoralists about our aim to conduct a study about their animals and households, that we are from a university or sometimes just about a plan to write a book. Once at the location<sup>214</sup>, some further relaxing words (gossip) between the respondents and the team were exchanged in order to establish a friendly rapport or reduce jumpiness. If they heard that members of the team are from the veterinary sciences they were additionally excited about our visit and put questions

212 some parameters were not necessary to investigate, but this was first realised when collecting further secondary data

213 local appellation of a hut used as meeting point for the male members of a dwelling or settlement

214 people were at least sparing time but mostly offering seats, pillows, drinks and even meals



about some cases. Due to the introduction to them by known persons there were only two men who were hesitant to answer properly. Usually the interview was written up simultaneously. This was only possible because the interviews were carried out by a translator and the time during translation was utilised this way.

As mentioned above, qualitative interviewing puts a high demand on the interviewer and the communication and mediation skills. It was only partially and with help of resource persons possible to satisfy the quality of this skill. A further biasing factor for the validity of data was the length of time of interviews (~45 min) under the conditions of summer heat, since the team members but also the respondents became less concentrated and the context of questions could be left, thus creating non-informative errors in the data base. This developed positively after having passed through some interviews. Several times there was a huge crowd of people about, these watched and discussed the questions and responses. That is why it is possible that some interviewee responded differently. Sometimes there was the situation that, esp. experienced, translators added their knowledge about the subject into the responses. This was possibly caused by not introducing them properly to the objectives of the research

#### 4.2.2 Data Processing and Analysis

"Analysis of trials is the process by which team members evaluate and interpret trial results to determine the acceptability of a technology to farmers. Through the use of various analytical techniques, trial results are examined and evaluated systematically and used to predict whether farmers will find the technology acceptable" (FAO, 1995). The present research study attempts to find explanations for changes of farming systems. An interpretive consideration of the survey data is applied therefore. On this point, J. Mason (1997: 109) concludes, "an interpretive reading will involve you in constructing or documenting a version of what you think the data mean or represent, or what you think you can infer from them".

The analysis is based on data from the field survey which are not immediately analysable and must be processed before coming to the analysis. "Whatever methods of analysis are to be used, data coding is recommended. For quantitative, numerical information this simply means setting out the figures collected on the farm in a

convenient layout for further summary and analysis. In the case of qualitative data [...] coding consists of allocating numbers to each of the alternative possible answers and using these numbers in further analysis rather than the written answers" (M. Upton, 1996: 255).<sup>215</sup> When codes are analysed, these can be treated like other nominal or ordered categorical data.

So, a recording in spreadsheet could be set up in MS-EXCEL in a way that made it possible to enter all the primary data from the interview guides directly into a computer. This was done after the field work period as part of generating the field visit report. The entered data were checked visually and partially by range checks and extreme values, with the latter being only reasonable for quantitative data. If errors were detected these were checked with the interview guides and the information from the key informant interviews and field notes and corrected in the master copy or, if this was not possible, omitted from the data set to preserve data integrity. This provided data as a mixture of data as a mixture of counts and codes as an initial position for the analysis.

An important question for the socio-economic analysis is how to organise the information gathered into meaningful structures or clusters, i.e. to develop categories of farming systems sharing common socio-economic characteristics (recommendation domains). The wealth stratification, the aforementioned criteria of participants selection, was therefore put into practise by calculating the limits of the wealth groups. These cross-sectional categories were used when transferring the initial data set into an impact matrix (for a section of it, see the Annex).

Then cross-tabulations of the frequency distribution of observations could be applied together with the calculation of the arithmetic mean among the wealth groups and measures of accuracy, the standard deviation and confidence intervals. "A probability of 95 % is usually sufficient" (W. Doppler, 1992 cited by M. Maurer 1999: 18) and was also regarded as appropriate for the present study. A standard deviation of the sample of 20 % is considered acceptable.

This permits the comparison across all analysed variables and considered parameters, and makes it possible to construct explanations regarding the research questions which have been analysed.

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215 "the reasons is simply that it is quicker and more convenient to manipulate numbers rather than written answers" (ibid.)

## **5 Results and Discussion**

"The meat of the report is the section that presents and discusses the results" (E.F. Allan et al., 2006: 14). The following chapter works on the presentation of the empirical results of the field survey and develops the discussion of these by means of the working hypotheses.

The first of the two sections formed therefore deals with the criteria used in the selection practise during field work and for setting the recommendation domains of the analysis. As indicators are considered first the relationship of the farming systems with the development interventions and then their main wealth parameter. These become clarified here as continuation of the comments in section 4.2.. It is important to determine the data quality and representativeness achieved in the survey to be convinced of the extent of generalisability of the analysis.

The second section takes the research questions into consideration. It breaks the working hypotheses of the study down into causal sub-parts and links these to the data of the analysis variables. The variables become applied as factors in statistical methods which describe similarities and differences between the recommendation domains. By accounting for the validity of data, these are used in the interpretation process for constructing understanding of the impacts of development interventions on socio-economic and ecological reality.

### **5.1 Recommendation Domains**

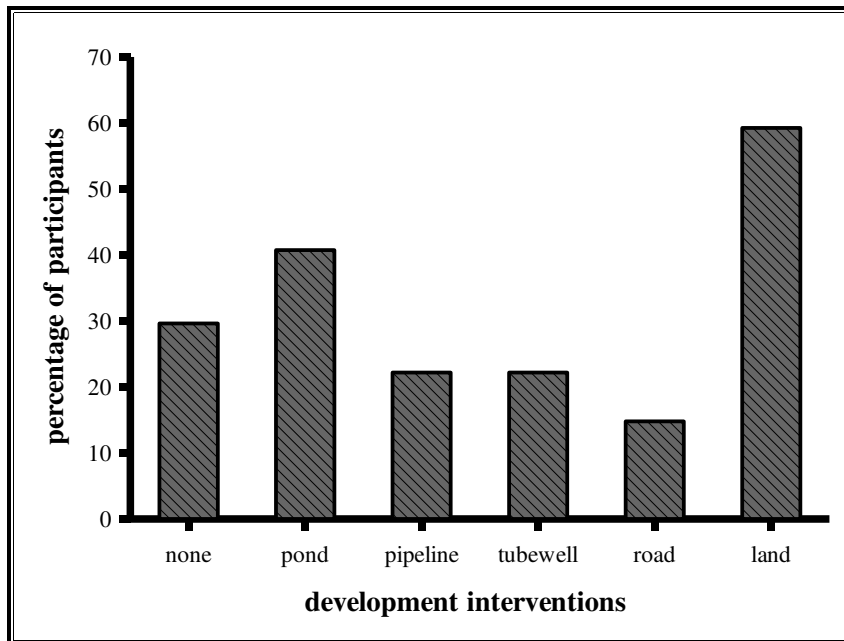
An accurate and reliable analysis of valid data leads to conclusions and recommendations that can be used to improve the livelihood of farming systems. Actually, it is impossible to analyse separately each farming system, that is why groups with as similar as possible circumstances, resources, problems and solutions to those problems are formed. It is assumed that the conclusions will be suitable for all farming systems in the group. Such a group is a recommendation domain and this section aims to point out these and their representativeness.

For the present analysis of farming systems it is important to know about the involvement of research localities and survey participants in the development projects.

These criteria make it possible to distinguish groups (categories) of participants in their relationship to the interventions. By the mentioned preparations in the run-up to the survey, the research area was divided in three categories as rough preliminary assumption in the research approach for locality selection. These make the situation in the field more clear.

The first category describes least developed and remote areas which are not covered by any innovation. At the localities, the water supply is made up with traditional *toba(s)* and open wells, transport to and from the dwellings in the desert goes on on *kaccha* roads (sandy tracks). The second category covers rangeland areas which lacks one or the other facility, which refers to localities either with desilted or newly constructed *toba(s)* or with water supply by the pipelines or recently sank tubewells or with newly paved roads. The third category of well-developed areas concerns rangeland areas which are involved in more than one intervention and irrigated areas with individual ownership pattern, supply of drinking water for livestock from canals and relatively proximity to settlements and market centres by the somewhat better developed transport system.

For the presentation in this section, a differentiation is made between each of the interventions presented in chapter 3 and a further category introduced, describing farming systems which are not involved.



**Figure 12:** Percentage distribution of survey participants involved in interventions

The particulars given by the interviewees are highlighted for that purpose. Figure 12 presents each single intervention and the percentage distribution of sample farming

systems participating in it.

The chart depicts that more than half of the 27 respondents are involved in anyway in the allotment of land. Above 40 % of the herders find a desludged or new pond on their rangelands. Identical number of farming systems (each 22 %) were found to be supplied with water from pipelines and new tubewells. 15 % of the pastoralists get connected with the improved roads. 30 % of the survey participants report about none involvement in development efforts. Overall around 50 % of the respondents find more than one intervention on their resource base (multiple response).

It is supposed that this distribution is only partially representative for the relationship between farming systems and the development interventions in the research area. The differing values per intervention are supposedly caused, beside bias in locality selection (4.2.1.1), by the different time frames of project implementation and the absolute numbers of functional units of each intervention. The relatively high value for land is probably based on the long time existence of allotment practises in Cholistan. For the two newly paved roads the same logic applies reverse and explains thus the small of involved herders selectable for the survey. The high number in the pipeline category is a little astonishing, because the project was still in the implementation phase during the field work period. This can be attributed to the aforementioned bias in locality selection, as the surveyed part of the research area is supplied by even two pipelines. It is not clear if the same cause biases the amount of reported involvement in *toba* (and *kund*) improvement and tubewell installation, because details about their spatial distribution are not on hand. But, the numbers for implemented functional units of each of them actually suggest a larger ratio. Moreover, it can be assumed that there is a larger fraction of farming systems being not involved in any of these development efforts because the survey was conducted at the peak of seasonal outmigration, so that the most herders using common (traditional) infrastructural facilities were not situated in the desert area. The in some cases very small categories make an analysis of impacts of every single intervention problematic. Because there are insufficient data to be quoted, it is not justified to consider them separately. Due to this, an analysis of improved roads has been rejected entirely.

As explained in sub-section 4.2.1.1, the selection of survey participants was executed by the estimation of the economic situation of their farming system, indicated by the livestock holding, which included the observation of animal species and number of

heads.

To be able to summarise the kept species and respective animal numbers as a single figure which expresses the total amount of livestock present, making them comparable irrespective of the species composition, data received through the interviews had to be measured on a common denominator, in the sense of economic wealth which could be benefited from them. For this purpose the species are considered by substitution ratios which are fully based on market prices and bear relation to each other by referring to the price of one adult cattle (as the most "precious" species). The price ratios (PR) were taken from interviews with participants of the livestock market in Yazman about the prevailing situation.<sup>216</sup> Local references of typical herds sizes in Cholistan were added by enquiries at the Livestock Department to form wealth groups.

The table displayed below shows defined groups of small, medium and large livestock holding or liquidable capital assets. It is set aside to similarly display the group of large holdings because it is in every case only unilaterally bounded.<sup>217</sup>

**Table 10:** Wealth groups of households in Cholistan defined by livestock holding

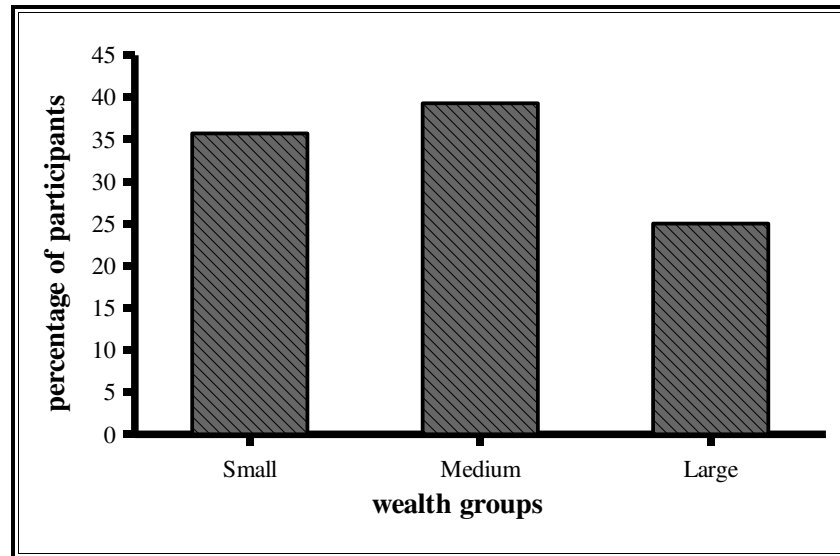
Substitution ratio by price		Small		Medium		Large
		TLU	PR	TLU	PR	
goat/ cattle	0.2	45	9	80	16	<
sheep/ cattle	0.125	80	10	120	15	<
cattle	1.0	5	5	35	35	<
camel/ cattle	1.2	2	2.4	20	24	<
$\Sigma$		132	26.4	255	90	<

TLU -indication in tropical livestock units, PR -unit calculated with substitution ratio by price

The result of adopting these group attributes to the statements of the survey participants about their herds and flocks can be seen in the following histogram (Figure 13). It provides the percental frequency distribution of survey participants among the wealth groups. It shows that by far the most herders the team came across have comparatively smaller and medium livestock holding or wealth. The distribution among the wealth groups is estimated as approximately representative of the research population by referring to a possible bias in the purposive selection.

<sup>216</sup> average market prices at this time: 35,000 PRs/ camel, 25,000 PRs/ cattle, 5000 PRs/ goat, 3000 PRs/ sheep

<sup>217</sup> the division in three wealth groups was predetermined by the details of herds size collected from Livestock Department



**Figure 13:** Percentage distribution of survey participants among wealth groups

This is supported when comparing the average livestock holding in Cholistan detected recently by AZRI (see Table 8) with the average among the presently surveyed farming systems (Table 11). One finds reasonable relativity between the numbers.

**Table 11:** Average livestock holding per species of the surveyed farming systems

	Cattle	Camels	Sheep	Goats
No. of heads per household	45	8	80	24

It becomes more clear when taking into account the summarised numbers in animal units (AU) and comparing this with numbers from the AZRI survey. The latter reports an average adult livestock holding per farming system of 86 AU, while the present work detected on average 85 AU at a minimum and maximum of 13 AU and 254 AU respectively.<sup>218</sup> This counts primary for the district of Bahawalpur but the report of AZRI (undated) found that differences in average herds size are not significant among the parts of the three districts containing Cholistan. According to that point of view, the farming systems having presently participated validly express the wealth distribution throughout Cholistan.

It has to be stated, in summary, that despite the theoretical research construct being well implemented, the validity of the data basis is partly very limited, which thus restricts the

<sup>218</sup> the conversion factors for calculation of animal units (AU) are taken from Sarwar et al. (2002)

representativeness of recommendation domains. It is remarked in each case if these inconsistencies affect the analysis in the following.

## **5.2 Analysis of Impacts on the Farming Systems**

This section conducts the data analysis and deduces explanations of the causal relations in the hypotheses. The impacts of the development interventions on the migration pattern of the farming systems and with that on their natural environment and social relationships are examined first. Important for the structure of the discussion is that the land allotment schemes are considered in the first hypothesis from an external perspective, that means as an environmental factor. The point of view on irrigated land as internal production factor is taken up under subsection 5.2.2. when the impacts of land allotment and colonisation on the farming systems' endogenous resource management are analysed.

### **5.2.1 Impacts of the Development Interventions on Migration Patterns**

The first subsection accentuates if improved water supply in the desert causes changes in the decisions of the herders about their migration patterns. The results of this are addressed to the state of degradation of the natural environment around the localities and to the social relationships. The second subsection works out the impact of land allotment schemes on the pastoral migration patterns.

#### **5.2.1.1 Water Supply Developments**

The main concern of the projects of CDA and PCRWR for the development of the rangelands is the improvement of water supply, as water is the primary natural factor influencing the accessibility for livestock husbandry.

The conditions of the water stock at the respondents' locality is the initial cause for the considerations. The desludged and newly constructed ponds and tanks increase water



harvesting and storage capacities temporally. The pipeline water points and the new tubewells expand the useable drinking water stock all over the year.

Unfortunately, the number of respondents for each of these interventions (Figure 12) and the data of relevant analysis variables do not justify a consideration of each technique separately. Sufficient data were not acquired due to gaps in interviewing (4.2.1.2). This means that coverings and differences of impacts of the interventions are ignored, what is a strong restriction of the scope of inferences. The attempt to divide the water interventions for the analysis by rainwater dependent and groundwater fed techniques did also not succeed. Thus in the following all these are considered combined.

So in sum, 67 % of the survey participants (n= 27) are involved in water supply related interventions. To the question of possible changes of their decisions on mobility and the reasons for this, an average of 55 % of the wealth groups responded that the point in time to retreat from desert locations is delayed because livestock can be watered longer. By applying a calculation of the confidence interval range on that mean, it is possible to say that with 95 % confidence between 45 % and 66 % of the sampled pastoralists modify their mobility behaviour that way. Thus this effect is formally attested, but the information are very undifferentiated so that pros and cons can not be weighed up against these three innovation techniques.

A further effect in the migration patterns, caused by the improved water stock, is also hypothesised: the increase of stocking densities around localities of water interventions. Beside the proper stocking rate of Cholistan, which is already exceeded, and the previously identified longer residence time here, it is supposed that additional mobile pastoralists from other (not involved) areas become attracted by the watering potential and approach increasingly to here. It is important to differentiate between the seasonal changes of stocking densities and the changes in the last years induced by increased water stock. This was recognised in the interview guide by asking to compare the situation 20- 30 years ago with after the implementation of the projects. A distinction of this supposed impact and a human population dynamic increase was not concerned importantly and so not determined.<sup>219</sup> But, the suggested time frame was possibly too wide to rule out reliably an increase of the population of animal keepers and their herds, so that the validity of these data relied on the interpreters' comprehension to explain the

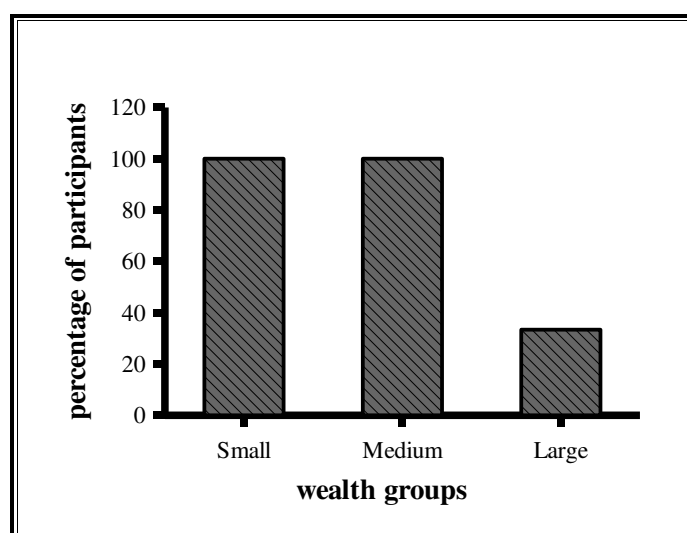
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<sup>219</sup> details about the human population development could not be attained

context of the question to the respondents.

However, 45 % of the interviewed pastoralists involved in water supply development reported to observe more herds from other areas near or on their grazing grounds.

The impact becomes more apparent when clustering down those respondents who attested increased water stock from improved water supply (n= 10) by those who observed increasing number of animals in the area around these facilities (see Figure 14). On this level, the eminent proportion (80 %) observe more non-resident herds.



**Figure 14:** Increased stocking density around improved water supply (clustered)

The calculation of a confidence interval range does not help on the analysis of the data here because the sample size does not justify that, as the standard deviation would be made up quite accidentally. For instance the response of only one herder regarding that variable could be acquired in the large wealth group. Also the 100 % parameter-value of the small and medium groups is supposed to be skewed.

Due to the small sample size the analysis is limited to a non-parametric consideration of the positive values for every wealth group. This supports the supposed impact of an stocking density increase around those sample localities which are equipped with at least one unit of improved water facilities.

The mentioned gaps in interviewing again mean that the differences of the impacts of each technique remain unobserved.

Directly connected, it is hypothesised that the previously identified higher stocking densities affect the natural vegetation around the improved water supply facilities in the desert negatively. It is important for the consideration to differentiate this impact and

the anyway existing causes for land degradation (exceeded carrying capacity and seasonal climatic conditions). The adoption of a qualitative methodological framework for the analysis of this ecological impact was justified during the research design by the interest to investigate the pastoralists' observation of natural environmental changes and socio-economic causes, i.e. their awareness of a possible link between the technical innovations, their resource use and degradation in their grazing areas.

All of the survey participants (n= 27) reported that they observe degraded vegetation, they said that they find less palatable grasses and trees and relatively more unpalatable bushes, a few also reported about less birds. Of the respondents from whom further statements about the causes could be acquired (n= 18), 14 % stated too much grazing animals on the ranges, but no one brought it in relation with the interventions.

Due to inconsistencies in the data base it must be refrained from doing an interpretation of that context here. The present work could not manage to determine empirically if additional degradation occurs around localities of water interventions. The reason given for this is that it is a quite difficult task to deduce from interviews the nuances of the parameter-value of seasonal degradation which interfere with each other, i.e. to sort out from another the long-term impacts of climatic change, recent impacts of the water supply improvements and impacts of the recent drought; neither for the ecological scientist nor for the experienced pastoralist. This lack of the data generation method was not paid regard to during the research design.

Subsequently is hypothesised that the development interventions affect the access to e.g. water supply, pastures and dwelling places, so that this becomes disputed and social conflicts arise. In the interviews, it was enquired for problems with existing tenure regulations. Only two respondents reported a contended access to improved water supply on the rangelands. The construction place of a new pond was ones chosen as such that the neighbouring communities dispute the claim to use this area. In one other case of a pipeline fed water point, the respondent mentioned that for some herders from other areas the pipeline point is too far away from their areas, thus they try to stay and use the pastures here.

Due to the already entitled invalidity of data it is refrained from interpreting this context.

In the previous paragraphs, it was only partially possible to identify impacts of the water supply development projects on the farming systems, the ecological conditions at the

selected localities and the social relationships of pastoralists. A generalisation to the entire research population and area is probably justified only for the delayed retreat from desert localities with improved water supply. This temporally adaptive behaviour is already an attribute of the pastoral mobility. An analysis of the other causal relationships in this hypotheses are not possible due to uncertainties in the data base.

In subsequent analyses of interrelationships of water facility development and land degradation, the consideration of socio-economic and ecological impacts should essentially differentiate between the temporally useable rainwater harvesting techniques and the perennial water supply by pumping up groundwater (pipelines and tubewells). It should also comprise their spatial distribution and the tenure to the resources. Conclusions about their contribution to the development of a sustainable livelihood in Cholistan should be made by comparison with the content of the following quotes.

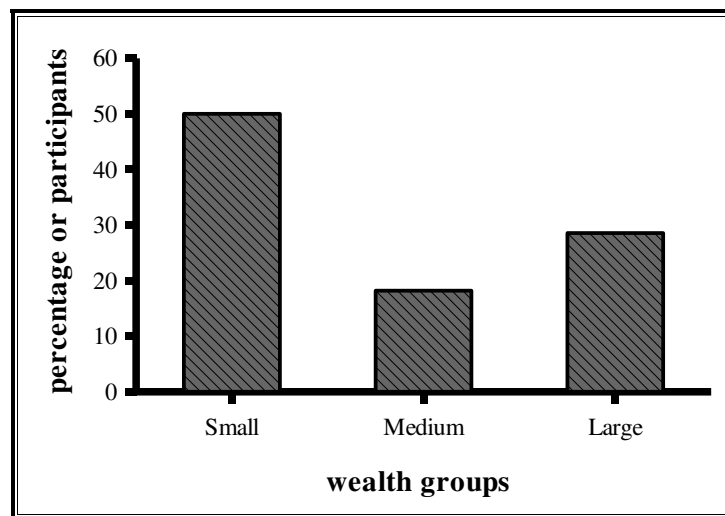
M. Nori et al. (2005: 23) states regarding the history of large investments in pastoral areas on technical innovations aimed at increasing the productivity that these "have achieved disappointingly poor results and often created conditions that contributed to degrade, rather than improve, pastoral livelihoods". The well-meaning expansion of water access points, through the construction of water catchments, wells and pipelines, "can wreak unintentional harm upon herder communities, by increasing herd density on pastures and by reshaping seasonal use pattern" (ibid.). Furthermore, "water projects have in many cases unintentionally destabilised social relationships, disregarded the local distribution of access rights and responsibilities for management of resources, thereby undermining mutual assistance networks and other means of averting risks" (Helland, 2000 cited by M. Nori et al., ibid.).

#### 5.2.1.2 Agricultural Colonisation

On average among the wealth groups 30 % of the participants responded that they have problems with disturbed routes northward to their drought season areas situated in the irrigated and riverine track. They mentioned the impact caused by the colonisation of irrigable land. Mixed farmers who have settled in canal colonies sometimes deny the trespassing of their livestock or increase the price of water and feed stuffs during that time. It is difficult thus for the mobile herders to reach areas where they suppose to

maintain their herds during the harsh pre-monsoon period. The following histogram (Figure 15) displays the results.

The large ratio of the standard deviation (16 %) to the mean demonstrates the large differences of this impact between the wealth groups. The high value for the small farming systems is possibly related to their social state, largely defined by the livestock holding (2.3.5). This means that they are not properly represented by the responsible institution on community level (*numberdar*), who could try to intervene on this conflict with cultivators.



**Figure 15:** Routes to drought season areas disturbed by colonisation schemes

Here an impact becomes obvious that is referred to F. Ahmad (2003: 81) as the "nomadic-sedentary conflict". He continues that this is a "major threat to livestock husbandry in Cholistan" which comes up from the "alienation of rangelands to agriculture".

As described in subsection 3.2.5, it comes even to a further expansion of the colonisation schemes, so that for instance several respondents met in the eastern part of Lesser Cholistan at *rodewala dahar* (see Figure 11) reported about forthcoming constraints on their migration pattern and conflicts of that kind.

F. Scholz (1998) refers this shrinking of living space of nomadic and transhumant families as the "Punjabisation" in Cholistan. He states that the socially marginalised, traditional pastoralists have problems to find supplementary summer period grazing opportunities on stubbles and commons in the irrigated tracks at the northern margins of the desert. F. Ahmad (2003: 82) relativises the intensity of that conflict and reports

about "local institutions which reinforce a mutual dependency between cultivators and pastoralists by providing contractual frameworks that reduce confrontation and marginalisation".

If questioned for ideas to settle such conflicts, below 50 % of the herders responded that the traditional *panchayat* system is sufficient for that. Probably the number is even lower as the unanimity about the feasibility of the traditional institutional system was only stated in the framework of the less trust-inspiring one-visit interviews.

The disturbed routes reveal the socially marginalised situation of parts of the pastoral population.

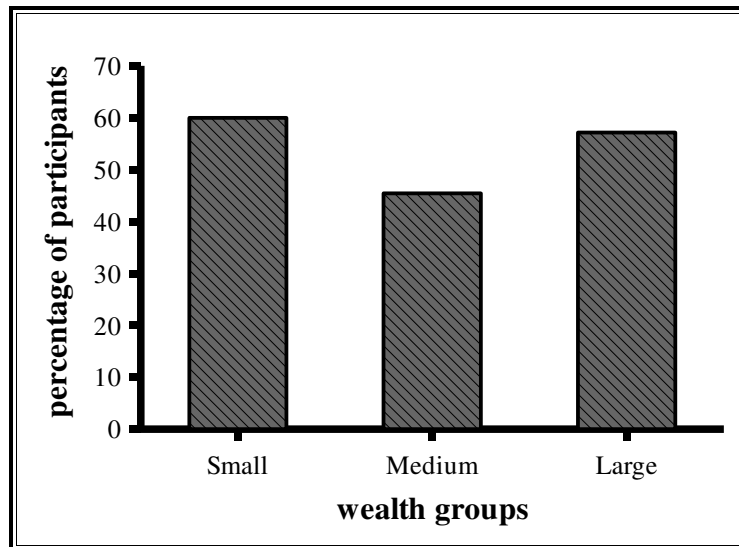
### 5.2.2 Impacts of Acquiring Land on Pastoral Farming Systems

This section is concerned with the analysis of impacts of land allotment in Cholistan on mobile pastoral farming systems from an internal perspective. It considers if the hypothesised attraction of land ownership on the decision-makers of families exists and in what form they possibly modify the farming systems.

Subsection 3.2.5 delineates that till the recent past there were implemented schemes for the allotment of state-owned land in Cholistan. Land was provided for reclaiming it as irrigated land for the cultivation of food and feed crops and for settlement. When herders were asked during the survey for the needs of their families in the future, in mean of the wealth groups above 50 % of all participants (n= 27) responded that they want (more) irrigated land. Figure 16 depicts those respondents' distribution among the wealth groups.

The application of a 95 % confidence interval on the mean provides a range of 45 % and 63 % which is highly likely to contain the truly quantity of research population being pulled by land allotment to modify the farming systems. The high parameter-value obtained by the small group seems clear when considering that small livestock holdings provide only little potential to generate income from it. It can be said thus, that the socio-economic situation of the smallholders creates need either to diversify their farm activities or to decide to abandon mobile animal husbandry. The high value for the large wealth group expresses a strategy some similar as of the smallholders but under reversed signs. For them irrigated cultivation is not primarily a risk aversion opportunity

but a way to expand their profit and prestige promising resource access and production activities. The lower value of the medium group represents either a comparative stability of the livelihood of these pastoral farming systems or that these households have not sufficient resources to diversify and manage both production systems. Medial in between poor conditions of largely subsistence production and expansive market-oriented production, they have lower motivation to change.

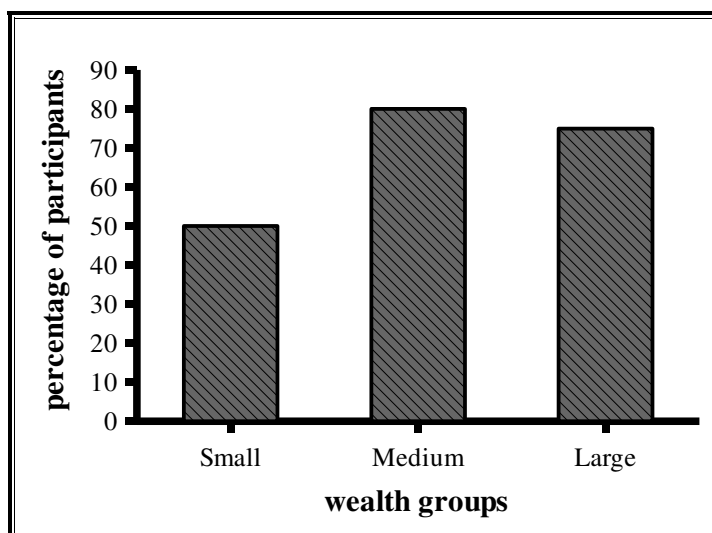


**Figure 16:** Proportions of respondents telling interest to acquire irrigated land

The question is now, how far goes the interest to shift the management of households' endogenous resources. The previous data related to the pull factor land are clustered down therefore by the surveyed parameter of pastoralists' future expectations to increase the number of kept animals. The result of that is demonstrated in the following histogram (Figure 17). In mean among the wealth groups nearly 70 % of the families in the sample population who told to want land (n= 15) also want more livestock.

The calculation of a 95 % confidence interval of the mean results in a range of 50 % and 86 % and in the interpretation that probably more than half of the pastoralists who want to gain land ownership do not want to abandon livestock utilisation completely.

The comparatively lower parameter-value of the small wealth group here is associated with the context one step back. Due to their little socio-economic capacities they are subjected to a conflict of objectives between the two farm activities. That is why the account to livestock production declines when opportunities for cultivation come up. For members of the large wealth group such a conflict of objectives seems to be non-existent. That is why they can attempt to diversify their farming systems to both sectors.



**Figure 17:** Proportions of respondents interested to keep more livestock (clustered)

The remarkably high parameter-value of the medium group characterises clearly now that these farming systems are lesser attracted by land allotments, possibly due to lacks of family labour force. Thus they can try only to develop the need satisfaction of their families by increasing the livestock holding.

The details of the survey participants reveal that the partially very different socio-economic situation of the farming systems is a factor which motivates or enables the decision to change the farm production activities. If acquiring a title to land this implies two effects in the decisions of households of the research population about the allocation of their resources, with both constituting very different livelihood development prospects. On the one hand, comparatively more Cholistani pastoralists with small livestock holding abandon animal husbandry and emigrate finally from the rangelands. While on the other hand, those pastoralists with large wealth contribute comparatively more to the spread of crop-farming with limited transhumance, referred to in subsection 2.3.2 as the agro-pastoral farming system. FAO (1992: 13) speaks in this context about a "obvious trend to the agro-pastoral system", which shows that both traditional farming systems, nomadic and transhumant, together are practised today by no more than a minor part (25 %) of the households in Cholistan.

According to W. Doppler (1991: 64), agro-pastoralists raise predominantly cattle which are used for dairy production for home consumption and market sale. They benefit from keeping cattle (esp. the lactating ones) on irrigated land and the other herds extensively on the rangelands. If considering the species preferences of survey participants who own land, which is by their own account useful for cropping (>12 acre), than it becomes



obvious that more than 2/ 3 of them (n= 12) prefer to keep large ruminants, analogical to the conclusions of W. Doppler.

Another attribute of agro-pastoralism is connected to landholding as stated by Doppler (ibid.). The families with for cropping feasible land tend to fix their homesteads. This was specified by more than 80 % of the surveyed agro-pastoralists. This tendency to more sedentary life, of at least parts of the family, was already described in subsection 2.3.1. The push to mobility is reduced if a society begins to engage in cultivation because the provisioning with food becomes more intensive. Doppler continues that with the partial settlement begins a detachment of life of the family and mobile livestock husbandry. Often there is a distribution of labour insofar that young males move with the animals, women make the milk production and male heads make the plant production. This development is also detected for the above 2/ 3 of the respondents who manage also a crop production system. All they reported that their families can stay longer at the margins of Lesser Cholistan where large parts of the irrigated areas are situated.

The rising preference for cattle implies a higher dairy production potential and, combined with settlement more near to markets (e.g. Nestlé milk collection system), this provides a higher economic potential to the agro-pastoralists as compared to the traditional farming systems. Their livestock production systems are better supplied with fodder by the integration with the cropping systems, what reduces the risk of drought, and they can still make use of the open rangelands. Where their economically and socially higher standing is traditionally characterised, so that "agro-pastoralists are occupying significantly higher number of *toba(s)* than the pastoralists" (AZRI, undated). Their social position is strengthened further by the land allotments because they are no more solely based on livestock and stepped inside the agro-centred Pakistani society. F. Ahmad (2003: 134) gives a resumé regarding the latter that "although the ethos of [livestock] quality still lingers, land ownership has engendered new privileges". On the other hand is the land only valuable if it is properly irrigated. As was mentioned in subsection 2.2.1, this is very questionable due to emerging shortages of water supply to canals by the Sutlej River.<sup>220</sup>

For the families in the small wealth group which decide to abandon mobile pastoral production in Cholistan come the agricultural colonisation schemes in Lesser Cholistan

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220 "given the uncertain water supplies, crop yields are lower than those achieved in the rest of the Punjab" (FAO, 1992: 14)

into question as alternative source of livelihood (irrigated cultivation and settlement). Their prospects there are determined by the weakness of water supply by the canal system which becomes the qualifying factor of the production potential. The important issue of marginalisation or participation of Cholistani families in land allotment practise is not considered by the survey, so there are no primary data about it available.

Cropping is a higher input system which increases the pressure to commercial success (commercialisation). They become more dependent on market conditions and consumption of household items.

Through both prospects the pastoral society loses traditions and probably what they call *azadi*<sup>221</sup>.

## 6 Summary and Conclusions

The present study addressed impacts of development interventions on mobile pastoral farming systems and their natural production environment in the Cholistan Desert.

Cholistan is a dryland area with huge parts of sandy dunes laying remote and lacking almost every modern facility. It is occupied traditionally in mobile manner by the Seraiki ethnic group which keep ovine, bovine and dromedary. These pastoralists utilise ancient rainwater harvesting technology at here and there existing flat, dense and poorly drained soils and open-wells and they are adapted to the seasonal climatic stress by a nomadic or transhumant mobility behaviour.

The aftermath of the perennial, severe drought around the year 2000 was the trigger that directed large financial resources to the provincial government and its development organisation which launched short- and long-term drought mitigation and development projects in Cholistan. The interventions on which was focussed are improvements of water supply techniques (ponds, tubewells, pipelines) and of the road network. A further strategy declared as reducing the vulnerability of pastoralists is the allotment of irrigable land at the fringes of the desert.

The present qualitative descriptive analysis of cause-effect relations was conducted with the aim of investigating the contribution of the development interventions to minimising desertification effects and to resolving socio-economic issues. Therefore were analysed

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<sup>221</sup> means "freedom, liberty" in Persian, is also borrowed by Urdu and other languages in the larger region

possible impacts on migration patterns, stocking densities, conditions of range vegetation, social relationships and households' resource allocation. The scope of the study limited the field work to the parts of Cholistan falling in the district of Bahawalpur. Due to administrative restrictions the research area was limited again. However, a one-shot survey with semi-structured interviewing of individual pastoralists was carried out as primary data generation method. Its accuracy and reliability was partially biased.

That is why roads could not be analysed and the techniques of water supply could not be analysed individually but were considered combined what restricted the scope of inferences. The study identified that on average 55 % of the survey participants involved in the water innovations delay the point in time of transhumant retreat from localities on the rangelands if water stock is longer accessible. This is a common behaviour of the pastoralists, thus the socio-economic impact can probably be generalised on the entire Cholistan area.

An increase of stocking densities around those localities as compared to localities without water supply improvements was deduced only by a non-parametric analysis, but this should not find expansion in the conclusions. The data generation methods applying qualitative parameters were not feasible to identify possible ecological impacts of interventions on the conditions of range vegetation empirically.

For considerations of the ecological sustainability of the water supply techniques or of the interrelationships of water facility development and land degradation, subsequent studies should essentially differentiate between the temporally useable rainwater harvesting techniques and the perennial water supply by pumping up groundwater, because both water sources are probably characterised by varying long-term prospects. In order to clear their economic and social potentials and constraints such a study should also comprise the spatial distribution and the tenure to and the maintenance of the facilities. Impacts on the natural vegetation should be measured by ecological methods, as e.g. remote sensing with vegetation sampling or infra-red soil diagnostic.

On average among the wealth groups 50 % of the survey participants were motivated for acquiring irrigable land. The socio-economic situation of the households was deduced as a factor for this impact.

Diversifying pastoral farming systems is opportune only for the households with comparatively larger wealth. They shift to systems of crop-farming with limited

transhumance. 66 % of the survey participants which modified their pastoral farming systems showed preference for cattle keeping what represents their objectives to open more market potentials. Smallholders have a conflict of objectives and must choose between both production opportunities. If they decide to abandon mobile pastoral production they shift to settled crop-farming in the irrigated areas. They have to deal with the continuing shortages of water supply to canals by the Sutlej River there and with their already marginalised economic and social status. The expansion of irrigated land leads to shrinking of rangelands what affects also the households with relatively satisfactory livestock system (medium wealth group). They can not afford to diversify to agro-pastoralism and must deal with the risk of investing in livestock during the process of declining range resources.

Also due to the expansion of these schemes to the rangelands the mobile pastoralists come into social conflicts with cultivators about migration routes to the drought season areas away from the rangelands. On average among the wealth groups 30 % of the sample population were found to be affected that way, with comparatively higher parameter-value in the small wealth group.

These impacts revealed that parts of the pastoral population are disadvantaged or even marginalised by the allotment of land, because they can not participate on the benefits of a shift to the agro-pastoral system.

The farming systems which can not acquire sufficient amount of land will try to satisfy their needs by increasing the herds size what puts further burden on the carrying capacity of the rangelands. With this quantitative change and with the structural change of species preferences of agro-pastoralists it can be concluded that the agricultural colonisation drives on the cycle of desertification. This ecological impact is generalisable to all parts of Cholistan which are used by pastoralists disadvantaged as mentioned before. If looking on the map (Figure 11) one can see that the largest parts of the northern and north-western fringes of Cholistan are already involved in land colonisation. These are the spaces which are essentially needed by the pastoralists to pass through to the river banks or to stay and survive the pre-monsoon period.

With that must be concluded that the realised impacts of land allotment and colonisation oppose the aimed reduction of grazing pressure on the rangelands and come up to a socio-economic uplift only for those residents of Cholistan with already larger wealth.

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## **8 Annex**

### **Locally and Regionally Important Research and Development Institutions**

Arid Zone Research Institute (AZRI)

Bahawalpur Rural Development Project (BRDP)

Cholistan Development Authority (CDA)

Cholistan Institute of Desert Studies (CIDS)

Federal Bureau of Statistics

Livestock and Dairy Development Department Bahawalpur District (L. & D.D. Dept.)

National Rural Support Programme (NRSP)

Pakistan Council of Research in Water Resources (PCRWR)

Punjab Forestry, Wildlife and Fisheries Department

Punjab Livestock and Dairy Development Department

World Wide Fund for Nature (WWF)

### Traditional Water Pond



Source: by the author

### Traditional Open Dug-Well



Source: by the author

### Newly Constructed Water Pond



Source: by the author

### Delivery Point of a Water Pipeline



Source: by the author

**Interview Guide**


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Date: \_\_\_\_\_ interview site: \_\_\_\_\_

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***Hh's animal******mark***

1.1.1) *Resp.?* Name: \_\_\_\_\_ Sex: \_\_\_\_\_, Age \_\_\_\_\_,

1.1.2) # fam.members: \_\_\_\_\_.

1.1.3) read & write/ school level ? \_\_\_\_\_

1.1.4) *Did any member of your household participate on elections of government ?* NO YES

1.2.1) Any developments in the desert (water, road, electricity, *service, schools*) ? NO YES  
*orga name ? Are you satisfied by their action ? How was the influence on Hh ?*

1.2.2) Infrastructure **Rohi/ Neheri** area ?

Road ? kaccha \_\_\_\_\_, metalled \_\_\_\_\_ ?

Electricity ? n0 \_\_\_\_\_, interurban \_\_\_\_\_, solar \_\_\_\_\_ ?

Vet. Services ? n0 \_\_\_\_\_, mobile dispensary \_\_\_\_\_, vet. Centre \_\_\_\_\_, not maintained \_\_\_\_\_ ?

School/ level ? \_\_\_\_\_ ?

Health care ? \_\_\_\_\_ ?

Communication ? \_\_\_\_\_ ?

Mosque ? \_\_\_\_\_ ?

1.3.1) Main household activities ? L/S\_\_\_\_\_, Agro\_\_\_\_\_, Employed\_\_\_\_\_, Handicrafts\_\_\_\_\_, charcoal\_\_\_\_\_ ?

1.3.2) Do you hire employees for any of your activities ? NO YES - Number:\_\_\_\_\_.

1.4.1) Where is your main locality for raising animals ?

1.4.2) How do you move with your herds ? (1) Stationary\_\_\_\_(2) TH\_\_\_\_(3) Nomad:\_\_\_\_\_

1.4.3) Where is your main homestead ?

1.5) Fuel:\_\_\_\_\_, Tractor:\_\_\_\_\_, Motorbike:\_\_\_\_\_, Camel/- Donkey- cart:\_\_\_\_\_  
Cycle:\_\_\_\_\_, Radio:\_\_\_\_\_, TV:\_\_\_\_\_, Mobile:\_\_\_\_\_, Watch:\_\_\_\_\_,  
Pump:\_\_\_\_\_, Solar oven:\_\_\_\_\_, Bank account:\_\_\_\_\_

1.6.1) Percentage of purchased food on overall diet ? \_\_\_\_\_

1.6.2) Yearly expenses on market for food and non- food good ? \_\_\_\_\_, - PRs

1.6.3) What has changed since you were young ?

2.1.1) How many acre irrigated land ? \_\_\_\_\_, 2.1.2) When got it ? \_\_\_\_\_,

2.1.2) How much earning from crops ? (% overall Hh income) \_\_\_\_\_

2.1.3) Was the number of animals influenced by allotment ? \_\_\_\_\_

2.1.4) What changed for females and children ? \_\_\_\_\_



2.2) Number of animals – males, females, own, not own, in poor, average or good conditions ?

2.3.1) milk sale ? Beopari (from) \_\_\_\_\_, Market (which) \_\_\_\_\_,

Company \_\_\_\_\_

	Breeds	# total	# adult males	# kids per a	herd Milk/day	Milk sold	price	Conditions
Goat								
Sheep								
Cattle								
Camel								
Others								

2.3.2) Ghee prepared in desert ? NO YES

2.3.3) Did the amount of milk/ ghee sale change since you were young ? NO YES - Why ?

2.3.4) Any problems of milk sale ?

2.4.1) Wool production ? Shearing season – biannual: \_\_\_\_\_, or annual: \_\_\_\_\_,  
Rupees/ animal ? Sheep: \_\_\_\_\_; Goat:

2.4.2) Problems of sheep keeping and wool sale ?

2.5) *live off-take since last dry season ?*

i) main season of sale ? winter\_\_\_\_\_, dry \_\_\_\_\_, monsoon\_\_\_\_\_, Id-ul-hazar/ -feta\_\_\_\_\_

ii) purpose of sale ? cash\_\_\_\_\_, animal purchase,\_\_\_\_\_, home occasions\_\_\_\_\_, scarcity\_\_\_\_\_

ii) sale to ? Beopari (from)\_\_\_\_\_, Market (which)\_\_\_\_\_, else\_\_\_\_\_

iv) *How are your sale activities depending on price ?*

not\_\_\_\_\_, low p low sale/ high p high sale\_\_\_\_\_, else\_\_\_\_\_

v) *What is the price depending on ?* animal conditions\_\_\_\_\_, demand\_\_\_\_\_, trader competition\_\_\_\_\_, else\_\_\_\_\_.

vi) *Any problems with sale ?* Pricing\_\_\_\_\_, unfamiliarity\_\_\_\_\_, not always traders available\_\_\_\_\_.

vii) *Ever thought about bringing animals together to market, and getting better price? why (not)?*

Calf or kid,,,,,mature male,,,,pregnant female								
Goat		Sheep		Cattle		Camel		
	♂	♀	♂	♀	♂	♀	♂	♀
#								
age								
Price/unit								

2.6.1) *Criteria for breeding/ selection of animals: (show best male)*

2.6.2) *sometimes purchase animals ? for what purpose ? (influence of drought)*

2.7) *are your herds properly vaccinated ? why (not) ?*

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3.1.1) *In the last 20 – 30 years how did animal number develop ?*

3.1.2) *what are the reasons ? (drought, diseases, sale/ price/ transport)*

3.1.3) *do you prefer any species ? (why)*

3.2.1) *routes of seasonal migration ? (name areas, water supply, on foot/ road, duration)*

3.2.2) *what changed in the routes in last 20 – 30 years ? (time of stay, daily distances, grazing flocks/house herd)*

3.2.3) *what was influencing this changes ? (road/ market, water, vegetation, allotted)*

3.2.4) *which area do you prefer ? (why- money, azadi)*

3.3.1) *Any disputes ? (more herds from other areas, unclear tenure, politics, externals, borders, military) ?*    NO    YES - *Why ?*

3.3.2) *any institution/ regulation to settle conflicts ? (sianas, court, police)*    NO    YES - *Why ?*

3.3.3) *how should power or land right be distributed ?*

3.4.1) *any grazing preserves ? why not ?*

3.4.2) *Hay, Silage, Straw, Concentrates, Supplements, minerals ?*    YES    NO - *Why not/ probs ?*

4.1) *signs of degradation in your grazing area ? (drought, gras, trees, soil, shoppers, wild life)*  
NO    YES

4.2) *Name of (medical) plants which are reduced or increases ? ( how affect you )*

4.3) *change of the climatic conditions since you were young ?* NO YES - *describe !*

4.4) *productivity of animals influenced by these ? (mortality, calving period, yield)*

4.5) *Any places that you can not/ no more use ?* NO YES - *How degraded ?*

4.6) *What would you suppose are the causes of these problems ? (own grazing)*

4.7) *Do you have any ideas how to prevent it ? (planting new trees)*

5.1) *how to increase production of your animals ? (better feeds/ breeds)*

5.2.1) *how is your family living today as compared to 20 years back ? (socially, economically)*

5.2.2) *what criteria do you use for this characterisation ?*

5.3) *what do your family needs to get better ? (irri land, more animals, gov employee)*

5.4) *how do you would like to be involved in organising development of this area ?*



Hiermit erkläre ich feierlich, dass ich die vorstehende Diplomarbeit unabhängig und ohne Nutzung von Quellen oder anderen Hilfen, ausser den genannten, abgeschlossen habe.

Datum

Unterschrift