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Dietary Analysis of Cold Arid Inhabitants of Leh (Ladakh): Need for Integrated Agricultural Systems

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Abstract: The study uses cross-sectional data of a sample of 178 individuals from eight villages in Leh district of Jammu & Kashmir state in India. Dietary diversity and availability of nutrients are assessed in the overall socio-demographic, agricultural and nutritional systems. Subjective and objective measures like socio-demographic survey, household dietary diversity score and 24 hr dietary recall were used. It emerged that the region has adequate level of diversity in the diet, however, further improvement is needed to have balanced nutrition. The role of Public Distribution System (PDS) is very crucial in achieving the same. There is a need for designed agricultural system with integration of field crops, horticulture and livestock. Crop diversification with inclusion of high value agricultural crops and introduction of new tuber and cereal varieties like finger millet (*Eleusine coracana)* and maize (*Zea mays)* was suggested to imply the self-reliance in food production and gradually decrease the dependency on subsidized food grains. Legumes and dairy products were significantly deficient in their diet thus interventions are required also to revive the traditional livestock based livelihoods for better nutrition and remuneration.

Key words: Dietary analysis, cold desert, Leh (Ladakh).

Ladakh lies on the rain shadow side of the Himalaya, where dry monsoon winds reaches Leh after being robbed of its moisture in plains and the Himalayan mountains. The district combines the condition of both arctic and desert climate, therefore, Ladakh is often called as the "Cold Desert". Ladakh has acute environmental constraints of extremely high altitude and very harsh climatic conditions permitting agriculture in favorable niches such as valleys and lower slopes. Of the five ecological subzones in Ladakh our survey was mostly confined in Indus valley area which is the eastern part, characterized as cold mountain desert with lakes, poor quality pasture land, and predominantly inhabited by *Ladakhi budhhists* settled along the river beds and alluvial fans. There is wide diurnal and seasonal fluctuation in temperature with –40°C in winter and +35°C in summer. Precipitation is very low with annual precipitation of 10 cm mainly in the form of snow. Air is very dry and relative humidity ranges from 6-24% (www.Leh.nic.in).The net area of the Leh district is 45167 ha in which the net area sown is 10,184 ha of which 8,477 ha is irrigated through channels (*www.diragrikmr.nic.in/*). The stocking of essential items like food grains is a common practice to prepare for harsh winters when most of Ladakh is cut off from rest of the world due to snow bound roads. In such harsh environmental conditions, availability of adequate nutrition and consequent survival assumes significance and priority, especially when crop diversity is low. Nutritional requirements for healthy life at such high altitude, their sources from locally grown crops and their adequacy or otherwise are poorly understood in Ladakh. Hence this study was conducted as a baseline survey to understand the socio-demographic features, the agricultural as well as nutritional system, dietary diversity and availability to suggest and formulate the appropriate developmental plans keeping in view the deficits and priorities (Gopalan *et al*., 1985).

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Methods

Locale

Leh district is situated between 32 to 36 degree north latitude and 75 to 80 degree East longitude and altitude ranging from 2300 m to 5000 m above sea level (Leh.nic.in). The district Leh has only one tehsil i.e. Leh. Present study was primarily confined in 8 villages namely Shey, Spituk, Stakna, Chuchot, Phey, Matho, Sabu and Khagsar of Leh district.

Four to five families were randomly selected in each village representing different religions and landholding size. Data was collected in three rounds on a random sampling basis of 30 households covering 178 individuals. Data collection took place at the beginning of the rainy season (end of May to mid-August). All the data were collected by trained enumerators in face-to-face interviews.

Socio-demographic aspects

All the selected households were examined for socio-demographic aspects such as caste, age, sex, number of family members, size of land holding, occupation, annual income from different sources, local agriculture and nutritional system prevalent over there etc. The data were collected by personal interview method using a pre-structured interview schedule.

Household dietary diversity

The household dietary diversity score (HDDS) is meant to reflect, the economic ability of a household to consume a variety of foods. Dietary diversity score of each family were created by summing either the number of individual foods or food groups consumed over the reference period. The HDDS of sample population can be created by the following formula (FAO, 2007).

Average HDDS=Sum (HDDS)/Total number of households

For this purpose, an open qualitative recall of all foods consumed during the previous 24 hours was performed with one key respondent in the household, preferably a woman. If there was no woman available or no woman at all in the household, the respondent was the head of household. From this open qualitative recall, the enumerator, with the assistance of the respondent, checked which food groups were consumed from a list of locally adapted food groups. The HDDS was constructed according to FAO recommendations by recompiling all the fooitems in 12 food groups and attributing 1 point for each group consumed in the previous 24 hours.

Dietary survey (24 hr recall)

Dietary data was obtained from the respondent through an oral questionnaire of diet survey. Multiple recalls were carried out with the help of trained enumerators. For this purpose, housewife or a member (respondent) who invariably cooks and serve food to the family members was asked about the types of food preparations made according to meal pattern during the previous 24 hours. An account of the raw ingredients used for each of the preparations was obtained. Information on the total cooked amount of each preparation was noted in terms of standard cups by weight/ volume. Manual calculation of nutrient intakes was carried out for each respondent with the help of food composition table developed by National Institute of Nutrition (NIN), India.

Statistical analysis

All the statistical analysis was drawn out by computerized statistical package MS Excel. Simple descriptive statistics was used by taking the sampling design into account. Clustered smooth column plots were drawn to graphically represent the relationship between each of the candidate indicators.

Results and Discussion

Socio-demographic characteristics of households

A total of 178 individuals were surveyed in eight selected villages covering 30 households. Most households comprised a male head of household with spouse, children and their parents. The particulars of households (Table1) revealed that adult population (>18 years) was maximum. Education level was good, 44.60% educated up to higher secondary and 11.2% graduate and others. Some 93% population belonged to Scheduled Tribe (group of disadvantaged people recognized in article 341 and 342 of the Constitution of India) that were *ladakhi* buddists and rest were primarily *Muslim* and others. According to the land size classification 58% were small, 35% medium and 7% large farmers in the area. As per the socio-economic criteria middle class was highest in the area.100% population was living in the compact settlement rather than scattered like in hot arid regions of India.

Multiple livelihood strategies were adopted (farming, non-agricultural work, livestock, other activities) by households. When the sources of income were analysed it was seen that the largest share of average annual income was

Table 1. General characteristics of sample population

Socio-economic characteristics	Category	Population (%)
Age	Under 5 yrs.	7.30
	5-18 yrs.	16.50
	>18 yrs.	76.20
Education	Illiterate	19.40
	Primary	24.80
	High school -intermediate	44.60
	Graduate and others	11.20
Caste	General	6.66
	Other backward caste (OBC)	-
	Scheduled caste (SC)	-
	Scheduled Tribe (ST)	93.10
Land holding size	Up to 3.5 ha	58.06
	3.51-7.00 ha	35.48
	> 7 ha	6.45
Type of settlement	Compact	100.00
	Scattered	-

obtained from non-agricultural work (3,64,000) followed by agriculture (60,400) and livestock (45,000).

Agriculture and nutritional system in Leh

The information related to agricultural practices, dietary and nutritional system was collected from the selected farm household. Only one crop was possible annually in Ladakh in the cropping season of April-October. The main crops were barley, wheat, pulses, vegetables, and fodder and fruit crops. Irrigation is mainly through channels from the melted glaciers. Indus river which originates from Mount Kailash in Tibet, and the tributaries of Indus, river Zanskar was major sources of irrigation resulting in the concentration of the majority of population settled in the valleys along these rivers. Agriculture in the past was the main occupation of the rural people of the Leh district in the 1970s as over 70% of the working force were then cultivators, which has been decreased due to development of tourism and other industries. According to 2001 census, only 37.92% of the working force now constitutes cultivators. Different crops grown by cultivators (Fig. 1) indicated that wheat was the major cereal crop taken by more than 70% of farmers. In fact, barley was the major food grain crop in the district earlier as revealed by group discussion with respondents and this has now been replaced by wheat. Pulses and some millets were also grown in the area. Lately, vegetable cultivation has gained importance and is now flourishing over there. More than 50% cultivators were producing different kinds of vegetables like tubers, green leafy vegetables, cruciferous vegetables, root stocks to meet requirements of defence forces as well as their own. Apple and Apricot are the major horticultural fruit crops. The other important crops are fodder, particularly Lucerne (Alfa-Alfa) which is primarily used for livestock purposes. As per the data provided by WFP & MSSRF (2008) Index of food insecurity in Leh district was found below 0.5 (level of insecurity range from 0 to 1; a higher index value represents a higher level of food insecurity), showing a better performance. In fact, the food availability was good primarily due to the high subsidy and public distribution system which provides cereals on a very low price in the area and not because of its own higher production which is a matter of concern for the policy makers. In the past, the economy was based on subsistence agriculture (main crops were barley, wheat, pulses, potatoes, apricots), livestock activities and self-reliant existence. In the past food-grain security in Leh was assured by local production of barley, wheat and, in small amounts, other millets. The population of Leh has doubled from 70,000 in 1981 to 1,45,000 in 2011 and tourism sector developed a lot during past decades increasing the demand over supply. To overcome this demand supply imbalance a large quantity of rice and flour wheat is being brought in from plains every year by traders, cooperatives and other agencies. These commodities are distributed, at subsidized prices or in some cases even free of charge, to the local population via the Public Distribution System (PDS). Thus, the traditional subsistence agrarian economy has been progressively and indirectly influenced by the emergence of changes in socio-economic dynamics with new off-farm income opportunities (Pelliciardi, 2010; 2013). Moreover, in the last few decades Leh district is no longer self-sufficient in food-grain, and a major quantity must be provided every year in order to fill the gap and feed the growing population which can be understood from the fact that the quantity of food grain

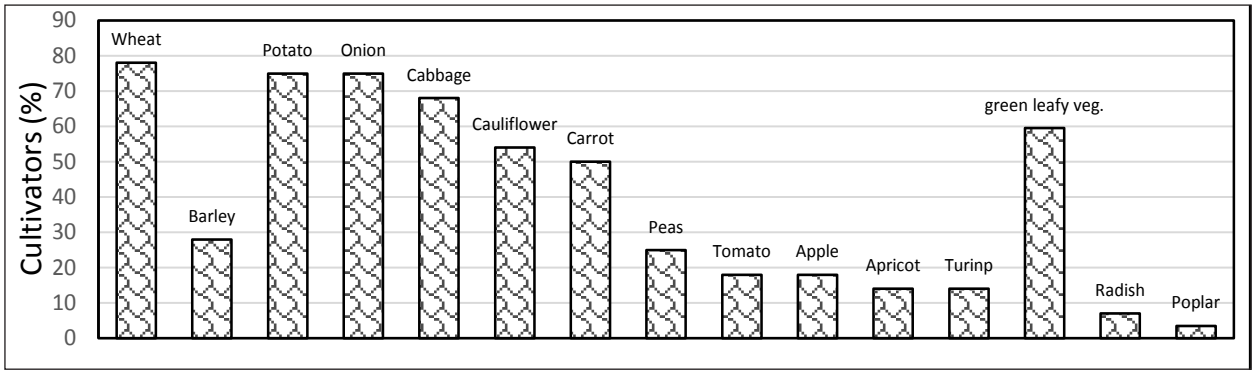

Fig. 1. Food and cash crops.

imported was about 56 tons 2000-01 and this reached up to 103 tons in 2009-10 (DESA, 2009).

Local diet: The caravan to nutrition

The overall composition of the *ladakhi* diet was different from the staples grown over there which was due to the supply of the subsidised food grain by different agencies. This subsidised food grains now make a staple of the household diets and it has also affected the food habits of people. There was a large difference between the earlier *ladakhi* diets comprising mostly barley grains and new eating habits, as in case of rice which was a luxury in earlier times is now a cheap staple subsidised by the government. This is in conformity with the findings of Dame (2009) and Nusser (2011) who also concluded that the new food habits have a marked seasonality with more consumption of imported subsidised wheat in summer and rice in winter along with persistent consumption of the locally produced cereals.

Household Dietary Diversity score was 7.86 which showed that dietary diversity was good in sample population and 7-8 food groups among the 12 standard food groups were included in the diet of households (Bamji *et al*., 2010). Dietary pattern of households was also evaluated. It was found that there was a clear differentiation in the dietary pattern of the households and they could be subdivided in to three groups based on their dietary habits; strictly vegetarians (6.8%), eggetarians (31.03%) and non-vegetarians (62.06%). The percentage of non-vegetarian population was quite high in the area. Eggetarians were primarily taking pulses and eggs but no consumption of meat was reported in this group of population while non-vegetarians were taking substantial amount of animal protein (meat, chicken and eggs) in their diet.

The consumption level of different food groups was also observed and it was found that percent intake was highest for cereals especially subsidised rice and flour wheat which made the largest portion of the local diet followed by tubers, cruciferous and leafy vegetables, milk and milk products, meat, chicken, pulses and eggs. Per capita availability of different foods varied (Fig. 2) and it was maximum for cereals (1103.30 g), followed by tubers and other vegetables (430.79 g), leafy vegetables (178.20 g), milk and milk products (131.36), meat/ chicken (106.24 g), pulses (48.29) and eggs (33.61 g). A comparison of dietary availability of different food groups in this study with their Indian standard of recommended allowances highlighted the trends of dietary availability and deficiencies, on the basis of which current interventions could be outlined. When the per capita availability was compared with the recommended amounts, the intake of pulses, fruits and milk group was found deficient in the sample population while substantial consumption of vegetables was recorded in the study area.

The results highlighted that in the current situations strategies are required to improve the production and availability of pulses and horticultural crops. Availability of milk and other milk products was significantly lower than the prescribed allowances (ICMR, 2009). There is a need to focus and strengthen the livestock component in Leh region. In the present situation Ladakh is highly dependent upon the assistance from the central government and especially the food grain availability is sufficient due to the provision of import of

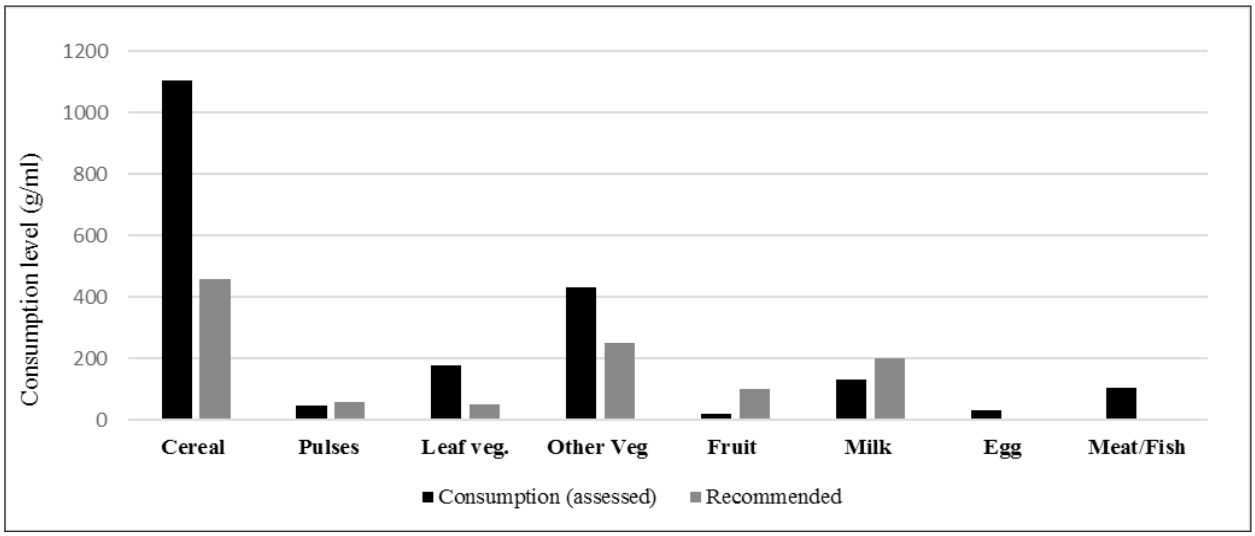

Fig. 2. Per capita availability of different foods in diet.

subsidised cereals. Agricultural interventions to meet out food demand and reduce externally brought supply and to make the region self-reliant should be the prioritized area of the long term developmental plans for the region.

Strategies for agricultural development and sustainable nutrition

This hill district has subsistence farming culture which was sufficient earlier to meet the needs of the limited population. Being a land locked territory with restricted level of resources and huge distances from capital markets, sources of off farm income have gradually increased because of tourism, migration and a growing trend of remittance economy in the region. Thus the traditional farming is loosing hold because of escalating costs, poor returns and alternatively available subsidized foods through PDS on one hand while on the other hand it has failed to meet the overall food and nutritional needs of people here. In order to meet this dual requirement, appropriate crop diversification strategies along with agricultural intensification emerge as a possible solution. This will also revive the land based economy and foster self-sustainable system of agriculture with technical inputs like high yielding varieties, quality seeds, suitable agro techniques, mixing of traditional crops with newer ones and moderate farm mechanization to compensate the labour shortage at farm. This will also reduce high dependency of Leh on imported food grain for food security of inhabitants. Though agriculture potential of hill soils are little less for the field crops yet it permits good scope for oleri-horti farming as well as high value agriculture given the fact that technology of storing glaciated water in tanks for its reuse during summer cropping is already proven and well established, and needs to be promoted. There is also a scope for brand equity for organic green produce which will harness the profitability of organic produce. Incentivizing young entrepreneur for processing and marketing will boost high value agriculture. Besides improving agricultural production in Leh, improved grain storage structure technology is crucial in view of climatic limitations that keeps it cut off for almost half of the year from rest of the country and at that time the stored grain becomes the prime source of nutrition for inhabitants. Proper grain storage is also essential to protect the food grain from spoilage in case of other climatic vagaries like huge snow fall or flooding etc. Versatile light weight movable grain storage structures may be of great help in such areas. Further, availability and consumption of milk group was low and that too brought from plains. On the other hand, large tracts of available native range lands being underutilized now could be scientifically managed to support livestock that could itself meet requirement of meat, milk besides providing handsome livelihood to pastoralists and help to revive the traditional pastoral economy. In addition to pastoral livestock sector, huge potential exists for development of organized dairy, meat and poultry industry. Dairy product availability is almost fifty per cent than recommended allowances in the selected population which

can be increased by revival of livestock sector and integrating it in the farming system perspective. Systematic processing technology of perishable agricultural and milk products will help fetch better prices.

Conclusions

Filling the gap between the required quantity to feed the growing population and the quantity locally produced can be a difficult task in this high altitude cold desert region. This study attempts to quantify the "needs" in order to know future directions in agri-livestock sector that will help to satisfy the local nutritional demands *vis-à-vis* agricultural situation. Although, the dietary availability of food grains and food energy supply was adequate in the study area but it was largely due to subsidized grains and public distribution system. Availability of different food groups such as pulses, fruits and milk and milk products was inadequate. Scope to increase the cultivable area under these crops is very low, almost negligible. The only option is to increase the production and productivity of agricultural crops and integration of cereals with horticultural and vegetable cultivation to revitalize the land based economy so to increase their availability. There is a need to introduce some leguminous crops as these are the main sources of proteins in the vegetarian population and their intake was below the recommended amounts. Fruit group was highly deficient in the diet thus, related measures are required to increase the production and productivity of horticultural crops and same may also help to increase the dietary availability. Consumption of milk and milk products was almost fifty per cent of the recommended allowances which can be increased significantly by the interventions mentioned. There is a need to incorporate appropriate measures for strengthening of livestock component. A look at current agricultural trends in Leh district would reveal that wheat and barley are the major cereal crops and there is high possibility of successful introduction of other cereal crops like finger millet and Maize. Finger millet is also a very important source of calcium and may significantly help in preventing calcium deficiency due to lack of the dairy products. Beet root can also be tried keeping in view its commercial value due to very high carotene content. Cow pea and other leguminous crops may also be tried keeping in view of their dietary deficiency. Crop diversification, horticulture and livestock intervention are therefore recommended for achieving self-reliance in dietary sufficiency and nutritional security.

References

Bamji, M.S., Krishnaswami, K., Brahmam, G.N.V. 2010. *Human Nutrition* : Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi pp. 322-342.

FAO 2007. Guidelines for Measuring Household and Individual Dietary Diversity, Version, Rome.

Dame, J. 2009. Barley and Potato Chips: New Actors in the Agricultural Production of Ladakh.

Gopalan, C., Sastri, B.V.R., Balasubramanian, S.C. 1985. *Nutritive Value of Indian Foods*. National Institute of Nutrition. Hyderabad.

Nüsser, M. 2011. Food security in high mountain regions: Agricultural production and the impact of food subsidies in Ladakh, Northern India. *Food Security*, 3, 179-1943.

Pelliciardi, V. 2010. Tourism traffic volumes in Leh district: An overview. International Association for Ladakh Studies, Ladakh Studies, 26: 14-23.

www.diragrikmr.nic.in/

Pelliciardi V. 2013. From self-sufficiency to dependence on imported food-grain in Leh District (Ladakh, Indian Trans-Himalaya). *European Journal of Sustainable Development*, 2, 3, 109-122.

http://leh.nic.in/pages/VISIONDOCUMENT.pdf