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From self-sufficiency to dependence on imported food-grain in Leh District (Ladakh, Indian Trans-Himalaya)

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Abstract
For many centuries the population of Ladakh (Indian Trans-Himalaya) has led a self-reliant existence mainly based upon subsistence agriculture (self-sufficient in food-grain production), pastoralism and caravan trade. Since several decades, Leh District, a part of Ladakh, whose population is doubled from about 70000 in 1981 to 145000 in 2011, is no more self-sufficient in food-grain production. To overcome the demand-supply imbalance a large quantity of rice and flour wheat is imported every year by traders, cooperatives and central government. However to be self-sufficient is an important issue for this land locked territory which has not trade restrictions but severe constraint in transportation. Importing goods to Ladakh necessitates the shipping of goods by truck across the Himalayas, with passes as high as 5300 m, covering the distance of Manali to Leh (480 km) or Srinagar to Leh (420 km) will takes about three days. By plain is only one hour of fly but cargo airfares are very costly.The stocking of the essential items, like food grains, in Ladakh, by the Jammu and Kashmir government, is an annual practice ahead of harsh winters which cuts off by road, for seven-height months, the twin districts of Leh and Kargil from the rest of the country. 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. Quantifying those "needs" helps developing policy and programmatic decision in regard to the local food security problem. In this study, the Leh District dependence on imported food-grain is investigated and results are presented as Import Dependency Ratio (IDR) in 2012 and the expected value in 2025.

Key Words: Food self-sufficiency; Import Dependency Ratio; Ladakh; Trans-Himalaya.

1. Introduction

During the period of 2006–08, about 839,4 million of undernourished people lived in developing countries and the majority of them, 567,8 millions, resided in Asia (FAO 2011). According to the "Report on the state of food insecurity in rural India" (WFP & MSSRF 2008), the nation is home to more than 230 million undernourished

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people (21% of the country population). In 1951/52[1], the grain production, mostly in the Gangetic plains, was around 52 million tons, and in 2001/02 production increased up to 212 million tons (Narwal *et al.* 2005), making India self-sufficient in food grain production, but self-sufficiency in production does not mean a food secure country for everybody. In fact, even if the demand for more and nutritious food has raised, as a consequence of the increasing of the per capita income (7.2% during 2007/08), it is relates only to the urban poor and middle-class, leaving the rural poor, who did not experience such a rapid growth of income, food insecure (DTE 2008); thus, food imbalance in India seems to be not in food production but in food economy. In the future, the projected demand in 2020 from the growing population will be about 307 million tons and the gap will be met only by putting more land under cultivation in addition to the actual 140 million hectares (DTE 2008) or by import.

The rural areas of Jammu & Kashmir State, to which Ladakh and Leh Districts belong, has recorded an Index of food insecurity 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, together with only three other states of the Indian Union, than the rest of the nation (WFP & MSSRF 2008). In Ladakh the traditional diet of barley and wheat has been the base of the nutritional system for centuries. Other items, non locally producible, like spices, sugar, tea and rice (latter, particularly expensive, was consumed only during special occasions), were imported trading goods from Tibet, central Asia, and Indian plain in caravans (Rizvi 1999). The mix of these diet components varied depending on the population considered, be it urban or rural, nomadic or sedentary, and budget. Moreover, the traditional farming system has been socio-eco-compatible, by recycling energy and matter using manure as fertilizer (Pelliciardi 2012a), by adopting suitable social mores, like fraternal polyandry, primogeniture inheritance, and monastic life for at least one family member (Rizvi 1983), to produce enough food-grain (self-sufficiency) in balance with the population size. Unlike the Kathmandu Valley in Nepal, until the introduction of maize in the 17th century and potato in the 18th century to complement rice, Ladakh does not seem to have suffered any serious famine (Dollfus *et al.* 2009). In the past, cereals surplus in Leh District was accumulated, as a buffer stock, in a granaries system inside the most influential monasteries (Handa 2004) and, in Leh town, inside the Basti Haveli government building (Kaul 1998).

After the Srinagar-Leh road was opened in 1962, the process of modernization became faster, and new lifestyles, practices and social mores have permeated the Ladakhi community against a backdrop of secular indigenous traditions and culture (Norbert-Hodge 1991). Since the Food & Supplies Department (later renamed Consumer Affair Department) came into existence in the 60s, and the Food-Grain Program was initiated, thousands quintals of rice and wheat flour (in addition to sugar and kerosene), produced in the plains of India, were imported every year in Leh District. 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, especially

[1] Fiscal year in India runs from April 1 to the next March 31.

in the urbanised area - e.g. employment in the civil administration or in the Indian Defence Forces stationed in Ladakh, as wage labourers or soldiers - (Manjula 2007), and, since 1974, by the work opportunities in the booming tourism industry (Pelliciardi 2010; Pelliciardi 2013). Nowadays Ladakh is a region in transition (from the land based traditional economy to off-farm new economy, modernization, globalization) characterized by population increase, general economic growth, consistent human development, raised in life expectancy, literacy rate, and GDP per capita (NHDR 2001). This process is also accompanied by environmental concerns, pollution (Dawa 2008, Humbert-Droz 2004) increasing reliance and dependence on Indian economy (imported goods, food, chemical fertilizers and fuel) (Pelliciardi 2012b) and socio-economic imbalance among the local population (Morup 2010).

Moreover, in the last few decades Leh district is no longer self-sufficient in food-grain, and a certain amount must be imported every year in order to fill the gap between the amount needed to feed the growing population and the local production. The "2025 Vision Document" (VD), a road map to local sustainable development prepared by the Leh district administration, stress that one of the main problems faced today by the local economy and the District administration is the excessive dependence on others: "*Ladakh is getting excessively reliant on the outside world for critical needs such as food*" (LAHDC-L 2005)[2]. Growing enough food for the increasing population is not easy in Leh District, a cold bare desert region high in the mountains of Jammu and Kashmir, India's most northern state, where farming is possible only from May to August.

The absolute quantity required of cereals (barley, wheat and rice) is related to the total population size but the relative quantity required of each cereal is related to the new food habits and diet preferences. For instance, rice, previously a luxury in the Ladakhi diet, has become now a cheap staple, subsidised by the government. According to Dame & Nüsser (2011), the new Ladakh food habits show a marked seasonality, with a persistent consumption of locally produced cereals and imported subsidized wheat flour during winter months, and an increasing consumption of subsidized imported rice in summer months, that coincide with the agricultural season. The annual deficit of food-grain, as a difference between the quantity required and the quantity available (locally produced), is imported via commercial traders, cooperatives and the Consumer Affair Department (CAD). During the past 10 years, the quantity of food-grain imported in this District by PDS has increased from about 56000 quintals, in 2000/01, up to 103000 quintals in 2009/10 (61000 rice + 42000 wheat flour called "atta"), catering for about 111800 souls through the 130 sale outlets (DSEA 2009).

This study, focussing on the minimum quantities of food-grain required to feed the District population and on the quantity locally produced , estimates the dependence from the imported food-grain calculating the IDR in 2012 and the expected value in 2025, according to a modified FAO procedure (FAO 2001).

[2] The VD reports a food requirement of 233160 quintals in 2004 estimated to rise up to 396412 quintals in 2025.

2. Area under study

Ladakh is a high cold desert region of Trans-Himalaya (northern India) semi-autonomous part of the Jammu & Kashmir State, divided into two districts: Leh in the central and eastern part (area: 45,110 km2; 147,104 inhabitants), largely Buddhist, and Kargil (area:14,036 km2; 143,346 inhabitants), predominantly Muslim, in the North-West.

Figure 1: Ladakh (outlined) is located between Great Himalaya and Karakorum ranges. Source: Humbert-Droz & Dawa Eds. 2004[3].

Geographically classified as "high cold desert" (altitude ranging from 2300 m to 7672 masl) it is located between Karakoram Range (north), Himalayan Range (South and West) and the Tibetan Plateau (East) bounded by Pakistan occupied Kashmir in the west, China in the northern and eastern part, and Lahaul & Spiti of Himachal Pradesh in the South-East (Negi 2002). Both districts are governed by their respective Ladakh Autonomous Hill Development Council. Population is rather scattered in almost all of the accessible areas with the exception of the cities of Leh and Kargil. Settlements are typically located around banks and terraces of major rivers and streams; the nomadic breeder communities live on the plateau, up to 4,500 m. above sea level. The Leh district economy was based on subsistence agriculture (main crops are barley, wheat, pulses, potatoes, apricots), livestock activities and self-reliant existence. Moreover, trading goods, in caravans, with Tibet, central Asia, and Indian plain contributed to the livelihoods. FAO (2008) classifies Ladakhi agriculture among the possible "Globally Important Agricultural Heritage Systems", defined as "*remarkable land use systems and*

[3] Note that the Permission from the Editor to use this figure has been received by email on 18/05/2011. (Humbert-Droz, B. & Dawa, S. (Ed.) (2004). *Biodiversity of Ladakh: Strategy and Action Plan*. Sampark, New Delhi).

landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development". Modernization governmental programmes, booming of the tourism sector, and the progressive openness to external resources (imported goods, food, fertilizer, fuel, and more), and globalization, characterize the development paths under way. However, these factors may also bring about unsustainable behaviour in the use of resources and land, and a loss of traditional knowledge and environmental wisdom. However, agriculture still remains the backbone of every village economy, engaging up to 70% of the working force as cultivators, agricultural labourers and breeders (LAHDC-L 2009). In the past, food-grain security was assured by local production of barley, wheat and, in small amounts, other millets. A dynamic balance between the population and the food-grain needs was granted by a deep linkage between the social mores, to maintain the size of productive household farms (e.g., polyandry, primogeniture inheritance, one of the family members involved in monastic life), and the farming system best practices (e.g., soil fertility management, nutrient recycling, crops rotation, community controlled irrigation, selection of short growing season seeds quality, and more). Public health implementation, household income diversification, general economic improvement, among other factors, have induced a population growth from around 40,000 people in 1951 up to around 145,000 in 2011 (a fourfold increase in only sixty years). The demand-supply imbalance between food-grain requirement and local production became a major concern for the local administration, which dreams of a regained self-sufficiency through an extensive land reclamation and irrigation project.

3. Methodology

An important aspect in analysing the food situation of a country, region or district (food system, food Security, food Self-Sufficiency), is knowing how much of the available food supply in the area has been imported from outside and how much comes from the local production[4]. According to FAO (2001:49), the Import Dependency Ratio (IDR), expressed in percentage, which answers this question, is defined as:

$$IDR_{FAO} = \frac{\text{imports (in mass)}}{\text{(local production + imports – exports) (in mass)}} \times 100 \qquad \text{[formula 1]}$$

Assumptions made in this study are: the quantities are calculated and expressed in quintals [q], instead tons (SI unit), because this is the unit used by the District administration and others stakeholders; the amount of food-grain exported from Leh District is 0.0 [q]; imports of food-grain are intended as the minimum quantity to be imported to fill the deficit in food-grain, latter calculated as difference between the required (R) and the available produced quantities (AP) identifies as the minimum amount that must be imported to satisfy the District needs (the numerator of formula 2). Thus the simplified FAO's formula is:

[4] In this study all these quantities are calculated and expressed in quintals [q], instead tons, because this is the unit used by the District administration.

$$IDR_{\text{this study}} = \frac{\text{imports (in mass)}}{\text{required (in mass)}} \times 100 \qquad \text{[formula 2]}$$

4. Data collection

An extensive review of literature was carried out regarding food production and consumption in Ladakh. Acquisition of data necessary to calculate the IDR has been carried out during a mission in the Leh District in May-June 2010 were major agencies involved in development planning where enquired and several stakeholders interviewed.

4.1 Required quantity of food-grain

The daily average energy consumption, for a normal life, is ensured by eating a mix of different food and beverages. According to Dev *et al.* (2004), in rural India the consumption of total cereals, in terms of quantity, is scaling down from 15.3 kg/month, in 1972/73, to 12.7 kg/month, in 1999/00.

In Ladakh, a sufficient daily energy from cereals was traditionally assumed by eating barley and wheat locally produced. Osmaston (1994) argues, after household investigation in Zangskar, that Ladakhis consume a minimum of 1600 kcal/day by eating local cereals. According to Darokhan (1999), the per capita average of food-grain quantity (aggregate of rice + wheat + barley) needed to support a normal quality of life in Ladakh is evaluated in 14 kg per month, equivalent to 1.68 quintals per capita per year [q/pc yr]. In this study the quantity of food-grain required (R) during one year has calculated multiplying the per capita requirement (R_{pc}) by the Leh District population in the concerning year, without difference in gender and age groups due to lack of specific data; this value is the denominator of the formula n° 2. Population for the 2012 and 2025 is estimated using data from the last two Indian Census Reports accounting a population of 117240 in 2001 and 147104 in 2011 with an annual growth of 2.3% (Census of India 2011).

4.2 Local production

The total area under barley and wheat in Leh District has remained almost constant during 2001-2008 (around 7,400 hectares); the fields under barley, decreased of 282 ha (-6%), is stabilized since 2004 around 4,452 ha, while fields under wheat, increased of 364 ha (+14%), is stabilized around 2,968 ha (SHB 2009). The quantity of food-grain produced (P) in Leh District is calculated multiplying the hectares under different crops by the corresponding average yield per hectare assuming a conservative average yields of 21.6 and 17.5 q/ha, respectively for barley and wheat, according to Agriculture Department data. These values are assumed constants also for the years 2012 and 2025 due to the fact that there aren't preview main changes in the area under cultivation and in

the crop yields[5]. The available quantity (AP) as food, defined as a difference of the quantity produced (P) and the quantity of seeds for sowing (S) plus the quantity lost during mill processing (extraction rate of 85% (FAO 2001: 45)). The amount of seeds to be subtracted to the total production is calculated by multiplying the total area under crop by the averaged sowing rate. The Agriculture Department[6] suggest an averaged value of 400 kg/ha as sowing rate valid for local varieties of barley and wheat seeds. Moreover, the quantity of barley used to make chang (a mild local beer) is not computed due to a lack of reliable data.

5. Results

The requirement of food-grain (R), total production (P) and available quantity produced (AP) in the 2012 and in 2025 are calculated below:

$R_{2012} = R_{pc}$ [q/pc] x District population$_{2012}$ [pc] = 1,68 x 150480 = 252806 [q]

$R_{2025} = R_{pc}$ [q/pc] x District population$_{2025}$ [pc] = 1,68 x 202110 = 339545 [q]

$P_{2012\text{-}2025} = P_{barley} + P_{wheat} = \sum$ (area under crop [ha] x local average yield [q/ha])
= (4452 x 21.6) + (2,968 x 17.5) = 96163 + 51940 = 148103 [q]

AP = P – S – 15% (P – S) = 0.85 (P – S) = 0.85 (148103- (4 x 7420)) = 0.85 (148103-29680)
= 0,85 x 118423 = 100660 [q]

District's food-grain requirement in 2012 has been estimated in 252806 quintals which will rise up to 339545 quintals (+34.3%) in 2025. The quantity of barley and wheat produced and the quantity available are 148103 [q] and 100660 [q] respectively, both considered constant along the period under investigation. The imports (deficit) calculated are equal to152096 quintals in 2012 which gives an IDR of 60.2% that will increase up to 238885 quintals in 2025 corresponding to an IDR of 70.3%.

6. Discussion

The Leh District traditional agricultural practices, integrated with livestock husbandry, have followed, since several centuries, an eco-compatible way to produce enough food-grain in balance with the population. Population growth, insufficient fertile area under grain crops, crop yields, land use change, new food habits, off-farm income opportunities and national policies (food-grain at subsidized price) are the actual main limiting factors that influence the food-grain dependence from outside.

[5] Blocks wise basic data for the District 2007/08, Agriculture Department unpublished photocopies

[6] Interview with official at Chief Agriculture Office, Leh, May 2010.

In 2011, District population was147104 inhabitants double of the population in 1981 (Census 2011). The decadal percentage of growth, after an increasing from 8% in the 1951-1961 to 32% during 1971- 1981, is now declining to 26% in 2001-11. Density is 1442 persons per km^2 referred to agricultural area of only 102 km^{2}allowing a mere 0.07 ha of productive land per capita (LAHDC-L 2009). Therefore, the dependence on imported food-grain will increase, year after year, unless the local food-grain production is drastically boosted (or hypothetically the population reduced).

The performance of Ladakh agriculture is still under debate. Crop yield varies in function of several factors: seasonality, location, altitude, geomorphology, orientation, sowing rates, quantity of manure utilized, soil fertility, water availability and farmer knowledge and experience, among others. According to Osmaston (1994), many misconceptions exist on the Ladakh traditional farming system, which is reputed by some Indian scientists (Singh 1992; Kaul 1998; ICIMOD 1999) and Government officials as backward, unproductive, and characterized by very low yields. "*The harsh environment and apparently simple subsistence agriculture in Zanskar have led most visitors and government officials to assume that the local crops are rather unproductive*" (Osmaston 1994). However, Demenge (2007) states that, in spite of harsh climatic conditions, Ladakhis has managed to develop a remarkably productive agricultural system, using manure as fertilizer, with yields often comparable to, and even outcompeting, those of European intensive regimes. The 2008 average yields in Leh district for barley and wheat, reported by the Agriculture Department in Leh on unpublished photocopies, are respectively 21.3 and 17.5 q/ha, while yields for the same products, measured or recorded by some independent international scholars and researchers, in different sites, villages or fields in Ladakh, are higher. A conservative aggregate average of 30 q/ha is accounted for Zanskar valley (Osmaston 1994)[7] and 52.8 q/ha in Padum village (Mankelow 1999) both in Kargil district. In Khaltsi block of Leh district an average of 32 q/ha is reported for the Trans-Singe La villages, and 26 q/ha in Alchi and Saspool villages (Demenge 2007). In Hemis Shupkachan village, during 2010, in a case study of small family managed farm, a yield of 24.7 q/ha for barley and wheat is recorded (Pelliciardi 2012a). All these values can be compared with cereal yield in India which, in 2000, was around 23.4 q/ha (FAO 2009), in India and Jammu & Kashmir State, from 2001-02 to 2005-06, were for barley 20.1 and 6.4 q/ha and for wheat 26.7 and 16.9 q/ha respectively (DAC 2006).

The total area sown in the District has been evaluated around 10599 ha (LAHDC 2009); some authors argue that the theoretical increase of cultivable land could be estimated to a maximum of 1% of all the administrative territory allowing a possible arable land for cultivations up to 45110 hectares (Osmaston 1994; Demenge 2007). Nonetheless the area under barley and wheat has remained almost the same in the last years around 7420 hectares. Assuming an aggregate yield for barley and wheat of 20 quintals per hectare (using the conservative data given by the local Agriculture Department, see note 4) it is possible to calculate the increment, in hectares, of new cultivated land to reach an IDR of 0% (self-sufficiency) without considering the new

[7] Yields estimated in Zanskar valley by Osmaston (1994) ranging from 20 to 110 q/ha (latter for the best fields).

food habits and preference[8]. Value is calculate dividing the required quantity of grain by the average yield and subtracting the existent area under crops. For the year 2025, without taking into consideration the quantities for sowing or grinding loss, calculation[9] leads to adding an area of 9557 ha to the current cropped area with an increment of 129%. In case considering a rise to 30 q/ha by integrating traditional farming system (e.g. using manure for fertilization, animal for ploughing, and more) with more modern farming system, without losing the remarkable land use systems and landscapes rich in globally significant biological diversity, the increment, in new land under barley and wheat cultivation, has been calculated of only 53%[10].

Due to the geomorphology conditions of "high cold desert" these objective seems a difficult target to reach in the District. Increasing the area under crop is, in fact, a difficult task to achieve without major irrigation works, that requiring huge investments. In the last few decades, the Ladakh Desert Development Programme (DDP) has undertaken the maintenance and repair of traditional canals and others irrigation works including the Igoo-Phey canal in Leh district. Started in 1979, this 43.1 km long canal, whose intake from Indus is near the Igoo hamlet, is still under construction aiming to irrigate approximately 7800 ha in the lateral uncultivated expanse on the banks of the river Indus near Leh (4688 ha in the Command Area and 3143 ha under the Desert Development Programme) (ICIMOD 1999). Public interest in this hydraulic work is strong, but at present only 1600 ha of the 7800 previous are serviced by canals; 387 ha are allocated to government farms, and the rest to nearby villages that provide plots of about half-a-hectare to farmers, although bureaucratic and technical obstacles still need to be overcome (Nüsser *et al.* 2012). Instead, leasing the area to local entrepreneurs to set up mechanised, commercial-scale operations may make the biggest dent in reducing Leh District massive food dependency. Moreover, these new eating habits, powered by imported rice and wheat flour at subsidized price, discourage local farmers to increase grain production and stress to shift to cash crop cultivations which products are sold to Defence Forces that stationed in Ladakh or exported to other Indian states. In spite of the protein and energy content in barley is 11.5% and 3360 kcal/kg compared to a generally around 5% and 1750 kcal/kg in rice (Gopalan *et al.* 1985), and according to Dev *et al.* (2004), in rural India the consumption of the so-called superior cereals, rice and wheat, is increased. This behaviour could be interpreted as a liberation from the atavic mountain poverty which is popularly considered overcome by eating the same food (rice and wheat flour) consumed in the richest plains of India (Reifenberg 1998). It is interesting what The Himalayan Times, a Nepali newspaper, reports: "*People of Dailekh district* [hill area in Western Nepal Region] *prefer white maize* [produced in the plain], *which is not so nutritious, to highly nutritious yellow maize* [locally produced], *because these people believe that*

[8] Paradoxically, if people prefers to eat only rice, which can't be produced in the District, and disdain the traditional grains, the dependence on imported food-grain will be 100% for any population size and any technical, economic and agrarian policies adopted to boost production and for whatever agricultural yields and hectares put under cultivation.

[9] 339545 [q] / 20 [q / ha] = 16977 [ha]; 16977 [ha] – 7420 [ha] = 9557 [ha]

[10] 339545 [q] / 30 [q / ha] = 11318 [ha]; 11318 [ha] – 7420 [ha] = 3898 [ha]; calculation without taking into consideration the quantities for sowing or grinding loss.

the [urban] *high-class partakes on white maize*" (Kokila 2007). According Chandrasekhar & Bhaduri (2005), in the past rice was a symbol of social prestige, mainly due to its past scarcity: "*However, while the so-called status good characteristics may explain the initial switch from barley to rice they do not explain the sustained consumption of rice once the access to rice was economised through governmental supply mechanisms*".

Conclusions

According to Thomson & Metz (1998), the concepts of food self-sufficiency and food security differ: while food self-sufficiency is linked to an overall perspective on self-reliance development, i.e. an auto-centric approach, food security takes into account commercial imports, international specialisation, comparative advantage and food aid as possible sources of commodity supply. The food self-sufficiency of a nation/region/district occurs when are satisfied the food needs from its own domestic production; therefore, to increase a country's food security level it is necessary to increase its level of self-sufficiency, having more control over its food supply in order to avoid dependence on international food markets.

Supported by national and local government policies, while income in kind, i.e. subsistence food-grain production in Ladakh, is more likely to be used for family consumption than cash income. Modifications over the past three decades of the land-use system in Leh District has also reflected the changing in household strategies and local dietary habits. Moreover, subsidised rice supplied through the Public Distribution System is increasingly replacing locally grown barley as the main staple of the summer diet (Dame & Nüsser 2011).

How this subsidized price policies could stimulate local grain production, if government ask for food grain from the state allocation food reserves through the Food Corporation of India and merchants are importing large quantities of inexpensive wheat and barley grown on huge mechanized farms owned by multinational corporations? Even after being transported long distances, the barley and wheat are sold for much less money than that grown in Ladakh.

These factors discourage farmers to intensify their local grain production and stress the diversification of agricultural production toward cash crops by exploiting the so called "niche advantages" (Jodha 1990), since one of the District specificity is the relatively good climate in summer. In particular, horticulture (vegetable and fruit) production to improve nutrition but also to cater the Defence forces (Sabharwal & Singh 2005), potatoes to be sold to a national food corporation for chips production (Dame 2009), and flower production for export to Indian towns in the plain (DIHAR 2008) .To reduce the dependence from imported food-grain different strategies have been implemented by local and central administrations – i.e. reviving people's interest in land based economy; building human resources among the local population; promoting land based entrepreneurs to make agro-pastoral livelihoods more remunerative; improving the area under crops and the quantity produced in existing fields; organising a sustained marketing initiative; encouraging a mix of agricultural innovations and traditional methods (LAHDC-Leh 2005). Furthermore, infrastructures (e.g., irrigation canal projects

to divert water from the main rivers, hydraulic ram pumps, artificial glaciers, and more) and integration of the old knowledge with the new scientific practices (e.g., suitable local seeds and High Yielding Varieties, the use of the organic manure side by side with a prudent use of chemical fertilizer, the implementation of a moderate mechanization to compensate the lack of manpower in rural areas) are necessary to increase the local production of wheat and barley by improving crop yields and augmenting irrigated lands (LAHDC-Leh 2005). Therefore, more attention should be paid to the local anthropic dynamic between greater integration and dependence on the Indian economy.

Taking account of all the factors influencing the food system in Leh District, this study has evaluated the dependence on imported food-grain calculating the IDR in 2012, 60,2% which is expected to rise up to 70,3% by 2025. In the future, in the District, the supply of required food grain will be probably assured with a mix of local produced and imported food grain, but the ratio between the two quantities will depend on the evolution of the driving factors of the local food system highly influenced by the new, and probably irreversible, food preferences.

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