



Review Article

Developing Evidence Based Policy and Programmes in Mountainous Specific Agriculture in Gilgit-Baltistan and Chitral Regions of Pakistan

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Abstract | The article is based on a detailed review of literature, and synthesis of information amassed from various published sources. Moreover, salient outcomes of a multi-stakeholder discussion on mountain specific innovative solutions for potential up-scaling in Pakistan have also been highlighted to cover the opinion of technical experts. The data presented herein is important for development of evidence based policy and designing development projects in agriculture and related sub-sectors in Gilgit-Baltistan and Chitral regions of Pakistan. The regions are unique in topographical and agricultural perspective from other areas of the country. Cultivated area is just 0.57% of the geographical area. Operational per capita land holding in the region is just 0.05 ha (less than 500 m²) which is insufficient to produce sufficient amount of food to feed a person throughout the year. The arable land in the region is 1.37% of the geographical area. Thus, production base of the region can be almost doubled by bringing it under cultivation. It is possible through supporting rural communities in use of light to medium type of machinery, adoption of innovative technologies to harvest and use water, use of recommended agricultural production technologies, and through development of related infrastructure. It would require strenuous medium to long term efforts and substantial investments. Similarly, forest land with wood and non-wood products and grazing pastures along with farming and tourism related activities have good potential to fulfill livelihood needs of the people along with farming and tourism related activities. Public and private sector initiatives to improve agricultural resource base of the area have also been identified in the article.

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Introduction

Gilgit-Baltistan and Chitral (GBC) regions possess diverse types of natural resources. The region has majestic mountain ranges of Himalayas,

Karakorams and Hindu Kush with; snow covered peaks and glaciers, which is basis of water supplies, precious minerals and gyms, range lands and forest cover. The diverse climate of the regions are suitable for cultivation of a number of crops, fruits, nuts,

pinus, medicinal plants and condiments; as well as the rearing of different kinds of livestock species, fisheries and poultry. The Gilgit-Baltistan and Chitral regions lie in the extreme north of Pakistan. The region has border with Xinjiang province of China in the North-East, with Afghanistan in the North-West, with disputed territory of Jammu and Kashmir in the South-East. Gilgit town the capital of Gilgit-Baltistan (GB) is located at distance of about 500 km from Islamabad and lies at a height of 1500 meter above sea level (MASL). Chitral town, the capital town of Chitral district of Khyber Pakhtunkhwa province, is at a distance of approximately 425 km from Islamabad and lies at height of 1493 MASL (Kreutzmann, 2015; Zain, 2010). The Princely state of Gilgit (comprised of GB region, previously called Northern Areas) joined Pakistan on 1st November, 1948 (IUCN, 2004). Chitral retained its status as a 'princely state' (independent autocracy) till 28th July 1969, when the power was handed over to government of Pakistan and it became the northern most district of Khyber Paktunkhwa province, earlier called North-West Frontier Province (Cutherell, 2011).

The GB regions is comprised of three administrative divisions viz. Gilgit, Diamer and Baltistan. Gilgit division is comprised of Gilgit, Ghizer, Hunza and Nagar districts, Diamer division contains Diamer and Astore districts, and Baltistan division consists of Skardu, Shigar, Ghanche and Kharmang districts

(GoGB and UNICEF, 2017). Chitral division of Khyber Paktunkhwa province is divided into two sub divisions viz. Chitral and Mastuj (GoNWFP and IUCN, 2004). The GBC region has a tough terrain and frequent road blockages occur, which generally last for few hours to even weeks to get cleared (Kreutzmann, 2004). It takes about 12-14 hours to travel from Islamabad to Gilgit and 10-12 hours to Chitral by road. With the passage of time road infrastructure in the region, specifically in GB area has been much improved due to construction of CPEC. A few years back, hanging bridges which were connecting the region with rest of the country and China have now been replaced with concrete structures. There is an improvement in accessibility to far-flung areas of the region due to construction of shingle and standard metaled roads. Road density in the GB region is 8.85 Km/100 Km² (GoGB, 2020). Geographical areas of Gilgit Baltistan and Chitral regions of Pakistan are 7.24 and 1.49 million hectares, respectively. Thus, total area of the GBC region is 8.73 million hectares, which is 11.0% of total geographic area of Pakistan (Table 1).

In Pakistan, 61.0% geographical area is mountainous (GoP, 2018) which accommodates nearly 50 million people, about 24% of the country's population (GoP, 2017). Range land, conifer forest cover and area under ice and snow (waste land) are the main features of landscape of the GBC region and collectively cover 6.687 million hectares (Table 1), 8.4% of total

Table 1: Geographic and socioeconomic features of GBC region.

	Gilgit-Baltistan	Chitral	GBC Region	Pakistan	Share/status in Pakistan
Geographic Area (million hectare)	7.24	1.49	8.73	79.61	11.00%
Population (million number)	1.49	0.45	1.94	211.17	0.92%
Number of Households	0.19	0.06	0.25	31.52	0.79%
Average Household Size	7.59	7.90	7.66	6.70	-
Population Density (number/ km ²)	20.58	30.20	22.22	265.26	11.94 time lower
Cultivated Area (million hectare)	0.040(0.55)*	0.022(1.48%)	0.062(0.71%)	17.25(21.20%)	0.48%
Average Land Holdings per HH (ha) by agricultural land reporting households	0.48	0.40	0.46	2.09	22.00%
Average Land Holdings per capita in farming households (ha)	0.03	0.05	0.04	0.31	7.75 time lower
Arable Land (%)	1.60	0.26	1.37	38.2	36.83 lower
Uncultivated (%)	50	2.0	41.8	28.8	13.0 higher
Forest Area (million hectare)	0.646(9.0%)	0.042(2.8%)	0.688(7.9%)	4.55(5.71%)	15.10
Forest Area per HH (per capita)	2.62 ha(6.72k)	0.68(1.84k)	2.23(5.8k)	0.15h(0.44)	13 time higher
Range Lands (million hectare)	1.63	0.92	2.55	47.77	5.30

Source: GoP, 2021, GoGB, 2020 and GoKP, 2018. *% of geographical area.

geographical area of the country (GoKP, 2018; GoGB, 2013). Total area of land with similar features in other parts of the country is 55.329 million hectares, 69.5% of total geographical area (Khan, 2012), thus these land types in GBC roughly form 11.00% of total land scape with similar features in the country. The GBC regions has very diverse culture. There are five religious sects in the GBC region viz. Sunni and Ismaili (in both GB and Chitral), Shia Imami and small communities of Noorbakshi in Baltistan region, and polytheistic religion of Kalash in Chitral region (Sökefeld, 2014). These four denominations of Islam Shia Imami, Sunni, Ismaili, Noorbakshi share 39, 27, 18 and 16 percent in population of Gilgit-Baltistan. Thus, Gilgit-Baltistan is the only Shia-majority region in the Sunni-majority country of Pakistan (Hunzai, 2013).

Five main native languages viz. Shina, Balti, Brushuski, Khovar and Wakhi are spoken in GB region in 36 dialects. Pashtu, Hindko, Gujri and Punjabi are other languages mainly spoken by migrants from other areas of the country into GB region (Sökefeld, 2014). Khovar is the main language of Chitral region; however, six other languages are also spoken in this region viz. Warshikwar (in Upper Chitral: Warshigum and Yaseen Areas), Dangarik in Ashuret, Kalkatak and Buri), Narsatwar (in Arandu), Damariwar (in Domel), Kalashwar (in Kalashgum) and Persian (in some parts of Madaklasht and Broghil), (GoKP and IUCN, 2014).

Along with religious festivals, many other events are celebrated in the GBC region including Nowroze (Persian New Year). At the eve of Nowroze, free style polo tournament, poetry and other literacy activities are organized. Similarly, Shandur Polo Festival is organized from 7th to 9th July every year in Shandur Pass at the border of GB and Chitral. This pass lies at 3738 MASL, and is the highest polo ground in the world. Qaqlasht festival, Jashn-e-Chitral, Boroghol and Kalash festival are other main cultural events of Chitral region. The article is organized in three sections; (1) Socioeconomic features of the population and access to amenities of life, (2) Status of agriculture sector in the GBC region, and (3) Innovative technologies and opportunities in the agriculture sector.

Socioeconomic features

The human population in Gilgit-Baltistan and

Chitral regions are 1.49 and 0.45 million, respectively (UNPO, 2017; Burki, 2015; GoP, 2017). Thus, GBC region has human population of 1.94 million which is 0.92% of national population. In GBC region, percentage share of urban and rural population is 16.5 and 83.5, respectively. Total number of households in GBC region are 0.25 million, out of this 0.19 million (76%) are in Gilgit Baltistan and 0.06 million (24%) are in Chitral region (Table 1). Mean household size in the region is 7.66 (GoKP, 2018), against an average HH size of 6.70 persons in the country (GoP, 2021). Population density in the regions is about 12 times less than in the country, 22 persons per km² against 265 persons per km² in the country. Population densities in GB and Chitral regions are 21 and 30 persons per km², respectively. Major pillars of region's economy are tourism, crop, horticultural and livestock farming. Livestock has always been more important than arable farming at higher elevations. Remittances, small business, wage labour, tourism, and collection of non-wood forest products viz. medicinal plants, mushrooms, spices and other herbs also contribute to livelihoods and food security. The cultivated area in GBC region is 0.062 million hectares (0.71% of total geographical area of the region), which is 0.48% of cultivated area in the country (GoGB, 2020; GoKP and IUCN, 2004; Rasul et al., 2014).

Natural beauty, tourism and related activities

Tourism brought a huge amount of revenue to local economy of the GBC region. In the GB region alone more than one million tourists visit the area annually. In year 2019, domestic and foreign tourist inflow in GB regions was 1.02 million (97.8%) and 22,780 (2.2%), respectively. Overtime, the influx of tourists has increased in the area, as average annual flow of tourists in GB region from 2011-15 was just 82,840. Thus, an increase of 11.6 times has occurred from average inflow from 2011-2015 to that of 2019. The peak tourism season in the region is from June to September, as 67.1 percent tourists visit the area in these months. It is estimated that the GB region has potential to generate local business worth Rs. 1 billion each year, if tourism related facilities are ensured. The tourism influx in Gilgit-Baltistan in the days to come can further improve through the establishment of tourist facilitation centers at all entry points of GB, development of Rest Areas for tourists along KKH and of interest-free/ subsidized loaning to private sector for development of hotels and motels. The GB has very much to offer in four seasons with the highest

plateaus including Deosai Plains (4114 m ASL), Sadpara Lake in Skardu, cultural sites including Altit and Baltit forts in Hunza, Shigar Fort and Khaplu Fort in Baltistan, waterfalls of Skardu region, ancient rock art carvings and inscriptions along KKH in Diamer district, lush green meadows and lakes in Ghizer district and Astore, Rakaposhi, Nanga Parbat, Diran Peak and Hopper glacier in Nagar, rich culture, and the fresh and dry fruits and hospitality of Hunza that attract tourists to the area (GoGB, 2021).

The GB is a living museum. It harbours rich diversity of flora and fauna including 230 species of birds, 54 species of mammals, 23 species of reptiles, 20 species of fish and 6 species of amphibians; mostly rare, endangered and endemic to Karakoram-Himalaya-Hindu Kush highlands. The government has established a network of 19 Protected Areas and 26 Community Managed Conservation Areas (CMCA) covering about 28 percent of the total area to protect and manage the precious wild resources of the area (Business Recorder, 2017). The world's most famous mountain ranges viz. the Himalayas, Karakorum and Hindukush lie in the region. It also holds Karakorum-2 (K2) world's second highest peak (8,611 meter ASL). Five peaks are over 8000 meters ASL and 101 peaks over 7000 meters ASL lie in the region. There are 5100 glaciers, 119 lakes, 4 national parks, 23 historical forts, 65 archeological sites in the GB region (GoGB, 2021).

Mountain climbing, hiking, trekking and para gliding are the activities which attract tourist from all over the globe. In this regard, Nazir Sabir and Smina Baig from Hunza valley, Hassan Sadpara from Sadpara village-Skardu and Muhammad Ali Sadpara from Skardu are three big names. Nazir Sabir was born in Ramanji a small hamlet in Chiporsun, upper Hunza in year 1955. He is the first Pakistani man who climbed Mount Everest (8,848 metres ASL) in year 2000 (Dawn, 2021). Hassan Sadpara is the first Pakistani to have climbed six eight-thousanders including the world's highest peak Everest (The News, 2016). Muhammad Ali Sadpara successfully climbed all eight-thousanders throughout his career (Ali et al., 2021). Samina Baig was born in village of Shimshal, in Hunza region in year 1990. She climbed Mount Everest in 2013 and then all Seven Summits by 2014. She obtained his early mountain climbing training from his brother Mirza Ali Baig, who worked as porter and expedition organizer in his early carrier

and then became a mountaineer, photographer, and social worker (Dawn, 2014).

Nongovernment organizations and development programs

A large number of NGOs are working both in GB and Chitral regions. In GB region alone the number of NGOs was around 1200 in year 2015. Provincial government in Gilgit and Baltistan regions canceled registration of 320 and 220 NGOs, respectively in year 2015 and 2016 due to non-submission of audited reports since 2008. Thus, number of NGOs was reduced by almost half to 660 in year 2016. Notable NGOs working in the GB regions are Agha Khan Rural Support Program (AKRSP) with its health, cultural and education services, World Wide Fund for Nature Conservation-Pakistan (WWF-P), Hashoo Foundation and Pakistan Red Crescent Society (PRCS) etc. (Nation, 2016). Similarly, notable NGOs working Chitral region include AKRSP, Sarhad Rural Support Program (SRSP), Terich Area Development Organization (TADO), Nasir Iqbal Memorial and Welfare Organization, and Young Star Development Organization (YSDO), (PCDC, 2012; PPAF, 2015).

Remarkable development programs in GB region include the IFAD sponsored Northern Area Development Program/ NADP (1998-2009) with an objective to reduce poverty through community participation. The Diamir Poverty Alleviation Program (DPAP) a successor institution of IFAD-funded NADP was established through joint financing of Government of Pakistan and IFAD with an objective to engage existing social mobilization and local development entities. DPAP inherited over 2000 male and female community organizations (COs) established under NADP (IFAD, 2015; PESA, 2012). Similarly, IFAD launched a seven-year irrigation sector project named Economic Transformation Initiative in GB in 2015. The objective of the project was to increase agricultural land, income and employment. The approach has been to organize producers' groups for value chain development of high value crops, to increase agricultural production and to introduce high value crops i.e. fruits, vegetables, potato and milk through development of irrigation and other agricultural schemes. The project has sought to link farmers to local markets through fully funding the development of rural roads. Similarly, the project is facilitating the provision of certified training in construction and other employable traits

(GoGB and IFAD, 2021). Chitral Integrated Area Development Program (CIADP), Integrated Chitral Development Program (ICDP), Creative Approaches Development (CAD), Broz Integrated Development Program (BIDP) and Chitral Area Development Project (CADP) are noteworthy development programs launched in Chitral region (PPAF, 2015; PCDC, 2012).

Peoples access to amenities of life, literacy and poverty

In GBC regions, majority of households use mud bricks or mud in walls. In Chitral region, 53 percent and 84 percent rural and urban houses have adequate walls, respectively. While, in Gilgit-Baltistan region, 79 and 97 percent rural and urban houses have satisfactory walls. Population in the regions is using improved sanitation facilities. In GBC region almost all the household have electricity, with availability in 98 percent and 96 percent of houses in GB and Chitral, respectively (GoGB and UNICEF, 2017; PPAF, 2015). The regions are supplied with fuel at subsidized rates. In the region, literacy rate in men and women population is 63 percent and 38 percent, respectively (Figure 1). This is less than national literacy rates in men and women by 7 and 10 percent, respectively. The highest literacy level in the region in females is in Hunza district and the lowest is in Diamer district (GoGB and UNICEF, 2017; GoKP, 2018). The reason is better access to educational facilities in Hunza district and community's better exposure to outer world due to high out migration of males, high tourist inflow and support provided by AKRSP in development of community through provision of educational opportunities and services. While, in Diamer district people have quite limited exposure to outer world, and are still quite conservative. People in Ghizer, Gilgit and Nagar districts have quite high literacy and similar literacy levels in both men and women across districts. These are followed by Astore, Kharmang, Skardu and Chitral districts with quite similar literacy levels by gender across districts. Similarly, Ghanche and Shiger districts are almost at par in literacy figures, with quite low literacy levels in the region. Literacy level in these districts is also less than national average of 62.3 percent. Literacy level details by districts in the region are presented in Figure 1 (GoGB and UNICEF, 2017; GoKP, 2018; GoP, 2021).

According to Multiple Indicator Cluster Survey (MICS) 2016-17, based on short consumption

modules about one-third of the population (35%) in GB is multi-dimensionally poor, 16.9% and 38.5% in urban and rural areas, respectively. The poverty is the highest in Diamir division (64.2%), followed by Baltistan division (33.7%), and Gilgit (14.6%) division. The poverty is the lowest in Hunza district (2%) with the highest number in Diamir district (74%), followed by Shiger (47.2), Skardu (36.1), Astore (35%), Kharmang (34%), Ghanche (24%), Gilgit (17%), Nagar (15.2%) and Ghizer (14.3%) districts. Socioeconomic backwardness and distant locations having difficult typography are reasons of high poverty (GoGB and UNICEF, 2017; PPAF, 2015). In GB region poverty is low in Gilgit region than Baltistan and Diamer regions, within regions it is low in districts which are open to tourism, have more productive lands, and comparatively lengthy cropping seasons. Gilgit regions is hub for transportation and other economic activities, as Gilgit, Hunza and Skardu are main tourist destinations. Diamer is socioeconomically more backward than other regions and it is not visited by common tourists. Chitral is among the districts having comparatively low incidence of poverty in Khyber Pakhtunkwa province, with a poverty headcount of 25.93% (GoP, 2020).

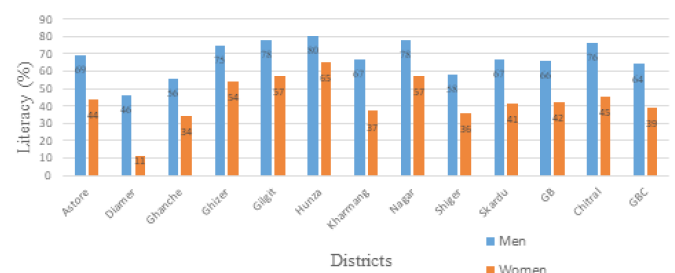


Figure 1: Literacy levels in Gilgit Baltistan and Chitral regions.

The GBC region is particularly deficient in the production of cereals and pulses, which contribute 50-60 percent of the average human calorie intake. That's why subsidized wheat is supplied in GB regions by the government of Pakistan which is procured from plain areas of the country. The proportion of the population that is food insecure is also higher in the region than in the plains, with more than half food insecure population (ICIMOD, 2014). Food security situation in GB is worse compared to other regions of the country. Similarly, a higher percentage of household reporting food consumption below average recommended levels are found in GB (68%) against 40.0% at national level. Prevalence of Undernourishment (PoU) is the highest in GB (51%) against 18.0% at national level. The percentage

of households with total consumption of proteins below total household's requirement is also high; 15% against 8% at national level (WFP, 2017).

Agriculture sector in GBC region

In the GBC region, most of the households in both rural and urban areas own agricultural land as well as farm animals/livestock e.g. in urban areas of GB region alone 71.7 and 64.1 percent of households have agricultural land and livestock, respectively. Similarly, in rural areas 90.5 and 91.4 percent households have agricultural land and livestock, respectively (GoGB and UNICEF, 2017). In the GB region, 90 percent households are engaged in subsistence agriculture (GoGB and IFAD, 2021). However, agricultural production in the region is insufficient to fulfill local food demand. Thus, male out-migration is high, 41% in GB due to which women play major role in agriculture. Average operational land holding per household in the GBC region (0.48 hectare) is about four times smaller than in the country (2.09 hectare). Per capita land in the regions is just 0.04 hectare (less than one kanal), which is insufficient to fulfil food requirements of the people. Arable land in the regions is 1.37% of the geographical area in the region, with sub regional availability of 1.60% in GB and 0.26% in Chitral regions. Arable land can be brought under cultivation with strenuous long term efforts through substantial investment in human as well as mechanical resources. Thus, production base of the region can be doubled by bringing arable land under cultivation and investing in training and capacity building of extension workers and farmers. Uncultivated area in the GBC region is 41.8% mainly due to mountains, rivers and streams. While, uncultivated area in the country is 28.8%, thus land that cannot be brought under cultivation in the region is 13.0% higher than at the national level. Forest cover in the region is 0.688 million hectares; 0.646 and 0.042 million hectare in GB and Chitral, respectively. Per capita forest areas in Gilgit-Baltistan and Chitral regions are 2.63 hectare (6.72 kanal) and 0.68 hectare (1.84 kanal), respectively. Similarly, range lands in Gilgit-Baltistan and Chitral are spread over 1.63 and 0.92 million hectares, respectively (GoGB, 2014; GoKP and UNICEF, 2014).

Farmers are using primitive technologies for agricultural production in the region, as land holdings are very small thus farming does not receive due attention. Capacity as well as capability

of local extension system is quite limited. Similarly, use of agrochemicals is mainly limited to vicinity of cities and main towns. High prices, low quality and improper utilization due to lack of training are main reasons behind low adoption of chemical control of crop insect-pests. However, in distant isolated valleys in the region, crops and fruit plants are insect-pest and disease free. Thus, region has advantage in production of scab free potato seed and disease free seed of other crops (GoGB and IFAD, 2021).

Use of farm machinery in the regions is quite limited. In Chitral region, only 252 farms had four-wheel tractors, 168 threshers and 48 maize shellers. Thirty-three farms had wheat harvester and 14 had rice husking machines (GoKP, 2018). Similarly, in Gilgit-Baltistan use of farm machinery is much limited e.g. Water Management Department has only one power tractor normally rented out to farmers/contractors for land grading/leveling etc. (GoGB and IFAD, 2021). About half of the farmers in GB plow their fields mostly with rented four-wheel tractors (51%). While, out of the remaining, 87% use bullocks and 13% spades/ *kasola* as an alternate to tractor plowing. Two-third of the farmers (68%) have to face delay in farm operations due to non-availability of farm machinery. Non-availability of repair facilities for farm machinery also limits its use in the region (Tariq *et al.*, 2015).

Crop production in GBC region mainly depends on ice and glacier melt water for irrigation. In GB region, about 65.8 percent of the irrigated area is mainly under channel (*Kuhl*) system fed by snow and glacial resources. Water-related hazards are dwindling water supply for irrigation and seasonal shifts. On-farm Water Management Department has been established in year 2020 to maximize crop and water productivity by ensuring efficient conveyance, application and use of irrigation water (GoGB, 2020). Irrigation channels are based on indigenous management systems, which are vulnerable to even small changes in climate. The regions are not amenable to large scale, intensive infrastructure. Thus, climate change will have severe impact on the farming and livestock production in the region (CSCCC, 2018). Due to small land holdings farmers have limited marketing surplus and marketing opportunities. The crop production season and harvest window are short. Processing of the surplus produce is considerably limited. Gluts of produce in harvest season result into low prices and high post-

harvest losses (GoGB, 2020). In GB region, less than 10 percent of total cultivable land is used for fruit production and nine percent for vegetable cultivation (ICIMOD, 2014; Hashmi and Shfullah, 2003). In GBC regions, the main livestock production systems are transhumant and nomadic, though sedentary farming is also practiced on limited scale specifically in urban and peri-urban areas. Livestock production in the region is characterized with well adopted low yielding indigenous nondescript breeds, inadequate veterinary services, degrading pastures and rangeland, long lean period in winter, feeding non-chopped fodder and straw, unhygienic housing conditions etc. (Raziq et al., 2010; ICIMOD, 2014; Hussain et al., 2005).

Livestock is the largest contributor in household farm income in the GB region, shares 43%, followed by cereals (21%), fruit (17%), forest products (13%), and vegetables (6%), (AKRSP, 2010). Livestock has always been more important than arable farming at higher elevations. Degradation of pastures and rangelands has seriously affected the livestock population and food security in Gilgit-Baltistan (ICIMOD, 2014). Livestock products are generally used for subsistence, although some households use them as a source of cash income (Ahmad et al., 2012; PDDNA, 2003). Projected livestock population based on the Livestock Census of Pakistan 2006 in GB and Chitral regions are 2.621 and 0.966 million, respectively. In this way, mean herd size in GB region is 13, with number of cattle, goats and sheep per household of 3, 7 and 3, respectively. Similarly, in Chitral region, mean herd size is 16 with number of cattle, goats and sheep per household of 4, 8 and 4, respectively. Poultry population in GB and Chitral regions is 0.593 and 0.458 million, respectively. Number of poultry birds per household in GB and Chitral regions are 3 and 8 per the two regions, respectively. There are 21 veterinary hospitals and 168 dispensaries in GB region. In this way, for 13868 animals one health facility is available in the region (GoGB, 2020; GoP, 2006).

GBC region is heterogeneous in terms of elevation, topography, climatic conditions, and environment. The eastern part of GBC i.e. Himalayan mountain range is a moist zone, while western parts i.e. Karakoram and Hindu Kush range are considered dry zones. In Gilgit region, mean monthly precipitation is 111 mm, with great monthly variation i.e. the highest in March (145 mm) with a lowest in November (73 mm). Similarly, in the region temperature variation

is high across regions. In the GB region mean maximum and minimum temperatures are 22.2°C and 10.9°C, respectively. In Gilgit and Diamer districts summer days are hot while night is cold, while all other districts remain cold in summer (Climate Data.Org, 2021; AKRSP, 2010). The region faces a major climate challenge, as the glacier cover is decreasing over time, and has reached the lowest level in the past 10,000 years (Chaudhry et al., 2009). Temperature has increased over time, over fifty years (1960 to 2010) with a variation of -1.5 to 1.5° C in northern mountains has occurred (Rasul et al., 2014). An opposite movement of temperature in 20th century has been reported in the region i.e. 1.4 °C rise in Skardu and 0.4 °C decline in Gilgit (Awan, 2004). Short crop duration and small window for harvesting (of just two weeks) is also creating uncertainties about production (GoGB, 2017).

The region is broadly classified into four agro-ecological zones with different agricultural characteristics, and also in the supply of institutional services (GoGB, 2017):

- A double cropping zone (elevation ≤ 1900 m ASL), characterized typically with wheat as a winter crop and maize in summer.
- A marginal double cropping zone (elevation 1900-2300 m ASL), can be converted into double cropping zone with use of short season crops and early maturing varieties of wheat and maize.
- Single cropping zone (2300m-3000 m ASL), just one crop is planted out of wheat, maize, buckwheat and oats etc.

Thus, we can broadly declare that out of ten districts of GB region, Diamir and Gilgit districts are in a double cropping zone, Skardu, Shigar and Kharmung districts are in a marginal double cropping zone, Ghizer, Hunza, Nagar, Astore and Ghanche districts are in single cropping zone. While the areas which lies over 3000 m ASL are the alpine pastures with no cultivation.

Production and utilization of major cereals and vegetables in GBC region

Statistics of main crops and vegetables grown in the region are presented in Table 2. Wheat is the main crop grown both in GB and Chitral regions. Productivities of wheat and other crops as well as vegetables are quite low as compared to our national averages. As the area is quite limited and productivity

Table 2: Production and Utilization of Major Cereals and Vegetables.

	Area (ha)	Production (Tons)	Productivity (ton/ha)	Per capita demand per annum	Demand (Tons)	Gap (Tons) Surplus (+) Deficit (-)
A. Gilgit-Baltistan						
Wheat	6422	17143	2.25	87.12	896434	-87929 (98.09)
Maize	1392	3245	2.46	23.57	35114	-31869 (90.76)
Potato	3419	29175	14.05	14.40	21456	7719 (36.00)
Tomato	-	2069	-	5.88	8761	-6692 (76.4)
Pea	-	23	-	4.40	6556	-6533 (99.6)
B. Chitral						
Wheat	8141	17618	2.16	87.12	39204	-21586 (55.06)
Maize	5517	13903	2.52	23.57	10607	3297 (31.08)
Rice	1831	4566	2.49	11.88	5346	-780 (14.59)
Barley	1725	2535	1.47	-	2535	0.00
Pea	7	20	2.86	4.40	1980	-1960 (98.99)

Note: Figures in parenthesis are percentages. Source: GoGB, 2020.

is also low: Resultantly the region is deficit in meeting consumption demand of local population in most of the commodities. Thus, wheat and most of the other agricultural commodities are supplied to the regions from down country areas on subsidized rate. However, in GB the potato crop is produced but does not meet the local demand by 36%, and in the Chitral area barley crop is produced to an extent sufficient enough to meet the local demand.

Sowing and harvesting schedule for major vegetables and fruits

Single cropping zone has the shortest cropping season in the GBC region, followed by marginal double cropping zone and with the longest season in double cropping zone. In the region, crop production is abandoned from November to January due to extreme weather conditions. Sowing and harvesting times for some major vegetables in all three agro-climatic zones are presented in Table 3. In general, there is 10-15 days difference in sowing dates across the zones. Vegetable production schedule depends on climate, availability of irrigation water, and time management for growing food crops like wheat and maize. Sowing of vegetables crops starts from potato crop in double cropping zone in the month of February. Potato is a five-month crop, harvesting of the crops starts in June and ends in October. Similarly, tomato and onion are 7-8 month crops. Cabbage and pea are being 4-7 and 4-6 month crops depending on the cropping zone. Bell pepper is only grown in double cropping zone with a crop duration of half a year, respectively. Turnips are grown in all the cropping zone with a

crop duration of 6 months. Vegetable and zone wise details are given in the Table 3.

Due to topography and location privilege, fruits are produced organically in natural climate having unique taste and flavour. Perennial fruit plants are grown throughout the GBC region. Harvesting calendar of these fruits is given in Table 4. Harvesting of fruits starts from cherry in the month of May. It is followed by apricot, apple and pear in July, pomegranate, grapes and almond in August and walnut in September. Thus, fruit production season in GB is half year i.e. from May to October. Fruit and zone wise details are given in the Table 4. Fruits' production, utilization and losses in GB are presented in Table 5.

Table 3: Sowing and harvesting schedule for major vegetable crops.

Crops	Zone	Jan	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Potato	D												
	MD												
	S												
Tomato	D												
	MD												
	S												
Onion	D												
	MD												
	S												
Cabbage	D												
	MD												
	S												
Pea	D												
	MD												
	S												
Bell Pepper	D												
	MD*												
	S**												
Turnip	D												
	MD												
	S												

Source: GoGB, 2017. D: Double cropping Zone; MD: Marginal Double Cropping Zone; S: Single Cropping Zone. *Not grown in the zone ** Climate is not fit for production.

Apricot is the fruit produced in the largest quantity in the region followed by apple, cherry and walnut. As far as consumption of the fresh fruit is concerned it is just 12.1 percent of the total produce. Per capita fruit consumption in the region is 10.20 kg per annum, which is almost equal to the national average of 10.08 kg. Remaining produce is either marketed fresh, dried both for marketing as well as consumption at home in winters or goes waste (GoGB, 2020; GoP, 2019). Main shares of fresh produce of peaches (54.6%), apple (46.9%), mulberry (41.2%) and pomegranate (37.7%) is consumed locally. About half of the dried apricot produce is marketed (50.6%). While, cherry, grapes, pear, walnut and almond produce are mainly marketed, with sale shares of total production of 75.9, 72.8, 72.3, 71.7, and 61.8 percent, respectively. More than one-fifth of the total fruit produce goes waste i.e. post-harvest losses are 22.7%. Mulberry is the most perishable commodity with the highest post-harvest losses of 58%, followed by apricot (38.1%), pomegranate (26.7%) and apple (25.5%). In Chitral region, annual fruit production is 4556 tons (31.05% of GB region), with apple, walnut and pear as main fruits with shares of 36.4, 25.0 and 10.4 percent in the total production, respectively. Similarly, pomegranate and apricot share 9.1 and 5.8 percent in total fruit production of Chitral (GoKP, 2018).

Table 4: Harvest Calendar for major fruit crops.

Crops	Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Apricot	D												
	MD												
	S												
Apple	D												
	MD												
	S												
Pear	D												
	MD												
	S												
Cherry	D												
	MD												
	S												
Pomegranate	D												
	MD												
	S												
Grapes	D												
	MD												
	S**												
Almond	D												
	MD												
	S**												
Walnut	D												
	MD												
	S												

Source: GoGB, 2017. D: Double cropping Zone; MD: Marginal Double Cropping Zone; S: Single Cropping Zone. * Climate is not fit for production.

Physical infrastructure for agriculture research and development in GB is quite sufficient to meet farmers need. A decade ago, there were 49 fruit nurseries, 12 seed farms and three tissue culture labs in the region. Food processing is improving over time in GB region.

There are eight private sector food processing units in GB region. The number of processing units in Gilgit, Hunza/Nagar, Skardu and Ghizer districts are 5, 2, 2 and one respectively. In all the processing units fruits are dried, nuts are deshelled and oil is extracted, except in Ghizer where fruit drying is not done. Apricot and apple are processed in Gilgit, Hunza, Nagar and Skardu districts; cherry in Gilgit, Hunza and Nagar districts; almond in all the districts and walnut is processed in Gilgit, Ghizer and Skardu districts. Thus, fruit processing facilities are limited to regional headquarters i.e. Gilgit and Skardu and Huza/Nagar districts, mainly due to availability of better transportation and related infrastructure in these cities. Sole public sector food testing facility in the region is being run by Pakistan Council of Scientific and Industrial Research (PCSIR), Skardu. Fifteen organizations both in public and private sector provide training in fruit processing. The Department of Agriculture has training centers in Gilgit, Ghizer, Astore, Diamer and Skardu district. Karakoram International University, and Mountain Agricultural Research centre (MARC) have fruit processing training centers in Gilgit. PCSIR, Skardu also provide training in fruit processing (GoGB, 2021A). There are two universities in Gilgit Baltistan region viz. Karakoram International University, Gilgit and University of Baltistan, Skardu. Karakoram International University, Gilgit has three campuses in Ghizer, Hunza and Daimer district headquarters. There are three faculties in the university; the department of agriculture and food technology lies under Life Sciences Faculty (KIU, 2021). The University of Baltistan, Skardu does not provide agriculture/ food technology related departments (UOB, 2021).

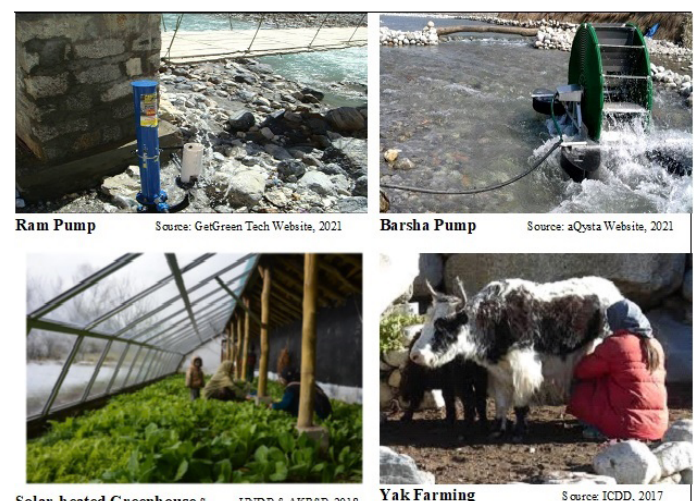


Figure 2: Promising Innovative and Traditional Technologies.

Overtime road infrastructure of the GBC region has been much improved. Construction of Karakoram Highway (KKH) impacted the land use pattern and agricultural development in the region. Previously, the agriculture system was subsistence and crude techniques were used by the farmers. Openness of the area due to KKH resulted in a significant change in land use and development, and availability of modern inputs, machines and techniques have also improved. Still, land use and agriculture sector need public sector attention, specifically in areas of land use planning, regulations, improvement of water channels, the introduction of high yielding seeds and planting material and farmers' awareness about recommended production packages (Anwar *et al.*, 2019). GBC region has geopolitical and topographical importance; that is why international interest has increased in the region overtime. In this context one special economic zone (SEZ), Maqpondass Industrial Estate- Mining and Food Processing will be constructed in GB on 250 acres at Maqpondass under China-Pakistan Economic Corridor, located at Gilgit-Skardu road, 35 km from Gilgit city (Khan and Anwar, 2016). The construction of SEZ may have substantial economic impact on local economy.

Innovative technologies and opportunities in the agriculture sector

Innovative technologies: Low cost water fetching along with development of arable land for cultivation is needed to increase the production of fruits and crops. In this regard, use of the Ram pump can be

a useful option. The pump is run by hydraulic power generated by the water stream. It has capacity to lift water up to six meter (about 20 feet) which can be used for uphill plantations. Even water can be stored at height and used for plantations at the foothill levels. The first Ram pump was installed in 2019 in Khyber Gojal Hunza valley by the local community. It can be fabricated locally with little know-how. Similar, ready to install units are also available in the country at prices less than 0.1 million including installation cost (UNDP, 2019). Many units have already been installed in Gilgit-Baltistan, Chitral, Kohistan and Swat. In the same way, Barsha pump is another innovative technology than can be used for lifting water from streams with a capacity of 20 meter (about 66 feet) above the stream. Water can be conveyed up to two kilometer distance with the pump. Maximum flow rate is 0.5 liter per second (40,000 liter per day) i.e. a pump can irrigate up to two hectare (5 acre) per day (aQysta, 2018).

Solar-heated greenhouses are another potential technology that could be promoted for adoption on large scale in GBC, specifically in single cropping zone. The greenhouse can be used to produce winter season vegetable all winter long up to -4°C. Similarly, along with harnessing the full potential of common local livestock species i.e. cow and goat, yak farming also has a substantial potential to improve the livelihood of people in some? areas of GBC. Yaks are traditionally reared by subsistence-level agricultural households. The total population of yaks in GBC

Table 5: Production, utilization and losses in fruits.

Fruits	Production Tons	Consumption Tons	Per capita/ annum (kg)	Marketed Tons	Losses Tons
A. Fresh fruits					
Apricot	61188	2256 (3.7)	1.5	35619 (58.2)*	23313 (38.1)
Apple	6606	3097 (46.9)	2.1	1824 (27.6)	1686 (25.5)
Grapes	1367	103 (7.5)	0.1	996 (72.8)	269 (19.7)
Pears	396	35 (8.8)	0.0	286 (72.3)	75 (18.9)
Peaches	414	226 (54.6)	0.2	94 (22.8)	94 (22.7)
Pomegranate	169	64 (37.7)	0.0	60 (35.6)	45 (26.7)
Cherry	4500	585 (13.0)	0.4	3415 (75.9)	499 (11.1)
Mulberry	1937	799 (41.2)	0.5	15 (0.8)	1124 (58.0)
Walnut	4178	1002 (24.0)	0.7	2996 (71.7)	180 (4.3)
Almond	661	240 (36.3)	0.2	408 (61.8)	13 (1.9)
Total	81416	9842 (12.1)	10.2	45713 (56.1)	18473 (22.7)
B. Dried fruit					
Dried Apricot	14675	5345 (36.4)	3.6	7422 (50.6)	1908 (13.0)

* Either dried or marketed fresh. Source: GoGB, 2020. Note: Figures in parenthesis are percentages.

region is more than twenty-six thousand, 18507 in GB and 7845 in Chitral. Mean herd size of yaks in the region is 5.6 animals per household. In GB, main yak farming areas are Hunza Nagar, Skardu, Ghizer, Gilgit and Astore, and in Chitral yak population is mainly found in Laspur, Yarkhoon, Torkhow, Terich and Bobbor valleys (GoGB, 2020; Ning *et al.*, 2016). Most of the areas with yak population are lying 3500-4500 MASL (Jasra *et al.*, 2016). They are used for multiple purposes, as draught animals, for production of milk, meat and manure. Though the productivity of yak cows is low i.e. 1.36 liter per day, but the fat content in yak milk is 6.5% (ranged from 5.5% to 7.5%) and is higher than that of common livestock species of cow and goat with milk fat content of 3.5% (ranged from 3% to 4%), (FAO, 2021). High fat content in yak milk has an added advantage for cheese, butter and desi ghee making.

Opportunities in agriculture sector

There are enormous opportunities in the agriculture sector of the region. However, to harness these potentials public and private sector commitment is required. Opportunities in the sector include, promotion of high density orchards i.e. introduction of semi-dwarf and dwarf varieties of fruit plants with appropriate plant to plant distance and improved orchard management practices. Along with this, quality of fruit plants should also be ensured through supply of true to type germplasm of fruits to private/ public sector fruit nurseries. Public sector should come forward to establish germplasm units for fruits backed by private sector nurseries to produce true to type fruit plants in the region. Similarly, cultivation of medicinal plants and condiments along with exploring proper disposal mechanisms of the produce is required to motivate farmers for their sustainable production. One of the most feasible option is adoption of commodity cluster development approach for these commodities. In the same way, cultivation of olives, pistachio, saffron and other high value crops along with up-scaling of promising varieties is needed.

Seabuckthorn is a wild plant having many therapeutic uses against cancer, cardiovascular diseases, gastrointestinal ulcers, skin disorder and as a liver protective agent (Zeb, 2004). There is a huge potential of harvesting wild seabuckthorn and cultivating it on cultivable land in areas above 3000 m ASL e.g. Gojal and Shimshal etc. Similarly, other non-timber forest products (NTFPs) like other medicinal plants, morel

mushrooms specifically in Shishi valley of Chitral, wild honey, wild fruits/ vegetables, pine nuts and silk cocoons etc. can be harvested for improvement of livelihood of locals (Ahmad *et al.*, 2017; Ajaz and Latif, 2007). Thus, collection and use of NTFPs would result in enhanced per capita intake of these nutritious products along with conservation of natural resources.

The GBC region has an advantage for production of trout fish due to continuous availability of fresh waters of river Gilgit and Indus rivers in GB, and Kabul river in Chitral. Trout fish production can be increased by importing germplasm of high yielding yellow trout fish from China and its introduction in GBC. Public sector has taken a few initiatives to develop trout farming. Still more efforts are required to tap the potential of trout farming in the region. Similarly, honey bee keeping and honey production along with orchard establishments can have good potential for increasing the yield of apple, apricot and other fruits. Partap *et al.* (2017) reported that placement of honeybee hives in apple orchards resulted in enhanced fruit set by about 9 to 13, reduced fruit drop by 1 to 7 percent and enhanced overall fruit yield by about 45 percent in Chitral, Pakistan. Similarly, the bee pollination also enhanced the quality i.e. weight, shape and colour of apple fruit. Weather of the region, specifically in summer seasons favours low cost production of mushrooms and poultry farming. Similarly, solar powered drip irrigation system for fruit plants and vegetables on uneven topography i.e. on terraced land can be helpful for low cost irrigation with clear advantage over electric power systems. There is a need to introduce innovative technologies through development plans and projects vis-à-vis preservation of indigenous knowledge to minimize environmental and production risks. Untapped potential of non-agriculture sectors, entrepreneurship, skill development and mining etc. should also be explored. In this regard, role of private sector in up-scaling of the technologies for product/ enterprise development should be considered. Livestock productivity can be increased by development of feed cakes keeping in view nutritional requirements of local livestock in the lean period. Similarly, silage and hay making technologies can help in meeting fodder shortage in lean period. These can be supplied from the plain areas of the country.

Agricultural production of the regions needs to be changed keeping in view local and regional demand

and reproductive and adoption capacities of the system. The region has advantages in the production of organic production of high-value crops. Still, piloting climate smart technologies and promotion of low use of chemical fertilizers and pesticides should be envisaged to keep this premium sustainable over long run (ICIMOD, 2018). As far as change/ decrease in water supplies is concerned, use of promising water saving technologies viz. roof top rain water harvesting, micro-catchments/ planting basins, mulching and cover crops, crop rotation, agroforestry, legumes/ intercrops, permaculture, sustainable intensification and climate smart agriculture etc. should be promoted (Snapp *et al.*, 1998; Hussain *et al.*, 2018; Coulibaly *et al.*, 2019; HLPE, 2019). Similarly, composting can have added advantage in ameliorating soil health and fertility in the region. It will be easy to use surplus fruit produce which goes waste to make compost. Peer-driven farmer led methods mobilize communities to test and use such agroecological practices (Bezner *et al.*, 2007). The region is not amenable to large scale, intensive infrastructure, and there is need to invest in more efficient cropping methodologies and crop rotations to secure livelihood of the population (CSCCC, 2018). Farmers and entrepreneurs should be apprised with risk management tools to cater high production and development risks. In the same way, programs like Indus basin initiative should be implemented with full zeal and promoted holistically to teach, train and habitulize local communities to adopt farming practices and technologies that are resilient to mitigate impacts of climate change on food production specifically to adjust sowing times of crop to seasonal pattern of rainfall, cryosphere, and water resources (ICIMOD, 2018).

Conclusions and Recommendations

The region is unique in natural and human resource endowment, geographical location, topography and agricultural perspective. Land holdings are quite small and insufficient to supply local food needs in grains. However, nature has endowed the region with diverse flora and fauna and provided immense explorable avenues for the benefit of local population. Productivities of crops are lower than national averages, however, fruit production is enough to cater local needs. Definitely, use of commercial seed and agricultural chemicals may have positive or negative impact on the revenues, as both prices as well as quality and effectiveness of these inputs matter considerably.

The area deserves more research, specifically in the region. While, in the livestock sector, supplies of milk and meat are insufficient to cater local needs. Selection and inbreeding of high producing local livestock species and introduction of exotic livestock species with supply of silage from down country, cultivation of medicinal plants, sustainable collection of non-forest wood products, honey bee farming, fishing farming, fruit and vegetable processing are some of the areas that need immediate interventions by the public sector. Farmers should be supported to acquire new knowledge, skills and technologies to exploit the local agricultural potential. Along with this, making additional land arable through water and land development, promotion of processing and value addition technology, improving storage and transport infrastructure, and taking advantage of opportunities provided through CPEC construction need to be explored.

Novelty Statement

The data presented in the article is important for development of evidence based policy and in designing development projects in agriculture and related sub-sectors in Gilgit-Baltistan and Chitral regions of Pakistan.

Author's Contribution

Abid Hussain: Conceptualized the research idea, guided research team in reviewing relevant literature, synthesis of the literature & data, and incorporated comments of the anonymous reviewers.

Saifullah Khan: Reviewed the literature and assisted first author in draft write up of the article.

Shamas Liaqat: Updated the literature & data, and assisted first author in preparation of initial draft of the article.

Shafullah: Provided guidance at every step of the research work.

Conflict of interest

The authors have declared no conflict of interest.

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