

Review Article



Problems and Potential of Agriculture for Improving Livelihood in Malakand Division, Pakistan

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Abstract | Malakand division has rich natural resources, having large potential for agriculture and tourism development, while its strategic location indicates a tendency of increasing importance of this region in the near future. Agriculture, one of the main sources of income of 52% of population of Malakand division, is less profitable due to traditional farming methods. Therefore, this paper is aimed to investigate the key agricultural issues and to identify strategies for utilizing the full potential of agriculture for improving livelihood in this region. This study indicated that climate change induced hazards of land degradation and water scarcity due to frequent floods and droughts, decline in traditional springfed Kuhl (gravity channel) irrigation system, low productivity of crops and horticulture, less productive livestock, large postharvest losses and lack of value addition facilities are the main hurdles in utilizing the full potential of agriculture for achieving improved food security and better livelihood in this region. Lack of government spending and less available research facilities are considered the main hindrance in agricultural development in this region. Therefore, this review study was focussed on identification of strategies for the conservation of natural resources, improvement of crops, horticulture, livestock, postharvest management and farm operation sectors in Malakand division. The study illustrated the potential for agricultural improvement, explored key issues and identified strategies and recommendations for agriculture sustainability and improved food security that may lead to better livelihood in Malakand division of Khyber Pakhtunkhwa (KP).

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Introduction

Agriculture provides employment to 44% of the labor force (FAO, 2019) and has about 23% contribution to the GDP of Pakistan (Pletcher, 2019). Agriculture is more important for Malakand division by providing livelihood source for more than 52% population. However, agriculture is facing low productivity, profitability and sustainability challenges due to population growth, climate change induced hazards and lack of resources. Therefore,

this study is aimed to illustrate potential, issues and options for agricultural development in Malakand division. The salient features of Malakand division that can be instrumental in improving livelihood of local communities are detailed below.

Study site description

Malakand division covers 40% land area and is home to around 25% population of Khyber Pakhtunkhwa (KP) excluding FATA (GOP, 2019). Malakand, the largest division of KP, is comprised of seven districts

(i.e. Chitral, Upper Dir, Lower Dir, Swat, Shangla, Bunir and Malakand) that extends from 71.43 to 73.85° E longitude and 36.07 to 36.40° N latitude. The land area distribution and layout of different districts of Malakand Division in comparison with the rest of the areas of KP province and FATA is shown in Figure 1. Malakand division is among the least developed areas of the KP and have faced multiple natural and manmade calamities recently. The international support played an important role in the rehabilitation of affected people of Malakand division. Lack of effective research facilities, interest, assessment studies, and low capability of communities to respond to miscellaneous calamities are the main causes of poor livelihood, food insecurity, and agricultural sustainability issues (Ahmad et al., 2016a, 2016b). Limited research facilities are the main constraint in highlighting the emerging issues of significant importance and in diverting government/policy makers' attention towards the development of this region. The rapidly emerging issues of degrading natural resources, climate change induced risks, declining water resources, especially drying of the traditional spring/seasonal river fed Kuhl (Gravity channel) irrigation system, less productive agriculture and livestock urgently demands for strong research facilities, skilled human resources and better linkages between provincial and federal governments for the development of agriculture and livelihood in this region on priority basis.

The demographic details of different districts of Malakand division are shown in Table 1.

Potential for agricultural development

Strategic importance of Malakand division:

Malakand division covers majority of the Northern part of KP province. The KP province in general has a diverse landscape stretching from high altitude mountains (Himalayan) in the north to the desert in the South. It comprises of 10.17 million hectares of total geographical area, which is 13% of total area of Pakistan (GOP, 2001). The major portion of the province area is occupied by high peaks, hills, valleys, plateaus and sloppy lands. Interestingly the South is only 250 m above mean sea level but the rise in altitude quickly reaches 7708 m (Tirchmir in Chitral district) within few hundred kilometres towards the North (GoKP, 2005). Malakand Division, in particular is more important, because of its strategic and economic importance as it can link Pakistan with China, Afghanistan and Central Asian countries. The diverse landscape of Malakand division hosts precious natural resources, vital for the economy of the country. The Malakand Division is a major stake holder in the ongoing mega project of China Pakistan Economic Corridor (CPEC), as it not only hosts the existing route but also the recently approved alternative safe route linking Mardan, Dir, Chitral and Gilgit to China. Similarly, a narrow belt of Wakhan in Afghanistan, around 13 km wide, separate Tajikistan from Chitral, which illustrate huge economic and strategic prospects of this region for Pakistan in the near future. Therefore, agricultural, economic, and social development in this region is in the best interest of the government of Pakistan in general and local people in particular.

Tourism potential of Malakand division:

Malakand division is famous for the scenic spots and tourism. For instance, Kalam valley and Malam Jabba in Swat, Kumrat valley, Lawari top and Usharay dara in Upper Dir, Ben Shahi point along border area with Afghanistan and Laram peak in lower Dir, Kalash area and Shandur polo ground in Chitral and many other historic places attracts thousands of local, national and international tourists each year. Being associated with multiple subsectors like transportation, hotels, restaurants, tourist shops, travel guides, tour operators, etc., the sector has economic implications and a role in creating employment opportunities. Travel and tourism also acts as a bridge for bringing people from

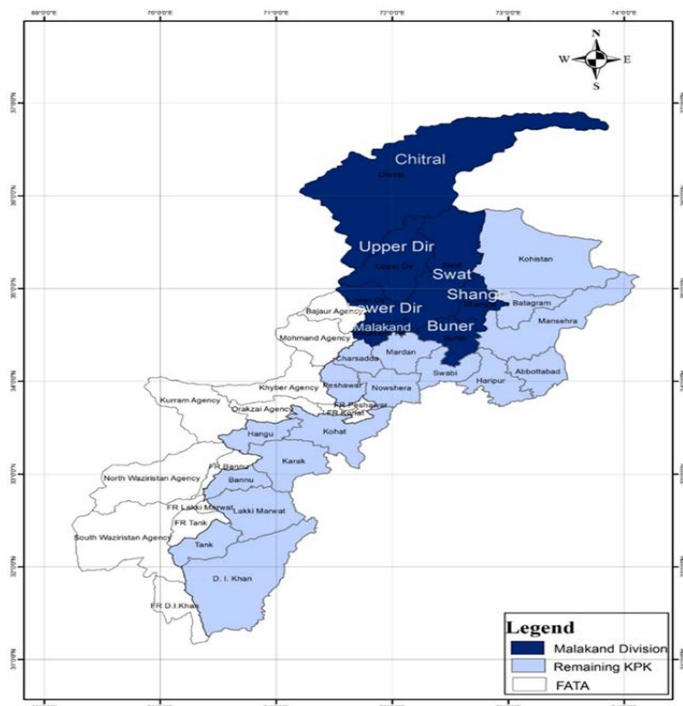


Figure 1: Land area distribution and layout of seven districts of Malakand division in Khyber Pakhtunkhwa Province.

Table 1: Demographic and social information of seven districts of Malakand division.

Districts	Population (2017)	Population density (persons/km ²)	Growth rate (%)	M/F ratio (%)	% Urban	Area (km ²)
Chitral	447362	30	1.80	102	13	14850
Dir Upper	946421	256	2.64	97	5	3699
Dir Lower	1435917	907	3.71	97	3	1583
Swat	2309570	433	3.24	103	43	5337
Buner	897319	481	3.05	99	0	1865
Shangla	757810	478	2.96	104	0	1586
Malakand	720295	757	2.47	101	10	952
Total/Ave	7514694	477.42	2.41	100.43	10.57	29872

different cultures and traditions together. However, due to long insurgency, bad law and order situation, worse natural and manmade calamities, climate change induced hazards, over grazing, erosion and deforestation negatively affected tourists attraction and overall aesthetic value of these tourist spots, thus reduced income for the local population in particular and the related sectors of the country in general. Sustainable management of watersheds may lead to increased aesthetic value of these scenic tourist areas, which will ultimately enhance income generating opportunities in the country in general and Malakand division in particular.

Scale of natural resources: Malakand division has been blessed with fertile land resources. Agriculture is practiced on only around 12% of the total geographical area. The rest of the land is either used for grazing, forest, or barren hilly lands. Majority, of cultivable lands are in the valley bottom but agriculture is also practiced on sloppy lands with access to water supply. Cropping pattern depends on available water and double cropping is common below 1,700 meters elevation.

Water resources: Malakand division is rich in water resources by hosting a major portion of the frozen and flowing river water resources of Pakistan. The Kabul river contributes ~30% water to Indus River, while Swat, Panjkora and Chitral rivers are the major tributaries of Kabul River, which basically originates in Malakand division, as shown in [Figure 2](#). However, majority of agriculture in Malakand division depends on traditional spring/river fed Kuhl (gravity channel) irrigation system, as most of agricultural lands are located at higher elevation from river beds. Importantly, the climate change induced decline in water availability of springs and pipe diversion of spring water for domestic purposes negatively affected

agriculture in many areas of Malakand division. Many areas producing rice and maize in the near past are no longer capable to produce a single wheat crop during a whole year due to non availability of irrigation water or uncertain water supply during peak demand period. Interestingly, there is huge potential for agriculture improvement through developing the perennial river fed Kuhl irrigation system for replacing the declining traditional spring fed system due to population growth and climate change induced hazards. The river fed Kuhl irrigation system has shown positive impacts on productivity and water availability of dying springs located at the downstream end of Kuhl in many locations of Malakand division, where Kuhl irrigation system has been developed. Moreover, the poor water management has placed immense stress on available irrigation water on sloppy watersheds in Malakand division. This is because the rainwater (500-1200 mm per year) has never been fully utilized and available water is mismanaged. Consequently, reduced water availability negatively impacted on orchard production, which is the most common source of income to local farmers of Malakand division. The traditional surface irrigation methods are either flooding or flat basin, which are inherently inefficient ([Akbar et al., 2016](#)) and did not suit the undulating and unlevelled fields under crops and orchards of these valleys. Hence, the available water through surface and groundwater resources demands for pressurised and efficient irrigation methods, like sprinkler, drip and furrow bed. However, the sprinkler and drip irrigation methods have not yet been introduced into this region, while lack of resources and knowledge compel farmers for not adopting these efficient irrigation methods.



Figure 2: River amp of Pakistan, highlighting contribution of Malakand division to Kabul river through river Swat, Panjkora and Chitral.

Energy resources: Electricity or power for pumping is the main constraint in promoting agriculture in Malakand division, because conventional energy through national grid or diesel engines may not be preferable due to sparse far flung location, unlevelled geography, lack of convenient access and large associated operational cost. In the current scenario of energy crises and water scarcity situation of the country in general and Malakand division in particular, there is need to promote alternative energy resources solar/hydel/gravity powered water lifting system for sustainable and profitable agriculture in these less developed areas. The traditional river fed Kuhl irrigation system is the most suitable option with no significant energy requirement and can be more sustainable than other options. The second sustainable option is the local generation of hydel power for use in agriculture. The third sustainable option can be solar water pumping systems coupled with high efficient irrigation systems, which has been already demonstrated at several locations in the country. Solar powered pumping systems have been proved useful for irrigation around the world. Therefore, the available water from springs, streams, and rivers can be successfully utilized for improved agriculture production using solar powered pumping and hose fed gravity irrigation systems.

Bee keeping: The Malakand division has a vast scope for bee keeping and already attracts so many people's

involvement in this business. The total numbers of the beekeepers entrepreneurs in KP are around 3500 mobilizer with direct employment for 17500 people. There are sufficient natural resources for providing food for honeybee, particularly in district Chitral areas like Ayun, Darosh, Chitral Town, Rashune Valley, Bony and Lasanpur. In, Uper Dir, Lower Dir and Swat district, Mangora, Malam Jabba, Kalam, Shangla, Butt Khela, Khwarza Khela and Madian have a great potential for beekeeping for local people due to its richness in honeybee floral resources like Russian olive, Robinia, Shane etc. Due to the presence of pesticide residues and low quality of honey, export from Pakistan has stopped to Europe. Therefore, federal and provincial governments should play a vital role in boosting this declining sector by promoting beekeeping in Malakand Division through improved knowledge and methods used. The beekeepers need training for maintaining honey quality, separating honey from beeswax, rendering beeswax and producing secondary by-products. Linkages and technical guidance of Chitral Beekeepers Association, Chamblee Group of Women Beekeepers, Swat Beekeeper Association can be instrumental in promoting the beekeeping.

Rangelands

Rangelands are another potential natural resource of Malakand division, which is facing many threats. The increasing trend of livestock population is putting pressure on the existing range lands. The rangelands are generally exploited in excess of their carrying capacities, leading to decline in range productivity. According to [Forestry Sector Master Plan \(1992\)](#), rangeland productivity is estimated to be only one third of its potential. Moreover, due to energy constraints in Malakand division, the use of biomass for fuel is increasing, which tend to accelerate removal of woody vegetation, ultimately leading to serious land degradation and loss of biodiversity. The local communities are predominantly poor and unaware of the conservation and sustainable management of range resources. Being common property resource, rangelands are overexploited by everyone, but owned and cared by none: Thus, are presenting a gloomy picture of tragedy of the commons. Climate change induced increase in temperature and changes in precipitation pattern may lead to sharp decline in the rangeland productivity, which may lead to total collapse of the rural livelihoods in these areas. There is no effective rangeland institutional setup in Malakand division.

Major problems affecting livelihood in Malaknd division

Climate change induced risks: The global climate risk index of Pakistan has shown significant variations during the last decade and at one stage Pakistan reached the top ten countries at-risk due to climate change (Immerzeel et al., 2010; Eckstein et al., 2019). Climate change has been termed as a big threat then terrorism in Pakistan, thus demands a warlike response. Although climate change induced risks are common throughout the country (Abid et al., 2016) but Malakand division is facing severe social, environmental and economic challenges due to climate change. Climate change impacts are already evident in the form of growing frequency of droughts and floods, increasingly erratic weather behaviour, changes in agricultural patterns, reduction in freshwater supply, declining of traditional irrigation water resources and the loss of biodiversity. The frequent prolonged dry spells poses serious threats to the survival of fruit plants, cereals, vegetation and drinking water. On other hand, the growing trend of short duration intensive rains generates huge runoff losses, which accelerates land slide/ erosion and land degradation. These negative impacts have been felt by the local communities (Maryam et al., 2014; Ullah et al., 2015). Unfortunately, the land resources are poorly managed, thus erosion, landslides, land degradation is the norm due to climate change, resulting greater sediment load and soil fertility loss thus causing reduced production potential of lands. The traditional tillage management, inadvertent fertilizer input and lack of knowledge of chemical, physical and biological characteristics of soil are negatively impacting on tapping the full productivity potential of Malakand division. Therefore, identification of soil properties, rationalizing the fertilizers input and improved land management practices like terracing, minimum tillage, insitu soil moisture conservation practices needs to be adopted for improving soil structure and productivity of lands in Malakand division. Thus, promotion of best climate change resilient practices is urgently needed.

The climate change induced floods, especially in 2010, proved very detrimental to the whole Malakand region, while majority of the farmers have not yet fully recovered. Moreover, the worse law and order situation and insurgency in the past years further exacerbated the problems faced by the local farmers as they have lost their livestock, poultry and orchards, while in some cases their houses were destroyed when

they were displaced in a warlike situation. According to one estimate (<http://archives.dawn.com/archives/154700>) around 3.5 million people were displaced while fruit orchards and livestock worth over RS 6 billion were suffered. Therefore, agriculture has been significantly suffered due to non-availability of water during peak demand periods. The climate change negatively affected the traditional spring/river fed Kuhl (Gravity channel) irrigation system, which has shown significant decline in the last decade due to drying of springs or increased pipe diversion of spring water for domestic purposes due to population growth. Several areas are now suffering from drinking water issues due to drying of springs and people living at elevation are now compelled to meet their daily water needs through tankers, which is very costly and not bearable for longer. This may lead to migration in the future. All these factors demand for greater support, funding and coordination between provincial and federal agencies for the rehabilitation of the affected communities and conservation of natural resources while agriculture development can be instrumental in achieving this goal.

Low agricultural productivity

Agriculture, the major source of livelihood in Malakand division, is facing the challenge of very low precipitation, insufficient cultivable land, low productivity and water management issues (Khan, 2012). Malakand division hosts thousands of orchards of high quality peaches, plums, pears, apples and citrus fruits. For instance, Malakand division has been reported to produce up to 53% pears, 33% plums, 95% of walnuts, 80% of persimmon, ~67% of apricots, 83% apples and 50% citrus out of total provincial yield <http://archives.dawn.com/archives/154700>. Moreover, wheat, maize, rice and vegetables are integral part of existing subsistence farming system in this region (GoKP, 2017). However, agriculture is facing multi-dimensional challenges (climate change, anthropogenic, degradation, sedimentation, lack of resources, skills etc.), which is affecting the livelihood of the local community. The district wise agriculture production of major crops, vegetables, and fruits are given in Table 2.

Malakand division is comprised of deep valleys and lofty peaks in the Himalayan and Hindukush Mountains. This region falls in a wide range of agro ecological zones from the semi-arid, sub-humid and sub-tropical southern plains of Malakand district (500 meters altitude above mean sea level) to the dry,

Table 2: District wise agriculture land area and production of Malakand division (area in hectares and production in tons).

Attribute	Dir Lower	Dir Upper	Chitral	Swat	Shangla	Buner	Malakand	Total	% of KP
Cropped area	41004	31572	21500	97281	41128	55970	45681	334136	20
Irrigated area	41757	22388	20934	84780	3019	13009	35578	221465	25
Forest area	77515	81332	41949	138282	44405	41001	4409	428893	34
Wheat area	28630	23735	8302	62709	24750	50548	27117	225791	33
Wheat production	51340	44285	17868	122616	41760	72536	37480	387885	30
Maize area	9495	5895	5394	61600	37453	47937	4782	172556	39
Maize production	21850	11749	13485	115734	62510	75510	10940	311778	37
Rice area	9254	7535	1828	5235	1377	346	4985	30560	57
Rice production	21551	14796	3660	14585	3438	686	11059	69775	56
Barley area	1172	778	1728	116	392	359	472	5017	49
Barley production	1027	682	2641	125	388	397	310	5570	53
Vegetable area	777	493	1885	9640	333	1058	1690	15876	46
Veg. Production	9504	6705	16118	99740	3865	14289	17553	167774	44
Fruits area	705	1520	621	13065	424	729	1610	18674	49
Fruits production	5266	14939	460	84545	4344	6813	11825	128192	38

(Development Statistics of Khyber Pakhtunkhwa, Govt. of KP, 2015-16).

cold temperate valley of Chitral district (2,500 meters altitude above mean sea level), which is suitable for a variety of agricultural production. Importantly, a major portion of the population is agricultural employed but the existing subsistence farming system with low productivity and traditional farming practices did not ensure better economic return, thus results poor livelihood and reduced access to modern agriculture technologies and development (GOP, 2018-19).

Majority of agriculture in Malakand division is on sloppy watersheds or on valley bottoms, while rural livelihood largely depends on vegetation, shrubs, forest trees, fruit plants, cereals and livestock production. However, this area is under severe anthropogenic pressure in the form of water scarcity, deforestation, over-grazing and clearance of forests (Ilyas et al., 2012). Non availability of water or cost of energy for water pumping is among the major hurdles in agriculture development from flowing streams, springs and rivers. Consequently, this continues trend of reduced vegetation and increased land deterioration are leaving the watersheds non-productive and vulnerable to further accelerated degradation.

Malakand division produces a variety of horticultural and cereal crops due to its varied micro-climates and seasons. Wheat, Maize, Barley, Rice are the main cereal crops grown in Malakand division. However,

the production is very low evidenced through the 1.72 ton/ha production for wheat, 1.81 ton/ha for maize and 2.28 ton/ha for rice during the year 2016, as already presented in Table 2. The major kinds of fruit produced in Malakand division are citrus, apple, guava, persimmon, apricot, peach, pear and grapes. However, the production has further potential for significant improvement. The major vegetables produced in Malakand division are potato, onion, chillies, tomato, turnip, okra, carrot, cauliflower, and peas. The existing production of vegetables on farms are negatively affected by the traditional seed varieties with less production potential, poor farming management practices, weeds infestation and diseases infections. Importantly, Malakand division has the huge potential to fill the gap of less availability of vegetables in the Market during the summer season due to its moderate temperature. For instance, vegetables like tomato, chillies, onion, potato, cabbage etc, are also grown in May to July, which is off season for the rest of the country. Therefore, introduction of improved varieties of horticultural and cereal crops, capacity building of farmer on improved agronomic practices, disease control and optimised management of input can significantly increase the horticultural and crops production in Malakand division.

Table 3: Livestock population in Malakand Division (million no.).

Districts	Cattle	Buffaloes	Sheep	Goat	Camels	Horses	Mules	Asses	Poultry
Buner	0.132	0.0800	0.032	0.131	0.0020	0.0012	0.0012	0.014	0.720
Chitral	0.175	0.0003	0.181	0.348	0.0000	0.0003	0.0001	0.003	0.423
Lower Dir	0.249	0.0160	0.048	0.293	0.0003	0.0001	0.0004	0.003	1.049
Upper Dir	0.232	0.0050	0.091	0.352	0.0003	0.0006	0.0030	0.004	0.711
Malakand	0.074	0.0200	0.006	0.065	0.0001	0.0007	0.0001	0.003	0.253
Shangla	0.205	0.1290	0.059	0.240	0.0003	0.0030	0.0040	0.008	0.884
Swat	0.254	0.1170	0.080	0.236	0.0003	0.0050	0.0030	0.018	1.140
Total	1.321	0.3673	0.497	1.665	0.0033	0.011	0.0118	0.053	5.180
% of KP	22	19	15	17	5	14	18	9	19

*Estimated from Pakistan Economic Survey, 2006.

Less livestock production

Livestock sector directly relates to livelihood of farming communities by supporting food, wool, fuel and farming in Malakand division. It provides cash income, employment, and secure food on daily basis to around 30-35 million population. It also safeguards against the risks due to crop failure or any other reason. Livestock contributes approximately 56% to the agriculture value added and around 12% to national GDP, as per 2012-13 record. Gross value addition of livestock is around US \$ 13 billion (2012-13), with a recent annual increase of 3.7 %. The 30 to 40% of income is generally derived from 2-3 cattle/buffalo and 5-6 sheep/goat per average household. Thus, the socioeconomic conditions of rural masses of Malakand division can be uplifted through certain incentives for livestock improvement as per given potential and details available in Table 3. There is also around 5000 yalk population in Broghil, Torkhow, Laspur valleys of Chitral. The major issues of livestock in Malakand division include less productive breeds', scarcity of feeds, lack of awareness on modern animal husbandry techniques, nonexistence of selection and culling practices and absence of prophylactic measures against diseases.

Malakand division has huge potential of cold/cool/warm water fish farming. Two cold water species (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) have established themselves in rivers of Malakand division. Trout is usually cultured in cemented raceways under flow through water system and fed by artificial diets manufactured from local feed ingredients. A fifteen months period is required to grow fish from hatchling to table size. Water temperature of 15°C is considered optimum for the culture of trout and it cannot survive above 18 °C. Due to limited production, the existing

selling prices are above RS 600 per Kg, usually available in tourist's places like Chitral and Kalam. Walleye and yellow perch are examples of cool (15.6 to 29.4°C) water species, while Channel catfish and Tilapia are warm (24-32°C) water species. The fish can be transported live in fish hauling tanks or fresh in Styrofoam boxes packed with ice. Therefore, all these fish species have huge potential in Malakand division, which need to be further explored and improved management practices needs to be demonstrated. The farmers should be facilitated in developing raceways at their farms. Linking of farmers to available hatcheries, training on best cold/cool/warm fish management practices and value addition of fish products would be helpful in increasing fish production and improving livelihood of poor farmers.

The livestock sector in Malakand division is facing the problems of diseases infections, poor health condition, lack of convenient availability of quality feed and sometime low quality drinking water. Livestock veterinary services are not easily available, while farming is not common. Furthermore, there are less available resources with the local farming communities to provide healthy environment to the livestock at their houses, while their grazing areas are shrinking due to urbanization, natural resources degradation and climate change. Commercial livestock for milk production is almost non-existent in Malakand division.

Postharvest management and farm operations issues

The majority of farm operations from sowing to harvest are carried out manually, which make the production of these crops time consuming, laborious and less profitable, thus less attractive in Malakand division. Importantly, up to 30-40% postharvest

losses has been recorded in fruit and vegetables due to lack of appropriate farm operation and postharvest technologies, which bring low return to growers (Rolle, 2006). Similarly, the postharvest losses for major grain crops, such as paddy, wheat and maize are around 17 %, 15 % and 13%, respectively has been recorded (Chaudhry, 1980) at the country level. The major constraint in availability of fresh fruit and vegetables round the year is their short shelf-life as they deteriorate, decompose and produce undesirable smell in a short period of time after harvest. Thus, postharvest management is important for both producer and consumer.

Postharvest losses may be due to environmental conditions (heat or drought), mechanical damage during harvesting and handling, improper postharvest sanitation or poor cooling and environmental control. Similarly, the living parts of plants, which continue respiration and undergo other biological processes, may damage the fresh produce. Due to lack of post harvest management facilities and poor marketing conditions valuable fruits and vegetables are lost in Malakand division. Postharvest processes include integrated functions of harvesting, cleaning, sorting, grading, cooling, drying (as per need), packaging, transporting and marketing. Postharvest handling involves the practical application of engineering principles and knowledge of physiology of agricultural produce to solve problems and to bridge the gap between the producer and consumer. Moreover, the hygienic standards are also poor that need a lot of trainings of growers and associated workforce engaged in value addition activities as they are unaware about latest postharvest management and value addition methods. Thus, there is need to reduce postharvest losses substantially.

Less agricultural research facilities

Agricultural research has got limited focus in Malakand division through the federal government. Importantly, the provincial government has established various research stations in Malakand division. For instance, research activities in Swat by KP government were initiated in early sixties through Agriculture Research Institute (ARI) Tarnab that eventually led to the establishment ARI Mingora in 2007. The main objectives of ARI Swat are to develop appropriate, safe and cost effective field crops, vegetables and fruit varieties; formulate nutrient requirement, cost effective agronomic practices, integrated pest and

disease management (IPM); produce and distribute basic seed and fruit nursery saplings; develop methods for fruit and vegetable drying, squash making and jams and pickles; transmit improved varieties and technologies through adaptive research, field days, training courses, workshops, seminars. The ARI swat successfully produced 54 approved renowned varieties including sequential ripening peaches and apples, introduced new fruits and vegetables types, off season vegetables/tunnel farming and miscellaneous interventions in Swat District.

However, research on climate change induced challenges of water scarcity, floods, droughts, reduced productivity, erosion, increased run-off losses, sustainable watershed management, degradation of natural resources, farm operation, postharvest management and breeding of crops needs further strengthening. The linkages between federal and provincial agricultural research institutes needs to be further strengthened in Malakand division.

Strategies to improve livelihood in Malakand division

The emerging food security and livelihood issues in Malakand division due to low agriculture productivity, degradation of natural resources, non availability of water for drinking and agriculture, climate change induced frequent floods and droughts and less government spending has been seriously felt by the local communities. Less agricultural research facilities and focus has been considered to be the main impediment in formulating effective strategies to cope with the emerging food security and livelihood challenges in this region. Therefore, all the major stake holders including local governments, provincial and federal governments should develop a consensus in maximizing the research and development activities and in improving government spending in agriculture sector in this region. Based on the above discussion and literature review few measures, research and development activities has been summarised, which needs to be strengthened for promoting profitable agriculture and improving livelihood of local communities in Malakand division.

Improvement of natural resources management

Natural resources and their management play a key role in improving livelihood of local community. Therefore, this sector needs to be strengthened through the following research and development initiatives:

- Land use and hydrological characterization of

- watersheds using GIS, RS technique;
- Promoting climate smart agricultural technologies for sustainable natural resources;
 - Establishment of laboratories on soil and water testing and GIS-RS analysis;
 - Assessment and integrated nutrient management for improving soil fertility;
 - Promoting hydel/solar powered and gravity fed high efficiency irrigation systems;
 - Development and promotion of perennial river fed Kuhl (gravity channels) irrigation system for replacing the declining spring fed Kuhl irrigation systems;
 - Supply of natural gas and LPG fuels to remote areas of Malakand division at subsidized rates to avoid use of wood as fuel for controlling decline in ground cover;
 - Rain water harvesting and management for improving water availability;
 - Assessment of range land resources for promoting improved interventions;
 - Honeybee ecto-parasitic mites management and quality queen production, honey analysis and value addition of by-products;
 - Develop watershed community Associations (WCA) to stimulate adoption of technologies;
 - Develop research cum demonstration sites of integrated natural resource management;
 - Promoting improved natural resources interventions through capacity building, mass awareness, financial support and follow-up development programs.

Horticultural and crop productivity improvement

Horticulture and crops are the main income generating resources thus needs improvement for poverty alleviation. The following research and development measures have been suggested for improving this sector in Malakand division.

- Promoting high yielding field and horticulture crops for the target areas;
- Establishment of clean and true to type fruit plant nurseries;
- Open field off season vegetable and flower production;
- Vegetable, flower seed and bulb production (Tulips, Tuberoses, Gladiolus, etc);
- Breeding and selection studies for field crops;
- Plant protection management of horticultural crops;
- Promoting horticultural and crop productivity

improvement through demonstration, capacity building, financial assistance, awareness and follow-up development programs.

Livestock improvement

Livestock plays a key role in the rural livelihood and food security of remote communities in Malakand division. Thus, the following research and development initiatives are proposed for strengthening this sector in Malakand division.

- Preservation of native livestock breeds through selective breeding innovations;
- Problem oriented research on native livestock through optimum feeding, health management and husbandry practices;
- Enhancement of rural poultry production through introduction of high producing poultry breeds for backyard rearing;
- Improvement of cold/cool water fish production with national/international collaboration;
- Promoting livestock improved technologies through demonstration, capacity building, mass awareness and follow-up programs.

Postharvest management improvement and value addition

Postharvest management and value addition can enhance income generating resources of farming communities thus can be instrumental in alleviating poverty. The following research and development measures have been suggested for boosting this sector:

- Establishment of postharvest management laboratory and farm operations workshop;
- Value addition of perishable commodities (fruits/vegetables/dairy products);
- Improvement of technology for packaging and transportation of fruit and vegetables;
- Introduction of low cost on-farm cool store facility for fruit and vegetables;
- Promotion of improved drying technologies for fruit and vegetables;
- Introduction of on-farm washing, sorting and grading of agricultural produce;
- Improvement of small-scale pre-cooling technology for fruit and vegetables;
- Promotion of small agricultural machinery for promoting mechanized agriculture;
- Hay production and value addition of fodder and packaging;
- Postharvest management technologies promotion through demonstration, capacity building, mass

awareness, financial facilitation and follow-up programs.

Conclusions and Recommendations

- Malakand division has been blessed with plenty of natural resources, huge potential for agriculture, livestock and tourism development along with key strategic importance, which should depict an improved community livelihood for this region;
- However, mismanagement of natural resources, emerging climate change induced risks, less research and development focus and government negligence in paying attention and investment for agriculture sector are the main hurdles in fully exploring and utilizing the available potential for improving the livelihood of local communities in particular, which may be equally beneficial for the country in general;
- The traditional spring/river fed Kuhl (gravity channel) irrigation system plays a key role in the agriculture of Malakand division but is now negatively affected due to drying of feeding springs or increase in pipe diversion of spring water for domestic purposes due to rapid population growth. Therefore, the perennial river fed Kuhl irrigation system needs to be developed for replacing the declining traditional spring fed irrigation system to make agriculture more sustainable in Malakand division;
- More access to natural gas and LPG at subsidized rates for fuel for the inhabitant of Malakand division will save the environment by controlling decline in forest areas and ground cover thus may lead to reduced erosion and loss of natural resources;
- Increased investment and improved need based research and development initiatives in the fields of natural resources management, crops and horticulture, livestock, postharvest management of agricultural commodities have been proposed for improving climate resilience and livelihood of communities in Malakand division;
- Promoting appropriate climate resilient and site specific intervention through capacity building, mass awareness, demonstrations, stimulating their adoption through participatory financial support and follow-up programs may be helpful in agricultural development in this region, which may lead to improved community livelihood and food security on sustainable basis.

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Conflict of interest

The authors have declared no conflict of interest.

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