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Risk management for small farmers in Pakistan: A review

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Limited progress has been made in the area of risk management for small farmers in Pakistan. Thus, in this review based study, maximum efforts have been made to collect relevant information on the topic from available published sources over last two decades. The local information is supplemented by synthesis of information about regional as well as non-regional countries. In the country, wide gap in agricultural productivity exists between average and progressive farmers that is causing difficulty for small farmers in managing risks. Small farmers are unable to access and compete in high end agricultural markets. Profitability of major crops is quite low and producers' shares in consumer rupee are also quite low for fruits and vegetables. It affects farmers' capacity to invest in the sector. While, in the farming business, disbursement of right amount of credit at appropriate time is a key challenge. Similarly, cost of borrowing is inversely related to size of land holding. Thus, small farmers are to rely on informal sector for finances and bear high interest rate on small size loans. Their crop choices depend on productivity and price risks and prudent risk sharing among themselves. Furthermore, their choice to diversify farms also depends on consumption price risk. Illiteracy and inability to read or write make them susceptible to various personnel and human health risks. Crop and livestock insurance schemes, Kissan package, value chain contract financing are the initiatives taken by the public and formal sector banks to support small resource poor farmers. However, there is lack of coordination among agriculture related provincial institutions, provinces as well as with and within federal institutions. Similarly, absence of institutional arrangement and regulatory framework is resulting in vulnerability of livelihood for small farmers as well as undue pressure on natural resources.

Keywords: Finances, health, Insurance, Management, Small farmers, Natural Resources, Pakistan, Productivity, Price, Risks

INTRODUCTION

Pakistan has very diversified food producing agro-ecological zones and large population of livestock. Agriculture sector is the linchpin of the national economy as it contributes 19.31 percent to the GDP and employs 38.49 percent of the labour force. The agriculture sector registered a growth of 2.67 percent in the financial year 2019-20. Crop, livestock, and fisheries & forestry sub-sectors of the agriculture contributed 37.34, 60.56 and 2.10 percent, respectively to agriculture GDP (Anonymous, 2020). In the financial year 2018-19, the sector grew at just 0.85 percent; crop, livestock, forestry and fisheries sub-sectors grew at -4.4, 4.0, 6.47 and 0.79 percent, respectively. The country produces 24.946 million ton wheat, 9.178 million bales of cotton, 66.880 million ton sugarcane and 7.410 million ton rice. Pakistan has livestock population of 207.4 million heads with milk and meat productions of 61.69 and 4.71 million ton per annum, respectively. Annual productions of citrus, mango and guava are 2.47, 1.64, 0.56 million ton, respectively. Similarly, the country produces 0.40 million ton chickpea, 0.12 million ton mung bean and 2.06 million ton onion (Anonymous, 2019).

Agriculture sector deserve higher public sector investment because, it guarantees food security to 212.82 million people, it is life line for industrial sector, provides job opportunities for millions through services and value addition. The sector has maximum return; with minimum investment, cost of development, dependence on energy and gestation period. Moreover, agriculture sector is the most potent weapon for poverty alleviation and equitable distribution of wealth in the society. While, agricultural productivity in Pakistan is low due to subsistence holding sizes by majority of the farmers, inferior organization, poor human capital, old age technologies and limited use of physical inputs. The sector is characterized by large number of small scale producers, having less than 2 ha landholdings (8.3 million, 64% of the total farmers in the year 2010), who mainly depend on agriculture for their livelihood. The total number farms under

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two hectare has more than tripled since 1960 (Anonymous, 1960, 2000 & 2010). Subsistence farmers play a big role not only in crop and vegetable farming but also in livestock husbandry. Their contribution can be gauged from the fact that they share ninety percent of total milk that enters the marketing channels from smallholder farms (Anonymous, 2018). However, most of the small farmers are either illiterate or poorly educated. This can be gauged from the statistics that the literacy rate of the population, aged 10 years and above in rural areas is much lower (49%) than in urban areas (74%), (Anonymous, 2016a). Which is a main hindrance in knowledge dissemination, adoption of high yielding varieties and improved technologies.

The farming business is much risky due to openness to nature, input and output price fluctuations, inconsistent public policies and varying international markets etc. These features impact farming income and can cause wide swings in farm income (Anonymous, 2020a). In Pakistan, small farmers have restricted ability to take risk and diversify their farms due to less than viable/ productive land holdings and bourgeoning poverty. Furthermore, land titling/ records tie up a large proportion of them in litigation and unproductive activities. These factors lead to reduced access to farm inputs, credit, technology, services, justice and output markets etc. (Malik, 2015). Thus, livelihood of the farmers and employment in agriculture are endangered by frequent price instabilities, natural hazards and crop failures (Bwambale *et al*., 2022; Khan *et al.,* 2015 and Brida *et al*., 2013 and Anonymous, 2011). As small scale farmers in the country also lack access to financial sources, thus they are reliant on middlemen, and input suppliers. Which generally results into high cost of production, as high prices are charged for low quality inputs supplied to them. Similarly, they are to rely on middlemen to dispose of their produce. It results into low prices of the produce for them. A broad range of disasters including, earthquakes, landslides, glacial lake outburst floods, flash and riverine floods, snow and hail storm, extreme temperatures/ droughts, cyclones and insect-pest attack also affect farming sector and livelihood of the farmers in many parts of the country from time to time (Anonymous, 2016b; Javaid and Yang, 2016). Natural hazards in Pakistan's could be ranked between moderate to severe. Moreover, agricultural risks vary with the topography, farm families in semi-arid, mountainous and semi-desert areas of the country are more vulnerable to environmental shocks than in irrigated plains and other ecologies due to limited in-situ livelihood sources (Banerjee *et al*., 2016). People in these areas have less arable land, there are variable climatic extremes, subsistence based farming systems, and insufficient value chain development (Jasra *et al.,* 2016). Climate change projections are not in favour of farming sector. Similarly, it is predicted that there will be mounting pressure on limited surface and ground water resources (Anonymous, 2018).

While, risk management by choosing among alternatives reduces financial effects of such uncertainties (Anonymous, 2020a). Keeping all this in retrospection, the study is carried out to amass and synthesize information about risk management in the farming by small landholders in the country. Relevant literature about the topic has been amassed from various published public, semi-government and private sector documents, including research articles, published research reports, books, conference/ seminar proceedings, official documents including policy papers, working papers, published essays, reports and unpublished student thesis over last three decades. The essence of literature has been presented under different sections in the article; first, overview of different types of risks in Pakistan's perspective is presented viz. production, technical, marketing, financial, institutional, human & personal, and catastrophic risks. Secondly, existing programs and approaches for risk management are summarized. Finally, based on the comprehensive review of relevant information, farmers' risk management practices, feasible options and measures to manage risks by their types are summed.

***Overview of Farming Risks*:** In Pakistan small land holders are the largest stakeholders by livelihood dependence and investment in agriculture. High level of risks with restricted access to financial resources and support services make them susceptible to impoverishment spiral. They have to face pressure to feed the family and repay loans at harvesting time. Thus, their cash income as well as investment potential are get affected (Anonymous, 2018). Smallholders consider that price and yield variability can considerably affect their income. While, other sources of risk are considered less important in affecting their earnings, that may arise due to changes in input cost, farm programs, government regulations, and land rent etc. Small farmers prefer to maintain financial reserve and enterprise diversification over forward price and crop insurance for effectiveness in reducing risk. However, most of them do not consider risk/reward trade-off that underlies most of risk management (Coble *et al.*, 2004). Different types of risks faced by smallholders in the country along with their impact on farmers' livelihood are presented in following sub-sections.

***Production and Technical Risks*:** The country experienced considerable yearly variations in crop production. Wide gaps in productivity between the progressive and average farmers had failed to narrow, keeping Pakistan well behind other nations both in terms of agriculture growth and resource-use efficiency (Aslam, 2016). In this regard, seed is a vital input for crop production upon which, the efficiency of other agricultural inputs greatly depends. The supply of certified seed in the country is limited to only few major crops viz. wheat, rice and cotton. While, farmers are to rely on non-certified seed for minor crops like fodder, pulses, and vegetables. In the same way, true to type nursery plants for vegetables and fruits is also lacking throughout the country

(Anonymous, 2018). Availability of improved seed for all the crops is much less than requirement except paddy, the availability for which is higher than the total requirement. Excluding rice, availability of improved seed is about 4.85 percent of requirements for all other crops (Table 1). Just in case of four crops viz. cotton, maize, vegetables and fodders the country have availability of improved seed greater than one-third of the requirements. Moreover, in case of potato, maize, vegetables, fodder and oil-seed we are mainly reliant on imported seed and private sector for other crops (Anonymous, 2020).

Farmers in the country have well adopted few crop production practices while lacking in others (Mahmood *et al.,* 2006). Farmers are deficient in recommended information, specifically regarding fertilizer, seed rate and insect-pest identification (Hassan *et al.,* 2020). Extensive and imbalanced use of chemical fertilizers has resulted in stagnancy in crop yields along with environmental implications. Small farmers are unable to prepare land properly and adopt other mechanical production practices due to limited access to farm machinery. Moreover, farm mechanization is based on old technologies, which results into low resource use efficiency and high repair and maintenance cost for them.

Farmers in the country have awareness about major insect pests, but they face great difficulty in distinguishing different insect pest species. Similarly, knowledge about crop diseases and major weeds is very limited. Small land holders, generally perceive that weeds are a constant and unresolved problems. They consider that weeds have less impact on crop yield than insect pests. They are unaware about pest scouting as well as judicious use of pesticides. Farmers mainly relay on chemical methods for pest control. However, knowledge on pesticide safety issues is below average (Khan and Damalas, 2015). Access and adoption of Integrated Pest Management (IPM) practices, and precision agriculture technologies viz. land laser leveling, yield monitors and micro-sprinkler fertigation etc. by small farmers is limited due to small holdings and non-applicability of most of these technologies in the small scale farming (Mahmood *et al*., 2016).

The country has entered into the arena of agricultural biotechnology. Though progress on this front is limited, as only a few institutions have reached a stage where they have some deliverable products, which are limited to potato & cotton crops and banana fruit (Malik, 2014). In the country, organically produced food is now being preferred over conventionally produced food. Most of the smallholders in Gilgit-Baltistan region and Balouchistan province organically produce crops and fruits. However, the produce is not certified as organic, thus they are unable to reap economic benefits of their produce in real terms. Similarly, most of the national livestock herd is low producing nondescript in nature. Dairy animals in the country (buffaloes and cows) mostly strive on low quality feed stuffs. Feeding of the animals on roughages and crops residues having low nutritive value along with poor livestock husbandry result into less than optimum milk production and poor reproduction performance. Furthermore, recent investigations show that there is also issue of unjustified feeding without considering

Table 1. Improved seed requirement and availability in Pakistan.

Sr. No.	Crops	Area (000Ha)	Seed rate (Kg/Ha)	Seed requirement (ton)	Seed Availability				
					Public	Private	Imported	Total	As % of requirement
1	Wheat	9,160	124	1,131,260	5,887 (12.18)	42,458 (87.82)	-	48,345 (100)	4.27
2	Cotton	2,895	20	57,205	89 (0.41)	21,755 (99.59)	-	21,844 (100)	38.19
3	Maize	1,328	25	32,794	195 (1.28)	3,074 (20.12)	12,006 (78.60)	15,275 (100)	46.58
4	Pulses	1,185	36	42,674	504 (17.89)	2,313 (82.11)	-	2,817 (100)	6.60
5	Oilseeds	830	13	10,790	356 (23.12)	429 (27.86)	755 (49.03)	1,540 (100)	14.27
6	Vegetables	280	30	8,400	-	35 (1.24)	2,792 (98.76)	2,827 (100)	33.65
7	Fodders	2,038	30	61,140	10 (0.04	4,270 (17.89)	19,590 (82.07)	23,870 (100)	39.04
8	Potato	465	2,502	1,163,500	-	-	5,211 (100)	5,211 (100)	0.45
	Total	18,181	-	2,507,763	7,041 (5.8)	74,334 (61.1)	40,354 (33.2)	121,729 (100)	4.85

Source: Anonymous, 2020;
Note: Figures in parentheses are percentages shares

the production and physiological stages of dairy animals (Tariq *et al*., 2016). National level survey revealed that gaps in milk yield of Nili-Ravi and Kundhi breeds of buffalo are 42% and 32%, respectively (Aujla and Hussain, 2015). Similarly, gap in the milk yield of majorcow breeds is even more viz. 112% and 44% in case of Sahiwal and Red Sindhi breeds, respectively (Hussain *et al*., 2014). Dairy animals are undernourished and prone to suffer from various diseases, which result into low animal productivity and put at stake livelihood of subsistence farmers.

***Marketing Risks*:** The agricultural marketing system in the country is inadequate to handle volume of the produce. It lacks basic infrastructure and facilities for the farmers and market intermediaries. Inappropriate and inefficient marketing system results into both quantitative and qualitative losses of the agricultural produce and causes welfare loss to stakeholders. On the other hand, it creates opportunities for numerous market players to exploit small farmers. Due to inefficient market system, an agricultural commodity changes seven to eight different hands before reaching ultimate consumer. Similarly, farm market roads are less than required length of 0.35 million kilo meter by almost five times. Furthermore, most of the existing road infrastructure is in poor conditions due to lack of regular repair and maintenance. Due to inappropriate post-harvest handlings, 35-40 percent of the fruit and vegetable produce goes to waste. Similarly, 8-12 percent of food grains is lost (Anonymous, 2009).

Due to improper market facilities, insufficient road infrastructure and to inappropriate post-harvest handlings, producer's share in consumer rupee for fruits and vegetables are quite low in the country. Mean shares of producer in consumer's rupee for fruits and vegetables are 23%and 57%, respectively. On the contrary, in case fruits, pre-harvest contractors and retailers; while in case of vegetables, wholesalers and retailers share major chunk of consumer rupee. (Table 2).

Small farms are seriously challenged today in ways that make their future precarious. Increasing cost of production and low commodity prices have affected farmers' capacity to invest in the sector. The demand for fruit, vegetable and livestock products is increasing in changing marketing chains. Thus, it is an opportunity for the farmers to produce and market high value products. However, their produce doesn't enter high-end local and international markets. As small farmers have limited ability to compete in high end markets as they are not well positioned to compete with their counter parts having large land holdings and better access to these markets (Hazel, 2005).

Value chain contract farm financing and interest free/ low cost loaning are other options that should be adopted at wider scale to increase smallholders risk bearing capacity. Contract farm financing (CFF) is a mean of organizing commercial agricultural production both for large and small scale farmers (Eaton and Shepherd, 2001). CFF stabilize their income and minimize variations over time. However, it should be taken with few precautions about is applicability and scope. As, Dhillon and Singh (2006) expressed that varying quality norms adopted by contractors results in exploitation of smallholders. While, sometimes dishonesty at the part of farmers also sometimes results into failure of contracts. Saqib *et al*. (2016) stated that forward contracts are also use to manage agriculture risk in the country. However, the practice is adopted more by medium and large subsistence farmers than smallholders.

***Financial Risks*:** Rural credit markets in the country are characterized with many constraints. In case of formal credit, collateral is one of the major constraints as acceptable collaterals are land, houses and gold jewelry. In comparison to urban formal credit markets, key issues in rural credit are high transaction cost, small loan size vis-à-vis high interest rate and cumbersome procedures (Anonymous,2018) Thus, poor tenants and share croppers are left out of the credit programmes (Akram *et al.,* 2008). Furthermore, family labor involvement in farming, literacy status of the farmers, their off-farm income are important determinant of access to formal credit. Small farmers generally have low levels of education and off-farm income. Thus, informal credit is important source of financial access for them. While in case of informal credit, their total operated area, family labor, literacy status and off-farm income are important factors in determining the credit status of the smallholders from informal sources (Amjad and Hasnu, 2007).

Though rural support programs and micro-finance banks have increased their operational scope in rural areas. However, demand for agricultural credit by small land holders, tenants and sharecroppers is still unmet to a large extent. Thus, they

Table 2. Shares of producers and market intermediaries in consumer rupee for fruits and vegetables in Punjab (Percent)

Commodities	Producers	Pre-harvest contractor	Commission Agent	Wholesaler	Retailer
Fruits*	23 (15-37)	29 (20-39)	5 (2-6)	9 (5-13)	34 (24-44)
Vegetables**	57 (25-64)	-	6 (2-11)	24 (18-29)	13 (2-21)

Source: *Khushk and Sheikh, 2004; **Sharif, 2008

Note: Figures in parenthesis are ranges, Fruits = Mango, Dates (fresh), Citrus, Guava, Vegetables= Potato, Onion, Tomato, Peas, Carrot & Brinjal

are compelled to rely on informal sources to avail credit at a very high cost. It is estimated that total credit need of farming sector was Rs.1016 billion in year 2016-17. While, target set for institutional credit disbursement was even less than seventy percent of the demand. Similarly, due to increased supply of agricultural credit by commercial banks, disbursement of the credit by Zarai Traqiati Bank Limited (ZTBL) has reduced from 56% in 2001-02 to 19% in 2015-16. Small poorly educated farmers still hesitate to borrow from formal sector institutions due to non-acclimatization to sophisticated atmosphere of commercial banks and cumbersome documentation processes. Similarly, in case of farming business disbursement of right amount of credit at the right time has also been a challenge (Anonymous, 2018).

Disbursement of agricultural credit in the country is low e.g., in year 2012 it share in total credit was eight percent as compared to share of agricultural sector GDP as a share of total GDP (24%). Financial institutions consider rural financing unattractive in the country due to high cost of service delivery and credit risks due high price variability of agricultural produce, policy risks and willful rejections (Aslam and Latif, 2014). Resultantly, rural households often lack the resources they need to mitigate risk. Farming households commonly use stored grain, livestock holdings and monetary assets as a form of precautionary saving (Kazianga, 2004). Mutual credit and produce gifts have also been described risk sharing conduits among members of the same community (Fafchamps and Lund, 2003), or with distant relatives (Rosenzweig and Stark, 1989). Similarly, farmers' crops choices and extent of crop-livestock mix are affected by the produce price and productivity risks and efficient risk sharing among themselves. Furthermore, these choices also depends on consumption price risk (Kurosaki and Fafchamps, 2002).

Institutional Risks: The institutional setup of agriculture sector has changed significantly after 18th Amendment in the constitution, through which agriculture is declared a provincial subject. However, to remain abreast with the international technological development, price and stock situations, and provide national policy direction, Ministry of NFS&R was created at federal level by replacing the ministry of Food Agriculture and Livestock in 2011. The ministry was assigned key challenges such as narrowing technology gaps, ensuring food security, and overcome poor nutritional levels. Still there are lacunas in implementation of effective projects, plans and programs due to lack of coordination among provinces and with MNFS&R.

Similarly, weak institutional arrangements as well as regulatory framework for groundwater management is resulting into mining of aquifers. Resultantly, the agriculture sector is not achieving the desired performance and ultimate sufferers are small and marginal farmers (Anonymous, 2018). In the country, land holdings are skewed with high fragmentation and thin markets. Consequently, small farmers have decreasing access to farming land (Qureshi and Qureshi, 2004). On the contrary, small proportion of households (2%) control about half (45%) of the farm land in the country, which severely constraining agricultural production competitiveness and livelihood opportunities (Abbas, 2013). The country pursued efforts to address equity issues related to land tenure through land reforms in 1959 1972 and 1977 but with little success. Approximately 2.5 million acre land (5% of total farm area) were brought under reforms to reallocate land from landlords to tenants (Gazdar, 2009; Nabi *et al.*, 1986).

Likewise, access to rural credit is an issue closely related to land markets in Pakistan. Credit markets allow farmers to combine factors of production and enhance farm-level productivity, but only where those markets function effectively, and particularly where they serve the needs of small-scale owner-cultivators. The credit markets in rural Pakistan continues to be fragmented and are affected by distortions. The credit policy is diverted to influential large landowners (Malik and Nazli, 1999). Thus, it needs to be reviewed and should be implemented in a true letter and spirit to improve financial access of smallholder's access. The Zarai Taraqiati Bank Limited (ZTBL) is major formal loaning institution in rural areas. It provides about ninety percent of the formal loans in rural Pakistan. Though, ZTBL incurs high default costs and loaning by the banks is not cost-effective. Yet, the government support its working, as farming is highly risky business due to covariate risks. In brief, the bank contributes to welfare of farming households and its impact is higher for small farmers than large land holders (Anonymous, 2018; Khandker and Faruqee, 1999). Most of the federal and provincial level institutions could not get significant achievements as per their mandate viz. seed certification and registration, agricultural training and extension, plant protection, soil fertility and testing, irrigation & water management and market committees etc. Thus, over time weak performance of these intuitions has made smallholders more risk prone rather than risk secure.

***Human and Personal Risks*:** Pakistan imports huge quantities of chemicals for control of crop pests. Just for an instance, the country imported about 71.27 thousand ton insecticides/ herbicides/ fungicides in the year 2014 (Anonymous, 2016). The use of chemical pesticides increased 107 times from year 1980 to year 2014 i.e. from 665 ton to 71265 ton, respectively. Thus, use of chemical pesticides increased at the rate of 14% per annum (Hussain, 2018). Mean number of pesticide applications per crop season for cotton crop is eleven (Khan *et al.*, 2015). Their indiscriminate use result into accumulation of residues in various agricultural commodities, contaminated ground water and polluted environment. Which cause health risks for small farmers and farm labour (Anonymous, 2018). Most of the small farmers and labourors are either illiterate or can hardly read or write. They are unable to understand safety instruction for use of

agro-chemicals that generally written in English on the packing. Furthermore, they are not well aware of safety precautions required in their use. Thus, most of them do not use protective equipment during use of agro-chemicals e.g. in Southern Sindh half of the small farmers growing vegetables do not follow/ use safety equipment during their application as well as in harvesting the produce (Hashmi and Khan, 2011; Sheikh *et al*., 2011). Thus, they occasionally suffer from headache, flu/fever, cough, eye irritation, skin problems and sleeplessness. Bakhsh *et al.* (2016) reported that during cotton picking season in the country, one third of the pickers (66%) had to face one or more health effects of pesticides. They reported that cost of medical treatment of sufferings from exposure to pesticides use was also substantial considering meager financial resources of smallholder farmers i.e. more or less Rs.600 per season per household per annum. Similarly, Damalas and Eleftherohorinos (2011) and Jin *et al.* (2016) reported that substantial exposure to pesticides can also occur in or around the farming homes.

Lack of education, inadequate agricultural extension services and absence of state of art trainings to farmers are the reasons for non-adherence to the protection measures. IPM approach through establishing Farmer Field School can help reduce the use of agro-chemicals and decrease cost of crop production (Qadri *et al.* 2010). However, main constraint in the adoption of the approach is large allocation of financial resources required to upscale its use. Thus, pest scouting for judicious use of agro-chemicals, alternative cropping to avoid dependence on pesticide use and crop mulching to avoid use of weedicides etc. are options to reduce use of agro-chemicals and avoid toxic effects on farmers' health and environment. In addition, human health and environment risks can be minimized by taking necessary precautions along with use of suitable, well-maintained and calibrated spraying equipment (Damalas and Eleftherohorinos, 2011).

***Catastrophic Risks*:** Pakistan is ranked high among the countries most vulnerable to climate change (Bokhari, 2014). Surface and ground water availability per head is low and decreasing over time due to raid population increase (Parry *et al.,* 2013). This will have negative implications for agricultural production and urban water supplies specifically in Southern Pakistan (Tanner *et al.,* 2011). It is projected that greater variability in weather would result in frequent flood and droughts. The mode and extent by which these disasters would affect people and different sectors differ to great extent. However, openness to nature make farming sector more vulnerable to these changes (Anonymous, 2018). Sector-specific data about damage and loss caused by catastrophes is pre-requisite for effective policy and practice for the agriculture sector. The impact of natural calamities on agriculture sector growth and development and food security can be minimized by designing crop, livestock, fisheries and forestry sub-sectors specific measures and adopting more systematic strategies. Furthermore, there is pressing need to enhance commitments and financial allocations to risk reduction for the farming sector at both national and international levels (Anonymous, 2015). Likewise, livelihoods and food security of the people in Pakistan as well as South Asia are more vulnerable to the effects of extreme weather conditions like heat waves, cold spells, droughts, floods and windstorms. Due to climate change, timings of sowing, crop husbandry and harvesting have changed. Smallholders are unable to adapt themselves to changed situations suffer the most. They are averse to modern soil preparation, sowing techniques, mechanization and water saving irrigation techniques (Sukhera, 2017). Overtime, number of small and tenant farmers has increased. Increase in mean annual temperature and irregular rain fall patterns has affected both area and productivity of crops, specifically in semi-arid and arid areas. Thus, people residing in these areas have become more vulnerable to climate change than in irrigated plains. Sustainability in production and water management practices are the main strategies adopted to mitigate effects of the climate change. Smallholders are to adopt different strategies to manage effects of climate change including, occasional sale of livestock, reduction in household living cost, and migration to nearby cities for non-farm employment (Khan *et al.,* 2011).

***Programs and approaches for risk management in Pakistan*:** Agricultural Risk Management aims to build the adaptive capacity of farmers to cope with various risks described in section 1. One of the internationally recognized tool to improve farmers' adaptive capacity is R4 risk management program it includes; risk reduction, risk transfer, risk reserves and prudent risk taking. Risk management programs and approaches are always overarching i.e. a program or approach intended to manage a specific risk may also reduce one or more other farming related risks. Let take an instance, supply and use of quality seed would reduce production risk for smallholders on one hand, it also help them build risk reserves and enable them for prudent risk taking on other hand.

In Pakistan, public sector have taken few initiatives to reduce farming risks, most of these are directed toward production, marketing and financial risks viz. establishment of soil & water testing laboratories, interest free loaning, improving farmers' market access through increasing road infrastructure length from farms to markets and subsidized installment of high efficiency irrigation systems etc. However, farmers' trust building on public sector service providers is required to be improved to reduce institutional risks. Similarly, human and financial resource gaps in this regard can be filled by encouraging public-private partnerships (PPPs). These can be used to train farmers in crop production, plant protection and value chain development. Similarly, PPPs can provide services in farm mechanization, crop/ farm diversification, pest scouting & judicious use of pesticides, livestock checkups and vaccination etc. (Anonymous, 2018a).

Crop and livestock loan insurance schemes, Kissan package, value chain contract financing are few initiatives taken by the government and formal sector banks to support small resource poor farmers. Crop &livestock loan insurance schemes and value chain contract financing are risk transfer mechanisms. Crop and livestock loan insurance schemes aim to mitigate farmers' risks due to natural calamities. State Bank of Pakistan in collaboration with Government of Pakistan introduced Crop Loan Insurance Scheme (CLIS) in 2008 to reduce smallholders' vulnerability. The scheme was launched to cater the default risk of farmers due to natural calamities on all production loans. It provides repayment assurance to ZTBL and commercial banks. The crop loan insurance scheme is limited to major corps viz. wheat, rice, sugarcane, cotton and maize. Federal government bears the cost of premium to a maximum of two percent per crop in each crop season on account of eligible small and medium farmers, having subsistence land holdings viz. 12.5 acre in both Punjab & Khyber Pakhtunkhwa, 16 acre in Sindh and 32 acre in Balochistan (Anonymou, 2014). The scheme has limited coverage of small farmers in the country. It is applicable to the farmers having crop entries of major crops in the Land Revenue Record. Thus, it is also applicable to land less farmers and lessees etc. An alternate option to increase farmers' coverage for risk management is Index Based Crop Insurance (IBCI). It is the amount of money an individual farmer or a farming household is willing to pay for purchasing the insurance product, given its expenditure levels as well as background characteristics related to risk perception and risk aversion. In this reference, Ali (2013) reported that farmers in rain-fed areas of Pakistan consider IBCI to be an important risk management strategy. He found that farmers' willingness to pay a higher insurance premium depends on their economic status, assets holding and membership in community based organizations. Similarly, Livestock Loan Insurance Scheme for Borrowers (LISB) aims to mitigate the risk of losses of livestock keeping farmers due to natural calamities. The scheme provides insurance coverage for death of livestock due to disease/ natural death/ accident and floods, droughts, windstorm and heavy rains. It was launched in 2013 to covers all livestock production loans for purchase of animals up to Rs.5 million. The scheme is applicable for loans of Banks/MFBs extended for the purchase of cows, buffaloes and bull to the borrowers having maximum 10 animals are eligible. As is the case crop insurance, federal government bears the cost of premium for eligible borrowers. LISB facilitate small livestock farmers through reimbursement of livestock insurance premium up to maximum of 4% for the farmers getting financing up to 10 cattle. It is effective for all dairy, milch animals, fattening animals aged from 9 months to 7 year old. Main exclusion from the scheme is death of livestock due to epidemic diseases vis. anthrax, black quarter, food & mouth dieses, hemorrhagic septicemia and rinderpest, if animals is not inoculated/ vaccinated. Similarly, animals with pre-exiting diseases or injuries are also excluded from the scheme (Anonymous, 2014).

Prime Minister Kissan Package was announced in 2015 to help resource poor farmers in wake of hardships faced by them due to high cost of production, decline in prices of cotton and rice, and loss to cultivated land of cotton and sugarcane during floods in 2015. Annual policy analysis reports on major crops (cotton, sugarcane, rice and wheat) are issued by Agricultural Policy Institute (API). While, support prices are announced just for the wheat and sugarcane crops. Wheat is a food security cum political crop tilted towards large farmers. Most of the small farmers do not have enough marketable surpluses of wheat after meeting household requirements, thus are not benefited by the support price policy (Anonymous, 2018). Though support prices are announced for the crop by the government at the sowing time, however market forces play a main role in price determination of the wheat produce in wholesale markets at harvesting time. Dorosh and Salam (2008) stated that policies of Pakistan government that promote the private sector wheat trade can both increase price stability and reduce public sector fiscal costs. However, with the passage of time, depletion of public sector stocks and excessive hoarding by the private sector have resulted in excessive price volatility, and it becomes extremely difficult to manage wheat based food security. In case of sugarcane crop farmers' profitability is quite low due to weight loss caused by delays in start of crushing season, delayed crushing also results into delay in the sowing of Rabi crops particularly wheat, unstandardized weighing practices of sugarcane, unfair issuance of permits, low pricing of the produce than support prices& undue deductions, delayed payments, and overlap of domain of action between Food Department & Hilal Food Authority etc.

Contractual production of crops, vegetables, fruits, livestock and poultry provides a link to stallholders to either input market, output market or both. The farmers are linked to input supplying entrepreneurs, buyers including processors or both through formal or informal contracts. Contractual production is being practiced in the country for three major crops viz. sugarcane, maize and rice, and for tobacco and potato crops as well. Contractors also buy standing fruits crops e.g. mango, citrus, banana, dates, guava orchards and market them. Similarly, VCCFF by State Bank of Pakistan (SBP) is being practiced in the country by commercial banks. The scheme provides an alternate to smallholders who are unable to obtain traditional loaning by commercial bank due to collateral requirement. The key value chain players are farmers, input dealers, processors, traders and financing banks (Anonymous, 2014). This is a demand-driven credit scheme through which commercial banks provide a package of inputs, credit and agricultural advisory services to the smallholders in return for offering their land, labour and farming expertise (Anonymous, 2017). Financial support programs to enhance risk bearing ability of rural people indirectly include Benazir

Income Support Programme (BISP), Waseela-e-Haq to break the vicious circle of poverty through small loans, Waseela-e-Taleem to provide additional cash support to BISP beneficiary family for education of children up to primary level, and Wattan cards, Ehsas Kafaalat Program, and Ehsaas Emergency Cash program etc. BISP was launched in 2008 to help poor families by providing them financial protection against general price rise. Likewise, Watan cards scheme was launched in year 2010 to provide grants to flood affected rural population to manage their life style. Similarly, Ehsas Kafaalat Program, and Ehsaas Emergency Cash program are launched by the Poverty Alleviation and Social Safety Division in the era of present government.

Farmers' Risk Management Practices, Feasible Options and Measures to Manage Risks

Production and Technical Risks: Seed is the basic farming input on which the efficiency of all other inputs depends. Adoption of new high yield seed varieties is proved risk management measure. Thus, availability of certified seed along with true to type nursery fruit plants and pure livestock breeds is required to be enhanced. The country need to enhance scope of certified seed production from few major to maize and sugarcane along with minor crops like fodder, pulses, and vegetables. Reliance on imported seed should be minimized and smallholders access to certified seed be improved through subsidized supply, probably through money back security warranted vouchers. Public sector should also come up with simplifications in registration process of seed companies with relaxation in requirements for private entrepreneurs. So that healthy competition among them may result in enhanced production and distribution of certified seed. Along with this strict checks on the certified seed system should be maintained. Similarly, mechanisms should be developed for distribution of true to type certified nursery plants and semen of pure breed for artificial insemination specifically for smallholders in the country. In case of crop seed production, partnerships and value expansion (PAVE) for inclusive seed systems by Engro Foundation is an exceptional example. PAVE has built the capacity of considerable number of smallholder farmers around quality seed use and multiplication for rice, wheat and vegetables (Engro, 2021).

Revamping agricultural extension system is required to enhance adoption of recommended production practices for production of crops, fruits, dairy & fattening animals and fisheries. Agricultural extension, livestock & dairy departments and fisheries departments should have full-fledged livestock/ fisheries programs to impart latest knowledge to the farmers about management of dairy & fattening animals and fisheries on scientific lines. In this regard, effective use of Information and Communication Technologies (ICT) could be very instrumental. Rural youth should be involved in use of ICT for dissemination of farming knowledge, as their involvement will also stimulate their interest in farming business. There is need to promote and adopt balanced used of agricultural inputs to minimize production risks. Similarly, promotion of mix/ inter cropping can help farmer minimize crop failure risks. There is need to conduct research studies by analyzing whole farm economics by covering crops, orchards and livestock interactions to make viable recommendation to farmers to optimize crop-crop, crop-orchard, crop-livestock and crop-orchard-livestock mixes. Similarly, off-farm employment as an alternate livelihood strategy should also be considered an option to provide a hedge against production risks.

Farmers can manage production risk through increasing application of farm yard manure to increase organic matter and soil PH for better crop productivity. Similarly, farmers perceive enhanced use of agricultural inputs as a risk management strategy, as they attribute most of the increase in productivity to higher use of chemical inputs, specifically fertilizers and plant protection chemicals (Anonymous, 2018a). Production risks can also be minimized by through adoption of recommended farm production practices. In the same way, proper farm lay out, cleaning of water channels on regular basis, proper land preparation and appropriate crop & livestock care and management should be promoted. Though, small farmers have little affordability and applicability for adoption of hi-tech water savings techniques i.e. drip and sprinkler irrigations system; however, low cost technologies like ridge/ bed planting in case of field crops and mulching in case of both crops and fruit orchards have the potential to be adopted to reduce irrigation expenses. Similarly, in rain-fed areas, micro-catchments in case of fruit trees/orchards, gully plugging, check dams and spillways in case of field crops/ fruit plants/ forest plants have the potential to be adopted to averse production risks (Hussain, 2018). Similarly, land laser levelling should also be supported by the public sector to upscale its adoption by smallholder farmers (Hussain *et al.* 2016). On-farm management practices, particularly those that emphasize crop diversity through the use of poly cultures, cover crops, crop rotations, and farm-forestrycan significantly enhance small farmers risk bearing ability (Anonymous, 2019a).

***Marketing Risks*:** Improvement of marketing infrastructure and post-harvest handling is required to dispose of huge volume of the agricultural produce. Storage facilities at farm and market level along with development of cold supply chains in public-private mode are required to ensure smallholders substantial prices for their produce. Smallholders' access to high end markets and more integrated and demanding market chains should be enhanced through appropriate policy formulation and programs. Digitization of land ownership/ tenancy records to design buyback guarantee mechanisms from smallholder producers specifically for food grains is much needed. Similarly, strict enforcement of ceiling on commission/ profit charges by middlemen on purchase of farm produce is required. These steps would reinstate

farmers' confidence in the public sector institutions for procurement of wheat and other food commodities. There is need to abolish already existing politicized marketing committees that are tilted towards large landholders and serve the benefits of key market players/ middlemen. Middlemen role as an agent for transferring and reducing risks for smallholders have been overcame by their role as being a source of risk. Thus, it would be ideal to make formal liquidity arrangement for smallholders to save them from middle man trap.

***Financial Risks*:** Unfortunately, most of the smallholders in the country and even the large land owners do not take farming as an enterprise. Which results into inappropriate farm practices, non-judicious investments, as well as low profitability. While, agricultural decisions typically involve multiple criteria, some of which are subjective. In this perspective, decision making by farmers is often under undue constraints, pressures, temporary affluence of financial resources specifically at harvesting time. Baba and Hakemzadeh (2012) stated that such situations may result either from incomplete information, or an overload of information and engagement in multiple practices. It results into sub-optimal area allocation to crops and combinations of cereal crops, livestock, fruit, vegetables, poultry, fisheries etc. While, informed decision making leads to better farm management, better productivity and returns. Better farm level decisions reflect at national level so information based on real farm situation contribute to more effective policies.

There is need to document and assess the existing possible enterprises and selection of different activity combinations at farm level in terms of input requirements, resource base, rotational factors, market situations, productivity and profitability, and other necessary factors. Simple decision support systems are needed in doing such kind of analysis. Smallholders would also require to take farming as an entrepreneur rather than just a way of living. They would require to keep proper daily farm record of cash inflows and outflows. Moreover, it is important to train farm managers in analyzing different activity combination simultaneously and in using model based decision support systems to perform better at farm level which ultimately reflect at national level in increased production, diversified farming systems, raised farm incomes, import substitution and sustainable use of natural resources. Similarly, the country should sought promotion of integrated farming to improve smallholders' resource management strategy and compress financial risks.

Productivity and output price are the risks generally kept in focus by the farmers. While, input and consumption price risks are not given due consideration. Thus, smallholders should also emphasize these risks in judicious decision making at farm level in purchase of inputs and disposal of the produce. Advance selling of the standing crops and purchase of inputs on credit are risk transfer and aversion strategies adopted by the small farmers. Smallholders have already started to adopt alternative crops for major grain/cash crops e.g., replacement of potato crop in major production area with tinda gourd & cucumber in low tunnels to avoid price risk due to price fluctuations in mixed cropping zone. Similarly, in the cotton-wheat zone, maize and sugarcane are being adopted to averse financial risk due to price volatility of cotton as well failure of the crop due to low quality seed and other related factors.

***Institutional Risk*:** Improved coordination among provinces and with Ministry of NFS&R is required to overcome institutional risks. Similarly, better inter-ministerial as well as intra ministerial coordination i.e., within institutions/ departments of Ministry of NFS&R as well as provincial agricultural ministries is required. The institutes/ departments should also be strengthen as per their human, financial and logistic resources are concerned. This is specifically required for the institutions/ departments which are at the verge of redundancy due to either any of the above stated constraints or non-functionality due to time laps between their active involvement in routine functions as well as crisis management. In this regard, the most pertinent example is of Department of Plant Protection, working under the aegis of Ministry of National Food Security and Research. The department had to tackle locust attack in year 2020, after a time span of about 22 years. The outposts of the department lacked the capacity to destroy locust breeding places in plain areas of Balochistan, Thar and Nara deserts in Sindh and Thal desert in Punjab, specifically in terms technical manpower, both in number of vehicle mounted sprayers& spraying aircrafts, and quantity of chemicals and fuel. Resultantly the spawns became difficult to control and destroyed the crops almost round the year. Similarly, the performance on the land consolidation front needs to be improved through grass root level involvement of the concerned departments. Institutions should also be strengthened to generate rural off-farm employment by replacing food grains with hi-value crops viz. vegetables, fruits, livestock and fish production in first place, and then by increasing processing of hi-value agricultural products.

***Human and personal Risks*:** IPM approach through establishing Farmer Field Schools (FFS) can help reduce the use of pesticides and decrease cost of crop production (Qadri *et al.,* 2010). Similarly, implementation of alternative cropping systems that are less dependent on chemical pesticides could reduce the adverse effects of farming and particularly the toxic effects of the pesticides. Use of appropriate and well-maintained spraying equipment along with taking all precautions that are required in all stages of pesticide handling could minimize human exposure to pesticide and their potential adverse effects on the environment (Domalas and Elftherohorions, 2011). In the same way, use of bio-pesticides should also be promoted.

***Catastrophic Risks*:** Designing crop, livestock, fisheries and forestry sub-sector specific measures and adoption of more

systematic strategies can help smallholder to minimize the impact of natural calamities on agriculture sector growth &development, and ensuring food security. In this regard, crop and livestock loan insurance scheme and Index Based Crop Insurance are designed and used in the country. However, enhanced national and international commitment and budget allocation to risk reduction for the sector in this perspective is required (Anonymous, 2015).

***Conclusion and Recommendation*:** Small farmers are to face various types of risks mainly due to less than viable land holdings, burgeoning poverty and financial inability to invest in the farming. Crop production risks arise largely due to limited access to certified seed, true to type fruit plants and credit. Low use of farm yard manure, imbalanced use of chemical fertilizers, injudicious and excessive use of chemical pesticides and reduced access to technology and services also add into production risks. Similarly, non-availability of semen of pure livestock breeds, unjustified feeding of farm animals, inappropriate livestock husbandry and prevalence of epidemic diseases results into production risks. Marketing risks arise due to limited access and ability to compete in high end markets. Lack of farm to market roads, marketing infrastructure and poor enforcement of market regulations add into marketing risks for the smallholders. Financial risks generally arise from little access to formal credit markets due to lack of collateral and small loan size. Moreover, illiteracy and non-acclimatization of the small farmers to sophisticated environment of commercial/ ZTBL banks keep them out of the market. Resultantly, rural households often lack the resources required to mitigate risk. Institutional risks are caused by poor inter and intra coordination among provinces, concerned ministries and institutions. Furthermore, most of the federal and provincial institutions failed to achieve their mandated targets. Major consequences of weak institutional performance are depleting water resources, skewed land distribution, fragmented credit markets and poor extension services etc. Overtime, weak institutional performance has made smallholder more risk prone rather than risk averse. Likewise, irrational over use of pesticides cause human and personal risks. Variability in climate is causing shifts in cropping seasons and may results into catastrophic events like frequent floods and droughts. Corrective policy and implementation measures are needed both at public and farm level to overcome farming risks for smallholders. In this regard, prudent public sector support is required to improve their access to pertinent information, certified farm inputs, high end markets, finances and land. Similarly support services are needed to manage human & personal and catastrophic risks. A detailed primary data based study with a comprehensive sample size is required at national level to access small farmers risk management practices; to document success stories, innovative applications for management of various types of risks along with their direct impact on farming household, and to devise appropriate programs, approaches, strategies and tools for the risk management.

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REFERENCES

Abbas, S. 2013. Pakistan: Priorities for agriculture and rural development. Agribusiness Pakistan. Available online at https://www.agribusiness.com.pk/pakistan-priorities-for-agriculture-and-rural-development/

Ali, A. 2013. Farmers' willingness to pay for index based crop insurance in Pakistan: A case study on food and cash crops of rain-fed area. Agricultural Economics Research Review. 26:241-248.

Akram, W., Z. Hussain, M. Sial and H. Ijaz. 2008. Agricultural credit constraints and borrowing behavior of farmers in rural Punjab. European Journal of Scientific Research. 23:294-304.

Amjad, S. and Hasnu, S. A. F. 2007. Smallholders' access to rural credit: Evidence from Pakistan. The Lahore Journal of Economics. 12:1-25.

Anonymous. 2020. Economic Survey 2019-20. Economic Adviser's Wing, Finance Division Government of Pakistan, Islamabad.

Anonymous. 2020a. Risk in agriculture. U.S. Department of Agriculture. Economic Research Service 1400 Independence Ave., SW Mail Stop 1800, Washington, DC. USA.

Anonymous. 2019. Economic Survey 2018-19. Economic Adviser's Wing, Finance Division Government of Pakistan, Islamabad.

Anonymous, 2019a. Sustainable food and agriculture: An integrated approach. The Food and Agriculture Organization of the United Nations, Rome, Italy.

Anonymous. 2018. National Food Security Policy. Ministry of National Food Security and Research. Islamabad.

Anonymous. 2018a. Risk management practices of small farmers-A feasibility study for introducing R4 rural resilience initiative in Punjab. Sustainable Development Policy Institute, Islamabad, Pakistan.

Anonymous. 2017. Guidelines for value chain contract farming. Agricultural Credit and Microfinance Department. State Bank of Pakistan, Karachi, Pakistan.

Anonymous. 2016. Working paper meeting of the Federal Committee on Agriculture (FCA) Kharif season 2015-16. Ministry of National Food Security and Research. Islamabad.

Anonymous, 2016a. Household Integrated Economic Survey (HIES) 2015-16. Pakistan Bureau of Statistics (Statistics House), Islamabad, Pakistan.

Anonymous, 2016b. National institutional assessment on the integration of disaster risk management into agricultural sectors of Pakistan. FAO Representation, NARC Premises, Park Road, Chak Shahazad, Islamabad.

Anonymous. 2015. The impact of disasters on agriculture and food security. The Food and Agriculture Organization of the United Nations, Rome.

Anonymous. 2014. Guidelines for livestock financing. Agricultural Credit and Microfinance Department. State Bank of Pakistan, Karachi, Pakistan.

Anonymous, 2011. International Finance Corporation, Annual Report 2011. Washington, DC.

Anonymous. 2009. Final report of the working group on agricultural marketing infrastructure and post-harvest management for the 10th Five Year People's Plan, 2010-15. Food and Agriculture Section, Planning Commission of Pakistan, Islamabad.

Anonymous. 1960, 2000 & 2010. Pakistan Report. Pakistan Bureau of Statistics, Government of Pakistan, Islamabad.

Aslam, M. 2016. Agricultural productivity current scenario, constraints and future prospects in Pakistan. Sarhad Journal of Agriculture. 32:289-303.

Aslam, S. and Latif. M. 2014. Credit risk management practices used by banks in agricultural finance: A case study of Pakistan. International Journal of African and Asian Studies. 5:31-39.

Aujla, K.M. and Hussain. A. 2015. Economics of milk production of major dairy buffalo breeds by agro-ecological zones in Pakistan. Pakistan Journal of Agricultural Research. 28:179-191.

Baba, V.V. and Hakemzadeh, F. 2012. Toward a theory of evidence based decision making. Management Decision. 50:832-867.

Bakhsh, K., Ahmad, N., Kamran, M. A., Hassan, S., Abbas. Q., Saeed. R., and Hashmi. M. S. 2016. Occupational hazards and health cost of women cotton pickers in Pakistani Punjab. BMC Public Health. 16:1-11.

Bwambale, B., M. Nyeko, J. Sekajugo and M. Kervyn. 2022. The essential contribution of indigenous knowledge to understanding natural hazards and disaster risk: historical evidence from the Rwenzori (Uganda). Natural Hazards: 110:1847-1867.

Banerjee, S., M.Z. Anwar., G. Grioli, S. Bisht, S. Abid, N. Habib, S. Sharma, S. Tuladhar and A. Khan. 2016. An index based assessment of vulnerability to floods in the upper Indus sub-basin: What role for remittances? In: A. Milan, B. Schraven, K. Warner and N. Cascone (eds.), Migration, risk management and climate change: Evidence and policy responses. International Organization for Migration (IOM), Springer International Publishing, Switzerland. pp. 3-24.

Bokhari, A. 2014. Rising threat to crops from climate. Daily the Dawn. Available online at https://www.dawn.com/news/1084573

Brida, A. B. and T. M. Owiyo and Y. Sokona. 2013. Loss and damage from the double blow of flood and drought in Mozambique. International Journal of Global Warming. 5:514-531.

Coble, K. H., J.C. Miller, M. Zuniga and R. Heifner. 2004. The joint effect of government crop insurance and loan programmes on the demand for futures hedging. European Review of Agricultural Economics. 31: 309-330.

Damalas, C.A. and I.G. Eleftherohorinos. 2011. Pesticide exposure, safety issues, and risk assessment indicators. International Journal of Environmental Research and Public Health. 8:1402-1419.

Dhillon, S.S. and N. Singh. 2006. Contract farming in Punjab: An analysis of problems, challenges and opportunities. Pakistan Economic and Social Review. 44:19-38.

Dorosh, P. and A. Salam. 2008. Wheat markets and price stabilization in Pakistan: An Analysis of Policy Options. The Pakistan Development Review. 47:71–87.

Engro. 2021. Partnerships and value expansion for inclusive seed systems (PAVE). Engro Foundation, Karachi.

Available at https://www.engrofoundation.com/what-we- do/pave#:~:text=what%
20we%20do-
,partnerships%20and%20value%20expansion%20for%20inclusive%20seed%
20systems%20(pave),MEDA%20as%20the%20monitoring%20partner.

Fafchamps, M. and S. Lund. 2003. Risk sharing networks in rural Philippines. Journal of Development Economics. 71:261-87.

Eaton, C. and A. W. Shepherd. 2001. Contract farming: Partnerships for growth. No. 145. The Food and Agriculture Organization of the United Nations, Rome.

Gazdar, H. 2009. The fourth round and why the fight on: An essay on the history of land and reforms in Pakistan. Collective for Social Science Research, Karachi.

Hazel, P.B.R. 2005. Is there a future for small farms? Agricultural Economics. 32: 93-101.

Hashmi, I. and Khan D. A. 2011. Adverse health effects of pesticides exposure in agricultural and industrial workers of developing country. In: M. Stoytcheva (ed.), Pesticides - The Impacts of Pesticides Exposure. Intech, London. pp. 155-178.

Hassan, G., I. Ashraf, S. Ashraf, U. Talib, M. Luqman, S. Aslam, S. Shaukat and A. Ullah. 2020. Training
need assessment of radish growers in peri-urban areas of the Punjab, Pakistan. International Journal of Biosciences. 16:47-53.

Hussain, A., N. Akmal, H. Shah and W. Akhtar, 2016. Laser leveling as a resource conservation technology for sustainable agriculture. In: International conference on sustainable agriculture in Pakistan. U.S.-Pakistan Center for Advanced Studies in Agriculture and Food Security, University of Agriculture, Faisalabad.

Hussain, A., K.M. Aujla and S. Hassan. 2014. Economics of cow milk production in Sindh and Azad Jammu & Kashmir. Pakistan Journal of Agricultural Research. 27:21-29.

Hussain, A. 2018. Agroecological case studies from Pakistan, Proceedings of public seminar in the University of Uzbekistan, Tashkent, Uzbekistan. FAO, High Level Panel of Experts on Food Security and Nutrition. December 6, 2018. Available at https://www.fao.org/cfs/cfs-hlpe/news-archive/detail/en/c/1175276/

Hussain, A. 2018. Adoption and cost-benefit analysis, feasibility assessment and projection of the potential impact of water-saving technologies in Pakistan. An Unpublished Report of Social Sciences Research Institute (SSRI), PARC-National Agricultural Research Centre, Park Road, Islamabad.

Jasra, A.W., M.W. Maqsood, K. Waqar, A.B. Shrestha and D.J. Molden. 2016. Policy and practice challenges for mountain resilient villages in Pakistan. In: International Conference on Sustainable Agriculture in Pakistan. Jointly organized by University of California, Davis, USA & University of Agriculture, Faisalabad, Pakistan.

Javaid, T, and R. Yang. 2016. Improving farmers' access to crop loan insurance in Pakistan: Based on Punjab province. An unpublished thesis of Department of Agricultural Economics, China Agricultural University, Haidian Beijing China.

Jin, J., W. Wang, R. He, and H. Gong. 2016. Pesticide use and risk perceptions among small-scale farmers in Anqiu County, China. International Journal of Environmental Research and Public Health. 14 :1-29.

Kazianga, H. 2004. Consumption smoothing? Livestock, insurance and drought in rural Burkina Faso. Journal of Development Economics. 79:413-446.

Khan, M. and C.A. Damalas. 2015. Farmers' knowledge about common pests and pesticide safety in conventional cotton production in Pakistan. Crop Protection. 77:45-51.

Khan, M.A., A. Hussain, I. Mehmood, and S. Hassan. 2011. Vulnerability to climate change: adaptation strategies and layers of resilience in semi-arid zones of Pakistan. Pakistan Journal Agricultural Research. 24:65-74.

Khan, M., H.Z. Mahmood and C.A. Damalas. 2015. Pesticide use and risk perceptions among farmers in the cotton belt of Punjab, Pakistan. Crop Protection. 67:184-190.

Khan, M.M.H., I. Bryceson, K.N. Kolivras, F. Faruque, M.M. Rehman and U. Haque. 2015. Natural disasters and land-use/land-cover change in the southwest coastal areas of Bangladesh. Regional Environmental Change. 15:241-250.

Khandker, S.R. and R.R. Faruqee. 1999. The impact of farm credit in Pakistan. World Bank Policy Research Working Paper No. 2653.

Khushk, A.M., and A.D. Sheikh. 2004. Structure, conduct and performance of the marketing system, margins and seasonal price variation of selected fruits and vegetables in Pakistan. An unpublished report of PARC-Technology Transfer Institute, Tandojam, Sindh.

Kurosaki, T. and M. Fafchamps. 2002. Insurance market efficiency and crop choices in Pakistan. Journal of Development Economics. 67:419-453.

Mahmood, A., A.D. Sheikh, A. Hussain and M. Abbas. 2006. Recommended technologies and production practices at farm level: Wheat scenario. Pakistan Journal of Life and Social Sciences. 4:52-57.

Mahmood, H.S., T. Ahmad, Z. Ali and M. Ahmad. 2016. Adoption of precision farming technologies in Pakistan. In: Current Status and Future Prospects of Adopting Precision Agriculture in Pakistan's Farm Settings. University of Agriculture, Faisalabad, Pakistan.

Malik, K.A. 2014. Biotechnology in Pakistan – Status and prospects. Pakistan Academy of Sciences. Constitution Avenue, Sector G-5/2, Islamabad.

Malik, S.J. 2015. Agriculture policy in Pakistan – What it is and what it should be. Conference Paper presented at PIDE. (Available at www.pide.org.pk/pdf/Seminar/AgriculturePolicyPakistan.pdf)

Malik, S.J. and H. Nazli. 1999. Rural poverty and credit use: Evidence from Pakistan. The Pakistan Development Review. 38:699-716.

Nabi, I., N. Hamid and S. Zahid. 1986. The agrarian economy of Pakistan. Issues and Policies. Karachi: Oxford University Press.

Parry, J.E., M. Keller and D. Murphy. 2013. Identifying priority adaptation actions in Pakistan: A Situation Analysis. Water security. International Institute for Sustainable Development. 1-37.

Qadri, M.A., A.A. Siddiqui and Z. Mirani. 2010. Study of the farmers' awareness and adoption of integrated pest management for cotton in Khairpur Sindh. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences. 26:87-98.

Qureshi, M.G., and S. Qureshi. 2004. Impact of changing profile of rural land market in Pakistan on resource allocation and equity. The Pakistan Development Review. 43:471-492.

Rosenzweig, M.R. and O. Stark. 1989. Consumption smoothing, migration, and marriage: Evidence from rural India. Journal of Political Economy. 97:905-926.

Saqib, S., M.M. Ahmad, I. Pal, and S. Panezai. 2016. Forward contract as means for managing agriculture risk: the case of Pakistan. In: Conference on Linkages and Cooperation in Agricultural Production and Marketing in the Context of International Economic Integration at Vietnam National University of Agriculture.

Sharif, M., 2008. Structure conduct and performance of the marketing systems margins and seasonal price variations of selected fruit and vegetables in Balochistan NWFP Northern Areas and Azad Jammu And Kashmir. An unpublished report of Social Sciences Division. Pakistan Agricultural Research Council, Islamabad.

Sheikh, S.A., S.M. Nizamani, A.A. Jamali and M.I. Kumbhar. 2011. Pesticides and associated impact on human health: A case of small farmers in southern Sindh. Journal of Pharmacy and Nutrition Sciences. 1:82-86.

Sukhera, N., 2017. The perils of inaction on climate change in Pakistan. Daily the Dawn. Updated March 27, 2017 (Last Accessed on 8thMarch, 2018).

Tanner, T., S. Surminski, E. Wilkinson, R. Reid, J. Rentschler and S. Rajput. 2011. The triple dividend of resilience. Overseas Development Institute (ODI), International Bank for Reconstruction and Development / International Development Association or The World Bank. A report published by The Global Facility for Disaster Reduction and Recovery (GFDRR).

Tariq, M., P. Akhtar, Z.U. Rehman and A. Waheed. 2016. Prospects of feeding and nutrition for sustainable dairy production in Pakistan. In: Abstracts of International Conference on Sustainable Agriculture in Pakistan. Jointly organized by University of California, Davis, USA & University of Agriculture, Faisalabad, Pakistan.