Economic review of the pulses sector and pulses-related policies in Pakistan

David Vanzetti, Elizabeth Petersen and Saima Rani

Australian National University, University of Western Australia and PARC[1]

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Abstract

In Pakistan, pulse production has stagnated over the past 70 years, caused by the absence of growth in area planted and yields. Consumption has increased steadily and imports have risen dramatically in recent years. Concerned about this increase in imports, in 2007 the Pakistani Government stopped pulse exports by imposing a 35 per cent export tax. This was done with the intent to secure domestic production for domestic consumption. Since that time, pulse exports have all but ceased and pulse prices have increased dramatically in level and variability, in contrast to other crops. The Government also supports agriculture through subsidies on fertiliser, water and energy. These subsidies distort markets and prices and favour more fertiliser-intensive crop production over pulse production, which requires relatively less fertiliser. The Government implements a procurement price for wheat, which discourages pulse production by making pulses relatively less profitable and more risky to produce compared with wheat. We suggest that the Pakistani government remove the pulses export tax, phase out all agricultural subsidies, and remove the wheat procurement price. It should not implement a pulses procurement price. Instead, we suggest the Government diversify sources of imports, encourage participation in open markets, investment into sustainable agricultural productivity growth (through infrastructure development, research, development and extension), and develop social protection programs to provide safety nets during economic and food crises.

[1] The authors thank the Australian Centre for International Agricultural Research for funding this project. The views expressed are those of the authors, and do not necessarily represent the views of the affiliated institutions. Contact: david.vanzetti@anu.edu.au.

1. Introduction

Pulses are edible seeds of legumes. The main pulses produced or consumed in Pakistan are chickpeas, mung beans, mash beans and lentils (Harrison *et al.* 2017a). These products are international traded, and are substitutes in production and consumption with wheat, rice, sugarcane, cotton and other cereals. Like these substitutes, pulses are a storable commodity. Two desirable characteristics of legumes are that they fix nitrogen (production benefit) and are high in protein (consumption benefit) compared with other vegetable crops (Harrison *et al.* 2017a,b). Popular pulse dishes are hummus, made from chickpeas, falafel, made from chickpeas or mung beans, and dahl, made from lentils.

Pulses are a minor crop in Pakistan, grown on only five per cent of cropped area (PARC 2016), and hence it is important to establish their substitutability in production with major crops like rice, wheat, sugar and cotton. The main pulse crop is chickpeas (white gram) which is grown in the winter, as is lentils (masoor), and are substitutes in production with the other winter crops which include wheat, oats, barley and maize. However, chickpeas are grown on marginal lands and, due to their relatively low profitability, are generally considered not to be close substitutes for other winter crops.[2] On the other hand, lentils are considered quite substitutable with other winter crops.

There are two main summer pulse crops; mung beans (green gram) and mash beans (black gram). They are substitutes in production for cotton, sugarcane, rice and maize. However, like the summer crops, they are not close substitutes in production due to their relatively low profitability.

Prior to approximately 2005, real domestic prices of pulses showed only modest variability and growth over time. Since then, the variability of prices has been significant and prices have experienced a four-fold increase (PARC 2016). The area planted through time has remained constant since the late 1940s, as has pulse yields. This is in stark contrast to yields of rice and wheat which have experienced five-fold increases since 1960 in Pakistan. Pulse yields (0.4t/ha for chickpeas) are currently about half reported yields in India (1.0t/ha), and one-third of yields achieved in the United States (1.4t/ha), Myanmar (1.5t/ha) and Australia (1.2t/ha) (FAO 2017).

The consumption of pulses in Pakistan has increased steadily since 1960. To meet the shortfall between consumption and production, imports have increased dramatically from very little in 1980 to 420kt in 2011 (although this halved in 2013). Exports of pulses were negligible prior to 1980, and have been highly variable since then, reaching a peak of 170kt in 2007. Concerned about rising exports, in 2007 the Pakistani Government imposed a 35 per cent export tax with the aim of securing production for domestic consumption. The tax had the effect of all but stopping pulse exports from Pakistan.

Since implementation of the export tax, pulse prices have increased further in level and variability. With continued concern about stagnant production, variable and rising prices, and escalating imports, the Government has proposed that the provincial governments consider

[2] Our econometric evidence, presented in companion papers, suggests that at a national level at least, farmers switch between crops in response to changes in relative prices (Vanzetti *et al.* (2017a,b).

giving farmers a support price for pulses (particular lentils and mash)[3]. If the provinces agree, the support price for pulses will be similar to that already given to wheat growers.

The Australian Centre for International Agricultural Research, in collaboration with the Pakistani government, is currently funding research into improving productivity and marketing of pulses, as well as conducting evidence-based economic analysis of policies that impact pulse production and trade in Pakistan. This paper is one of a number produced from the research. The aim of this paper is to provide an overview of the pulse sector in Pakistan, and to review government policies affecting pulses production, consumption and trade. This information provides a background for economic modelling work that considers the economic welfare impacts of current and potential Government policies affecting pulses (Vanzetti *et al.* 2018a,b).

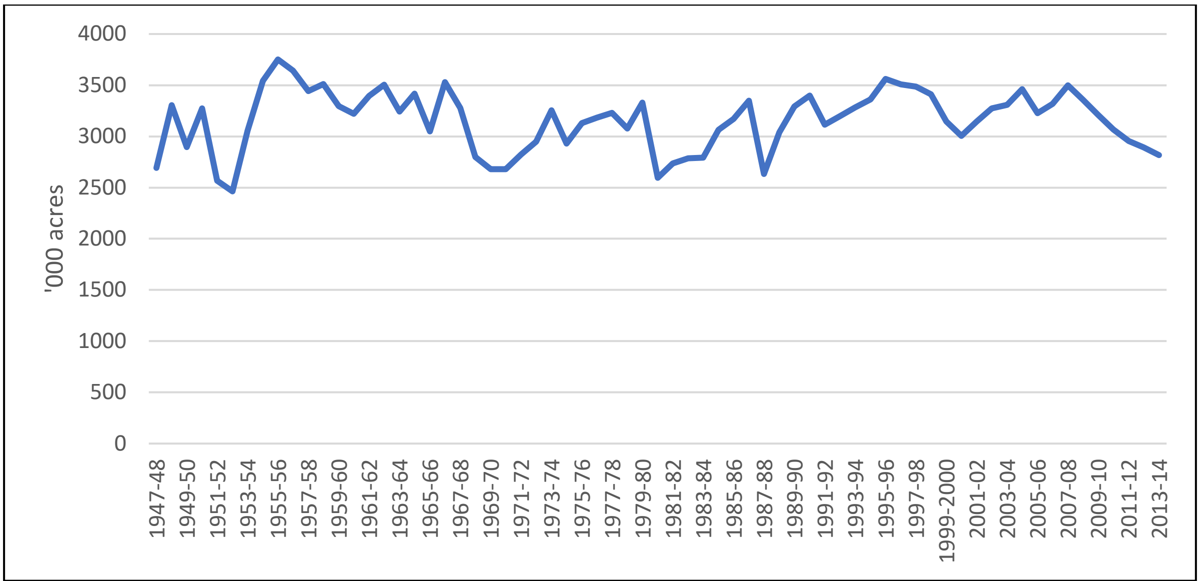
2. Overview of the pulse sector in Pakistan

This overview provides a background in developments of the sector over time in respect to area, yields, production, disposal, consumption, imports, exports, prices and cost of production.

Area

In the last ten years, production of pulses has stagnated and not kept up with consumption. The gap has been replaced by imports. The area planted to pulses has been steady since approximately 1960 (figure 1), reflecting the constant area planted to chickpeas (figure 2), the dominant pulse crop produced in Pakistan. The current area is around 2.8 million acres, compared with a maximum of 3.8 million in 1955.

Figure 1 Area planted to pulses in Pakistan

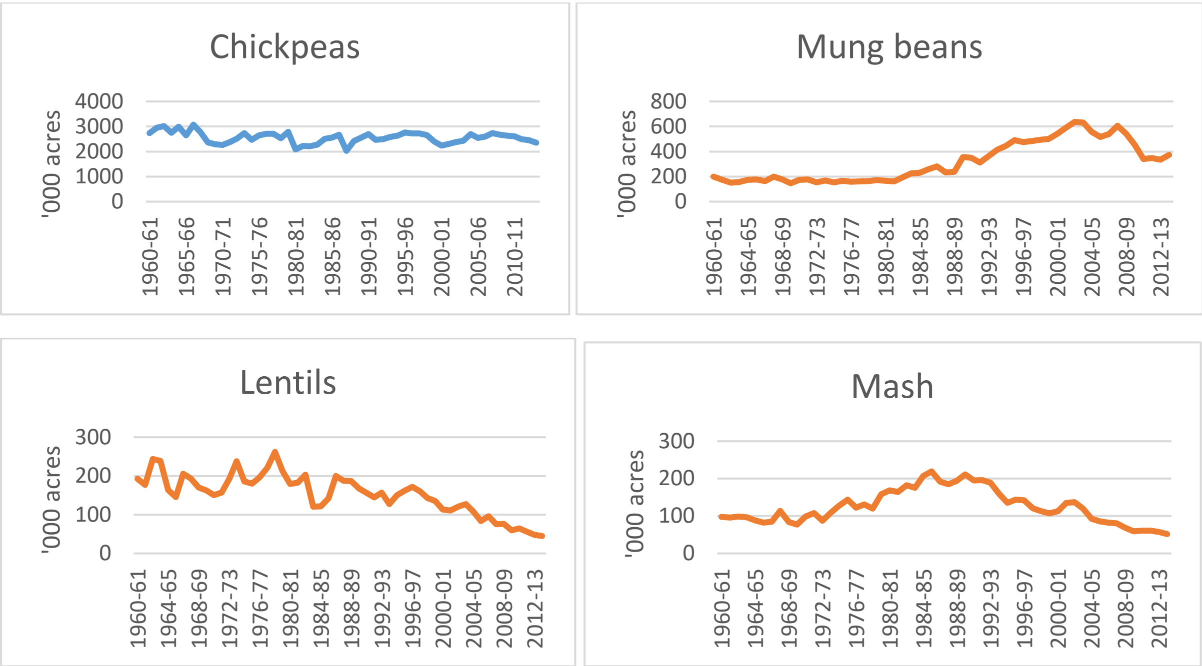


Source: Pakistan Agricultural Statistics via AMIS (2017).

[3] http://www.dawn.com/news/1216837.

While the area planted to mung beans has been increasing since the early 1980s, it too has declined since 2005 and is currently 373,000 acres. The area planted to mash beans has declined to 52,000 acres, and lentils to 48,000. Total area planted to pulses has been largely maintained since 1947-48, but there has been a significant decline since 2008. However, such falls have been observed previously, followed by an equally strong recovery.

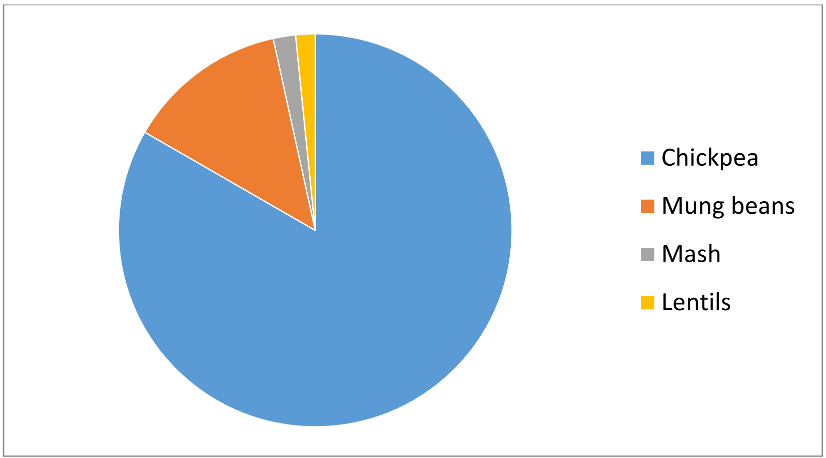
Figure 2 Area planted to pulses in Pakistan by type



Source: Pakistan Agricultural Statistics via AMIS. Note scale differs in each chart.

Chickpeas (gram) account for the bulk of the pulses crop, some 83 per cent in 2013-14 in terms of area planted (figure 3). The next largest is mung beans (moong) (13 per cent). Mash and lentils contribute barely 2 per cent each.

Figure 3 Pulses area planted in Pakistan, 2013-14



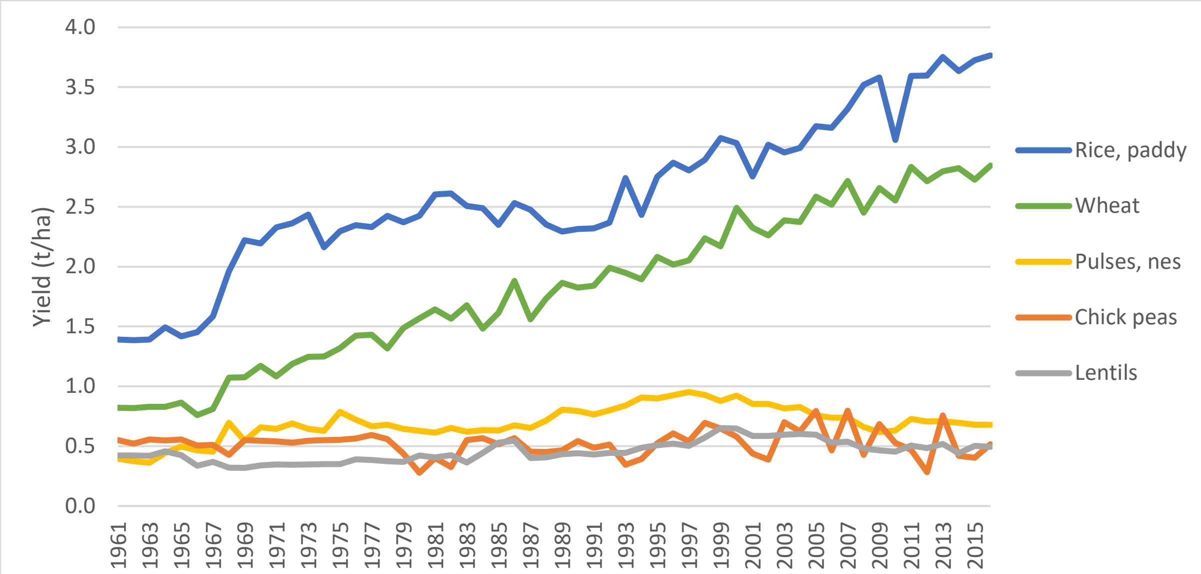
Source: Pakistan Agricultural Statistics via AMIS.

Yields

Although area planted to pulses has been relatively constant since the 1950s, yields have stagnated, meaning that the growth in production has not kept up the growth in other crops or with consumption of pulses. This has led to an increase in imports which has raised concerns within Government.

Average yields from 1961 are shown in figure 4. While rice and sugar (not shown) yields have doubled and wheat yields have tripled since 1961, yields of chickpeas, lentils and other pulses have barely increased. Of course, these are average, rather than potential, yields, and in any given year the average can be reduced by a poor year due to droughts or floods, particularly in non-irrigated areas, but nonetheless the contrast is somewhat striking. This is especially true when comparing the average yield of chickpeas and lentils in Pakistan (0.4t/ha for both crops) with that in India (1.0t/ha for chickpeas and 0.6t/ha for lentils) (FAO 2017).

Figure 4 Yields of pulses and competing crops in Pakistan



Source: FAOSTAT.

Growth in yields is dependent on a number of factors, one of which is public agricultural research and development (R&D) spending. Table 1 show trends in agricultural R&D intensity ratios in Asia Pacific for 1996, 2002 and 2008. In 1996, Pakistan's agricultural R&D intensity was similar to that of other middle-income countries Asia-Pacific countries. Since then, spending has been significantly lower. In addition, there is significant anecdotal evidence from agricultural policy stakeholders in Pakistan (informal interviews conducted by the project funding this research) that much of this research is focussed on the high-production crops in Pakistan (wheat and rice) rather than pulses.

Table 1 Agricultural research and development intensity ratios in Asia-Pacific, 1996, 2002, 2008

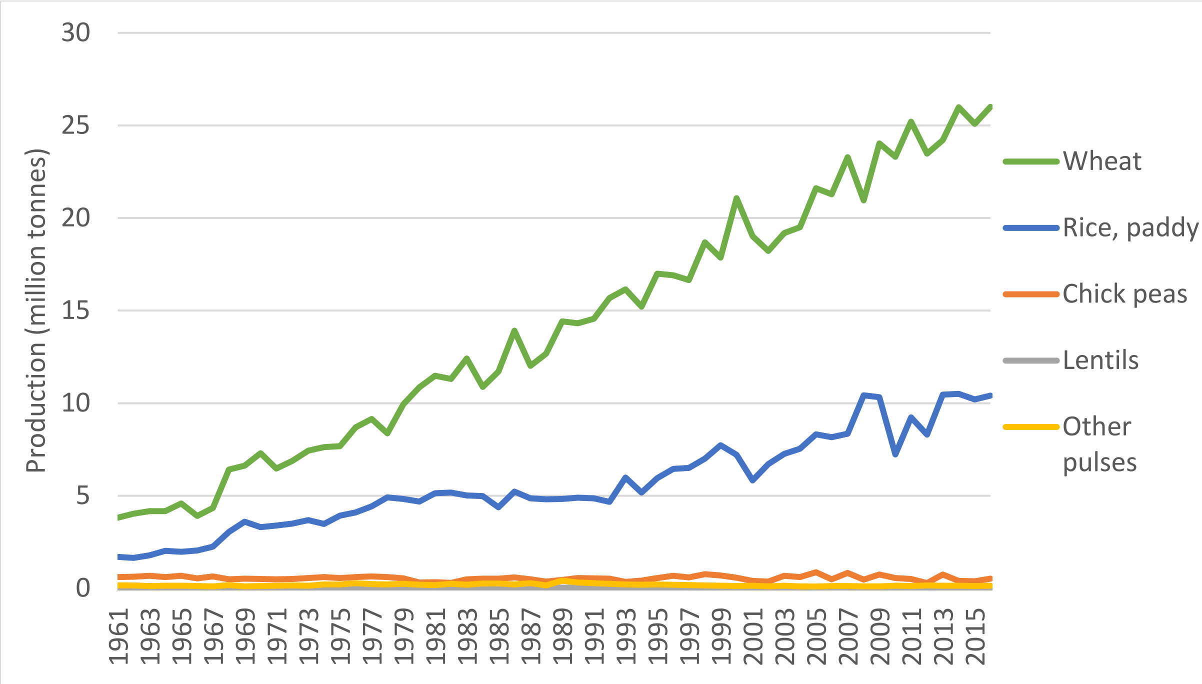
Income group/country	Public agricultural research and development spending as a share of agricultural GDP		
	1996	2002	2008
Low-income country average	*0.23*	*0.25*	*0.21*
Bangladesh	0.33	0.36	0.34
Cambodia	na	na	0.16
Myanmar	0.06	0.03	na
Nepal	0.25	0.35	0.27
Middle-income country average	*0.34*	*0.43*	*0.43*
China	0.33	0.46	0.50
India	0.25	0.38	0.40
Indonesia	0.37	0.28	0.31
Lao PDR	na	0.30	na
Malaysia	1.15	1.92	1.05
Pakistan	0.36	0.24	0.25
Papua New Guinea	0.77	0.54	0.39
Philippines	0.34	0.48	0.33
Sri Lanka	0.43	0.53	0.34
Thailand	0.69	0.51	0.32
Vietnam	0.09	0.17	0.17
High-income country average	*3.23*	*3.48*	*4.13*
Australia	4.06	3.35	3.56
Japan	4.03	4.79	5.46
Korea, Rep. of	1.66	1.45	2.30
New Zealand	2.57	2.15	2.22
Asia-Pacific average	**0.62**	**0.70**	**0.63**

Source: Flaherty *et al.* (2013)

Production

Production is area multiplied by yield. Production of pulses has remained constant over the decades as area planted and yields have stagnated (figure 5). Production of wheat has grown steadily, while rice production has grown in fits and starts.

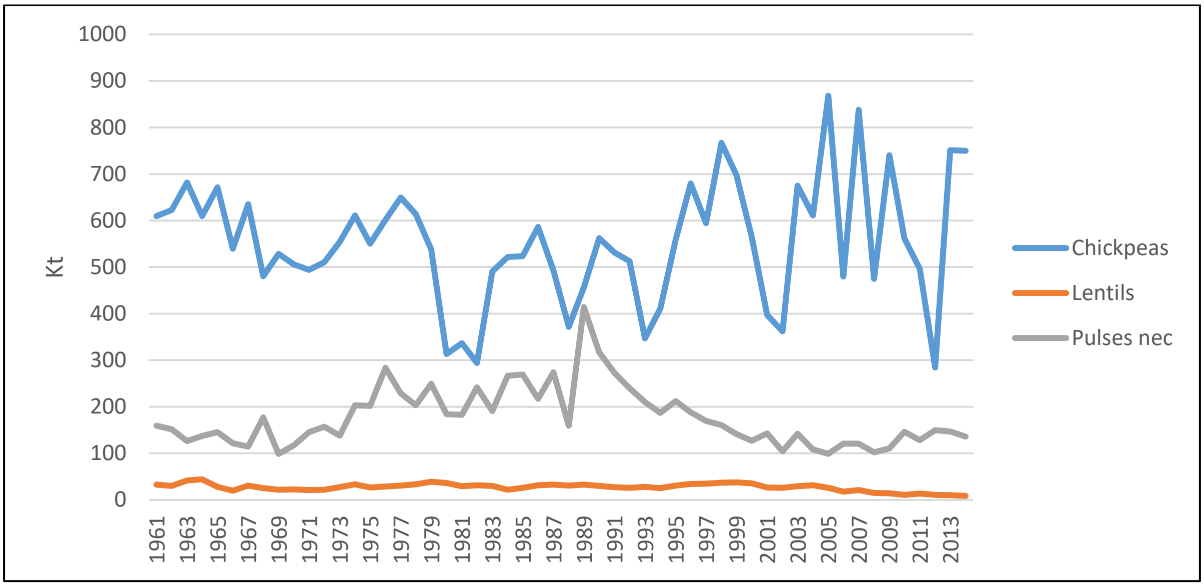
Figure 5 Production of pulses and competing crops in Pakistan, 1961 to 2016



Source: FAOSTAT.

Figure 6 shows national production of pulses in more detail. Chickpea production is extremely variable. This is a non-irrigated crop grown on marginal lands. Almost all the variation in production is explained by yields rather than area. The correlation between yield and production is 0.93. However, the decline in production of lentils and other pulses is due to a steady decline in area planted.

Figure 6 Production of pulses in Pakistan, 1961 to 2013



Source: FAOSTAT.

So far, we conclude that in the long run the area planted to pulses has remained relatively constant, although there has been a significant decline in the past ten years. Most of the variation in production stems from the variation in yields for chickpeas, the largest crop.

Disposal

Domestic production can be used for food, feed (for livestock), seed for planting future crops, export, storage (stocks) or lost through post-harvest waste. If domestic supply is insufficient for consumption, the shortfall can be imported. FAO food balance sheets for Pakistan pulses indicate that in 2013 domestic production of 906 kt was supplemented by imports of 176 kt (table 2). Exports are minimal, at least partly due to the 35 per cent export tax implemented in 2006. Domestic consumption (1.1 million tonnes) was dominated by food (74 per cent), feed for livestock (19 per cent), and to a lesser extent seed (5 per cent). Very little post-harvest waste was reported (2 per cent).

Table 2 Disposal of pulses in Pakistan, 2013

Source of domestic supply	**tonnes**	**%**		**Use of domestic supply**	**tonnes**	**%**
Production	905,800	84		Feed	202,997	19
Import quantity	176,454	16		Seed	59,204	5
Stock variation	0	0		Waste	21,636	2
Export quantity	101	0		Food supply quantity	798,316	74
Domestic supply quantity	*1,082,153*	*100*		*Domestic supply quantity*	*1,082,153*	*100*

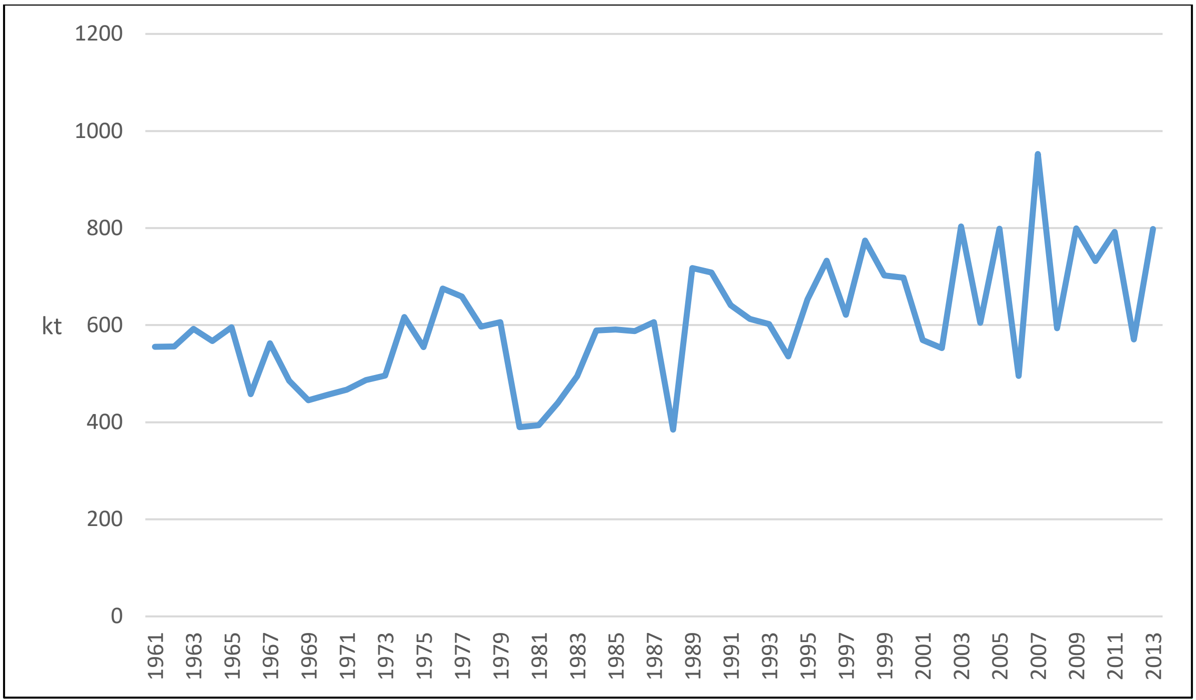
Source: FAOSTAT Food balance sheets.

Consumption

Apparent consumption of pulses in Pakistan, calculated from data on production, trade, stocks and other uses, has trended upwards slightly since 1961 (figure 7). A feature of the data is great variability. In other words, a shortfall in production does not lead to an offsetting increase in imports. For example, in 2006 production, at 618 kt, was well down on the previous year's crop of 980 kt. Imports rose somewhat but did not fill the gap (see figure 8 in next section). Feed and food consumption fell well below trend.

This approach was changed somewhat in 2011, another poor production year with 644 kt. On this occasion, imports rose to a record 425 kt and consumption was maintained at around 792 kt. 2012 was another poor production year, but imports did not fill the gap.

Figure 7 Consumption of pulses in Pakistan, 1961 to 2013



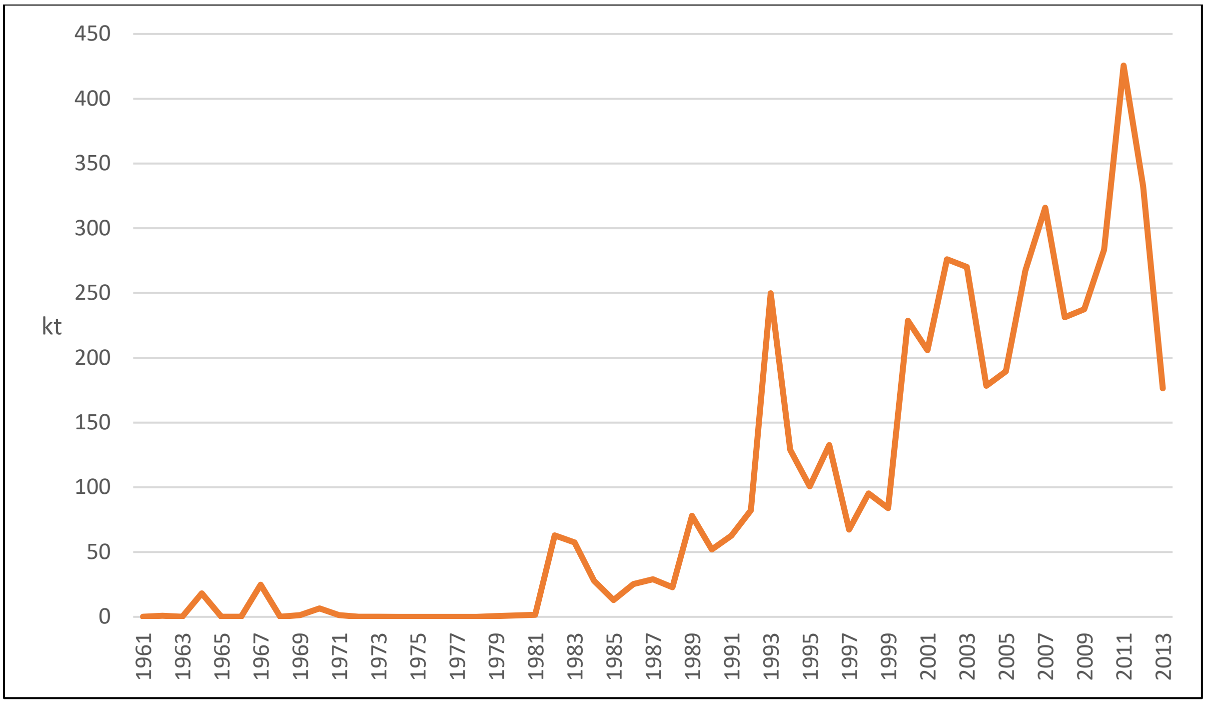
Source: FAOSTAT.

Imports

Imports of pulses in Pakistan have risen quite dramatically since 1981, with noticeable spikes in 1993 and 2011, both years of below average production (Figure 8). Data sources other than FAO suggest that imports increased in 2014 and again in 2015, leading to concerns that Pakistan is too dependent on imports.

Currently, there are two main types of pulse imports, chickpeas and lentils. The major import is lentils (US$96 million) and the major sources are Canada and Australia. Chickpea imports are worth $34 million, the major suppliers being Iran and Australia. There are many suppliers (20 or so) although India is a minor player in the market.

Figure 8 Imports of pulses in Pakistan, 1961 to 2013

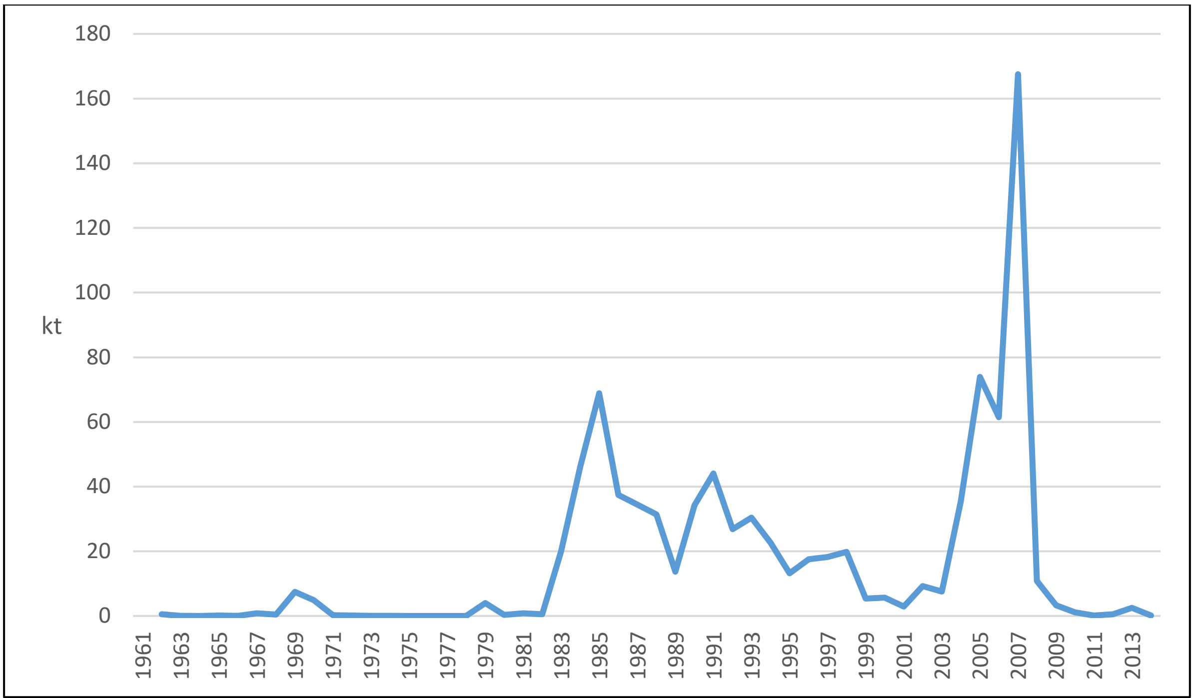


Source: FAOSTAT.

Exports

Exports of pulses from Pakistan were abruptly cut off in 2007 when the Government imposed a 35 per cent export tax. Prior to that there were few exports until 1982 when Pakistan opened to trade. Exports dwindled in the late 1990s until a boom in the early 2000s. Exports reached a peak of 167 kt in 2006, more than a quarter of the volume of production. 2006 was a low production year, and consumption of feed and food was low. Exports were effectively banned to assist consumers and users of pulses. The year the ban was imposed, 2007, was a good production year leading to a spike in consumption (figure 9). Since this time, prices have been steadily rising (see next section).

Figure 9 Exports of pulses in Pakistan, 1961 to 2013



Source: FAOSTAT.

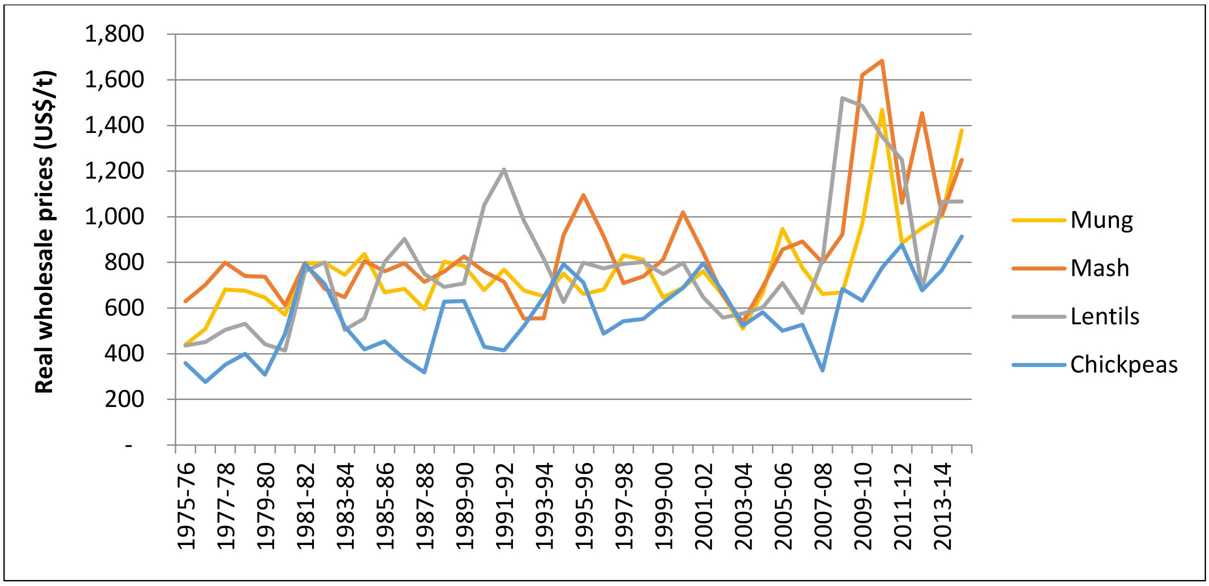
What explains the simultaneous importing and exporting of pulses? In 2006, 100 kt of chickpeas were imported and 69 kt exported. Lentil imports amounted to 81 kt but exports were relatively trivial, only 2.6 kt. Chickpea imports come from a variety of sources – the main suppliers being Iran, Canada, Myanmar and India – while the major export destination was India, which accounted for 90 per cent of total exports.

There are different varieties of chickpea so it is possible one type of chickpea was imported while another was exported. Another possibility was that a Government subsidy was implemented to discourage re-exports, thereby keeping domestic prices down. Traders could make money by importing chickpeas and re-exporting them to India. The Government may have applied an export tax to prevent this.

Prices

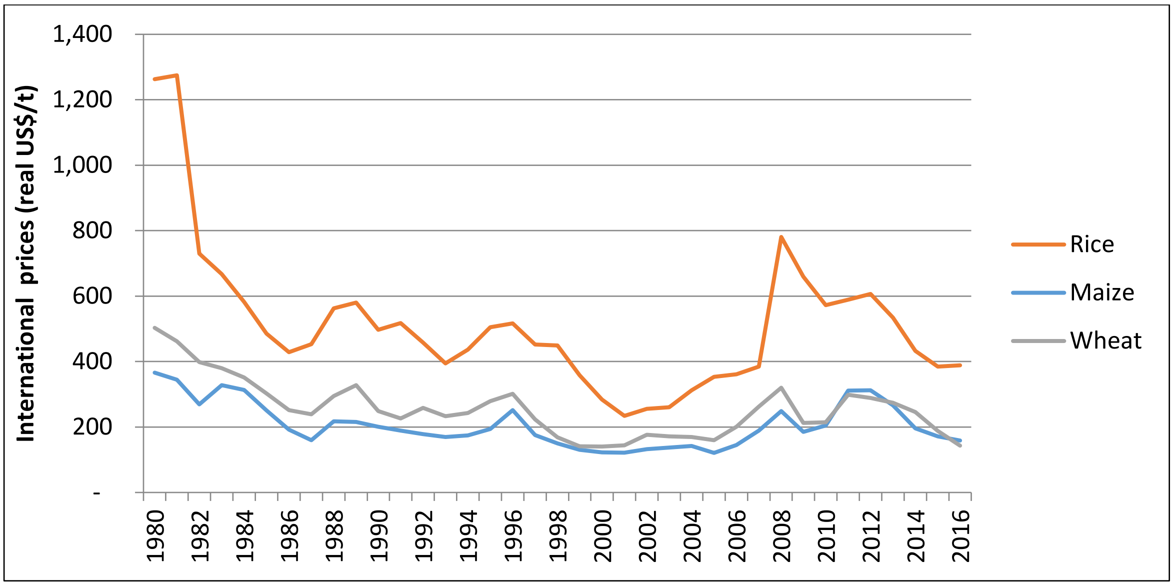
Producers and traders are responding to prices. Pulse prices have risen dramatically since 2008, from around US$700/t to US$1,100/t (figure 10). In terms of percentage change, chickpeas have increased the most over the last seven year of data (179 per cent), followed by mung (108 per cent), mash (56 per cent) and lentils (32 per cent). In 2006 the Government imposed a 35 per cent export tax in an effort to hold down domestic prices for consumers. In that respect, the policy does not seem to have been effective, although prices rose sharply for many international traded commodities in 2008 (figure 11). However, international grain prices have largely receded while domestic pulse prices have continued to rise.

Figure 10 Wholesale prices of pulses in Pakistan, 1975-76 to 2014-15 (real US$/t)



Source: Provided by PARC

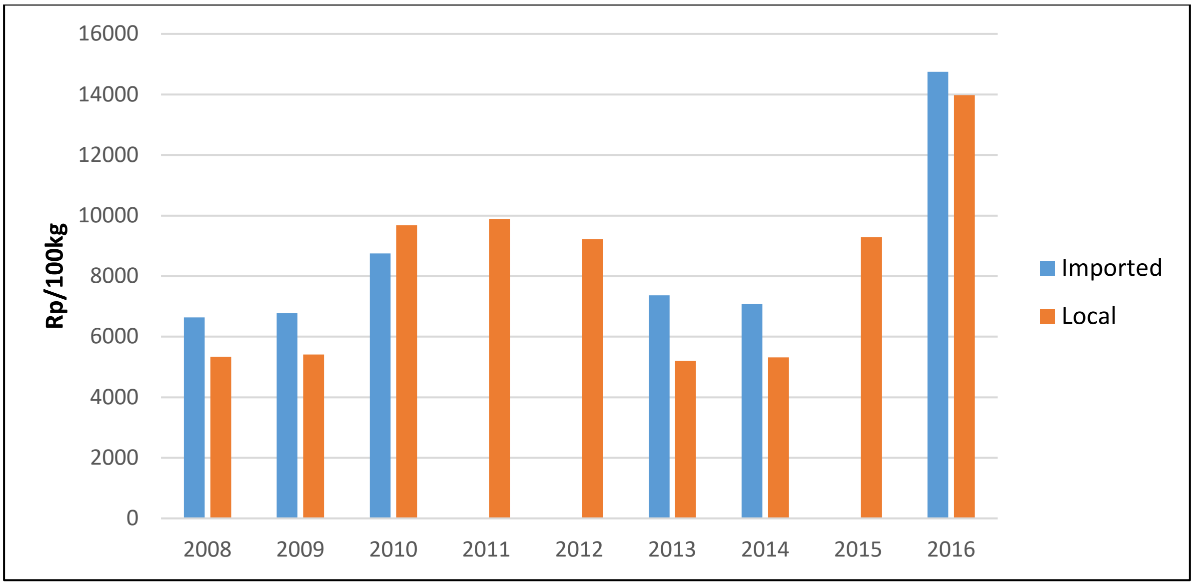
Figure 11 International rice, maize and wheat prices, 1980 to 2016 (real USD/t)



Source: IMF (2017).

Where there is scope for substitution producers respond to relative prices, for example between domestic production and imports, or between lentils and wheat. It is useful to look at relative prices as an explanation for the increase in imports. Since 2008, end of season (October) domestic (local) and imported chickpea prices have tended to move together, according to AMIS estimates (figure 12). Local chickpea prices have generally been sold at a discount to import prices although 2010 was an exception. World pulse prices were very high in 2016, and domestic prices went up accordingly. Prices fell back in 2017.

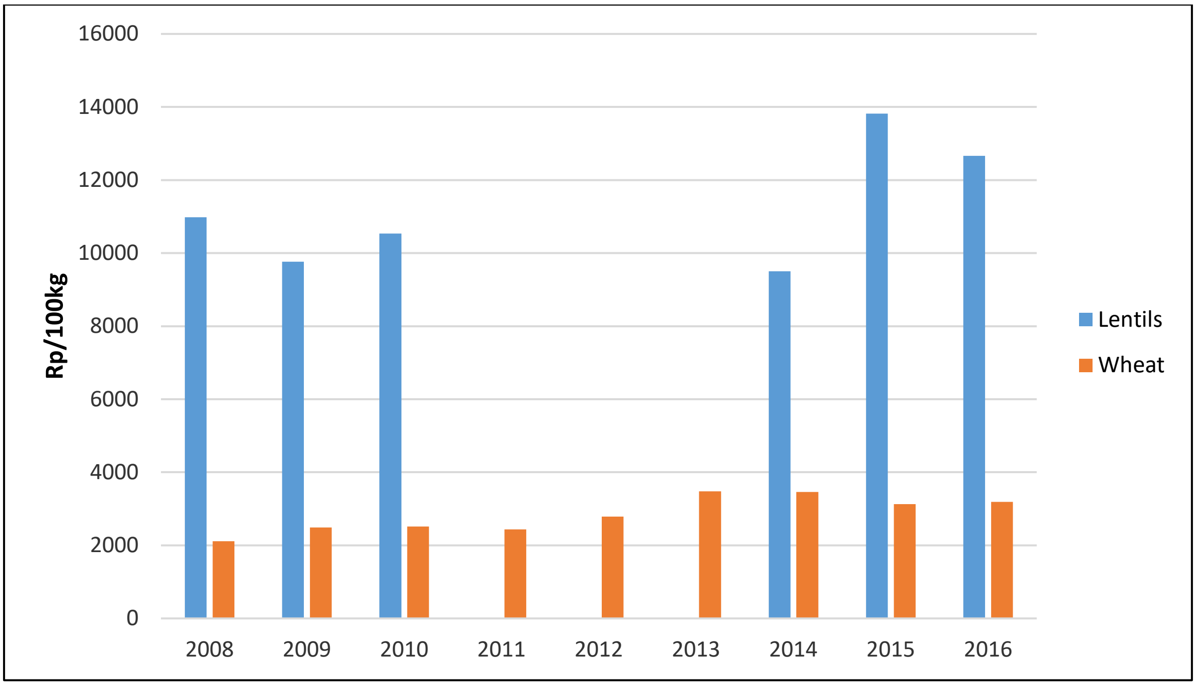
Figure 12 Prices of imported and local chickpeas in Pakistan, 2008 to 2016



Source: AMIS. Average October prices. Note: Some import prices are not available (2011, 2012 and 2015).

The ratio between prices of wheat and lentils shows significant variation in recent years, ranging from 2.9 in 2013 to 5.7 in 2015 (figure 13). Wheat and lentils are substitute crops grown in the winter.

Figure 13 Prices of wheat and lentils in Pakistan, 2008 to 2016



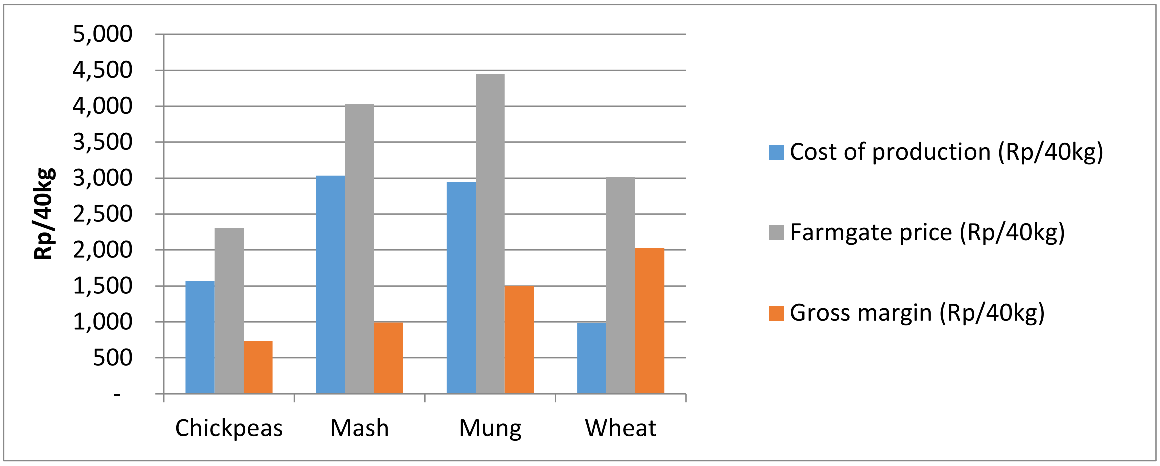
Source: AMIS. Average October prices.

The conclusion from this analysis is that pulse prices have risen faster than alternative crops since 2000, and especially since 2008. However, domestic chickpea prices have tended to follow international prices, which have also risen sharply in the past couple of years. Despite these price movements, the area planted to pulses has not kept up with the price increase, as shown in figure 1. One possible reason is that the costs of production have risen faster than prices, so that the profit from growing pulses has declined over time and is no better than substitutes in production. Fortunately, the Ministry of Agriculture has collected data on cost of production.

Cost of production

The Government publishes cost of production estimates for a variety of crops, including wheat, chickpeas, mash and mung (figure 14). The cost of production for mash and mung is three times higher than that of wheat and for chickpeas 1.6 times higher. However, farm-gate prices for mung and mash were significantly higher than that of wheat in some years, although chickpea prices may be lower (also figure 14). There is a guaranteed price for wheat and sugarcane but not for other crops.[4] The Government calculates an indicative recommended price by adding a 25 per cent "investment incentive" to the estimated cost of production. For wheat in 2013-14 the support price was Rp 1,200/40kg (equivalent to US$284/t). The gross margins on a per unit production basis (Rp/40kg) for pulses are 30 to 60 per cent lower for pulses compared with wheat (also figure 14). Dividing the price by the cost of production provides a benefit to cost ratio for wheat that is approximately double that of the pulse crops (figure 15).

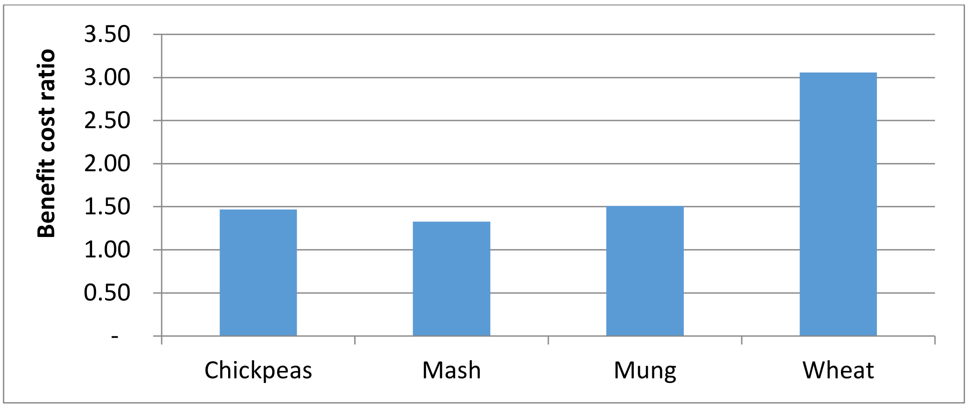
Figure 14 Cost of production, farm-gate price and gross margins for various crops in Pakistan



Source: Data for chickpeas and wheat are 2013/14, and mash and mung are 2014/15. Cost of production data: AMIS, farm-gate prices are assumed to be wholesale prices less a 25 per cent margin. Gross margins (per unit production basis) are estimated by the authors.

[4] http://www.amis.pk/Agristatistics/SupportPrice/Default.aspx

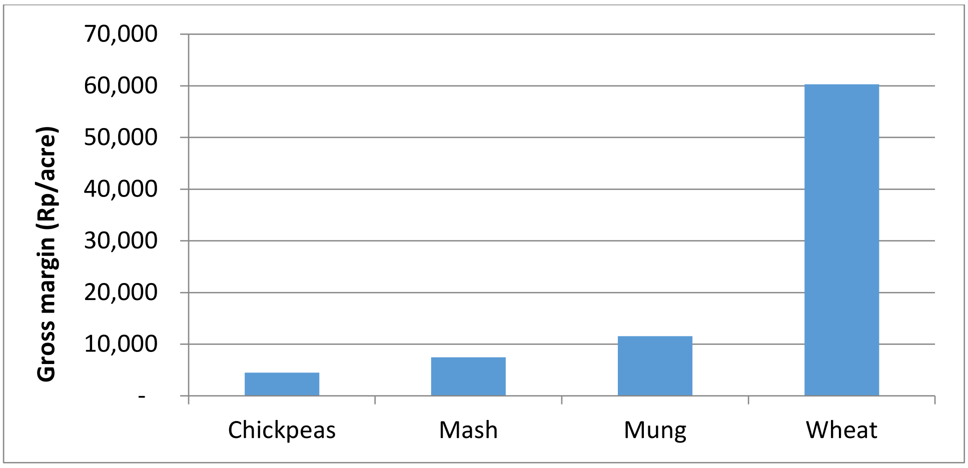
Figure 15 Benefit cost ratio for various crops in Pakistan



Source: Authors estimates. Chickpeas and wheat are 2013/14, and mash and mung are 2014/15.

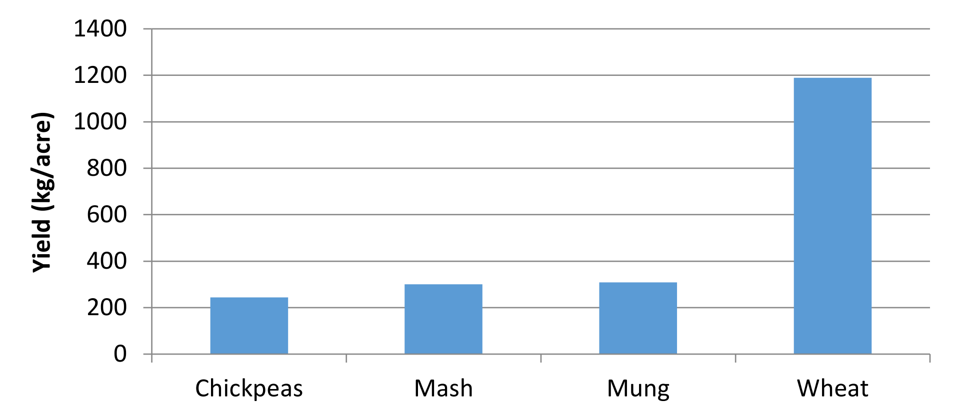
The gross margin on a per unit area basis (Rp/acre) (figure 16) can be calculated by multiplying the gross margin per unit of production by yield (figure 17). Using 2012-13 data for chickpeas and wheat, and 2013-14 data for mash and mung, pulse yields are approximately one-fifth of wheat. Hence, gross margin per unit area is five to ten times higher for wheat than pulses.

Figure 16 Gross margins on a per unit area basis for various crops in Pakistan



Source: Authors estimates.

Figure 17 Yields for various crops in Pakistan



Source: AMIS. Chickpeas and wheat are 2013/14, and mash and mung are 2014/15.

To summarise this section, profits from pulse production are significantly lower than wheat in Pakistan. It is significantly more risky to grow pulses than wheat, given that pulses have a higher cost of production, a greater variation in yield, a lower return on investment, and wheat has a guaranteed price which is 25 per cent above production costs.

2. Review of policies affecting pulses production in Pakistan

The main Government policy applying directly to pulses is an export tax of 35 per cent. There are various other policies that support agriculture in general but do not favour pulses specifically. These include subsidies on fertiliser and, to a lesser extent, water and energy. The Government also provides concessional credit which is used for capital improvements, including tractors and irrigation and drainage systems. Almost all agricultural income is exempt from income tax. Pakistan imposes no tariffs on imports of pulses.

Indirect policies affecting pulses include a floor price policy for wheat of 1,300 Rp/40kg bag (2014/15 and 2015/16, equivalent to US$309/t) and for sugar cane of Rp 180/40 kg (2014/15-2016/17 equivalent to US$43/t).[5] Wheat is a substitute in production for winter pulses, lentils and chickpeas (mung beans and mash beans are summer pulses).

The export tax, domestic support and tariffs are discussed in more detail in the following subsections.

Export tax

The export tax was implemented in 2007. The Federal Board of Revenue imposed a 35 per cent regulatory duty on exports of pulses.[6] Statutory Regulatory Orders are used to provide ad hoc exemptions to normal tariffs and taxes.

Export taxes may possibly be justified on several grounds. One is to raise tax revenue. Another is to encourage the development of a downstream processing sector. A third is to

[5] Agriculture Policy Institute, Islamabad.
[6] S. R. O. 492(I)/2006.

supress prices for the benefit of consumers. None of these possible objectives have been fulfilled with pulses. There is no tax revenue raised because the tax is virtually prohibitive, allowing almost no exports, and hence no tax revenue. It is not clear that a downsteam industry has developed. And since the tax was imposed, domestic prices have been higher than ever. Chickpea and mash prices have almost doubled since 2007, while mung bean prices have tripled. Lentil prices have doubled since 2006-07.

The export tax had the effect of reducing exports from 160 kt per year to practically nothing. In 2015, exports of pulses amounted to 1,962 tonne, mainly to Sri Lanka and Mauritius.

Domestic support

Data on domestic support is difficult to collect because it is provided at a provincial level. However, the national Government is required to notify the WTO of its domestic support arrangement. The last notification is dated 11 March, 2015, and relates to marketing year 2011-12. The WTO divides domestic support into amber, blue and green boxes, depending on the extent of production distortion the support measures cause. Green box measures, such as infrastructure, research and extension, are exempt from reduction commitments. Amber box measures are subject to reduction commitments, but support up to 10 per cent of the value of production is exempt under the *de minimis* provisions. For Pakistan, the major product-specific support is given to wheat (table 3). The Government buys a share of the crop at an indicative "procurement" price, which is currently Rp 1300/40kg (US$309/t). The cost of this was US$647 million in 2011-12, about ten per cent of the value of production. In that year, the administered price, US$294/t, was well above the external reference price[7] of $175/t. The difference was applied to eligible production of 5.4 million tonnes to generate a subsidy of US$647 million.

Table 3 Domestic support in Pakistan, 2011-12

Box	**Measure**	**Value (US$m)**
Green	Irrigation system rehabilitation	107.4
	Provision of wheat storage facilities	111.7
	Agricultural extension	18.8
	Agricultural extension	17.3
	Other green box	9.8
Amber	Wheat market price support	647.2
	Fertiliser subsidy	566.0
	Electricity subsidy	4.6

Source: WTO (2015a, b).

[7] The external reference price is a price agreed at the World Trade Organization as a basis for calculating domestic support.

Another means of measuring support to producers is the producer subsidy equivalent, which takes account of transfers from consumers to producers instead of just taxpayers to producers. The producer subsidy equivalent varies according to the world price and the procurement price and quantity. The world price for wheat in June 2017 was US$157/t. The 2017 procurement price of Rp 1300/40kg is equivalent to US$305/t.[8] This generates a producer subsidy equivalent of 94 per cent.

However, not all farmers receive the procurement price. Wheat production in Pakistan is currently around 26 million tonne per year and the Government normally buys 4-5 million tonnes. This represents a subsidy of 16 per cent, depending on the relevant world price. The Government sells the grain to millers so the cost to the Government is the difference in buying and selling prices times the quantity purchased. It is likely the cost of the subsidy is passed on to millers and hence consumers.

The fertiliser subsidy, worth $566 million in 2011-12, benefits all users of fertiliser. However, pulse producers do not use as much fertiliser as wheat or other producers. According the Government's cost of production exercises, fertiliser costs for wheat producers are Rp 6,725 per acre whereas mung producers use Rp 3,750 per acre and chickpea producers use none at all. Therefore, the fertiliser subsidy favours non-pulse growers. Removal of the subsidy would benefit pulse growers relative to wheat, rice and sugar growers, but it would also disadvantage agriculture as opposed to non-agriculture. On the whole, the subsidy probably leads to greater production of mung bean and lentils but not chick peas.

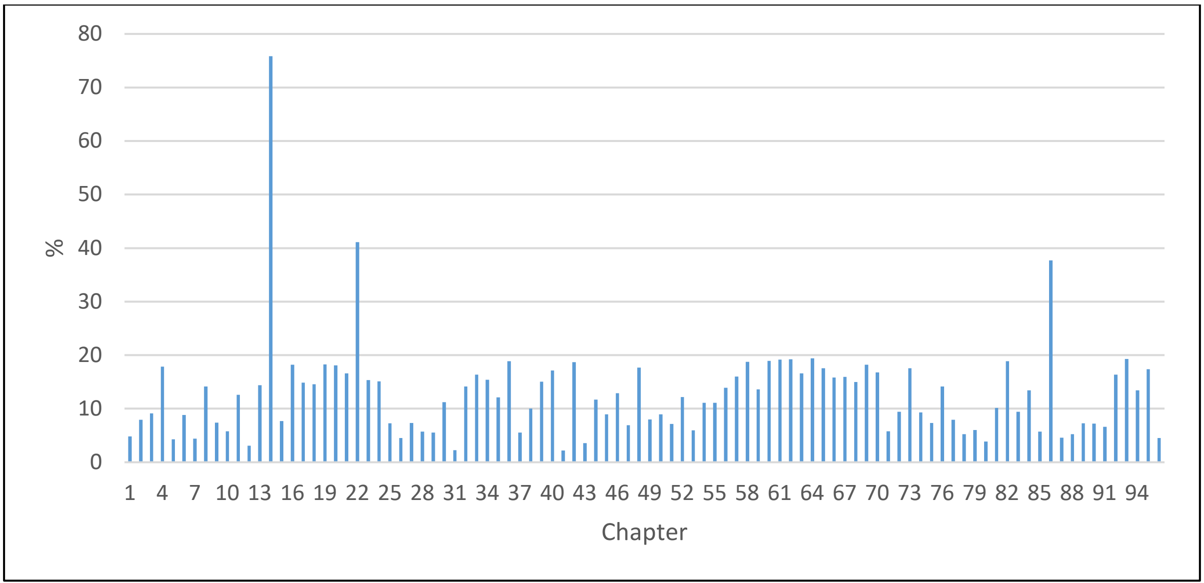
Tariffs

Pakistan has no tariffs on imports of pulses, including chickpeas and lentils, the major pulse imports. By contrast, the average applied tariffs on agricultural products is 15 per cent. The trade weighted average is seven per cent, indicating the presence of some prohibitive tariffs such as on specific vegetable products[9] where the maximum tariff is 830 per cent. Average applied tariffs for all 99 groups (called 'chapters') are shown in figure 18. Overall, the highest tariffs are on some vegetables (Chapter 14), tobacco (Chapter 22) and motor vehicles (Chapter 87).

Also relevant are tariffs on imported inputs used by growers, such as fertiliser, pesticides and machinery. There are no tariffs of note on fertiliser.[10] Pesticides[11] attract about a 5 per cent tariff, while the tariff on agricultural tractors vary between 5 and 15 per cent, with a weighted average around 12 per cent.

[8] This assumes the December 2016 exchange rate of Rp 106/US$.
[9] HS 140490.
[10] HS Chapter 31.
[11] HS 3808.

Figure 18 Pakistan applied tariffs, 2015



Source: WITS (2017). Simple average applied tariffs.

3. Discussion and conclusions

This paper has presented an overview of the pulses sector and a review of government policy that affects pulses production, consumption and trade. The overview has showed that the area of land planted to pulses, pulse yields and therefore pulse production has stagnated over the past 70 years. Consumption has steadily increased since approximately 1990, and to meet the shortfall between production and consumption, imports have risen dramatically since then. Concerned about this increase, in 2007 the Pakistani Government stopped pulse exports by imposing a 35 per cent tax. This was done with the intent to secure domestic production for domestic consumption.

While concerns about domestic food security are laudable, this is effectively a self-sufficiency policy. Self-sufficiency policies serve to meet consumption needs through domestic production rather than imports. Such policies, while often intended well, are an inefficient and expensive way of achieving food security compared with policies that allow the market to determine a mix of domestic production and international trade (Naylor and Falcon 2010, Anderson 2014). Generally, self-sufficiency policies lead to an increase in the volatility of domestic prices as prices in relatively small markets (e.g. one country) move more in response to any change in supply or demand, compared with relatively larger markets (e.g. regional or global). Prices are especially volatile during supply and demand shocks (e.g. during droughts or food safety scares). The most food secure nations (e.g. Singapore) are those that rely on a diverse source of food imports, rather than trying to reduce imports. Since implementation of the export tax on pulses, domestic pulse prices in Pakistan have increased dramatically in both levels and volatility.

This export tax on pulses is the only direct policy that impacts pulses exclusively. Other policies that directly impact pulses include funding of infrastructure, research, development and extension. These policies are likely to increase productivity growth, which in turn is likely to lead to economic growth, improved food availability and increased household incomes. We believe this is sound policy.

The government also supports agriculture through subsidies on fertiliser, water and energy. These subsidies distort markets and prices (Nechyba 2017, WTO 2006). As pulse production requires fewer fertiliser inputs than other crop production, this type of agricultural support has the effect of favouring more fertiliser-intensive crop production over pulse production.

With the aim of increasing food security, the Government implements a procurement price for wheat and sugarcane. This discourages pulse production by making pulses relatively less profitable to produce compared with wheat and sugarcane. While wheat and sugarcane producers may be benefiting from this policy, consumers are penalised through higher prices. Producer welfare gains are generally lower than consumer welfare losses and there is a loss of economic efficiency. These schemes are difficult to reverse and are often mismanaged - requiring greater government expense than expected and often leading to significant post-harvest losses (WTO 2006).

Concerned about rising imports and domestic prices of pulses in Pakistan, the Federal Government has proposed to the Provincial Governments that they introduce a procurement price scheme for pulses. We argue that this is likely to further distort prices and reduce economic efficiency of the pulses sector.

We suggest that the Pakistani Government remove the pulses export tax, remove all agricultural subsidies, remove the wheat and sugarcane procurement prices and choose not to implement a pulses procurement price. Instead, we suggest the Government focuses on achieving inclusive economic growth through encouraging participation in open markets (to create jobs, support local economics, contribute to raising living standards and improve food security). We recommend they do this through supporting a rules-based trading system, ensuring enforcement of contractual obligations, underpinning the rule of law and enforcing secure tradeable private property rights (especially for land) (Grafton *et al*. 2015). We also recommend the Government increases its investment into sustainable agricultural productivity growth through research, development and extension that increases mechanisation, adoption of higher-yielding varieties, efficient use of inputs, improved infrastructure and adoption of innovations (World Bank 2012). Rather than encouraging specific industries, we argue that a government's overwhelming responsibility is to create an institutional environment in which private enterprise can flourish, and to develop social protection programs to provide safety nets during economic and food crises (OECD 2009).

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Pulse production in Pakistan: A literature review

Stephen Harrison[1], Robert Harrison[1], Muhammad Qasim[2], Saima Rani[2], Abdul Ghafoor Chaudhry[3], Khuram Sadozai[4], David Vanzetti[5], Elizabeth Petersen[6]

[1]The University of the Sunshine Coast, [2]The National Agricultural Research Centre, [3]The University of Agriculture Faisalabad, [4]The University of Agriculture Peshawar, [5]The Australian National University and [6]The University of Western Australia

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Abstract

This paper discusses various aspects of food cropping in Pakistan, with particular emphasis on pulses crops. Basic information has been compiled on pulses species, area under cultivation relative to other crop species, and cropping systems. More general information is included on Pakistan food security, crop support measures, gender issues, trade statistics, and opportunities and constraints for expansion of pulses production. It is found that chickpeas and mung beans account for most of the pulses production in Pakistan, but comprise a small planted area relative to other crops, particularly wheat and rice which are critical for food security. Pulse crops are an important source of dietary protein, and the national government has a policy to lift pulses production and reduce spending on pulses imports. This poses major challenges, but a number of opportunities for increased pulses production can be identified. The provision of support prices for major crops but also pulses (particularly for the minor species of lentils and urdbeans) is periodically under review.

SOME BASIC INFORMATION ABOUT PAKISTAN AND PULSES CROPPING

Pakistan has a land area of approximately 800,000 km^2, excluding disputed territories. The latest population census data available at the time of writing is from 1988, but Jorgic (2017) has reported a national population estimate, attributed to the Pakistan Bureau of Statics, of 208 million. The country is both a major food importer and food exporter, and has a long history of grain crop and pulses production. The administrative units of Pakistan consist of four provinces (Balochistan, Khyber Pakhtunkhwa, Punjab and Sindh), one federal capital territory, two autonomous and disputed territories, and a group of federally administered tribal areas. The provinces and autonomous territories are divided into administrative *divisions*, then districts, tehsils and union councils. The Islamabad Capital Territory and the Federally Administered Tribal Areas have equivalent status to provinces. Punjab province contains nearly half the national population and is the second largest administrative area after Balochistan**.**[1] The Express Tribune (2018) observed that Punjab is a major pulse-growing province in terms of area (producing about 80% of Pakistan production); other important pulse-growing provinces are Sindh and NWFP.

FAO (2016a) described pulses as a subgroup of legumes, for which the edible seeds are eaten by humans and animals in dry form, as opposed to vegetables or extracted oils. The main species of pulses grown in Pakistan are chickpeas, mung beans, lentils and urdbeans (mashbeans). According to AGT (2018), the name 'pulse' is derived from the Latin words puls or pultis meaning "thick soup", and there are more than 1800 species in this legume group; further archaeological evidence suggests that peas were grown in the eastern Mediterranean and Mesopotamia regions at least 5,000 years ago. According to this source, Pulses provide about 10% of the total dietary protein consumed in the world and have about twice the protein content of most cereal grains.

Pulses are an important source of protein as well as vitamins and minerals for human diets, and have various recognized health benefits, as highlighted in FAO (2016a) and Harrison *et al.* (2017). The major beneficiaries of pulses production in Pakistan are poor people, especially children and women, whose diets typically lack protein and iron.

Pulses are considered secondary to cereal crops and relegated to marginal soils in Pakistan, because they are perceived to be low yielding and less remunerative than cereals. According to Special One Grain (2018), Pakistanis consume 6-7 kg of pulses annually, of which chickpeas (3-4 kg) and red lentils (0.5-1 kg) are the two most commonly consumed varieties. Pulses play an important role in the nutritional security and major source of protein especially among the poorer section of the population who rely on plant sources for their protein and energy requirements. Currently, Pakistan pulses production falls well short of domestic demand, and Pakistan imports large quantities of pulses to meet the ever-increasing supply gap.

Some excellent web sources are available to provide an understanding of pulses types, production systems, health benefits of consumption and environmental contribution in Pakistan, several of which were produced shortly before or during 2016, which was designated the 'International Year of Pulses'. Examples of these are FAO (2016a,b) on

[1] Pakistan maps of major city locations, administrative units, cropping pattern and food security area classifications are provided in Appendix A, and some Pakistani units of measurement and conversion factors are listed in Appendix B.

varieties, production and marketing systems, nutrition and health benefits, cooking methods, and environmental benefits, and Tahir and Rehman (nd) on chickpeas, Arain (2012) on mungbeans and Islam *et al.* (2013) on mung beans and urd beans. A web source from Agribusiness Pakistan by Abbas (2013) provides introductory information about the importance and opportunities of the five major crops in Pakistan (wheat, rice, cotton, sugarcane, and maize) and also about coarse grains, oil seeds and pulses. A substantial volume of research papers on pulses is also available in literature from India, the world's largest producer and importer of pulses.

MAJOR PULSES SPECIES IN PAKISTAN

Wikipedia (2018) observed that FAO recognizes 11 primary groups of pulses, namely dry beans (9 species, including mung bean and black gram), dry broad beans (3 species), dry peas (2 species), chickpea, dried cow pea, pigeon pea, lentil, Bambara groundnut, vetch, lupins, and minor pulses (5 species). Table 1 lists the main pulse species grown in Pakistan. Small areas of some other species as listed in Table 1 are also grown in Pakistan.

Table 1. Pulse species grown in Pakistan

1	Kalay Channay / Chickpea / Gram	*Cicer arietinum*	Rabi
2	Kabuli Channay / Chickpea / White Gram	*Cicer arietinum*	Rabi
3	Field pea	*Pisum sativum*	Rabi
4	Masur / Lentil	*Lens culnaris*	Rabi
5	Mung bean / Oregon Pea / Green Gram	*Vigna radiata*	Kharif
6	Mash / Urd Bean / Black Gram	*Vigna mungo*	Kharif
7	Pigeon pea / Red Gram / Arhar	*Cajanus cajan*	Kharif
8	Lobia / Cowpea / Black-eyed Pea	*Vigna unguiculata*	Kharif
9	Rawan / Cowpea	*Vigna unguiculata*	Kharif

Source: Shaukat (2012).

According to PARC (2011c), pulses are the most important source of vegetable protein (in terms of quantity) in Pakistan, and are cultivated on 5% of the total cropped area, and research is being carried out on improving varieties and management practices to meet increasing demand.

This review has a particular focus on the four pulse species most commonly grown in Pakistan, viz. chickpeas, mungbeans, lentils and mashbeans (black gram). Chickpeas and lentils are rabi (winter) crops while mungbeans and mashbeans are karif (spring and summer) crops. In Pakistan, rabi crops are sown about November and harvested about March-April, while *karif* crops are cultivated and harvested during the rainy season, which is typically between April and October. In terms of other important crops, wheat is a winter crops, while rice, cotton and maize are monsoon or summer crops; sugarcane is planted in autumn and spring, with autumn planting generally leading to higher yield. Areas of the four target species are listed in Table 2.

Table 2. Areas of the main pulses species grown in Pakistan

Species	Area planted (1000 ha)	Share of pulse area (%)
Chickpea, gram, chana, garbanzo beans, hommes (*Cicer arietinum L.*), desi and Kabuli	945	83.8%
Mung bean, moong bean, green gram (*Vigna radiata L.*)	146	13.0%
Lentil, masoor (*Lens culinaris Medic.*)	17	1.5%
Urdbean, mashbean, mash, urad, (*Vigna mungo L. Hepper*)	19.2	1.7%

Source: Area data are provisional estimates from Pakistan Economic Survey 2015-16, Ch. 2, Agriculture, p. 30. Area shares are calculated from these area estimates, and percentages are slight overestimations because small areas are grown of species not listed in Table 1.

Various other species names are commonly used in literature on pulses in Pakistan. KhanaPakana (2016) provided a glossary of English and Urdu names, Urdu being the national language of Pakistan. KhanaPakana noted the name gram is also applied to several types – basically colours, seed sizes and whether split – of other pulses species, including chickpeas (brown chickpeas are referred to as Bengal gram), mung beans (golden and green gram), black and white lentils, and pigeon peas (red gram). Rani *et al.* (2012) listed 'gram, masoor, mung and mash' as the major pulses in Pakistan, these names corresponding to chickpeas, mung beans, lentils and mash beans or urdbeans respectively in Table 1. *Vigna mungo* is also sometimes called black gram, black lentil, mungo bean or black matpe bean.

PULSES SITE REQUIREMENTS AND MAJOR CROPPING AREAS IN PAKISTAN

Khan (1990, p. 28) described Pakistan in ecological terms as having three legume-producing regions. The northern region has a high rainfall where both rainfed and irrigation facilities are available. The central region has highly fertile soils but the climate is mostly semi-arid where crop production is mostly aided by surface irrigation. Legumes are also grown under rainfed conditions in some areas of this region. In the southern region, rainfall is low and cropping is carried out under irrigation.

Pulses are sometimes grown continuously as an annual crop, particularly in relatively low-rainfall sites. However, as noted by FAO (2016b, biodiversity factsheet), 'pulses are a crucial component of multiple cropping systems, namely intercropping, crop rotation and agroforestry. These cropping systems have a higher species diversity than monocrop systems (which) could translate into not only a more efficient use of resources, namely light, water and nutrients, but also into higher outputs as yields are increased, and a lower risk of overall crop failure. As leguminous crops, pulses can fix atmospheric nitrogen in the soil, hence supporting non-nitrogen-fixing crop species which follow. Also, as break crops, they can assist to reduce the disease and pest buildup from repeated growing of other species'.

In Pakistan, pulses are widely grown without irrigation (rainfed, grown on drylands), which constrains yield and results in high yield variability between years. In contrast, much of wheat and rice (major food crops for domestic consumption and also export) are grown with irrigation, particularly along the Indus River. Baig *et al.* (2013) noted that in Pakistan, dryland agriculture sustains 80% of the livestock population and contributes 12% of wheat, 27% of maize, 69% of sorghum, 21% of millet, 25% of rape and mustard, 77% of gram, 90% of groundnut, 53% of barley and 85% of pulses.[2] Anecdotal evidence suggests that pulses in Pakistan are being increasingly pushed back to be a dryland crop grown by smallholders.[3]

According to Baig (2018), the Thal desert of Punjab that is well known as the home of chickpeas because the area cannot support major cash crops due to low soil fertility and lack of irrigation Chickpeas can perform well under conditions of moisture stress in marginal soils. The drought tolerance in this crop is extremely desirable attribute for moisture deficient areas of the country. The medium fertility, moderate moisture levels, sandy loam soils and moderate winter provide optimal conditions for chickpea cultivation. Davies *et al.* (2016) observed that mostly pulses are cultivated on marginal lands in rain-fed areas, and that investments in irrigation at the national level have not benefitted pulses (although Baig (2018) noted current attempts to provide some sprinkler irrigation in 3 districts).

According to Abbas (2013), gram (chickpeas) is the major pulse crop grown in Pakistan, and Punjab is the major pulse-growing area, followed by Sindh, NWFP (now called Khyber Pakhtunkhwa, KP) then Balochistan. Chickpeas have a number of desirable features, various sources (e.g. Saskatchewan Pulse Growers,c2010) noting they are a short duration crop (as little as 4 months), have climate adaptability, and can withstand drought due to long taproots (often greater than a metre) which can access water from greater depths than other pulses species.

Punjab is the major mung bean growing province, accounted for about 88% area of the national mung bean production. It is often grown in a mung a mung bean – wheat crop rotation in the rainy season (Davies *et al.* 2016).

Lentils are grown in all provinces in Pakistan but predominately in Punjab province. Light to medium textured soils with low levels of fertility are appropriate for the cultivation of this crop whereas fine textured soils are not desirable. Similarly, Oplinger *et al.* (1990) noted that lentils have been grown extensively in semi-arid parts of the world, and that they are ‘adapted to all soil types, from sand to clay loam, if there is good internal drainage’. Also, Pulse Australia (2015) commented that lentils are grown in semi-arid regions, the planting window is wide (depending on variety), their price is relatively high among pulse crops, they have a short growing season, and the species is useful in crop rotations to break the life cycle of cereal root diseases.

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[2] A similar situation is found in India, where only 15% of the 25 million ha area sown annually for pulses is irrigated, compared to 60% for paddy and 90-95% for wheat and sugarcane (Damodaran, 2015). Further, as noted by Malhotra (2016), in India pulses are mostly grown with rainfed conditions ‘in marginal to sub-marginal lands’.

[3] This view is further supported by email correspondence from Dr Azeem Khan, DG, NARC, that ‘The usual practice of pulses sowing is on marginal areas and rain-fed conditions. The prospects of pulse productivity and profitability in better areas with controlled conditions like irrigation and optimal input use can be studied’ and ‘Traditionally the pulses area in the rice wheat cropping zone has been shifted towards rice growing’. It is also reinforced by the view communicated by Aamer Irshad, Chief, Food and Agriculture Planning Commission, Government of Pakistan, that pulses are generally grown as a marginal crop, and questioned the wisdom of committing fertile land to pulses cropping.

Ahmed (2015) reported that Punjab is the major Pakistan producer of mash (urdbean) (82.7%), followed by Khyber Pakhtunkhwa (6.7%) and Balochistan (6.1%) and Sindh (4.7%). Mash grows on marginal land where other crops perform poorly, and has a relatively high protein content. Lack of suitable high-yielding varieties and disease resistant varietied discourages production,

An examination Pakistan crop area data in the last few decades reveals that there has been a steady increase in the major food crops of wheat and Basmati rice, as well as cotton and sugarcane. Kirby *et al.* (2017, p. 41) reported that the production, area and yield of pulses have remained more or less constant since 1961. According to Aazim (2017), the pulses area over the last four years has averaged about 1.15 m ha.

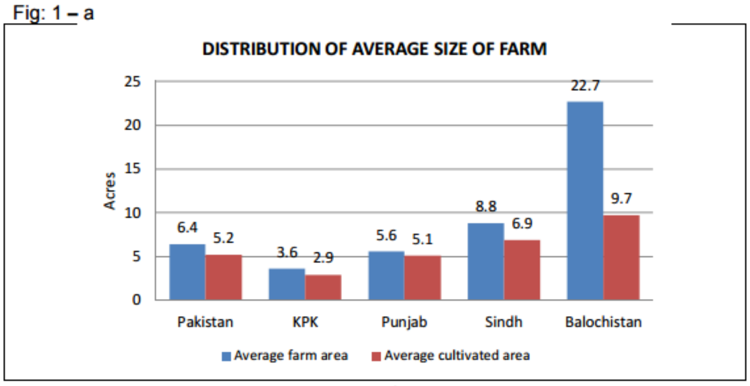
FARM SIZE AND PRODUCTIVITY IN PAKISTAN

Major land reforms in Pakistan took place during Ayub Khan's martial law in 1959 and Zulfiqar Ali Bhutto's rule in the 1970s, limiting the area of land an individual could hold, although Supreme Court rulings that the reforms were unconstitutional taking effect in 1990 somewhat undid the main reforms (Anon, 2010). Table 3 reports 2010 Pakistani farm sizes nationally and by administrative unit, in terms of numbers of farms and (in the appended figure) by average farm sizes in acres. The average farm size in Pakistan in year 2010 was about 6.4 acres, of which 5.5 acres was cultivated.

Table 3. Number of farms and farm area by province in Pakistan, 2010 (by million and million acres)

Administrative Unit	Number of Farms		Farm Area		Average size (in acres) of	
	Number	Per cent	Total	Per cent	Farm Area	Cultivated Area
Pakistan	**8.26**	**100**	**52.91**	**100**	**6.4**	**5.2**
Khyber Pakhtunkhwa	1.54	19	5.57	11	3.6	2.9
Punjab	5.25	64	29.33	55	5.6	5.1
Sindh	1.11	13	9.87	19	8.8	6.9
Balochistan	0.36	4	8.14	15	22.7	9.7

Fig: 1 – a

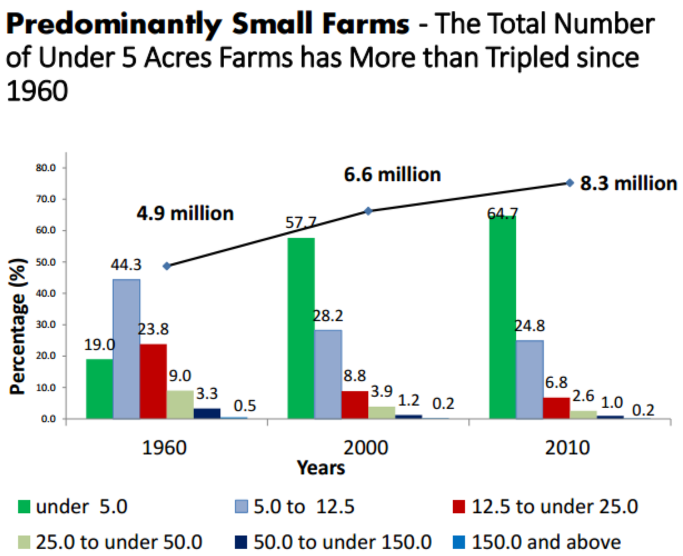


xlvii

Source: Government of Pakistan (2010), p. xlvii

Overall, there has been a dramatic decrease in farm size (Figure 1), particularly in the late 1900s, as land redistribution took place. The widely documented land reforms in Pakistan were driven by the government's social equity imperative, but may have led to an increase in production costs due to a reduction in economies of size, including affordability of mechanization.

Figure 1. Change in farm size distribution in Pakistan between 1960 and 2010



Source: Malik (2015).

Some research has been conducted on the relationship between farm size and productivity in Pakistan. Using econometric analysis, Sial *et al.* (2012, p. 159) found that 'Small farmers are getting about 18.6 percent higher output than large farmers from one acre indicating an inverse relationship between farm size and productivity'. Also, Mahmood *et al.* (2014) analysed 'the relationship between farm size and productivity and its various correlates like total and partial factor productivity, cropping intensity, gross margins, on and off farm incomes, credit availability with reference to different farm sizes in the irrigated perennial areas' in Pakistan, and confirmed an inverse relationship between farm size and productivity, although the relationship was weak.

PAKISTAN FOOD SECURITY POLICY

Raza (1993, p, 39) reported that the main focus of food policy in Pakistan has been to increase the yields of the main food and cash crops and increase the area under cultivation, noting that important elements to achieve self-reliance in the food sector are provision of increased water supplies through large-scale government projects, and increased provision of all other agricultural inputs. These other inputs were identified as:

- pure seeds of improved varieties of crops;
- pesticides, fertilizers, tractors, improved implements; and
- credit in a package programme for the intensive development of various project areas involving the complete reorganization with responsibilities for agriculture.

Maintaining a reliable food stock and distribution system in the face of a large and growing population is a major concern for Pakistan. Earlier comments were made by Raza (1993, p. 57) that the Pakistan food policy consists of combination of output price and input subsidization policies and is primarily guided by the objective of accelerating the rate of growth of agricultural output and achieving national food security. Government intervention in the pricing of major crops and farm inputs has been important for agriculture since early 60s. The policy of support prices for major and minor crops (wheat, rice, cotton, sugarcane, pulses and oilseeds) and subsidies on prices of farm inputs – particularly fertilizer and water, has been advocated to encourage farmers to raise production.

Raza (1993, p. 63) further noted that 'Minimum support prices have been fixed in the case of oilseeds and pulses in order to protect the producers against steep price declines, particularly in the international market … The support prices for major and minor crops continued in the Fifth Five Year plan (1978-83) and the Sixth Five Year Plan (1983-88). …The cost of production has been the most important factor influencing the level of support prices but other factors such as international prices, the relative prices of competing crops and quality considerations have been given due consideration … non-price measures like agricultural extension training, development of improved seeds, credit facilities … were implemented during the last decade … to reduce cost … '. Raza (p. 64) commented that the support price program has also been applied to gram and masoor (i.e. chickpea and lentil).

A detailed examination of food security in Pakistan was conducted by Suleri and Haq (2009). This report presents detailed assessment of the food security situation at district level in the country by considering three broad parameters, viz. food availability (physical availability through production, import, aid and other factors), food access (social, economic and cultural access to food), and food absorption (food utilization and assimilation). It is notable that 'Islamabad Capital Territory is the most food secure district of Pakistan. Among the top twenty districts with best conditions for food security, besides Islamabad, are 14 districts in Punjab and 5 districts in Sindh'. This report further elaborated the worsening condition of Pakistan regarding food security. Many factors – social, economic and political – are responsible for such conditions. Natural disasters including a severe earthquake have also aggravated the situation.

Carrasco and Mukhopadhyay (2012) concluded that policy responses to food price escalation in South Asia have been immediate and mainly focused on short-term reduction of food prices to consumers. A wide range of policy instruments have been used to ease the impact of the renewed food crisis including food price reduction, safety net programs and stimulation of production. These authors drew attention to the following table of policy responses to increasing food prices from a report by the ADB (2011, p. 20) entitled Global Food Price Inflation and Developing Asia.

Table 4. The ADB table of policy responses to escalating food prices in south Asia

	Domestic Food Price Reduction				Safety Net Programs				Production
	Reduce Food Taxes	Increase Supply (Grain Stocks)	Export Restriction	Price Controls Consumer Subsidies	Cash Transfer	Food for Work	Food Aid	Feeding Programs	Stimulate Response
Afghanistan		✓					✓		✓
Bhutan	n/a								
Bangladesh	✓	✓	✓	✓		✓	✓		✓
India		✓	✓	✓			✓	✓	✓
Maldives	n/a								
Pakistan	✓	✓	✓	✓			✓		
Nepal		✓		✓					
Sri Lanka	✓	✓		✓					

Source. Carrasco and Mukhopadhyay (2012), Table 10, p. 20 (from ADB, 2011).

Ramay (2014) examined food security at the national level in Pakistan through the FAO criteria of food availability, access and utilization. He noted that production of cereal or crop-based food is heavily concentrated in Punjab and Sindh provinces, and concluded that 82 districts of the country are extremely deficient in terms of food availability, 103 districts are deficient, 10 have sufficient food availability, and only 31 districts are in surplus. Amongst the report recommendations, the following are noteworthy:

- broad-based agriculture and rural development strategies and actions backed by strong legislation are needed to achieve food security in Pakistan. This would include ensuring access of small-scale farmers to farm technology, machinery and credit;

- there is a need to address chronic constraints of domestic food production – low agricultural productivity and yields, pre and post-harvest losses, lack of storage facilities – and enhance agricultural growth and food diversification for poor farmers that cannot afford agricultural inputs; and

- the research/extension/farmer relationship needs to be revitalized.

On the food demand side of the equation, a major report was prepared by Hayat *et al.* (2016). These authors estimated a 'Linear Approximation/Almost Ideal Demand System (LA/AIDS)' model through a system of equations for household budget shares to estimate demand elasticities of seven commodity groups in Pakistan, using household survey data, as well as making simple demand projections. Amongst other findings, they noted that

- the decline in household purchasing power has resulted in an increase in the percentage spending on food and reduced spending on health and education;
- there is high total and per capita demand for food grains, pulses, ghee, milk, sugar, meat and vegetables; and
- per capita and total household food demands will approximately double over the next two decades.

Regular issues of the *Pakistan Food Security Bulletin* are produced by the Vulnerability Analysis and Mapping (VAM) Unit of the World Food Programme (WFP) to monitor the food security situation. Together with updates, a map of the national food security status is produced, examples being provided in Appendix A. Notably some areas usually have a high food security rating, including much of major grain growing areas of Punjab province, while other areas frequently have food insecurity. Wheat and rice are the most important carbohydrate sources. Wheat has a protein content of about 7% to 14% depending mainly on variety, and rice has a typical protein content of about 7%. The protein content of dried pulses varies between about 13% and 30%, depending mainly on species.

OTHER SUPPORT MEASURES FOR CROP PRODUCTION IN PAKISTAN

Various support measures are available for a range of crops – including pulses – in Pakistan. These include input subsidies for fertilizers (notably urea and di-ammonium phosphate), machinery, irrigation equipment, research and extension services, and credit.

A 'mega relief package' of Rs 341 billion including direct cash support and provision of soft agriculture loans was announced by the Prime Minister of Pakistan in 2016, some of which was targeted to small farmers (Ministry of Finance, Pakistan, 2016). Components included:

- Cash support for farmers cultivating rice and cotton at up to 12.5 acres of land would be given cash support of Rs 5,000 per acre.
- Up to Rs 20 billion fund to reduce prices of Potassium and Nitrate fertilizers fertilizers.
- Reduced cost of agricultural insurance.
- Markup-free loans for solar tubewells for the farmers who own up to 12.5 acre of land, with pegging of the price of electricity for running tubewells at peak hours, and sales tax savings.
- Reduction from 45% to 9% in the custom duty, sales tax and withholding tax on the agriculture machinery.
- A 50% guarantee on bank loans, and access to higher loans.

Pakistan has a major agricultural sector, employing over 40% of the labour force, and is well supported by research and extension. As noted by Shahbaz and Ata (2014), Pakistan's National Agricultural Research System (NARS) has several 'federal and provincial research centers and institutes, agricultural universities and regional adaptive research farms'. The Pakistan Agricultural Research Council (PARC) has headquarters in Islamabad and technology transfers centres in provincial capitals. These authors also note that most major private national and multinational companies selling inputs to farmers also provide them with advisory services, as do NGOs and farmers' organizations.

Bergvinson (2016) as Director General of ICRISAT reported that the agency is conducting research on pulses in Pakistan, focussing on: improved grain quality, nutritional traits, food safety, nitrogen-fixing properties and hybrids; drought tolerance and adaptation to diverse dryland agroecosystems; and differing rotations with cereal crops. Plant breeding is enhanced with modern genomic and molecular tools, precise phenotyping and crop simulation modelling, and 'ICRISAT works along the whole value chain of pulses in an integrated manner to create a win-win situation for the farmer, consumer and the planet'.

PAKISTAN IRRIGATION POLICY

Only a small proportion of the pulses cropping area in Pakistan is irrigated, a similar situation to in India. Both Pakistan and India rely to some extent on the same water resources. Bakshi and Trivedi (2011) explained that Pakistan receives its water from the Indus, Karan and Makran River Basins. The Indus is one of the longest rivers in Asia (over 3000 km) and runs from Tibet to the Arabian Sea near Karachi. Thomas (2015) observed that construction of dams for irrigation and power has choked off much of the fresh water supply … its 17 major creeks are drying out and salty water from the sea is steadily entering the basin. Dam construction, over committal of water for irrigation, pollution from wastewater and climate change are blamed for much of the river, delta, mangrove forest, river dolphin and marine fishery damages

The Indus River Basin covers 71% of Pakistan's its territory – comprising the whole of Punjab, Sindh, NWFP, Azad Jammu and Kashmir (AJK), and the eastern parts of Balochistan – and provides water for 77% of the population. The Karan and the Makran rivers originate along the plains of Balochistan and cover only 15% and 14% of Pakistan's territory respectively. Bakshi and Trivedi (2011) argued that there is "internal water mismanagement", citing a number of water management issues. They also mentioned unequal distribution amongst the provinces (AJK compared to Pakistan, and Sindh compared to Punjab), and impacts of climate change.

Most urban and rural water in Pakistan is supplied from groundwater sources. The Indus Basin has a large groundwater aquifer, with mostly diesel pumps but some using electricity. There is concern about water quality, with Saleem and Hussain (2018) reporting that "about 60 per cent of tubewell water used for irrigation in Pakistan is saline to sodic in nature … The overall aquifer, with a potential of about 50 MAF, is being exploited to an extent of about 38 MAF by over 562,000 private tube-wells and about 10,000 public".

Bagel (2016) reported that "Grappling with increasing water scarcity and its far reaching implications on everyone, the Pakistan government has readied a comprehensive National Water Policy … prepared by the Water and Power Development Authority (WAPDA) The planned water resources management regime includes building reservoirs, efforts at water conservation and improving the availability, reliability and quality of freshwater resources to meet critical municipal, agricultural, energy security and environmental needs. ,,, the policy pushes for promoting appropriate technologies for rainwater harvesting in rural as well as in urban areas, controlling groundwater pumping and reducing over-extraction. The draft policy also introduces the concept of adequate water pricing for proper operation and maintenance of the irrigation system and its long term sustainability". Khalid (2017) observed that Pakistan has had a number of draft water policies, but has as yet not been able to secure widespread agreement on a policy.

PAKISTAN TRADE IN PULSES AND OTHER AGRICULTURAL PRODUCTS

OECD data reported by Atlas Media (2016) in relation to total national trade reveal that in 2014, total exports from Pakistan were valued at US$28.3 billion and total imports were valued at $47.4 billion, resulting in a negative trade balance of $19.1 billion. Pakistan's most highly-valued export commodities were rice (second most highly-valued export to house linen) and cotton ($2.04 billion). Given that Pakistan exports substantial quantities of rice to Australia, and Australia exports substantial quantities of pulses to Pakistan, it appears that each country is specialising in goods for which they have comparative advantage, and hence benefiting from trade. According to Rana (2017), Pakistan had a record trade deficit in 2017 of $32.6b

The quantity of pulses produced in Pakistan is low relative to grain crops, and large quantities are imported, particularly in years when domestic production is relatively low. According to Austrade (2018), Russia, Turkey, Canada, Myanmar, USA and Australia are the main source markets for pulse imports into Pakistan, with Pakistan as Australia's second largest pulses customer, as a large chickpea producer.

Khan (2017) reported that Pakistan made record imports of 1.2 million tonnes of pulses during 2016-17. The high pulses prices (over Rs 100/kg) apparently led to some substitution by green vegetables and reurced pulses prices.

Measures have been adopted to reduce pulses exports from Pakistan. The Government of Pakistan imposed a 35% regulatory duty on export of pulses in 2006 (Federal Board of Revenue, c2015). While the export ban of the Indian government on pulses was a major source of discussion until it was lifted and replaced by an export charge, no recent information has been identified about bans on pulses exports from Pakistan. Most import products to Pakistan face a duty, and notably 'pulses and chick peas are duty free' though soya beans have a customs duty of 10 per cent' (Austrade, 2016).

CONSTRAINTS AND OPPORTUNITIES FOR PULSE PRODUCTION IN PAKISTAN

Constraints on expansion of pulses production

A number of constraints exist for pulse production in Pakistan. Junejo (2016) summarized these as relatively low farm-gate prices compared with other crops, lack of modern technology, improper sowing and harvesting techniques, delayed sowing of seeds, use of non-certified seeds, poor disease resistance in pulse varieties, improper Government policies and lack of research on pulses to increase production.

Khan and Anwar (2016, p. 124) identified various constraints to pulses production in Pakistan, including 'use of rainfed marginal lands, susceptibility to pest and disease attack, weather aberrations, lack of genetic breakthrough and diversion of pulse areas to more remunerative crops with availability of irrigation water. The wide gap between the attainable yield potentials and farmers' yield is due to various biotic, abiotic and socio-economic factors. Biotic factors are diseases, insects and weeds. … weeds are another serious constraint to increased production. Pulses are generally poor competitors to weeds because of slow growth rates and limited leaf area development at early stages of crop growth and establishment. In storage, bruchids can cause severe losses'. Comments have been made in meetings with farmers in Pakistan in this project that pulses are a difficult crop to grow, including with regard to control of weeds and also pests and diseases.

According to Amanullah (2016), 'the low yields and overall production of many pulse crops in many parts of the world is attributed to major constraints which includes: (1) strong competition from cereals (wheat, maize and rice), cash and industrial crops (cotton, sugarcane, tobacco, oilseed crops etc.) which gave better economic returns, (2) lack of modern pulses production technologies designed to maximize resource use and so ineffective crop management practices, (3) shortage of experienced personnel and lack of effective research and extension programmes and (4) lack of high yielding pulses varieties and the poor state of seed multiplication, certification and distribution systems".

In terms of production technologies, low level of mechanization in Pakistan can lead to high pulses harvest and postharvest losses. Grain losses from harvesting through to sale or consumption are sometimes a major deterrent to pulses production. No systematic analysis of these losses have been identified for Pakistan. However, Lal and Verma (2007) estimated these losses during harvesting and through to milling and storage in India of 25-50%, with more than half of this during storage and milling (Table 5).

Table 5. Some estimates of harvest and post-harvest losses in pulses yields

Stage	Yield loss (%)
Harvesting	1.0-3.0
Handling	1.0-7.0
Threshing	0.5-5.0
Drying	1.0-5.0
Transport	0.5
Primaly processing	1.0
Storage	5.0-10.0
Milling	15.0-20.0
Total	25.0-50.0

Source. Lal and Verma (2007), Table 2.3, p. 6

Also in India, Rani (2011) reported that postharvest losses were up to 14.5% for red gram (pigeon pea), and that according to the World Bank "Missing Food" report of 2011, loss of red gram is estimated to be 7-10% at the farm to market level and another 4-5% at market and distribution level. Rani (2011) concluded that development of threshers specifically designed for pulses are required, with improved storage methods, for the promotion of pulse crops.

Some further comments on constraints are provided by FAO (2016c, p. 28) under the heading of 'Scaling up, Seed Delivery Systems, Technology Transfer, Value Chain'. This report states (p. 28) that 'Moving research from the lab/field to the farmer, and commercializing research results, are themes mentioned directly by several respondents and indirectly through comments about the need for expanded extension services by others. One respondent makes the point that scaling up pulse crop for value-added opportunities can be problematic simply because production is relatively small and must compete with perceived higher-value or lower risk crops, so it may be difficult to see the opportunity, justify investment, or keep the project supplied with product. Critical mass along the value chain is important. Other respondents mention that appropriate technology at the farm level, with a minimal capital investment, can be a limiting factor, and that research is needed in both high- and low-input farming systems. The need for development of mechanical harvesting capability (from plant architecture through to appropriate harvesters) is mentioned by several respondents. Seed multiplication and systems for delivery of seed of new, improved varieties to farmers is fundamental to crop improvement at the farm level. Several funding agencies make it clear that a technology transfer component is critical to the success of a research application.'

A further general constraint of agriculture in recent years has been the global recession resulting in high oil prices that has pushed up the price of urea as a nitrogen fertilizer.

Davies *et al.* (2016) under the USAID Strategy Support Program provided a number of comments on pulses production in relation to national food security in Pakistan, noting that there has been very little growth in Pakistani pulses production in the last 30 year, and they tend to behave as subsistence crops. Most pulses production has been on rain-fed areas of marginal land, wheat yields far outweigh those of legumes. Also, the wheat procurement price has possible negative effects on pulses production. On this latter point, the wheat procurement price is low relative to wheat prices, and appears difficult to obtain for small-scale growers.

Opportunities for expansion of pulses production

Khan and Anwar (2016, p. 127) suggested that 'production of pulses can be increased by adopting high-yielding varieties and production technology developed through coordinated research. The major output of the coordinated effort was the release of 27 varieties of chickpea, 11 of lentil, 15 of mung bean and 7 of mash bean for commercial cultivation'. These authors (pp. 127-128) identified the following opportunities for increasing pulses production:

- availability of certified seed of pulse crops to farmers;
- induction of pulse crops in irrigated areas with the development of high input responsive varieties;
- introduction of lentils and blackgrams in high lands of Balochistan, Khyber Pakhtunkhwa, reverine areas of the districts of Bhakkar, Layyah, Muzaffargarh and Dera Ghazi Khan which are suitable for the cultivation of these crops;
- intercropping mungbeans in spring-sown sugarcane in central Punjab and Sindh;
- short duration varieties of mungbeans introduced as catch crop in rice-wheat cropping systems to expand the area of cultivation and improve soil fertility;
- introduction of mungbean in wheat-fallow cropping systems under rainfed conditions of Pothohar;
- inoculation of seeds with Rhizobium bacteria to improve nitrogen fixation and increase yields.

Dasgupta and Roy (2016) edited a wide-ranging set of proceedings on pulses production in various countries, in which each of the participating countries identified constraints and opportunities for expansion of pulses production. These authors (p. 14-15) concluded that the production of pulses can be increased by:

- adopting high-yielding varieties and production technology developed through coordinated research;
- development of chickpea varieties resistant to blight (Ascochyta rabiei);
- release of short duration mung and mashbean varieties coupled with matching agro-technologies;
- intercropping mungbeans with sugarcane in central Punjab and Sindh;
- short duration varieties of mungbeans grown as catch crop in rice-wheat cropping systems to expand the area of cultivation and improve soil fertility.

Bokhari (2015) described a program in Pakistan under which the government intends to distribute planting or 'seed' drills for planting pulses for which growers having 5-25 acres of land are eligible on subsidised rates during 2015-16, and has selected one tehsil from each district for the program. Bokhari reported that the Punjab government will, under the new plan, conduct training programmes for farmers in modern production technology, provide certified seeds at subsidised rates and hold demonstrations of the use of latest techniques for sowing pulses at farmers' fields.

Davies *et al.* (2016) suggested there is a need for more research on pulses, including breeding work, and for greater mechanization in pulses production, and support for pulses production could be a pro-poor strategy.

A few further suggestions to increase pulses production can be noted:

- New areas of systems research which need attention, including intercropping, winter cropping, water use efficiency, fertilizer use efficiency, and high- and low-input farming systems' (FAO, 2016c, p. 27).
- Provision of improved agricultural extension to promote favourable farm practices, e.g. in weed control and nodulation to increase atmospheric nitrogen fixation in the soil
- Plant breeding, and making seed of improved pulse varieties more widely available to smallholder farmers, so as to increase pulses yields, make more pest and disease resistant and drought tolerant species available, and reduce rotation length (to make double and even triple cropping available).
- Support for greater mechanization for pulses growers, reducing, labour demands (e.g. in crop harvesting)
- Increasing the use of irrigation in pulses production. , e.g. by making available inexpensive solar pumping systems.

PAKISTAN CROP SUBSIDY AND PRICING POLICIES

Earlier support regimes

Government assistance and incentive measures are often used to assist particular agricultural industries, and the use of support and procurement prices and input subsidies has been notable in Pakistan. Knight (2000, p. 121) pointed out that 'in developing countries such as India, Pakistan and Bangladesh, governments can control market prices and the supply of pulses to some extent. This includes manipulation of the price paid to growers. … The Pakistan Government has a price support policy for chickpeas, determined by the cost associated with crop production. This policy is reviewed annually'. He further commented that 'The Pakistan Agricultural Storage and Supply Corporation (PASSCO) can buy pulse grain from farmers and keep it in storage. Also, the Public Utility Store Corporation of Pakistan can procure local produce and supplement shortfalls with imports'. Afterwards, the chickpea price support system was apparently discontinued.

Knight (2000, p. 45) argued that 'Policy issues will be important and in many cases will involve removal of policy distortions such as support prices, input subsidies, and special programs to promote cereals and soybeans that have occurred in the last two decades. Where appropriate technologies are available, it is appropriate to consider raising the general awareness of the role of legumes, and to target seed and extension programs. … any breakthroughs that result in a sharp reduction in prices will open up a role .. in animal feeding. The expansion of the livestock industry with growing incomes in the developing world provides a virtually unlimited market for feed that can be exploited by producers in industrialized and developing countries.

Dorosh and Salam (2008) found that 'increases in wheat procurement prices have relatively small effects on the overall consumer price index' in Pakistan. Further, 'Partial equilibrium analysis of wheat markets suggests that fluctuations in production, rather than market manipulation, are plausible explanations for price increases in recent years'. These authors concluded that 'market forces play a dominant role in price determination in Pakistan, and policies that promote the private sector wheat trade can both increase price stability and reduce fiscal costs'.

The Pakistan Bureau of Statistics (2016) reported recent support prices for agricultural commodities including wheat, cotton and sugarcane. The procurement price for wheat increased progressively during the period 2010-11 to 2014-15 from 950 to 1300 Rs/maund (40 kg) and that of sugarcane from 125 to about 180 Rs/maund. The procurement prices of seed cotton was set at 3000 Rs/maund in 2014-15. Apparently there was no support price for rice during this period.

The recent pulses price support regime

A distinction can be drawn between a support or procurement price and an indicative price. A support price continues to be available for wheat, which for 2017 was set at 1300 rupees per 50 kg (Government of Punjab, 2017). If the market price were to fall below this level and if farmers were suffering financially, the national government would step in and purchase a substantial part of the production volume.

In case of sugarcane, there is an indicative price where the government attempts to set a market price with mutual agreement between sugarcane growers and sugar mill owners so that neither group exploits the other. However, if the sugarcane price falls below the indicative price the government is not obliged to make purchases from the sugarcane growers. There is however flexibility to adopt measures to increase sugar exports if necessary. Office of Agricultural Affairs, Islamabad and USDA (2015) noted that the Pakistan government had imposed a 25 percent tariff on sugar imports, Also, according to Office of Agricultural Affairs, Islamabad, and USDA (2018), "In response to large carry-over stocks at the onset of the current harvest, the Government of Pakistan has increased the volume of sugar eligible for an export subsidy from 500,000 metric tons to two million metric tons. The subsidy is categorized as a freight subsidy of up to $97 per metric ton, for total potential subsidy expenditures of $194 million. Pakistan has utilized export subsidies to move sugar off its domestic market during four of the past five marketing years".

While there is evidence of support prices for pulses in Pakistan in earlier years, these have been discontinued. Given the relatively small production volume and high production cost of pulses crops, price support could not be justified on the basis of food self-sufficiency. However, these leguminous crops can make an important contribution to community health by providing 'complementary proteins' relative to grain crops, and hence reducing the incidence of non-communicable diseases.

It has been argued by a group of experts at the University of Agriculture in Faisalabad that a support price mechanism should be introduced for pulses and oil seed crops to reduce expenditure on imports and domestic prices, given the very high import expenditure on these (pakissan.com, 2015). Saif *et al.* (2015) also reported that a meeting of agricultural experts in Islamabad demanded that government introduce a 'support price mechanism for pulses and oil seed crops to promote cultivation that will help in reducing prices and imports of these commodities'.

Ahmed (2015) reported that the Pakistan federal government "has proposed that the provincial governments consider giving farmers a support price for pulses, particularly masoor and maash [lentils and urdbeans], whose local production is declining and their shortfall is being met through imports'. If the provinces agree, the pattern of support prices for pulses will be similar to the one being given to wheat growers. … The national food security minister believes that farmers have been focusing on traditional crops like wheat, rice and sugarcane and have ignored other important crops like pulses. Support prices for pulses will create some balance in the production of various crops, he says. The country has a surplus of wheat, rice and sugarcane but faces a deficit of pulses because of their low output".

In contrast to Pakistan, India has in recent years used support prices for a number of crops, including several pulses species. Some concern has been expressed at the extent of support prices in India, in terms of their distributional impacts (which may favour traders over growers), cost, limited ability to increase production, and compatibility with World Trade Organization provisions. Also, conflict has arisen from the fact that that only a small proportion of Indian pulses growers actually receive the support prices. The effectiveness of support prices for pulses in India has been questioned by Joshi *et al.* 2016). Joshi (p. v) argued that 'The minimum support price (MSP) for pulses, without direct government procurement, helps traders more than farmers because it acts as a focal point for tacit collusion among traders. Farmers will benefit from the MSP only if it is raised substantially from its current levels. The increase in farmgate prices due to a higher MSP will not necessarily lead to an increase in the retail price of pulses because much of the wedge between farmgate prices and consumer prices is traders' margin. … We suggest, as more potent solutions, investing in research and extension for pulses, aggregating pulse growers into farmer producer organizations, and paying pulse growers or pulse-growing areas for the ecosystem services offered by pulses'.

When international pulses prices are high, and pulses imports expensive, consumer prices for pulses in Pakistan become a concern. Sims (2016) reported that a Pakistan survey by The Nation indicated that shopkeepers in Lahore 'are not adhering to the government's official price list. For instance, mung beans were being sold for 185 rupees (per kilogram) despite the fact that the official price was 145 rupees (per kilogram)'.

World Bank (2017) approved USD $300 million to modernize agriculture in Punjab province "to modernize agriculture in Punjab province … raise farmers' incomes, give consumers better quality and safer food at lower prices, create jobs on farms and agribusinesses, and improve the use of irrigation water … by shifting resources away from ineffective subsidies towards supporting farmers to produce higher value products such as vegetables, fruits, pulses, oilseeds, milk and meat". It was noted that demand for these products is growing much faster than "lower value crops such as wheat". A similar view was promoted in India where Bera (2017) noted that 60% of the pulses crop was sold at less than minimum support prices, and the chief economic advisor recommended moving away from subsidies and support to cereals such as rice and wheat and increasing assistance to pulses and livestock'.

SOME FURTHER PULSE POLICY LITERATURE RELEVANT TO PAKISTAN

Many web items can be found relating to agricultural policy – including pulses production policy – in Pakistan. Khan (1984, p. 243) made a systematic classification of dominant agricultural policy issues in Pakistan, for analytical convenience dividing these into three groups, viz (i) Agricultural Inputs, (ii) Agricultural Services, and (iii) Institutions and Policy Instruments, as in Table 6. Comments were provided on each issue, and at least some have relevance with current policy.

Table 6. Khan's systematic classification of agricultural policy issues

Agricultural inputs	Agricultural services	Institutions and policy Instruments
Fertilizers	Credit	Land reforms
Tractors	Storage and marketing	Agricultural taxation
Water	Education, research and extension	Support prices and subsidies

Ali and Abedullah (1998) estimated supply and demand price elasticities for pulse and cereal crops. They noted (p. 35) that generally lack of innovation in pulses, except in mungbean, has reduced their production and they are pushed to low intensive areas which are marginal for cereal and cash crop production, with pulses not benefiting from the investment in irrigation infrastructure.

Bashir and Schilizzi (2012) argued that food security assessments in Pakistan have been carried out at the aggregate (national) level, and that the results based on averages can be misleading because they ignore the dynamics of food security at the micro level. They recommend (p. 1188) that 'food security policy assessment … be carried out at disaggregated levels, in particular at the household level'. More specifically, they concluded (p. 1186) that partial equilibrium models are a better choice for policy assessment than computable general equilibrium (CGE) models to analyse the direct effects of governmental interventions on food security status.

Valdés (2013) developed an informative report on agricultural trade and price policy for agricultural products, as part of a Policy Paper Series on Pakistan. This paper presents a synthesis of the major trends in the performance of the agriculture sector, and also provides a broader context in which to view the functioning of agricultural trade and price policies. It also discusses Pakistan's "extraordinarily complex, opaque and discretionary, and continually-changing trade regime". Mention is made of direct interventions by parastatals (government-owned companys with some political power) in procurement and sales price determination for the major crops. The paper presents a disaggregated analysis of the broarder measures for the selected products (with trade and price interventions varying by product), and estimates the joint effect of trade and procurement policies on farm prices.

Rani *et al.* (2014) carried out an econometric analysis to investigate factors determining farmers' decisions to allocate land for production of chickpea and mung bean, finding acreage response results revealed that farm harvest prices, lagged area and good moisture availability at sowing time positively influence the area allocation decision of the farmers. However, yield for mung and fertilizers price for both species were not statistically significant in influencing the farmers' decision to allocate land.

Malik (2015) observed that major constraints to 'transforming Pakistan's Agriculture' are related to:

- weak and fragmented markets with substantial government intervention;
- non-performing land markets;
- inefficient allocation and use of irrigation water;
- the regulatory environment that discourages investment and reduces market efficiency;
- primitive rural non-farm economy and limited interface with modern business practices; and
- rapidly declining investment – especially public investment – with serious under-investment in research and technology development and almost non-existent extension and outreach.

FAO (2016c, p. 27 et seq,) in a global survey of pulses production and research found overarching themes emerging in gaps and opportunities for pulses research, including in relation to pland breeding and genetics, agronomy, systems and sustainability, supply chains, and researcher funding and training.

As explained by IFPRI (nd), responding to a request from the Government of Pakistan, the Pakistan Strategy Support Program (PSSP), launched in July 2011, is a flexible country-led and country-wide policy analysis and capacity strengthening program. The program provides analytical support on a range of economic policies affecting agricultural growth and food security in the country. The core purpose of the program is to contribute to pro-poor economic growth and enhanced food security through strengthened national capacity for designing and implementing evidence-based policy reforms. This requires improving research-based policy analysis; building capacity, leadership and networks among researchers and policy analysts within and outside the government; and disseminating research results among diverse stakeholders'.

PAKISTAN GENDER EQUITY POLICY AND GENDER ROLES IN AGRICULTURE

Mittra and Kuman (2004, p. 272) reported that 'In Pakistan, women participate extensively in the production of major crops …Women's participation is particularly high in cotton, rice, pulses and vegetables … In the rainfed areas of Punjab, women contribute to almost all of the 22 identified crop tasks with the major contribution to seed preparation, collection and application of farmyard manure, husking maize and storage. Men's involvement is higher in the early stages of cultivation such as field preparation. Men also monopolize mechanical work. … hand-threshing is a women's domain of task. … Food processing and storage is an area where women's participation is considerably higher than men's'. Begum and Yasmeen (2011) noted that women have an important role to play in agriculture but their role is often not recognized due to gender biases.

Bridge, a specialised gender and development research and information service within the UK Institute of Development Studies, examined gender and food security issues in developing countries under 'the 'four pillars' of food security – availability, access, utilisation and stability – that were identified at the World Summit on Food Security in 2009'. Bridge (2014), in a multi-authored report, noted that 'food and nutrition insecurity is a gender justice issue. Low status and lack of access to resources mean that women and girls are the most disadvantaged by the inequitable global economic processes that govern food systems and by global trends such as climate change'. The report observed that men's landholdings in Pakistan are twice the size of those of women, and that 'in the Federally Administered Tribal Areas (FATA) of Pakistan, tribal Pushtun women suffer from the highest levels of poverty, illiteracy and poor health not only in Pakistan but in the whole of South Asia'.

According to USAID (2016), Pakistan has a very low ranking on the annual Gender Gap Index by the World Economic Forum based in Geneva, with large gaps between men and women in health, education, politics, and economic participation. The agency is provides number of assistance programs for rural women, examples including: a Dairy Project to increase incomes and job opportunities for rural women by training them to work with livestock and supporting self-employment; a partnership for Agricultural Market

Development (AMD), expanding the roles of women entrepreneurs in targeted product lines of mangoes, citrus, livestock, and high-value vegetables; a Maternal and Child Health (MCH) program; and a program on increasing girls' access to education and improving education quality.

According to S.H.K. Bosan, Federal Minister of National Food Security and Research, Government of Pakistan, in the Foreword to the report by Samee *et al.* (2015), the FAO report highlights overall status, challenges and contribution of women in sub-sectors of agriculture and gives a road map for further improving these across the four provinces and three regions of Pakistan. The report notes (p. 134) that 'In most of the [development] projects, women are only involved for handicrafts/ sewing /stitching and embroidery works and not in natural resource management activities'. Many constraints are faced by women in seeking to play an active role in agriculture in Pakistan, and they are sometimes restricted to menial tasks. There is much scope to increase the role of women in agriculture. The report makes 16 key recommendations for the federal and provincial governments for improving practices of small farms and enhancing the role of women in these farms.

SUMMARY

Two pulse species (chickpeas and mung beans) account for most of the pulses production in Pakistan, but comprise a small planted area relative to other food crops, particularly wheat and rice. Pakistan has a high population density, and food security is a major concern for the Pakistani government. Pulse crops are an important source of dietary protein, and the Pakistan government has a policy to lift pulses production and reduce spending on imports. This poses major challenges, but a number of opportunities for increased pulses production can be identified. Only wheat has a support price, but assistance measures are made available for other crop species.

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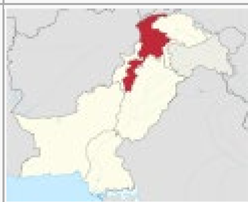
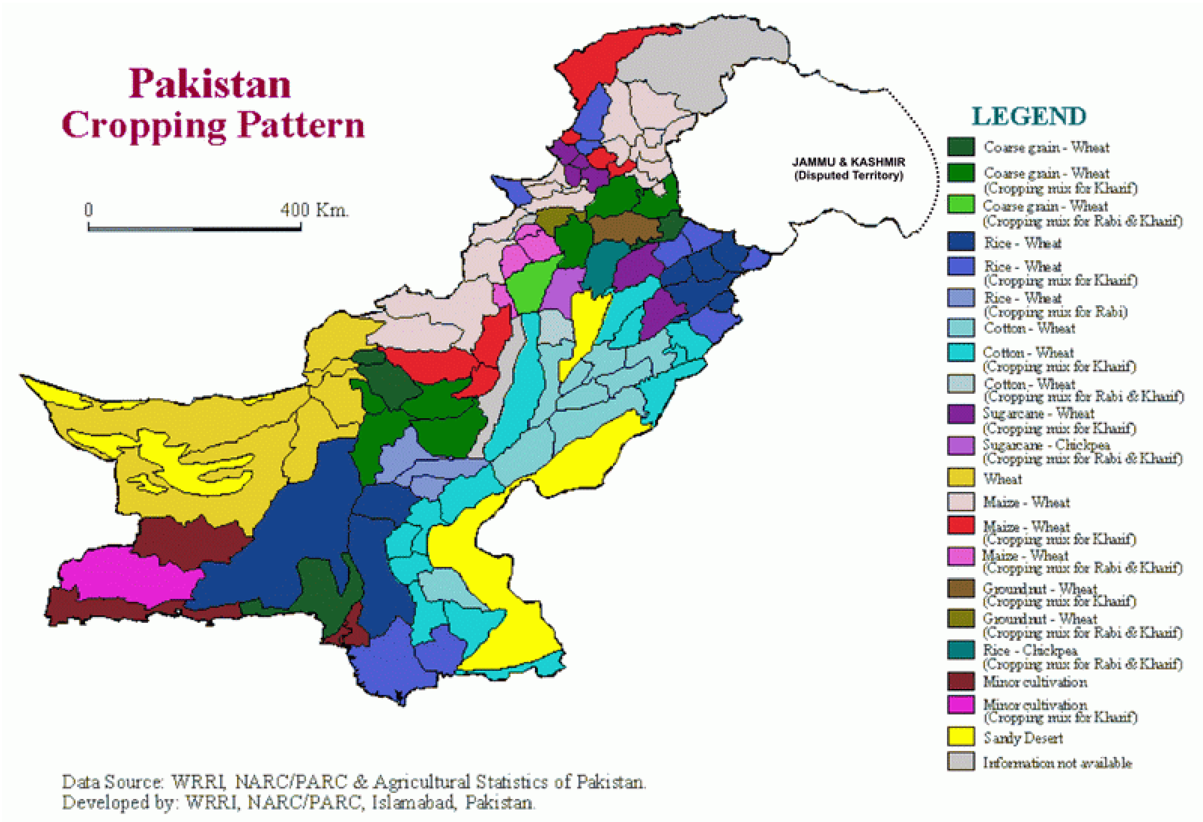
APPENDIX A. MAPS OF PAKISTAN CITIES, PROVINCES, INDIVIDUAL ADMINISTRATIVE UNITS AND CROPPING PATTERN

Pakistan map indicating major cities (Source: Google Maps)

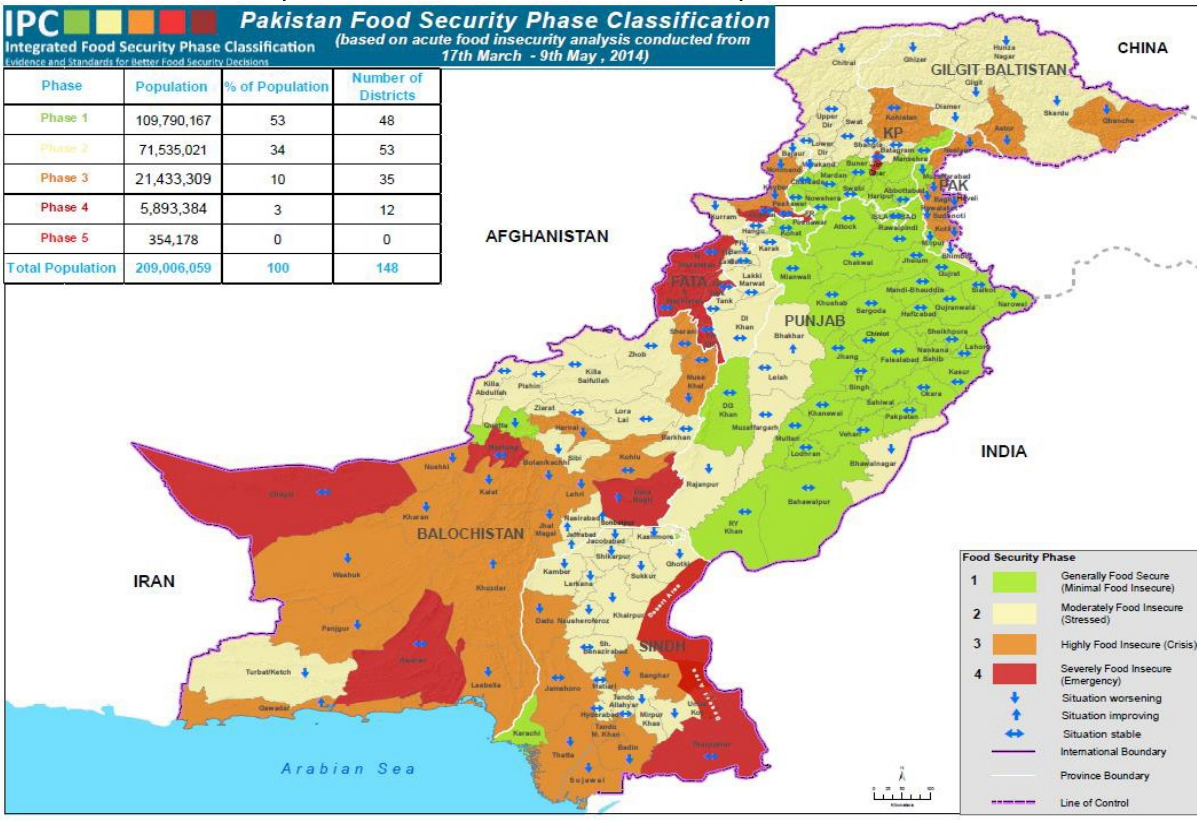
Pakistan provinces
Source: Government of Pakistan (2010), p. iii

Structure of administrative units in Pakistan (Source: Wikipedia, 2016a).

Abbreviation	**Administrative unit**	**Capital**	**Population (2012)**	**Area (km²)**	**Density (per km²)**	**Map**
AJK	Azad Jammu and Kashmir (autonomous territory)	Muzaffarabad	2,972,501	13,297	223.55	
BN	Balochistan (province)	Quetta	13,162,222	347,190	37.91	
FATA	Federally Administered Tribal Areas	Peshawar	3,930,419	27,220	144.39	
GB	Gilgit-Baltistan (autonomous territory)	Gilgit	1,441,523	72,971	19.75	
ICT	Islamabad Capital Territory (federal capital territory)	Islamabad	1,151,868	906	1,271.38	
KP	Khyber Pakhtunkhwa (province)	Peshawar	26,896,829	74,521	360.93	
PB	Punjab (province)	Lahore	91,379,615	205,344	445.01	
SD	Sindh (province)	Karachi	55,245,497	140,914	392.05	
	Pakistan	**Islamabad**	**197,361,691**	**882,363**	**223.79**	

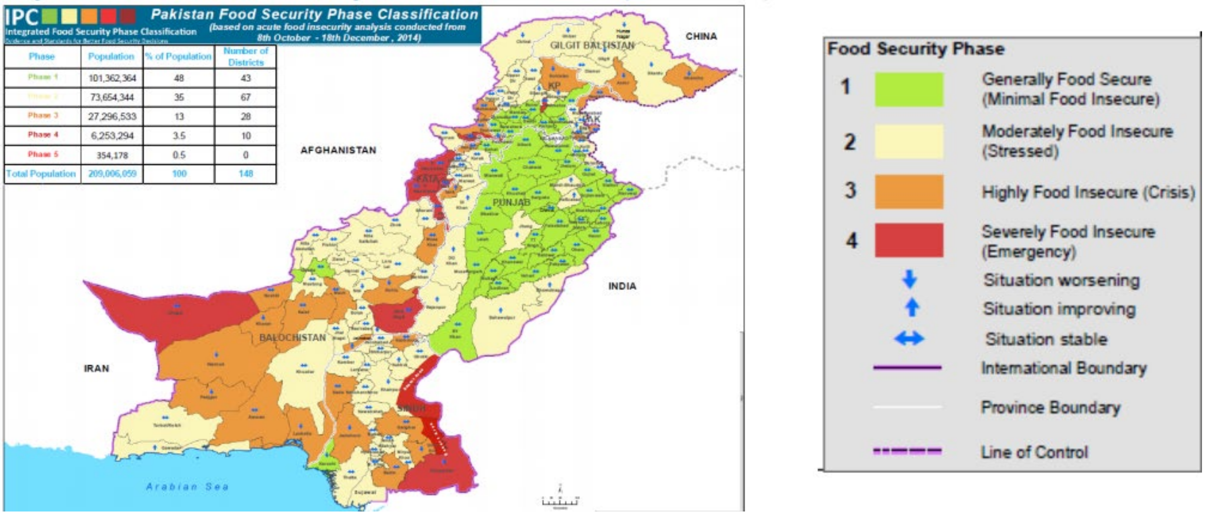


Pakistan Food Security Phase Classification, March – May 2014



Phase	Population	% of Population	Number of Districts
Phase 1	109,790,167	53	48
Phase 2	71,535,021	34	53
Phase 3	21,433,309	10	35
Phase 4	5,893,384	3	12
Phase 5	354,178	0	0
Total Population	209,006,059	100	148

Pakistan Food Security Phase Classification, Oct - Dec 2014



APPENDIX B: SOME PAKISTANI UNITS OF MEASUREMENT AND CONVERSION FACTORS

Exchange rate: 1 Pakistan Rupees = $0.013 Aust (14 Nov 16)

Area: 1 kanal = 20 marlas; 1 marla = 25.2929 m^2; 1 acre = 0.404686 ha

Weight: 1 maund = 40 kg; 1 quintal = 100 kg

Farm-level financial and economic review of pulses production in Pakistan

Stephen Harrison[1], Robert Harrison[1], Khuram Sadozai[2], Muhammad Qasim[3], Saima Rani[3], Abdul Ghafoor Chaudhry[4], Elizabeth Petersen[5]

[1]The University of the Sunshine Coast, [2]The University of Agriculture Peshawar, [3]The National Agricultural Research Centre, [4]The University of Agriculture Faisalabad, [5]The University of Western Australia

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Abstract

The objective of the working paper is to provide a platform for data collection and financial and economic modelling of pulses cropping systems including crop rotations in Pakistan. Pulses cropping systems and rotations adopted or advocated in Pakistan are described. Cost components relevant to gross margins (GM) analyses of individual pulses species are identified, literature on benefits which have been attributed to pulses production are reported, and further information requirements needed for economic evaluation are highlighted.

INTRODUCTION

One of the research activities of ACIAR small research activity (SRA) ADP/2016/043, *Economic analysis of policies affecting pulses in Pakistan* is to investigate the financial aspects of pulses production at the farm level – including cropping systems and rotations which include pulse species – and to elicit farmer perceptions regarding constraints to pulses production. This working paper reviews the economic and financial analysis options, describes pulses systems and rotations reported in the literature, describes cost components relevant to gross margins (GM) analyses of individual pulses species, reviews literature on benefits which have been attributed to pulses production, and highlights aspects where further information appears to be required to evaluate pulses cropping system. The research approach used in this paper is literature review.

The financial or economic analysis of pulses cropping systems including crop rotations can be viewed at four levels of complexity and information value for policy-making. The simplest context for viewing pulses production is as stand-alone crops, competing with other crops for use of the farmers' resources. However, as noted by Gul (2016), 'pulses are a crucial component of multiple cropping systems, namely intercropping, crop rotation and agroforestry'.

The four pulses species listed in Table 1 account for most of the pulses cropping in Pakistan. Notably, the peas (chickpeas, lentils) are winter crops and the bean species are spring and summer crops. As reported by Abbas (2013), among the Pakistani states Punjab grows the greatest area of pulses, and also of rice, cotton and sugarcane for which pulses must compete for resources.

Table 1: Areas of the main pulses species grown in Pakistan

Species	Area planted (1000 ha)	Share of pulse area (%)
Chickpea, gram, chana, garbanzo beans, hommes (*Cicer arietinum L.*), desi and Kabuli	945	83.8%
Mung bean, moong bean, green gram (*Vigna radiata L.*)	146	13%
Lentil, masoor (*Lens culinaris Medic.*)	17.x	1.5%
Mashbean, mash, urdbean, urad, (*Vigna mungo L. Hepper*)	19.2	1.7%

Source: Area data are provisional estimates from Pakistan Economic Survey 2015-16, Ch. 2, Agriculture, p. 30. Area shares are calculated from these area estimates, and are slight overestimates because small areas of pulse species other than these four are grown in Pakistan.

The relevant crop species for financial or economic analysis might include these four most commonly grown pulse species in Pakistan, together with the other crop species that are used or recommended for mixed cropping systems which include pulses – notably wheat, rice, cotton, sugarcane, maize, vegetables, tree crops – as well as tree plus crop (agroforestry) systems.

METHODS FOR ASSESSING THE ECONOMICS OF PULSES PRODUCTION

Gross margins analysis of pulses and alternative crop species

The financial performance of growing individual pulses species at particular locations may be compared with that of growing other crops, notably cereals, through GM analysis. GM analysis as applied to crops involves estimating the variable costs in production of a crop and the revenue generated from the crop (basically yield multiplied by farm-gate price) and subtracting from it the variable (as distinct from fixed or overhead) costs in production, typically for a 1 ha crop area. The level of variable costs will depend on the scale of production and extent of mechanization. Only variable costs are taken into account, on the assumption that the components of fixed costs – e.g. land rates, machinery overheads – will vary little regardless of what crop or crops are grown.

Estimation of variable costs requires identifying the steps in the cropping cycle, and associated costs, from site preparation to marketing (or in part on-farm consumption) of produce, and the inputs required in the crop cycle which may include seed, inoculum, fertilizer, weed control, irrigation water if any, agrochemicals, fuel and oil, and labour. This type of analysis is widely reported, but not taking into account any overhead costs or any interaction with other crops limits the range of uses of the information generated. Some details pulse of cropping practices in Pakistan and of cost items often included in GM budgets are summarized in Appendix A. Various GM models (typically in spreadsheet format) for Pakistan and some other countries are presented in Appendix B.

Financial analysis of cropping systems including a pulses component

When pulses are grown in combination with other crop species, there will be some interactions between crops (e.g. fixing of atmospheric nitrogen in the soil by pulses, other legumes and some other crop species) and the amount of inputs applied to succeeding crops can be reduced (e.g. nitrogenous fertilizer).

Intercropping systems including pulse species are widely practiced. For example, FAO (2016a) noted that 'Being drought-tolerant, pigeon peas (*Cajanus cajan* (L.) Huth) are often intercropped with cereals in smallholder farming systems in Asia, Africa and the Caribbean. As pigeon peas are also deep rooting, they do not compete with maize for water.'

Sometimes a regular crop rotation system is practiced. Two simple cases sometimes mentioned in Pakistan are a chickpea – wheat and a mung bean – rice rotation, conducted over several years. A chickpea and wheat rotation seems to have particular appeal for rainfed cropping in subtropical areas of relatively low rainfall and soil fertility, due to benefits of chickpea nitrogen fixation and from improvement in soil condition (organic matter content).

Even greater crop interactions can arise if pulses are grown as a component of agroforestry systems where the agroforestry may include other crop and livestock species. While there is some sharing of land between trees and pulse crops, trees may provide a favourable microclimate (wind protection, a desirable level of shading and temperature reduction), recycling of soil organic matter and nutrients, and reduction in pest and disease damage. When pulses are grown along with livestock species (typically in blocks rather than closely integrated, possibly with increased crop protection cost), the pulses may provide harvest residues as livestock fodder, and farmyard manure may be used as organic fertilizer for pulse crops.

Amin (nd) citing PARC (1980) observed that the main agroforestry crops in the tropical thorn forests of the desert scrub in Pakistan are wheat, sorghum, millet and *gram*, and (citing PARC 1980) that 'The important crops include millets, maize, wheat, oilseeds, *pulses* and fodder'. Rainfed cropping is practiced in these areas, which have very cold winters and hot dry summers.

Another example of use of pulses in cropping systems has been reported by Misha and Arunachalam (2015), who noted with respect to agricultural diversification in India that alley cropping of arable crops with widely planted fodder shrubs offer an opportunity to grow short-duration less water demanding oilseeds and *pulses* in fragile rainfed ecosystems. They reported (p. 20) that 'these systems besides providing additional output in terms of food grain also enrich the soil and help as a natural soil cover against water and wind erosion. The important agroforestry systems may be Casuarina/Leucaena + green gram/black gram/cowpea, sunflower'.

Clearly, GM analysis is not appropriate for evaluation of returns from cropping systems, including mixed cropping, crop rotations and agroforestry systems. A more suitable method of estimating likely returns to growers would be financial analysis in the form of discounted cash flow (DCF) analysis, where the timing of project costs and returns over time are taken into account. Allowance could be made for the interaction between species (in terms of reducing fertilizer requirement for grain crops following legumes). Also, in that pulses can be used as 'break crops', there may be a reduction in pest and disease control costs after pulses crops. Pulses stubble can provide a high-quality fodder for crop growers who also raise cattle. It should be reasonably easy to make some estimates of these additional financial benefits. With crop rotations at different stages in different positions of a farmer's land, there is also some buffering of risks, e.g. due to drought resistance and differential price movements.

The DCF methodology appropriate for investment project evaluation replaces the classification of fixed costs, variable costs and annual profit and loss by the concept of incremental annual cash flows, divided into capital outlays, operating costs and net revenues. The net cash flow in any year is given by the project revenue less the sum of capital and operating costs for that year. Decisions have to be made about project life and the discount rate. The usual performance criterion is the net present value, often supplemented with internal rate of return, peak deficit and payback period. Sensitivity analysis is sometimes conducted with respect to discount rate, work rates (labour often being a major input), and product quantities and prices. Further, sometimes breakeven analysis for individual parameters and scenario analysis where a number of parameter values are adjusted simultaneously, are also sometimes applied. DCF analysis would be appropriate for evaluation of a crop rotation sequence or agroforestry system carried out over several years. A number of conventions are typically adopted in investment project evaluation. For example, a system of within-year timing is adopted where capital outlays are assumed to take place at the beginning of the year and operating costs and project revenue are timed for the end-of-year.

Economic analysis including some non-market benefits

A wide range of social and environmental benefits have been identified from increasing production on farms, e.g. with respect to community health, industrial development, trade benefits, soil improvement and climate-change mitigation. An economic analysis (or cost-benefit analysis, CBA) involves calculating not only market costs and returns but also placing values on non-market social and environmental benefits and disbenefits. While indicative values of these are reported in the literature, comprehensive estimation for particular provinces or districts would be a major task, although credible estimates of some particular benefit categories could be included in a partial economic analysis. The advantage of this approach is that it provides a more comprehensive assessment of how a project will affect a community, be it a local community, a state or province, or a nation. Such an analysis (with estimates of social cost-benefit payoff) would be more useful for policy support in relation to pulses production.

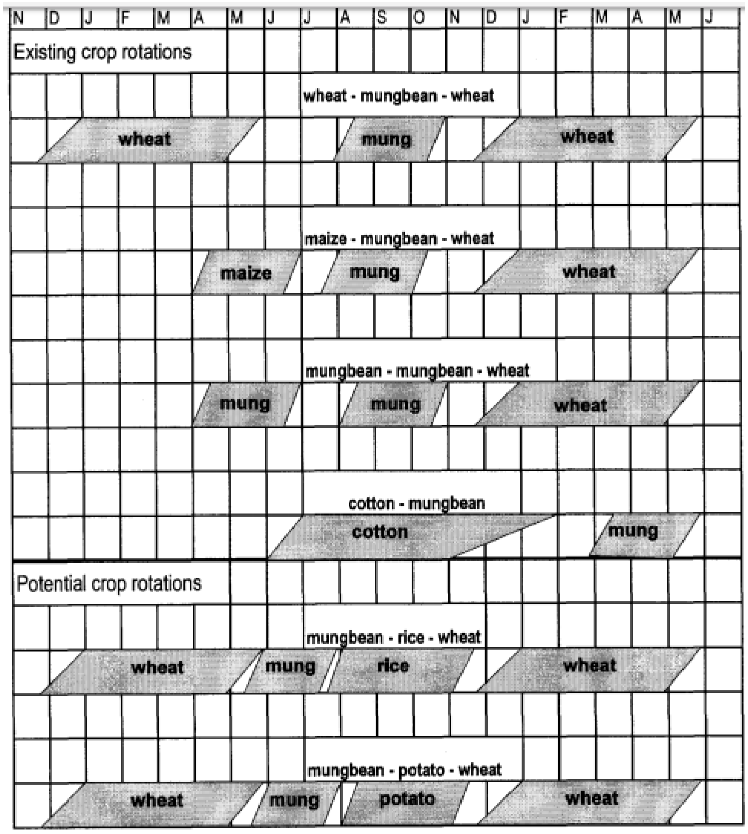
Portfolio analysis of cropping systems including a pulses component

A further form of financial analysis which could be applied to cropping systems including a pulses component is the optimization technique of linear programming, specifically, the mixed-integer linear programming (MILP) technique. In this approach, individual crop species can regarded as investment activities, and threshold and additional units of these can be specified, so that relationships between crops can be formulated as for example mutually exclusive, competitive or complementary. In this way optimal crop rotations, in the sense of maximizing the aggregate net present value, can be identified. Various software packages are available to perform MILP, but MicroSoft Excel is often adequate, depending on the dimensions of the decision problem formulation (number of matric rows and columns).

PULSES SYSTEMS AND ROTATIONS REPORTED IN THE LITERATURE

Various suggestions have been reported in the literature of suitable and unsuitable rotations of pulses and other crops, with relevance to pulses systems in Pakistan.

Ali et al. (1997, p. 25) suggested a number of crop rotations of mungbean combined with wheat, rice, maize, potatoes and cotton, and illustrated the timing of each crop. These were represented graphically as follows:



Hobbs (2001, p. 4) commented on pulse crops (for grain and fodder) that substitute for or are used as break crops for wheat, but are less suited for growing with rice because of 'the flooded and saturated soils in the monsoon season'.

According to Chaudhry (2008), chickpea cultivation is the mainstay of rural populations in mostly rainfed areas (such as the Thal desert areas), but this species 'is also grown as a relay crop in the standing rice crop in Sindh and Balochistan. At some places chickpea is grown after harvesting paddy in Sindh in its residual moisture'.

Mung bean is one of the important kharif (summer season, July to October) pulses of Pakistan. It is also grown during spring, mainly in southern Punjab and Sindh province. Punjab is the major mung bean growing province, alone accounting for 88% of area and 85% of the total production of mung bean. Cultivation is concentrated in the districts of Layyah, Bhakkar, Mianwali and Rawalpindi. It is mainly grown in the kharif season. Although it is grown in different crop rotations, about 75% of cultivation follows mung a bean-wheat crop rotation. With the development of short duration and uniform maturing varieties, mung bean can be fitted in various cropping systems. Research activities on mung bean have been mainly focused on the development of high yielding varieties with wider adaptability, resistant to diseases including mung bean yellow mosaic virus (MYMV) and Cercospora leaf spot (CLS), early maturity and insensitivity to photo period.

Islam et al. (2013) described four crop rotations including pulses for the West Garo Hills administrative district in Meghalaya state of India, bordering Punjab province in Pakistan. These rotations were maize (cobs) – pea – black or green gram; rice – rice – black or green gram; rice – vegetables – black or green gram; and rice – mustard – black or green gram. Here, black gram or mash refers to *Vigna mungo*, and green gram refers to mung bean or *Vigna radiata*.

While mungbean is usually grown in rotation with wheat in Pakistan, AVRDC (the World Vegetable Centre or Asian Vegetable Research and Development Center) is broadening opportunities for the crop by intercropping it with sugarcane. Short-duration mungbean can enrich soils – and farmers – when intercropped in sugarcane's long production cycle. Mungbean intercropping improves soil fertility and provides extra income for farmers without interfering with the long sugarcane cropping cycle. There are 700,000 ha in Pakistan with the potential for intercropping in the February-March planting of sugarcane (World Vegetable Center, 2014).

Dasgupta and Roy (2016) identified a number of potential crop rotations including pulses for growing in Pakistan (Table 2).

Table 2. Possible crop rotations and new planting niches for pulses in Pakistan

Cropping Pattern	Possible niches	Suitable varieties of pulse crops
Rice – wheat – Mungbeans	Gujranwala, Sheikhupura, Sialkot, Narowal, Mandi Bahudin, Larkana, Shikarpur, Jacobabad	NM-11
Wheat – mungbeans	Pothwar Region	NCM-13, NM-11
Spring sugarcane + mungbeans	Punjab and Upper Sindh	NM-11, NM-06
Autumn sugarcane + lentils or chickpeas (Kabuli)	Punjab and lower Sindh	Lentil (Markaz-09, Punjab Masoor-09) Chickpea (Noor- 09, Noor- 2013)

Dasgupta and Roy (2016, Table 5, p. 214).

Grain crop and pulses rotations have been widely adopted in Australia (one of the major exporters of pulses to Pakistan). In 2014-15, production of the major pulses in Australia was

555kt of chickpeas, 549kt of lupins, 290kt of field peas, 284kt of faba beans and 242kt of lentils (ABARES 2016). As early as 2002, Slatter and Lucy noted that chickpeas are playing an increasingly important role in Australian cotton farming systems, as a financially attractive break crop, and 'to utilise remaining water held in on-farm storages that may otherwise evaporate'. Pulse Australia (2016) noted that 'Chickpea is a winter pulse crop well-suited to the northern grain production region. It is the most widely grown pulse crop in the region and is a permanent part of the cropping rotation on many farms'. Cotton growers in central Queensland now plant sacrifice areas of chickpea in their irrigated cotton fields, the chickpea residue being sold to graziers (Harrison, personal communication).

PULSES BENEFITS – FINANCIAL, ENVIRONMENTAL, SOCIAL

Production of pulse crops is often advocated of the grounds that they provide multiple benefits to a society. In this section an attempt is made to identify the types of benefits reported for pulses species, and any quantity or value estimates placed on these.

Studies reporting multiple benefit categories

Various authors have listed a bundle of benefits from growing pulses in rotations with other crops (Table 3). Kissinger (2016) developed a framework for evaluating multiple benefits of adding pulses into crop rotations, taking into account environmental, social and economic benefits, with case studies in Saskatchewan Province in Canada and in Sub-Saharan Africa. Kissinger (2016) prepared a set of criteria and guiding questions to evaluate the economic, social and environmental benefits of pulse production. These criteria provide a comprehensive oversight of the financial and non-market benefits of pulses cropping, which could form a basis for cost-benefit analysis of specific policies to promote the growing of pulse crops.

Several other references listing multiple categories of benefits are those of Valdez (2016), FAO (2016b) and GPC (2016). The first of these commented on the benefits of pulses crops in terms of 'break crop' pest and disease control benefits, nitrogen fixation, climate change mitigation, soil condition improvement, and use of crop residue as a stock food. The Food and Agricultural Organization of the UN developed a series of fact sheets, as an activity to support the International Year of Pulses. Topics covered by fact sheets as listed in FAO (2016c) include: Nutritional benefits of pulses; Pulses contribute to food security; Health benefits of pulses; and Pulses and biodiversity. The Global Pulse Federation commented on the nitrogen fixing ability and low fertilizer requirement, benefits for following crops, beneficial impact on soil quality, low carbon and water footprint, and human health of pulses production (GPC 2016).

According to ICRISAT (2016a) in relation to pulses, 'These climate-smart crops help the smallholder farmers in arid and semi-arid regions of the world withstand weather variability, require less water, enrich the soil and are packed with nutrition. These crops provide more nutrition per drop not only for humans and livestock but for soils as well through their nitrogen-fixing properties. … Pulses are what we call Smart Food – good for you, good for the planet and good for the smallholder farmer. Pulses like chickpea and pigeonpea will contribute towards the new Sustainable Development Goals to reduce poverty and hunger, improve health and gender equity, promote responsible consumption and help adapt to climate change'.

Table 3. Kissinger's checklist of pulse benefits

Environmental	Social	Economic
Ability of pulse crop to offset fertilizer needs within cropping system Ability of pulse crop to offset or reduce herbicide and pesticide use Diversify the cropping sequence Productivity improvements rather than area expansion Applications to improve livestock pasture Ability of pulse crop to reduce GHG emissions Reduced non-renewable energy use Water use efficiency and management (use of residual moisture) Improved soil management (erodible soil)	Food security The addition of pulses in the diet boosts nutrition The addition of pulses in the diet reduces likelihood of disease Protein content of a cereal crop increases following a pulse crop Multiple uses of crop residues Reducing pressures of increased meat production Boosting nutritional content of manufactured foods Increase global and regional production of crops with climate adaptation capability Women's role in production, processing and sales Getting the enabling environment right for pulses	Lower fuel costs (with mechanization) Labour productivity Increased income from added rotation + financial contribution of pulse crop Increased income from higher yield on subsequent crop Lower costs due to conservation tillage or no-tillage practices Avoided costs of less soil, air and water degradation Investments in crop research have high rates of return Livestock forage system intensification

Source: Adapted from Kissinger (2016).

Each of the above five sources provides a quick introduction to pulses benefits, but the sources are also reported in the more systematic presentation of benefit categories below. Economic, social and environmental benefit categories are adopted, though in practice these tend to be overlapping rather than distinct categories.

Financial benefits of pulses, including quantitative estimates of benefits and revenue impacts

Revenue generation for to growers

Many GM analysis tables can be found for individual pulse crops. Some of these are stand-alone estimates, and some are GM comparisons with grain and other crops. The comparison of GMs of pulses and other crops is complicated by the fact that in Pakistan other crops – including wheat, rice, cotton and sugarcane– are mainly grown with irrigation, while pulses are most often rainfed or only partially irrigated crops.

Nitrogen fixation from the atmosphere

As expressed by Valdez (2016), pulses 'bring 'free' nitrogen fertilizer into the soil, where it fuels production of pulse grains that contain more than double the protein (over 25%) found in cereal grains (less that 8-10%)'. Pulses bring free nitrogen fertilizer into the soil through a symbiotic relationship with nitrogen fixing rhizobia bacteria that live inside their root systems (Sørensen and Sessitsch, 2007). Other plants benefit from N-fixing bacteria when the bacteria die and release nitrogen to the soil. Valdez (2016) noted that given the large genetic variation in their ability to harvest atmospheric nitrogen, there is a significant opportunity to increase the favourable effects of pulses on farming systems by breeding cultivars with high nitrogen-fixing capacity.

Fatima et al. (2008) carried out dryland trials of chickpea nitrogen fixation for subsequent wheat crops in a well-drained sandy soil at National Agricultural Research Centre, Islamabad. These authors commented on the importance of wheat – pulses cropping in rainfed areas in Punjab province, noting that no nitrogen fertilizer was required for chickpea and finding that about 100 kg N/ha was fixed by a chickpea crop, hence boosting wheat yield and providing savings on nitrogen fertiliser inputs.

ACIAR (nd) reported that 'Values exceeding 300 kg N/ha were recorded for irrigated pigeonpea and mungbean in the North West Frontier Province (NWFP), Pakistan, and for soybean in the Hills of Nepal. But more commonly, values were in the range 50-150 kg N/ha'.

ACIAR (nd) also noted that 'Researchers estimated that about 30,000 tonnes N is fixed annually in Nepal by legumes, valued at A$30 million', implying a benefit of about $A1000 per ton of nitrogen fixed.

Increased phosphorus availability for other crops

As reported by Kayani et al. (2010), Alvey et al. (2001) examined the relative contribution of increased nitrogen (N) and phosphorus (P) availability to cereal/legume rotation effects, and found a larger increase in P uptake in cereal-pulse rotations than in continuous cereals. FAO (2016a) noted that 'In multiple cropping systems, services such as nutrient recycling and soil formation are improved through the pulses' abilities to fix nitrogen and free phosphorous and their capacity to increase soil biodiversity'.

Species diversity benefits, including income stabilization and food security

According to FAO (2016a), mixed cropping systems including pulses with their higher species diversity than monocrop systems could not only make more efficient use of resources, namely light, water and nutrients, but also have higher yields, and lower risk of overall crop failure. Gul (2016) commented that growing pulses could 'help sustain the food security of farmers, by helping them to diversify their sources of income'.

Cost reduction from 'break crop' pest and disease reduction for following crops

Pulse Australia (2015) noted that 'Chickpea is a break crop that can be used successfully in rotations to effectively break the lifecycle of cereal root diseases like take-all and crown rot'. This function would reduce the production cost and perhaps increase the yield of subsequent crops in a rotation system. According to Valdez (2016), citing Angus et al. (2015), when pulses are used as a 'break crop' for pest or disease reduction, wheat yield has been shown to increase by up to 1.2 tons per hectare, and the benefit even lasts for an additional wheat crop. Similarly, FAO (2016a) reported that when used in multiple cropping systems, pulses help to curb and control pests and diseases.

Livestock fodder from pulses harvest residue

Harvest residue after threshing to extract pulses seeds (dry peas or beans) is frequently used as a form of livestock fodder. Dost (nd) commented on the use of crop residues available as by-products from the cultivation of grains, pulses, and cotton for feeding dairy cattle. According to Sarwar et al. (2002, p. 189), 'Wheat straw, rice straw, barley straw, gram straw … are important crop residues' for livestock fodder. FAO commented on 'Residues of pulse crops, as follows: 'Many of these have a higher feeding value than cereal straws, but are much more difficult to recover; in humid climates the leaves tend to discolour or drop at or before harvest, and in dry conditions they shatter. Where the final drying of the crop takes place at the homestead, it is easier to recover the leaves and stems. The leaves and stems of … many of them also useful feeds, such as the various *Phaseolus* spp., green and black grams, and the leafy parts of pigeonpea. Faba beans, however, have coarse, woody stems, while the straw of chick-pea (*Cicer arietinum*) has a very high oxalic acid content, is unpalatable, and reputed to be toxic'.

According to Valdez (2016), after harvest, pulse crops leave behind nitrogen-rich residues that are good for feeding cattle and for 'feeding' the soil and subsequent crops. In fact, a protein-rich food is available which can also be used for buffalos and goats. Ahmad (2013) reported that as of year 2012-13 Pakistan had 38.3 million cattle, 33.7 million buffalos, 28.8 million sheep and 64.9 million goats.

Social benefits of pulses

Health benefits for consumers

FAO (2016c) in their report on health benefits of pulses noted that 'Pulses are … rich in complex carbohydrates, micronutrients, protein and B-vitamins, which are vital parts of a healthy diet. Low in fat and rich in fibre, pulses are excellent for managing cholesterol, digestive health and regulating energy levels. Pulses are also particularly rich in folate, iron, calcium, magnesium, zinc and potassium' and commented that in Pakistan pulses are 'An important source of protein for the population, chickpeas, lentils, mung beans … [are] used widely in spicy recipes with grains and chicken, from baby food to delicacies'. Increased pulses production in Pakistan and particularly production in more districts could, by providing 'complementary proteins' reduce the risk of diabetes (World Diabetes Foundation, 2016), as well as wasting and poor vision in children and poor health of women (Malik et al. 2015).

Role of women in pulses production

Mittra and Kuman (2004, p. 272) reported that 'In Pakistan, women participate extensively in the production of major crops, but the intensity of their labour depends on both the crop in question and the specific activities related to that crop. Women's participation is particularly high in cotton, rice, pulses and vegetables'. These authors go on to describe the tasks performed by women (some of which are menial). They report (p. 272) that 'In the rainfed areas of Punjab, women contribute to almost all of the 22 identified crop tasks with the major contribution to seed preparation, collection and application of farmyard manure …Men … monopolize mechanical work … they carry out mechanical threshing … while hand threshing is a women's domain'.

Environmental benefits of pulses

Pulses have been widely advocated for their environmental benefits. From an analysis viewpoint, it is often difficult to distinguish financial and environmental benefits, in that environmental benefits can translate into financial benefits although these may be difficult to quantify.

Nitrogen fixation and other break crop benefits for following crops

According to FAO (2016b), 'it is estimated that globally, some 190 million hectares of pulses contribute to five to seven million tonnes of nitrogen in soils'.

Angus et al. (2015) pointed out that ‘Wheat crops usually yield more when grown after another species than when grown after wheat’. Based on more than 900 comparisons of wheat growing after a break crop with wheat after wheat, they found the mean wheat yield increase ranged from 0.5 t/ha after oats to 1.2 t/ha after grain legumes, with benefits even lasting for an additional wheat crop.

Low water requirement, and ability to grow as a rainfed crop on low-rainfall sites

Various authors have described the ability of pulses to grow and yield crops as a rainfed crop on low-rainfall sites. GPC (2016) reported that pulses have a low water requirement, noting that ‘the water footprints to produce a kilogram of beef, pork, chicken and soybeans are 43, 18, 11 and 5 times higher than the water footprint of pulses’.

Improved soil condition and surface protection

Gan et al. (2002) found major improvement in soil condition in the semi-arid Canadian prairies from using pulses species with wheat in crop rotations, with inclusion of lentil in a wheat cropping system increasing soil microbial biomass by 45% to 75%, and soil organic matter by 1.8 Mg/ha.

Arian (2012) observed that ‘The leftover leaves, stalks and husks of the mungbean plants are used as fodder, and the whole plant can be ploughed under as green manure for soil improvement’.

In relation to controlling soil erosion, Majumdar (2011, p. 24) observed that ‘Pulses having spreading habits with good vegetative growth provide effective cover to land surface and prevent soil erosion by wind in dry and low rainfall areas and by water in high rainfall areas … Crops like …blackgram, green gram, … [and] lentil … provide good soil cover and prevent soil erosion. Greengram and blackgram are best adopted as intercrops in widely spaced crops’. Similarly, Mishra and Arunachalam (2014), noted that agroforestry including fodder shrubs and pulse crops in India enrich the soil and help as a natural soil cover against water and wind erosion.

GPC (2016) noted that pulses have a direct positive impact on soil quality because they help feed soil microbes, which benefits soil health. Pulses have also been shown to produce greater amounts and different types of amino acids than non-legumes and the plant residues left after harvesting pulse crops have a different bio-chemical composition than other crop residues. Similarly, ICRISAT (2016), observed that ‘Pulses enrich soils by fixing nitrogen and also increase soil microbe diversity. The leaf droppings provide green manure and in severely eroded soils these crops help conserve top soil and rejuvenate degraded land’.

According to ACIAR (nd), ‘The high productivity rotations incorporating legumes and fertiliser N increased soil organic fertility. For example, after 4 years of the chickpea-wheat rotation experiments in Pakistan, soil organic matter had increased between 28 and 56% through inclusion of chickpea’

Low carbon footprint and contribution to climate change mitigation

FAO (2016b) quoting Jensen et al. (2012) noted that since pulses often promote higher rates of accumulation of soil carbon than cereals or grasses, they can contribute to improve the carbon sequestration of agro-ecosystems’.

According to GPC (2016), ‘Pulses have a lower carbon footprint in production than most animal sources of protein. In fact, one study showed that one kilogram of legume only emits

0.5kg in CO_2 equivalent, whereas 1kg of beef produces 9.5 kg in CO_2 equivalent …By fixing nitrogen in the soil, pulses also help reduce the footprint of other crops so the benefits extend much further into the food production cycle. For example, a recent study showed that durum wheat preceded by a biological nitrogen-fixing crop, such as chickpeas or lentils the previous year, lowered its carbon footprint by 17% compared with durum preceded by a cereal crop. The impact was even stronger is a pulse-pulse- wheat system, with the carbon footprint of the durum wheat down by 34% compared to a traditional cereal-cereal–durum rotation'.

FAO (2016b) in a factsheet on *Pulses and climate change*, noted that climate change has a huge impact on global food production and food security, and that more climate-resilient strains can be developed for use in areas prone to extreme weather events. FAO further commented that 'As pulses can fix their own nitrogen in the soil, they need less fertilizer, both organic and synthetic, and in this way, they play a part in reducing greenhouse gas emissions. Additionally, when included in livestock feed, pulses' high protein content contributes to increase the food conversion ratio while decreasing methane emissions from ruminants, thus at the same time reducing greenhouse gas emissions'. FAO (2016b) also argued that 'Agroforestry systems are more able to withstand climate extremes as pulses are hardier than most crops and help to nourish the soil. Farmers see an increase in crop productivity that extends to subsequent crop yields. In addition to adaptation, it is important to note that trees, and thus agroforestry systems, also sequester more carbon than field crops alone'.

Gul (2016) in the context of pulses as a component of multiple cropping systems (intercropping, crop rotation and agroforestry) argued that introducing pulses into farm production can be a key to increasing resilience to climate change. 'Agroforestry systems are abler to withstand climate extremes as pulses are hardier than most crops and help to nourish the soil. … agroforestry systems … also sequester more carbon than field crops alone. Pulses are climate smart as they simultaneously adapt to climate change and contribute towards mitigating its effects. …Drought-resistant pulses … can be cultivated in arid climates that have limited, and often erratic, rainfall of 300-450 mm/year. These are lands where other crops can fail or produce low yields'. Gul further noted that including pulses with high protein content in livestock feed 'contributes to increase the food conversion ratio while decreasing methane emissions from ruminants, … reducing greenhouse gas emissions'. A further point made by Gul is that because 'pulses are shelf stable, the proportion of food waste at the consumption stage due to spoilage is very low'.

Limitations and weaknesses of pulses

Low profitability as a crop

Pulses have a relatively low yields compared to grain crops including wheat, rice and maize. According to Valdez (2016), flowering and seed-setting are extremely sensitive to increases in temperature. Expected increases in the frequency of heat waves can badly decrease the number of pods and seeds on a pulse plant, reducing yield dramatically. For instance, chickpea yield decreases if exposed to temperatures above 30ºC during flowering.

Low levels of methionine and tryptophan, hence need for 'complementary proteins'

Most non-animal sources of protein, aside from soybeans and quinoa, lack one or more of the nine essential amino acids that are needed to keep your body functioning properly. Essential amino acids cannot be made by the body, so they must come from food. They include: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Legumes, such as lentils, beans, and peas, typically lack adequate methionine and tryptophan, while whole grains, such as brown rice, oats, and whole wheat, lack isoleucine and lysine. Combining these two food groups yield “complete” proteins, providing the body with the full range of essential amino acids.

‘Poor man’s food’ reputation

As noted by FAO (2016c) in relation to health benefits, pulses including lentils, dried beans, peas and chickpeas have been staple foods for many civilizations, but nowadays their nutritional benefits are often greatly underestimated. In some cultures pulses have a stigma of being a ‘poor man’s food’ and are replaced by meat once people can afford meat. Reasons why benefits of pulses are underestimated include: the length of cooking time (much longer than vegetables); some beans can cause flatulence because they contain oligosaccharides, a carbohydrate that is difficult to digest; and raw pulses contain high levels of 'anti-nutrients' such as phytate, tannin and phenol, which can limit the body’s absorption of minerals, including iron and zinc’. Kamal (2016) commented on the second of these reasons by stating that ‘Lentils, beans, chick peas, and other pulses often produce negative “collateral social effects” on people hanging around, just a couple of hours after eating them’.

PRICE AND YIELD OF PULSES AND OTHER CROPS GROWN WITH THEM IN ROTATIONS

This section examines pulses yield and price data in Pakistan, which are critical parameters for financial analysis of domestic pulses production. Information about other parameters typically included in GM budgets for pulses is presented in Appendix A. Appendix B contains examples of GM analyses for the four pulses crops listed above. Financial information has also been sought on the various crops with which these are grown – including wheat, cotton, sugarcane and rice. Some information on inflation rates in Pakistan – relevant for adjusting cost parameters in the GM budgets to current prices – are provided in Appendix C.

Current Pakistan Pulses Yield Data

Many papers report observed or expected yields of pulse crops in Pakistan. AYAB (c2014) reported potential yields for various pulses. Yields for desi chickpea ranged between 1850 and 3400 kg/ac, kabuli chickpea 1400 to 3000 kg/ha, mung bean 2200 kg/ha (only one species) and mashbean (1700-1900 kg/ha). PAR (2015a) suggested ‘yield potential’ of 1000 kg /acre for various chickpea varieties in Pakistan, though noting 720 and 800 kg/ha for two particularly drought-resistant varieties. According to PAR Agricultural Education (2016), the wheat average yield is 2.5 tons/ha against food legumes yield of 0.43 tons/ha for chickpea, 0.72 tons/ha for mung beans, 0.53 tons/ha for mashbeans and 0.48 for lentils. Arifeen (2016) suggested that ‘a good crop’ of desi chickpeas yields 15 to 20 quintals per hectare and of Kabuli varieties about 25 to 30 quintals per hectare’. (1 quintal = 100 kg)

Khan and Anwar (2016) observed that there is a large gap between observed pulses yields of the four major species for Pakistan, averaging 500 to 600 kg/ha, and the suggested potential farmer yields, which imply an increase of 150% to 300% (Table 4).

Table 4. Yield gap of major pulse crops

Crop	National av. yield (kg/ha)	Potential yield* (kg/ha)	Yield gap (kg/ha)
Chickpeas	600	1 500	900
Lentils	600	1 500	900
Mungbeans	525	1 500	975
Mashbeans	500	2 000	1 000

* Farmers' yield with optimum management practices.

Source: Khan and Anwar (2016, Table 8, p. 126).

PAR Agricultural Education (2016) noted that Pakistan is continuously developing varieties with higher yield potential that respond to improved management practices so as to meet the increasing demand of food legumes. They suggested that: the lack of appropriate technology and inefficient harvesting and threshing machinery are the major factors contributing to low productivity and loss of mature crop in the field (due to shattering): crop losses at the time of harvesting and during threshing can make pulses uneconomical; planting machinery is not available to the farmers; the prices of food legumes have increased many-fold but due to lack of appropriate technology and machinery, it is not economical for the farmers to grow these crops until the potential yield can be increased.

Combining the above information, expected yields of pulses and some other crop species in Pakistan are expected to be approximately as shown in Table 5:

Table 5. Expected yields of pulses and other crops species in Pakistan

Crop species	Expected yield (kg/ha)
Chickpea (desi)	600
Mung bean	525
Lentil	600
Mashbean	500
Wheat	2450
Cotton	1040
Paddy rice	1400
Sugarcane	3000

Source: Pulses yields taken from Khan and Anwar (2016), wheat yield from PAR Agricultural Education (2016); cotton, rice and sugarcane yields from Khan (2015). Pulses are mainly grown as rainfed crop and the other species are mainly grown with irrigation.

Comparison with Australian Pulses Yields

Pessimistic, best bet and optimistic yields for a number of crops prepared by the Australian Grains Research and Development Corporation and reported in GRDC (2015) (Table 6). These would in general apply to rainfed cropping, on reasonably favourable cropping land. Notably, the national average yields of chickpeas and lentils in Pakistan reported by Khan and Anwar (2015) are below the GRDC's pessimistic estimates for Australia, even though the latter are mainly dryland crops.

Table 6. Crop yields used in Australian wheat and pulses GM budgets (1000 kg/ha)

Crop species	Pessimistic yield	Best bet yield	Optimistic yield
Wheat	1.5	2.7	4.0
Red lentils	0.7	1.2	1.8
Chickpeas (Kabuli)	0.7	1.3	2.0

Source: GRDC (2015).

PAR Agriculture Research (2015) citing Pakistan Bureau of Statistics noted national wheat yields over 2009-10 to 2013-14 averaging about 2739 kg/ha, i.e. very similar to Australian yields. However, it is noted that 'wheat is mostly grown by means of irrigation' in Pakistan, apart from in the Baluchistan and Postwar plateau which lack irrigation facilities, and have yields of about half that in irrigated fields.

Current Pakistan Pulses Price Data

Shahzad (2016) commented on an exceptional increase in the prices of pulses in April 2016, noting that in the last few days:

- the price of white chickpeas increased by Rs40/kg to Rs 155/kg
- the price of chana daal (split yellow gram, desi chickpea) increased from 120 Rs/kg to 153/kg.
- The price of black chickpea increased by Rs 30 per kg.
- The price of mashbean daal (urad, urdbean) increased from Rs275 to Rs280 per kg.

Khan (2016a) also commented on the sharp price rises for pulses, noting that 'The wholesale price of black gram (kala chana) has gone up to Rs120-125 from Rs95-100 per kg, and that of good quality white gram (kabuli channa) to Rs160-170 from Rs148 per kg. The price of lower-quality white gram has jumped to Rs145 from Rs110 per kg.

Sims (2016) further noted that 'A survey by The Nation indicates shopkeepers in Lahore, Pakistan are not adhering to the government's official price list. For instance, mung beans were being sold for 185 rupees (per kilogram) despite the fact the official price was supposed to have been 145 rupees (per kilogram).

Farm-gate prices for pulses would be expected to be below market prices or wholesale prices, but further information is needed to estimate these margins. It is expected that the farm-gate prices will be estimated from results of a pulses grower survey data in Pakistan. Limited information suggests that farmgate prices of pulses are between 50% and 60% of Based on the limited information collected at this stage, the following table sets out initial and tentative prices for various pulse and other species (Table 7).

Table 7. Current consumer prices of pulse species (Rs/kg)

Species	Typical wholesale price	Pessimistic farmgate price	Farmgate price	Optimistic farmgate price
Chickpea	100	48	60	72
Mung bean	120	57.6	72	86.4
Lentil	120	57.6	72	86.4
Mashbean	150	72	90	108
Wheat		40		
Rice		56		
Sugarcane				

Note: Farmgate price is assumed to be 60% of wholesale price.

Current retail prices of pulses and other crop species in Pakistan

Product prices for the major food commodities in Pakistan are reported monthly, along with the year-on-year changes in the general and food Consumer Price Index (CPI), under the World Food Program. The current prices, in both PKR and $US as well as the recent change percentages and directions, are reported for five major Pakistani cities (Lahore, Multan, Karachi, Peshawar and Quetta). There is considerable price variation between cities, with typically relatively high prices in Quetta. The most recent data available at the time of writing is presented in the Table 8.

Hassan et al. (2002) investigated the relative shares of producers in the prices that consumers pay for various commonly purchased items of fruit and vegetables, in rural and urban areas in Pakistan. They found that the producer’s share was consistently higher in urban markets (typically about 40-50%) than in rural markets (typically about 30-45%). The discrepancy between urban and rural markets may be influenced by transport costs.

Carrasco and Mukhopadhyay (2012) found that the retail price increment over farmgate price for rice and wheat in Bangladesh in 2011 were 39.8% and 27.6% respectively, and that these had been lower but highly variable in the previous 6 years. Notably, Bangladesh had implemented various food price reduction policies, including releasing grain stocks, price controls, consumer subsidies and food aid.

Table 8. Retail prices of various food commodities in major cities – January 2016

Major Commodities	Markets	Current Prices (Jan 2016) / KG		% Change Over			
		PKR	USD	1M	3M	6M	1Y
WHEAT	Lahore	35.63	0.34	0.00%	4.40%	9.62%	1.06%
	Multan	33.50	0.32	0.45%	9.84%	12.61%	1.13%
	Karachi	37.00	0.35	0.00%	5.71%	5.71%	7.25%
	Peshawar	34.25	0.33	0.74%	10.48%	9.60%	-12.18%
	Quetta	37.50	0.36	1.90%	7.14%	4.17%	-2.60%
WHEAT FLOUR kg	Lahore	39.00	0.37	-0.26%	3.86%	6.70%	-2.26%
	Multan	38.50	0.37	0.26%	5.12%	9.22%	0.00%
	Karachi	44.35	0.42	0.06%	7.35%	10.02%	2.95%
	Peshawar	39.13	0.37	0.43%	4.10%	5.80%	-0.21%
	Quetta	40.50	0.39	1.76%	6.58%	3.85%	-1.22%
RICE IRRI-6	Lahore	46.90	0.45	3.49%	-22.75%	-25.13%	-28.20%
	Multan	35.00	0.33	0.00%	-5.41%	-5.41%	-13.04%
	Karachi	43.31	0.41	0.00%	-2.94%	-10.92%	-23.40%
	Peshawar	41.55	0.40	-0.29%	-2.24%	-2.24%	-11.75%
	Quetta	50.00	0.48	0.00%	0.00%	0.00%	0.00%
RICE BASMATI BROKEN	Lahore	53.15	0.51	7.22%	-25.96%	-26.87%	-29.13%
	Multan	63.33	0.60	0.52%	-9.53%	-9.53%	-18.28%
	Karachi	68.37	0.65	-0.22%	-6.44%	-6.44%	-10.67%
	Peshawar	67.29	0.64	-0.31%	-1.52%	-1.52%	-9.28%
	Quetta	80.00	0.76	0.00%	0.00%	0.00%	-11.11%
SUGAR	Lahore	60.93	0.58	1.03%	-7.53%	-3.71%	9.53%
	Multan	59.38	0.57	7.77%	-5.94%	-3.45%	14.74%
	Karachi	58.73	0.56	1.15%	-8.12%	-7.57%	5.97%
	Peshawar	59.92	0.57	3.54%	-8.06%	-5.20%	8.37%
	Quetta	60.00	0.57	6.38%	-5.88%	-7.34%	13.74%
Pulse Masoor, Washed	Lahore	159.46	1.52	-1.54%	-1.54%	-1.54%	4.94%
	Multan	142.50	1.36	1.42%	3.64%	3.64%	3.64%
	Karachi	140.91	1.34	0.23%	-1.52%	-1.52%	10.02%
	Peshawar	137.92	1.32	1.85%	7.12%	7.12%	7.82%
	Quetta	150.00	1.43	2.74%	7.14%	0.84%	2.56%
Pulse Moong, Washed	Lahore	161.07	1.54	0.62%	-0.66%	-8.71%	0.00%
	Multan	147.50	1.41	0.00%	6.63%	-6.35%	-9.23%
	Karachi	159.14	1.52	-0.37%	-8.05%	-8.05%	-2.42%
	Peshawar	151.67	1.45	0.78%	4.30%	-5.21%	-4.71%
	Quetta	173.75	1.66	0.43%	11.20%	-6.08%	-5.44%
Pulse Mash, Washed	Lahore	254.29	2.43	5.20%	25.35%	26.36%	43.70%
	Multan	255.00	2.43	0.79%	36.60%	43.66%	61.90%
	Karachi	258.03	2.46	6.88%	36.08%	49.08%	68.56%
	Peshawar	253.33	2.42	5.26%	30.33%	34.36%	56.06%
	Quetta	275.00	2.62	4.56%	18.28%	27.91%	51.72%

Source: WFP (2016, February).

FURTHER INFORMATION REQUIRED FOR FINANCIAL ANALYSIS

To support financial and economic analysis of pulses cropping, various pulses crop input and product quantity, cost and price parameters are needed. In the case of smallholder cropping systems, which are typically labour-intensive, data estimates of the labour time input for the various cropping tasks are needed. The physical and financial coefficients are generally estimated on a one-hectare area unit basis. Appendix A identifies cost and revenue categories relevant to gross margins analysis and financial analysis in general.

Some input and output prices are often difficult to estimate, e.g. the labour cost – which varies with the rate of completing cropping tasks and wage for hired labour or opportunity cost of labour supplied by the farm family – and the farmgate price of pulses products sold (which may be considerably lower than the market prices of pulses).

A further data requirement concerns the systems under which pulses are grow, e.g. whether there is continuous monocropping, rotations of particular legume and non-legume species, or whether pulses are grown as a component of agroforestry systems together with trees (of timber, fruit or nut species) and with other crops. In the case of crop rotations and monocropping systems, estimates are required of the species interaction effects, e.g. yield increases or input cost reductions due to the nitrogen fixing ability of the pulses crops.

If an economic analysis is to be undertaken, then estimates are not only required for the crop inputs and revenue generation, but also for the non-market benefits of cropping – items not purchased and sold in markets – such as the nitrogen fertilization benefits to other crops from nitrogen fixation, benefits of break crops in reducing pest control costs, and boost to livestock production from consumption of pulses crop residues.

Estimates of most of the market costs and price are available from the gross margins analyses case studies provided in spreadsheet style in Appendix. A household survey of pulse growers is being carried out, to identify the cropping system and to further refine the financial and economic parameters.

Pakistan loan interest and inflation rates are provided in Appendix B. The borrowing rate is required – together with the financing arrangement details for investment in pulse cropping – to determine the relevant discount rate for financial analysis of pulses production. The inflation rate is required if a *current price analysis* (in the sense of adjusting estimated prices for each is to be conducted of pulses cropping. This rate is also required if gross margins or financial models are available from recent years, to update them to *current prices*.

Some further information is required in order to carry out any analysis of optimal pulses production systems, using a portfolio analysis approach. This approach requires the comparison of alternative pulses production systems in terms of their revenue generation and constraints over time with a mixed-integer linear programming model (as described and illustrated in Dayananda et al. Ch. 12), It is anticipated that much of the data requirements for this purpose will be met through the pulse grower survey,

CONCLUSIONS

Pulse production can be evaluated in terms of individual gross margins, financial analysis of crop rotations, portfolio analysis, and with economic analysis that include non-market benefits. The significant production benefits of growing pulses include ability of pulse crops to offset fertiliser, herbicide and pesticide needs within cropping systems, and provision of diversification of income. Pulses also have major health benefits for consumers, provide significant livelihood options for women, and provide environmental advantages (in terms of improved soil nutrition and condition, low carbon footprint and contribution to climate change mitigation). However, relative to grain crops, pulses typically have low yield and profitability, but the economic importance of pulses production may be high when wider environmental and social benefits are taken into account. Broader data collection including from landholder survey is needed to perform a comprehensive financial analysis.

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APPENDIX A: COST AND REVENUE COMPONENTS OF GROSS MARGINS ANALYSIS

Observations are provided here about the various activities which give rise the cost items of gross margins analysis.

Land preparation may include some clearing of weeds or other vegetation, and perhaps cultivation with machinery or hand tools to prepare a seedbed.

Seed and inoculum. Seed may be retained from a previous crop, in which case a storage cost will be incurred. Spraying seed with an inoculum will typically be required to improve nitrogen fixation from the atmosphere.

Irrigation. PAR (2015b) suggested that pre-planting irrigation may be needed if the amount of moisture stored in the soil is low at time of planting. For irrigated (as distinct from rainfed) crops, furrow or spray irrigation is typically practiced. Irrigation is uncommon for chickpea but more frequent with mung bean.

Weed control. According to PAR (2015a), 'Chickpea being a stature crop suffers severely by infestation of weeds. One hand weeding or inter culture with hand hoe or wheel hoe after 25 – 30 days and a second if needed after 60 days of sowing may take care of weeds. Roundup herbicide as pre-planting spray may be used as an effective herbicide. Hand weeding or inter culture with the help of hoe is always better than herbicides because inter culture operations improve aeration in the soil and root zone.' Weed control for small areas may be done by hand tools.

Crop fertilizing is usually done at or soon after planting, by manual spreading or with machinery. [Note paper on drills]

Pest and disease control is sometimes not practiced by small-scale growers, but can be done using a knapsack strayer, or a tractor-mounted power spray.

Harvesting and threshing (separation of the pulse seed from the stems) could be done manually or with machinery, depending largely on the scale of production. For small-scale growers, harvesting is typically done with sythe and threshing by buffalos trampling of the seedpods, or using threshing boards, with a high labour requirement and grain loss.

Drying of the pulse grains is generally done by spreading grains in the sun or under cover. A grain dryer would be needed for large-scale production.

On-farm storage for dried pulses grains allows farmers to wait for higher market prices, or to hold crop for household consumption, and some storage costs may be incurred, e.g. to prevent pests.

APPENDIX B: CASE STUDIES OF WHEAT AND PULSES GROSS MARGINS ANALYSES

Various gross margins analyses of wheat and pulses crops are reported in the literature. Most of the GM models are recent – post 2010. Some adjustments may be needed to the parameter estimates, to inflate to current prices and to reconcile where there are major discrepancies between parameter values. Screenshots of selected GM models are presented , first for wheat and then for the four major pulses species grown in Pakistan.

Gross margins budgets developed in Pakistan for chickpeas, mung beans, lentils and mashbeans, are first presented, and then GM budgets from other countries are provided. The screenshots may be expanded on screen for greater clarity of viewing.

Gross margins budgets for chickpeas

Shah et al. (2007) noted the subsistence nature of chickpeas in Thal desert of the Punjab, and developed a gross margins budget based on 2006 survey data.

Table 1: Economic Analysis of Chickpea Production during 2005-06 in the Study Area

Items and units	Units	Amounts (Pak Rupee)
Inputs side		
Cost of ploughing	Rs./ha	741.33
Cost of sowing	Rs./ha	679.60
Seed rate	kg/ha	51.00
Cost of seed	Rs./ha	1166.40
Weeding cost	Rs./ha	840.20
Harvesting cost	Rs./ha	988.45
Threshing cost	Rs./ha	1482.67
Land rent @ Rs.5085/ha (for six months)	Rs./ha	2563.77
Managerial cost	Rs./ha	4942.20
Mark up @ 11 %	Rs./ha	1474.51
Total cost of production	Rs./ha	14879.11
Output side		
Grain yield	kg/ha	1477.00
Dry stalk yield	kg/ha	951.38
Returns from grain yield	Rs./ha	33794.05
Returns from dry stalk yield	Rs./ha	2739.96
Returns Analysis		
Gross benefit	Rs./ha	36532.05
Net benefit	Rs./ha	21652.99
Returns per rupee invested		1 : 2.46

Source: Shah et al. (2007).

A more recent gross margins budget was prepared by Khan and Anwar (2016) for production of dryland chickpeas in the Thal desert area of Punjab province.

Table 2. Economic analysis of chickpea production under rainfed conditions of Thal

Input	Unit	With traditional farmers' practices	Improved variety and practices
		Amount (Pak Rupee)	
Cost of ploughing	Rs./ha	1 200	1 500
Cost of sowing	Rs./ha	1 200	1 200
Seed rate	kg/ha	50	75
Cost of seed	Rs./ha	4 000	6 000
Weeding cost	Rs./ha	2 000	5 000
Harvesting cost	Rs./ha	4 000	4 000
Threshing cost	Rs./ha	3 000	3 000
Managerial cost	Rs./ha	5 000	5 000
Total cost of production	Rs./ha	20 400	25 700
Output			
Grain yield	kg/ha	1 750	3 750
Dry stalk yield	kg/ha	1 000	2 000
Returns from grain yield	Rs./ha	113 750	243 000
Returns from dry stalk yield	Rs./ha	6 250	12 500
Returns analysis			
Gross benefit	Rs./ha	120 000	255 500
Net benefit	Rs./ha	99 600	229 800

1 US$ = 102 Pak Rupees

Source: Khan and Anwar (2016, p. 122).

Gross margins budgets for mungbeans

Habib et al. (2014) developed gross margins models based on data from NARC Experimental Station, Islamabad, to compare the financial performance of three recommended mungbean varieties.

Table 2. Economic profitability analysis of mungbean varieties

(Rs. acre^{-1})

Items	AZRI-06	NM-06	NM-98
Input			
Cost of ploughing	3500	2500	2750
Cost of sowing	1111	1500	1000
Cost of seed	1680	1680	1780
Fertilizer	4300	4300	4300
Weeding cost	1200	600	650
Pesticide	1700	950	800
Harvesting cost	2250	1750	1350
Threshing cost	2030	2532	3170
Total cost of production	17771	15812	15800
Output			
Production (kg acre^{-1})	480	400	360
Price (kg^{-1})	150	150	150
Return from yield	72000	60000	54000
Profitability			
Gross income	72000	60000	54000
Net profit	54228	44188	38200
Output-input ratio	3.05	2.79	2.41
Revenue crop day^{-1} (Rs.)	451	368	318

Source: Habib et al. (2014).

The World Vegetable Center (AVRDC, 2016) produced a recent gross margins analysis for mung bean production, based on a stratified sample of 83 farms in Punjab and Sindh provinces in Pakistan. Farms were divided into sizes of less than 5 ha, 5 to 10 ha, and more than 10 ha. Some detail on production systems, and on cost variation with size of farm, was provided.

Table 15: Cost of Production

	Farm Size Groups			
	Small Farmers	Medium Farmers	Large Farmers	Overall Average
Ploughing (PKR/ha)	4813	2799	4117	3732
Planking (PKR/ha)	2204	1976	2011	2039
Sowing (PKR/ha)	1270	1054	1308	1162
Mungbean Seed rate (kg/ha)	26	28	26	27
Seed Cost (PKR/kg)	3498	3269	3144	3317
Land preparation and Sowing Cost	**11786**	**9099**	**10580**	**10250**
Urea Cost (PKR/ha)	4446	4060	5002	4521
DAP Cost (PKR/ha)	5317	6651	6079	5780
NP Cost (PKR/ha)	0	7410	7410	7410
Other Fertilizer Cost (PKR/ha)	0	4940	0	4940
Fertilizer Cost	**9763**	**23061**	**18491**	**22651**
Hoeing Operational Cost (PKR/ha)	2668	2668	2717	2703
Pesticides (PKR/ha)	2503	2305	2141	2391
Weeds (PKR/ha)	1891	479	399	845
Weeding, Weedicides and Insecticides Cost	**17440**	**14200**	**12984**	**14669**
Canal Irrigation (PKR/ha)	494	494	494	494
Tube Well Irrigation (PKR/ha)	1976	1976	1976	1976
Irrigation Cost	**2,470**	**2470**	**2470**	**2470**
Harvesting (PKR/ha)	1751	3516	3912	3159
Threshing (PKR/ha)	3238	2313	1972	2459
Other Cost	1168	581	0	561
Harvesting and Threshing Cost	**6157**	**6410**	**5885**	**6179**
Total Cost	**37236**	**46789**	**42682**	**42236**
Average Yield (40 kg/ha)	747	789	816	780
Potential Yield (40 kg/ha)	1298	1545	1528	1471
Grain Price (PKR/40 kg)	3000	3000	3000	3000
Value of By-Product (PKR/ha)		7410	7410	7410
Average Gross Profit (per hectare)	**56034**	**65763**	**68617**	**65878**
Potential Gross Profit (per hectare)	**97389**	**123275**	**122018**	**117750**
Average Net Profit (per hectare)	**18797**	**18975**	**25935**	**18389**
Potential Net Profit (per hectare)	**60152**	**76486**	**79336**	**70260**

Source: Author calculation from survey data

Source: AVRDC (The World Vegetable Center) (2016, p. 17).

Gross margins budgets for lentils production

Khan and Anwar (2016, p. 122) carried out a gross margins study for lentils in the Pothwar plateau region in northern Punjab province, in which financial performance was compared for production using farmers' practices and using an improved variety and improved practices.

Table 4. Economic analysis of lentil production in Pothwar region

Inputs	Unit	Farmers' practices	Improved variety and practices
Land Preparation	Rs./ha	8 432	8 432
Sowing/Planting	Rs./ha	1 488	1 488
Seed for Sowing	Rs./ha	1 500	5 952
Fertilizer	Rs./ha	0	11 160
Weedicide/Labor Cost	Rs./ha	0	4 960
Harvesting (Manual)	Rs./ha	14 880	14 880
Threshing (By Thresher)	Rs./ha	6 944	6 944
Total Expenditure (Rs.)	Rs./ha	33 244	53 816
Total Produce (kg)	kg/ha	600	1 500
Total Benefit (produce × market Price*)	Rs./ha	54 000	135 000
Net Benefit (Rs.)	Rs./ha	20 756	81 184

Source: Khan and Anwar (2016, p. 123).

Qasim et al. (2013) investigated the reason for the decrease in lentil production in Punjab province, including estimation of gross margins for lentils for small, medium sized and large farms from survey data. It was found that gross margins were considerably higher on large farms than on small farms.

Table 5: Lentil Cost of Production (Rs/Ac)

Costs (Rs/ac)	Small	Medium	Large	Total
Land preparation cost	9468.42 (4778.55)	8661.11 (4159.77)	11885.71 (4036.68)	9522.73 (4460.31)
Input cost	3608.53 (2122.29)	5080.00 (4015.03)	4023.00 (2723.79)	4276.43 (3125.98)
Harvesting cost	2647.37 (1281.65)	2133.33 (1417.54)	2442.86 (1416.40)	2404.55 (1348.72)
Threshing cost	1642.11 (740.36)	1583.33 (931.95)	1257.14 (884.79)	1556.82 (836.77)
Labor cost	1847.37 (998.82)	1983.33 (997.05)	2657.14 (1422.27)	2031.82 (1082.85)
Interest cost	1152.83 (329.70)	1166.47 (460.94)	1335.95 (434.98)	1187.54 (400.26)
Variable costs	20366.62 (5824.78)	20607.58 (8143.30)	23601.81 (7684.71)	20979.88 (7071.27)
Land rent for lentil	2707.89 (1086.82)	2002.78 (910.15)	2578.57 (809.76)	2398.86 (1013.20)
Total costs	23074.51 (5701.31)	22610.36 (7925.97)	26180.38 (7554.94)	23378.75 (6926.25)
Lentil yield (mound s/ac)	10.21 (4.93)	8.11 (3.60)	13.14 (3.98)	9.82 (4.54)
Total revenue	25710.53 (11672.52)	22383.33 (10990.49)	32542.86 (13234.66)	25436.36 (11890.55)
Gross margins	5343.91 (13554.77)	1775.76 (11369.71)	8941.05 (13620.13)	4456.48 (12677.25)
Net margins	2636.01 (13205.70)	-227.02 (11614.52)	6362.48 (13940.82)	2057.62 (12601.58)
Percent profit margins (%)	36.71 (60.93)	30.81 (91.33)	47.39 (60.61)	36.00 (73.46)
Benefit Cost ratio	1.18 (.50)	1.10 (.57)	1.30 (.53)	1.16 (.53)

Source: Qasim et al. (2013).

Gross margins budgets for Mashbeans

No Pakistani example was found, but a gross margins budget from Fiji is presented below.

Gross margins budgets for wheat and other non-pulse crops in Pakistan

Mehmood et al. (2011) developed a GM models for wheat to compare the financial performance of organic and inorganic systems, in Sheikhupura district of Punjab province, Pakistan.

Table 2: Per acre cost of production of organic and inorganic wheat crop

Sr. No	Inputs	Organic Wheat Production (Rs.)	Inorganic Wheat Production (Rs.)	t test
1	Cost on seed [a]	764	963	-6.84
2	Cost on fertilizer/ manure [b]	3070	6495	-18.46
3	Cost on land preparations [c]	1705	1537	2.22
4	Cost on pesticides/ organic plant protection [d]	519	807	-5.03
5	Cost on labor [e]	4903	4007	3.80
6	Cost on irrigation [f]	1336	1701	-4.93
7	Cost on other inputs/ (Marketing and Transportation Cost) [g]	975	1139	-1.63
Total cost of production [C_p = a+b+c+d+e+f+g]		13274	16650	-8.46

Significant at 95% confidence level

Table 3: Gross margin of organic and inorganic wheat system

Sr. No	Particulars	Organic wheat	Inorganic wheat
1	Income	Rs. 27717	Rs. 33586
2	Total cost	Rs. 13274	Rs. 16650
Gross Margin	Rs. 14442	Rs. 16936	

Gross margins budgets or summaries for multiple species and rotations in Pakistan

Comparative gross margins budgets for production of lentils, wheat and mustard were prepared by Qasim et al. 2013).

Table 6: Comparative Cost of production and Returns of lentil and competing crops			
Costs (Rs/ac)	**Lentil**	**Wheat**	**Mustard**
Land preparation cost	9522.73 (4460.31)	12267.20 (5527.55)	8817.65 (3460.29)
Input cost	4276.43 (3125.98)	3920.00 (4087.86)	3886.65 (2065.26)
Labor cost	2404.55 (1348.72)	2012.00 (573.19)	925.00 (1203.42)
Harvesting cost	1556.82 (836.77)	2316.00 (847.88)	1673.53 (1443.76)
Threshing cost	2031.82 (1082.85)	1808.00 (548.42)	955.88 (1185.31)
Interest cost	1187.54 (400.26)	1677.62 (389.30)	975.52 (389.35)
Variable costs	20979.88 (7071.27)	29638.02 (6877.71)	17234.23 (6878.56)
Land rent	2398.86 (1013.20)	2394.00 (843.27)	2542.65 (1199.69)
Total costs	23378.75 (6926.25)	32032.02 (6768.46)	19776.88 (6613.60)
Yield (maunds/ac)	9.82 (4.54)	34.85 (11.33)	15.72 (2.77)
Total revenue	25436.36 (11890.55)	39580.00 (12931.33)	30367.65 (15728.70)
Gross margins	4456.48 (12677.25)	9941.98 (13312.45)	13133.42 (11942.78)
Net margins	2057.62 (12601.58)	7547.98 (13595.52)	10590.77 (11931.43)
Percent profit margins (%)	36.00 (73.46)	40.62 (65.61)	61.32 (89.61)
Benefit Cost ratio	1.16 (.53)	1.29 (.59)	1.41 (.75)

Source: Qasim et al. (2013, p. 65).

Khan and Anwar (2016) presented a summary of the financial returns of various crop combinations (mostly including a pulse crop) for various districts of Punjab province in Pakistan. While the performance criterion is referred to as 'net benefits', this appears to be a sum of gross margins for the crop combinations.

Table 3. Economics of various cropping patterns in Punjab (amounts in Rs./ha)

Cropping Patterns	Districts	Total cost of production	Total income	Net benefit
Rice – Wheat	Gujranwala, Sheikhupura, Sialkot, Narowal, Mandi Bahudin	136 648	406 472	269 824
Rice – Wheat – Mungbeans	-do-	166 408	510 632	344 224
Fallow – wheat	Rawalpindi, Attock, Chakwal, Jehlum	32 240	53 568	21 328
Mungbeans – wheat	-do-	69 440	163 380	93 940
Masoor – Mungbeans	-do-	68 200	247 008	178 808
Wheat – Mashbeans	-do-	69 440	191 000	122 016
Chickpea – Mungbeans	Bhakkar, Layyah (irrigated area)	63 240	243 040	159 960
Chickpeas (Kabuli) – Mungbeans	-do-	75 144	327 360	252 216
Wheat – Mungbeans	-do-	79 360	243 040	163 680
Wheat – Cotton	-do-	166 160	523 280	357 120
Chickpeas – Cotton	-do-	151 280	523 280	372 000

Source: Khan and Anwar (2016, p. 123).

Khan (2015) compiled data on the cost of production and grower returns for the kharif crops of cotton, rice and sugarcane in rural areas of Pakistan, concluding that growers now make a loss from these crops. Khan further noted to impediments of delayed payments, and increasing inclusion of middlemen in the payment process.

Cotton, paddy rice and sugarcane gross margins

Yield and returns	Cotton	Paddy rice	Sugarcane
Yield (kg/ac)	1040	1400	3000[a]
Farmgate price (Rs 1000/kg)	8.8	4.8	4.5
Crop revenue (Rs 1000/ac)	57.2	36	151.7
Production cost (Rs 1000/ac)	84.1	67.2	135
Gross margin (Rs 1000/ac)	-26.9	-31.2	-16.7

a. Pakistan's sugarcane yield averages about 46 tonnes per hectare. Harvested sugarcane contains about 13.39% sugar.
Source: Calculated from information reported by Khan (2015).

Gross margins budgets of pulses crops in other countries – Fiji

Leslie (2013) reported gross margins estimates for 54 fruit, vegetable and root crops – including mungbean and mashbean – for the sugarcane belt of Viti Levu island in Fiji. The background to this modelling was that if raw sugar export prices declined due to loss of preferred access to European markets, then there may be a need to grow other horticultural crops. In the case of fruit trees, multi-year extensions to the GM approach were adopted. Particular attention was given to labour time estimates, which may be for comparison of labour input requirements in Pakistan.

Gross margin analysis for mung bean, Fiji

Gross Margin Budget for MUNG *(Vigna radiata)*

1 ASSUMPTIONS				
Spacing (m)	0.65 x 0.2	Planting density (pl/ha)	77,000	
Yield Range (kgs)	1,000 - 1,600 (dry seed)	Average price ($/kg)	$5.00	
2 INCOME ($)	**Quantity**	**Unit**	**Unit Price**	**Total**
Sales (dry seed)	1,300	kg	5.00	6,500
Total Income				**$6,500**
3 DIRECT COSTS ($)	**Quantity**	**Unit**	**Unit Price**	**Total**
Land Preparation				
Ploughing	3	ha	112.00	$336.00
Harrowing	2	ha	84.00	$168.00
Rotovating	1	ha	120.00	$120.00
Inter-row cultivation	1	ha	80.00	$80.00
Planting Materials				
Seed	22	kg	2.50	$55.00
Fertilisers				
Blend A+B	5	40kg bag	65.00	$325.00
Bio Brew	0.3	20ℓ	200.00	$60.00
Fungicide				
Beniate	5	100g	5.91	$29.55
Insecticide				
Sunthene	10	100g	5.66	$56.60
Rogor	2	ℓ	32.75	$65.50
Transportation	1,300	kg	0.20	$260.00
Total Variable Costs				**$1,555.65**
4 LABOUR INPUTS (person days)	**Unit**	**Quantity**	**Price $/Unit**	**Total ($)**
Description				
Planting	days	25	20.00	$500.00
Fertiliser application	"	10	20.00	$200.00
Weeding	"	20	20.00	$400.00
Spraying	"	8	20.00	$160.00
Harvesting	"	30	20.00	$600.00
Windwing	"	10	20.00	$200.00
Drying	"	10	20.00	$200.00
Bagging	"	20	20.00	$400.00
Total Labour Cost @ $20/day		133		**$2,660.00**
Total Cost				**$4,215.65**
Gross Margin per hectare				**$2,284.35**
Return per Labour Inputs				**$17.18**

Source: Leslie (2013).

Gross margin analysis for mashbean, Fiji

Gross Margin Budget for URD *(Vigna mungo)*

1	**ASSUMPTIONS**				
	Spacing (m) 0.45 x 0.2		Planting density (pl/ha)	111,000	
	Yield Range (kgs) 1,200 - 1,800 (dry)		Average price ($/kg)	$5.00	
2	**INCOME ($)**	**Quantity**	**Unit**	**Unit Price**	**Total**
	Sales	1,500	kg	5.00	7,500
	Total Income				**$7,500**
3	**DIRECT COSTS ($)**	**Quantity**	**Unit**	**Unit Price**	**Total**
	Land Preparation				
	Ploughing	3	ha	112.00	$336.00
	Harrowing	2	ha	84.00	$168.00
	Rotovating	1	ha	120.00	$120.00
	Inter-row cultivation	1	ha	80.00	$80.00
	Planting Materials				
	Seed	17	kg	5.00	$85.00
	Fertilisers				
	Blend A+B	5	40kg bag	65.00	$325.00
	Bio Brew	0.3	20ℓ	200.00	$60.00
	Fungicide				
	Benlate	5	100g	5.91	$29.55
	Insecticide				
	Sunthene	10	100g	5.66	$56.60
	Rogor	2	ℓ	32.75	$65.50
	Transportation	1,500	kg	0.25	$375.00
	Total Variable Costs				**$1,700.65**
4	**LABOUR INPUTS (person days)**	**Unit**	**Quantity**	**Price $/Unit**	**Total ($)**
	Description				
	Planting	days	25	20.00	$500.00
	Fertiliser application	"	10	20.00	$200.00
	Weeding	"	20	20.00	$400.00
	Spraying	"	12	20.00	$240.00
	Harvesting	"	30	20.00	$600.00
	Windwing	"	10	20.00	$200.00
	Drying	"	10	20.00	$200.00
	Bagging	"	20	20.00	$400.00
	Total Labour Cost @ $20/day		137		**$2,740.00**
	Total Cost				**$4,440.65**
	Gross Margin per hectare				**$3,059.35**
	Return per Labour Inputs				**$22.33**

Source: Leslie (2013).

Gross margins budgets of pulses crops from other countries – Australia

GRDC (2015) – the Australian Grains Research and Development Corporation in conjunction with the South Australian Grain Industry Trust Fund (SAGIT) and the Government of South Australia – has provided a set of farm gross margins for crop and livestock enterprises for 2016, including for lentil and chickpea. These data could also be useful for checking the cost categories and comparison of labour requirements. Notably, an interactive spreadsheet has been developed, where farmers can enter their own parameter estimates, and predict the gross margin during the cropping year.

GRDC gross margins budget for chickpeas (6-8mm Kabuli)

Chickpeas (6-8mm Kabuli) Gross Margin

INCOME									
		Rainfall Zone			*LOW*		*MEDIUM*		*HIGH*
Price (16/17 Forecast)					$600		$600		$600
Quality	6-8 mm Kabuli								
Yield (t/ha)					0.7		1.3		2
GROSS INCOME					**$420**		**$780**		**$1,200**
VARIABLE COSTS				Rate/ha		Rate/ha		Rate/ha	
Seed	Cost			Low	$/ha	Medium	$/ha	High	$/ha
Seed	$1.05	/kg	@	90	$94.50	100	$105.00	110	$115.50
Seed Inoculant	$45.00	/tonne	@	90	$4.05	100	$4.50	110	$4.95
P-Pickel	$72.00	/tonne	@	90	$6.48	100	$7.20	110	$7.92
Levies									
GRDC Levies	1.0%	Gross Income			$4.20		$7.80		$12.00
EPR &state levies	$5.30	/tonne sold			$3.71		$6.89		$10.60
Fertiliser (Bulk)									
MAP	$720	/tonne	@	40	$28.80	60	$43.20	80	$57.60
Chemicals-Herbicides									
Summer Weed Control	Various	Allow			$20.00		$20.00		$20.00
Pre-emergents									
trifluralin 480g/L	$7.50	/litre	@	1.25	$9.38	1.25	$9.38	1.25	$9.38
Glyphosate 540	$7.00	/litre	@	1.2	$8.40	1.2	$8.40	1.2	$8.40
Balance®	$0.22	/gram	@	100	$22.00	100	$22.00	100	$22.00
Post-emergents									
Select (incl Oil)	$12.00	/litre	@	0.4	$7.61	0.5	$8.81	0.5	$8.81
Verdict® 520	$48.00	/litre	@	0.075	$3.60	0.075	$3.60	0.075	$3.60
Insecticides									
Omethoate	$29.00	/litre	@	0.05	$1.45	0.05	$1.45	0.05	$1.45
Karate Zeon®	$165.00	/litre	@	0.024	$3.96	0.024	$3.96	0.024	$3.96
Fungicides									
Chlorothalonil	$18.00	/litre	@	1	$18.00	1.5	$27.00	2	$36.00
Desiccation									
Paraquat	$7.00	/litre	@	0.8	$5.60	0.8	$5.60	0.8	$5.60
Operations									
Fuel & Oil					$11.58		$13.90		$16.21
Repairs & Maintenance					$19.19		$23.03		$26.87
Freight									
Grain (t)	$25.00	/tonne	@	0.7	$17.50	1.3	$32.50	2.0	$50.00
Fertiliser (t)	$20.00	/tonne	@	0.04	$0.80	0.06	$1.20	0.08	$1.60
Contract Work									
Aerial spraying	$14.00	/ha	@		$0.00		$0.00		$0.00
Windrowing	$35.00	/ha	@		$0.00	0	$0.00	0	$0.00
Insurance	$10.00	/$1000	@		$4.20		$7.80		$12.00
Other	$0.00	/ha							
	$0.00	/ha							
TOTAL VARIABLE COSTS					$295		$363		$434
GROSS MARGIN/hectare					$125		$417		$766

Source. GRDC (2016, p. 38).

GRDC gross margin budget for red lentil

Red Lentils Gross Margin

INCOME								
	Rainfall Zone			*LOW*		*MEDIUM*		*HIGH*
Price (16/17 Forecast)				800		$800		$800
Quality	Nugget							
Yield (t/ha)				0.7		1.2		1.8
GROSS INCOME				**$560**		**$960**		**$1,440**
VARIABLE COSTS	Cost		Rate/ha Low	$/ha	Rate/ha Medium	$/ha	Rate/ha High	$/ha
Seed								
Seed	$1.34 /kg	@	50	$67.00	50	$67.00	50	$67.00
Seed Inoculant	$0.05 /kg	@	50	$2.25	50	$2.25	50	$2.25
P-Pickel	$72.00 /tonne				50	$3.60	50	$3.60
Levies								
GRDC Levies	1.0% Gross Income			$5.60		$9.60		$14.40
EPR &state levies	$5.30 /tonne sold			$3.71		$6.36		$9.54
Fertiliser (Bulk)								
MAP	$720 /tonne	@	40	$28.80	50	$36.00	60	$43.20
Chemicals-Herbicides								
Summer Weed Control	Various Allow			$20.00		$20.00		$20.00
Pre-emergents								
Glyphosate 540	$7.00 /litre	@	1.2	$8.40	1.2	$8.40	1.2	$8.40
trifluralin 480g/L	$7.50 /litre	@	1.25	$9.38	1.25	$9.38	1.25	$9.38
Terbyne 875	$26.50 /kg	@	0.9	$23.85	0.9	$23.85	0.9	$23.85
Broadstrike®	$0.60 /gram	@		$0.00	25	$15.00	25	$15.00
Select (incl Oil)	$12.00 /litre	@	0.4	$7.61	0.5	$8.81	0.5	$8.81
Verdict® 520	$48.00 /litre	@	0.075	$3.60	0.075	$3.60	0.075	$3.60
Paraquat(Topping)	$7.00 /litre	@	0.8	$5.60	0.8	$5.60	0.8	$5.60
Insecticides								
Karate Zeon® (1)	$165.00 /litre	@	0.024	$3.96	0.024	$3.96	0.024	$3.96
Karate Zeon® (2)	$165.00 /litre	@	0.024	$3.96	0.024	$3.96	0.024	$3.96
omethoate (3)	$29.00 /litre	@	0.05	$1.45	0.05	$1.45	0.05	$1.45
Trojan (4)	$175.00 /litre	@	0.025	$4.38	0.025	$4.38	0.025	$4.38
Fungicides								
Mancozeb (5)	$10.00 kg	@		$0.00		$0.00	2.2	$22.00
Carbendazim (6)	$22.00 /kg	@	0.5	$11.00	1	$22.00	1	$22.00
Operations								
Fuel & Oil				$14.38		$17.25		$20.13
Repairs & Maintenance				$20.94		$25.13		$29.32
Freight								
Grain (t)	$30.00 /tonne	@	0.7	$21.00	1.2	$36.00	1.8	$54.00
Fertiliser (t)	$20.00 /tonne	@	0.04	$0.80	0.05	$1.00	0.06	$1.20
Contract Work								
Aerial spraying								
Windrowing								
Insurance	$12.00 /$1000	@		$6.72		$11.52		$17.28
Other								
TOTAL VARIABLE COSTS				$274		$346		$414
GROSS MARGIN/hectare				**$286**		**$614**		**$1,026**

Source. GRDC (2016, p. 32).

GRDC gross margins model for wheat

INCOME									
		Rainfall Zone			*LOW*		*MEDIUM*		*HIGH*
Price (16/17 Forecast)					$260		$260		$260
Quality	APW (Change Price for other grades)								
Yield (t/ha)					1.5		2.7		4
GROSS INCOME					**$390**		**$702**		**$1,040**
VARIABLE COSTS	Cost			Rate/ha Low	$/ha	Rate/ha Medium	$/ha	Rate/ha High	$/ha
Seed									
Seed	$0.25	/kg	@	60	$15.00	80	$20.00	90	$22.50
Seed Treatment	$0.05	/kg	@	60	$2.94	80	$3.92	90	$4.41
Levies									
GRDC Levies	1.0%	Gross Income			$3.90		$7.02		$10.40
EPR & state levies	$3.30	/tonne sold			$4.95		$8.91		$13.20
Fertiliser (Bulk)									
18:20:0	$720	/tonne	@	40	$28.80	60	$43.20	80	$57.60
Urea	$500	/tonne	@		$0.00	60	$30.00	120	$60.00
Chemicals-*Herbicides*									
Summer Weed Control		Various	Allow		$20.00		$20.00		$20.00
Pre-emergents									
Trifluralin 480g/L	$7.50	/litre	@	1	$7.50	1	$7.50	1	$7.50
Glyphosate 540	$7.00	/litre	@	1.2	$8.40	1.2	$8.40	1.2	$8.40
Oxyfluorfen	$21.00	/litre	@	0.075	$1.58	0.075	$1.58	0.075	$1.58
Sakura (1)	$340.00	/kg	@		$0.00	0.118	$40.12	0.118	$40.12
Post-emergents									
Topik (2)	$65.00	/litre	@	0.065	$7.04	0.085	$8.34	0.085	$8.34
M.C.P.A. LVE	$10.00	/litre	@	0.5	$5.00	0.7	$7.00	0.7	$7.00
Metsulfuron methyl(3)	$0.08	/gm	@	5	$0.85	5	$0.85	5	$0.85
Clopyralid (Lontrel)	$25.00	/kg	@	0.075	$1.88	0.075	$1.88	0.075	$1.88
2,4-DAmine(625g/l)(4)	$6.00	/kg	@		$0.00		$0.00	1.2	$7.20
Fungicides									
Tebuconazole	$12.00	/litre	@			0.2	$2.40	0.2	$2.40
Prothioconazole(Prosaro)	$70.00	/litre	@			0.15	$10.50	0.15	$10.50
Operations									
Fuel & Oil					$10.11		$12.13		$14.15
Repairs & Maintenance					$14.66		$17.60		$20.53
Freight									
Grain (t)	$20.00	/tonne	@	1.5	$30.00	2.7	$54.00	4.0	$80.00
Fertiliser (t)	$20.00	/tonne	@	0.04	$0.80	0.12	$2.40	0.20	$4.00
Contract Work									
Aerial spraying	$14.00	/ha	@		$0.00	1	$14.00	1	$14.00
Urea spreading	$8.50	/ha	@		$0.00	1	$8.50	2	$17.00
Insurance	$8.50	/$1000	@		$3.32		$5.97		$8.8
Other	$0.00	/ha							
	$0.00	/ha							
TOTAL VARIABLE COSTS					$167		$336		$442
GROSS MARGIN/hectare					$223		$366		$598

Source. GRDC (2016, p. 12).

APPENDIX C: PAKISTAN INFLATION RATES AND LOAN INTEREST RATES

In order to determine the discount rate for financial analysis, it is necessary to make estimates of the loan borrowing rate, earning rate on own funds, rate of inflation and risk margin (Dayanandra et al. 2002). Also, to adjust previous GMs to current prices, it is necessary to compile recent inflation rates, and hence a compound rates of inflation from the year of analysis to the present time.

The general inflation rate in Pakistan is estimated on the basis of the Consumer Price Index (CPI). Khan (2016b) and Quandl (2016) reported that the inflation in Pakistan was 4.53% in 2014-15, 8.62% in 2013-14 and 7.36% in 2012-13. Earlier figures reported by Quandl include 11.1% for 2011-12, 13.66% for 2010-11 and 10.01% for 2009-10. These rates provide a basis for adjusting GMs estimated in Pakistan in recent years, and also for removing the inflation component in financial analysis of cropping systems which include pulses crops.

Recent annual inflation rates are summarized in Table 9.

Table 9. Recent annual inflation rates

Year	Inflation rate (%)	Cumulative inflation rate to 2017
2016-17	5 (targeted rate)	
2015-16	5 (targeted rate)	
2014-15	4.43	
2013-14	8.62	
2012-13	7.36	
2011-12	11.01	
2010-11	13.66	
2009-10	10.10	

Trading Economics (nd, c2015) reported recent lending interest rates in Pakistan, defined as the rate charged by banks on loans to prime customers. For 2013 and 2014 these were 14.0% and 11.7% respectively, against deposit interest rates of 8.2% and 7.3% respectively.

The borrowing rate if often high for farmers, because of the high risk perceived by banks, and perhaps the need to source funds from informal lending sources. On the basis of these data, an initial estimate of the borrowing rate over the next decade for pulse growers would be 10-12% or more, and that of the inflation rate 5-7% or more. Given that pulse yields and prices are highly volatile, a few percentage points could be added for project risk. This would imply a discount rate of the order of 8%.

SOME CONVERSION FACTORS

Rs 1 Pakistan = \$0.013 Aust
1 ha = 2.47105 acres
1 maund = 40 kg
1 quintal = 100 kg

PROJECT FUNDED BY THE AUSTRALIAN CENTRE FOR INTERNATIONAL AGRICLUTURAL RESEARCH

ADB/2016/043 “Economic Analysis of Policies Affecting Pulses in Pakistan”

Report on a survey of pulse growers in the Thal region of Punjab, Pakistan

Dr. Abdul Ghafoor

Assistant Professor / Research Collaborator

Dr. Muhammad Nazam

Assistant Professor / Team Member

University of Agriculture, Faisalabad

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Executive Summary

In developing countries like Pakistan, agriculture is the most important sector of the economy and the single largest sector for economic growth and development. Punjab is the province with the largest agricultural production in Pakistan, with 69% of the cropped area of the country. In Pakistan, chickpea and mungbean are the most widely grown pulse crops. Pakistan spends a major portion of funds on the import of pulses to fill the gap between its demand and supply in the domestic market. Pulses are cultivated all over the world but in Pakistan it is being cultivated on 5% of total cultivated area of crops and chickpea white/black, mungbean, mash, masoor and few others are grown. These pulse crops are grown mostly as a cash crop in the summer or autumn seasons in the Nurpur Thal region of Punjab province. Pulses are consumed in several forms including cooked, roasted, sprouted or milled grains.

Mungbean is one of the important pulse crops of Pakistan. It is mainly grown in southern parts of Punjab and Sindh. Punjab alone provides 88% of Pakistan's mungbean area with 85% of the country's mungbean production.

In Pakistan, pulses consumption is 6 to 7 kg/capita annually which shows the interest of Pakistani people in pulses. In order to fulfill the requirements of pulses consumers, there is increasing demand and supply gap as consumption exceeds supply Pakistan is mainly depended on Canada, Australia, Burma, India, and African countries to fulfill the domestic requirement of pulses every year.

A survey was conducted in 3 major districts across the Punjab province in Nurpur Thal region to understand the challenges faced by mungbean and chickpea growers. A total of 130 randomly-

selected farmers were interviewed across the Nurpur Thal region. Most of the farmers did not produce their own pulses seed, and a majority sowed the crop by broadcasting.

Research findings demonstrate the overall financial analysis of three selected pulse crops; chickpea white, chickpea black and mungbean. Survey results indicate that average annual farm output quantity of chickpea white was 261 kgs/per acre with a farm-gate price of Rs. 113/kg and a gross revenue of Rs. 29,345/acre. By deducting the total cost Rs. 23,053/acre, the resulted gross profit was Rs. 6,292/acre. Adopting the similar calculations the gross profit of chickpea black was Rs. 5,545/acre. Finally, the gross profit of mungbean was calculated to be Rs. 25,152/acre. From the results it can be noticed that the profitability of the mungbean crop has been relatively high as compared to chickpea crops. The reason for this is due to higher yields and therefore farm output, in turn due to the utilization of agri inputs in the form of fertilizer, pesticides and irrigation water. Chickpea farmers were reliant on rainfall instead of irrigated water and agri-inputs.

The main concerns of pulses growers were the susceptibility of pulse crops to diseases and insect pests, yield variability and availability of certified seed. Pakistan's pulses sector faces a number of challenges, including lower farm-gate prices for their outputs resulting in farmers switching to other crops. If the Government of Pakistan (GoP) develop a roadmap to resolve these issues, then Pakistan will be able to produce greater quantities of pulses, contributing to improved agricultural growth.

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List of Acronyms and Abbreviations

ACIAR	Australian Center for International Agriculture Research
Ac	Acres
DAP	Di-ammonium Phosphate
GoP	Government of Pakistan
Hrs	Hours
Kgs	Kilograms
Mds	Mounds
NP	Nitrate Phosphate
PBS	Pakistan Bureau of Statistics
Rs.	Rupees
UAF	University of Agriculture, Faisalabad
Yrs	Years

CHAPTER 1

INTRODUCTION

This chapter aims to discuss the background of pulses in Punjab province of Pakistan and outline of the research report with concrete objectives as well as limitations. In recent years, the need to increase crop yield is crucial for the small as well as big farmer. In this context, this chapter is divided into three sections. The first section explains background of pulses production and constraints in Nurpurl Thal region of Punjab province, the second section presents the overall objectives of the report, and the third section describes the outline of the report in descriptive and diagrammatic form.

1.1 Background of Pulses in Punjab Province

In recent years, pulses play an essential role in our daily lives. The meaning of word "Pulse" is derived from the Latin word "Puls" which means pottage i.e. seeds boiled to make porridge or thick soup. Pulses provide a cheap source of dietary protein and vitamins. The proportion of calories is similar as other cereals but the protein level fluctuates. The proportion of protein in pulses are double that of grains/cereals (20–25%) and approximately equal to that of white meat (Singh et al., 2017).

Chickpea production is the main livelihood of rural and urban people in the Nurpur Thal desert of Punjab province, the productivity of which is highly dependent on seasonal rainfall. There are two main types of chickpea, namely white and black characterized by seed size, cosmetic appearance and color. White chickpea has relatively small seeds and is commonly called ‘desi’, whereas black chickpea has relatively large seeds and is commonly called ‘kabuli’. Most commonly used desi chickpea white/black is cultivated mainly on the subcontinent i.e Pakistan and India. Pakistan produces approximately 900,000 tonnes of pulses each year. The Thal region produces a significant volume of pulses. On average, the Punjab province contributed about 80% of Pakistan’s production and the Sindh, KPK and Baluchistan provinces produced the remaining 20% (PBS-2016). Within Punjab, the Khushab district contributed 28% chickpea production while the remaining comes from all other districts of Punjab. In the Khushab district, where no other crop grows so successfully, pulses plays a vital role in the cropping systems of subsistence farmers. Pulses help manage of land fertility, especially in dry fields of the Nurpur Thal desert. They ‘fix’ nitrogen in the soil by absorbing soil N_2 in small nodules on their roots and bacteria (rhizobia) in the nodules convert the N_2 into a form that can be used for plant growth in subsequent crops. Hence, pulses enhance much required organic matter to sustain and recover soil fertility levels contributing to ecosystem sustainability (Herridge, 2009). The emerging food security pressure on our economy, exacerbated by population growth, has contributed to the importance of availing the substantive rain fed areas of Pakistan to increase food production and address malnutrition (Mahmood et al.,1991).

Chickpea has been considered as the major Rabi pulse crop, amounting for 76% of approximately total production of pulses in Pakistan, which is mostly chickpea (white/black) and mungbean (Statistical Bureau of Pakistan, 2016). There has been an increase of 26% in the production volume of grams (chickpea white/black) during the period of 2016-17 compared with the previous year, and a similar increase in the production of mungbean (Govt. of Pakistan 2017). The production volume of other crops, including barley, jawar, rapeseed and mustard, and tobacco declined in yield during this period, with negative growth of 9.8%, 7.8% and 2.6%, respectively. These decreases were largely due to drops in area sown. The production volume of mung, onion and chilli witnessed positive growth of 27%, 2.7% and 0.2%respectively, as compared to yield of last year. The reason behind this positive increase is due to increases in sowing area as shown in Table 1.1.

Table 1.1: Area and Production of other Kharif and Rabi Crops

Crops	2015-16		2016-17 (P)		% Change in production over Last year
	Area (000 Hectares)	Production (000 Tonnes)	Area (000 Hectares)	Production (000 Tonnes)	
Gram	940	286	931	359	25.5
Mung	146.3	102.1	178.8	130.1	27.4

Source: Pakistan Bureau of Statistics 2016-17

Chickpea (white and black) is a tolerant cash crop and is the main source of income for growers of the Nurpur Thal region. Many festivals and activities of growers in this region are based on the successful harvesting of this crop. There is a big gap between expected and actual yield, which reflects various constraints including marketing, production management, farm management, and infrastructures (Nain, et al., 2015 and Rehman et al., 2015).

Due to several socio-economic constraints resulting in technological constraints, large-scale adoption of pulses crops is not sustained. With declining yields of chickpea, it has been noticed that there is stagnant per capita availability of this crop in the widely cultivating areas. Therefore, a policy question arises whether the decrease in per capita productivity of pulses is due to supply or demand constraints. From the historical perspectives, supply constraints have been more prevalent than demand constraints for chickpea (white and black). Increases in population and income growth, and positive income elasticity of demand ensure increasing levels of consumption (Rani et al., 2014). In the long run, demand may be more constrained due to changes in tastes, preferences, and urbanization. The overall benefits of pulses production in Thal extend much beyond generating income to resource poor farmers. For the long run, sustainability of agricultural systems, improvement in production through improved varieties resistant to pests and diseases, and better agronomic management should continue in the future (Amutha 2011, and Burman, et al., 2006).

The focus of this study is to conduct economic analysis on pulses production in Thal, understanding adoption of production technologies and advanced infrastructure for diverse environments, and eliciting farmer perceptions of current constraints to pulses production. This will provide information for evidence-based policy analysis and development of a roadmap for reform of policies affecting pulses production in the Punjab.

1.2 OBJECTIVES

The objectives of the study were follows:

1.2.1 General Objective

The study is part of a larger project aimed at providing evidence-based analysis and advice to policy-makers on policy reform to reduce constraints to pulses production and trade, and increase pulses productivity in Pakistan. The report contributes to this larger project by providing data and economic analysis of the pulses sector in the Punjab province of Pakistan.

1.2.2 Specific Objectives

The specific objectives of this research study are to**:**

- assess the socio-economic characteristics of the pulses growers,
- estimate the cost and benefit of chickpea (white/black) and mungbean crops at the farm level in order to determine the profitable of these crops and prospects for sustainable growth, and
- Suggest the policy implications regarding the factors affecting average cost of pulses and mungbean production and returns at farm level in the Punjab province of Pakistan.

1.1.3 Limitations of the Study

- It was very difficult for the researcher to collect the accurate information from the farmers due to illiteracy in rural areas. The farmers are very reluctant to adopt new technologies/approaches as they are not familiar with new farming practices. Therefore, the study was limited to the un-educated farmers but the Government should take steps to establish pulses crops capacity building centers to train the small farmers and change their attitude towards advanced farming practices.
- The study was limited to three major zones including Khushab, Bhakkar and Layyah only.

1.3 Overall Framework of Project Report

This project report comprises of five chapters. Chapter one entitled “Introduction” presents background of the study, the rationale, objectives and limitations. In the second chapter, relevant review of literature has been cited and it provides an overview of the knowledge accumulated on factors affecting the production of mungbean and chickpea white/black crops in the project area. This chapter provides an outline of the most commonly used techniques for producing pulses, sheds light on the current state of research in this field, and makes suggestion on how the current research could be linked to existing knowledge. The research design (a face-to-face survey of pulse producers), demographic factors of survey respondents, validity and reliability of the research instrument, sample size, procedure and techniques adopted for selection of sample selections, and techniques used for data analysis, are described in the third chapter entitled “Research Methodology”. In chapter four, results and discussions are presented. Finally, a summary of findings and recommendations in the light of study objectives are provided in chapter five.

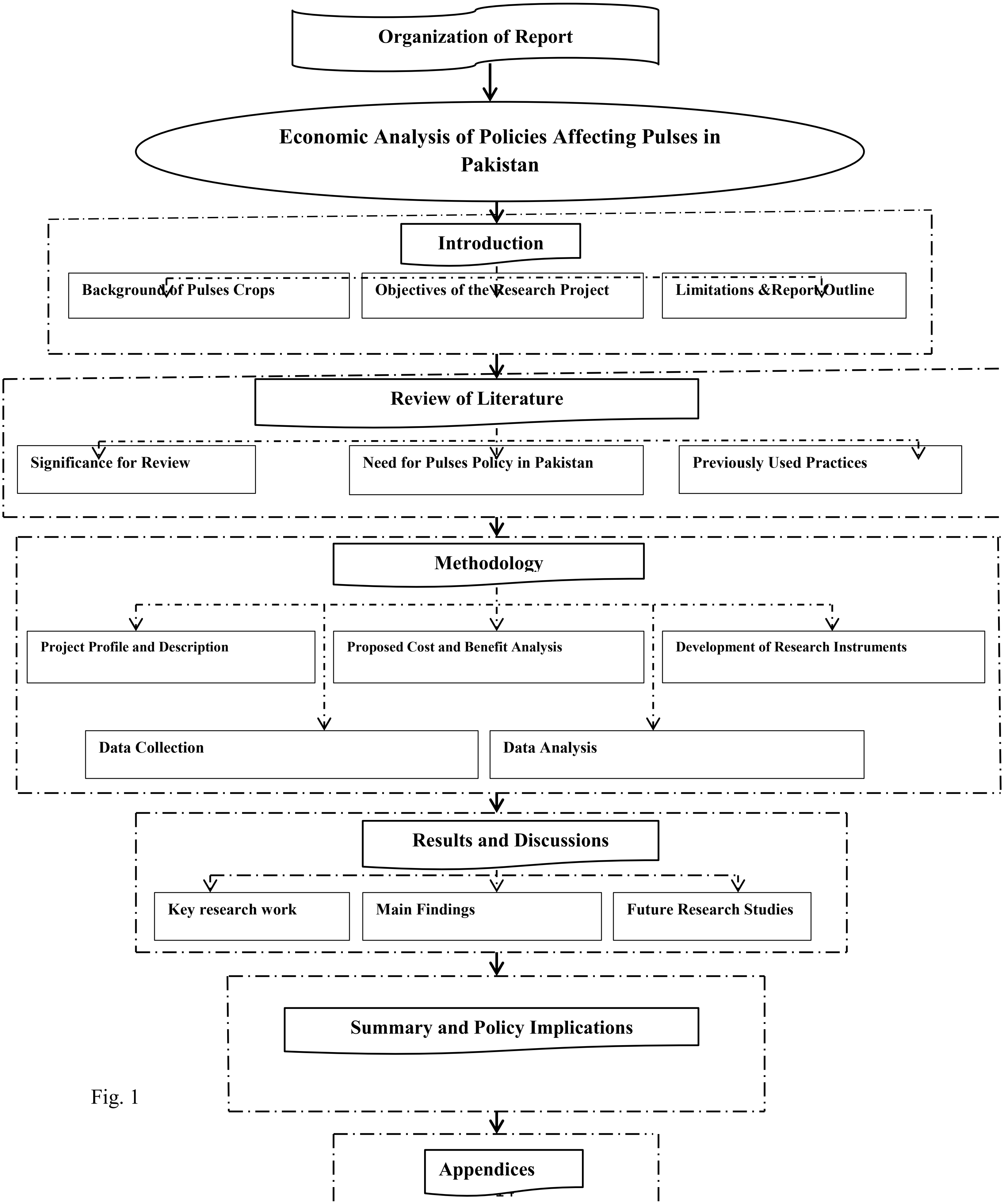
Chapter 1: Introduction - explains research background and motivation to the assigned research project title and key objectives addressed with limitations as well as diagrammatic outline.

Chapter 2: Review of literature - discusses the detailed review of literature with fundamental concepts and techniques to solve the identified problem of this research

Chapter 3: Methodology - deals with project profile and development of research instrument with analytical note

Chapter 4: Results and discussion - analyzes the data through SPSS software and discusses the key findings with future research avenues in pulses-policy formulation

Chapter 5: Summary and policy implications - summarizes the conclusions and suggests policy implications for stakeholders, Government and funding agency etc.



Organization of Report
Economic Analysis of Policies Affecting Pulses in Pakistan
Introduction
Background of Pulses Crops
Objectives of the Research Project
Limitations &Report Outline
Review of Literature
Significance for Review
Need for Pulses Policy in Pakistan
Previously Used Practices
Methodology
Project Profile and Description
Proposed Cost and Benefit Analysis
Development of Research Instruments
Data Collection
Data Analysis
Results and Discussions
Key research work
Main Findings
Future Research Studies
Summary and Policy Implications
Appendices

Fig. 1

CHAPTER 2

In this chapter, some definitions about pulses crops and its scope have been explained within the context of previous research. The basic concepts and methodologies adopted for economic analysis of pulses are interpreted in this chapter for the reader's comprehension.

REVIEW OF LITERATURE

Pakistan's economic growth is dependent on sustainable agricultural production and development of Rabi and Kharif crops. Pulses crops are a potential sector in the Thal region that not only develops the rural economy but also produces an extensive range of nutrient rich grains and condiments. Effective agricultural marketing is a process of delivering quality products and services at reasonable prices and right time. Marketing systems in Pakistan are, to some extent, dynamic and competitive and demand continuous change and improvement. Generally, efficient stakeholders can prosper by enhancing market demand of quality products and reducing marketing costs. Pulses supplement nutritious food to our vegetarian population as protein, feed for our cattle and also helping in improving soil health and productivity of other crops. The growth and development of the Pakistani population is, in part, being met by pulses as they form a vital part in the diet of poor as well as the rich (Govt. of Pakistan, 2016).

Even though organized and integrated commodity exchanges have a long history, for more than a century, it remained largely confined to industrialized nations. However, with market liberalization and increasingly affordable information technology since 1990, commodity exchanges have mushroomed around the world (Burman et al., 2006; Boye et al., 2010).

Kumar et al., (2011) defined as an auction market where contracts on commodities are available for purchase or sale at an agreed price and for delivery on a specified date. It is an association or a company or any other body corporate organizing trading in commodities for which a license has been granted by regulating authority. As the theoretical experiences teach us, having efficient domestic agricultural commodity marketing system plays a decisive role in accelerating the growth and development of the agriculture sector.

A set of constraints spans the pulses value-chain in production, aggregation and trading, and demand sinks/export. Productivity is below potential due to low input usage, especially chemical fertilizers inability to increase yields, limited availability of seed, limited familiarity with the variety of existing seed types, and limited usage of modern agronomic practices (Karthikeyan et al., 2014).

Ali and Rashid (2009) investigated the growth trends and supply response behaviour of pulse crops in Punjab. This study examined the trends in area, production and productivity of gram, mung, mash, masoor and matar pulses, and also estimated the growth rates of area, production and productivity of different pulses. Moreover, they examined the response of supply of different pulses to changes in; relative price of the crop, relative yield of the crop, own price of the crop, own yield of the crop, gross irrigated area to gross cropped area, rainfall during the critical periods, price risk and finally, yield risk. They applied Nerlovian partial adjustment lagged model which was used to test the factors influencing the farmers supply allocation. The results of this study revealed that the slow growth in most of the pulses production can be mainly attributed to stagnation and decline in area. The causes of this stagnation and decline in area may be due to stagnation and decline in yield, in turn due to factors expressed by Karthikeyan et al., (2014).

The link between the producers and the export markets is weak, due to the large number of ineffective intermediaries operating in the value chain. The fragmentation of intermediaries between the producer and consumer markets creates a lack of transparency in markets. In addition, identifying the production and marketing constraints for pulses crops as well as six major food crops in Asian and African farming systems is very crucial tasks (Waddington et al., 2010; Davari et al., 2012, and Weinberger, 2005).

Based the literature review, there is a need to improve and enhance domestic and international competitiveness in pulses industry. In fact, resource poor growers do under-invest in agricultural inputs that creates reduction in yield and poor grain quality. There is an inadequate space for storage and poor logistics facilities affects supply chain and buyer-seller prices. Precautionary measures and well-planned pulses policy could improve marketable surplus and efficiency and effectiveness of pulses industry.

In addition, feasible production and distribution strategies involving Good Agricultural Practices (GAP), infrastructural commitments and compliance of ISO 9001 and 14001 standards could increase pulse productivity and make members of the pulses sector more prosperous. If the Government of Pakistan (GoP) developed a roadmap to resolve these issues, then Pakistan will be able to produce substantial amount of pulses and make a stronger contribution to fulfilling the domestic as well as international needs of pulses consumers.

CHAPTER 3

METHODOLOGY

This chapter describes the project methodology for data collection and analysis. Information is presented about the study area, research procedure including instrumentation, sampling procedure and sample size, selection and data collection, data analysis, and difficulties faced during data collection.

3.1 Project Area

The project was executed in throughout the Nurpur Thal region of Punjab covering one district each from three major ecological cropping zones namely Khushab, Bhakkar and Layyah. These locations are marked in the map of Pakistan in Fig. 2.

A detailed well-structured questionnaire was designed for collection of data covering comprehensive information regarding production and marketing constraints, sustainable sowing and harvesting practices, likely markets access, the availability of resources and per acre yield of growers for the last 3 years.

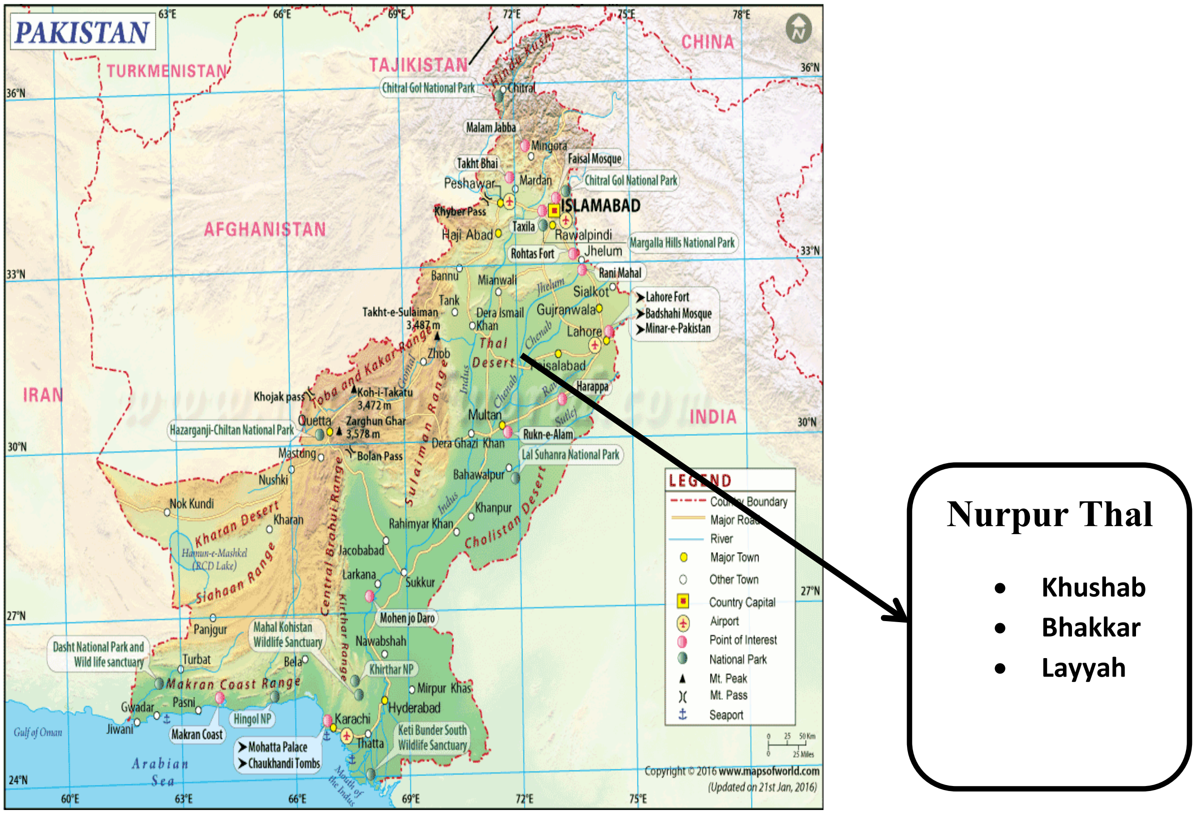


Fig. 2 Map of Pakistan by highlighting the selected locations of data collections

3.3 Research Design

The choice of suitable research design is the real essence of getting the solution of the research problem as well as the decision about the selection of the correct and right methods pertinent to the problem under study (Farooq, 2001). The worth of research increases through the comprehension of the various dimensions of data and targeting the correct results. For the purpose of accessing the destination of accurate, reliable and valid results, the smooth path is the appropriate research design (Khan, 2007). Survey research is helpful to get deep insight about the problem to get a real picture of the situation (Denscombe, 2003). Keeping in view the vitality of survey research, it was used for obtaining the data concerning the developing a policy economic analysis for policies affecting pulses in Punjab province of Pakistan. In this research, a cross-sectional research design was used during survey. The cross-sectional research design facilitates collecting information from a single point in a time (Borg and Gall, 1989).

3.4. Research population

Population of the research comprised following:

- All farmers residing in Nurpur Thal region of the Punjab i.e. Khushab, Bhakkar and Layyah with pulses crops
- Individuals trading pulses varieties at grain market and interviewing progressive farmers

3.5 Sampling procedure and Sample Size

There is no hard and fast rule for sample size (Wimmer and Dominick, 2003; Best and Kahn, 2006). The "nature of research" may determine the sample size. The more important is the way of selection subjects rather than the size (Best and Kahn, 2006). The real worth of a sample lies in the representativeness rather than the size (Wimmer and Dominick, 2003).

For this study, three different districts i.e. Khushab, Bhakkar and Layyah of the Punjab were selected purposively. The sample was randomly drawn with the help of Fitzgibbon table (Fitzgibbon and Lynn, 1987). Total sample sizes of 130 respondents were selected.

3.6 Data Collection

3.6.1 Development of research instrument

There are various tools/techniques to be used for collection of information/data like questionnaire and interview schedule. The data collection through personal interview method provides opportunity to an interviewer to dig out the dependable factual data due to more flexibility, validity, response rate, and in depth probing (Denscombe, 2003; Khan, 2007).

For collection of information, two different interview schedules were constructed one for chickpea white/black growers and one for mungbean growers. It was constructed in structured and reliable way.

3.6.2 Validity

Validity ensures accuracy of the instrument judged on the part of experts by checking the instrument, keeping in view the purpose for which it is developed (Wimmer and Dominick, 2003). As the accurate data collection is mainly the outcome of research instrument having both face and content validity. For this purpose, before giving the interview schedule a final shape, the experts from institute of Agricultural and Resource Economics, Univ. of Agri., Faisalabad were consulted to check the validity of the instrument. They critically checked the interview schedule and gave their positive and constructive suggestions which were incorporated, while giving it final shape.

3.6.3 Reliability

Reliability of the research instrument is the counterpart of the validity. Both reliability and validity of research instrument are essential for getting quality data. Among these aspects internal consistency of the instrument has its own distinctive place. Internal consistency is related to the "homogeneity" (Singh, 1986). Cronbach's Alpha is a well-accepted form of measuring the internal consistency of an instrument in terms of reliability (Santos, 1999). Considering the appropriateness like in other researches (Koukel and Cummings, 2002; Lodhi, 2003), Cronbach's Alpha was calculated to check the reliability of the interview schedule by using Statistical Package for Social Sciences (SPSS) software.

3.6.4 Pre-testing of the research instrument

Considering the significance of pre-testing, the interview schedule was pre-tested on 20 farmers who were not included in the actual sample. As a result, some minor amendments were incorporated in the interview schedule.

3.6.5 Training of the Data Collection Team

Training of the interviewers is very important aspect. The training must encompass the essential skills pertinent to interview method. The training should cover both the aspects i.e. interviewing skills as well as training about understanding the instrument related to research (Rossi et al., 1983). It was rather difficult for the researcher to collect all data personally. So, it was decided to collect the data by a team of interviewers, including the researcher himself.

The data collection team was comprised of two research assistant and one team member. Training in local languages (Punjabi and Saraiki) was provided for getting real and credible information. After the training, they were sent to field to collect the data. The data collection process by the team members was monitored by the researcher in the field.

3.7 Data Analysis

Data analysis is essential for smoothening the way of presenting the data in an understandable and comprehensive manner. The data analysis has been completed and interpreted in chapter four.

3.8 Outline of Methodology for Economic Analysis

In order to conduct the economic analysis of pulse production from the survey data, the following steps were used:

- Firstly, both quantitative and qualitative data collection techniques (i.e. Personal Interview and Focus group) were used to collect data from the selected cropping region of the Nurpurl Thal and three major districts were selected,
- Secondly, a validated research instrument (structured questionnaire) was used for the collection of data from 130 farmers.
- Thirdly, focus group and key informant interview techniques were also used for the collection of qualitative data. Three focus group interviews were held with progressive farmers and extension personnel in each selected district to collect the in-depth information.
- Fourthly, descriptive statistics including average and frequency were used to draw inferences about basic socio-economic and business characteristics of pulses growers.
- Finally, this report was written to aid dissemination of survey results.

CHAPTER 4

RESULTS AND DISCUSSION

In this research project, survey data is discussed, analyzed and interpreted in order to draw conclusion and formulate appropriate suggestions for policy stakeholders in the light of results obtained. The general objective of the study is to provide evidence-based economic analysis of pulses crops at the farm level to inform policy analysis. The basic aim of this research is to identify the factors which affects productivity and profitability of pulses production. This chapter includes four components: (i) the demographic characteristics of survey respondents, (ii) identification of important crops and their yields, (iii), financial analysis of pulses production, and (iv) concluding remarks.

4.1 Socioeconomic characteristics of respondents

Socioeconomic characteristics of respondents are presented in Table 4.1. Age is a significant demographic variable which affect the farmers working efficiency and ability to use and innovate with cultivation techniques. Age reflects farming experience. The average respondent's age was 52 years, ranging from 18 to 86 years. Regarding their involvement in farming, 32% had up to 10 years' experience, 39% up to 20 years, whereas 29% had enriched experience participation (above 20 years). Around 15% respondents were illiterate, 39% had education levels up to primary-middle level, and 45% had education levels higher than matriculation.

Table 4.1: Socioeconomic characteristics of respondents

Description	Minimum	Maximum	Mean
Age (years)	17	86	51.5
Education (years)	0	16	8.0
Farming Experience(years)	2	42	22.0
Family Members(No.)	2	18	10.0
Income from Crops(Rs.)	20,000	500,000	350,000
Income from Livestock(Rs.)	15,000	200,000	107,500
Total Annual Income(Rs.)	35,000	700,000	367,500
No. of Land Parcels	1	8	4.5
Size of Land Holding (Acres)	2	52	26.0
Arable Area (Acres)	2	55	28.5
Land Suitable for Intensive Cropping	3	45	24.0

Table 4.1 reveals that the income from crops ranges from Rs.20,000/acre to Rs.500,000/acre whereas income from livestock was lowed at Rs15,000/acre to Rs200,000/acre. The number of land parcels owned by farmers was 1 to 8 and the size of land holding was 2 to 52 acres. Land suitable for intensive cropping ranges minimum 3 acres to maximum 45 acres for intensive pulses cultivation.

4.2 Land Resources and Operational Holdings

Pulses growers can be categorized according to their land resources as shown in Table 4.2.

Table 4.2 Land Resources and Operational Holdings (Acres)

Size of land holdings	**Percentage**
Up to 12	52
>12-25	30
Above 25	18
Arable area	**Percentage**
Up to 12	59
>12-25	26
Above 25	15
Land suitable for intensive cropping	**Percentage**
Up to 12	58
>12-25	21
Above 25	13
No	8
Area owned	**Percentage**
Up to 12	50
>12-25	31
Above 25	19
Operational Holding	**Percentage**
Up to 12	52
>12-25	29
Above 25	19
Land fertility level	**Percentage**
High	16
Moderate	77
Low	7

Growers holding up to 12 Acres, 12 to 25 and more than 25 acres cultivated land were considered as small, medium and large growers. The land fertility was considered moderate.

4.3 Ownership of Plant and Equipment

It was important to understand that how farmers use farm machinery to grow pulses crops. The below Table 4.3 specified that from the sample of 130 respondents most farmers used tractors and animals. Overall, the usage rate of tractors was high (89%) and animals' low (5%), as the farmers have traditional implements only. Some of the farmers rent (21%) or own machinery (77%). Tractor was seen as a major source of power in the study area instead of more advanced farm machinery. There was a major gap between the selected cities about the usage/availability of the implements. The Government should take initiatives to empower farmers by considering how advanced machinery can be available and affordable to farmers. Currently, they cannot access these machines in agri-markets.

Table 4.3 Ownership of Plant and Equipment

Power source	**Percentage**
Tractor	89
Animal	6
Both	5
Ownership of tractor	**Percentage**
Owned	77
Rented	21
NA	2

4.4 Irrigation Sources and Water Brackishness

Water acts as a major input to the cultivation of pulses crops, but most farmers in study area were facing water scarcity issues due to less rainfall and non-availability of irrigated water. In the deserts of Nurpur Thal, most of the farmers relied on rainfall instead of irrigated water. From the research findings, 1% of survey respondents had canal irrigation, 30% had tube well irrigation, 59% had both i.e. canal and tube well, and 10% had no irrigation (Table 4.4). Annual and seasonal systems were used to irrigate the fields, whereas 64% were based on seasonal canal type. Around 51%) of respondents indicated that the quality of water is fit for irrigation, 43% indicated it was to some extent fit and 6%) indicated water was unfit for irrigation. However, 45% of respondents perceive their water to be brackish. Table 4.4 indicates that water brackishness is not so common in the pulses fields.

Table 4.4: Irrigation Sources and Water Brackishness

Irrigation source	**Percentage**
Canal only	1
Tube well	30
Both	59
Based on rain	10
Canal type	**Percentage**
Annual	25
Seasonal	64
NA	11
Quality of water	**Percentage**
Fit for irrigation	51
To some extent fit	43
Unfit	06
Water brackishness	**Percentage**
No	10
Low	45
Medium	36
High	10

4.5 Chickpea and Mungbean Per Acre Yield (Mds) for the last 3 years

Pulse cropping pattern and yields varied over the last three years. It was evident that land used for rabi and kharif crops was not separated from land of other crops like wheat and lentils. Mostly growers grow chickpea white and black as cash crops and some vegetables in rabi season. During the kharif season, cotton and vegetables were grown. It was observed that in Layyah and Bakkar districts, growers were cutting their fruits orchards and preferred mungbean crop instead of other cash crops due to good soil condition and high yielding capacity. Table 4.5 indicates that pulse yields have followed a decreasing trend over the last three years. In 2014 yield of chickpea white recorded from 7 to 14 mds/acre, chickpea black 5 to18 mds/acre and mungbean 6 to 25 mds/acre.

The yield of the chickpea white/black and mung was high in 2014 as the major reason described by the farmers was heavy rainfall.

Table: 4.5 Chickpea and Mungbean Yield (Mds/Acre) for the last 3 years

Crops Descriptions	Minimum	Maximum	Mean Value
A. Chickpea (white)			
2016	1	12	6.50
2015	2	13	7.50
2014	7	14	10.50
B. Chickpea (black)			
2016	3	13	7.99
2015	4	15	9.48
2014	5	18	11.50
C. Mung bean			
2016	2	21	11.50
2015	4	25	14.50
2014	6	25	15.50

4.6 Source of grain losses of pulses crops

Table 4.6 presents farmer perceptions of the main sources of pulses grain loss during and after harvest, identified in term of high, medium and low percentile values. At the harvesting stage, chickpea suffer high perceived losses (79%) and mungbean crop as a medium perceived loss (65%). Secondly, in the drying stage, perceptions of chickpea losses were similar in the high, medium and low categories. The mungbean crop was considered to have medium perceived losses during drying (52%). Similarly, in threshing stage, chickpea crop encountered high perceived losses (57%) and the mungbean crop medium perceived losses (46%). Finally, in storage, chickpea perceived losses was recorded as a medium (55%) and in mungbean crop as high (43%).

Table: 4.6 Source of losses in percentage at different levels of pulses crops

Losses Stages	Crops	High	Medium	Low
Harvesting	Chickpea	79 %	18 %	3 %
	Mung	9 %	65 %	26 %
Drying	Chickpea	35 %	32 %	33 %
	Mung	46 %	52 %	2 %
Threshing	Chickpea	57 %	25 %	18 %
	Mung	23 %	46 %	31 %
Storage	Chickpea	15 %	55 %	30 %
	Mung	43 %	26 %	31 %

4.7 Techniques adopted in sowing and harvesting of pulses crops (%)

Most commonly used sowing techniques were drilling, pora/kera and broadcast in cultivation of pulses crops. Table 4.7 demonstrates the adoption rate of the drilling method (9%), pora/kera (21%) and broadcasting (70%) for chickpea. Similarly adoption rate can be seen in Mungbean crop through pora/kera (29%) and broadcasting (71%). Most of the farmer gained seed sources information through seed dealers (65% 49% in chickpea and mungbean crops respectively). Moreover, most farmers manually harvest their pulses (90% of chickpea and 70%of mungbean farmers, respectively). Reapers and combine harvesters were implemented on a small scale by respondents.

Table: 4.7 Techniques adopted in sowing and harvesting of pulses crops (%)

	Chickpea	Mungbean
Sowing method		
Drill	9	0
Pora/Kera	21	29
Broadcast	70	71
Seed sources		
Punjab seed corporation	7	0
Agricultural Research Station	0	9
Seed Dealer	65	49
Fallow Farmers	16	0
Own	12	42
Harvesting		
Manual	90	70
Reaper	4	10
Combine Harvester	6	20

4.8 Average amount of pulses sold and price received in an average year

Disposal of pulses crops especially through various market stakeholders is an important management decision. Growers allocate their resources effectively and efficiently based on revenue generated from various marketing channels. Table 4.8 describes the average amount of pulses sold and price received in an average year. Average amount sold of chickpea white is 261kg/yr at the rate Rs.113/kg. Similar quantities are sold for chickpea black and mung. The chickpea black price is similar to that of chickpea white, but the mung price is relatively low.

Table 4.8 Average amount of pulses sold and price received in an average year

Product	**Amount/Price**	
Chickpea (white)	Amount Sold (Kg/yr)	261
	Price received (Rs./kg)	113
Chickpea (black)	Amount Sold (Kg/yr)	241
	Price received (Rs./kg)	83
Mung	Amount Sold (Kg/yr)	660
	Price received (Rs./kg)	108

4.9 Sources generating information regarding growing pulses crops

The different sources of information regarding pulses cultivation are listed in Table 4.9. The major sources of information are family members 40%, neighbors 20%, extension officers 15%, other Govt. worker s12%, sale representatives 8% and seed dealers 5%. This indicates that the role of family members is relatively important in providing information, but that of seed dealers and sales representative is relatively unimportant.

Table 4.9 Sources generating information regarding growing pulses crops (%)

Sources	
Family member	40
Neighbor	20
Extension officer	15
Other government worker	12
Sales representative	8
Seed dealers	5

4.10 Consumption of pulses crop residues in percentile

Consumption pattern of pulses crop residue are shown in Table 4.10. The most common response was giving the residue to field laborers as payment (33%) while the least common response was to plough it under.

Table 4.10 Consumption of pulses crop residues in (%)

Pulses Crop residue	
Give to field laborers as payment	33
Collect it and sell it	30
Let animals feed in the field	10
Collect it and feed to animals	9
Use as fuel for cooking	8
Burn it in the field	7
Plough it under	3

4.11 Declining factors in Production of pulses

There are numerous reasons/factors affecting the sustainable production of pulses at farm level.

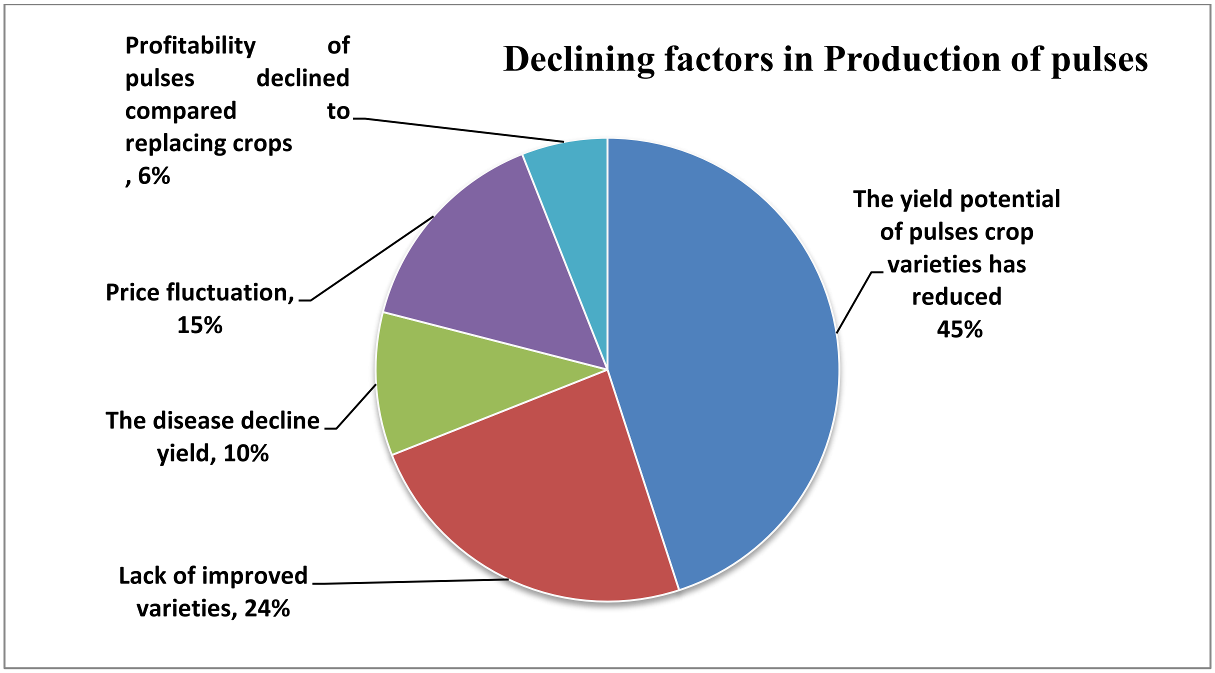


Fig. 3 Declining factors in production of pulses

The major reason affecting pulses production are shown in Figure 3 and relate to the reduction in yield potential of current pulse varieties 45%. Other major and related reasons are lack of improved high-yielding varieties and disease problems. Production is also affecting by price fluctuations and increasing profitability of other crops relative to pulses.

4.12 Annual Financial Analysis of Chickpea White

Financial analysis discusses the process of evaluating agri-businesses and determines their suitability and profitability. This research examines the ability of chickpea white growers to earn income and sustain growth both in the short and long term. The grower's level of profitability is mainly based on income and expenditure statements, which reports grower's results of operations in the field.

In order to optimize the operations of chickpea white growers, land preparation is to be considered the first step in production, and it has an important impact on soil moisture conservation by killing weeds and in breaking soil hardpans that decrease root growth and yields. In the study area, all respondents used a tractor-mounted plough for cultivating followed by smoothing with a wooden plank (locally known as sohaga) for the primary tillage. The average cost of tractor ploughing was Rs. 2023/acre, and farmers spent 5.09 hours/acre ploughing the land for chickpea. Total pre-harvest costs, post-harvest costs, and logistics costs were Rs. 8,240/acre, Rs. 7,010/acre, and Rs. 2,500/acre respectively, and this did not take so many variations between different farming fields having different sizes. Findings reveal that the average chickpea white seeding rate was 30.10 kg seed/acre, with a seeding cost of Rs. 3,540/acre.

The total average output was calculated 260.85 kgs/acre with an average selling price of Rs 112.5 per kg and gross revenue was estimated at around Rs 29,345/acre for growers. On average the total annual net revenue of the chickpea white crop for all categories in the study area was estimated to be about Rs.6292/acre.

Table: 4.11 Annual Financial Analysis of Chickpea White

Description	Profit	
Total Avg Output (Qty) 260.85 kgs per acre	Gross Revenue (GR) = Qty x Price = 260.85 x 112.5	
Average Price 112.5 PKR/kg	Gross Revenue (GR) = 29,345 PKR per acre	
	Per Acre	**Gross Margin** = GR – TVC
Pre-Harvest Costs (I)		=29,345-17750=11,595 PKR per acre
Seed cost	3,540	
Ploughing cost	2,000	Gross Margin – Over Head/Fixed Costs = **Gross Profit** =11,595– 5,303
Pesticides	1,500	**Gross Profit** = 6,292 PKR per acre
Labor	1,200	
……		
Total (I)	8,240	
Post-Harvest Costs (II)		
Harvesting	2,023	
Threshing cost	3,947	
Labor cost	1,000	
Drying Cost	15	
Storage Cost	5.0	
Cost of Grading and Packing	10	
Packing Material Cost	10	
Total (II)	7,010	
Logistics Costs (III)		
Loading Cost	500	
Transportation Cost from Farm to Market	1,500	
Unloading Cost	500	
Total (III)	2,500	
Total Variable Costs (TVC) (I + II + III)	8,240+ 7,010+ 2,500= 17,750	
Total Fixed Costs (TFC)	5,303	

4.13 Annual Financial Analysis of Chickpea Black

Financial analysis discusses the process of evaluating agri-businesses and determines their suitability and profitability. This research examines the ability of chickpea black growers to earn income and sustain growth both in the short and long term. The grower's level of profitability is mainly based on income and expenditure statements, which reports grower's results of operations in the field.

In order to optimize the operations of chickpea black growers, land preparation is to be considered the first step in production, and it has an important impact on soil moisture conservation by killing weeds and in breaking soil hardpans that decrease root growth and yields. In the study area, all respondents used a tractor-mounted plough for cultivating followed by smoothing with a wooden plank (locally known as sohaga) for the primary tillage. The average cost of tractor ploughing was Rs. 2,023/acre, and farmers spent 5.09 hours/acre ploughing the land for chickpea. Total pre-harvest costs, post-harvest costs, and logistics costs were Rs. 5,650/acre, Rs. 4,050/acre, and Rs. 2,100/acre respectively and this did not take so many variations between different farming fields having different sizes. Findings reveals that the average chickpea black seeding rate was 30.10 kg seed/acre, with a seeding cost of Rs. 2,450/acre.

The total average output was calculated as 240.55 kgs/acre with an average selling price of R. 82.5 per kg and gross revenue was estimated at around Rs 19,845/acre for growers. On average the total annual net revenue of the chickpea black crop for all categories in the study area was estimated to be about Rs.5,545/acre.

Table: 4.12 Annual Financial Analysis of Chickpea Black

Description	**Profit**	
Total Avg Output (Qty) 240.55 kgs per acre	Gross Revenue (GR) = Qty x Price = 240.55 x 82.5	
Average Price 82.5 PKR/kg	Gross Revenue (GR) = 19,845 PKR per acre	
	Per Acre	**Gross Margin** = GR – TVC
Pre-Harvest Costs (I)		=19,845-11,800=8045 PKR per acre
Seed cost	2,450	
Ploughing cost	1,500	Gross Margin – Over Head/Fixed Costs = **Gross Profit** =8,045– 2,500
Pesticides	900	**Gross Profit** = 5,545 PKR per acre
Labor	800	
……		
Total (I)	5,650	
Post-Harvest Costs (II)		
Harvesting	1,200	
Threshing cost	2,200	
Labor cost	600	
Drying Cost	25	
Storage Cost	5.0	
Cost of Grading and Packing	10	
Packing Material Cost	10	
Total (II)	4,050	
Logistics Costs (III)		
Loading Cost	400	
Transportation Cost from Farm to Market	1,200	
Unloading Cost	500	
Total (III)	2,100	
Total Variable Costs (TVC) (I + II + III)	5,650+ 4,050+ 2,100= 11,800	
Total Fixed Costs (TFC)	2,500	

4.14 Financial Analysis of Mungbean

In order to optimize the operations of mungbean growers, land preparation is to be considered the first step in production, and it has an important impact on soil moisture conservation by killing weeds and in breaking soil hardpans that decrease root growth and yields. In the study area, all respondents used a tractor-mounted plough for cultivating followed by smoothing with a wooden plank for the primary tillage. The average cost of tractor ploughing was Rs. 3026/acre, and farmers spent 5.92 hours/acre ploughing the land for mungbean.

Fertilizer is very important agri-input to maintain soil nutrition level and adopting the recommended fertilizer rates increases productivity in most pulses crops especially in mungbean. In the selected study area, urea, di-ammonium phosphate (DAP), and nitrate phosphate (NP) were the most commonly used bio-chemical fertilizers carrying costs. Another major source for costing is the more money spent by all farmers on tube well irrigation rather than canal irrigation system. All these cost directly or indirectly reflected the gross margin of growers.

From the findings reveal that total pre-harvest costs, post-harvest costs, and logistics costs were Rs. 18,275/acre, Rs. 8,450/acre, Rs. 4,100/acre respectively and this did not take so much variations between different farming fields having different sizes. Also it can be noticed that the average mungbean seeding rate was 35.19 kg seed/acre, with a seeding cost of Rs. 2,700/acre.

The total average output was calculated 660 kgs/acre along average selling price 108.45 per kg and gross revenue was estimated at around Rs 71,577 for growers. On average the total net revenue of the mungbean crop for all categories in the study area was estimated to be about Rs. 25,152.

Table 4.13: Annual Financial Analysis of Mungbean

Description	Per Acre	Profit
Total Avg Output (Qty) 660/ kgs per acre		Gross Revenue (GR) = Qty x Price = 660 x 108.45
Average Price 108.45 PKR/kg		Gross Revenue (GR) = 71,577 PKR per acre
	Per Acre	**Gross Margin** = GR – TVC
Pre-Harvest Costs (I)		=71,577-30,825=40,752 PKR per acre
Seed cost	2,700	
Ploughing cost	1,300	Gross Margin – Over Head/Fixed Costs = **Gross Profit** =40,752 – 15,600
Pesticides	2,200	**Gross Profit** = 25,152 PKR per acre
Labor	3,000	
Urea	1,200	
DAP	2,925	
NP	2,350	
Weedicide	2,600	
Total (I)	18,275	
Post-Harvest Costs (II)		
Harvesting cost	3,000	
Threshing cost	2,400	
Labor cost	2,500	
Storage Cost	300	
Cost of Grading and Packing	150	
Packing Material Cost	100	
Total (II)	8,450	
Logistics Costs (III)		
Loading Cost	600	
Transportation Cost from Farm to Market	3,000	
Unloading Cost	500	
Total (III)	4,100	
Total Variable Costs (TVC) (I + II + III)	18,275 +8,450 +4,100 =30,825	
Total Fixed Costs (TFC)	15,600	

4.14 Overall Financial Analysis of Pulses Crops in Kgs Per Acre

Table 4.14 demonstrates the overall financial analysis of three selected crops in this study. Average output quantity of chickpea white was 261 kgs/ acre having unit price Rs. 113/ kg with a gross revenue Rs. 29,345/acre. By deducting the total cost Rs. 23053/acre, the resulted gross profit is R.s 6,292/acre from chickpea white crop. Adopting the similar calculations the gross profit of chickpea black is Rs. 5,545/acre. Finally, the gross profit of mungbean was recorded Rs. 25,152/acre.

Table: 4.14 Overall Financial Analysis of Chickpea White/Black and Mungbean Crops

Description	Average Output (kg/acre)	Unit Price (Rs/kg)	Gross Revenue (Rs/acre)	Total Cost (Rs/acre)	Gross Profit (Rs/acre)
Chickpea White	261	113	29,345	23053	6,292
Chickpea Black	241	83	19,845	14,300	5,545
Mungbean	660	108	71,577	46,425	25,152

Based on the above mentioned results, the profitability of the mungbean crop is relatively high compared with the chickpea crops. The reason behind this is higher yields due to utilization of irrigated water and availability of agri input in the form of fertilizer, pesticides and water. Chickpea farmers relying on rainfall instead of irrigated water and agri-inputs. There is a need to encourage chickpea farmers to utilize irrigation providing them information implements and resources.

4.16 Potential Constraints in Pulses Production and Commercialization

Perceived constraints to pulses production and commercialization, and their severity, are shown in Table 4.15.

Table: 4.15 Perceived Constraints to Pulses Production and Commercialization (% of respondents)

Constraints	Not a Constraint	Low	Moderate	High	V. High Constraint
A. The land is not suitable	67	5	13	5	10
B. The pulses price is too low	45	17	19	4	15
C. Lack of a support price	21	39	9	14	17
D. The yield of pulses is too low	29	17	18	21	15
E. The yield of pulses is too variable between years	16	27	12	18	27
F. Lack of a local market for selling pulses	45	11	13	23	8
G. It is difficult to obtain certified seed	13	17	24	11	35
H. Pulses require too much labour input	59	13	7	6	15
I. It is too difficult to control weeds in pulses crops	21	19	29	9	22
J. Pulses are too prone to insect pests	26	13	19	7	35
K. Pulses are too prone to diseases	11	12	16	27	34
L. Pulses are too difficult to harvest	44	16	13	21	6
M. Pulses are too difficult to thresh without losses	19	28	35	9	9
N. It is too difficult to dry the grain	61	11	8	19	1
O. It is too difficult to store the grain without losses	47	21	11	12	9
P. It is difficult to obtain extension advice	61	24	6	5	4

The mungbean crop, and to a lesser extent chickpeas, are profitable crops in the selected study area. However, there are still major constraints to improving yields (Table. 4.15). Respondents perceived that susceptibility to diseases and insect pests, yield variability and availability of certified seed to be the main constraints with high and very high impact on production and commercialization.

Most of the farmers were also concerned about the below mentioned constraints.

- **Production related issues.** Most of the pulses growers reported that cost of farm management during operations were very high significantly reducing profit margins.
- **There was inadequate supply of certified seed varieties.** Approximately 35% of respondents indicated that inadequate supply of certified seed was a major constraint. Seed dealers dealing in pulses varieties are not registered. The role of Punjab seed corporations is not so active to provide sufficient support to farmers. While interviewing growers, they explained that they did not know whether pulses varieties purchased from various sources such as neighbors, Punjab seed corporation, seed dealers, or fallow farmers was genuine or non-genuine.
- **Low yields.** The yield of pulses commodities was very low for the last 3 years and 27% of respondents considered it to be a very high constraint in production.
- **Pulses were too prone to insect pests and diseases.** Most of the farmers blamed inadequacy of available pesticides and other chemicals to manage pests and diseases.
- **Fertilizer quality.** It was a common observation that pulses growers were not satisfied with the quality of fertilizers. Chickpea growers did not use any type of fertilizers whereas mungbean growers perceived the price of urea and potash fertilizer to be extremely high. Growers were not away of any available potash fertilizer subsidy.
- **Canal irrigation facility was limited in Layyah and Bhakkar area.** In the Nurpur Thal area of Khushab district, canal water was not readily available. Farmers in this region relied on seasonal rainfall. In other regions, growers mostly rely on tube well for irrigation

purpose. Electricity and diesel expenses for running tube wells further enhance the cost of production management.

- **Pulses are very difficult to cultivate, harvest, thresh and store without losses.** Most of the farmers were facing pre-harvest and post-harvest losses which directly affect the gross margin of growers.

4.16.1 Marketing-related Constraints

Survey respondents were concerned about the below-mentioned marketing constraints:

- **Lack of a local market for direct selling through potential retail outlets.** In selected districts, farmers rely on contractors and middle-men to dispose the pulses products in wholesale and local markets.
- **Poor post-harvest handling.** Almost 90% growers don't follow post-harvesting techniques to safely secure and providing finest quality grains in the market. Equipment used for harvesting logistics is mostly traditional.
- **Poor on-farm storage.** The majority of farmers do not have storage facilities on their farms. Without these facilities, grain that is not sold directly after harvest fed to animals or given to field laborers as payment.
- **Packaging and processing facilities are inadequate.** Grains are mostly sold in sacks for processing, which often results in damaged and poor-quality grain.
- **High transport costs.** For logistical activities, loader rickshaw, pickups and small vans were used for transporting pulses to market. Regional/wholesale markets are far away from the pulses producing areas resulting in high transportation cost and reduced profit margins.

CHAPTER 5

SUMMARY AND POLICY IMPLICATIONS

5.1 SUMMARY

Agriculture is the mainstay of the economy of many developing countries and is a major source of livelihood for people in Pakistan. The result of this research indicates that the majority of pulse growers, whether poor, mediocre or progressive, preferred to grow mungbeans rather than chickpea because of higher intensity of production and marketing constraints in local markets. There are significant constraints to chickpea production. It is important for research analysts, extension workers, agri-engineers, economists and policy makers to make joint efforts to resolve these obstacles of concern and facilitate chickpea white/black cultivation for farmers in Pakistan.

5.2 POLICY IMPLICATIONS

In the light of above mentioned research findings and personal discussions with the farmers, extension officers and stakeholders the following suggestions are made:

- Pulses growers are mostly reluctant to cultivate pulses due to marketing and financial constraints. The pulses prices are too low in the market. Currently there is an export tax for pulses that is making exports prohibitive. Any productivity increases of pulses must therefore be consumed domestically, which is suppressing farm-gate prices. It is suggested that the export tax be removed.
- Development of proper research, development and extension (RD&E) stations in Nurpur Thal that can enhance the process to diagnose the soil and climatic conditions on which proper and suitable variety must be planted. It has been considered as a major issue in the selected pulses areas.

- The Government should launch specialized programs on increasing the productivity of pulses crops at the village level. Capacity building programs should be planned just before the start and during the cropping season. Government department should provide timely training for production and marketing to growers with sufficient ongoing follow-up.
- Pakistan is a water stress country and due to climate change there is scarcity of water which is a crucial issue for pulses growers. Government should focus on alternate sources of water like drip irrigation, sprinkle irrigating through efficient and effective irrigation systems to improve pulse yields.
- The majority of farmers, independent of farm-size, , preferred cultivating chickpea white/black and mungbean, but they appeared to be reluctant to grow these crops on a large scale because of climatic factors, non-availability of mechanical harvesting/threshing machinery, low yielding varieties, and low prices for pulses grains in local markets. It is important for researchers, extensionists, agricultural engineers and policy makers to make consolidated efforts to resolve these issues of concern and promote pulses cultivation to farmers in Pakistan. This can be done through increasing spending on RD&E, facilitating the distribution of improved pulse varieties, encouraging mechanization, and promoting market access.
- Women are mostly involved in household affairs, crop storage and livestock management, with less involvement in ploughing and harvesting. Most of the farm operations are exclusively dominated by men rather than women. There is a need to overcome gender discrimination in the fields.

- Policy makers should focus on development of pulses centers in Nurpur Thal region for proper capacity building during crop season. These pulses centers should act as focal point to monitor the issues of pulses growers and solve these issues in a timely manner.
- Availability of farm machinery was major issue for survey respondents. There is a need for the development of farm machinery service centers at the village level. Agricultural machinery for land preparation must be made available at affordable prices by dealers.
- The availability of the finest quality of seeds of improved pulse varieties, as well as chemical and fertilizer inputs, at village level should be managed and monitored by personnel of district Governments.
- In the Nurpur Thal region, there is no of electricity and farmers were using solar panels by purchasing their own. In order to strengthen the farmers, Government should provide electricity infrastructure to these regions..
- The Pakistan Government should develop policies to discourage the export incentives for pulses. This may include the removal of the 35% export tax and exploration of new exports markets. This could be aided by facilitating growers to enhance the quality of pulses production by adopting 9001 ISO standards for export.
- Efficient and effective agri. marketing information system must be engaged. Proper use of mobile, sms services and newspaper advertisements can be used to encourage good agricultural practices, such as appropriate use of fertilizers, timely use of irrigation, and sanitation.

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Appendix

Some Pictorial Views of Study Area

Collecting Data from Mungbean Growers in a Village of Layyah District

A Group Photo with Growers and the Data Collection Team

A Focus Group Discussion in Sheean Village of Bhakkar District

Visiting a Traditional Seed Store in a Village of Bhakkar District

Collecting Data from Farmers in their Home at Nurpur Thal Region

Collecting Data from a Progressive Grower in Peelo Waince Village of Nurpur Thal

Scenic View of Mungbean Crop in a Farm Field

A Random View of Chickpea White/Black in a Shop at a Grain Market

PROJECT FUNDED BY THE AUSTRALIAN CENTRE FOR INTERNATIONAL AGRICULTURAL RESEARCH

ADP/2016/043 "ECONOMIC ANALYSIS OF POLICIES AFFECTING PULSES IN PAKISTAN"

Survey results report for the Pothwar and (rice-wheat) irrigated areas of Punjab, and Sindh

Muhammad Qasim, Saima Rani and Hassnain Shah

National Agricultural Research Centre, Pakistan

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EXECUTIVE SUMMARY

Pulses crops have been largely neglected by research, development and extension services in Pakistan over the last three decades compared with major crops such as wheat, cotton, rice and sugarcane. Evidence of this neglect is relatively small pulses breeding programs, poor distribution of certified pulses seed, lack of pulses production technologies and mechanization, and the pushing of pulses production towards marginal areas with no irrigation facilities. Pulses crops are relatively drought resistant crops and can survive in the drought conditions but current varieties are largely unimproved and are prone to climate related diseases and insect/pest attacks. These factors have resulted in the decline in area, yield and therefore production of pulses crops. With increasing domestic consumption, this reduction in production has led to a gap in demand and supply. Pakistan has a significant dependence on imports to meet domestic consumption needs.

This report presents data from a farm-level survey of 130 pulse producers conducted in 2017 to identify the constraints and opportunities in pulses area and production. The survey was conducted as part of a larger project, funded by the Australian Center for International Agriculture Research (ACIAR), to conduct economic analysis of policies affecting pulses in Pakistan. The survey was conducted in the Pothwar and rice-wheat regions of the Punjab province and the major pulses producing areas of the Sindh province. The regions and districts were selected after consultation with district extension departments and based on district-wise pulses crop area share in agricultural statistics of Pakistan. A stratified random sampling technique was used to selected households to be surveyed. A structured questionnaire was used to collect cross-sectional data of a large number of variables.

The key findings of the surveys are summarized as following:

- The average age of respondents was 50 years, and the average education level of respondents was 8 years. Farmers had 13 years of experience in growing pulses in Pothwar and Sindh, and 22 years of experience in the rice-wheat region.
- Two third of respondents were owner operators, while one third were owner-cum tenants.
- The average operational land holding was 17 acres.

- Tube well was the main irrigation source as mentioned by 58 percent farmers while canal irrigation was another significant source of irrigation as mentioned by 33 percent of respondents.
- The average household size of sampled farmers was 10. Apart from household labor, an average of two male and one female workers were employed on each farm.
- Mechanization is low. The majority of farmers sow pulses crop using the broadcasting method and manually harvest their crops.
- Private seed dealers were the major source of seed for pulses, rather than using their own seed or buying from government research institutes or corporations.
- Significant post-harvest losses were reported due to the harvesting of chickpea and lentils.
- Pulse prices are relatively stable across regions. The price received for lentil is highest (Rs.184/kg), followed by chickpea white (Rs.96/kg), mung bean (Rs.95/kg), chickpea black (Rs.84/kg), and mash bean (Rs.79/kg).
- Overall pulses are low inputs crops and still profitable but farmers are concerned about the level and riskiness of pulses yields.
- Neighbors and family members were the highest reported information source of pulses growers.
- Respondents' perceive that the major constraints to pulses production and marketing are susceptibility to diseases and insect pests and the lack of affordable certified seed which reduce the level and increase the variability of yields
- This highlights the need to increase investment in research, development and extension activities for pulses to allow improved varieties with reduced susceptibility to disease and insect pests to be available at affordable prices to pulses producers.

Introduction

Pulses are the edible seeds of legumes. They comprise a small, but very important part of the 1800 species in the legume family. The word “pulse” is derived from the Latin words “puls or pultis”, meaning thick soup (PAR Agricultural Education, 2015). The use of pulses dates back more than 20,000 years ago and spans the globe. Records of their use were also found in the Egyptian pyramids’. Similarly, FAO (2016) described pulses as a subgroup of legumes for which the edible seeds are eaten by humans and animals in dry form, as opposed to vegetables or extracted oils in human diet.

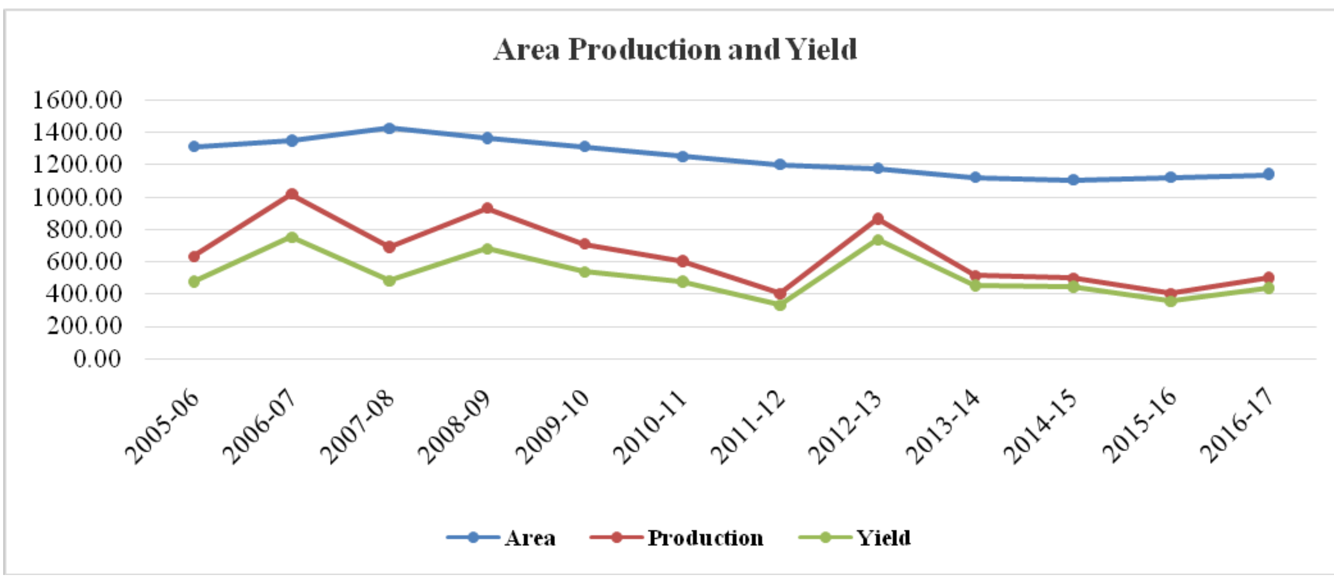
Agriculture is the lifeline of Pakistan’s economy accounting for 19.5 percent of the country’s gross domestic product, employing 42.3 percent of the labor force and providing raw material for several value-added industries. It thus plays a central role in national development, food security and poverty reduction (GOP, 2017). Chickpeas (gram), mung bean, lentil, and mashbean are the major pulses grown in Pakistan. Chickpea is the largest Rabi pulse crop, accounting for 76 percent of total production of pulses in the country (GOP 2016). Pulses play an important role in the nutritional security of a large number of people across the world. They are a major source of protein in many developing countries, especially among the poorer section of the population who rely on vegetable sources for their protein and energy requirements (FAO, 2005).

Pulses are short duration crops and therefore have less water requirements compared to summer crops. They are, to some extent, drought resistant and can withstand adverse environmental conditions, growing successfully in rain-fed areas (Anjum et al., 2006). A decline in per capita availability of some crops, such as cereals and pulses, results in some pressure on their prices. Recent increases in pulses prices can be attributed to both supply and demand factors (Sher, 2012). Farmers make decisions about areas of crops to cultivate keeping in mind expected farm-gate prices and allocate their limited resources accordingly. Pulses prices was unstable compared with wheat, and chickpea yields are unstable compared with most other crops. This price and yield instability leads to significant profit variability of pulses compared with other crops (Petersen 2018).

Pulses not only cheap protein sources (compared with relatively expensive animal proteins of meat, fish and egg), but also carry out an important task of improving soil fertility by supplying nitrogen to the soil through nitrogen fixation. Crops include mash bean (black gram), mung bean, lentil, peas and chickpea.

Pulses area has remained the same over the last decade with only minor fluctuations (Figure 1). However, yield and production has been decreasing, with significant variation over the same timeframe. Among pulses, chickpea is the major winter food legume and mung bean is the major summer legume. Chickpea is the major Rabi pulses crop, accounting for 76 percent of total production of pulses in the country. Chickpea registered a decline of 9, 21 and 13 percent in area, production and yield respectively during 2005-15 (GoP, 2015). Mung bean registered a decline of 64 and 14 percent in area and production, respectively, but a 42 percent increase in yield during the same period. The production of lentil registered a decline of 92, 156 and 25 percent in area, production and yield, respectively. Mash bean registered a decline of 66, 83 and 9 percent in area, production and yield.

Figure 1. Area, Production and Yield of Pulses in Pakistan



Source: Pakistan Economic Survey, 2016-17

Although yield potential is high, the average yield of pulses in Pakistan is very low compared to this yield potential and compared to yields of many other countries. Due to low production and slow growth rate of pulses, Pakistan imports large quantities of pulses to meet the increasing gap between the domestic production and consumption requirements.

There are many constraints to pulses production, including weed infestation, disease and insect pest attack, and lack of awareness of farmers about pulses production technology. Along with this crop, profitability in the irrigated zone in Pakistan has been declining due to the increasing costs. Small farms, which dominate Pakistan's agriculture, are particularly vulnerable to pest infestation because of their inability to bear any form of financial risk (Farooqi, 2010). IFPRI (2009) indicated that the cultivation of pulses brings many benefits to farming community in Pakistan. The crop has the potential to provide income and better nutrition to smallholder farmers. In many ways the cultivation of pulses should be a very attractive livelihood activity for smallholders in Pakistan.

Historically, pulses production in Pakistan has been pushed towards marginal areas where there is no facility of irrigation. Pulses crops are relatively drought resistant crops and can survive in the drought conditions. The decrease in the importance of pulses research and its cultivation in marginal areas have reduced the productivity of these crops. Keeping in view the importance of pulses in the economy of country, the present study was conducted to explore the potential of pulses in Pakistan, to analyze the factors affecting pulses area and production, major constraints in pulses production, and to suggest integrated approaches for increasing area and production of pulses crops. For this purpose, a farm level survey was designed to identify the constraints and opportunities in pulses area and production in the study area. The survey is part of a large project aimed at conducting economic analysis of policies affecting pulses in Pakistan, funded by the Australian Center International Agriculture Research (ACIAR).

Research Methodology

Data Collection and Study Area

The current study was based on primary data collected in 2017 by using a comprehensive and pre-tested questionnaire for pulses growers. Pulses are grown in many regions in Pakistan. The survey was administered in three regions of Pakistan - Pothwar and rice-wheat regions of Punjab province, and Sindh province. Table 1 presents the districts within these regions that were surveyed. The regions and districts were selected after consultation with the district extension department and by studying district-wise pulses crop area shares of Pakistan. Farmers in these districts grow Pakistan's four major pulses crops, namely chickpea, mung bean, lentil and mash bean in the study area.

Table 1: Region wise districts for pulses for the study

District	Pothwar area of Punjab	(Rice–wheat) Irrigated area of Punjab	Sindh
Chickpea	Chakwal	--	Kashmore, Shikarpur, TandoAllahYar
Lentil	Chakwal	Narowal, Zafarwal, Shakargarh	--
Mash bean	Chakwal Jehlum	Narowal, Zafarwal, Shakargarh	--
Mung bean	Chakwal Jehlum	--	Kashmore, Shikarpur, TandoAllahYar

Sampling Techniques and Data Collection

The stratified random sampling technique was used to select survey respondents within sampling regions. This survey included collection of detailed farm level information through a formal questionnaire. This ensured the elicitation of quality data to have an in-depth understanding on different socio-economic aspects of pulses production in Pakistan. The questionnaire was pretested in-field before necessary amendments and it was finalized. The data was compiled in SPSS and analyzed in SPSS Software. The obtained data has been processed, analyzed and results are presented in the next Section.

Sample Size

The sample size for each region was determined by share of pulses area sown in these regions. The data were collected for the whole cropping pattern for two cropping seasons - *Rabi* 2016-17 and

Kharif 2017. Information was gathered from 130 pulses producers. Details about the sample size by pulses crops across the regions and production systems are presented in Table 2.

Table 2: Sampling distribution according to representativeness

Pulses	**Punjab**		**Sindh**	**Total**
	Pothwar	**Rice-Wheat**		
Chickpea	34	-	28	**62**
Lentil	-	11	-	**11**
Mash bean	-	29	-	**29**
Mung bean	16	-	12	**28**
Total	**50**	**40**	**40**	**130**

Results and Discussion

Socio-economic Characteristics

Socio-economic characteristics play an important role in farming by including farmer's attitudes and behaviours (Hassan, 2008). The socio-economic characteristics elicited in the survey include age, education, farming experience, and size of land holding. . The average age of survey respondents was 50 years (Table 3), ranging from 46 to 52 years depending on the region. Education as an investment in human capital has been regarded as a growth factor as it is expected to increase labor productivity and reduce income inequality and poverty (Amin and Awung, 2005). Average education was reported as 9 and 11 years, in the Pothwar and Rice-wheat regions, while Sindh farmers were relatively less educated with an average education length of 4 years. Likewise, HH head education was also reported low in Sindh (5 years) compared with the Pothwar and rice-wheat regions (7 years). Experience of pulses growing was reported to be 13 years in the Pothwar and Sindh regions, while 22 years in the rice-wheat region.

Table 3: Socio-economic characteristics

Characteristics	Pothwar	Rice-Wheat	Sindh	All
Age of respondents (years)	51.8	51.4	45.9	49.85
Education of respondents (years)	9.44	10.39	3.85	7.95
Household size (no)	7.94	9.28	14.97	10.48
Education of HH head (years)	6.5	7	5	6
Pulses growing experience (years)	13	22	13	19
Farm Income (PKR)	158,000	298,000	330,100	254,000
Off-farm Income (PKR)	201,000	277,000	40,000	175,000
Total Income (PKR)	358,000	575,000	370,000	429,000

Annual farm income was reported to be PKR 254,000 in the study area, which was highest (PKR 330,1000) in Sindh followed by rice-wheat (PKR 298,000) and Pothwar (PKR 158,000). The Pothwar region exhibited the lowest annual farm income as it is characterized by rain fed-farming, whereas the other two regions have irrigation options leading to higher farm incomes. Off-farm annual income was found to be PKR 201,0000760, 277,000 and 40,000 in Pothwar, rice-wheat and Sindh, respectively. This shows that dependence on off-farm income was relatively higher in Pothwar and Rice-wheat region, and relatively low in Sindh.

Land Characteristics and Tenancy Status

The increase in population, subdivision and fragmentation of land holdings due to the breakdown of joint family systems has resulted in the conversion of large and medium farms into small and marginal farms, which leads to small parcels and scattered land holdings in general (Singh, 2012). Table 4 presents information about the number of land parcels, suitability of land for intensive cropping, soil fertility level and tenancy status. The number of land parcels is an indicator of land fragmentation. Farms in the Pothwar and rice-wheat regions are more fragmented (with an average of approximately 4 parcels of land) compared with farms in Sindh (with an average of approximately 3 parcels). There is a impact of attributes/characteristics of land on the value of agricultural land (Vasquez et al. 2002). Land was reported as having high to moderate fertility in almost all the study sites. Only a small number of respondents reported low fertility. The tenancy status results demonstrate that most landholders own their farm (about two-thirds of landholders) while almost one third were owner-cum-tenants. Only a small number of farms were tenant-operated in Sindh.

Table 4: Land characteristics and tenancy by region

	Pothwar	**Rice-Wheat**	**Sindh**	**All**
No of Parcels of land	4.67	4.4	2.89	4.08
Area suitable for intensive cropping (acres)	6.23	11.62	23	13.13
Land fertility level (%)				
High	44	53	55	50
Moderate	56	40	43	47
Low	0	8	3	3
Tenancy Status (%)				
Owner	70	60	60	64
Owner cum Tenant	30	40	25	32
Tenant	0	0	15	5

Land Ownership

The average size of operational land holdings was explored to assess the resource base of farmers. A number of studies have indicated that the size of landholding affects the efficient utilization of resources and type of cropping pattern a farmer will follow (Singh *et al.* 2009). Farmer owned an average of 13 acres of land (Table 5). The land ownership across regions was 14, 10 and 14 acres in Pothwar, rice-wheat and Sindh respectively. Only small areas are uncultivated, which includes hills, urbanization etc. s Approximately 1acre were rented in and 6 acres shared in in the study area.

The average operational land holding was 17 acres. Across regions, operational land holding was 18, 12 and 21 acres respectively in Pothwar, rice-wheat and Sindh. Highest land holding size was reported in Sindh (21 acres) followed by Pothwar (18 acres) with lowest land holding size in the rice-wheat region (12 acres).

Table 5: Average land ownership (acre)

	Pothwar	Rice-Wheat	Sindh	All
Area Owned	13.74	10.18	14.23	12.79
Uncultivated	3.92	0.30	1.15	1.95
Rented In	1.26	1.93	0.20	1.14
Rented Out	0.16	0.00	0.00	0.06
Share In	7.98	0.08	8.53	5.72
Share Out	0.56	0.00	0.78	0.45
Operational Land Holding	18.46	12.18	21.48	17.45

Irrigation Sources

Irrigation has a vital role in the growth of some crops, enhancing vegetative growth and efficient utilization of plant nutrients leading to a better crop yield compared with rainfed systems. The availability of underground water in addition to canal water provides an opportunity for timely application of irrigation at critical stages of crop growth. The quality of tube well has a significant effect on irrigation performance (Taj *et al.,* 2011). Table 6 shows that tube wells was the only irrigation source in both the Pothwar and rice-wheat regions. In Sindh, 66 percent of farmers were using canals as their irrigation source, 11 percent were using tube wells, and 23 percent were using a mixture of both.

The salinization of soils is a major threat to agriculture, which is being further compounded by irrigating the soils with saline groundwater. There are reports that underground water pumped in the Kasur district varied greatly in its chemical composition, with 70 percent of water sampled by Shakir *et al.* (2002) found unfit for irrigation purpose. In Pothwar, all surveyed farmers reported that ground water is fit for irrigation purposes while 26 percent of farmers reported low or high levels of water brackishness. In the rice-wheat region, 71 percent of surveyed farmers indicated that their water is fit for irrigation and 19 percent reported that water has low or medium water brackishness. In Sindh, 80 percent farmers reported that water was fit for irrigation, with 6 percent of respondents indicating high levels of water brackishness.

Table 6: Source of irrigation by farm and quality of water

	Pothwar	Rice-Wheat	Sindh	All
Irrigation source (%)				
Canal	0	0	66	33
Tube well	100	100	11	58
Both	0	0	23	10
Quality of Water (%)				
Fit for irrigation	100	71	80	81
To some Extent fit	0	29	3	13
Unfit	0	0	17	6
Water Brackishness (%)				
No	74	81	94	83
Low	13	5	0	6
Medium	0	14	0	6
High	13	0	6	6

Cropping Pattern

Cropping pattern can indicate the proportion of area under various crops at a point of time in a unit area, or it can indicate the yearly sequence and spatial arrangements of crops and fallow area. Cropping pattern is determined by a number of indicators, including land type, soil texture, and water availability. In Pakistan, there are two main cropping seasons – Rabi and Kharif. According to present study, the major crops of the Rabi season were wheat and chickpea with an average farm area of 10. and 3 acres, respectively (Table 7).

Rice was the major Kharif crop in the surveyed region, with an average area of 8 acres, followed by Kharif fodder, millet, mash bean, mung bean and groundnut with relatively lesser areas. The cropping pattern for the Kharif season in Pothwar is characterized with mono crops – groundnut as the major crop followed by mung bean and Kharif fodder. The major portion of land was kept fallow during summer season (12 acres). In the rice-wheat and Sindh regions, the major crop was rice with an area of 6 and 19 acres, respectively, followed by mash bean in the rice-wheat region (2 acres) and mung bean in Sindh (1 acre). The land was suitable for intensive cropping as the proportion of fallow land was significantly less in Sindh compared with by rice-wheat region. In the Pothwar region, agriculture is purely rain dependent. The major portion of land is in this region is kept fallow in one season for preparing the land and conserving soil moisture for the next season's crop.

Table 7. Average land use and cropping pattern (Area/Acre)

Crops	Pothwar	Rice-Wheat	Sindh	All
Rabi Crops				
Wheat	9.8	10.1	10.3	10.1
Chickpea	2.2	0.1	9.7	4.0
Rabi fodders	1.1	0.7	0.2	0.7
Lentil	1.1	0.6	0.0	0.6
Rabi vegetables	0.0	0.1	0.7	0.3
Fruit/orchards	0.0	0.1	0.4	0.2
Other	0.3	0.0	0.01	0.1
Fallow Area	3.8	0.3	0.2	1.4
Kharif Crops				
Rice	0.0	4.6	19.3	7.9
Kharif fodders	1.4	1.1	0.2	0.9
Millet	0.4	2.0	0.0	0.8
Mash bean	0.4	1.7	0.0	0.7
Mung bean	1.4	0.0	0.5	0.6
Groundnut	1.9	0.0	0.0	0.6
Sorghum	0.6	0.1	0.0	0.2
Kharif vegetables	0.0	0.2	0.1	0.1
Other	0.0	0.5	0.5	0.3
Fallow Area	11.5	2.1	0.9	4.8

Yield of Pulses

Average per acre yield of chickpea, lentil, mung bean and mash bean in the study area is presented in Table 8. It includes a comparison of last three years 2014-2016 for the four major pulses crops in three production regions. Overall, the yield of chickpea white was stagnant during 2014-16, while chickpea black, lentil and mash bean showed a 9 percent, 15 and 14 percent increases in the yield and mung bean showed a 3 percent decline in the yield.

Table 8. Average yield of different pulses at farm in three years (Munds/Acre)

Crop	Year	Pothwar	Rice-Wheat	Sindh	All
Chickpea (white)	2016	10.4	--	15.1	13.9
	2015	11.0	--	15.9	15.1
	2014	12.0	--	14.4	13.9
Chickpea (black)	2016	8.4	12.0	15.7	10.9
	2015	9.6	12.0	15.0	10.6
	2014	10.3	12.0	14.5	10.0
Lentil	2016	7.1	9.6	--	9.3
	2015	9.0	10.4	--	9.8
	2014	6.8	11.3	--	8.1
Mung bean	2016	4.3	9.5	11.3	6.2
	2015	3.5	10.0	8.1	5.3
	2014	4.9	11.5	12.0	6.4
Mash bean	2016	4.3	5.5	--	5.9
	2015	3.8	6.7	--	5.6
	2014	4.0	6.8	--	5.2

Labor Use in Agriculture

Overall, average household size of sample farmers was about 10. The household size in Sindh was highest (15) followed by that of the rice-wheat region (98) and lowest in the Pothwar region (8) (Table 9). On average, there was approximately 2 male full-time farm workers and 1 female full-time farm worker per farm holding. The number of male and female full-time workers was highest in Sindh Province (3 and 2, respectively) as household size was also high in this region. There was less involvement of female farm workers in the Pothwar and rice-wheat regions.

Table 9. Average family labor resources and involvement in agriculture (Nos/ Farm)

Involvement in Agriculture	Pothwar	Rice-Wheat	Sindh	All
Household size (Nos)	7.9	9.3	15.0	10.5
Full time				
Adult Male	1.5	1.3	2.8	1.9
Adult Female	0.6	0.2	2.1	1.1
Youth<18 Year	-	-	1.6	0.2
Part time				
Adult Male	1.1	1.5	2.1	1.5
Adult Female	1.8	-	2.3	1.3
Youth<18 Year	-	-	2.0	1.2

There was approximately 1 part time male and female worker involved in agriculture in each household in the study region, with higher part time representation in Sindh compared with the other regions. Youth full and part time employment in agriculture was reported only in Sindh (approximately 2 part time and 2 full time youth per household).

Sowing and Harvesting of Pulses

Sowing of pulses crops is mostly done by broadcasting, whereas wheat and groundnut is mostly drilled (Table 10). Seed dealers was major source of seed for pulses and non-pulse crops (with the exception of lentil where seed was mostly sourced from their own supplies). Usually these dealers are located at the nearest grain market or local retail markets. Manual harvesting was reported by farmers for the pulses crops and was the dominant harvesting method for wheat and groundnut.

Table 10. Sowing method, seed sources and harvesting of different crops (% Farmers)

Farm Activities	Wheat	Chickpea	Mung	Mash	Lentil	Groundnut
Sowing method						
Drill	59	6	0	0	4	74
Broadcast	35	80	94	70	88	9
Pora/Kera	6	14	6	30	8	17
Seed sources						
Seed Dealer	68	70	59	47	46	54
Own	25	25	34	43	54	46
Fallow Farmers	3	2		6	0	0
Punjab seed corporation	2	3	0	0	0	0
Agricultural Research Station	2	0	6	4	0	0
Harvesting						
Manual	46	100	100	100	100	60
Reaper/Digger	31	0	0	0	0	40
Combine Harvester	23	0	0	0	0	0

Post-Harvest Losses in Pulses

Pulse growers, traders, and processers face significant economic losses due to post-harvest losses. Post-harvest losses are associated with harvesting, drying, threshing and storing. Table 11 shows farmer's perceptions of the severity of post-harvest losses during various stages of the production chain for pulses crops. For chickpea major losses were reported by 83 percent of farmers during harvest, and for lentil 58. For mung and mash beans, moderate losses were reported by 78 percent and 56 percent of farmers, respectively. Major losses during drying were reported for chickpea and mash bean, while moderate losses were reported by all crops during threshing. Major losses during storage were not reported for any of the pulse crops.

Table 11. Farmer's Perceptions About the Severity of post-harvest losses at different stages of pulses crop (% of Respondents)

Losses Stages	Crops	Major	Moderate	Minor
Harvesting	Chickpea	83	17	0
	Lentil	58	33	8
	Mung	6	78	17
	Mash	6	56	38
Drying	Chickpea	50	42	8
	Lentil	0	0	0
	Mung	33	33	34
	Mash	67	33	0
Threshing	Chickpea	45	45	9
	Lentil	40	50	10
	Mung	33	56	11
	Mash	38	38	25
Storage	Chickpea	0	0	0
	Lentil	0	0	0
	Mung	33	33	34
	Mash	0	0	0

Residue Management of Pulses Crops

The uses of pulse residues as reported by survey respondents include burning in the field (55 percent of respondents), collecting and selling it (34 percent) collecting it and feeding it to animals (25 percent), paid as wage to laborers (16 percent), plowing it in for soil organic matter (12 percent), using it as fuel for cooking (12 percent) and grazing by animals (5 percent) (Table 12).

Table 12. Use of crop residues (%)

Pulses crop residue use	Pothwar	Rice-Wheat	Sindh	All
Burn it in the field	56	63	48	55
Collect it and sell it	40	30	30	34
Collect it and feed to animals	20	50	8	25
Give to field laborers as payment	16	0	33	16
Plow it under	14	5	15	12
Use as fuel for cooking	6	28	3	12
Let animals feed in the field	2	5	10	5

Pulses Sales and Price Received

Quantity sold and price per unit of chickpea, lentil, mung bean and mash bean and are presented in Table 13). Large amount of white chickpea was sold by farmers in Sindh (3804kg/year) while it was not a common crop in the Pothwar and rice-wheat regions. Chickpea black is largely sold in the rice-wheat region (627kg/year), and lesser amounts from Pothwar (294kg/year). Chickpea black is not produced in Sindh. Lentil is sold in Sindh (814kg/year) and Pothwar (615kg/year) but not in the rice-wheat region. Mung bean is sold from the Pothwar (637kg/year) and rice-wheat (345kg/year) regions, but not from Sindh. Lastly, mash bean is predominantly sold from Sindh (1,550kg/year) and to a lesser extent the Pothwar (996kg/year) and rice-wheat (200kg/year) regions.

Table 13. Average amount of pulses sold and price received (Per Farm)

Product	**Amount/Price**	**Pothwar**	**Rice-Wheat**	**Sindh**	**All**
Chickpea (white)	Amount Sold (Kg/yr)	170.00	--	3804.45	1987.22
	Price received (Rs./kg)	93.33	--	96.64	96.35
Chickpea (black)	Amount Sold (Kg/yr)	293.64	626.92	--	474.17
	Price received (Rs./kg)	73.18	93.62	--	84.25
Lentil	Amount Sold (Kg/yr)	614.82	--	814.38	668.03
	Price received (Rs./kg)	193.14	--	175.13	184.15
Mung bean	Amount Sold (Kg/yr)	636.66	345.27	--	403.55
	Price received (Rs./kg)	99.11	93.45	--	94.72
Mash bean	Amount Sold (Kg/yr)	995.92	200.00	1550.00	1007.48
	Price received (Rs./kg)	78.00	100.00	84.00	79.26

Pulse prices are relatively stable across regions. The price received for lentil is highest (Rs.184/kg), followed by chickpea white (Rs.96/kg), mung bean (Rs.95/kg), chickpea black (Rs.84/kg), and mash bean (Rs.79/kg).

Information Source for Production Technologies

Information is an essential resource in farm management and innovation. There are various means and sources by which information is sourced for use by an individuals and organizations. Major sources of information include radio, television, extension workers, cooperative societies, friends and colleagues, newspapers and magazines, books/leaflets, phones, libraries, institutes and the internet (Bitso, 2012). Table 14 presents the information sources usually used by surveyed farmers to source information about the production technologies of pulses. Neighbors and family members were highest reported information source (68 percent of respondents for each). Government workers were the third highest source with a 50 percent farmer response, while extension departments were recorded as an information source by 30 percent of respondents. Overall 23 percent, 11 percent, and 10 percent of respondents indicated that sales representatives of private companies, seed dealers and non-government agronomists were major sources of information.

Table 14. Information sources regarding pulses production technology (% Farmers)

Sources	Pothwar	Rice-Wheat	Sindh	All
Neighbor	50	65	93	68
Family member	50	65	93	68
Other government worker	34	70	50	50
Extension Department	26	23	43	30
Sales representative	4	25	45	23
Seed dealers	0	10	25	11
Non-government agronomist	0	25	8	10

Factors Responsible for the Decreasing Trend in Pulses Production

Table 15 shows the reasons for the decrease in pulses production in the study area over the last ten years. Highest reported problem was disease occurrence which reduced the yield, as reported by 54 percent of respondents. In the Pothwar and rice-wheat regions, this problem was reported by 76 percent and 73 percent farmers respectively however in Sindh province it was not reported by a majority of farmers. The main reason behind this problem is the humid climate of the Pothwar and rice-wheat regions during the cropping season of pulse crops. In Sindh, the climate is relatively dry and it is not conducive to disease spread in the pulses crops.

Table 15. Reasons for the decreasing trend in pulses production

Reasons	Pothwar	Rice-Wheat	Sindh	All
The disease problem reduced the yield	76	73	8	54
Lack of improved high-yielding varieties	56	70	10	46
The yield potential of pulses crop varieties has reduced	56	58	18	45
Price fluctuation	56	60	15	45
Profitability of pulses has declined compared to the replacing crops	24	23	15	21

The second most important reason was the lack of improved high-yielding varieties of major pulses crops which was overall reported by 46 percent of respondents in the study area. It was reported by a majority of respondents in the Pothwar and rice-wheat regions, but only a small percentage of Sindh respondents. The agricultural research and development institutions working under the federal and provincial governments are mostly concentrating on major crops while pulses, being perceived as crops of marginal areas, don't get due importance in the breeding program of these institutions.

Overall, 45 percent respondents reported that the yield potential of pulses crop varieties have declined overtime. This shows that the varieties being grown by farmers of the study area are relatively older ones with reduced yield potential. Price fluctuation and seasonality of price was also reported by 45 percent of farmers of the study area. Declined profitability of pulses in comparison to competing crops was reported by 21 percent farmers. One can draw the conclusion that pulses are still profitable compared to replacing crops but the major hindrances in improving the area and production of major pulses crops are the risky nature of these crops (prone to severity of weather), non-availability of certified seed of improved varieties and price risks. Overall, fewer problems were reported by Sindh farmers, the reason may be that the climate of that area is better suits to pulses crops which is also visible from the chickpea yield results in Sindh.

Major Constraints in the Pulses Production and Marketing

Farmers consider pulses as profitable crops due to their low inputs/cost requirements. Despite the profitability of these crops, farmers reported different constraints in pulses production and marketing as reported in Table 16. The most significant constraints to pulses production and marketing reported by farmers included the proneness of pulses towards diseases (57 percent off respondents indicated this as a very high constraint), susceptibility of pulses to insects/pests (44 percent), low pulses yields (36 percent), difficulty in obtaining certified seeds (34 percent), and high variation in pulses yield over the years (24 percent). Constraints that were not considered to be a significant hindrance to production and marketing include labor requirements, lack of local markets for sale, difficulty in harvesting, high storage grain losses, lack of extension services, unsuitability of land and difficulty in drying the pulses grains.

Table 16. Major constraints in the pulses production and marketing (% Farmers)

Major Pulses Constraints	**Not A Constraint**	**Low Constraint**	**Moderate Constraint**	**High Constraint**	**V. High Constraint**
Prone to diseases	15	6	6	16	57
Prone to insect pests	16	3	9	27	44
The yield is too low	12	13	8	31	36
Difficult to obtain certified seed	19	15	14	18	34
The variation in yield overtime	14	7	16	38	24
Lack of a support price	31	19	10	18	21
The prices are too low	36	13	12	19	19
Difficult to control weeds	31	21	19	13	15
Too much labor required	54	23	10	4	9
Lack of local market for selling	35	19	11	24	8
Too difficult to harvest	53	26	5	11	3
High storage grain losses	51	34	4	4	3
Lack of extension services	51	34	4	4	3
Unsuitability of land	89	7	2	1	2
Difficult to dry the grain	57	30	5	4	1

CONCLUSIONS AND RECOMMENDATIONS

Pulses crops are relatively neglected crops over the last 3 decades compared with major crops such as wheat, rice, sugar and cotton. The major indicators for this neglect includes the pushing of pulses towards marginal areas where there is no facility of irrigation, less importance given to pulses breeding program, low spread of certified pulses seed, lack of pulses production technologies including technologies to manage pulses diseases, weed problems and lack of mechanization opportunities. Pulses crops are relatively drought resistant crops but are severely prone to climate related diseases and insect/pest attacks. These factors have resulted in the decline in area planted, yields and therefore production of pulses crops over time. With increasing domestic demand for pulses, this decrease in production has led to a gap between domestic demand supply and major dependence on pulses imports. The present study was conducted to explore the potential of pulses production in Pakistan and identify major constraints to this production. Data from a face-to-face survey of 130 pulses farmers in Sindh and the Pothwar and rice-regions of Punjab is presented.

Pulses were grown on 26 and 8 percent of the cultivated area in Rabi and Kharif seasons, respectively. Chickpea is major pulse crop in Pakistan which is widely cultivated across different zones of country. Mung bean crop is the second largest crop in terms of area planted. All the four major pulses crops (chickpea, mung bean, lentil and mash bean) have experienced a declining trend in area and production from the year 2005-06 to 2014-15, while during the same period all the pulses crops except mung bean had experienced a declining trend in yield. Mung bean yields have increased over this time period as it is mainly sown on fertile lands under irrigated conditions while the rest of the three pulses crops are generally sown on marginal land under rain-fed conditions.

The humid climate of the Pothwar and rice-wheat regions during the cropping season is the major cause of disease in the major pulses crop, which can drastically reduce pulses yield. Insect and pest infestations are also significant in these climatic conditions. The agricultural research and development institutions working under the federal and provincial governments are mostly concentrating on major crops while pulses significant less research and development resources. The varieties sown in the study area are largely unimproved varieties with lower yield potential compared with improved varieties. Survey respondents indicated there was significant lack of certified seed. Yield variability was reported by a considerable percentage of pulses producers in the study area.

The harvesting of pulses crops is labor intensive and costly due to a lack of uniform crop maturity and mechanization. Farmers weren't looking for professional advice to improve pulses management practices as sources of information regarding production technology and marketing was largely based on friends and family support with low support from representatives of input companies and pulses processing industry. This has significant impact on the ability of pulses producers to innovate.

One can draw a conclusion that pulses are still profitable compared to replacing crops but the major hindrances in improving the area and production of major pulses crops are the risky nature of these crops (due to susceptibility to diseases and insect pests) and poor availability of certified seed of improved varieties.

An increase in pulses productivity may lead to increased pulses production in Pakistan, especially in non-irrigated areas. For this purpose, there is need for significant improvements in research, development and extension activities in the area. For improving the research and development activities there is need have extensive investment in infrastructure and human resource development. Separate pulses research institutes could be established for improving pulses breeding research and supporting improved access to certified seed for pulses producers. There is a need to establish a strong link between the private sector involved in the provision of agricultural inputs and services, pulses producers and pulses traders/processors. This will help in improving the access of farmers to improved production technologies and better marketing access for their produce. To improve market access, vertical linkages between pulses producers and pulses traders/processors in the form of formal contracts for arranging buyback could encouraged increased production. This mechanism has been a success story for maize, sugarcane and milk producers in certain regions of Pakistan.

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