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Status of Wheat Seed Sector in Pakistan: Opportunities and Challenges to Improve Quality Seed Supply for Increased Production and Food Security

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Abstract
Wheat accounts for 60% of the daily diet and 72% of the daily calorie intake in Pakistan. The average per hectare wheat yield in Pakistan is only 2.8 tons, which is far below potential yield of 6.8 tons/ha for wheat in Pakistan. In this study, we use time-series data from the previous 1.5 decades to analyze wheat seed supplies in four major wheat-growing provinces: Balochistan, Khyber Pakhtunkhwa, Punjab and Sindh. The regression analysis indicates that the use of certified seed has a positive and significant impact on wheat production which is a key pillar of ensuring food security at the national level. Province-wise there exist some variation as results show that certified seed is available from public and private sources in Punjab to meet nearly a quarter of the province's requirements and also supply a significant portion of Sindh's wheat seed needs. However, available certified seed in Khyber Pakhtunkhwa and Balochistan provinces constitutes only 10% or less of the wheat seed sown. Throughout Pakistan, early-generation improved wheat seed comes mostly from public sector institutions; the private sector is involved primarily in the sale of improved seed and does not take part in wheat research or development programs. Farmers' access to improved wheat seed can be enhanced through sustainable public-private partnerships, swift availability of pre-basic seed to well established private seed companies and introduction of legally-binding arrangements between public and private entities. This would not only help increase the wheat production but also bring improvement in the food security of rural households and country's economic growth.
Keywords: Wheat seed, Production, Public-private Partnership, Food security, Pakistan.

Running Head: Wheat Seed Status in Pakistan

1. Introduction

Agriculture contributes nearly 20% to Pakistan's GDP, employing 43% of the country's labor force and contributing to the growth of other sectors of the economy (Government of Pakistan, 2016). During 2015-16, agriculture sector showed a negative growth of 0.19% and crop output declined more than 6%, due in part to factors such as changing climatic conditions and lack of timely availability of key inputs, a chief one being the availability of quality seed (Government of Pakistan, 2016).

Grown on some 9 million hectares nationwide, wheat occupies some 38% of Pakistan's cultivated area of nearly 22.8 million hectares. It is Pakistan's leading food grain, accounting for more than 80% of the cereal production and 60% of inhabitants' daily diets (average annual per capita consumption is 125 kilograms), contributing more than 12% to value added in agriculture and occupying a central position in the formulation of agricultural policies (Government of Pakistan, 2016).

The major wheat-growing provinces of Pakistan are Balochistan, Khyber Pakhtunkhwa (KP), Punjab and Sindh. More than three-quarters of national wheat production comes from Punjab and the remainder from the other three provinces, despite their having larger wheat areas and cheaper labor (Government of Pakistan, 2012). The details about province wise area and production of wheat are presented in Appendix 1. Because Pakistan's food security depends heavily on the wheat crop, wheat production has expanded overall in recent years (Shah et al., 2010; Quddus and Mustafa, 2011; Nazli et al., 2014).

In Pakistan, wheat is also a political crop and every government tries to have self-sufficiency in wheat for food security and stability. Average yield for wheat was 2.8 tons per hectare (t/ha) in 2014-15, which is significantly below the estimated yield potential of 6.8 t/ha for this crop in Pakistan (Government of Pakistan, 2016). Diverse challenges constrain wheat productivity in Pakistan, including changing climatic conditions like rising temperatures and erratic rainfalls, lack of timely availability and quality inputs, lack of credit, inadequate extension services and above all farmers' lack of access to quality seed of newly released high yielding wheat varieties (Iqbal et al. 2002; Javed et al. 2008; Javed et al., 2009).

This paper is based on detailed review of the wheat seed sector using historical data. There is a first data based review to provide guidelines (expert opinion) to the policy makers for bringing needed intervention in the sector to improve quality seed supply for increased production. Additionally, the analysis presented covers wheat seed situation in all the four major provinces of the country and the time series based data set helped to draw some recommendations which could be helpful in policy formulations.

2. Materials and methods

We collected data from number of sources and details are presented as Appendix B to document the status of wheat seed sector in Pakistan. This is the first study in Pakistan that has focused both qualitatively and quantitatively on supply of improved wheat seed, including the composition of the wheat seed sector and the availability of certified seed in each province.

The ordinary least squares (OLS) regression analysis was carried out to assess the effect of certified wheat seed on wheat production and area in Pakistan. In the regression analysis, the dependent variable is the certified seed overall quantity at Pakistan level and the independent variables included in the model are the production, area and yield. Similarly the province- wise analysis was carried out to estimate and compare the regional heterogeneity.

The equation below describes the OLS model

$$Y = \alpha_0 + \beta_1 X_i + \beta_2 X_j + \beta_3 X_l + \varepsilon$$

Where Y is the demand of certified seed and α is the constant term and Xi is the production variable included in the model and Xj is the area variable included in the model and Xl is the yield variable included in the model while β s are the coefficients.

The results are based on the time series data set collected from a number of sources and the details of sources are given in Appendix B.

3. Results

3.1 Composition of the seed sector in Pakistan

The Pakistani seed industry used to be dominated by public sector seed corporations and Agricultural Research and Extension Departments; exclusive provider of wheat seed. However, following privatization policy and easing of government regulations, seed industry was declared as business in 1984 and 1996. Consequently private seed sector was encouraged to complement the efforts of public sector which was supplying not more than 9% certified wheat seed of the total requirement in the country. As a result there are at present approximately 729 functioning seed companies in Pakistan (Table 1). The listing includes small, intermediate-size and large companies that either multiply and market seed of wheat, rice, cotton, vegetables and fodder crops, or selling imported seed of those crops. Of this relatively large number of seed companies in Pakistan, a few market wheat seed, essentially because of low profits associated with wheat seed business and large quantities of seed. Majority of farmers are getting seed from the informal sources.

Table 1. Total Numbers of seed companies (suppliers) in Pakistan, by type and province

Category	Punjab	Sindh	Khyber PakhtunKhwa	Gilgit-Baltistan	Balochistan	Total
Public sector	1	1	1		1	4
National seed companies	600	91	20	2	7	720
Multi-national seed companies	4	1	-	-	-	5
Total active	605	93	21	2	8	729
Cancelled	129	14	7	-	-	150
Total	734	107	28	2	8	879

Source: Federal Seed Certification & Registration Department 2011-12.

3.2 Availability of certified wheat seed

Data from the past one and half decades regarding the availability of certified wheat seed show that only 20-25% of seed comes from formal sources while remainder comprises either farmers' saved seed or seed obtained from fellow farmers, middlemen, or village shops (Table 2) where information about the source of variety is in most cases unknown. The availability of certified seed did not improve much in the last 10 years, fluctuating between 20% and25%. The gap between the requirement and availability is continuously over 70%. The major share (14-17%) of certified seed comes from the private sector, with the exceptions of 2010-11 and 2011-12, when private sector contributions were 22 and 21%, respectively.

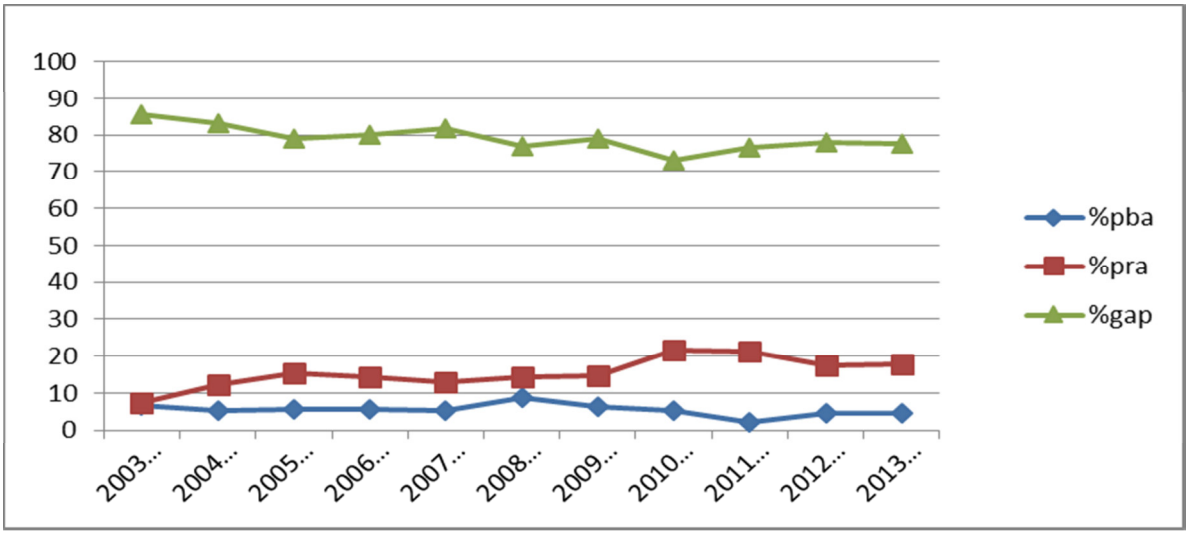
Table 2. The availability of certified Wheat seed Pakistan, 2003-14 (tons; the figures in parentheses are %).

Year	Total seed sown	Seed supplied, public sources	Seed supplied, private sources	Total availability	Gap
2003-04	978,960	66,050.62 (6.75)	73,632 (7.52)	139,682 (14.26)	839,278 (85.74)
2004-05	1,005,240	53,073 (5.27)	121,680 (12.1)	174,753 (17.37)	830,487 (83.04)
2005-06	1,008,840	57,603.57 (5.7)	153,709.2 (15.24)	211,312.8 (20.94)	797,527.2 (79.05)
2006-07	1,027,080	57,027.77 (5.55)	146,919.19 (14.30)	203,947 (19.85)	823,133.2 (80.14)
2007-08	1,044,964	55,534 (5.31)	135,100.94 (12.92)	190,634.9 (18.24)	854,329.1(81.75)
2008-09	1,085,920	94,587.57 (8.71)	156,167.49 (14.38)	250,755.1 (23.1)	835,164.94 (76.90)
2009-10	1,085,400	69,425 (6.39)	157,595.27 (14.51)	227,020.3 (20.91)	858,379.7 (79.08)
2010-11	1,085,400	58,054.0 (5.34)	233,966 (21.55)	292,020 (26.9)	793,380 (73.09)
2011-12	1,085,400	*23,947 (2.20)	231,947.05 (21.36)	255,894.1 (23.57)	829,506 (76.42)
2012-13	1,085,400	50,569 (4.65)	187,791.9 (17.3)	238,360.9 (21.96)	847,039.1 (78.03)
2013-14	1,085,400	49,129 (4.52)	194,642.17 (17.93)	243,771.2 (22.45)	841,628.8 (77.55)

Source: FSC&RD and Punjab Seed Corporation.

**In 2011-12, Punjab Seed Corporation has 37,000 mt left over; one of the reasons was late harvest of the cotton crop.*

Figure 1. Public and private sector contributions to Wheat seed production and gap (%), Pakistan, 2003-13.



pba = public sector availability; pra = private sector availability.

Note: On X-axis the years are presented

On Y-axis the seed availability and gap are presented in percentages

Figure 1 shows the desegregated availability of certified seed from the public vs private sectors. Beside availability from public and private sectors, the gap between supply and demand of certified seed constantly exists over the years. During 2015-16 the gap between supply and demand of certified seed is between 65-70 %. The findings indicate that there is a need for greater public sector participation, with emphasis on increasing early-generation seed production for use by the private sector for further multiplication as basic and certified seed.

3.3 Impact of Certified Seed on Production and Food Security

In the regression analysis, the data was used from 1994-95 to 2014-15 (21 years) and results are presented in Table 3. The dependent variable is the availability of certified wheat seed and independent variables included in the model are production, area and yield of wheat in Pakistan. The R-square value is quite high i.e. 0.81 indicating that 81 % variation in dependent variable is due to independent variables included in the model. The production and yield coefficient are positive and significant while the area coefficient is though positive but non-significant. The figures 2 and 3 also show the certified seed availability impact on wheat production and area in Pakistan. The figures present a positive impact of certified wheat seed availability on wheat production.

Table 3: Regression Results (Overall Pakistan)

Variable	Coefficient	T-values
Production	156.38***	2.76
Area	72.10**	2.12
Yield	23.67	1.46
Constant	213.59*	1.75
R-square	0.81	
F-Value	87.32	
Prob>F	0.000	

Note: Results are significant at ***,**,* 1,5 and 10 % levels respectively.

Figure 2: Regression analysis showing relationship between Certified Seed availability and Production

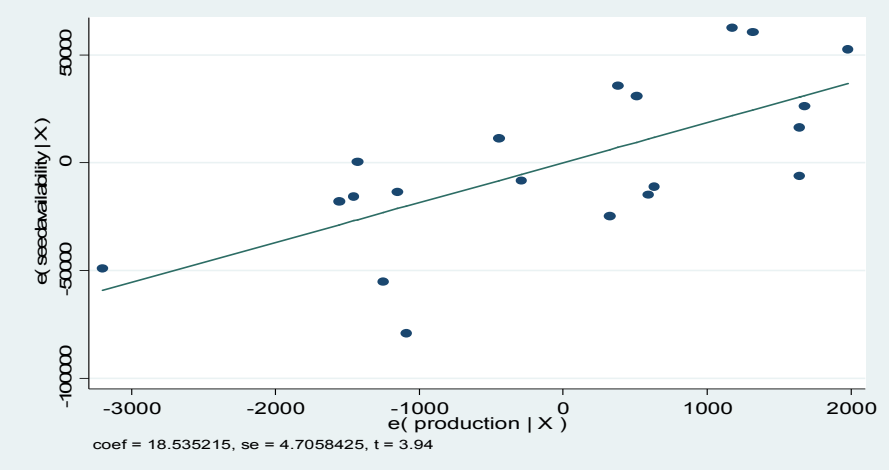
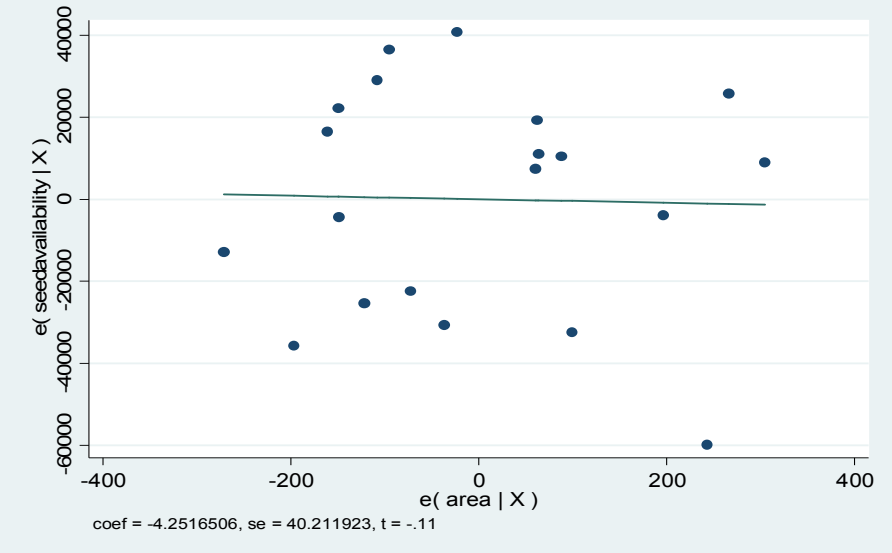


Figure 3: Regression analysis showing relationship between Certified Seed availability and Area



The province wise analysis was also carried out and is presented in Table 4. The empirical results indicate that province wise there are some differences but all in all the seed availability has a positive impact on wheat production which is so important in ensuring rural household food security in Pakistan.

Table 4: Regression Results (Province Wise)

	Punjab		Sindh		KP		Balochistan	
Variable	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values
Production	12.45***	2.62	10.60***	4.23	5.57	1.16	3.01	0.97
Area	52.26	0.99	-24.92	-1.54	-11.53	-1.01	1.71	0.28
Yield	12.31*	1.80	8.34*	1.92	1.28	0.83	1.38	0.36
Constant	32.57*	1.85	51.24	0.39	4.21	0.33	2.97	0.24
R-square	0.71		0.52		0.29		0.13	
F-Value	82.34		66.34		24.56		18.67	
Prob>F	0.000		0.000		0.000		0.000	

Note: Results are significant at ***,**,* 1,5 and 10 % levels respectively.

3.4 Analysis by province of certified seed supplies

3.4.1 Punjab Province. The availability of certified wheat seed in Punjab Province is 18-22% of all seed sown, with 4-5% coming from public seed sector and 18-19% supplied by private seed companies (Table 5). The Punjab Seed Corporation — currently the only public entity that supplies certified seed is facing diverse challenges including lack of research and development expertise, land litigation with tenants around its seed farms, stringent internal policies due to compliance to government rules and private sector competition.

Table 5. Supplies of certified wheat seed in Punjab Province, Pakistan, 2000-2014 (tons; figures in parentheses are %).

Year	Total seed sown	Seed supplied, public sources	Seed supplied, private sources	Total availability
2000-01	750660	64627 (8.60)	75533 (10.06)	140160 (18.67)
2001-02	732216	63548 (8.67)	51225 (6.99)	114773 (15.67)
2002-03	731676	60740 (8.31)	44019 (6.01)	104758 (14.31)
2003-04	745440	51170 (6.86)	47881 (6.42)	99051 (13.28)
2004-05	762000	37715 (4.94)	85000 (11.15)	122715 (16.10)
2005-06	778000	49475 (6.35)	79682 (10.24)	129157 (16.60)
2006-07	772000	44360 (5.74)	134261 (17.39)	178621 (23.13)
2007-08	768000	37824 (4.92)	122403.4 (15.93)	160227 (20.86)
2008-09	820000	61239 (7.46)	97170 (12.51)	134994 (16.46)
2009-10	823000	49470 (6.01)	142721 (17.34)	203960 (24.78)
2010-11	803000	49470 (6.16)	203115 (25.29)	252585 (31.45))
2011-12	778000	*13000 (1.67)	193959.85 (24.93)	206960 (26.60)
2012-13	830300	48000 (5.78)	148768 (17.91)	191897 (23.11)
2013-14	830300	44091 (5.12)	142297 (17.13)	184888 (22.26)

*Total procured seed was 51,878 tons; 37,000 tons was left over with P.S.C. during 2011-12. (Source FSC&RD)

3.4.2 Sindh Province. In the past, Sindh's seed requirements were met mainly by importing seed from Punjab. The contribution of public sector in wheat seed is from 1-3% of the total seed requirement of the province, while the contribution of the private seed sector is from 8 to 25%, over the last four years (Table 6). The private seed sector is aggressive and the availability of pre-basic seed was the main bottleneck for the production of basic and certified seed, which has now been addressed in the new seed legislation Act of 2015. Recently, the Sindh government established a seed production and development center at Sindh Agricultural University, Tandojam. The wheat seed situation in Sindh province is also not really encouraging and there is a huge scope for improvement on the part of all the stakeholders i.e. farmers, seed companies, provincial agricultural research and extension department as well as policy makers. Inherently the lack of professionals, rapid change of higher management and lack of consistency in policies resulted into low quality seed which gave set back to the credibility of Sindh Seed Corporation since its inception.

Table 6. Supplies of certified wheat seed in Sindh Province, Pakistan, 2000-2014 (tons; figures in parentheses are %).

Year	Total seed sown	SSC	SP&DC	Seed supplied, public sources	Seed supplied, private sources	Total availability
2000-01	97294	2777.24	-	2777.24 (2.85)	4422	7199.24 (7.39)
2001-02	105024	2543.6	-	2543.6 (2.42)	8636	11179.6 (10.64)
2002-03	103644	608.3	-	608.36 (0.59)	5424	6032.36 (5.82)
2003-04	105384	319.25	-	319.25 (0.32)	4678	4997.25 (4.74)
2004-05	106488	169.75	-	169.75 (0.16)	8758	8927.75 (8.38)
2005-06	111984	895.65	-	895.65 (0.80)	8401	9296.65 (8.30)
2006-07	117862	2711.55	91	2802.55 (2.38)	11330	14132.55 (11.99)
2007-08	118788	3460.07	53.5	3513.37 (2.95)	10234	13747.37 (11.57)
2008-09	123768	2475.95	68.3	2544.25 (2.05)	10417	12961.25 (10.47)
2009-10	131076	1770.8	57.05	1827.85 (1.39)	13077	14904.85 (11.37)
2010-11	137328	706.92	46.65	753.57 (0.55)	8935.5(6.50)	9689.07 (7.05)
2011-12	125904	1500.48	238.29	1738.77 (1.38)	22164.2(17.60)	23902.97 (18.98)
2012-13	127008	1833.04	294.61	2127.65 (1.67)	35084	32683.76 (25.73)
2013-14	134592	2813.28	294.72	3108 (2.31)	45172 (33.56)	47985 (35.62)

Source: Federal Seed Certification and Registration Department.

3.4.3 KP Province. In KP Province, formal seed suppliers, public and private, provide only 10% of wheat seed sown Table 7. The Province's former Agriculture Development Authority (ADA), which handled seed procurement and distribution through depots, but was abolished in May 2001 due to issues such as defaults on loans for inputs and poor management. A KP Agriculture Development Fund (ADF) created in the Agriculture Extension Department manages a $3.5 million revolving fund to provide certified seed to farming communities on competitive basis (Always less as compared to other provinces) and using state lands and seed processing facilities. Since it is not an independent seed organization its efficiency needs to be assessed. Responsibility for pre-basic seed is mainly restricted to research institutes which should now be open to the private sector. At present efforts are underway to establish an independent agency in the province in the public sector to fill the gap of seed availability and access to the farmers.

However, lessons learnt from the previous ventures in the province must be considered and one viable option could be to develop a partnership with the private sector especially for the efficient utilization of government seed farms, making available sufficient quantity of pre-basic seed, provision of seed processing units on subsidized rates, capacity building in quality seed production and managerial skills in seed industry management. Popularization of new varieties through Agriculture Extension and electronic media is essentially required to motivate farmers for adoption of certified seed of new and agronomically superior varieties.

Table 7. Supplies of certified wheat seed in Khyber PakhtunKhwa Province, Pakistan, 2000-2014 (tons; figures in parentheses are %).

Year	Total seed sown	Seed supplied, public sources	Seed supplied, private sources	Total availability
2000-01	94836	5764 (6.07)	20 (0.02)	5784 (6.10)
2001-02	89628	5495 (6.13)	350 (0.39)	5845 (6.52)
2002-03	87852	2932 (3.34)	370 (0.42)	3302 (3.75)
2003-04	88992	2739 (3.07)	570 (0.64)	3309 (3.71)
2004-05	89832	2661 (2.96)	275 (0.31)	2936 (3.26)
2005-06	86,556	2720 (3.14)	536 (0.61)	3256 (3.76)
2006-07	90,516	2663 (2.94)	1378 (1.52)	4041 (4.46)
2007-08	86,088	2190 (2.54)	1155 (1.34)	3345 (3.88)
2008-09	92,340	4267 (4.62)	1359 (1.47)	5626 (6.09)
2009-10	90,996	5140 (5.64)	3063 (3.36)	8203 (9.01)
2010-11	86,940	7181(8.25)	5958 (6.85)	13139 (15.11)
2011-12	87,516	4975 (5.68)	3000 (3.43)	7975 (9.11)
2012-13	86796	3425 (3.94)	2632 (3.03)	6057 (6.97)
2013-14	92280	4567 (4.94)	4876 (5.28)	9443 (10.23)

3.4.4 Balochistan Province. The availability of certified wheat seed of improved varieties, from either public or private sources, is only 8% of the seed sown as presented in table 8. The Balochistan Agriculture and Cooperative Department is responsible for seed production and distribution and has 12 state farms of 3,380 hectares in different ecological zones. Seed processing plants at Usta Muhammad and Gandhawa are not

efficiently used in terms of capacity and we suggest that private sector involvement could improve efficiency. In addition there is a poor link between the Agriculture Department and research systems which have access to pre-basic seeds for multiplication as basic or certified seed at the state farms. Since 2001-02, the public sector has not produced more than 1% of the certified seed needed to meet the provincial seed requirement. The provincial government, through policy and administrative measures, should mobilize the Agriculture Department to use the government seed farms efficiently.

Table 8. Supplies of certified wheat seed in Balochistan Province, Pakistan, 2000-2014 (tons; figures in parentheses are %).

Year	Total seed sown	FSCRD	Agricultural extension	Seed supplied, public sources	Seed supplied, private sources
2000-01	38916	404	167.11 (0.43)	175.5 (0.45)	8.39 (0.021)
2001-02	40032	408	137.17 (0.34)	148.9 (0.37)	11.73 (0.029)
2002-03	40896	200	112.3 (0.27)	124.9 (0.30)	12.6 (0.038)
2003-04	40908	258	254.6 (0.62)	268.6 (0.66)	14.0 (034)
2004-05	41172	185	159.4 (0.39)	809.4 (1.96)	650 (1.58)
2005-06	37200	93.5	43.94 (0.12)	756.64 (2.03)	712.7 (1.91)
2006-07	49068	95.34	27.73 (0.06)	329.63 (0.68)	301.9 (0.61)
2007-08	49260	53.45	161.37 (0.33)	1196.02 (2.42)	1034.65 (2.10)
2008-09	49068	438.54	30.37 (0.06)	1389.57 (2.83)	1359.2 (2.77)
2009-10	44100	500.3	285.54 (0.65)	709.94 (1.60)	424.4 (0.96)
2010-11	40896	90.5	31.1 (0.08)	1490.65 (3.64)	1459.55 (3.57)
2011-12	46608	60.6	60.65 (0.13)	2327.05 (4.99)	2314.4 (4.96)
2012-13	43584	36.9	36.9 (0.085)	3892.2 (8.93)	3855.3 (8.84)
2013-14	47904	22	22 (0.046)	3825.7 (7.98)	3803.7 (7.94)

Source: FSCRD.

3.5 Discussion

The data suggest that public participation in supplying certified seed is declining;, for example, the ineffectiveness of the Sindh Seed Corporation over the past a few years despite restructuring. In KP and Balochistan, no independent seed production organizations, such as those of Punjab and Sindh seed corporations, are in operation; rather, their respective departments of agricultural research and extension were given the responsibility for seed multiplication and distribution. Also, private seed suppliers in KP and Balochistan until recently focused on producing and marketing maize and vegetable seed, but have now diversified their seed offerings, which include wheat seed.

In contrast to private seed companies, marketing and promotion are not aggressively pursued by public entities. Moreover, the public sector lacks trained seed professionals and suffers financial constraints, particularly in Balochistan and Sindh, despite having access to state lands and seed processing facilities. Private seed companies are also capturing a slightly higher market share due to the limited number of varieties offered by public suppliers and the fact that there are more than 700 seed companies in competition with public suppliers. Seed obtained from the informal sector is often not of good quality and there is a need to educate farmers regarding the importance of using quality seed.

The Seed (Amendment) Act 2015 ensures access of the private sector to pre-basic seed, which will help to improve the slow varieties replacement rate and is also expected to enhance the supply of quality of wheat seed. The slow varietal replacement rate also decreases the technical efficiency of wheat producers (Battese, 2014). Also the approved Plant breeders' right can further enhance the wheat breeding efficiency in the public sector if the act is properly implemented, as there will be financial incentives for both research institutes and plant breeders. Private seed companies invest in and actively pursue seed marketing, distribution and extension, bringing them closer to the farmers and enabling them to capture more of the market share.

Our analysis revealed that the private sector market share in seed production is gradually increasing, which could be a signal for the government to streamline seed policies for more friendly seed business and the restructuring of the public sector entities.

The data and these trends suggest that continuous public and private efforts and partnerships are needed to meet demand for wheat seed in Pakistan. One of the keys to success of such partnerships in the seed value chain is to establish a legally binding system where the public sector develops and releases varieties which are then contracted to a company for seed increase and marketing, as per approved plant breeder rights or mutually agreed arrangements.

4. Conclusion

From the findings it can be concluded that there is large shortfall of certified wheat seed. Public and private seed suppliers currently account for 18-22% of the seed sown; the remainder comes from informal sources. To increase farmers' access to improved wheat seed the public and private partnership, electronic media, popularization of new varieties through seed exhibition, seed demonstration and distribution of small seed kits can help a lot. Currently, only one fourth of the farmers have access to wheat seed from formal sources, while the rest of the farmers either save their own seed or obtain it from fellow farmers. Normally seed from informal sources is not of good quality or of new improved variety which could be one of the major causes of a lower per-hectare yield. The seed replacement is recommended after every 3-4 years to make sure the introduction of new improved high yielding disease resistant varieties. Through effective public and private collaboration, extension and marketing efforts, certified seed of promising wheat varieties can be promoted among farmers. Public and private collaboration under legally-binding arrangements can enhance the availability of the improved wheat seed for the farming community. This would not only help to increase the wheat production and yields but also bring improvement in the food security of rural households and country's economic growth. Finally, the following measures could improve wheat seed availability for increased production.

- The participation of the informal seed sector, including non-governmental organizations (NGOs), community based organization (CBOs) should be activated by involving the local level seed production within the country seed law to produce high quality, cost effective seed for wide crop range including wheat. In particular, agricultural NGOs could play an effective role in seed production and marketing, in areas where the formal seed sector lacks access or profit margins are not attractive enough. One example would be Rural Support Programs and their subsidiaries, which have broad geographical coverage and strong linkages with farm communities in Balochistan, Punjab, KP and Sindh.
- Since the newly-approved Seed Act allows for the provision of pre-basic seed to private seed producers, interested companies and organizations needs to be equipped with prerequisite infrastructure, including seed processing and packaging units and storage facilities, along with staff trained in seed production and handling. The FSCRD under Seed (Amendment) Act 2015 has the provision for training and ensuring infrastructure availability in seed production technology for private seed companies which need to be implemented
- Public seed corporations in Punjab and Sindh, whose operations are constrained by stringent internal policies on seed pricing, crop diversification and other issues and thereby are unable to compete effectively with private companies, should be restructured as more liberal and independent public limited seed corporations that could operate with minimal public sector involvement. The main reason of keeping these public sector seed corporations is to act as a price trend setter; otherwise farmers will have no option except to buy costly seed from private sector unless very strict government price control regulation is in place.
- One approach would be to restructure the Punjab Seed Corporation as a public-private limited company to make it a more effective service provider.
- To enhance seed value chains in Balochistan, a pilot project could be initiated to train relevant actors, including research and extension staff and seed company employees in the production and marketing of all categories of seed (pre-basic, basic, and certified). The project should also strengthen or establish processing and storage infrastructure using state owned lands, and foster agreements for seed distribution among NGOs, seed companies and seed dealers.
- One option is to attract private investment and partners to revive the Sindh Seed Corporation and make it profitable and effective in fulfilling provincial seed requirements.
- Areas of Pakistan like Federally and Provincially administered triable areas, Gilgit Baltistan and Azad Jummu and Kashmir (AJK) would require a special program to introduce improved disease resistant wheat varieties to replace currently gown old varieties to improve wheat production in the areas.
- Provincial wheat breeding programs must be funded for establishing their own foundation seed cell with requisite infrastructure for seed production of pre basic and basic seed to make available to Agriculture extension and private sector.

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References

Battese, G. E., Nazli, H, and Samle, M. (2014). Productivity and Efficiency of four major wheat varieties grown by farmers in Pakistan. Harvest Plus Working paper.

Government of Pakistan. Pakistan Economic Survey. (2015). Economic Advisor's Wing, Finance Division, Islamabad.

Government of Pakistan. Pakistan Economic Survey. (2013). Economic Advisor's Wing, Finance Division, Islamabad.

Government of Pakistan. Pakistan Economic Survey. (2012). Economic Advisor's Wing, Finance Division, Islamabad.

Akhtar L. H., M. Hussain, A. H. Tariq and M. Nasim. (2010). A Review of Hundred Years of Wheat Research and Development in Punjab (1911-2010). *Pakistan Journal of Science* 32(2): 128-134.

Shah M., M.M. Khan and M.A. Atta. (2010). Comparative Study of Wheat Production before and after Chashma Right Bank Canal." *Journal of Management Science* 4(1): 97-105.

Quddus M.A. and U. Mustafa. (2011). Comparative Advantage of Major Crops Production in Punjab: An Application of Policy Analysis Matrix. *The Lahore Journal of Economics* 16 (1):63-94.

Nazli H., D. A. Marfo, M. Smale, S.J. Malik and E. Birol. (2014). Small Holder Farming and Crop Variety Choice: Wheat Variety Choice in Pakistan." Harvest plus Research for Action No. 02, August 2014.

Iqbal M., M.A. Khan and M. Ahmad. (2002). Adoption of Recommended Varieties: A Farm- level Analysis of Wheat Growers in Irrigated Punjab. *The Pakistan Development Review* 41(1):29–48.

Javed M.I., S.A. Adil, M.S. Javed and S. Hassan. (2008). Efficiency Analysis of Rice-Wheat System in Punjab, Pakistan. *Pakistan Journal of agricultural Sciences* 45(3):95-100.

Javed M.I., S.A. Adil, S. Hassan and A. Ali. (2009). An Efficiency Analysis of Punjab's Cotton-Wheat System. *The Lahore Journal of Economics* 14(2): 97-124.

Javed M.I., S.A. Adil, A. Ali and M.A. Raza. (2010). Measurement of Technical Efficiency of Rice-Wheat System in Punjab-Pakistan using DEA Technique. *Journal of Agricultural Research* 48(2):227-238.

Javed M.I., W. Khurshid, S.A. Adil, I. Hassan, N. Nadeem, A. Ali and M. A. Raza. (2011). Analysis of Technical and Scale Efficiency of Smallholder Farms of Rice-Wheat System in Punjab, Pakistan. *Journal of Agricultural Research* 48(2):125-137.

Khan M.A. and A.A. Burki. (2005). Wheat Market Reforms, Marketing Margins and Food Security in Pakistan." Paper presented in South Asia Regional Conference of International Association of Agricultural Economists and IFPRI on "Globalization of Agriculture in South Asia: Has it Made a Difference to Rural Livelihoods? Hyderabad, India: March 23– 25, 2005.

Appendix A: Province wise area and production of wheat in Pakistan

Province	Wheat Area (Million hectares)	Wheat Production (Million tons)
Punjab	6.9	19.7
Sindh	1.1	4.0
KP	0.8	1.4
Balochistan	0.4	0.9

Appendix B: Sources of data collection

Source Number	Source Name
1	Federal Seed Certification and Registration Department
2	Agricultural Statistics of Pakistan
3	Punjab Seed Corporation
4	Sindh Seed corporation
5	Agricultural Development Fund, KP