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Village-based Forage Seed Enterprises: A Sustainable Intervention for Rural Development in the Mixed Farming Systems of Pakistan[1]

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Abstract

This paper describes the on-farm profitability and sustainability implications of smallholder dairy farmers in Pakistan from an innovative informal strategy of developing village-based forage seed enterprises (VBFSEs) for berseem clover (*Trifolium alexandrinum*). The evaluation of agricultural innovations and their impact on whole farm profitability is often very difficult to relate to economic parameters. The agricultural interventions implemented in this study resulted in enhanced crop yields, but the farmers involved did not consider these gains fulfilled their economic rationale. The impact of growing improved varieties of berseem clover using research based technology and developing VBFSEs was validated through on-farm participatory research in the districts of Kasur and Okara, Punjab, Pakistan. The intervention was evaluated on the basis of net income and benefit:cost ratio to the farmers on their investment. The statistical analysis indicated that average net incomes of 512,340 Rs/ha (5,240 US$/ha) was achievable through establishing VBFSE for berseem clover when grown for both green fodder and seed production. The maximum green forage (50.58 t/ha) and seed yields (946 kg/ha) of berseem clover were produced by using improved seed and contemporary agronomic practices compared to 31.76 t/ha and 192 kg/ha, respectively with traditional methods of growing berseem clover. The average net income generated through berseem VBFSEs is eight times greater than for wheat (34,022 Rs/ha), six times more than for oats (45,541), five times more than for canola (56,083), four times more than for conventional berseem clover (67,723), and two times more than the net income from a potato crop (142,737) growing in the region. Thus berseem clover VBFSEs are more profitable than any other cash crop grown in the area, having a benefit to cost ratio of 5.32:1. They are therefore an economically viable agricultural option for smallholder farmers.

Key words: Forage, profitability, participatory research, poverty, smallholder farmers.

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Introduction

Historically, farmers had collected seeds from wild species and chosen new seeds through breeding, selection and evaluation of the selected progeny through farmer managed seed production systems (Reddy et al., 2006). Agriculture in the province of Punjab, Pakistan benefits from one of the largest canal irrigation systems in the world (Cain et al., 2007). Typical mixed farming systems in Pakistan consist of small land holdings of <3 hectares (Afzal, 2010), out of which three quarters is used for cash crops such as wheat, rice, sugarcane and potatoes, and the remainder is kept for growing forages such as berseem, oats, sorghum and maize for livestock feed (Cain et al., 2007). About two thirds of the country's population resides in rural areas and directly or indirectly depends on agriculture for their livelihood. Agriculture contributes 21 per cent to Pakistan's gross domestic product (GDP) (Farooq, 2014), generates more than 50 per cent of foreign exchange earnings (Cain et al., 2007), out of which the livestock sector shares 56 per cent. About 44 per cent of farmers are self-employed in agriculture. Wheat, cotton and rice are the main cash crops grown in Pakistan covering 37 per cent, 12 per cent and 11 per cent, of the farming area respectively. However, fodders are the second most important crops grown (16-19 per cent of the area) after wheat and are used largely for livestock feed (Saeed et al., 2011).

With respect to Punjab Pakistan cash crops utilise 79 per cent of land holdings and the remainder is used to grow fodder crops with a cropping intensity of 130 per cent. Farmers usually trade excess fodder to other farmers locally. Further, the locally produced fodder seeds are also marketed to farming communities both locally and further afield. However, the structure and functioning of these local fodder and seed markets are poorly understood and there is great potential for improving these markets locally at the village level. Furthermore the adoption of improved agronomic techniques and new seed varieties by these farming communities is also slow. It is important to recognise the complex and diverse relationship that exists between crops and animals in mixed production systems (Thomas et al., 2002). An important factor in fodder and seed marketing is the quality of the product (Singh et al., 2013a). Communication with farmers showed that they are well aware of the need to pay more for quality seed and fodder.

Pakistan is not self-sufficient in berseem clover seed and the amount imported is increasing annually (Farooq, 2014). The demand for seed cannot be fulfilled through the formal seed supply system, as the requirements for different varieties to fit with their diverse cropping systems often cannot be met. The government continues to confine its activities to the supply of seed for cash crops. Additionally, limited land holdings, inappropriate agronomic practices, lack of timely inputs and poor seed production methods at the farm level also contribute to the seed shortage problem (Anwar et al., 2012). Thus, there is a need for an alternative forage seed supply system, which not only supplies quality seed to farmers but also complements the current formal seed production and supply system in Pakistan.

The formal seed supply system is recognised as a vertically organised seed production and distribution mechanism with breeding, seed production and distribution as major components, while the informal seed supply system is characterised by the production and distribution of locally-used seed varieties at the farm level through varietal selection and evaluation, and conditioning practices such as seed cleaning (Reddy et al., 2006). In the formal seed system, new and improved varieties were evaluated by government research organisations, with systematic plant breeding, and the multiplication of seed through organised channels. However, the penetration of seed from the formal system in developing countries such as Pakistan has been very weak, supplying less than 20 per cent of the seed used by farmers, with the remaining seed being sourced through the informal supply system (Bishaw and Gastel, 2008).

The establishment of village-based forage seed enterprises (VBFSEs) was endorsed for Asia by Phaikaew and Stur (1998) as it develops an alternative and secure forage and seed supply system at the local level. It also increases the supply of seed of improved forage varieties, leading to increased forage and seed production. The VBFSE model enables participatory varietal selection and evaluation, which mobilises, involves and empowers smallholder farmers. Through this model, farmers cultivate improved, farmer-preferred and well-adapted varieties on their farms using a market oriented production approach. The quality of the seed produced by VBFSEs meets relevant quality standards which are appropriate for their farming operations but may not necessarily meet formal market standards (Bishaw and Turner, 2008). Stur et al. (2000) found that using a combination of traditional and improved evaluation technologies in an informal way through joint experimentation with farmers, resulted in the identification of the best varieties and subsequently greater adoption rates. In addition, VBFSEs offer a means of educating and increasing awareness of farmers about improved varieties and agronomic production technologies (David, 2004; Reddy et al., 2006; Nakamanee et al., 2008).

Therefore, this study is designed to evaluate the viability of VBFSEs at the village level in Punjab Pakistan in which forage seed enterprises were established with targeted farmers to produce and disseminate berseem clover seed. This was done in a pseudo-commercial setting to generate income and ultimately increase the profitability and sustainability of these small-holder farming operations.

Material and Methods

Throughout the research, participatory on-farm trials employing the smallholder farmers of Kasur and Okara districts were carried out. Although it was not examined directly in the research, it appears that the smallholders benefited from seeing and participating in the VBFSE trials first hand. Those farmers who were involved in these trials have indicated their intention to scale-up this forage seed business to a commercial level to increase profitability and sustainability. However, there are some constraints in terms of the widespread adoption of new varieties by smallholder farmers, and the seed certification and registration processes which are pre-requisites for the establishment of a new seed business (Singh et al., 2013b) which must be addressed.

Five case study smallholder dairy farmers (two from Kasur and three from Okara districts) were recruited for the development of VBFSEs. These farmers had previously participated in the on-farm varietal selection and evaluation research trials for berseem clover forage and seed production, conducted by the Australian Centre for International Agricultural Research (ACIAR) during the 2012-13 and 2013-14 growing seasons. These farmers were identified, mobilised and empowered as pioneer forage seed entrepreneurs, who then established VBFSEs in their respective villages and became sole seed producers and suppliers to other farmers. The farmers were provided with improved variety seed (Agaitti Berseem-2002 from the Forage Research Institute, Sargodha Punjab, Pakistan) to undertake on-farm trials to compare this variety with their local berseem varieties/landraces as a control. All the production and procurement costs were borne by the farmers except the improved variety seed cost, which is detailed in Table 1.

The farmers were trained and provided with proper technical knowledge on the different aspects of berseem clover seed production during the research trials conducted on their farms in the previous years. The trials were researcher-designed (experimental layouts, sowing and harvesting times) but farmer managed. The researcher played a facilitation role in accessing planting materials, taking soil samples, irrigation water and seed samples for analyses, and providing training and technical support on seed production techniques before planting, at harvest and at the time of data recording of different forage and seed parameters: the research was thus very much a co-operative effort. Seed yields of the traditional and improved varieties were determined to enable an estimation of the

economic value of the berseem seed production. Data were also collected on winter grown crops for the same VBFSE farmers on crop yields and the costs associated with their production at the farm level (see Appendix Table).

Estimation of net incomes and marginal rate of returns

Following the establishment of the initial VBFSEs involved in the present research project, an impact assessment survey was carried out with the five seed producer farmers (seed entrepreneurs) who produced and disseminated the Berseem clover seed through VBFSEs. The assessment involved face-to-face interviews. Statistical and partial budget analyses were carried out using the GenStat® and Microsoft Excel 2013® computer software programmes to estimate the benefits of the VBFSE intervention relative to other winter crops grown on the study farms. The analyses estimated the total gross income (GI), total variable cost of production (TVC) and net income (NI). The marginal rate of return (MRR) and benefit to cost ratio (BCR) were calculated using the data for the winter forages (berseem clover and oats) and cash crops (wheat, potatoes and canola) grown across the five case study farms. Market prices averaged across the time of application (2012-2014) were collected and used in the analyses for all crops and included green forage, seed, grain, tuber and straw products. The same was carried out for variable input costs such as seed, fertilisers, pesticides and labour. In addition, the costs associated with seed procurement in VBFSE development, crop inputs and output prices were also collected to estimate the profit margins and cost of production in relation to standard berseem production.

The farmers' gross income, total variable costs of growing cash and forage crops, and net income (whole farm including berseem clover VBFSE) were calculated on a per hectare basis using the following formulae (Shah et al., 2011, Imran et al., 2012):

$$GI = (Pf \times Yf) + (Ps \times Ys)$$

Where:
GI = gross income
P_f = price of the green forage
Y_f = total green forage produced (forage crops)
P_s = price of seed/grain, which vary with the crop
Y_s = yield (total quantity) of seed produced

$$TVC = Pi \times Li$$

Where:
TVC = total variable costs
P_i = price of crop inputs
L_i = level of input

$$NI = GI - TVC$$

Where:
NI = net income
GI = gross income
TVC = total variable cost

Prices for the green fodder (*Pf*), were calculated as 4040 Rs/t for the VBFSEs and 2500 Rs/t for conventional production of berseem clover. The (P_s) seed price also varied between the VBFSE and conventional production systems, being 450 Rs/kg for VBFSE seed and 283 Rs/kg for local (farmer) seed (average of 5 farms). All of the prices of crop inputs were based on average market prices, with labour charges based on the prevailing current wage rate of Rs. 320/day in the area (Government of

Pakistan, 2015). Marginal analyses were carried out to calculate the marginal rate of returns (MRR) between incremental total variable cost and the incremental net income using the following equation:

$$MRR\ (per\ cent) = \frac{NIi}{TVCi} \times 100$$

Where:
MRR = marginal rate of return
NIi = incremental net income
TVCi = incremental total variable cost

For the majority of situations, the marginal rate of return acceptable to farmers (between 40 to 100 per cent) was set as a benchmark for acceptance of agricultural intervention for the majority of situations when considering the capital cost, risk and inflation rate (Shah et al., 2011). The benefit to cost ratio of all the crops (forage and cash crops) was calculated to estimate the revenue generated per rupee of input cost by using the following formula:

$$BCR = \frac{GI}{TVC}$$

Where:
BCR = benefit to cost ratio
GI = gross income
TVC = total variable costs

Results

The average cost of production (Rs/ha) of winter forage and cash crops in Kasur and Okara districts varied from 73,067 Rs/ha for oats production to 252,870 Rs/ha for potatoes (

Table **1**).

Table 1. Average cost of production (Rs/ha) of winter season forage and cash crops across five smallholder farms in the districts of Kasur and Okara, Punjab, Pakistan. Prices and input costs were averaged across farms based on the market prices recorded for the period of 2012-2014

Crop inputs	Berseem clover (conventional)	Wheat	Oats	Potatoes	Canola	Berseem clover (improved + VBFSE)
Land rent	48719	47196	35397	35397	35397	47196
Land preparation	4942	8648	5930	13343	5683	6919
Seed	6108	4942	4606	75958	2570	5930
Fertilisers	19261	33349	17544	71333	19111	29533
Labour	1334	3944	1141	4309	3420	3529
Irrigation water	7591	3357	2222	7686	2269	7181
Pesticides	1977	4769	1112	15439	3632	3756
Harvesting and threshing	10279	11960	4250	21003	11367	9538
Seed procurement	4050	1853	865	8402	1977	5140
Total input costs	**104261**	**120018**	**73067**	**252870**	**85426**	**118722**

Overall, the two major costs involved in crop production were land rent (33 per cent of total costs) and fertilisers (25 per cent of total costs), and the combined average cost was 31,689 Rs/ha. However, for potato production the two major costs were seed and fertiliser, and these were both comparatively high due to high seed import costs and the high fertiliser requirements for this crop. The cost of land leased varied between the two districts of Kasur and Okara and therefore also varied between crops, depending on the growing season as some crops (wheat and berseem clover) have longer growing seasons compared to other crops (oats, potatoes and canola). The cost of production varied between conventional and improved (VBFSE) cultivation of berseem clover, which was due to the adoption of improved practices such as the balanced use of fertilisers, use of inoculum and seed procurement costs.

The average green forage, straw, tuber and seed yields across the five farms, together with their respective costs of production and gross and net crop incomes from the crops grown at the same time in the study area are presented in
Table **2**. Of all the crops, berseem clover VBFSE (utilising improved variety seed) had the highest net income, MRR and benefit: cost ratio, while wheat had the lowest benefit: cost ratio. The proportion of the berseem clover seed income in the VBFSE was almost eight times greater (425,700 Rs/ha) than that for conventional berseem production (54,336 Rs/ha).This was because of the increases in seed yield from the VBFSEs through the use of improved production technologies, and also the premium price on offer for the berseem clover seed produced.

Table 2. Average forage and cash crops yields, and their profit incomes obtained by conventional and improved production technologies of the VBFSEs farms in the districts of Kasur and Okara, Punjab, Pakistan. Crop yields, prices and input costs were averaged across farms and based on the local markets during the period of 2012-2014

Crops	Green forage/ straw yield (t/ha)	Seed/ tuber yield (kg/ha)	Total variable cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Marginal rate of return (%)	Benefit: cost ratio
Berseem clover (conventional)	31.8	192	104261	259292	155031	149	2.49:1
Wheat	4.6	4269	120018	154040	34022	28	1.28:1
Oats	32.4	2965	73067	118608	45541	62	1.62:1
Potatoes	-	26094	252870	395607	142737	56	1.56:1
Canola	1.4	2639	85426	141509	56083	66	1.66:1
Berseem clover (VBFSE)	50.6	946	118722	631062	512340	432	5.32:1

The benefits of the varietal selection and evaluation, seed production and establishment of VBFSEs compared to a conventional production system (Table 3) stems from the capacity building of the seed entrepreneurs (farmers) in knowledge and skills in Berseem clover forage and from seed production to the economic benefits through seed sale (incomes generated through VBFSEs). The assessment results indicated that both the improved variety (100 per cent) and improved agronomic practices (62-87 per cent) were adopted by the smallholder dairy farmers after the village based seed enterprise trials were conducted on their farms.

Table 3. The comparison of the adopted improved practices before and after village-based seed enterprises (VBFSEs) by farmers in the districts of Kasur and Okara, Punjab, Pakistan

Practices	Before VBFSE	After VBFSE
Use of improved variety (Agaitti Berseem-2002) of Berseem clover	Farmers used low yielding indigenous local varieties (74 per cent). These varieties had lower forage, dry matter and seed yields (Table 2).	100 per cent of the VBFSE farmers were satisfied with the research station variety when they compared it with local seed varieties. Amongst seed entrepreneurs, there was about a 37 per cent increase in forage and 82 per cent increase in seed yields recorded from the improved variety after the VBFSE was established.
Use of Rhizobium trifoli inoculum	Farmers were not well aware of inoculum practice and none of them used it.	Amongst seed entrepreneurs, 62 per cent of the farmers are now using *Rhizobium trifoli* seed inoculum.
Cutting schedule/ harvesting management	Farmers did not follow any cutting schedule in order to get more forage and seed yields.	The VBFSE farmers (87 per cent) followed the cutting schedule from the VBFSE trials, as first cut was taken after 60 DAS and later cuts were made at 30-35 day intervals.
Use of honeybees as pollinator	Farmers were mostly unaware of the role of honeybees in Berseem clover seed production.	Amongst seed entrepreneurs, 75 per cent of the VBFSE farmers selected the fields near to natural honeybee hives, indicating their increased awareness of the importance of these pollinators in Berseem clover seed production.

A comparison of the net income of VBFSE berseem clover, and other forage and cash crops (winter season) for each of the five farms involved in the study is presented in While the average cost of production of berseem clover VBFSE was higher than for conventional berseem clover production (Table **1**), the increased gross income from higher forage and seed production resulted in an average 230 per cent increase in net income over conventional berseem clover production across the five farms. The variability in net income that occurred between farms is highlighted in Figure 2.

Discussion

This study has provided insight into the activities of the smallholder farmers of Punjab-Pakistan, of growing Berseem clover forage and producing seed and the profitability of and constraints associated with forage seed production on small-holder farms. The potential size of the Berseem seed market in the country is huge, since more than 22 thousand tonnes of seed is imported annually (Government of Pakistan, 2015). Participation in varietal selection and evaluation is an entry point for farmers contemplating a VBFSE. VBFSEs provide an immediate supply of quality seed to the smallholder farmers. Clearly greater net returns for smallholder farmers were achieved from growing an improved variety of berseem clover for sale as both forage and seed relative to other crops in the central districts (Kasur and Okara) of Punjab, Pakistan for the season of 2013-2014. This can be seen from the higher benefit: cost ratios presented in
Table **2**.

Figure 1. For all five farms, berseem clover VBFSE was the most profitable activity and produced higher net benefits for farmers.

While the average cost of production of berseem clover VBFSE was higher than for conventional berseem clover production (

Table **1**), the increased gross income from higher forage and seed production resulted in an average 230 per cent increase in net income over conventional berseem clover production across the five farms. The variability in net income that occurred between farms is highlighted in Figure 2.

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Figure 1. Comparison of net incomes (Rs/ha) of berseem clover VBFSE, wheat, oats, potatoes and canola crops under the agro-climatic conditions of Kasur and Okara districts of Punjab, Pakistan

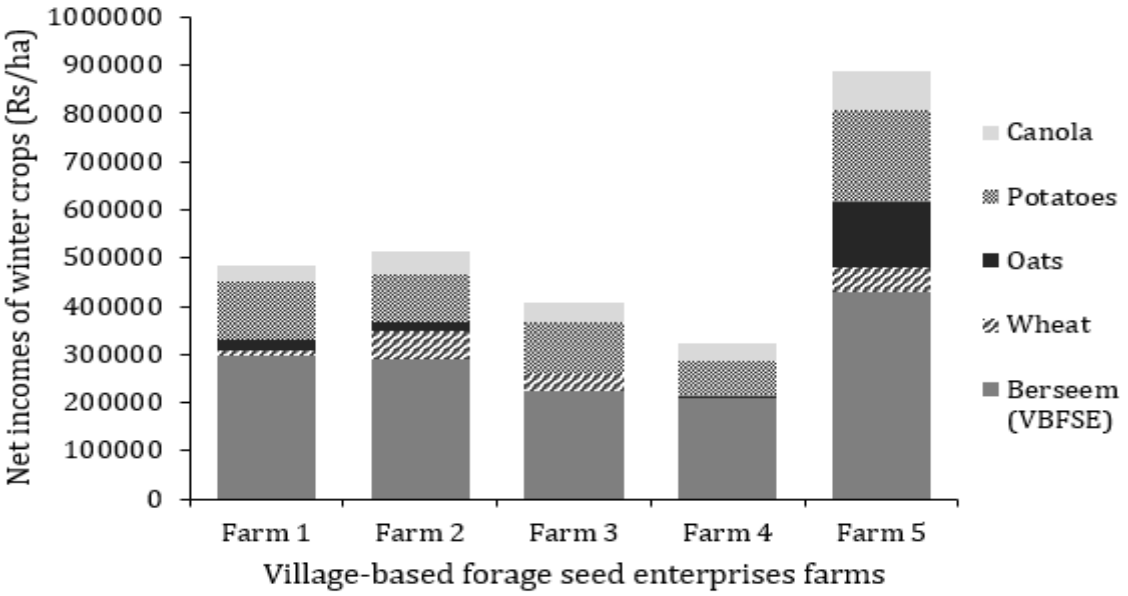
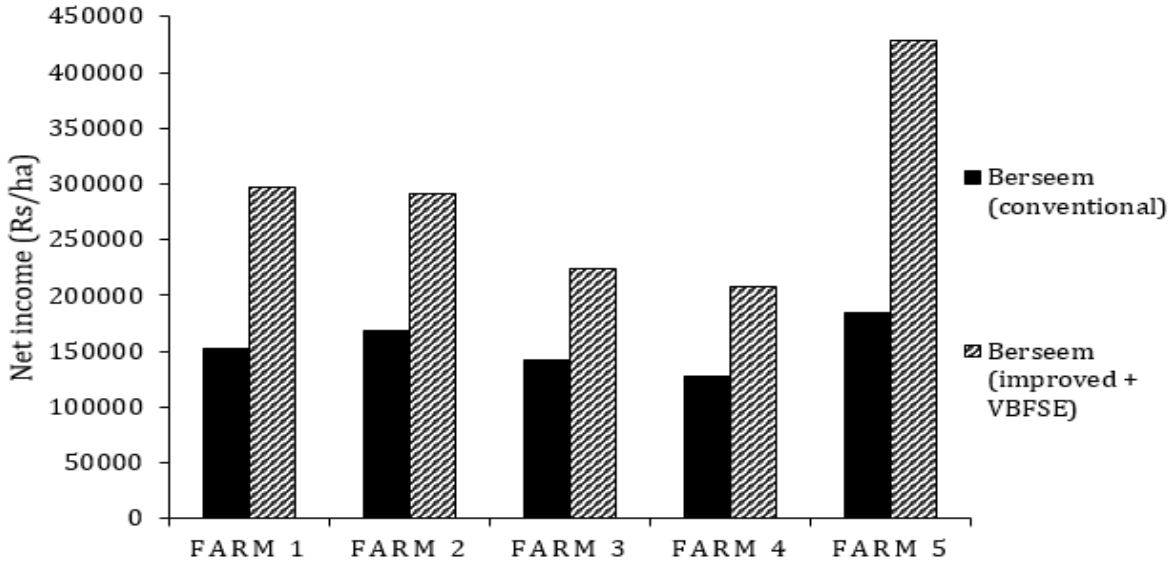


Figure 2. Comparison of net incomes (Rs/ha) of five farms growing berseem clover conventionally and with the use of a combination of improved practices plus seed selling through VBFSE



The variation between each farming operation (Figure 2) indicates that there may have been differences in management capabilities of the farmers. Regardless, the profit margins (from both forage and seed) would still be greater from using the improved variety seed of berseem clover with innovative farming techniques in comparison to using the local variety seed and conventional cultivation methods. This was a consequence of the use of standard genetic breeding practices increasing the phenotypic potential of the improved variety seed to boost profitability (Cain et al., 2007; Singh et al., 2013b). The present study was conducted across only two growing seasons and thus the longer term impact of VBFSEs could not be examined. It is anticipated however, that outcomes may actually improve over time as the greater berseem clover production may also lead to greater deposition of nitrogen (N) in the root zone, boosting the production and quality of subsequent crops. This alone may result in greater adoption of the new technology. Increasing farmers' capacity to produce quality seed through participatory varietal selection and evaluation, may also foster linkages between the technology and farmer participation, leading to adoption of both the improved seed variety and production technology at the farm level (Reddy et al., 2006).

Poverty levels in rural Pakistan have been associated with the financial viability of smallholder farm enterprises (Government of Pakistan, 2015). Crop net income, level of risk and attitude to that risk are important factors affecting a farmer's decision making to engage in certain cropping and other enterprises (Cain et al., 2007). Variability in market prices due to economic uncertainties poses a risk associated with the investments of farmers in crop inputs (Shah et al., 2011); however, the risk is lower in mixed farming systems because of the range of cash crops and forage crops, and livestock enterprises that contribute to whole farm profitability (Devendra and Thomas, 2002; Cain et al., 2007). In Pakistan, forage and (forage) seed marketing has no formal organised structure. The process of price formation is very simple as farmers accept the prevailing market price or negotiate with the producer farmer by using the prevailing market price as a reference (Cain et al., 2007). However, the prices of both green forage and seed are dependent on demand and supply and the quality of these products. The main quality traits for forage are good lustre, sweetness in taste and moisture contents, and, for seed, size, weight and cleanliness (Nakamanee et al., 2008; Singh et al., 2013a). The sale of quality forage seed locally has emerged as a new farm enterprise, providing high net returns for smallholder farmers.

The critical factors for the adoption of legume forages in dairy production systems include: the recognition of benefits by farmers, quality seed supply, a working knowledge of crop management; and clear financial signals on their profitability (Muir et al., 2014; Sarwar et al., 2002a). In a study

examining critical factors affecting the viability of smallholder farms, Cain et al. (2007) reported that the adoption of improved forage production technology increased net income by 113 per cent. The results of the present study are far superior, with the net income from the berseem clover VBFSE being 230 per cent greater than that of conventional berseem clover production. This was a result of not only the higher forage and seed yields but also the higher selling prices commanded by the superior quality forage and seed. The average selling price of the improved variety forage in the market was 4.04 Rs/kg compared to 2.50 Rs/kg for conventional berseem clover forage. In the present study, incomes were calculated based on improved variety seed attracting a premium price of 450 Rs/kg compared to 283 Rs/kg for farmers' (conventional) seed (see Appendix Table). Nakamanee et al. (2008) found that higher prices were paid for improved variety forage and seed in a study of forage for sale for smallholder farmers in Yasothon, Thailand. Moreover, the smallholder farmers in Thailand generated on average a 2.5:1 benefit to cost ratio which is lower than that produced (5.3:1) in the present study (
Table **2**).

Regarding seed certification and registration issues, both public and private seed entrepreneurs can develop realistic regulations for rigorous seed certification. These work both for the sale of informally produced seed as well as the management of genetic diversity among the improved varieties at the national level. The seed produced locally by VBFSE (as opposed to commercial seed companies) would need to only meet the relevant quality standards appropriate to farmers without having to meet the formal international seed quality standards for Berseem clover (purity > 97 per cent, inert matter < 2 per cent, weed/other crop seed < 0.10 per cent, noxious weeds < 0.05 per cent and germination > 70 per cent) as described by the Federal Seed Certification and Registration Department of Pakistan (Government of Pakistan, 1991). However, appropriate least cost grading, cleaning and treatment technology for processing, packing and storage of Berseem clover seed should be implemented through VBFSEs in combination with a degree of varietal certification to ensure the supply of quality seed at the farm level and the prevention of the spread of weeds.
Although financial considerations are a major factor affecting the decision to invest in a VBFSE, other factors included quick returns from forage (2 months after cultivation), feed availability for livestock and seed for maximum income. Apart from high net income, farmers mentioned other factors that enticed them to grow forage and seed from an improved berseem clover variety, through VBFSEs. A key factor was improved cash flows as the farmers get paid every month from the sale of forage while generating significant net profits from the harvest of seed once the crop matures. This contrasts with the incomes from other cash crops such as wheat, potatoes and canola which were received only once in a year. The second factor was that forage crops did not require the application of herbicides, which was found to be hazardous and costly in the production of cash crops.

In addition, the imbalanced use of nutrients is a major concern and cause of low productivity in forage crops (Nakamanee et al., 2008), and farmers often use phosphate (P) fertiliser below the recommended application rates while large deficits in potassium (K) fertiliser application rates have also been observed (Nakamanee et al., 2008, Ul-Allah et al., 2014). The major consequence of inadequate fertiliser use is decreased lower income from decreased seed yields although it must be conceded that variable costs may be decreased also. Variable costs increased with increased use of P and K fertilisers, labour, use of pesticides to save seed crop from pest damage and seed procurement, but increased use of these inputs ultimately enhances forage and seed yields and thus net incomes. This increase in P and K fertiliser costs may be in part offset by the savings in N fertiliser application that occurred through nitrogen fixation by berseem clover in the VBFSE system. The quantity of N fixed by berseem clover ranges between 115-400 kg/ha during the growing season depending on variety and seasonal conditions. This N is not only used by the berseem clover crop for its growth but also the subsequent crops (requiring 50-235 kg/ha of N) grown on the same land (Graves et al., 1990): this represents a major saving on N fertilizer for the farmers.

The participatory research approach generated direct results (Table 3) which are likely to be more sustainable in agricultural development of smallholder farms. Despite being only relatively small-scale trials, the research trials undertaken on the farmers' field acted as demonstration plots and thus would have helped in creating real demand for seed and adoption of the new seed varieties selected by the farming community. This small, informal research and extension system will speed up the flow of improved variety seed to the smallholder farmers because varieties were selected and evaluated under the local conditions operating within their farming systems. The adoption problems can be sorted out through establishment of further demonstration plots (as established in this study) of the improved variety seed and comparing it to the productivity of local varieties. Dissemination of the improved variety seed to the farming community (regular supply of foundation seed), improving seed availability at sowing time and reducing seed prices so they are affordable to farmers, are additional benefits derived from the VBSE concept. This will lead to the dissemination of improved variety seed to more farmers and complement the existing formal forage seed supply system in the country.

The minimum rate of return which is acceptable to Pakistan smallholder farmers in adopting any agricultural intervention is 40-100 per cent, which is largely dependent on the market prices for outputs (forage and seed) (Shah et al., 2011). The marginal rate of return for berseem clover VBFSE was 432 per cent, thus providing a very attractive business proposition for the small-holder farmers of Punjab, Pakistan. While the seed enterprises are highly profitable as shown in Table 2 and While the average cost of production of berseem clover VBFSE was higher than for conventional berseem clover production (
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This study has provided insight into the activities of the smallholder farmers of Punjab-Pakistan, of growing Berseem clover forage and producing seed and the profitability of and constraints associated with forage seed production on small-holder farms. The potential size of the Berseem seed market in the country is huge, since more than 22 thousand tonnes of seed is imported annually (Government of Pakistan, 2015). Participation in varietal selection and evaluation is an entry point for farmers contemplating a VBFSE. VBFSEs provide an immediate supply of quality seed to the smallholder farmers. Clearly greater net returns for smallholder farmers were achieved from growing an improved variety of berseem clover for sale as both forage and seed relative to other crops in the central districts (Kasur and Okara) of Punjab, Pakistan for the season of 2013-2014. This can be seen from the higher benefit: cost ratios presented in
Table **2**.

Figure 1, opportunities still exist to make forage and seed production even more profitable by using improved varieties of seed and production technologies (Nakamanee et al., 2008). Moreover, the demand for fresh forage and seed is likely to continue to expand as the dairy industry in Pakistan expands (Sarwar et al., 2002b).

Conclusion

The results of the present study show the great potential for VBFSE establishment among Pakistani farmers as a future approach to strengthen the current forage and seed production and supply system. The incorporation of both the improved genetics and better management systems demonstrated that berseem production could become a more attractive crop choice for farmers. There are production implications that extend beyond forage and seed production to the enhancement of the whole cropping enterprise through additional nitrogen fixation for use by subsequent crops. There are indirect advantages for animal production also through an improvement in the feed base on offer. This approach to strengthening smallholder farmers through the adoption of VBFSEs can improve sustainability of agricultural productivity and the livelihoods of the smallholder farmers of Pakistan which leads to more effective rural development and poverty reduction.

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Appendix Table. Average crop inputs and outputs prices at farm gates of the village-based forage seed enterprises farms in the districts of Kasur and Okara, Punjab, Pakistan during growing winter season of 2013-2014

Crop inputs		**Crop outputs**	
Input categories	Prices (Rs)	Output categories	Prices (Rs/ton)
Land rent per ha (12 months)	70794	*Green forage (conventional)*	2500
Seed per ha (Berseem clover)	764	*Seed (conventional)*	283000
Rhizobium inoculum per ha (Berseem clover)	148	*Green forage (premium price)*	4040
Farm yard manure per trolley (3 tonnes/trolley)	1750	*Seed (premium price)*	450000
Urea (50 kg bag)	1950	*Oats seed*	38000
Di-ammonium phosphate (50 kg bag)	3800	*Wheat grain*	30000
Sulphate of potash (50 kg bag)	5350	*Straw*	5778
Canal irrigation per ha (12 months)	338	*Potatoes*	15167
Tube well irrigation per ha (each)	2348	*Canola grain*	260000
Pesticides per ha (each application)	2100		
Labour wages (per person per day)	450		