

Sustainable Potato Farming in Mountainous Agriculture: Empirical Evidence from Khyber Pakhtunkhwa, Pakistan

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Abstract Potato cultivation in mountains has the potential to improve food security and provide income for the households. This article open-up the initial results of a project interventions to ensure availability of virus free seed potatoes to the farmers of merged districts, Khyber Pakhtunkhwa, Pakistan and down country, to generate livelihood opportunities for local populations through creation of potato seed industry and to increase farmers' earnings through increase in potato production using disease free certified seed potato. The study analyzed the effect of training imparted for skill development, improvement in potato production and potato produce from improved seed was used for further seed multiplication. A total of 69 project beneficiary farmers were interviewed through pretested questionnaire from two districts (Kurram and Orakzai) of Khyber Pakhtunkhwa, Pakistan. The farmers selected for seed potato crop cultivation were young, educated and well experienced. Farmers cultivated potato crop for earning more profit. The farmers liked high yielding varieties of seed potato crop introduced by the project. Agriculture Research Institute of the area is the main source of information/knowledge and potato seed. Farmers were satisfied from the knowledge they gained during the training and enthralled with training organization and management. The most important effect of the training was knowledge of crops outlook. The cultivation of seed potato crop in the area was found profitable, however, there was more potential for increasing seed potato production in the area. Local market traders were the main buyers of the majority of seed potato produced. The study suggests to continue the program along with introduction of trial based technologies applicable and varieties suitable to socio-econ-psycho-and climatic conditions of the area. Potato crop variety SM Kaghan along with diversified production system needs to be promoted in the area. More research was needed for understanding the behavior of market channels of seed potato crop.

Keywords: *Potato, seed, technology, mountains, Pakistan*

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1. Introduction

Mountain farming is family farming spread over patches of useable land at different altitudes. It has varying climates, often highly fragmented landscapes that has narrow limits for mechanization and mostly efficient and effectively managed by family farms. Majority of the produce are for family consumption [1]. Potato cultivation in mountains is market-oriented crops that on one-side provides food and on the other-side acts as a source of income for the household [2].

Potato (*Solanum tuberosum* L.) is an important annual crop, widely cultivated in diverse agro-climatic conditions of Pakistan and worldwide [3]. The crop is highly productive [4], income making [5], supplying cheap and

rich-nutritional staple food [4], potential of behaving in nutritional value and food security [6] and in earning livelihood that farmers have adopted the commercial cultivation of this crop [5]. The potential of potato crop as financial generator and source of food is much under-utilized in many emerging economies [4].

The crop is grown in three seasons in Pakistan i.e., Autumn (winter) Crop in Punjab, Sindh and Khyber Pakhtunkhwa from October to January, Spring Crop Northern Punjab and Khyber Pakhtunkhwa from January to March and Summer Crop at high altitudes like, Gilgit Baltistan, mountainous areas of Khyber Pakhtunkhwa and merged areas from April to July. The country ranked 15th in area (1.12 percent area) of the world under potato crop with 1.27 percent of the world's production. The area under potato crop was 42900 ha, production 448500 tonnes, yield 10.45 tonnes/ha during 1980 that increased

to 185360 ha, 4552656 tonnes, yield 24.56 tonnes/ha. The area, production and yield of potato crop from 1980 to

2020 was given in Figure 1 [7].

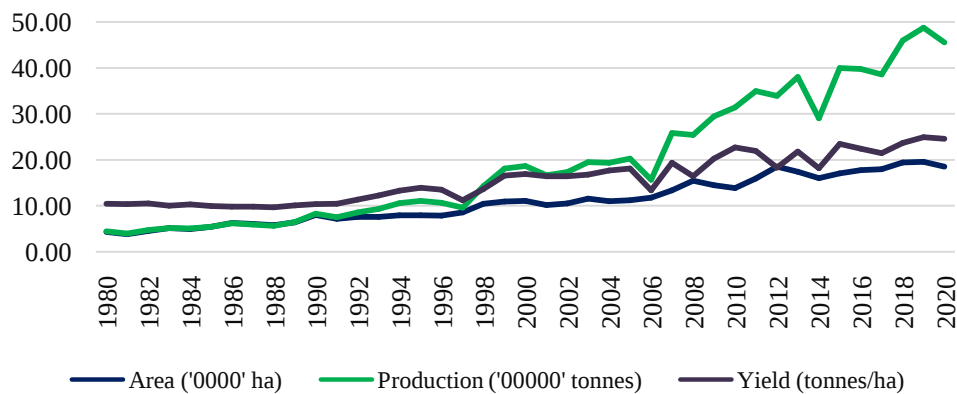


Figure 1. Area, production and yield of Potato in Pakistan (Source: FAO, 2022)

The potato growing sector is of great importance and is one of the popular food crops that create stability and support a nutritious diet for the country's population [8]. The average yield of potato crop is low, ranked 54th in the world, due to plethora of problems and issues. Less area allocation in comparison to other crops, non-availability of certified quality seed potatoes, pathogenic diseases, extremes of temperature, soil deficiency in nutrients, salinity, drought, poor irrigation water [3], costly inputs, output price fluctuations and lack of storage facility and credit [9] are the challenges to potato productivity in Pakistan.

This article open-up the initial results of a project interventions that was started to establish advance R&D facilities for bringing merged districts of Khyber Pakhtunkhwa, Pakistan in order to ensure availability of virus free seed potatoes to the farmers of merged districts and down country and to generate livelihood opportunities for local populations through creation of potato seed industry and to increase farmers earnings through increase in potato productions using disease free certified seed potato. In analyzing the effect of the project, the questions asked were:

- Whether the training imparted for skill development improved the skills?
- Is the seed potato production in the area was improved?
- Whether the farmers utilized the potato produce for further seed purpose?

The project interventions were made at high altitude areas of district Kurram (Upper) and district Orakzai, Khyber Pakhtunkhwa, Pakistan. District Kurram lies between 33°69' North latitude and 70°33' East longitude. Kurram has distinctively different agro-climatic conditions in upper and lower zones. Kurram Upper is mountainous, cooler, relatively rich in water – whereas Kurram Lower is drier and warmer. Crops grown in district Kurram are wheat, maize and vegetables. District Orakzai lies between 33°66' North latitude and 70°95' East longitude. Orakzai is a hilly region with a fertile valley. The valley is flanked by mountain ranges 2,100-meter high. The whole of the territory of Orakzai is a mountainous tract dissected by numerous dry watercourses, especially in the southwest part of the

district. Crops grown in district Orakzai are wheat, maize, vegetables, millet and fodder I [10].

Potato crop being the potential of income generation, nutritional value, food security and to improve the livelihood of the farmers. Directorate of Agriculture Research (Merged Districts) {AR(MD)}, Khyber Pakhtunkhwa implemented a project with the aim to develop a system of virus free seed potato production by taking advantage of the experiences gained by Hazara Agricultural Research Station, Abbottabad (HARS). Certified propegules for tissue culture was obtained from HARS or any other certified source that were put in the system at two tissue culture laboratories (ARI, Tarnab and ARSS Parachinar). Multiplication of micro seed potato tubers were also carried out at green houses at Tarnab and Parachinar. Large scale multiplication is proposed at high altitudes at Kurram and Orakzai. A cadre of potato seed growers are being trained at HARS and provided with necessary kits for virus free seed potato production. Their skills in seed potato production are being developed and they are grouped in seed potato enterprise association. Their linkages with prospective seed potato buyers were developed. The aim of the intervention is to harness the potential of the natural resource of the area and provide a sustainable basis for seed producers in the merged areas.

Major interventions in the scheme

- Skill development of 800 growers of Kurram and Orakzai Districts and provision of certified seed potato tubers for further multiplication.
- Provision of kits to 800 seed potato growers.
- Develop linkages with Federal Seed Certification Department.
- Construction of Tissue Culture Laboratory at Parachinar while renovation of Tissue Culture Laboratory at Tarnab.
- Construction of Green House at Parachinar while renovation of Green House at Tarnab.
- Construction of Seed Storage Bunkers at Kurram and Orakzai.

- Provision of laboratory chemicals, glassware and equipment.
- Provision of farm machinery for seed production.

2. Materials and Methods

2.1. Geographical Location of Study Area

The survey was conducted in two merged districts Orakzai and Kurram where the project interventions regarding seed potato cultivation were made during 2020-21 and 2021-22. A total of 80 seed potato beneficiary farmers were randomly selected from the beneficiary list during October 2022, that was accessed from the Directorate of Agriculture Research, merged districts, Khyber Pakhtunkhwa.

2.2. Data Collection and Analysis

In 2022, 69 farmers of the project direct beneficiaries were randomly interviewed through pretested interview schedule from project sites; district Kurram and district Orakzai, Khyber Pakhtunkhwa, Pakistan. The farmers had given with improved varieties of potato, farm inputs, farm machinery kits and training for skill development, provided by the project. The questions asked during survey from each farmers were focused on farmer's socioeconomic characteristics, trainings impact, production practices and utilization of potato produce. The data on cultivation practices, costs, yield and consumption were obtained from the farmers and the price was obtained in the national currency unit—1 USD = 221.4966 PKR [11]. Descriptive statistics along with index, Eta square and technical efficiency was used to find the answers of the questions.

3. Results

3.1. Demographic Statistics of Sampled Seed Potato Farmers

The study results revealed that average age of the sampled seed potato respondents was 35.58 years with family size of 16 persons per household (7 males and 9 females). The findings showed that the average schooling years of the sampled seed potato respondents was 7.70 years. The illiterate sampled seed potato respondents were 16 percent, more than half (54 percent) had upto matric and remaining 20 percent and 10 percent of the sampled respondents had above matric and primary education, respectively. Farming experience of the sampled seed potato respondents was 15.19 years and 87 percent were full-time while 13 percent had part-time involvement in farming. Farming was the main income source for four-fifth of the sampled household while one-fifth had non-farm activities as main income source. Average household income of the surveyed households was PKR 0.612

million per year where agriculture shared 68 percent while 32 percent was shared by non-farm income sources in the average annual household income. The findings revealed that a vast majority (93 percent) of the sampled seed potato respondents were owners of the land followed by 6 percent was owner-cum-tenants while small portion (1 percent) of the sampled seed potato respondents were tenants. The size of cultivated land was 3.89 acres and the lease rate per acre was PKR 36625 per annum in the study area (Table 1).

Table 1. Socioeconomic characteristics of sampled seed potato respondents

	Unit	Value
Age (Years)	Years (Std. Deviation)	35.58 (10.332)
Education (Years)	Years (Std. Deviation)	7.70 (4.532)
Illiterate	Percent	16
Primary	Percent	10
Upto matric	Percent	54
Above matric	Percent	20
Farming Experience	Years (Std. Deviation)	15.19 (10.544)
Full Time & Part Time	Percent	87 & 13
Family Size	Numbers (Std. Deviation)	16 (9.642)
Male & Female	Numbers (Std. Deviation)	7 (3.41) & 9 (4.51)
Main income source		
Agriculture	Percent (% of total income)	80 (68)
Non-Agriculture	Percent (% of total income)	20 (32)
Household income	PKR/year in millions	0.612
Tenancy Status		
Owner	Percent	93
Owner-cum-tenant	Percent	6
Tenant	Percent	1
Cultivated Land	Acre (Std. Deviation)	3.89 (4.162)
Land lease rate	PKR/Acre/year (Std. Deviation)	36625 (6817.78)

Source: Survey data 2022

3.2. Perceptions Regarding Different Features of Seed Potato Crop

The study results revealed that the sampled seed potato respondents ranked potato cultivation as 'More Profitable' and ranked first while 'Impressed Fellow Farmers', 'Family Tradition' and 'Growing in the Area' were ranked as second, third and fourth respectively by the sampled seed potato respondents in the study area. The findings showed that the sampled seed potato respondents were fond of those potato varieties that had 'high yield' followed by 'more market value', 'good taste' and 'own home seed'. AR(MD) of the area was ranked by sampled seed potato respondents as the main source of information/knowledge followed by fellow farmers/relatives, agriculture extension office and input dealers. Similarly, the sampled seed potato respondents ranked AR(MD) of the area as the main source of seed potato followed by own seed, agriculture extension office, relatives/fellow farmers and input dealers (Figure 2).

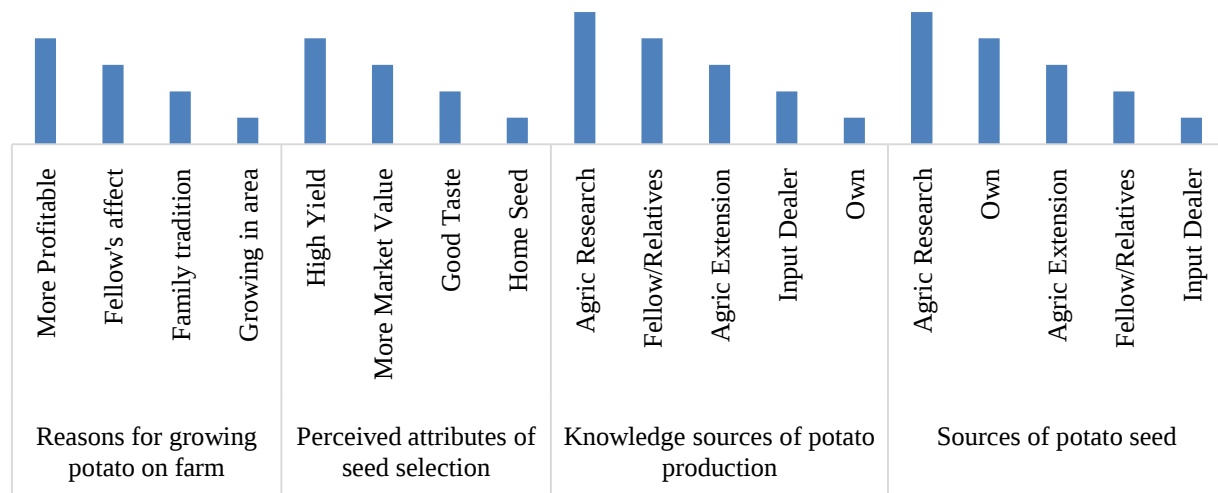


Figure 2. Perceptions regarding different features of potato crop

3.3. Perceptions Regarding Training

Human Resource Development is the change in education, knowledge, skills, self-awareness, attitudes and motivation to perform and act differently [12]. It is not a new wonder. The impact of training is increase in yield and decrease in diseases and mortality rate [13]. Increasing skills, knowledge and capabilities of farmers through training improves the agriculture productivity. Ahmad *et al.* (2007) showed that the training impact are positive in terms of increase in crop yield and the farmers has started to grow new crops.

Different question regarding training organization and management i.e., number of days, time for theory and practice, presentation of the lectures, improvement in agriculture knowledge, helped in skill development, knowledge about plants growth, knowledge of crops outlook and knowledge of quality of produce had been asked from the sampled seed potato respondents that already had completed the training. The response was categorized as 1=extremely insufficient, 2=insufficient, 3=neutral, 4=very sufficient and 5=extremely sufficient. Index was calculated that ranges in between 0 (Extremely Insufficient) to 1 (Extremely Sufficient) that indicates low to high score respectively and are unit free. The study results revealed that the overall training index was 0.82 to 0.86 showing that the sampled seed potato respondents were happy with training organization and management. Eta squared is the proportion of variance associated with each main effect and interaction effect in an ANOVA model. The Eta squared value ranges from 0 to 1, where values closer to 1 indicate a higher proportion of variance that can be explained by a given variable in the model. Rules of thumb to interpret values for Eta squared was .01: Small effect size, .06: Medium effect size and .14 or higher: Large effect size [14]. The result showed that the most important main effect was Knowledge of Crops Outlook followed by Number of Days, Improvement in Agriculture Knowledge, Knowledge of Quality of Produce, Helped in Skill Development, Knowledge about Potato Plants Growth, Presentation of the Lectures and Time for

Practical & Theoretical Training. The t-test was highly significant showing that the knowledge of sampled seed potato respondents before and after training regarding different crop management techniques of seed potato crop was improved (Table 2).

Table 2. Perceptions regarding training

Training Management	Index (Std. Deviation)	Eta Squared (Eta)
Knowledge of Crops outlook	.83 (.252)	.048 (.218)
Number of Days	.82 (.254)	.026 (.160)
Agriculture Knowledge Improvement	.84 (.239)	.023 (.152)
Knowledge of Quality produce	.86 (.220)	.016 (.128)
Helped in Skill development	.85 (.228)	.016 (.126)
Knowledge about Potato plants growth	.85 (.236)	.015 (.121)
Lectures Presentation	.83 (.245)	.014 (.119)
Time for Practical & Theory	.85 (.224)	.006 (.078)
Knowledge Improvement before and after	t	df
Land preparation techniques	-9.223***	68
Quality seed characteristics	-9.186***	68
Recommended Seed rate	-18.935***	68
High yielding varieties	-10.285***	68
Recommended fertilizers	-33.242***	68
Potato crop diseases	-10.968***	68
Controlling measures of disease	-15.170***	68
Insect/Pests	-6.906***	68
Controlling measures of Insect/Pests	-6.407***	68
Weeds	-5.422***	68
Controlling measures of Weeds	-6.601***	68
Dosage of pesticide and herbicide usage	-9.402***	68
Knowledge of irrigation methods	-9.402***	68
New packaging methods or materials	-6.412***	68

Source: Survey data 2022

3.4. Seed Potato Variety (mnds/Ac), Satisfaction, Storage Facilities and Post-Harvest Losses

Improving the adoption of improved potato varieties might impact on household food, farmer's income and nutritional security [15]. The study results revealed that majority (87 percent) of the sampled seed potato respondents had grown Kuroda variety of potato that produced 97.62 mounds per acre whereas 9 percent cultivated SM Kaghan variety that produced 117.67 mounds per acre and the remaining 4 percent of the sampled seed potato respondents had grown Asterix variety that produced 90.00 mounds per acre. The findings showed that the overall satisfaction index (Satisfaction level of the sampled respondents about the seed potato variety was categorized as 1=very dissatisfied, 2=dissatisfied, 3=neutral, 4=satisfied and 5=very satisfied. Index was calculated that ranges in between 0 (very dissatisfied) to 1 (very satisfied) and are unit free) was 0.68 showing that the sampled respondents were satisfied with the seed potato variety given by the AR(MD). More

than four-fifth (85 percent) of the sampled seed potato respondents had normally kept seed potato produce at home at one room (storage facility) while 15 percent of the sampled seed potato respondents had no storage facility for seed potato produce. The losses during the storage of seed potato were 4.61 percent in the study area (Table 3).

Table 3. Seed potato variety (mnds/Ac), satisfaction, storage facilities and post-harvest losses

Variety	Unit	Value	Unit	Value
Kuroda	Percent	87	40 kg	97.62
SM Kaghan	Percent	9	50 kg	117.67
Asterix	Percent	4	50 kg	90.00
Total	Percent	100	50 kg	99.03
Satisfaction level	Index	.68	Std. Deviation	0.373
Storage facilities (percent)	Yes	85	No	15
Post-Harvest losses during storage	Percent	4.61	Std. Deviation	1.508

Source: Survey data 2022

Table 4. Per acre cost seed potato production (remote Seed)

Particulars	Unit	Quantity	Rate (Rs.)	Amount	
Yield		Per Acre		Per acre	Per Ha
Produce	40 kg	104	2309	240136	593136
Output				240136	593136
Costs					
Preparatory tillage					
Deep Ploughing	Hrs	2.16	2259	4871 (3)	12031
Ploughing and Planking	Hrs	1.44	2259	3258 (2)	8048
Ridge making	Hrs	1.86	2259	4210 (2)	10400
Seed	Kg	1000	50	50000 (29)	123500
Sowing	Day	7.75	841	6515 (4)	16093
Manure and transportation	Trolley	2.22	2695	5976 (4)	14760
Labor	Day	1.46	841	1224 (1)	3024
Fertilizer(s)				0	
Urea	Beg	0.54	2405	1290 (1)	3185
DAP	Beg	0.81	7924	6431 (4)	15885
NPK	Beg	3.58	7054	25250 (15)	62367
BOP		0.74	2780	2055 (1)	5075
Green Soil	Hr	1.26	1659	2092 (1)	5167
Potassium Sulphate		0.20	12816	2600 (2)	6423
Fertilizer Labor	Day	0.49	745	365 (0.1)	902
Plant protection measure					
Weedicides	Bottle	1.00	845	845 (0.5)	2087
Pesticides	Bottle	1.00	657	657 (0.4)	1623
Fungicides	Bottle	2.04	1249	2553 (1)	6306
Harvesting					
Picking	Day	12.91	841	10851 (6)	26803
Tractor	Hrs	3.29	912	3000 (2)	7410
Land rent (for 6 months)		1.00	36625	36625 (21)	90464
Variable Costs	PKR			134044 (79)	331089
Total Cost	PKR			170669 (100)	421553
Gross Margin	PKR			106092	262047
Net Income without rent	PKR			106092	262047
Net Income with rent	PKR			69467	171583
Benefit Cost Ratio				1.41	1.41

Source: Survey data 2022

3.5. Benefit-cost Analysis of Seed Potato Production

The study in hand examined the profitability of seed potato crop of the sampled beneficiaries. To determine the profit level of seed potato crop, attempts were made to estimate the cost and return analysis, the data was obtained from seed potato beneficiaries growers on cost of input, yield, and output except water charges. The study results revealed that the land charges accounts for 21 percent of the total cost per acre of seed potato crop. The variable cost accounted for 79 percent per acre of seed potato crop in the study area. The major cost component was the seed that accounted for 29 percent of the total cost, combine together, land preparation cost accounted for 7 percent of the total cost, FYM 4 percent and chemical fertilizers accounted for combine together 24 percent. Combine together, plant protection measures accounts for 2 percent, tractor hours for seed potato crop harvesting accounted for 2 percent and labour accounts 11 percent of the total cost. The findings showed that a total cost of PKR 1,70,669 was incurred on one-acre of seed potato crop produce while the net income with rent was PKR 1,06,092 and net income with rent was PKR 69,467 indicating that seed potato crop in the study area was profitable. The Benefit-Cost Ratio was 1.41 that is greater than 1 indicating that according to the rule of thumb (a project with a cost ratio greater than one, equal to one or less than one indicates a profit, break-even, or loss respectively) is believed to be profitable (Table 4).

3.6. Seed Potato Production, Usage and Technical Efficiency

The study results revealed that three quarter of the seed potato produce were sold by the sampled seed potato respondents followed by 12 percent of the seed potato produce stored for seed purpose, while 7 percent exchanged and 6 percent was kept for home consumption by the sampled respondents. The findings showed that Technical efficiency scores of the sample seed potato farmers was ranged from 0.26 to 0.95, with mean score of 0.64. Thus, they can obtain 36 percent higher productivity than current level by using same level of input, just by improving the crop management practices. While, least efficient farmer can increase their crop productivity by 72 percent. Three-fourth of the farmers (75%) are obtaining 60 percent or less than achievable productivity (Table 5).

3.7. Problems and Suggestions

The problems in seed potato crop production in the study area as observed during the survey and stated by sampled seed potato respondents were wild animals (wild-boar, field mice, hedgehog, etc.) followed by less germination-low yield variety-mixed variety, erratic rain fall-wind-storm-flood, rotting in soil, disease, insect pests, high rates of inputs, rusting of stored seed, weeds and no proper agronomic practice. The suggestions given were provision of quality seed potato varieties followed by financial help and subsidy, extension of program, control of wild-boar, more training, water availability for

irrigation-canal cementation, agronomic tools, cold storage, infrastructure and timely availability of seed-other inputs on time.

Table 5. Seed potato production and usage

	40 kg	Percent	Std. Deviation
Production	104.00	100	44.726
Home consumption	6.59	6	8.720
Exchanged for seed	7.22	7	37.686
Sold as seed	77.55	75	39.880
Stored as seed	12.64	12	13.437
Price	2309		782.409
Efficiency level		Percent	Cum.
Up to 20		13	13
21 to 40		32	45
41 to 60		30	75
61 and above		25	100
Obs (Frequency)	69		
Efficiency (Mean)	0.64		0.20
Min	0.26		
Max	0.95		

Source: Survey data 2022

4. Discussion

The study results revealed that the sampled seed potato respondents were young, having large family size and majority were educated. It is a general belief that the young farmers were more productive as compared to old age farmers. The young farmers played a vital role in sustaining the viability of rural areas and food security. They performed better than older farmers as young farmers were more adaptable [16]. The larger family size with active age group might increase the livelihood output; however large number of family dependent members might lower the livelihood output [17]. Literally, education is one of the factors affecting agricultural productivity that have positive relationship [18]. The farmers had sufficient experience in farming and majority were full time farming. The impact of full time farming on agricultural productivity of labor has significantly positive [19]. Farming was the main income source for four-fifth of the sampled seed potato household and the average household income of the surveyed households was PKR 0.612 million per year where agriculture shared 68 percent in the average annual household income. Non-monetary benefits from farming is as important to farmers as monetary benefits [16]. Land is the main input in agriculture production and a vast majority of sampled respondents were owners and self-cultivated their land with farm size of 3.89 acres, having lease rate per acre was PKR 36625 per annum. The farmers had sufficient land to be used for multifunctional farming. There is a need for diversified production system by means of innovative technologies for sustaining the success of farming and to retain young people in the farming sector [16].

Potato cultivation is economical and food crop, referred as "Poor man friend" [20]. The sampled seed potato respondents ranked potato cultivation as 'More Profitable' and were fond of those potato varieties that had 'high yield' followed by 'more market value', 'good taste' and

'own home seed'. Agriculture Research Institute of the area was ranked by sampled seed potato respondents as the main source of information/knowledge followed by fellow farmers/relatives, agriculture extension office and input dealers. Fellow farmers/ relatives were referred to those they had received the same training with them. Similarly, the sampled respondents ranked agriculture research institute of the area as the main source of seed potato followed by own seed, agriculture research office, relatives/fellow farmers and input dealers.

Improvement in agriculture productivity requires education enhancement. Farmer's mind to knowledge is opened by formal education, hands- on training and better farming methods is given by non- formal education and keeping the farmers up-to-date with changing ideas, innovations and to allowing the farmers to share their experience gained by informal education. Hence, education improvement may improve the agricultural productivity via improving the ability of farmer's for making decisions regarding choice of input and farm equipment to increase output (Eric et al, 2014). Farmers were trained regarding the production and management of seed potato crop. The training index was quite satisfactory and the sampled seed potato respondents were happy with training organization and management. The most important effect was Knowledge of Crops outlook followed by Number of Days of training, Improvement in Agriculture Knowledge, Knowledge of Quality of produce, Helped in Skill development, Knowledge about Potato plants growth, Presentation of the Lectures and Time for Practical & Theoretical Training. The t-test was highly significant showing that the knowledge of sampled seed potato respondents before and after training regarding different crop management techniques of seed potato crop was improved.

Improving the adoption of improved seed potato varieties might impact on household food, farmer's income and nutritional security [15]. The findings showed that majority had grown Kuroda variety followed by SM Kaghan variety and Asterix. The higher yield obtained by sampled seed potato respondents was 117.67 mounds per acre from SM Kaghan variety followed by 97.62 mounds per acre from Kuroda variety and 90.00 mounds per acre from Asterix variety of potato. The yield obtained by sampled seed potato respondents were below the potential of these potato varieties e.g., the regular Kuroda varietal trial yield in Potato Research Institute Sahiwal, Annual Report 2019-20 was 17.05 t/ha that was quite larger than the yield obtained (8.90 t/ha) by farmers. However, the sampled seed potato respondents were satisfied with the seed potato varieties given by the AR(MD). Majority of the sampled seed potato respondents had normally kept seed potato produce at home at one room (storage facility) and losses during storage was 4.61 percent.

The results of the study in hand showed that the land charges accounts for 21 percent, variable cost accounted for 79 percent per acre of potato seed crop while the major cost component was the seed (29 percent) of the total cost per acre in the study area. The total cost of PKR 1,70,669 was incurred on one-acre of seed potato crop produce while the net income with rent was PKR 1,06,092 per acre and net income with rent was PKR 69,467 per acre indicating that seed potato crop in the study area was

profitable. The Benefit-Cost Ratio was 1.41 that is greater than 1 and in believed that the seed potato crop cultivation in the study area was to be profitable.

Majority of the seed potato produce was sold in the study area mainly to local market traders. The mean score of technical efficiency obtained was 0.64, showing that their potential for increasing seed potato production by sampled respondents. The problems in seed potato crop production were wild animals, less germination-low yield variety-mixed variety, erratic rain fall-wind-storm-flood, rotting in soil, disease, insect pests, high rates of inputs, seed stored are rusted, weeds and no proper agronomic practice. The suggestions given were provision of quality potato varieties followed by financial help and subsidy, extension of program, control of wild-boar, more training, water availability for irrigation-canal cementation, agronomic tools, cold storage, infrastructure and timely availability of seed-other inputs on time.

5. Conclusion

Mountain farming is family farming that are effectively and efficiently managed by family farms. Potato cultivation in mountains has the potential to improve the food security and provide income for the households. Directorate of Agriculture Research (Merged Districts), Khyber Pakhtunkhwa implemented a project in order to ensure availability of virus free seed potatoes to the farmers of merged districts and down country and to generate livelihood opportunities for local populations through creation of potato seed industry and to increase farmers' earnings through increase in potato productions using disease free certified seed potato. The project interventions are at high altitude areas of district Kurram (Upper) and district Orakzai, Khyber Pakhtunkhwa Pakistan. The farmers selected for seed potato crop cultivation in the project are young, well experienced and educated that can play a vital role in sustaining the viability of rural areas and food security and perform better in adopting new agricultural techniques. Seed potato cultivation by farmers is mainly for earning more profit and they are fond of high yielding varieties of potato crop. Agriculture Research Institute (Merged Districts) of the area is the main source of information/knowledge of potato seed cultivation, that might be due to selection by AR(MD) of those seed potato growers selected for the project and their linkages developed with them. Farmers are satisfied from the knowledge they obtained during the training and delighted with training organization and management. The most important effect of the training is knowledge of crops outlook. The cultivation of potato crop in the area is profitable, however, there is more potential for increasing seed potato production and yield in the area. Local market traders have buy majority of the seed potato produce from the farmers.

Based on study findings, the following suggestions are made:

- Agriculture Department along with related stakeholders are entailed to make awareness campaign and provide scientific guidance to rural farmers of other areas of said districts through equipping them with new farming techniques,

overcome capacity constraints and providing suitable varieties of seed potato crop along with introduction of trial based technologies applicable according to socio-econ-psycho- and climatic conditions of the area.

- Government and Non-Government Organizations are needed to encourage and facilitate true farmers by providing them free seeds, seedlings and fertilizers in the area. Maximum farmers need to be benefitted from these programs and the formalities need to be revised and further to be researched on how these programs could be made more effective.
- Sustainable development projects focusing seed potato crop need to be developed that rallies on the customary norms based on the economic status of the farmers through active participation of rural farm households during planning and implemented stages.
- SM Kaghan variety needs to be promoted in the area for earning more income to farmers.
- Market behavior of seed potato producers need to be researched on how the farmers could be more benefited from the market channels.
- Diversified production system through innovative agricultural technologies need to be introduced for successful farming and to retain young people in the farming sector.
- Linkages of farmers need to be developed with other line agencies.

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