

Potato Waste Reduction Mechanisms: A case study in Abshar district of Panjshir Province, Afghanistan

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ABSTRACT

The objective of the current study is to estimate the amount of potato waste and introduce suitable mechanisms to reduce it in different stages of production. The investigation was done based on primary data in the year 2021-22 and Abshar district of Panjshir province was selected through cluster sampling process as study area. The data was collected through questionnaires which were distributed randomly to 40 farmers in the district. The results revealed that the average gross income, costs and net income of farmers was estimated around about 1941.55, 414,06 and 1527.49 US\$, respectively. Average production of farmers was recorded 9.46 tonnes and average productivity was found 12.21 tonnes ha⁻¹. The highest quantity of potato waste was observed during planting and post-harvest periods. Proper planting date, frequency of irrigation, full ripening, keeping in standard storages and separating injured potatoes were the most important factors effective in waste reduction.

Keywords- Coefficient of Variation, Mechanisms, Potato, Standard Deviation, Waste.

I. INTRODUCTION

Afghanistan is a mainly agrarian country, with 80 per cent of its population residing in rural areas. Most of the country's population depends on agricultural crops, making agriculture the most important sector of the economy. The major products of the country are wheat, rice, and corn, all of which are primarily produced for domestic consumption (Muradi & buz, 2018). Afghanistan's agricultural sector supports almost 75 per cent of the overall population's livelihoods and contributes around 28 per cent of the gross domestic product (GDP). Therefore, Agriculture's growth is vital to drive the country's economy and maintain food supply at the national level (Samim *et al.*, 2021).

The potato is regarded as the most important crop in the world after wheat, rice, and corn. Around the world, this product took up 19.3 million hectares of cultivated land, from which 388 million tonnes of

products were produced. The major potato producing countries are China, India, Russia, Ukraine, USA and Germany. China ranked first in potato production, followed by the USA and Germany (FAO, 2018). Potato is one of the most consumed food products in human nutrition, and its yield is higher than that of many other crops (Lang *et al.*, 1999). United Nations named 2008 the year of the potato in order to draw the attention of governments to planting this important and strategic crop (FAO, 2008). It is a quick-growing crop that is adaptable in use, suited for growing in a variety of conditions, and whose production is rising quickly (Nasir and Toth, 2022). So, by improving the overall efficiency of agricultural production systems, potato contributes to a better land use ratio and increases food supply (Priyadarshini *et al.*, 2020).

Currently, the area under potato cultivation in Afghanistan is 32,116 hectares, with a production of 513,194 tonnes (FAO, 2018). With a 35% loss rate

among the highly consumed agricultural items in Afghanistan, potatoes are one of the most vulnerable crops (Sikka, 2015). Potato is approximately produced in all provinces of Afghanistan under different agro-climate conditions. About 65 per cent of potatoes are cultivated in central provinces of Afghanistan like Kabul, Bamiyan, and Panjshir as well as Badakhshan, Herat and Helmand (Honaryar, 2019). The famous potato varieties grown in the country are: Kufri Chandramukhi, Kufri Lauvkar, white-skinned, red-skinned, Safed gul, Be gul, Sabz gul, and Sorkh gul (Kadian, 2009). Besides the huge amount of potato production and the imposition of high costs in Afghanistan, pre-harvest and post-harvest potato waste is the issue about which Afghan farmers suffering more and are complaining about. Therefore, the present study was done to seek the root cause of the problem and provide suitable mechanisms for solving it.

II. MATERIALS AND METHODS

The research was carried out during the year 2020 in Abshar district of Panjshir province. The research was based on primary data that was collected through questionnaires. The questionnaires were filled out by the researcher based on a face-to-face interview.

Potato producers were purposefully selected based on their employment in the production of this product, and an interview was conducted with them. The samples were selected based on the cluster method; among all districts, Abshar was selected as the cluster under study based on being the largest potato-producing district in Panjshir province. Descriptive statistic tools such as mean, percentage, standard deviation, and variance were mostly used in data analysis.

III. RESULTS AND DISCUSSION

1. *Potato waste in different stages:*

The result revealed that potato waste was observed during different stages of production. The highest percentage of waste was recorded during planting stage (7.73%) due to traditional planing methods. The post-harvest stage was stood in the second rank (6.78%) because of non-availibility of modern storage and warehouse facilities in the region. The potato is also wasted during growing (4.95%) and harvesting (5.43%) stages of production due to low level of management, vulnerability from climate, non-availibility of modern machineries and adverse impacts of pests and diseases (Figure 1).

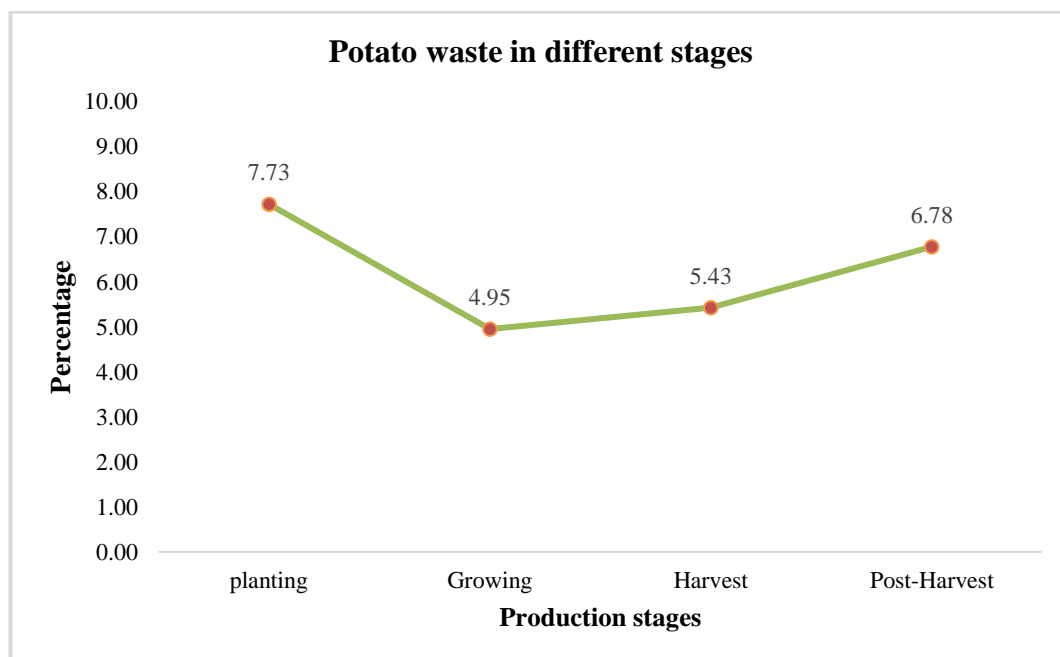


Figure 1: Potato waste in different stages

2. *Average production and productivity of potato producers*

The potato producers were categorized into three groups (small, medium and large) on the basis of their area under potato cultivation. Average production, productivity and cash income of farmers was analyzed in three groups. Average production of small scale,

medium scale and large scale farmers were 3.21, 7.45 and 17.72 tonnes, respectively. Similarly, average productivity of small scale, medium scale and large scale farmers were 11.90, 11.96 and 12.77 tonnes ha⁻¹, respectively. As Panjshir is a mountainous province most of farmers were included under small scale category and formed the highest percatage (Table 1).

Table 1: Average production and productivity of potato producers

Area (Hectare)	Production (Tonnes)	Productivity (Tonnes/ha)	Frequency	Share (%)
Small (0.1 - 0.5)	3.21	11.9	23	57.5
Medium (0.6 - 0.9)	7.45	11.96	9	22.5
Large (1 - 2)	17.72	12.77	8	20

Source: Research findings

3. Average income of potato producers

The result revealed that average gross income of small scale, medium scale and large scale farmers were 1263.69, 2096.68 and 2464.29 US\$, respectively. Similarly, cost of production of small scale, medium

scale and large scale farmers were 392.43, 331.89 and 517.86 US\$, respectively. Finally, net income of small scale, medium scale and large scale farmers were 871.26, 1764.79 and 1946.43 US\$, respectively (Table 2).

Table 2: Average income of farmers (\$)

Area (hectare)	Gross income	Cost of production	Net income
Small (0.1 - 0.5)	1263.69	392.43	871.26
Medium (0.6 - 0.9)	2096.68	331.89	1764.79
Large (1 - 2)	2464.29	517.86	1946.43
Average	1941.55	414.06	1527.49

Source: Research findings

4. Mechanisms prioritized by farmers

To determine the necessity and priority of using potato waste reduction mechanisms in different stages of production such as planting, holding, harvesting and post-harvest, the tables were designed in the form of a five-point Likert scale and 40 questionnaires were filled out. The result was discussed as follows:

4.1 Mechanisms to reduce potato waste during the planting stage

The result revealed that observing the appropriate planting date in planting stage was ranked

first by the respondents followed by depth of cultivation, planting depth, planting distance, animal manure, crop rotation, soil temperature, planting method, healthy tubers, soil moisture, suitable cultivar, land leveling, planting machines, size of seed tubers, cold-resistant cultivars, seed mixing, monolithic lands, pre-germination, field soil testing, cultivars resistant to pests, seed disinfection, certified potato seed and fungicide-disinfected knife, respectively. Hossaini (2011) also reported similar result (Table 3).

Table 3: Mechanisms to reduce potato waste in the planting stage

Particulars	Average	SD	CV (%)	Rank
1. Proper planting date	3.98	0.97	0.24	1
2. Planting depth	4.10	1.01	0.25	2
3. Planting distance	3.95	0.99	0.25	3
4. Suitable quantity of animal manure	4.15	1.14	0.28	4
5. Good crop rotation	4.15	1.17	0.28	5
6. Soil temperature during planting	3.78	1.12	0.30	6
7. Proper planting method	3.33	1.02	0.31	7
8. Planting healthy tubers	3.90	1.37	0.35	8
9. Proper soil moisture during planting	3.60	1.30	0.36	9
10. planting a qualified cultivar	2.80	1.02	0.36	10
11. Proper land leveling	3.60	1.45	0.40	11
12. Application of planting machines	1.15	0.48	0.42	12
13. Appropriate size of seed tubers	3.03	1.33	0.44	13

14.	Application of cold-resistant cultivars	2.25	1.08	0.48	14
15.	Prevention of seed mixing	2.30	1.11	0.48	15
16.	Utilization of monolithic lands	2.05	1.06	0.52	16
17.	Pre-germination of potato seed	2.83	1.50	0.53	17
18.	Field soil testing	1.33	0.73	0.55	18
19.	Cultivars pests and plant diseases resistant	1.93	1.07	0.56	19
20.	Disinfection of seeds before planting	1.25	0.74	0.59	20
21.	Certified potato seed	1.90	1.15	0.61	21
22.	Application of fungicide-disinfected knife	1.50	1.04	0.69	22

Source: Research Findings, SD= Standard Deviation

4.2. Mechanisms to reduce potato waste during the production stage

The result revealed that the frequency of irrigation during production stage was ranked first by the respondents followed by base of the plant, waterlogging and excessive soil moisture, weed management,

irrigation methods, burying contaminated potatoes, potato complications, quantity of chemical fertilizer, disease management and chemical pesticides, respectively, Musapour and Hasan (2018) found similar results (Table 4).

Table 4: Mechanisms to reduce potato waste during the production stage

	Particulars	Average	SD	CV (%)	Rank
1.	Frequency of irrigation	4.03	0.83	0.21	1
2.	Soiling around the plant	4.48	0.93	0.21	2
3.	Prevention of waterlogging and excessive wetting of the soil	3.88	0.99	0.26	3
4.	Weed management	4.15	1.08	0.26	4
5.	Proper irrigation methods	3.45	1.22	0.35	5
6.	Removing contaminated plants	3.65	1.44	0.40	6
7.	Prevention of potato complications	2.33	1.07	0.46	7
8.	Application of appropriate fertilizer quantity	2.90	1.37	0.47	8
9.	Diseases and pest management	2.00	0.96	0.48	9
10.	Optimal use of chemical pesticides	1.35	0.89	0.66	10

Source: Research Findings, SD= Standard Deviation

4.3. Mechanisms to reduce potato waste during harvesting

The result revealed that harvest after full ripening was ranked first by the respondents followed by pruning the bushes before harvest, glandular injury

during harvest, glandular injury, cleaning, climatic conditions during harvest and potato harvester, respectively (Table 5). Parwizi and Sidan (2018) also observed similar results.

Table 5: Mechanisms to reduce potato waste during harvesting

	Particulars	Average	SD	CV (%)	Rank
1.	To harvest after full ripening	4.30	0.82	0.19	1
2.	Pruning the plants before harvest	4.38	1.00	0.23	2
3.	Avoiding potato injury during harvest	3.98	1.17	0.29	3
4.	Cleaning of potato during harvest	3.78	1.14	0.30	4
5.	Harvesting in suitable climatic conditions	3.55	1.24	0.35	5
6.	Proper potato tools	2.30	1.36	0.59	6

Source: Research Findings, SD= Standard Deviation

4.4. Mechanisms to reduce potato waste during post-harvest stage

The result revealed that the operation of unloading and loading the product ranked first by the respondents followed by separating injured potatoes, to avoid direct light in the storage, grading before storage, coverage during transportation, suitable warehouse, appropriate storage period, packaging of raw materials, truck for transportation, proper ventilation, height of the

product from the land, germination in storage, quality of transportation road, storage temperature, pest and diseases management, conversion and packaging, control of the warehouse, disinfect of potatoes, healing in storage and disinfection of warehouse, respectively (Table 6). Similar results were reported by Baitmer Mohammadi (2009), Hassan Panah and Hassan Abadi (2014).

Table 6: Mechanisms to reduce potato waste during the post-harvest stage

Particulars	Average	SD	CV (%)	Rank
1. Proper loading and unloading potato	2.85	0.89	0.31	1
2. Separating injured potatoes	3.80	1.42	0.37	2
3. Avoid direct light in storage	3.65	1.39	0.38	3
4. Grading and packaging before storage	3.20	1.32	0.41	4
5. Proper coverage during transportation	2.95	1.26	0.43	5
6. Selection of a suitable warehouse	2.63	1.17	0.45	6
7. Appropriate storage period	2.63	1.17	0.45	7
8. Good packaging materials	2.58	1.17	0.46	8
9. Suitable truck for transportation	2.65	1.27	0.48	9
10. Opening proper ventilation	2.88	1.40	0.49	10
11. Suitable height of the product	2.33	1.19	0.51	11
12. Prevention of germination in warehouse	2.43	1.28	0.53	12
13. Good quality transport roads	2.03	1.12	0.55	13
14. Suitable warehouse temperature	1.98	1.19	0.60	14
15. Prevention and control of pests	1.88	1.18	0.63	15
16. Conversion and packaging	1.65	1.10	0.67	16
17. Control of the warehouse moisture	1.93	1.29	0.67	17
18. Potato disinfection before storage	1.45	1.04	0.71	18
19. Potato healing in storage	1.68	1.23	0.73	19
20. Disinfecting the warehouse	1.50	1.13	0.75	20

Source: Research Findings, SD= Standard Deviation

4.5. Common activities effective in potato waste reduction

The observation has shown that involvement of farmers in cooperatives for potato waste reduction was

ranked first by respondents followed by agricultural machinery, maintenance of equipment, gaining awareness, consulting services, training programs and loan facilities, respectively (Table 7).

Table 7: Common activities effective in potato waste reduction

Particulars	Average	SD	CV (%)	Rank
1. Membership in cooperatives	1.33	0.69	0.52	1
2. Utilization of joint machinery services	1.23	0.66	0.54	2
3. Maintenance of equipment	1.25	0.71	0.57	3
4. Gaining awareness	1.45	0.88	0.60	4
5. Utilization of consulting services	1.28	0.78	0.61	5
6. Participation in training programs	1.30	0.82	0.63	6
7. Use of loan facilities	1.33	0.86	0.65	7

Source: Research Findings, SD= Standard Deviation

IV. CONCLUSION

Potato is the major crop produced in Afghanistan. The area under cultivation of potato in

Abshar district ranged from 0.1 to 2 hectares. Most of farmers were from among small scale producers. The average gross income, costs and net income of farmers was estimated around about 1941.55, 414,06 and



1527.49 US\$, respectively. The average production of producers was 9.46 tonnes and average productivity of producers was around 12.121 tonnes ha⁻¹. Potato is being wasted during planting, growing, harvesting and post-harvesting stages. Similarly, the highest percentage of waste in the study area was found to be during the planting and post-harvest stages and the average of total potato waste was 24.88 per cent. It can be obviously seen that the waste of potato in the studied district was higher and significant. Appropriate date of planting, planting depth, irrigation frequency, soiling the base of the plant, harvesting the crop after fully ripening, unloading and loading operations and participating in potato cooperatives were ranked first and being considered as important factors in reducing waste during different stages of production. These wastes have led to decline of the productivity in different stages and create negative incentives for producers in the future. Therefore, the government should apply effective policies and important mechanisms for supporting producers and ensuring sustainable supply of potato in the markets.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration of three authors: Agha Mohammad Mohammadi designed the questionnaire, performed data collection, conducted statistical analysis and prepared the first draft; Hasibullah Mushair assisted in designing the study area, statistical analysis and review; and Sayed Sanaullah Habibi revised the first draft minutely and elaborated the final manuscript for submission.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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