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Estimating cost and net return: A profitability comparison of maize and potato in District Upper Dir of Khyber Pakhtunkhwa, Pakistan

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Abstract

The aim of this study was to examine the profitability comparison of maize and potato crops estimating their cost and net return in district Upper Dir of Khyber Pakhtunkhwa, Pakistan. Four villages namely; Ushirai, Sheringal, Kumrat and Palam were purposively selected, while Random Sampling technique was applied to select those farmers who were growing both maize and potato in the study area. In this way, total of 240 farmers from selected villages were randomly chosen for collecting primary data through a well-structured interview schedule. Study findings revealed that all of the respondents applied basic necessary inputs and used local techniques for growing maize and potato. Net revenue calculated was higher for potato as compared to maize due to better market income form potato crop. Cost benefit analyses were performed to investigate the profitability comparison between the two tested crops. Results showed that potato had higher productivity and gave more benefit to the growers in shape of money as compared to maize. Therefore, majority of the respondents allocated more land to potato crop. It is established that potato was more profitable crop among the farmers in the study area. It is recommended that extension department should disseminate modern farming techniques and provide timely information and trainings to potato growers. Government should subsidise farming inputs and facilitate potato growers in local markets in order to encourage them for getting more net return.

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Introduction

Agriculture is an important sector of Pakistan's economy. Agriculture contributes 18.5 percent to the country's Gross Domestic Product (GDP) and provides 38.5 percent employment opportunities to national labour force. Majority of the population that is almost 68 percent is involved in agriculture sector in one way or the other. Over the last decade, the performance of agriculture sector has fallen short of desirable level, mainly because of stagnant productivity of all important crops (Pakistan Economic Survey, 2018-19).

Maize (*Zea mays* L.) family (Poaceae) is the top yielding cereal crop in the world. Due to this special importance, maize has a significant value for Pakistan. In Pakistan, after wheat and rice, maize is the third important cereal crop. It contributes 2.6 percent to value addition in agriculture and 0.5 percent to GDP. During 2018-19, maize cultivated on 1,318 thousand hectares and witnessed an increase of 5.4 percent over last year's 1,251 thousand hectares. Its production increased by 5.1 percent to 6.309 million tonnes compared to target 6.0 million tonnes and 6.9 percent to the last year's production of 5.902 million tonnes (Pakistan Bureau of Statistics, 2018-19).

Maize can be grown over a range of agro-climatic zones and this quality makes it a versatile crop. Maize is suitable to be grown in diverse environmental conditions which is not possible for any other crop. It is grown from 58°N to 40°S, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rainfall per year (AICRP,2007; Tripathi *et al.*, 2011) and with a growing cycle ranging from 3 to 13 months (CIMMYT, 2000).

Maize is widely used in various products. It is a major component for raw materials in industrial processing, where it is processed for the preparation of corn starch, corn flake, dextrose, alcohol and tanning material for leather industry. Maize is a key source of ethanol which is used as a biomass fuel for several

purposes. It is also a chief source of calories for animal feeding as well as a best source in feed formulation. Maize offers the biggest conversion of dry material to milk, meat and egg as compared to other cereal grains. As maize contains high energy ingredients and other constituents that are low in fibre and protein, for this reason it is acknowledged a valued feed grain. For the stated reason animals like to eat it eagerly (PARC, 2005).

Potato (*Solanum tuberosum* L.) is the most commonly cultivated tuber crop and one of the most important food crops in the world (Haan and Rodriguez, 2016). It is an important vegetable belongs to the family Solanaceae and genus *Solanum*, with a basic set of 12 chromosomes (x = 12) (Watanabe, 2015). It has emerged as one of the leading food crops of the world. Solanum family includes tomato, tobacco, pepper, eggplant, petunia and some others.Potato (*Solanum tuberosum* L.) is one of the most widely produced and consumed tuberous crops in the world. Similarly, it is the most consumed food crop world-wide next to wheat and rice (Visser *et al.*, 2009; Champouret, 2010; Verzaux, 2010).

Potato crop has a probable origin in Peru (South America), from where it is believed to be introduced to the rest of the world by war expeditions, shipment, and transportation (Spooner *et al.*, 2005). Today, more than 5000 potato varieties are present in different parts of the world; the majority of them are mostly confined to South America. The crop is popular in Pakistan and elsewhere in the world based on its nutrient capacity, potentials for diverse uses (both in raw and processed form) and easy availability to low-income consumers. It is a rich source of water, carbohydrates, vitamins, minerals, proteins and fats, which accounts for 390 Kj 100^{-1} g of baked potato (Zaheer and khtar, 2016).

Potato is ranked as the third most produced and consumed crop following rice and wheat and almost billion people throughout the world consume it in different forms (Anwar *et al.*, 2015). More recent data

indicate that potato production in the world during 2014 was recorded as 381.7 million tonnes (MT) over an area of 19.1 million hectares (Mha), while in Pakistan, during the same period a total of 2.9 MT potatoes were produced from 0.15 Mha harvested area (FAOSTAT, 2017). In Pakistan, potatoes are used largely as a staple food in many parts and serve as a domestic vegetable available throughout the year. A significant portion of potato is also used in processed products such as finger chips, fry chips and salad.

Generally, three crops of potato namely spring, summer and autumn are grown in different agro-ecological conditions of Pakistan ranging from plains to hilly areas (Khan and Akhtar, 2006). Potato cultivation requires less labour input and the time from sowing till harvest is relatively shorter than other major crops (less than 90 days) which makes it an ideal crop for farmers. Nevertheless, besides the availability of suitable environment, ease of cultivation and low labour requirement, potato productivity in Pakistan is not promising compared to other developing countries. There are several biotic and abiotic stresses which limit potato productivity in the country (Majeed et al., 2017).

Nature has gifted Pakistan with wide-ranging climatic conditions that are ideal for potato production. It is generally sown in the hilly areas during the summer season and in spring and autumn, in the plains of Punjab and Khyber Pakhtunkhwa. Autumn crop is sown in September and harvested in the month of January, while summer crop is sown in the hilly areas of May/June and harvested in October. Land brought under cultivation for potato in Punjab is significantly greater than other provinces; hence it is the major potato producer province of Pakistan. Recent data indicate that during 2011-12, area harvested for potato in Punjab was maximum (148 kha) followed by Khyber Pakhtunkhwa (9.9 kha) producing 3340 and 118.2 thousand tonnes of potato respectively. During the same period, Baluchistan produced 29.7 thousand tonnes over an area of 2 kha followed by Sindh, which produced the lowest potatoes that is 3.9 thousand tonnes against area harvested 0.4 kha (GoP, 2014).

Keeping in view the importance of the study, the intended research is designed to investigate the profitability comparison of both maize and potato as they are widely used by the people of Upper Dir for domestic as well as commercial basis. In this regard the present research work was conducted with the following objectives (i) to analyse cost of production of maize and potato (ii) to carry out the economic comparison of maize and potato and (iii) to give recommendations based on findings of the research.

Materials and methods

Study Universe

The current research study was conducted in District Upper Dir of Khyber Pakhtunkhwa, Pakistan. The selected area is fertile for major crops like maize and this area is specifically popular for potato which is producing fine exporting quality of potatoes to the rest of the country.

Time of the study

This research study was conducted during the growing season of 2018-19 in order to collect the latest data on these both crops.

Sampling design

The total sampled respondents of maize and potato growers in the study area are depicted in Table 1. The Random Sampling technique was applied to select those farmers who were growing both maize and potato in the study area. This technique was used because it provides equal chances to every individual to be allocated for interview. In this way, a total of 240 farmers from selected villages were randomly chosen through proportional allocation sampling technique (Cochran, 1977).

Data

A well-designed interview schedule was prepared for the collection of cross sectional data. The interview schedule was pre-tested in field and was modified according to the suggestions of farmers and researcher's own observations. So, that the required and relevant information were obtained (Cho, 2002; Wingenbach et al., 2003; Khan and Akram, 2012).

Data Analysis

The collected primary data were put into computer software such as Excel and another software named SPSS was used to analyse the data. Furthermore, frequency distribution, cross tabulation and other simple budget techniques have been used to interpret the analysed data.

Analytical Framework

Conceptual and Empirical Modelling

According to Debertin (2012) growers' profit (Net Revenue) is equal to total revenue (TR) minus total cost (TC)

$\prod$ = *TR-TC*

Where

$\prod$ = Profit

TR = P xQ

TC = $V_1 X_1$

Where

P = Price of crop produced

Q = Quantity of crop produced

V_1 = Denotes the price of inputs used for crop production

X_1 = Denotes the input level/quantity of input utilized

Cost Benefit ratio (CBR)

$$\text{Cost benefit ratio (CBR)} = \frac{\text{Gross Revenue (Rs./acre)}}{\text{Total cost}}$$

Results and discussion

To estimate the cost of each input, the method designed by Ahmad *et al.* (2003 and 2004) was adopted. Profitability (net revenue) was estimated by deducting total cost from gross revenue. Net revenue = Gross Income - Total Cost.

Table 1. Number of respondents selected from each village.

Village	No. of sampled respondents
Ushirai	60
Sheringal	60
Kumrat	60
Palam	60
Total	240

Source: Survey Data, 2018-19.

Zangeneh *et al.* (2010) investigated the economic analysis of potato production, calculating net profit, gross profit and benefit to cost ratio of the respective crop.

Cost of production of maize

Table 2 shows cost of maize crop production per acre land in the study area. Various practices were followed by maize growers given in the Table. The cost incurred was on land preparation, seed, fertilizer (Urea & DAP), irrigation, weedicide, chemicals like pesticides, Farmyard manure (FYM), labour, picking and finally transportation.

Land rent and preparation

The first and important step in maize cultivation is

land rent and preparation. Ploughing and levelling are the two practices that are followed in order to prepare land. The average cost for land preparation was Rs. 288.078 contributing 0.52% in total cost of maize production. Similarly, Rs. 14000 were allocated for land rent, counting for 25.33% in overall cost of maize production.

Seed

In maize cultivation seed is sowed in the soil. The average cost of seed calculated was Rs. 2171.41 per acre which shares 3.92% in the total cost of maize crop production.

Fertilizer and irrigation

Chemical fertilizer again is an important input for the

maize crop and of course for every crop. It makes the soil more fertile and has direct impact on the yield. Fertilizers like urea and DAP were commonly used by farmers for the increased maize production. In Pakistan, farmers use both domestically produced and imported fertiliser (Khan and Akhtar, 2006). The

cost incurred on Urea was Rs. 2551.68 per acre, while for DAP average cost was Rs.9600 per acre, sharing 4.61% and 17.37% to the total cost of maize production respectively. Similarly, total cost on irrigation per acre land was estimated Rs. 503.8 which had 0.91% share in total maize production.

Table 2. Average cost of maize crop production per acre land.

Practice followed	Unit	Mean	Cost/Kg (Rs)	TC (Rs)	Percent
Land preparation	Hours	10.2885	28	288.078	0.52
Seed	Kg	40.97	53	2171.41	3.92
Urea	Kg	35.44	72	2551.68	4.61
DAP	Kg	8	1200	9600	17.37
Irrigation	Hours	0.2519	2000	503.8	0.91
Chemicals (pesticides)	Litre	948.28	4	3793.12	6.86
FYM	Kg	8.095	1100	8904.5	16.11
Labour	Days	24.44	550	13442	24.32
Total Input Cost	-	-	-	41254.6	74.66
Land Rent Cost	-	-	-	14000	25.33
Grand Total Cost	-	-	-	55254.6	100

Source: Survey data, 2018-19.

Pesticide and Farmyard manure
In modern farming, pesticides and weedicides are the inputs that are commonly used by the farmers. There are evidences of improving the total yield while using these two inputs. The average cost per acre for these inputs collectively came to be Rs. 3793.12 which had

share of 6.86% in the total cost of maize crop. Furthermore, Farmyard manure was also applied by local growers to enhance their crop yield which had expenses of Rs. 8904.5 per acre sharing 16.11% in total maize cost.

Table 3. Average cost of potato crop production per acre land.

Practice followed	Unit	Mean	Cost/kg (Rs)	Total cost(Rs)	% in total cost
Land preparation	Hours	2.24	1100	2464	2.69
Seed	Kg	911	33	30063	32.86
Urea	Kg	75	53	3975	4.34
DAP	Kg	50	72	3600	3.93
Irrigation	Hour	6	1200	7200	7.87
Weedicide	Kg/liter	2	1600	3200	3.49
Chemical fertilizers	Liter	2.5	2000	5000	5.46
FYM	Kg	2843	4	11372	12.43
Labour	Days	22	550	12100	13.23
Picking	Days	1	2200	2200	2.4
Transportation	Days	1	2275	2275	2.48
Total Input Cost	-	-	-	83449	91.25
Land Rent Cost	-	-	-	8000	8.74
Grand Total Cost	-	-	-	91449	100

Source: Survey data, 2018-19.

Labour

Labourers were hired for different purposes in the production of maize crop according to the needs of the farmers in the study area. The average cost of labour came to be Rs.13442 per acre which shared 24.32 % to the total cost of maize crop production.

Total cost (TC)

Total cost of production of maize crop per acre encompassed production cost on per acre area. The total cost of production per acre for maize crop recorded was Rs. 55254.6 and presented in Table 2. *Elahim et al.* (2016) indicated that the average cost per acre was Rs. 42,190 and average production (output) of maize was estimated to be 1350 kg per acre. Therefore, the gross return of maize production was Rs. 71,700 per acre. Similarly, Aurangzeb *et al.* (2007) estimated that production cost of maize crop of the small owner cultivators was higher than that of the large owner cultivators.

Table 4. Net revenue obtained from maize crop per acre land.

Variable	Unit	Quantity produced	Selling price/unit (Rs.)	Total (Rs)
Gross Revenue / Main product	Kg	1410.90	30	39327.0
Gross Revenue / By product	Kg	11274.45	3.5	35393.5
Gross Revenue (Total)	Rs	-	39327-	74720.5
Total cost	Per acre	-	-	55254.6
Net Revenue	Per Acre	-	-	19466.0

Note: Calculated by author.

Cost of production of potato

Similarly, data were collected to acquire full information about the total cost that is incurred on potato production. Table 3 depicts data regarding cost of production of potato crop in the study area. Same practices were followed by potato growers as done by maize growing farmers. The total cost of production for potato crop was Rs. 91449 out of which seed had highest cost of Rs. 30063 per acre, followed by labour that was Rs. 12100 per acre and FYM that had per acre cost of Rs. 11372. The lowest cost was observed for transportation charges that was Rs. 2275 per acre in the study area. Iqbal *et al.* (2005) conducted a similar study where total cost of potato crop production was Rs.76183 which is closer to our results of total cost of potato crop production that is Rs. 91449.

Table 5. Net revenue obtained from potato crop per acre land.

Practice	Unit	Quantity produced	Selling price/unit (Rs)	Total (Rs)
Gross Revenue / Main product	Kg	5872.33	32.5	190850.7
Total cost	Per acre	-	-	91449
Net Revenue	Per Acre	-	-	99401.7

Note: Calculated by author.

In a study performed by Bajracharya and Sapkota (2017), the average total cost incurred in potato production was found NRs. 197,186 per hectare in their study area of Nepal. Elhori *et.al;* (2009) and Elhori *et.al;* (2013) unveiled such type of findings in their studies related to potato production. They stated that farmers applied different practices such as seed, irrigation, and lesser spray than the recommended level due to financial shortage. As potato is a short durational crop and requires more expenditure in the form of costly seed, more fertilizer, sprays and excessive labour as compared to other crops. So it is necessary to fill in the requirements of potato farmers through credit or any other ways.

Net revenue obtained from maize crop

Before calculating net revenue, values of gross revenue and total cost of production are mandatory.

Gross revenue depends on how much the main product and how much by-products are obtained. The gross income was calculated by multiplying the average quantity produced with the price of the given product. Net revenue is the income acquired after subtracting total cost of production from total gross revenue for a particular crop.

Table 4 shows net revenue obtained from maize crop and the results revealed that net revenue obtained was Rs. 19466.0 per acre of land.

Table 6. Cost benefit analysis of potato and maize.

Crop	Cost benefit ratio
Potato	2.08
Maize	1.35

Note: Calculated by author.

Net revenue from potato crop

Accordingly, net revenue of potato crop was calculated as like maize crop. The gross revenue and total cost of production values are presented in the Table 5 and are discussed to gain the final net revenue of potato crop.

Potato yield

Higher potato yield depends on various factors that are availability of improved seed, adequate irrigation water, proper dozes of fertilizer, use of pesticide and weedicide etc. Yield is denoted in unit kilogram per acre. Some quantity of potato was stored at homes for domestic consumption, while the surplus of potato was sold in the local market. The gross revenue obtained from potato came to be Rs. 190850.7 per acre, while no by-product was obtained in potato crop production. So in this way the total revenue came from main product was Rs.190850.7 per acre in the study area. The net revenue computed for potato was Rs. 99401.7 depicted in Table 5. Similar results were found by Iqbal *et al.* (2005) stating that investing in one acre an output of 12246 kgs of potatoes were obtained and were sold on Rs.10.1 per kg which gave Rs.123807 as gross income.

Comparative Profitability Analysis

The benefit cost ratio was calculated by dividing the gross value of production by the total cost of production per hectare (Ozkan *et al.,* 2004; Canakci *et al.,* 2005; Demircan *et al.,* 2006). Comparative profitability analysis of potato and maize is shown in Table 6. Cost benefit ratio of potato is higher (2.08) than maize (1.35). It means that spending one rupee on potato cultivation will give the grower 1.08 extra benefits, while same amount of cost on maize will give 0.35 return benefit. These findings are concurred by Raghuvanshi (2018) where net return per rupee of the investment estimated from potato was 1.57 in their study area. In a study conducted by Aurangzeb *et al.,* (2007), the aggregate productivity of the maize owner cultivators was 1.49, or in other words, with the cost of one rupee, the owners earned a net income of Rs. 0.49. The overall productivity of the tenant cultivators arrived at 1.50, which shows that the investment of one rupee provided income of Rs. 0.50. This means that by spending one rupee the tenant received a net income of Rs. 0.50. Likewise, Bajracharya and Sapkota (2017) mentioned that the per kg cost of potato production was found NRs. 23.20 and the price was NRs. 26.71 which resulted the benefit cost ratio of 1.44 in the study area. This showed that one rupee spent on production yields 44 paisa of benefit from potato. They concluded that the potato production was profitable in the study area.

Conclusion and recommendations

In cost estimation; land preparation cost, seed cost, fertilizer cost, pesticide and weedicide cost, labour cost, picking cost and transportation cost are the main factors contributing the cost of production which was higher for potato as compared to maize. The gross revenue of maize was less than potato and had resulted lower net revenue of maize. The net

revenue of potato was higher than maize which provided quite reasonable profit to potato growers. So people allocated more land to potato.

From cost benefit analysis, it is concluded that income in cash from potato was 73% higher than maize. Potato has been an important food crop for growers and consumers not only in Pakistan but all over the globe. It is a crop that can generate high production and more income with more nourishing value. Its high returns attract the farmer to cultivate more and more.

Recommendations

Based on the findings of the study; several recommendations were made. Potato has higher productivity and results in higher net revenue. Therefore, the farmers should grow potato crop in the sample area keeping in view the importance of profit coming from potato. The farmers should be trained by extension personnel regarding the scientific ways of production technology i.e. use of optimum seed rate, certified seed, sowing time, pre and post-harvest practices etc. for improved crop productivity. The government should stabilize the inputs, out-put prices and provide convenient market facilities which play a vital role in sustaining higher productivity.

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