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Farm profitability and determinants of sweet potato production in Punjab, Pakistan

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ABSTRACT

Sweet potato (*Ipomoea batatas*) is an important and profitable crop in Pakistan due to its nutritional value, adaptability, and growing market demand. Despite this potential, limited economic assessments exist for Punjab. This study evaluates the economics of sweet potato cultivation in Sheikhpura District using primary data collected from 139 respondents through a field survey. Economic analysis was utilized to interpret the factors influencing production and profitability. The objectives were to estimate the cost of production, assess profitability, and identify measures to improve sweet potato production. Results show that farmers had an average of nine years of education and 22 years of farming experience, with 58.1% engaged full-time in agriculture. The average farm size was 5.32 acres, while the mean sweet potato area was 1.87 acres. Canal irrigation was the dominant water source (71%), and most farmers depended on rented tractors (71%). The total cost of cultivation was Rs. 442,851 per acre. Average output was 101.58 bags per acre (55 kg each), generating a gross income of Rs. 315,881. Net income amounted to Rs. 212,996 with land rent and Rs. 251,329 without land rent, confirming that sweet potato production is economically viable and profitable. Major constraints included high input and machinery costs, price fluctuations, and collusion among commission agents. The study recommends improving access to affordable inputs, strengthening farmers' knowledge of modern production practices, and enhancing government-led price monitoring to support sustainable sweet potato production in Punjab.

Introduction

Sweet potato (*Ipomoea batatas*) belongs to the Convolvulaceae family and is an important root crop widely cultivated in tropical and subtropical regions. The crop is believed to have originated in Central and South America, where it was domesticated thousands of years ago before spreading to other regions of the world through trade and exploration. In Pakistan, sweet potato is commonly known as “*Shakar Gandi*.” It is mainly cultivated for its sweet taste and starchy storage roots, which provide an important source of carbohydrates and dietary energy. The tuber skin shows considerable variation in color, including purple, brown, and white, reflecting the crop's genetic diversity and adaptability to different agro-ecological environments (Swamy, 2024).

Sweet potato is considered one of the oldest cultivated food crops, particularly in humid tropical regions, and today it is classified among the major root and tuber crops, such as cassava, yams, and aroids. These crops play a vital role in food security in developing countries, where they serve as an important staple food after cereals (Qi et al., 2025).

Sweet potato is a seasonal crop widely cultivated in tropical and subtropical regions, where it serves primarily as a food crop for human consumption. It is recognized as an important root and tuber crop contributing significantly to agricultural production, food availability, and nutritional security, particularly among resource-poor farmers in developing countries. Due to its high carbohydrate content, adaptability to marginal environments, and relatively low input requirements, sweet potato plays a vital role in improving food security and supporting rural livelihoods (Sapakhova et al., 2023). In Pakistan, the area under sweet potato cultivation has fluctuated considerably over the past decades, yet it generally exhibited an increasing trend from 1972 to 2021, reaching approximately 1,726 hectares in 2021. Globally, sweet potato is cultivated across more than 100 countries and territories, reflecting its adaptability to diverse agro-ecological conditions. The crop plays a significant role in global agriculture, with worldwide production reaching tens of millions of metric tons annually, making it an important staple food and food-security crop in many developing regions (FAO, 2023).

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Sweet potato is recognized as the seventh most important food crop globally, following major cereals and other staple crops, due to its high carbohydrate content and nutritional value. It plays a particularly significant role in subsistence farming systems across Asia and Africa, where it contributes substantially to household food security and rural livelihoods. Globally, sweet potato is cultivated on millions of hectares, with total production reaching over 90 million metric tons annually. The majority of this production occurs in developing countries, where the crop serves multiple purposes, including human consumption, animal feed, and as a raw material for starch and other agro-industrial products. China remains the largest producer of sweet potato worldwide, accounting for a significant share of global production (FAO, 2024; Mmasa et al., 2023).

Sweet potato possesses diverse nutritional and industrial applications, making it an economically valuable crop in many developing countries. The storage roots are widely utilized in the processing industry for the production of snacks, flour, starch, and other value-added food products, which offer significant commercial potential. In addition to its industrial uses, sweet potato is highly valued for its rich nutritional composition, particularly its high content of β -carotene (pro-vitamin A). A single medium-sized sweet potato can provide more than the recommended daily requirement of vitamin A, which plays a crucial role in maintaining healthy vision, immune function, and normal development of vital organs, including the heart and kidneys (Sapakhova et al., 2023; FAO, 2024).

In addition to its nutritional and industrial importance, sweet potato (*Ipomoea batatas*) is increasingly recognized as a valuable medicinal plant due to its rich phytochemical profile. Bioactive compounds such as flavonoids, phenolic acids, and anthocyanins have been shown to exhibit antioxidant, anti-diabetic, anti-inflammatory, and anti-cancer activities, suggesting potential applications in functional foods and therapeutic development. For instance, extracts from sweet potato leaves have demonstrated anticancer effects by inhibiting tumor cell proliferation and inducing apoptosis in breast and lung cancer cell models. Additionally, certain sweet potato varieties contain compounds that improve glucose metabolism and insulin sensitivity, which may help reduce the risk of type 2 diabetes. These findings underscore the crop's potential not only as a staple food but also as a source of natural compounds with significant health-promoting and medicinal properties (Chowdhury et al., 2025).

Objectives

- i. To estimate the cost and revenue of sweet potato cultivation in district Sheikhpura-Punjab.
- ii. To suggest measures in order to improve its cultivation in general in the Punjab and in particular in Sheikhpura.

Literature Review

Sweet potato cultivation has been shown to be economically viable, with profitability closely linked to variety selection, input management, and yield performance. A study in India evaluated the cost–benefit ratio of different sweet potato varieties and found that certain genotypes provided higher economic returns, highlighting the importance of variety selection in improving farmer income (. Similarly, field trials in Ethiopia examined the effects of phosphorus fertilization and variety choice on sweet potato yield and profitability, demonstrating that optimized nutrient management enhances both productivity and economic outcomes. These findings indicate that yield performance, input allocation, and genotype selection are critical determinants of sweet potato profitability in smallholder farming systems (Ranasingh and Singh, 2024).

Adewumi and Mahmud (2023) conducted an economic analysis of sweet potato farming in Karanganyar Regency, Central Java, examining cost, revenue, income, profit, and profitability, as well as evaluating farm efficiency through implicit and explicit cost calculations. Their results indicated that sweet potato cultivation in the region was economically efficient and generated positive profits for farmers. Recent empirical studies confirm that sweet potato production remains profitable under appropriate management conditions. For example, a budgetary analysis in Offa Local Government Area of Kwara State, Nigeria, reported that sweet potato production generated a benefit–cost ratio of 1.89, indicating profitability even with modest capital investment. The same study noted positive gross margins and net farm income, underscoring the crop's economic potential in smallholder agriculture

Adewumi and Mahmud (2023) conducted an economic analysis of sweet potato production in Kwara State, Nigeria. Using a two-stage sampling procedure, primary data were collected from farmers and analyzed through descriptive statistics and budgetary techniques. The findings indicated that labor, seed, and fertilizer constituted the major production costs, with labor accounting for the largest share. The results further showed that sweet potato production was profitable, with a positive gross margin and a favorable benefit–cost ratio. However, the study emphasized that improved management practices, efficient use of production inputs, and access to better production technologies could further enhance productivity and profitability among farmers.

Adeyonu et al. (2019) analyzed the production efficiency of sweet potato farmers in Nigeria using Data Envelopment Analysis (DEA). The study collected primary data from farmers through a structured questionnaire and applied descriptive statistics, DEA, and Tobit regression for analysis. The results indicated that farmers were not fully efficient in the use of production resources, suggesting the potential to increase output through better input utilization. The study further found that access to credit, farmer training, and extension services significantly improved technical and allocative efficiency in sweet potato production. These findings highlight the importance of improving farmers' access to institutional support and production technologies to enhance productivity and profitability.

Higashikawa et al. (2025) analyzed profit efficiency and marketing performance in the sweet potato sector in Nigeria using stochastic frontier analysis. Primary data were collected from market participants through structured questionnaires. The results indicated that several production and marketing factors significantly influence profit efficiency in the sweet potato value chain. The study further revealed that inefficiencies in input use, limited market access, and weak institutional support constrain farmers' profitability. The findings suggest that improving resource allocation, strengthening market systems, and providing institutional support could enhance efficiency and increase farmers' income from sweet potato production.

Recent studies have also examined the value chain and marketing systems of sweet potato production. Amirah et al. (2025) analyzed the sweet potato value chain and marketing structure in a rural production center using qualitative interviews and field observations. The study found that the marketing system involved several actors, including farmers, middlemen, wholesalers, and retailers, with farmers often having weak bargaining power due to limited access to market information. Price fluctuations and infrastructure limitations were identified as major constraints affecting farmers' income and productivity. The study emphasized that strengthening farmer institutions, improving market access, and promoting value addition could enhance farmers' welfare and the sustainability of sweet potato farming systems. The profitability of sweet potato production in Odeda, Ogun State (Nigeria). It was found that the major production constraints were insufficient land, pest, diseases and mechanization. The analysis revealed that sweet potato productivity was a profitable enterprise. The study recommended that policies should be implemented to enhance greater output and adequate access farm resources (Sanusi, 2018).

The factors affecting the profitability of sweet potato production in Philippines Purposive sampling technique was used to select the farmer-respondents. Results revealed that Sweet potato production is generally profitable with the high financial return. There is a positive relationship between income and farm size, labor\input cost, cost of other inputs and access to buyers, but inverse relationship exist between income and years of experience and tenurial status. Furthermore, farm size and cost of different inputs were significant variables that contribute to the increase in income (Lirag, 2019).

Hamidah and Marwanti, 2021 analyzed sweet potato farming economically and socially in East Java, Indonesia. The study was conducted using a survey method and a sampling method was carried out using census in rural villages. The data analysis employed revenue cost (R/C) and descriptive analysis. The utilization of small sweet potato tubers affected by Cylas Formicarius disease as a fish feed was used as the main feed, while most farmers used sweet potato stalks and leaves as goat feed. Sweet potato farming is profitable and feasible to develop for diversified food intake programs.

Research methodology

The research methodology provides a structured framework for systematically analyzing the study. It describes the data collection procedures and analytical techniques employed to achieve the study objectives. The primary aim of this research is to conduct an economic analysis of sweet potato production and to provide evidence-based policy recommendations. The study relies on primary data collected directly from farmers engaged in sweet potato cultivation.

To assess the economic performance of sweet potato farming, the costs associated with various production practices were calculated. These calculations enabled the estimation of total fixed cost, total variable cost, total cost, gross income, gross margin, net income, and the benefit–cost ratio. The cost components considered in the analysis included land preparation, seed, plant protection measures, labor, fertilizer, irrigation, transportation, marketing, land rent, and the average market price received during the season. This comprehensive approach allows for an accurate evaluation of the profitability and efficiency of sweet potato production practices under the prevailing conditions.

Sampling Design and Research Tool

The study was conducted in Sheikhpura district, Punjab, Pakistan, the sixth largest city in the country, contributing approximately 10 percent to Punjab's Gross Domestic Product. The area is a significant agricultural hub, well known for rice production. Primary data were collected from a sample of 31 farmers using a structured interview schedule, considering the limited availability of farmers due to their engagement in various farm activities. The collected data were analyzed using both simple budgeting techniques and econometric methods. Production costs were calculated by multiplying the quantity of each input by its respective price. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) to evaluate the economic performance and profitability of sweet potato cultivation.

Cost of Production and Profitability Estimation

Total amount, fixed cost, variable cost, land rent, Total cost, Gross income, and Net income (with land rent and without land rent):

$$\text{Total Cost: TA} = Q \cdot P \quad (1)$$

Where, TA = Total amount/cost of one input used in production, Q = Quantity/units of input used in production and P = Price of one unit of input used in production. Fixed costs are those expenses that do not vary within a single production season, and in this study they included land rent and Abiana. Variable costs, on the other hand, are those that change depending on the level of production. These included nursery costs, land preparation, fertilizer, irrigation, plant protection measures,

$$\text{Total Cost: TC} = \text{FC} + \text{VC} \quad (2)$$

Where, FC = Fixed cost, TC = Total cost of production, and VC = Variable cost of production.

$$\text{Gross Income: } GI = TQ * PQ \quad (3)$$

Where, GI = Gross income, TQ = Total quantity produced in season, and PQ = Price of one unit (bag) sold in the market

$$\text{Net Income: } NI = GM - TFC \text{ (With Rent)} \quad (4)$$

$$NI = GM - (TFC - LR) \text{ (Without Rent)} \quad (5)$$

Where, NI = Net Income, GM = Gross Margin, TFC = Total Fixed Cost, and LR = Land Rent.

Results and Discussion

The socioeconomic characteristics of farmers play an important role in determining the efficiency and productivity of sweet potato cultivation. These characteristics include age, formal education, overall farming experience, and specific experience in sweet potato farming. Agricultural knowledge and operational skills tend to increase with age, and the survey indicated that the average age of the farmers was 48 years. Formal education enables farmers to better manage production, operations, and decision-making processes; the respondents in this study had an average of nine years of formal education, suggesting a moderate level of literacy and management capacity.

In Table 1, The farmers were also highly experienced, with an average of 22 years engaged in general farming activities, which contributed positively to their farming income. Specifically, experience in sweet potato cultivation allows farmers to optimize the use of agricultural inputs, including pesticides, fertilizers, and labor, across all farming practices. The survey revealed that the average sweet potato farming experience among respondents was seven years, indicating a solid familiarity with the crop and its management requirements.

Table 1 . Socioeconomic characteristics of farmers

Characteristics (years)	Mean	Std. Deviation
Age	48.39	11.218
Education	9.13	4.639
Farming experience	22.23	15.541
Sweet potato experience	7.65	6.852

In Table 2, Farmer involvement in agricultural activities was assessed through various indicators, including type of engagement, source of input purchase, tenancy status, and methods of irrigation. Regarding the extent of farming activity, the survey revealed that 58.1 percent of farmers were engaged in full-time farming, while 41.9 percent participated part-time, indicating a higher level of commitment among the majority of respondents. The source of input purchase was predominantly cash-based, with 93.5 percent of farmers purchasing inputs directly, whereas only 6.5 percent relied on credit. Analysis of land tenure showed that most farmers (96.8 percent) owned their land, 3.2 percent leased land from tenants, and none reported having a combination of owned and tenant land. In terms of irrigation, 71.0 percent of farmers relied on canal water, 22.6 percent used tube wells, and 6.5 percent employed a combination of both methods. These results reflect the farming practices, resource accessibility, and management strategies of sweet potato farmers in the study area. Farmers' use of power sources and cultivation practices was also assessed. Regarding mechanization, 29.0 percent of farmers owned their own tractors, while 71.0 percent relied on rented tractors for farming activities. Sweet potato cultivation practices varied in terms of ridge usage, with 80.0 percent of farmers growing crops on one side of the ridge and 19.4 percent utilizing both sides. Land ownership and tenancy were additional factors influencing farm operations. Most farmers owned their land, with only 3.6 percent renting out portions of their land to others, typically charging a fixed lease for six months to one year. Similarly, only 3.6 percent of farmers leased land from others to expand their cultivation area. In such lease arrangements, the landowner (lessor) rents out the land to a tenant (lessee) for a predetermined period and agreed-upon payment. These patterns of land ownership, tenancy, and cultivation practices provide insight into the operational and resource management strategies adopted by sweet potato farmers in the study area.

Table 3; Production costs encompass all direct and indirect expenses incurred in the cultivation of a crop, including labor, raw materials, consumables, and overheads. In sweet potato farming, significant cost components include land preparation and sowing practices. Land preparation involves activities such as ploughing, harrowing, leveling, planking, rotavator use, and ridge making, which improve soil structure, enhance soil-plant contact, release nutrients, reduce weed growth and pest infestation, and facilitate proper crop establishment. The survey indicated that farmers with smaller landholdings primarily use manual methods for ridge formation. Sowing practices involve planting seedlings at appropriate depth and spacing in healthy, disease-free soil to ensure optimal growth. The survey revealed that most farmers employ manual sowing, typically during June. For planting on one side of a ridge, seedling rates ranged from four to six marlas, with most farmers using the

higher end of this range. For cultivation on both sides of a ridge, seedling rates ranged from ten to eleven marlas. These practices directly influence both production costs and crop productivity.

Table 2. Farmer involvement in farming

Agriculture farming activity	Percentage
Full time	58.1
Part time	41.9
Source of input purchase	
Cash	93.5
Credit	6.5
Tenancy status	
Owner	96.9
Tenant	3.2
Owner + tenant	0
Source of irrigation	
Tube well	22.6
Canal	71.0
Mix	6.5
Power source	
Own tractor	29.0
Rented tractor	71.0
Cultivation on ridges	
One	80.6
Two	19.4

Table 3. Land ownership

Ownership (acre)	Mean	Std. Deviation
Area owned	5.32	5.839
Rented in	4.0	
Rented out	3.60	2.881
Rent (RS)	38333.33	7527.727
Total operational land	4.87	5.104
Sweet potato area	1.87	1.284

Some fertilizers are suitable for sweet like CAN (calcium ammonium nitrate) gypsum, zinc, urea and SSP (Single super phosphate). The survey indicates that the most of the farmers are using gypsum, zinc and urea CAN be not common. FYM (farm yard manure) is not suitable for sweet potato its use increases the risk of pesticide. DAP is also not suitable for sweet potato it tears up the land due to this the growth of sweet potato is effect. The data collected from survey is presented in table 5.

The data collected through survey shows that the most of farming irrigate their crop 2 times. But in some villages soil is hard and rough this type of soil required irrigating 3 times. Tube well and canal irrigation system is common but the mix system is not common. People who are using canal system are paying abyana to Govt. after 6 months and those who are using tubewell are paying the money according to hours to the owner. The data collected from survey is presented in table 6. According to survey farmers do pesticide practice by using poison, 2-3 kg is required in 1 acre. There is no need for weedicide practices because weeds are not growing in sweet potato. The data collected from survey is presented in table 7.

Table 4. Land preparation and sowing practices

Items	Unit	Quantity	Mean price RS/unit	Total amount/acre
Land Preparation Cost				
Plough	No	3.03	2054.84	6226.1652
Rotavator	No	1.13	5006.45	5657.2885
Ridge making	No	1.16	4319.23	5010.3068
Manual ridge making	Labour	4.40	800.00	3520
Sowing practices				
Sowing cost	Labour	4.45	796.77	3545.6265
Seedling rate	Marla	6.48	2996.77	19419.0696

Table 5. Fertilizer application

Items	Unit	Quantity	Mean price RS/unit	Total amount/acre
Fertilizer application				
Urea	Bag	1.63	2250	3667.5
CAN	Bag	1.20	2726.67	3272.004
Gypsum	Bag	13.18	200	2636
Zinc	Bag	1.76	2250	3960

Table 6. Cost of irrigation

Items	Unit	Quantity	Mean price RS/unit	Total amount/acre
Irrigation				
Tube well	No	2.61	524.9	1369.989

Table 7. Cost of plant protection

Items	Unit	Quantity	Mean price RS/unit	Total amount/acre
Protection				
Pesticide	Kg	2.87	106.67	306.1429

According to survey those farmers who have small piece of land means they cultivate only 1 acre they use manual method of harvesting but the manual method is not too much good. But most of the farmer using manual method to harvest sweet potato. Farmers sell the vines of sweet potato as a fodder crop and fulfill the cost of harvesting. The farmers who use CAN or zinc fertilizer and seedling rate is 6 marla their yield is 60 bags or less than 70 bags and 1 bag contain 55 kg sweet potato. Mostly farmers sell sweet potato in market and transportation cost is more than 1500, and the price of sweet potato depends upon the size and thickness of sweet potato.

Table 8. Cost of harvesting, production and marketing

Items	Unit	Quantity	Mean price RS/unit	Total amount/acre
Harvesting				
Manual	Labour	5.20	790.00	4108
Production & marketing				
Yield	Bags	101.58	3109.68	315881.2944
Transportation	No	2.15	2360.00	5074
By products				
Residual	Acre	1.23	7104.17	8738.1291

Table 9. Total cost, gross and net income

Total income	Gross income	Net income
TC = FC + VC	GI = TQ*PQ	NI = GI – TC (With Rent)
TC = 38633.33 + 64251.84	GI = 101.58 * 3109.68	NI = 212996.12
TC = 102885.17	GI = 315881.29	NI = GI – (TC - LR) (Without Rent)
		NI = 251329.15

Constraints faced by sweet potato growers

In some villages there is no extension services in the result the new farmers have not much information they use wrong fertilizers that is not suitable for sweet potato they also don't have much information about suitable time and machinery all of these factors effect the growth of sweet potato.

In villages only some landlords have machinery like plough, rotavator, planking, ridge maker, tractor and vine killing machine when the harvesting time arrived every farmer needs machinery but due to lack of machinery some farmers have to order machinery from other villages or from city. Farmers have to pay more rent due to procurement of machinery from the city.

Conclusion

The results of this study revealed that growing sweet potato was a profitable enterprise in the study area. The objective of this study is to analyze the cost, revenue, income, profit, efficiency as well as the profitability of sweet potato farming in Sheikhpura district. Based on the study results, it was analyzed that the average sweet potato farming revenue was 212996.12/ acre.

The survey results showed that the respondent farmers aged over 45 years they were well educated and experienced in farming. Moreover, they have small piece of land. Young farmers were the most effective mean of technology dissemination activity. Most of the farmers were using both canal and tube well water for the irrigation. They use only pesticide spray for protection activity. Moreover, they didn't share their knowledge with their fellow or especially new farmers.

Farmers still follow traditional cultivation practices and are largely constrained by lack of awareness of improved cultural practices. Due to lack of awareness about the storage and post-harvest techniques the quality of product is not too much good.

Moreover farmers are not using their resources efficiently. Vine/planting materials, land preparation, fertilizer and labor are underused in the study area. The profitability as well as the gross return can be increased by applying more resources until it reaches to the optimum level

This study revealed that the extension wing of the provincial Department of Agriculture was not properly providing information to farmers regarding new production practices and fertilizers. That was not adequately evaluating the on-going patterns and practices of sweet potato cultivation in the study area.

This study exhibited that some of the farmers were participating in technology dissemination activity and sweet potato was more profitable activity as compared to peanut

Recommendations

- i. Government Research Institutes and Extension Departments of Agriculture should provide in time proper information to farmers about new technologies and production practices that will improve their understanding and production of sweet potato.
- ii. Findings of this exploratory sample study should be considered indicative only. Ultimately that might turn out to be a short-lived phenomenon. It is however, suggested that an in-depth analysis of the situation should be undertaken in an elaborate study and by digging deep the causes of non-adoption of new technologies.
- iii. Serious Government efforts are now needed to introduce an elaborate crop insurance program which may protect the farmer against fluctuation in their income due to variations in production, output and input prices.
- iv. Credit and subsidy from governmental and non-governmental agencies should be made available to rural farmers, for this will go a long way in addressing their inefficiency problems.
- v. Government and other relevant agencies should improve Sweet potato farmers access to improved varieties, modern storage technology and markets facilities.

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