COST OF PRODUCTION
FOR
MAJOR AGRICULTURE CROPS IN BHUTAN

DEPARTMENT OF AGRICULTURE

MINISTRY OF AGRICULTURE AND LIVESTOCK

June 2023

ROYAL GOVERNMENT OF BHUTAN

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FOREWORD

The Department of Agriculture, Ministry of Agriculture & Livestock (MoAL), is delighted to present the 3rd Edition of the "Cost of Production of Major Agricultural Commodities in Bhutan." This updated publication builds upon the previous document titled "Cost of Production of Field and Horticulture Crops Grown in Bhutan 2020."

Based on the 2020 survey data, this publication includes the recommended intermediate agronomic practices that accurately represent and capture the real economic cost of production. The analysis has been conducted at the national level. The primary objective of this publication is to facilitate evidence-based decision-making for producers, planners, policymakers, financial institutions, and agriculture entrepreneurs. It guides policymaking, enables farmers to make informed decisions, and helps agribusinesses optimize their operations. Accurate cost of production information fosters a sustainable and competitive agricultural sector, contributing to food security, economic growth, and rural development.

The Department of Agriculture would like to express gratitude to the Agriculture Research and Innovation Division for their contribution to this publication. Additionally, we would like to acknowledge the unwavering support of members from the Agriculture Production Division, ARDCs, and Central Program, without whom this publication would not have been possible.

The Department of Agriculture is pleased to inform all relevant agencies and organizations that the electronic copy of the document has been uploaded to our website (www.doa.gov.bt). We hope that this document will prove valuable to various users.

With best regards,

Yonten Gyamtsho
DIRECTOR

ABBREVIATIONS AND ACRONYMS

APD	: Agriculture Production Division
ARDC	: Agriculture Research and Development Centre
ARID	: Agriculture Research and Innovation Division
BCR	: Benefit- Cost Ratio
CoP	: Cost of Production
DoA	: Department of Agriculture
EOC	: Effective Operating Cost
FYM	: Farmyard Manure
FAO	: Food and Agriculture Organization
MoAL	: Ministry of Agriculture and Livestock
MSP	: Minimum Support Price
NPV	: Net Present Value
NPK	: Nitrogen Phosphorous Potassium
NMC	: National Mushroom Centre
NMDW	: National Minimum Daily Wage
NSC	: National Seed Centre
Nu	: Ngultrum
OC	: Opportunity Cost
PPD	: Policy and Planning Division
PV	: Present Value
SSP	: Single Super Phosphate
TFOC	: Total Fixed Operating Cost
TOC	: Total Operating Cost
TVOC	: Total variable Operating Cost
VC	: Variable Cost

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1. INTRODUCTION

The Cost of Production (CoP) of agriculture commodities is crucial for planning and decision-making at various levels. CoP helps in making effective decisions on a commodity, determining the gross and net returns from cultivating a specific commodity to assess and improve performance of a farm operation and for determining the minimum support prices by the government. Understanding the cost of production is vital for various stakeholders, as it directly impacts the profitability, competitiveness, and sustainability of agricultural activities.

Firstly, accurate cost of production data allows policymakers to formulate effective agricultural policies and strategies. By analyzing the cost structure of different commodities, policymakers can identify areas where farmers may be facing challenges or where there are opportunities for improvement. This information helps in designing targeted interventions, such as subsidies, incentives, or technology transfer programs, to enhance productivity and profitability in the agricultural sector.

For farmers, knowledge of the cost of production is essential for decision-making and financial planning. It enables them to assess the profitability of different crops and make informed choices regarding resource allocation, including land, labor, and capital. By understanding their cost of production, farmers can better negotiate prices, evaluate market opportunities, and optimize their production systems to achieve better returns on investment.

Agribusinesses also heavily rely on cost of production data for enterprise development. This information helps in determining pricing strategies, supply chain management, and investment decisions. By analyzing the cost structure of agricultural commodities, businesses can identify potential areas for cost reduction, efficiency improvement, and value addition. It also aids in assessing market viability and evaluating the potential for scaling up or diversifying agricultural operations.

Therefore, the Department of Agriculture (DoA) updates the CoP of major agriculture commodities every three years, incorporating expert opinions and secondary information to provide accurate and reliable information to end users. The 3rd edition of the CoP is built upon the previous document titled "Cost of “Production of Field and Horticulture Crops Grown in Bhutan 2020.”

1.1. Objectives:

- To revise, and update, the existing cost of production of major agriculture commodities at the national level.
- To generate data on the cost of production for policy and planning decisions, including the formulation of minimum support prices (MSP), buyback mechanisms, compensation schemes, crop insurance, and access to credit facilities.
- To provide standard data on the cost of production for key commodities, serving as a valuable resource for entrepreneurs and agro-based enterprises.

2. METHODOLOGY

2.1. Data collection and analysis

The third revision of the National level Cost of Production (CoP) for major agriculture commodities was published based on the survey data from 2020 and the cost of production published in the 2020 version. The CoP survey in 2020 covered eight dzongkhags and 16 gewogs, as shown in Annexure 1.1. Variable costs were updated through an online survey involving approximately 70% of the extension agents. The latest cost data for labor per day and labor required for ploughing an acre of field were collected through an online Google sheet shared to all extension colleagues. Telephonic interviews were conducted using the snowball method with few farmers from Wangdue, Punakha, Paro, Trashigang, and Samtse to validate various variable costs in relation to the time spent on crop guarding. During the interviews, the focus was on confirming and cross-referencing the variable costs associated with the time investment required.

Other input costs for fertilizers, plant protection chemicals, and seedlings were retrieved from official websites (see the bibliography). To ensure the quality of the publication, expert opinions and views from national commodity coordinators and specialists were sought on the analysed data. This is mainly to remove outliers and validate price variables. Additionally, data triangulation was carried out using the inflation rate 5.64% (Annexure 1.2) published by National Statistical Bureau, 2022 to test the consistency and other threats that influence the results.

Production volumes for each commodity were based on the Agriculture Statistics 2019-2022 published by the National Statistics Bureau (NSB). Costs were calculated using cross-sections data, with fixed capital depreciated using the straight-line depreciation method for annual crops. For inputs that are used in the production of more than one commodity (joint inputs), the volume and subsequent value are allocated across the commodities. Unit costs were calculated by dividing total costs by productivity (Kg per acre) for each input type every year. For annual crops such as cereals and vegetables, costs were calculated based on annual expenditure divided by total yield.

For perennial crops, the upfront costs during the initial years of establishment are considerable. However, in the subsequent years, these costs decrease and stabilize, forming what is commonly referred to as a "plateau year." Fruit trees reach their prime yield from the third year onwards and continue to produce substantial yields for a period of 7 to 8 years. To calculate the cost of production for perennial crops, the total average costs incurred over the entire year period are divided by the total expected average production (Formula 4). For the interested young entrepreneurs, the Net Present Value (NPV) and Benefit Cost Ratio (BCR) for the fruit's trees are also reported in this publication (Annexure 1.3). The calculation of present value (PV) costs and benefits considers a discount rate of 8% (Formula 1), which is the average prevailing rate in the financial market.

$$NPV = NB0 + \sum_{t=1}^{n} (NBt) * (1 + r) -^{t} \quad \ldots (1)$$

Production costs are computed based on the economic costs of both fixed and variable production factors, as well as operating expenses. This includes Effective Operating Costs (EOC), Total Variable Operating Costs (TVOC), and Total Fixed Operating Costs (TFOC). As fruit trees have a lifespan of 20 to 25 years, the first 4 to 5 years are typically considered as the orchard development period, followed by a fruiting period lasting 15 to 20 years. The highest production levels are generally achieved between the 10th and 15th year of the fruiting phase. Importantly, despite incurring higher costs during the initial establishment period, orchards involve relatively lesser investment and input costs over the subsequent years.

Human-wildlife conflict poses a significant challenge for agricultural communities, and one of the primary strategies to address this issue is the implementation of fencing around agriculture fields. Standardizing the cost estimation process is essential for cost of production at the National level. Therefore, the standard barbed wire fencing cost is being used in this publication. However, this paper presents a comprehensive list of modern fencing technologies along with their corresponding cost estimates, as outlined in annexure 1.4. Interested farmers and entrepreneurs can utilize this information to adjust their Cost of Production (CoP) based on their desired investment.

2.2. The concepts of cost of production

The cost of production refers to the total expenses incurred in the process of producing goods or providing services. It comprises all the costs associated with producing goods or service, including both direct and indirect costs.

Eestimating the cost of production for agricultural commodities involves the comprehensive assessment of all economic costs and revenues associated with producing that commodity. It necessitates the measurement and monetization of all inputs utilized in the production process, regardless of whether they are purchased or produced by the farmer. These inputs encompass various elements such as seeds, fertilizers, farmyard manure, irrigation, machinery rentals, draught power, and pesticides. Additionally, upfront expenses are to be considered, which encompass costs associated with fencing materials, irrigation materials, farm tools, transportation inputs, and harvesting tools.

Moreover, labor employed in the production process, whether it is paid labor, family labor, or labor obtained through exchanges, must be accurately valued in monetary terms by considering the prevailing regional labor wage rate.

In the estimation of fixed costs, the depreciation value of any fixed asset is taken into account during costing. The calculation of depreciation cost is conducted using the straight-line method (Formula 2).

By conducting a meticulous analysis of all these factors, farmers can arrive at a comprehensive understanding of the cost of production for the agricultural commodity in question. This information is invaluable for making informed decisions, setting appropriate prices, optimizing resource allocation, and ultimately ensuring the economic viability and sustainability of agricultural operations.

$$Depreciation\ Cost\ = \frac{Cost\ of\ the\ machinery}{Useful\ life\ of\ the\ Asset} \quad \ldots (2)$$

2.3. Two broad categories of cost used for analyzing the Cost of Production

Variable Cost - are the costs of different farm inputs used in the production of a given commodity valued at market price at that time. The different inputs may include cost of seed, manures, fertilizers, irrigation, and plant protection chemicals, hire charge of draught power, machineries, and value of farm labor and other consumables. Generally, the variable cost depends on the volume of inputs required to produce a certain quantity of produce. These costs vary with production and one can increase or decrease the cost with the use of inputs.

Fixed Cost: are those that do not vary with size of enterprise and have no bearing upon decisions to increase or decrease production. It includes building cost, machinery cost, irrigation equipment, fencing costs, tools, and implements. For the annual crops, a straight-line depreciation method has been applied for all the fixed costs involved. And for the perennial crops the opportunity cost of the capital is applied using the discount rate of 8%.

Total Cost: is the sum of Total Variable Cost and Fixed Cost.

Cost of Production – refers to the total sum of money needed to produce one unit of a particular commodity. It is calculated as:

$$Cost\ of\ Production\ \left(\frac{Nu}{Kg}\right) = \frac{Total\ Cost}{Total\ Quantity\ Produced} \quad \ldots (3)$$

Average Cost: For the perennial crops, the average expenditure is obtained, and it was divided by the average production. It gives you the average cost per year. This method is commonly used for understanding the cost structure and efficiency of production in a straightforward manner.

$$Average\ Cost = \frac{Average\ Total\ Cost}{Average\ Quantity\ Produced} \quad \ldots (4)$$

Overall, the cost of production is often referred to as the equilibrium price, which is determined by dividing the total operating cost by the total physical production. It represents the minimum price at which the product must be sold to cover all operating expenses and maintain profitability. The profitability index, on the other hand, is a measure of the available resources or operating profit as a proportion of the gross income.

2.4. Sensitivity analysis

A sensitivity analysis was conducted to identify the factors that exert the most significant influence on the cost of production. By understanding the sensitivity of the production costs to these critical factors, policymakers, farmers, and stakeholders can make informed decisions to enhance agricultural efficiency, manage risks, and devise strategies for sustainable crop management and pricing in dynamic market conditions.

The sensitivity analysis utilized the 'three versions of single-variable sensitivity approach' as proposed by Pannell (2017). MS 365 Excel version was employed to conduct all the analyses.

Among the 52 crops analysed for cost of production, four major crops, namely rice, potato, citrus, and chili, were chosen to undergo sensitivity testing. These crops were selected based on their importance as staple and commercial crops.

For the "three version of single-variable sensitivity analysis" price of fertilizer (NPK), labor cost (regional wage rate), and price of the seed and seedlings were used to evaluate the whether the cost of production varies at the same time (Table 1.1). These factors were selected based on their high percentage share of the overall expenditure and the significant variability of market prices. Full-factorials sampling strategies (3 input factors at 3 level) were used. They are combined at three levels and re-optimized 27 times (Annexure 1.5). The new prices for the inputs (fertilizer and seeds) are predicted based on past data maintained by the National Seed Centre (NSC). The price of the fertilizer (NPK) in Bhutan has increased by 70% in the last 5 years (2018-2022) as shown in the figure 1.1. Similarly, the labor cost varies by large between regions. For example, the highest region has the average labor cost at Nu. 751/person-day compared to the lowest with Nu. 338/person-day. The difference between the lowest and highest average labor cost is about 122% Figure 1.2). To abate the overemphasis of data and put it into realistic situation, a ± 50% variation in the cost of both fertilizer and labor was used in the analysis. However, for the labor cost, instead on 50% decrease in the cost, the proposed National Minium Daily Wage (NMDW) (Nu.415) was used. The use of NMDW may give a sense of direction for the policymakers to future decisions. Regarding the seed and seedlings, the price of ± 50% variation was used based on the selling price trend as shown below.

Table 1.1: Three uncertain model inputs

Variables	Default price (Nu)	Increased scenario (Nu)	Decrease Scenario (Nu
Labor cost (Nu. + 50%)	550	825	415 (NMDW*)
Fertilizer selling price (Nu. ± 50%)	60	90	30
Seed and Seedling selling price (Nu. ± 50%)			
Rice	51	77	26
Potato	21	32	10.5
Mandarin	50	75	25
Chili (Large)	20	30	10

* Proposed National Minimum Daily Wage was used in place of -50%)

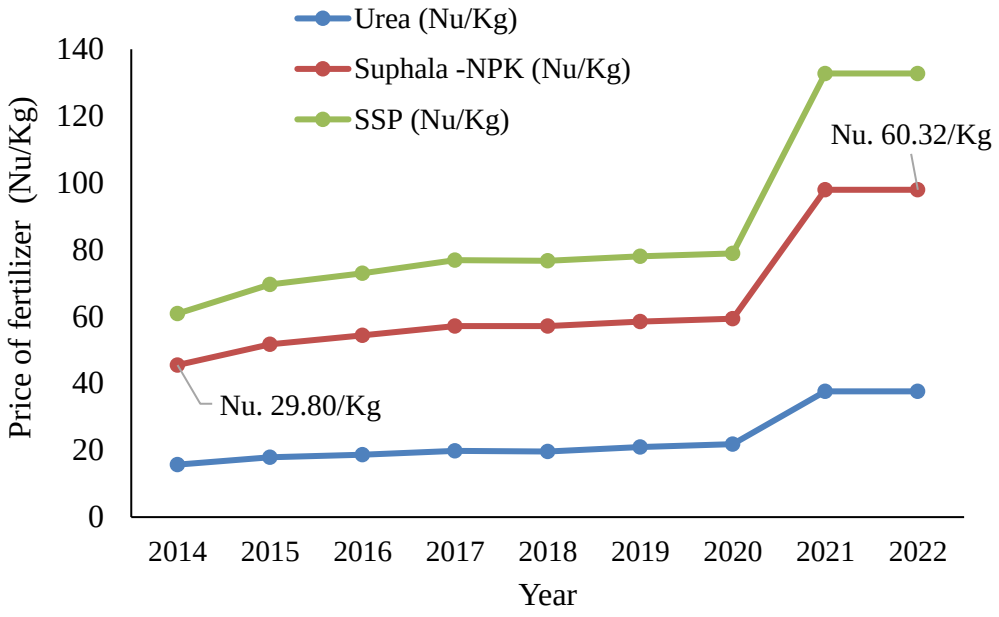

Figure 1.1: Increased price trend of fertilizer (Urea, Suphala, and SSP) 2014-2022)

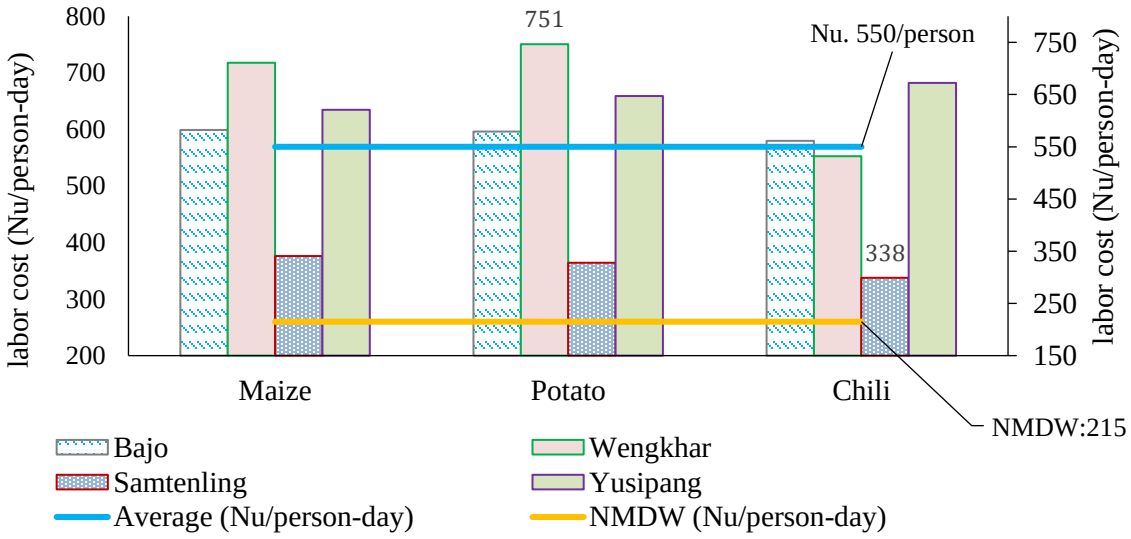

Figure 1.2: Regional average labor cost updated 2023 (Bajo, Wengkhar, Samtenling & Yusipang).

Paddy	Low Area	Mid-Area	High Area	National Average
Labor rate (Nu/person-day)	385	640	925	650

3. COST OF PRODUCTION

3.1. Cereal crops

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Paddy	82516	1700	49
2	Maize	38617	1500	26
3	Wheat	32460	695	47
4	Barley	31740	608	52
5	Buckwheat	31910	598	53
6	Quinoa	34580	450	77
7	Mustard	30315	394	77
8	Millet	30315	518	58

As mentioned in the methodology section, the recommended intermediate agronomic practices were considered when calculating the cost of production. The cost components encompassed almost all expenses, including seeds, fertilizers, plant protection chemicals, fencing materials, farm tools, field operations, and transportation of inputs. The per unit cost has marginally increased for majority of crops compared to the cost of production in 2020.

Regarding paddy cultivation, the estimated expenditure for one acre amounts to approximately Nu. 82,516, with a yield of 1700 kg per acre. Consequently, the cost of production is around Nu. 49 per kilogram of paddy. Notably, about 61% of the total cost is attributed to labor expenses, encompassing activities from fencing and field operations to the transportation of grain into storage facilities.

Among the other cereals, mustard and quinoa have the highest cost of production at Nu. 77/kg. The high cost per unit of production is primarily due to low yields. Mustard only produces 394 kg per acre, while quinoa yields 450 kg per acre. In terms of expenditure per acre, maize has the highest cost at Nu. 38,617 per acre. However, due to its high production, it has the lowest cost of production at Nu. 26/kg.

1.1. Pulses and grain legumes

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Rajma bean	32700	432	76
2	Lentil	23400	300	78
3	Soybean	27665	400	68

Among pulses and grain legumes, lentils have the highest cost of production at Nu. 78/kg, followed by rajma beans at Nu. 76/kg. Soybeans have a cost of production at Nu. 68/kg. In terms of expenditure, rajma beans incur the highest cost at Nu. 32,700 per acre. The high cost for rajma beans is primarily driven by the high seed cost compared to the other two pulses.

1.2. Vegetables

1.2.1. Solanaceous vegetable

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Chili (small)	81265	1000	81
2	Chili (large)	73024	2138	34
3	Tomato (open field)	70854	1425	50
4	Tomato (under protected)	347292	5700	61

1.2.2. Pod vegetable

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1.	Beans	54824	1425	38
2.	Pea	41050	1160	35

1.2.3. Bulb vegetable

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Onion	64489	1041	62
2	Garlic	66400	680	98

1.2.4. Cole crop

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Cauliflower	66104	1850	36
2	Broccoli	63089	1825	35
3	Cabbage	69859	3513	20

1.2.5. Stem vegetable

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Asparagus	49483	604	82

1.2.6. Root and tuber

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Potato	96389	4500	21
2	Radish	38850	2416	16
3	Carrot	41510	1380	30
4	Sweet Potato	44225	1211	37

Among the vegetables, the top five highest costs of production are as follows: garlic at Nu. 98/kg, asparagus at Nu. 82/kg, small chili at Nu. 81/kg, onion at Nu. 62/kg, and tomato (under protected field) at Nu. 61/kg. Other vegetables have a cost of production ranging between Nu. 30 and 50/kg, including sweet potato, carrot, cauliflower, broccoli, beans, peas, tomato (open field), and large chili. Vegetables with a cost of production ranging from Nu. 16 to 20/kg include radish, cabbage, and potato.

1.3. Mushrooms

Sl. No	Scale	PV (Cost) (Nu)	Yield (Kg)	Cost of Production (Nu/Kg)
1	Shiitake (1000 billets*)	209447	1200	175
2	Oyster (1000 bags*)	84152	1000	84

The cost of production for shiitake and oyster mushrooms was calculated based on 1000 billets and 1000 bags, respectively. From an economic standpoint, the cost of production decreases as the scale of production increases. Therefore, entrepreneurs or planners interested in calculating costs for large-scale farming can use the above information as a basis. The cost of production for shiitake mushroom cultivation is Nu. 175/kg, while for oyster mushrooms, it is Nu. 84/kg.

1.4. Spices

Sl. No.	Crop name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Cardamom	47578*	130	366
2	Ginger	100550	2095	48
3	Turmeric	132818	3400	39

Among the three spice crops, cardamom (dried yield) has the highest cost of production at Nu. 366/kg. This high cost is primarily attributed to the low yield of 130 kg/acre and the significant annual expenditure of Nu. 47578/acre. The present value (PV) cost of the cardamom is about 439561 in 15 years at the discount rate of 8% (Annexure 1.3.2).

Ginger, on the other hand, has a cost of production calculated at Nu. 48/kg, despite having one of the highest expenditures at Nu. 100,550/acre. This is due to its high yield of 2,095 kg/acre.

Turmeric has the lowest cost of production among all spices, estimated at Nu. 39/kg. This is mainly due to its exceptionally high productivity of 3,400 kg/acre.

* Yield: 1.2 Kg per billet
* Yield: 1 kg per bag
* Average cost @15 years

1.5. Fruits

1.5.1. Temperate fruit

Sl. No.	Name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Apple	79847	2818	28
2	Apricot	60976	2214	28
3	Persimmon	70931	2962	24
4	Plum	61761	4256	15
5	Peach	58109	3528	17
6	Pear	78964	4417	18
7	Walnut	53494	2664	20
8	Kiwi	85538	2615	33
9	Hazelnut	45488	1422	32

All the expenditures and yields for perennial fruit crops are reported as averages, considering the entire production cycle. The present value (PV) of costs and benefits, along with the financial indicators (NPV & BCR), is analyzed and documented in Annexure 1.2. Like cereal crops, labor costs significantly influence about 60-70% of the total production costs in fruit crops.

Among the temperate fruit crops, kiwi and hazelnut have the highest production costs, amounting to Nu. 33/kg and Nu. 32/kg, respectively. This can be attributed to their relatively high expenditure and comparatively low yield. On the other hand, the cost of production for other temperate fruit crops falls within the range of Nu. 15-28/kg, with plum having the lowest cost at Nu. 15/kg.

1.5.2. Plantation crop

Sl. No	Crop Name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Coffee	51509	1429	36
2	Areca nut	68639	3684	19

The cost of production for coffee and areca nut is estimated at Nu. 36/kg and Nu. 19/kg, respectively. Among the two crops, areca nut entails the highest expenditure per acre, amounting to Nu. 68,639, whereas coffee requires an expenditure of Nu. 51,509. The elevated cost associated

with areca nut cultivation can primarily be attributed to material expenses, as the inter-cultural field operations and labor requirements remain relatively consistent between the two crops.

1.5.3. Sub-tropical fruit

Sl. No.	Name	Expenditure (Nu/acre)	Yield (Kg/acre)	Cost of Production (Nu/Kg)
1	Mandarin	76282	2200	35
2	Mango	57271	1991	29
3	Banana	59767	5152	12
4	Litchi	46685	1827	26
5	Watermelon	82150	3,038	27
6	Passion fruit	78792	5455	21
7	Guava	49533	2410	21
8	Avocado	59983	1974	30
9	Pineapple	131135	5067	26

Within the category of sub-tropical fruit crops, mandarin, mango, avocado, watermelon, pineapple, and litchi exhibit the highest levels of production costs, with a range spanning from Nu. 26 to Nu. 35 per kilogram. Among these, pineapple stands out in particular, incurring the highest expenditure per acre at Nu. 131,135. This is primarily attributable to its significant seedling requirements, accounting for 56% of the total cost. Nevertheless, despite the higher expenses, the cost of production for pineapple remains relatively low, thanks to the fruit's notable yield potential of 5,067 kg per acre.

On the other hand, sub-tropical fruits such as guava, passion fruit, and banana display lower production costs, falling within the range of Nu. 12 to Nu. 21 per kilogram.

In summary, the cost of production for different sub-tropical fruit crops varies, with some fruits incurring higher expenses due to specific factors, while others maintain more cost-effective production processes, resulting in varying cost per kilogram values.

4. SENSITIVITY ANALYSIS AND KEY FACTORS DRIVING COST OF PRODUCTION

4.1. Three version of single-variable sensitivity analysis" (using full-factorials sampling strategies)

The overall sensitivity analysis results indicated that there was no significant variation in the cost of production for paddy, chili, potato, and mandarin crops (refer to figure 1.2). For most of these commodities, the cost per unit still stays around the median cost, which represents the existing cost of production. However, when comparing the four commodities, paddy and chili showed less variation in costs compared to potato and mandarin.

Specifically, in the case of paddy and chili crops, the frequency of cost variation from the median remained relatively low, with 8 and 1 occurrences in the re-optimized scenario with increased prices. On the other hand, for potato and mandarin crops, the frequency of cost variation from the low-cost categories have increased to 6 and 7 occurrences, respectively with increased prices.

These findings suggest that paddy and chili crops demonstrated more stable cost structures, with minimal fluctuations from the median cost, while potato and mandarin crops exhibited greater sensitivity to changes in prices, leading to a higher frequency of cost variations.

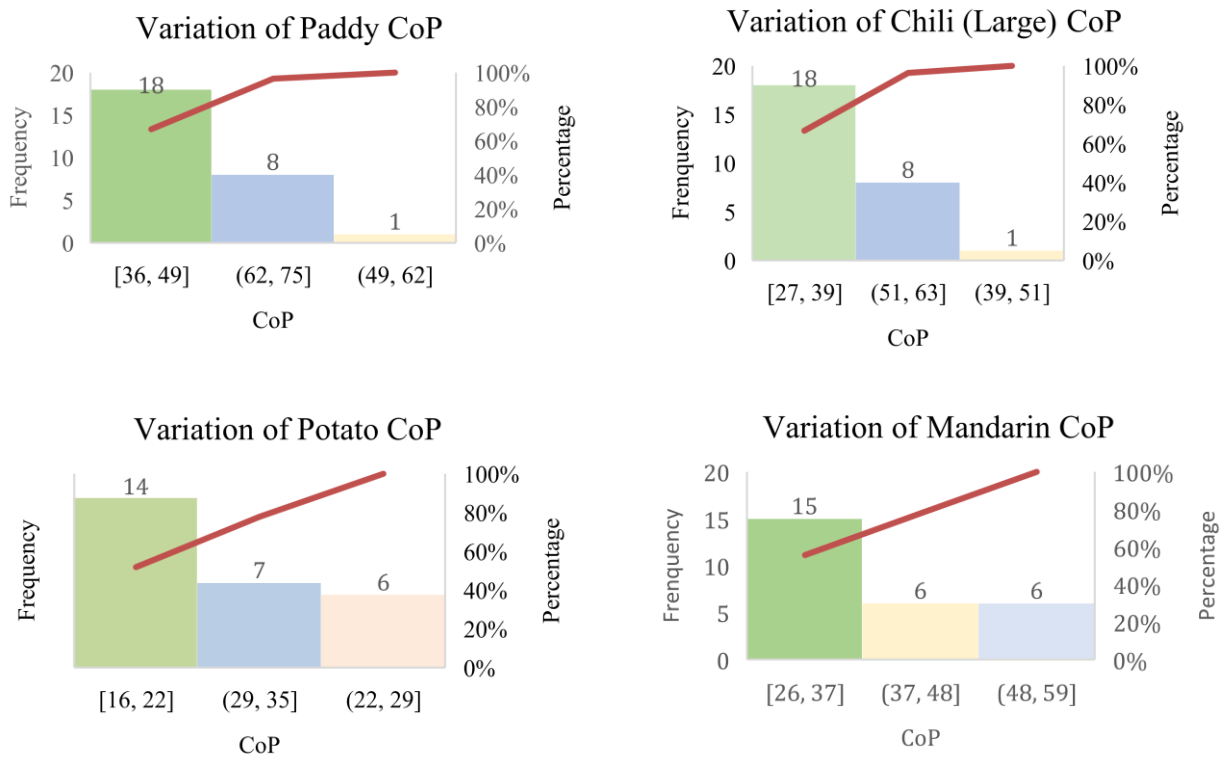

Figure 1.2: Histogram showing the distribution of CoP for the three most three uncertain variables, Cost of fertilizer, seed, and Labor.

4.2. Extended sensitivity analysis

The extended sensitivity analysis was conducted to examine the individual factors' effects on the cost of production (CoP) for potato crops. A step-by-step increase and decrease in the price of fertilizer, seed, and labor (Figure 1.2) was implemented to observe the variation in CoP.

The results indicate that, across all scenarios, the CoP was found to be more sensitive to changes in the labor factor compared to the seed and fertilizer factors. Specifically, when the cost of labor increased by 70% (from Nu. 550/person-day to Nu. 935), the CoP for potato rose to Nu. 29.36/Kg, reflecting a 36% increase. In contrast, in the case of seed and fertilizer, the CoP only increased by 18% and 2%, respectively.

Interventions from policymakers play a crucial role in striking a balance between promoting skill development, investing in agricultural research and innovation, and providing incentives for adopting efficient mechanization practices. These interventions are instrumental in addressing labor cost challenges and fostering sustainable agricultural development.

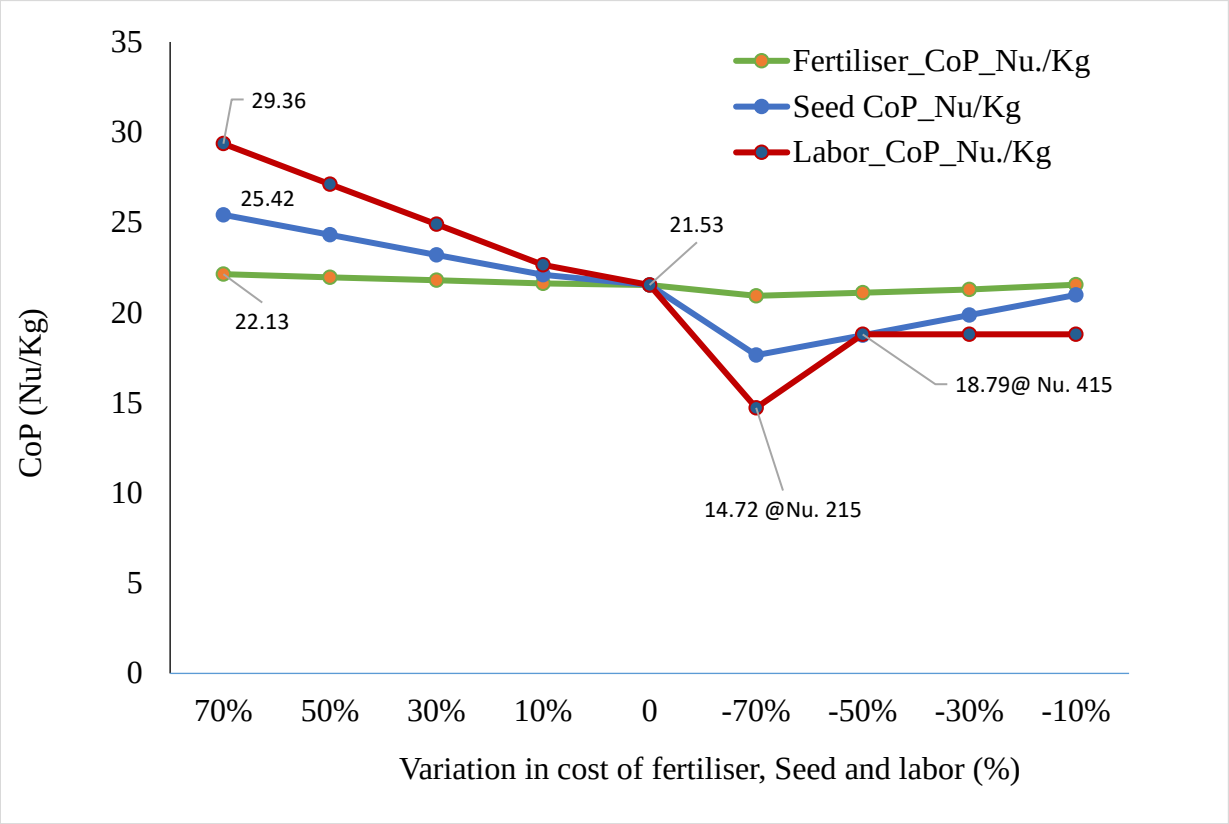

Figure 1.2. Extended sensitivity analysis: variation of cost of fertilizer, seed, and labor potato CoP.

5. LIMITATIONS AND RECOMMENDATIONS:

1. Variations in crop yields between different years contribute to significant differences in the cost of production. Therefore, users should exercise caution when assessing the cost of production.
2. Allocating joint production costs is a necessary step for determining the cost of production. However, due to lack of reliable data, and poor farm recordkeeping practices, the experts view, and secondary information were used in this publication. For future CoP exercise, such data needs to be considered in the survey questionnaires.
3. In this cost calculation, overhead expenses such as land rent, taxes, insurance, and interest on loans related to production are excluded. The inclusion of these costs depends on the objectives of the Cost of Production (CoP) analysis.
4. The lack of reliable data, especially regarding input supply, can pose a challenge when estimating the cost of production. Keeping detailed records of all inputs, including seed, fertilizer, pesticides, machinery, and fuel, will result in a more accurate cost estimation. The data used for the cost estimation is based on government institutes' information.
5. For future Cost of Production (CoP) analysis, conducting a comprehensive investment analysis exercise is highly recommended to capture all relevant costs along the commodities' value chain. Drawing a clear distinction between the production and post-harvest phases can be tricky, especially for commodities that are sold directly from the field. On the other hand, certain crops require additional costs for field storage, transportation, and minor processing.

6. ANNEXURES

Annexure 1.1 Sample size and survey record, 2020

Categories	Number of samples				Total
	ARDC Yusipang	ARDC Bajo	ARDC Samtenling	ARDC Wengkhar	
Cereals	466	351	669	708	2194
Pulses and grain legumes	29	187	249	453	918
Oilseed	7	82	189	350	628
Vegetables	807	863	1311	1891	4872
Roots and tubers	104	152	307	286	849
Fruit crops	186	585	708	1461	2940
Plantation crops	1	50	125	51	227
Mushroom	60	29	47	49	185
Spices	74	168	250	253	745
MAP	41	0	23	116	180
Total	1775	2467	3878	5618	13738

Annexure 1.2 Inflation rate of past 5 year

Year	Inflation (%)
2018	2.7
2019	2.7
2020	5.6
2021	7.35
2022	5.64
Average	**4.798**

Source: NSB (2018-2022)

Annexure 1.3. Financial feasibility indicators of the major agricultural commodities

Annexure 1.3.1: Cereal crops

Cereal crops	Total cost (Nu/acre)	Gross Revenue (Nu/acre)	Net Benefit (Nu/acre)	BCR
Paddy	82516	81600	-916	0.99
Maize	38617	60000	21383	1.55
Wheat	32460	24325	-8135	0.75
Quinoa	34580	112500	77920	3.25
Buckwheat	31910	59800	27890	1.87
Millet	30134	77700	47566	2.58
Mustard	30315	47280	16965	1.56
Soybean	27265	40000	12735	1.47
Lentil	23400	36000	12600	1.54
Rajma bean	32700	56160	23460	1.72

Annexure 1.3.2: Vegetable and Spices

Vegetables	Total cost (Nu/Acre)	Gross Revenue (Nu/Acre)	Net Benefit (Nu/Acre)	BCR
Chili (small)	81265	120000	38735	1.48
Chili (large)	73024	128280	55256	1.76
Tomato (open field)	70854	71250	396	1.01
Tomato (under protected)	347292	342000	-5292	0.98
Beans	54824	85500	30676	1.56
Pea	41050	127600	86550	3.11
Onion	64489	52050	-12439	0.81
Garlic	66400	204000	137600	3.07
Cauliflower	66104	120250	54146	1.82
Broccoli	63089	146000	82911	2.31
Cabbage	69859	175650	105791	2.51
Potato	96389	135000	38611	1.40
Radish	38850	60400	21550	1.55
Carrot	41510	75900	34390	1.83
Sweet Potato	44225	181650	137425	4.11
Oyster (1000 bags)	84152	250000	165848	2.97
Ginger	100550	209475	108925	2.08
Turmeric	128750	209475	80725	1.63

Perennial vegetables & spices	PV (cost) Nu/acre	PV (Benefit) Nu/acre	NPV (Nu)	BCR
Asparagus	364669	928480	563812	2.55
Shiitake (1000 billets)	209447	462730	253284	2.21
Cardamom	439561	457394	17833	1.04

Annexure 1.3.3: Fruit crops

Fruit Crops	PV (cost) (Nu/acre)	PV (benefits) (Nu/acre)	NPV (Nu/acre)	BCR
Kiwi	861166	6060529	5199363	7.04
Apple	841070	4758037	3916967	5.66
Areca nut	700051	3878088	3178037	5.54
Avocado	579927	2497014	1917087	4.31
Mandarin	781669	2606337	1824669	3.33
Pear	745477	2240394	1494917	3.01
Passion fruit	520918	1790833	1269915	3.44
Banana	281766	1298449	1016683	4.61
Persimmon	626226	1253959	627733	2.00
Walnut	586301	1197166	610864	2.04
Peach	625929	1161222	535293	1.86
Pineapple	649650	1095929	446279	1.69
Plum	637073	998399	361326	1.57
Coffee	527658	836453	308795	1.59
Mango	600608	874234	273627	1.46
Guava	537817	623778	85961	1.16
Litchi	539784	585161	45378	1.08
Hazelnut	511304	471314	-39990	0.92
Apricot	604539	428216	-176323	0.71

Annexure 1.4. Fencing cost information

Type of fencing	Price	Quantity	Cost
Barbed wire fence	: Cost including labor and materials		Nu. 870000/KM
Chain Link Fencing	: Cost including labor and materials		Nu. 2500000/KM
Electric fencing	: Wooden pole		Nu. 94450/KM
	: HDPE pole		Nu. 99560/KM
Stainless barbed wire (4 strands)	Nu. 95/ kg	715 Kg/KM	Nu. 67925/KM
MS angle post (7.8 ft) (75mm * 75 mm * 5 mm = 1.7 kg/m)	Nu. 87/ Kg	16320 Kg/KM	Nu. 1,41,984/KM
Wooden pole cost (Nu/Pole)	Nu. 205/pole	334 pole/KM	Nu. 68470/KM

Source: NPPC & ARDC Wengkhar

Annexure 1.5: Sensitivity analysis for the three most uncertain variables

Labor wage rate	Seed costs	Fertilizer cost	CoP Paddy Nu/Kg	CoP Potato Nu/Kg	CoP Mandarin Nu/Kg	CoP Chili (Large) Nu/Kg
Low*	Low	Low	36	15	26	27
Low	Low	Default	37	16	29	28
Low	Low	High	38	16	33	29
Low	Default	Low	37	17	26	27
Low	Default	Default	38	18	29	28
Low	Default	High	38	18	33	29
Low	High	Low	37	20	26	28
Low	High	Default	38	20	29	29
Low	High	High	39	21	33	30
Default*	Low	Low	47	18	31	33
Default	Low	Default	48	18	35	34
Default	Low	High	49	19	38	34
Default	Default	Low	48	20	31	34
Default	Default	Default	48	21	35	34
Default	Default	High	49	21	38	35
Default	High	Low	48	23	31	34
Default	High	Default	49	23	35	35
Default	High	High	49	23	38	35
High*	Low	Low	62	27	48	51
High	Low	Default	63	27	51	52
High	Low	High	64	27	54	52
High	Default	Low	63	29	48	52
High	Default	Default	63	29	51	52
High	Default	High	64	30	54	53
High	High	Low	63	31	48	52
High	High	Default	64	32	51	53
High	High	High	64	32	54	53
		Maximum	64	32	54	53
		Minimum	36	15	26	27
		Median	48	21	35	34

*Low: 50% decrease in price, High: 50% increase in price, Default: Current CoP

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Agriculture Research and Innovation Division (ARID)

Department of Agriculture

Ministry of Agriculture & Livestock

Tel# 02-322228/331316