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Navigating the Economics of Production and Marketing of Tomatoes in Lalitpur, Nepal

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Abstract— The study entitled ' Navigating the Economics of Production and Marketing of Tomatoes in Lalitpur District, Nepal ' was conducted from April 2023 to July 2023 by using a semi-structured questionnaire. The major objective of the study was to analyze the tomato production in the Lalitpur district of Nepal. Other specific studies included estimating cost and return, analyzing marketing channels, time series forecasting of tomatoes, and performing SWOT analysis. Tomato production in Nepal suffers due to insufficient data on production costs and profitability, leading to inefficient resource allocation and policymaker challenges. Lack of market information and infrastructure results in supply chain inefficiency and price volatility. The research aims to fill these gaps by studying tomato production in Lalitpur, and proposing solutions for industry enhancement. Data was collected from 100 respondents using random sampling, revealing a gender distribution of 62% male and 38% female. Most were adults with varying education levels. The average cost for building a plastic tunnel with dimensions 20×5 m² was determined to be NPR 23,747.81. The total cost for the cultivation under plastic tunnel was found to be NPR 3,601,223.26 /hectare. Total tomato production in Lalitpur district was. 96449.01 kg per hectare. The Benefit-Cost Ratio considering the cost of constructing a plastic tunnel house was 1.22 and excluding the tunnel house cost was 2.05. Among the respondents, 54% employed a single channel for tomato distribution, while 46% utilized a combination of distribution channels. Survey findings illuminated the influence of various stakeholders, including the government, traders and retailers on tomato pricing dynamics. Furthermore, price predictions indicated an ascending trend for large tomatoes and a consistent trend for small tomatoes.

Keywords— plastic tunnel, price trend forecasting, price volatility, profitability, SWOT Analysis

I. Introduction

Vegetables act as the bedrock of global food security, fortifying sustenance, resilience and sustainability. According to Ministry of Agriculture and Livestock Development, vegetable sector has emerged as a crucial contributor to Nepal's AGDP, with a contribution of *13.4361%* in 2022/23.Vegetables are cultivated in the area of 289,839 hectares with the production of 4,153,157 metric tons (MoALD, 2023). With a cultivated area of 22,911 hectares, tomatoes are the third most commonly grown fresh vegetable crop in Nepal after cauliflower and cabbage (MoALD, 2023).In particular, Lalitpur contributes 5,965 metric tons of tomato production in an area of 185 hectares, achieving a high yield of 32.24 metric tons per hectare. (MoALD, 2023). Tomato production reaches its highest point during the summer months (from May to September) in the hills, while it is considered the off-season in Terai. Conversely, it can be grown in Terai during the winter (from November to March) when the hills experience excessively cold weather (Ghimire et al., 2017).

Tomato production in Nepal faces a significant problem due to the absence of comprehensive data on the cost of production and profitability. Previous studies have presented conflicting outcomes regarding the benefit-cost ratio of tomatoes across various regions within Nepal. The research has overlooked advancements in cultivation technologies such as drip irrigation and mechanized equipment like tractors. Without reliable data on cost of production, farmers cannot accurately calculate their expenses and profits. This can lead to inefficiencies in the production process and allocation of their resources effectively. Additionally, without information on market demand and pricing, farmers may be unable to plan their production and marketing strategies effectively, which can result in excess supply or undersupply, leading to price fluctuations. Absence of data on price trend has hindered the production planning.

Objectives of the Study

General Objective

- To analyze economics of tomato production in Lalitpur district of Nepal.

Specific Objectives

- To estimate cost and return from tomato production.
- To analyze marketing channel of tomatoes in the study area.
- To analyze the price trend of tomatoes and speculate future trend.
- To determine marketing margin and producer's share.

The research not only assists in production planning and enhancing the efficiency of tomato cultivation and marketing but also provides valuable insights into potential opportunities for agricultural commercialization to farmers. The research holds potential benefits for both researchers and students, offering a foundation for future studies, as well as for

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policymakers to design effective policies.

II. METHODOLOGY

A. Sources of Data

Primary Source: Utilization of semi-structured questionnaires, in-depth interviews with farmers and Key Informant Interviews (KII).

Secondary Sources: Published and unpublished books, journals, newspapers, research papers, magazines, annual publications, reports, and related documents published by *NARC, MoALD, AKC, CBS, TEPC, KFVMDB, MRSMP* etc.

B. Study Area

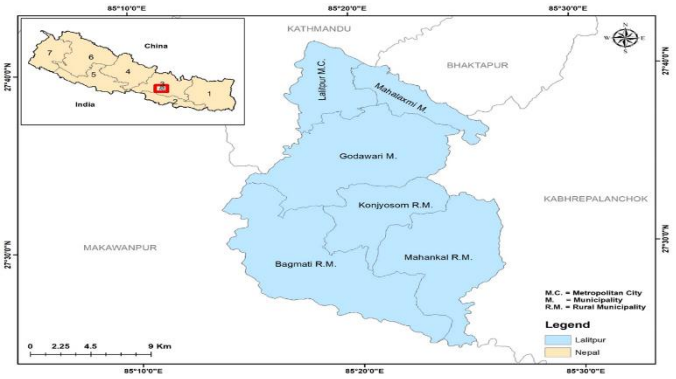

Fig. 1: Map of Study Area

C. Sample Size Determination

100 samples was selected for the study in Lalitpur district of Nepal. Simple random sampling technique was used for this purpose. Sample proportions were determined by referencing population data obtained from the Central Bureau of Statistics in different municipalities.

TABLE 1: SAMPLE SIZE DISTRIBUTION

Municipality	Sample Size
Lalitpur Metropolitan City	30
Mahalaxmi Municipality	30
Godawari Municipality	25
Mahankal Rural Municipality	5
Bagmati Rural Municipality	5
Konjyosom Rural Municipality	5

D. Data Analysis

Data Analysis was carried out using Microsoft Excel and IBM SPSS.

III. RESULT AND DISCUSSIONS

A. Socio-demographic Attributes

Out of 100 respondents, 62% of them identified themselves as male and 38% identified themselves as female gender. In the study area, 66% of the respondent were adults within age group of 20-39 while 32% of respondents were middle aged people. Only 2% of the respondent were senior citizens. There were no respondent below the age of 20. This pattern underscores the prevalent involvement of adult and middle-aged individuals in tomato farming within the study area. The research focused on examining the educational backgrounds of respondents in the designated area. The findings revealed that 27% of the respondents had not received any formal education while 23% of them had finished primary education. Additionally, 28% of respondents had accomplished secondary level education and 19% had completed high school education. However, only 3% of total respondents had pursued education up to the university level. The ethnic distribution showed that 20% identified as Brahmin, 15% as Chettri, the majority of 55% belonged to the Janajati community, 3% identified as Dalit, and the remaining 7% fell into other ethnic categories. Regarding family structure, 24% of respondents lived in joint families, while the majority 76% resided in nuclear family setups.

B. Institutional Attributes

TABLE 2: INSTITUTIONAL ATTRIBUTES OF RESPONDENTS

Training	44% of the respondents received training for tomato cultivation while 56% didn't.
Extension Services	46% received the extension service from various source.
Financial Assistance	Governmental financial aid was received by 31% of the respondents.
Crop Insurance	Only 4% of the respondents had opted for crop insurance, while the remaining 96% did not have any insurance for their crops.
Credit Facilities	73% of the respondent funded tomato cultivation using their own resources while 27% had acquired debt from both formal and informal sources.
Participation in Cooperatives/ Farmer's Group	50% of them indicated that they are part of cooperatives or farmer's groups, while the other 50% responded that they are not affiliated with any cooperatives or farmer's groups.
Farm Registration	62% of farmers had successfully registered their farms, while the remaining 38% had not yet completed the registration process.
Ownership of Land	16% of the respondents had their own land for tomato farming while majority, 84% rented the land for tomato cultivation.
Average Landholding	8.57825
Average landholding under tomato	6.5825

C. Cultivation Information

Among 100 respondents, 73% had 1-5 years of tomato farming experience, 23% had 5-10 years, and four participants had over 10 years of experience. Majority of farmers procured their seeds from Agro- vets. Only, 5 % sourced seed from government organizations. 81% of the respondents preferred cultivating single cultivar of tomato while 19% of them opted for mixed varieties. Among the farmers in Lalitpur district, the majority 96.2963% chose to cultivate the Srijana variety while a smaller percentage 3.703704% selected the Samjhana variety as a single cultivar. In the study area, 100% farmers irrigated land

rather than depending solely on rainfall. The finding is significant as it indicates that the farmers in the study area have adopted irrigation practices to ensure a consistent water supply for their crops.

D.Cost of Production

Average Cost of Construction of Plastic Tunnel House

From the analysis of result obtained from the survey, the average cost of construction of 20×5 m^2 size tunnel is NPR 23,747.81. In a ropani of land, farmer can adjust 3 plastic houses of size 20×5 m^2 (MRSMP, 2014/15).

TABLE 3: COST OF CONSTRUCTION OF TUNNEL DIMENSION 25×5M^2

S.N.	Particulars	Unit	Quantity	Rate	Total Cost
1	Bamboo	Piece	33.3	227.8	7585.374
	Plastic	Lump-sum			10146.05
2					
3	Rope	K.G.	1.37	171.85	235.43
	Binding Wires	K.G.	3.04	180.05	547.35
4					
5	Nail	K.G.	0.90	162.15	145.94
6	Labor Cost	Man-days	4.74	1039	4924.86
7	Transportation	Lump-sum			162.81
	Total Cost	NPR			**23747.81**
	Maintenance Cost				**1694.51**

E. Variable Cost

Total Variable Cost was found to be NPR 43636.67.Meanwhile, excluding the tunnel and incorporating the maintenance cost and bank interest, total variable cost was found to be NPR 18936.97.

TABLE 4: AVERAGE VARIABLE COST IN A TUNNEL DIMENSION 25×5 M^2

S.N.	Particulars	Unit	Quantity	Rate	Total
1	Seeds	Gram	2.40	172.60	414.88
2	Fertilizers				
2.1	Urea	K.G.	2.96	34.01	100.76
2.2	DAP	K.G.	3.94	52.99	208.93
2.3	Potash	K.G.	2.39	40.90	97.72
2.4	Others	Lum			1458.70
3	Micronutrients				412.04
4	PGR				153.29
5	Manures				
5.1	Cow Manure	K.G.	517.10	3.48	1799.19
5.2	Compost Manure	K.G.	75.11	12.28	922.27
5.3	Oilcakes	K.G.	8.39	46.26	388.28
5.4	Others	Lum			1730.18
6	Plant Protection Chemicals	Lum			1217.42
7	Machinery Use				
7.1	Ploughing	Hour	0.41	1087.64	443.98
7.2	Transportation	Lum			116.17
7.3	Motor Irrigation Cost	Lum			280.32
8	Labor Cost	Man-days			
8.1	Nursery Maintenance		0.36	781	280.01
8.2	Land Preparation		1.05	1003	1048.84
8.3	Transplantation		0.56	755	426.29
8.4	Weeding		0.80	731	586.35
8.5	Irrigation		0.32	989	314.27
8.6	Training and Pruning		0.68	760	514.74
8.7	Staking		0.87	746	651.27
8.8	Chemical Application		0.16	926	147.71
8.9	Harvesting		1.66	781	1299
9	Equipment Maintenance Cost	NPR			200.89
Total Variable Cost excluding Plastic Tunnel		NPR			15213.5
Total Variable Cost including Plastic Tunnel		NPR			38961.31
Interest on Variable Cost		**NPR**			**4675.36**
Total Variable Cost					**43636.67**
Total Variable cost in second year					**18936.97**

F. Percentage Contribution of Labor in Different Activities

TABLE 5: LABOR CONTRIBUTION TO EACH ACTIVITIES

Activities	Percentage Contribution of Labor
Nursery Maintenance	5.57
Land Preparation	16.25
Transplantation	8.67
Weeding	12.38
Irrigation	4.95
Training and Pruning	10.53
Staking	13.47
Chemical Application	2.48
Harvesting	25.70

Notably, harvesting demands the highest labor input, constituting 25.70% of the total effort, indicating that it is labor intensive work and chemical application accounts for lowest labor force of 2.48%.

G. Fixed Cost

Total fixed cost was found to be NPR 17421.71 in a tunnel with dimension of 20×5 m^2.

TABLE 6: AVERAGE FIXED COST IN A TUNNEL DIMENSION 25×5 M^2

S.N.	Particulars	Unit	Quantity	Rate	Total
1	Land Tax	NPR			10.27
2	Water Tax	NPR			34.07
3	Depreciation of Farm Equipment	NPR			7471.28
4	Crop Insurance Premium	NPR			265.86
5	Land lease	NPR			9640.23
	Total Fixed Cost	NPR			17421.71

H. Total Cost

Total Cost amounted to NPR 3601223.25 /hectare including the cost of plastic house and NPR 41451927.451/hectare excluding cost of tunnel construction.

TABLE 7: TOTAL COST IN A HECTARE OF LAND ALONG WITH PERCENTAGE CONTRIBUTION OF EACH COST

Cost	Amount (NPR/hectare)	Percentage
Total Variable Cost (TVC)	2,573,690.8	71.47 %
Total Fixed Cost (TFC)	1,027,532.46	28.53%
Total Cost	3,601,223.26	183,175.15

I. Production

Total production of tomato in Lalitpur district was found to be 96449.01 kg per hectares of land with average farm gate price of NPR 45.67.

J. Profitability Analysis

Gross revenue of NPR 4,404,826.29, gross margin of 1,831,135.49 and net profit of NPR 803603.03 was obtained in the study area per hectare of land.

K. Benefit-Cost Ratio

BC ratio of tomato including the cost of construction of plastic tunnel house was found to be *1.22*. This indicates that the farmers can cover all their investment cost in the initial year of tomato production with surplus income.
BC ratio excluding the cost of plastic tunnel house, second year onwards was found to be *2.05*.

L. Price Trend Analysis

Price Forecasting of Big Tomatoes
Tomatoes are marketed in Nepalese Market as Small and Big Tomatoes. Price forecasting of big tomatoes was performed from year 2023 to 2033. For this purpose, ARIMA model was used in SPSS.

TABLE 8: TABLE SHOWING PREDICTED PRICE, LCL AND UCL OF BIG TOMATOES

Year	Price of Big Tomatoes (NPR/kg)	Predicted Price (NPR/Kg)	LCL	UCL
2012	43.57	37.36	22.84	51.87
2014	36.36	40.65	26.13	55.17
2015	46.01	43.95	29.43	58.46
2016	43.06	47.24	32.72	61.76
2017	50.8	50.53	36.02	65.05
2018	44.32	53.83	39.31	68.35
2019	64.7	57.12	42.61	71.64
2020	59.18	60.42	45.9	74.94
2021	69.19	63.71	49.2	78.23
2022	64.63	67.01	52.49	81.53
2023		70.3	55.79	84.82
2024		73.6	59.08	88.12
2025		76.89	62.38	91.41
2026		80.19	65.67	94.7
2027		83.48	68.97	98
2028		86.78	72.26	101.29
2029		90.07	75.55	104.59
2030		93.37	78.85	107.88
2031		96.66	82.14	111.18
2032		99.96	85.44	114.47
2033		103.25	88.73	117.77

(Source: KFVMDB, 2023)

The prices of big tomatoes appear to be relatively fluctuating during the early years, ranging from around NPR 36.36 to NPR 50.8 from 2012 to 2018 B.S. Starting from around the year 2019, there's a noticeable uptrend in the price of big tomatoes. This trend continues until the year 2022. The price jumps significantly from around NPR 44.32 to 69.19.
From 2023 onwards, prices for big tomatoes are predicted to rise, following a generally ascending pattern. In year 2033, the price of tomato is predicted to be NPR 103.25. The upper confidence limit and lower confidence limit for the price in year 2033 is predicted to be 117.77 and 88.73 respectively.

TABLE 9: TABLE SHOWING R2, RMSE, MAPE, MAXAPE, MAE, MAXAE, NORMALIZED BIC AND ARIMA MODEL

R^2	RMSE	MAPE	Max APE	MAE	MaX AE	Normalized BIC	ARIMA Model
0.772	6.139	8.763	21.46	4.32	9.51	4.320	(0,0,0)

The value of 0.772 indicates that the expert forecast model has a relatively strong ability to explain the variation in the data. Approximately 77.2% of the variance in the dependent variable can be explained by the independent variables included in the model. A lower RMSE indicates better accuracy of predictions. In this case, the RMSE is relatively moderate with value of 6.139 units. Mean Absolute Percentage Error is 8.763 and comparatively lower. MaxAPE refers to maximum absolute error (Varshey, 2020). This value is 21.46%, representing the largest percentage difference between a predicted value and its corresponding actual value. MaxAE (Maximum Absolute Error) is 9.51 units, indicating that the largest difference between a predicted value and an actual value is 9.51 units.
The MAE of 4.32 indicates that the model's predictions are off by about 4.32 units on average from the actual values. The value of 4.320 for the normalized BIC suggests that the model might be moderately complex in relation to its fit to the data. ARIMA model (0,0,0) represents a specific configuration of the Auto-Regressive Integrated Moving Average. In summary, the model appears to have a reasonably good fit to the data.

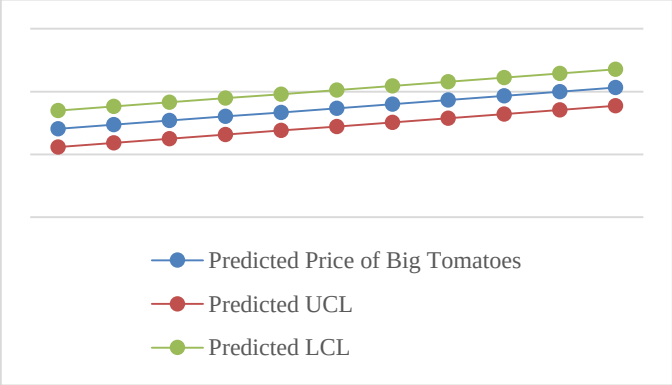

Fig. 2: Graph showing LCL, UCL and Predicted price of big tomatoes

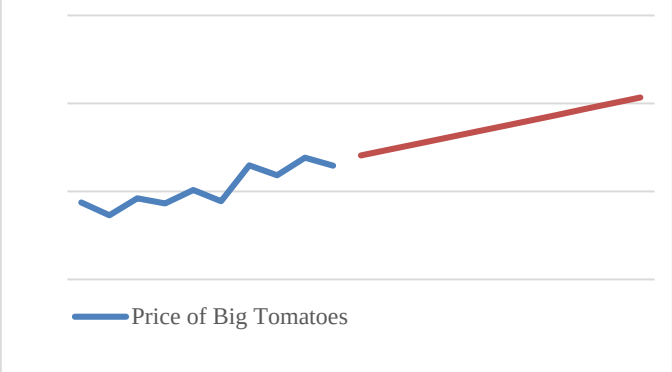

Fig. 3: Graph showing real and predicted price of big tomatoes from Year 2012 to 2021 and 2022 to 2032 respectively.

Price forecasting of small tomatoes

To predict the future price of small tomatoes, the exponential smoothing technique was applied.

TABLE 10: TABLE SHOWING PREDICTED PRICE, LCL AND UCL OF SMALL TOMATOES

Year	Price of Small Tomatoes (NPR/K.G.)	Predicted Price of Small Tomatoes (NPR/K.G.)	LCL (NPR/K.G.)	UCL (NPR/K.G.)
2012	35.71	38.83	28.66	49
2014	30.72	38.81	28.64	48.98
2015	39.02	38.77	28.6	48.94
2016	42.4	38.77	28.6	48.94
2017	41.6	38.79	28.62	48.96
2018	31.26	38.8	28.63	48.97
2019	44.06	38.76	28.59	48.93
2020	38.1	38.79	28.62	48.96
2021	38.67	38.79	28.62	48.96
2022	38.88	38.79	28.62	48.96
2023		38.79	28.62	48.96
2024		38.79	28.62	48.96
2025		38.79	28.62	48.96
2026		38.79	28.62	48.96
2027		38.79	28.62	48.96
2028		38.79	28.62	48.96
2029		38.79	28.62	48.96
2030		38.79	28.62	48.96
2031		38.79	28.62	48.96
2032		38.79	28.62	48.96
2033		38.79	28.62	48.96

(Source: KFVMDB, 2023)

During the years 2012 to 2019, the data displays a pattern of fluctuations, indicating that the prices of small tomatoes were not consistent but rather went up and down. However, starting from the year 2020 and continuing up to 2022, the price data seems to stabilize, showing a more consistent trend where the prices remained relatively constant.
In terms of the predicted prices, it appears that the model used to forecast tomato prices across all the years provided a constant prediction of 38.33. This suggests that the model expected the price of small tomatoes to remain steady at this value, regardless of the specific year.

TABLE 11: TABLE SHOWING R2, RMSE, MAPE, MAXAPE, MAE, MAXAE AND NORMALIZED BIC

R^2	RMSE	MAPE	Max APE	MAE	MaX AE	Normalized BIC
0.581	-0.040	4.496	8.96	26.334	8.093	3.237

Stationery value of R2 0.581 indicates that the exponential forecasting model has moderate ability to explain the variation

in the data. Approximately 58.1 % of the variance in the dependent variable can be explained by the independent variables included in the model. RMSE value is 4.496 indicating the lower magnitude of the errors made by the model's predictions. MAPE value of 8.958 suggests that, on average, the model's predictions have an absolute percentage error of around 8.958%. MaxAPE (Maximum Absolute Percentage Error) statistic has a value of 26.344 %, indicating model's prediction error is 26.344% .The MAE value of 3.166 explains that the average size of the mistakes that the model makes when it predicts price is 3.166. MaxAE (Maximum Absolute Error) is 8.093 units, indicating that the largest difference between a predicted value and an actual value is 8.093 units. The value of 4.320 for the normalized BIC suggests that the model fits the data well without being too complicated.

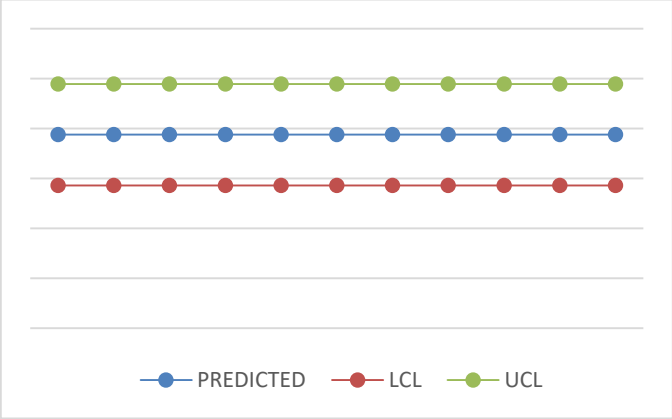

Fig. 4: Graph showing LCL, UCL and Predicted price of small tomatoes

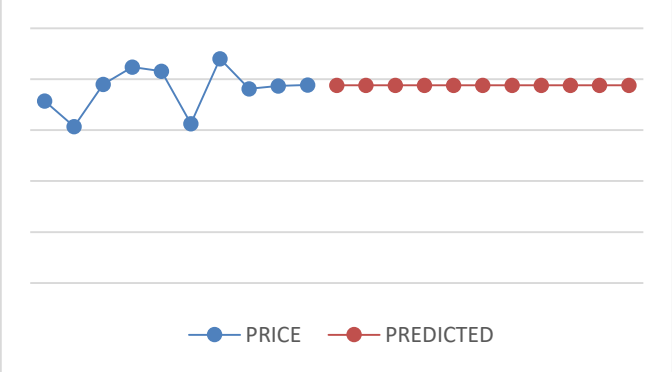

Fig. 5: Graph showing real and predicted price of small tomatoes from Year 2012 to 2022 and 2023 to 2033 respectively.

M. Marketing

The result from survey indicates that a relatively small proportion of 13%, preferred to grade their products prior to sale. Price satisfaction was assessed from the survey. Merely 1% indicated a high level of contentment, 16% showed satisfaction, 38% maintained a neutral stance, 40% conveyed dissatisfaction, and 5% demonstrated marked discontent. Similarly, market accessibility was studied, revealing that 26% had markets within 1 km, 67% within 1-5 km, 4% within 5-10 km, and 3% were over 10 km away.

The survey findings highlighted that several key actors exerted influence on the pricing dynamics of tomatoes, including the government, collectors, retailers, and the local market. The government's fixed price served as a benchmark for traders when collecting tomatoes. When it came to producers, their received prices fell into three categories: Kalimati mid-price, Kalimati low price, or Kalimati higher price. The determination of these prices was in the hands of traders.

Those who didn't choose this selling channel used either the local market price or the Kalimati price as a reference. Certain producers chose to sell their goods by themselves with a margin of either NPR 5 to15 based on the average Kalimati price. Some producers who sold product directly to consumers referred to local markets to set their prices. They sold their products at a slightly lower cost, usually 5 to 15 rupees lower than the local market price. In scenarios where farmers sold tomato to retailers, these intermediaries exerted substantial influence over the final pricing of tomatoes. Some producers didn't rely on any specific reference and instead set their prices according to their own preferences or considerations.

It was found that majority of respondents, 46% received lower Kalimati rate that is fixed by KFVMDB. 28% received the average Kalimati Wholesale Market price, and 2% were granted the highest rate within this market. 18% of the respondents received the price prevailing in the local market of their own area after deduction of NPR 5-15/kg. 4 % of respondents received Average Kalimati price with Margin of NPR 5-15/Kg. However, 2 % of the producers sold their products without any price considerations. Four distinct marketing pathways were identified for tomatoes within Lalitpur District. The delineated channels are provided below:

Producers- Traders – Wholesalers- Retailers – Consumers
Producers- Traders- Retailers- Consumers
Producers- Retailers- Consumers
Producers- Consumer

While 54 % of the respondents used single channel for the movement of tomato, 46 % of them used combination of channels for tomato distribution.

Marketing margin (MM) = Consumer's price (Pc) – Price received by the farmers (Pf)
= NPR 76.85 – NPR 45.67
= NPR 31.18 /kg

Producer's share is the proportion of the consumer's payment received by the producers.

$$\text{Producer's share} = \frac{Pf}{Pc} \times 100\%$$
$$= \frac{45.67}{76.85} \times 100\% \quad = 59.43\%$$

N. Production and Marketing Problems

TABLE 12: FORCED RANKING METHOD FOR DETERMINATION OF SEVERITY OF PRODUCTION PROBLEMS

Production Problems	Index Value	Rank
Unavailability of Inputs	0.766667	I
Pest and Disease Infestation	0.72	II

Environmental Hazards	0.653333	III
Irrigation Problems	0.623333	IV
Labor Shortage	0.385	V

The major marketing problem issue in the study area was found to be unavailability of inputs with the index value of 0.76. People in the study area faced a huge difficulty in obtaining the input especially the fertilizers. They had a problem getting fertilizer at government rate. Consequently, a substantial portion of the population was forced to procure fertilizers from the black market, incurring costs that were sometimes twice as high as the official government rate. One noteworthy concern expressed by the respondents was that even when fertilizers were present within cooperatives and municipalities, distribution favored individuals with influential connections or those who were local to the area.

The participants in the study area identified pest and disease issues as the second most significant challenge, with a corresponding index value of 0.72. To combat this issue, individuals within the study area resorted to the use of potent pesticides, primarily due to the diminished effectiveness of milder pesticide options. This reduction in efficacy was largely attributed to the development of resistance among pests.

Environmental Hazard was also seen as a significant problem with the index value of 0.65. Strong winds exerted considerable force on the plastics, leading to holes, tears, or even pulling them off completely. Bamboo was susceptible to bending, breaking and even falling over due to strong winds.

The topic of irrigation ranked fourth in terms of importance with an index value of 0.62. Farmers encountered difficulties as they had to travel a distance to access water from the river, which would often dry up during the season. However, in comparison to issues the challenge of irrigation was less significant because tomato growing areas were conveniently situated near water sources.

Labor shortage and lack of extension and training were ranked fifth and sixth with the index value of 0.38 and 0.35 respectively.

TABLE 13: FORCED RANKING METHOD FOR DETERMINATION OF SEVERITY OF MARKETING PROBLEMS

Marketing Problems	Index Value	Rank
Low Product Pricing	0.896	I
High Market Margin	0.658	II
Lack of Storage Facilities	0.638	III
Low Market Access	0.436	IV
Low Demand	0.362	V

Low Product Pricing and Price Fluctuation was ranked as the most critical issue by the respondents, indicated by its high index value of 0.896. Tomato farmers experience low pricing during the main season, resulting in inadequate compensation for their hard work. While prices may rise during the offseason, farmers are unable to take full advantage of this opportunity due to production constraints. The second most crucial problem identified by the respondents was the high market margin. Ranked third with an index value of 0.638, the insufficient availability of storage facilities poses a significant challenge. Tomatoes are perishable commodities, and the absence of proper storage facilities contributes to post-harvest losses. Low Market Access is ranked fourth while the issue of low demand is indicated by a relatively lower index value of 0.362.

O.SWOT Analysis

Strengths

- Climate Suitability
- Appropriate Soil Conditions
- Optimal Yield with Effective Management
- Longer Fruiting Period
- Production area adjacent to water resource.
- Rich agricultural knowledge

Weaknesses

- High labor wage
- Absence of collaboration of cooperative in tomato farming.
- Input Unavailability
- Perishable in Nature
- Absence of Farm Documentation
- Poor post-harvest infrastructure

Opportunities

- Support and subsidies from various program and projects.
- Technology Adoption
- High demand due to high population in valley.
- Value addition opportunities.
- Export Opportunities (India has removed import restrictions and has started importing tomatoes from Nepal.)
- Increasing nutritional consciousness among the consumers.

Threats

- High Pest Trans-boundary and Disease Infestations
- Massive Imports and open-borders.
- Price volatility.
- Expensive Inputs due to Adoption of Modern Techniques.
- Environmental hazards like wind, hailstorms and heavy rain.
- Higher degree of competition.

IV. CONCLUSION

Tomato farming presents a promising avenue for profitability within Nepal's agricultural landscape. The Benefit-Cost Ratio of 1.223 serves as a notable indicator, implying that farmers can recuperate their initial investment along with surplus gains in the very first year of operation. Subsequent years promise even higher returns, with a BCR projected to reach 2.054. This signifies a favorable economic outlook for tomato cultivation, highlighting the potential for sustained financial gains and long-term viability.

The SWOT analysis conducted on tomato production underscores both its challenges and opportunities. While the sector contends with various constraints, such as input unavailability and market-related issues, it enjoys an extensive scope for growth. This optimism is fueled by the availability of support and subsidy programs, advancements in agricultural technology, a robust local demand driven by the valley's burgeoning population, possibilities for value addition, and avenues for export. By leveraging these strengths and addressing the identified weaknesses, the tomato industry has the potential to overcome obstacles and thrive in the evolving agricultural landscape.

Price trend forecasting provides crucial insights into the future trajectory of tomato prices. The anticipated rise in the price of big tomatoes over the next years presents an encouraging prospect for farmers engaged in tomato cultivation. On the other hand, the predicted stability in the price of small tomatoes indicates a consistent demand and market stability. This information enables farmers to make informed decisions about their production strategies and market engagement.

A particularly noteworthy observation that emerges from the study is the prevailing distribution pattern among commercial farmers, wherein a substantial majority opts for the longest channel involving multiple intermediaries. This distribution route, which encompasses producers, traders, wholesalers, retailers, and consumers, highlights the complex and multifaceted nature of the market landscape within the tomato industry.

In sum, the analysis and findings underscore the viability and potential of tomato farming as a profitable venture in Nepal. The projected BCR, insights from SWOT analysis, price trend forecasting, and distribution patterns collectively paint a picture of an industry with promising prospects.

V. SUGGESTIONS

Based on the findings of the study, following conclusions have been made.

• Need to establish vegetable production and marketing cooperatives and sell produce through group marketing practices.

• Develop collection centers in rural areas to efficiently gather, sort, and distribute produce, minimizing waste and improving supply chain efficiency.

• Government should provide agricultural inputs in right time and in required quantity.

• Deploy field-level extension staff to provide farmers with practical guidance on modern techniques and pest management for improved yields.

• Enhance transportation infrastructure for perishable commodities such as vegetables to prevent spoilage and enhance market accessibility.

• Raise awareness about the advantages of crop insurance among farmers.

• Setting up at least one tomato processing facility in each municipality within the district to address the issue of excess production during the main season and to maintain price stability.

Implementing the suggestions has the potential to trigger a significant boost in the tomato sector, fostering expanded growth and development. By acting upon these suggestions, farmers, consumers, and the broader agricultural economy can reap substantial benefits.

ABBREVIATIONS AND ACRONYMS

MoALD - Ministry of Agriculture and Livestock Development
FAO - Food and Agriculture Organization
AGDP - Agriculture Gross Domestic Product
SWOT- Strengths, Weaknesses, Opportunities, Threats
NARC- Nepal Agriculture Research Council
SPSS- Statistical Package for Social Sciences
KFVMDB- Kalimati Fruits and Vegetable Market Development Board
CBS- Central Bureau of Statistics
MRSMP - Market Research and Statistics Management Program
MT- Metric Tons
NPR- Nepalese Rupee
LCL- Lower Confidence Limit
UCL- Upper Confidence Limit
ARIMA - Auto-Regressive (AR), Integrated (I), and Moving Average (MA)
RMSE - Root Mean Square Error
MAPE - Mean Absolute Percentage Error
MaxAPE -Maximum Absolute Percentage Error
MAE- Mean Absolute Error
MaXAE- Maximum Absolute Error
BIC- Bayesian Information Criterion
R^2- Coefficient of Determination
BCR-Benefit Cost Ratio
TVC-Total Variable Cost
TFC-Total Fixed Cost
TC- Total Cost

REFERENCES

- Bajracharya, B. M., & Paudel, P. (2020). *Tomato Value Chain Analysis in Nepal: A Case Study of Chitwan and Kavre Districts*. Journal of Agriculture and Natural Resources, 3(1), 63-74.
- Bhandari, N.B., Bhattarai, D., & Aryal, M. (2015/16). Demand and supply situation of tomato in Nepal, 2015/16. [online] Available at: http://www.doanepal.gov.np/downloadfile/tomato%20book_1614144109.pdf
- Chalise, M., and Bhandari, T., (2014). Comparative economics of plastic house and open-field tomato production in Lamjung district, Nepal. [online] Available at: https://www.researchgate.net/publication/352017657_Comparative_economics_of_plastichouse_and_openfield_tomato_production_in_Lamjung_district_Nepal (Accessed On: 15th August, 2023)
- KFVMDB. Annual Magazine 2012-2022 [Internet]. Available from: https://kalimatimarket.gov.np/notices/publication (Accessed: 16 March 2023).
- Encora. (2022). Exponential Smoothing Methods for Time Series Forecasting - Encora.[online]Available at : https://www.encora.com/insights/exponential-smoothing-methods-for-time-series-forecasting (Accessed On: 16th August, 2023)

- Ghimire, N.P., Kandel, M., Aryal, M. & D. Bhattarai (2017). Assessment of Tomato consumption and demand in Nepal. The Journal of Agriculture and Environment [online]Available at: https://www.researchgate.net/publication/325109886_Assessmentof_tomato_consumption_and_demand_in_Nepal (Accessed:16 March.2023)
- Hayes, A., Stapleton, C., Munichilleo, K., (2022). Autoregressive Integrated Moving Average (ARIMA) Prediction Model [online] Available at: https://www.investopedia.com/terms/a/autoregressive-integrated-moving-average-arima.asp (Accessed On: 16th August, 2023)
- IBM SPSS. (2023). Forecasting statistical details Available at:https://www.ibm.com/docs/en/cognosanalytics/11.1.0?topic=forecasting-statistical-details (Accessed On: 16th August, 2023)
- Lamichhanne, J., Ghimire, Y.N., Timsina, KP.,Magar DB.,Sharma ,T.,Timsina, Mishra, RC & Adhikari SP., (2017). Profitability Assessment of tomato cultivation under plastic house in western hills of Nepal. [online] Available at: https://www.researchgate.net/profile/Jeevan-Lamichhane/publication/329023605_PROFITABILITY_ASSESSMENT_OF_TOMATO_CULTIVTION_UNDER_PLASTIC_HOUSE_IN_WESTERN_HILLS_OF_NEPAL/links/5bf0ff834585150b2bbefce7/PROFITABILITY-ASSESSMENT-OF-TOMATO-CULTIVTION-UNDER-PLASTIC-HOUSE-IN-WESTERN-HILLS-OF-NEPAL.pdf (Accessed On: 15th August,2023)
- MoALD. (2023). Statistical Information On Nepalese Agricult¬ure 2078/79 [2021/22], Singha Durbar, Kathmandu, Nepal: Ministry of Agriculture and Livestock Development
- MRSMP. (2014/15). Average Production Cost and Profit Margin of Cereal, Vegetable and Industrial Crops .Hariharbhawan,Lalitpur,Nepal
- Paudel, P. and Adhikari R.K., (2018). Economic analysis of tomato farming under different production system in Dhading district of Nepal.[Online] Available at: https://www.researchgate.net/publication/326698915_Economic_analysis_of_tomato_farming_under_different_production_system_in_Dhading_district_of_Nepal (Accessed On: 15th August, 2023)
- Prasain, K., (2023).The Kathmandu Post. Nepal sends tomatoes to India, and asks for rice. Available at: https://kathmandupost.com/money/2023/08/11/nepal-sends-tomatoes-to-india-and-asks-for-rice (Accessed On: 16th August,2023)
- Reddy A.A.,(2018).Price Forecasting of Tomatoes.[online] Available at : https://www.researchgate.net/publication/326274997_Price_Forecasting_of_Tomatoes (Accessed On: 16th August, 2023)
- Robert H. Shumway, R.H. and Stoffer, D.S., (2016). Time Series Analysis and Its Applications [online] Available at : http://www.stat.ucla.edu/~frederic/415/S23/tsa4.pdf
- Sharma, M.,Dhakal,S.C., Adhikari R.K and Tiwari U., (2021).Profitability, productivity and resource use efficiency of banana production in Hetauda-Dumkibas road corridor, Nepal.[online] Available at: https://www.researchgate.net/publication/351141654_Profitability_productivity_and_resource_use_efficiency_of_banana_production_in_Hetauda-Dumkibas_road_corridor_Nepal (Accessed On: 15th August,2023)
- Subedi, M., Pandey, M.,Ojha, R.K.& Acharya, B.,(2020).Production economics and resource use efficiency of tomato under open field condition in Kapilvastu, Nepal.[online] Available at: https://agriculturistmusa.com/causes-of-price-fluctuation-in-agriculture/ (Accessed On: 29th March,2023)
- Varshney, P., (2020). Measure Performance for a Time Series Model [ETS or ARIMA]. [online] Available at : https://towardsdatascience.com/measures-performance-for-a-time-series-model-ets-or-arima-18b0a3e91e83 (Accessed On: 16th August,2023)