Economics of Medicinal Plant Production and Supply Chain Management in Mohmand Valley

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Abstract

The medicinal value of plants and products derived from plants is widely recognized. A study was conducted using Medicinal Plant and their Supply Chain mechanism in Mohmand valley. This research examines the economics and value chain of a medicinal plant grown by marginal farmers in Mohmand's villages. In order to do regression analysis was conducted a field market supply chain survey in different Mohmand areas. The statistically significant outcomes of the regression analysis in this study were demonstrate the regression linearity outcome within the variables. The existing estimates of the quantities removed from Mohmand District are not based on the optimal, regulated use of these species in the valleys. However, it has been noted that the availability of MAPs, training and education, and market excess have an effect on the Mohmand MAP supply chain. Still, efficiency results in advantage. Due to a lack of competition in the value chain system for medicinal plants, middlemen dominate both the primary and secondary wholesale markets, driving up prices. It has been recommended that the Central and State Governments adopt certain actions to better the lot of these plant's impoverished growers and to enhance the nation's marketing of medicinal plants. It is recommended that sustainable strategies for MAPs be developed and that there is an urgent need for research into the connections between overexploitation of species and the quality of herbal medicines marketed worldwide. Developing training courses for medicinal plant collectors is also advised in order to enhance sustainability, trade monitoring and community involvement in natural resource management.

Keywords: Economic Development, Medicinal Plants, Tribal Communities, Value Chain Analysis, Sustainable Farming, Marketing Margins, Mohmand district, Supply Chain Management

INTRODUCTION

Supply chain management, or SCM, is essential to any the organization's success in the modern global economy. Management thus serves as the foundation of sourcing, production, and logistics, all of which have an impact on the total cost, productivity, and quality of the supply chain (Ferdous et al., 2023).The supply chain includes every action that is made between receiving an order and fulfilling it. In brief, support tasks include product management, advertising, operations, supply chain management, accounting, and customer assistance (Will Kenton, 2021). A values-based supply chain preserves the morality of its suppliers as well as the social, environmental, and communal values ingrained in the products it distributes (Jennifer et al., 2016).

From production to distribution, agricultural and horticultural goods are moved through a sequence of procedures called "agri-food supply chains" (ASC) These issues are considerably more complex in the case of fresh goods, where producers also have to manage greater marketing risks and a shorter shelf life. Thus, harvesting rules, marketing channels, logistics operations, vertical coordination, and risk management are all components of the fresh food supply chain that must be organized in order to construct specific planning models that consider aspects (Epperson & Estes, 1999). But instead of taking the time to understand the complex series of events that goes from farm to table, a lot of consumers just take their crop supply at face value. The "crops supply chain" refers to every link in the network that transfers food from the farm to the table (Barmanw et al., 2021).Over the past 15 years, demand for MAPs has exceeded supply, leading to price rises and increased demand worldwide. About 25 percent of the medicines prescribed in prosperous countries come from wild plant species, while 80% of people in Asia and Africa mostly get their medical care from these plant-based pharmaceuticals (WHO, 2008).

In 2016, the value of exports was USD 3.07 billion, while in 2017, it reached USD 3.12 billion. Global trade in MAPs is thought to involve 3,000 species, which are used to make flavorings, nutritional supplements, cosmetics, natural health products, and medications. However, according on the source, the number of plants classified as MAPs varies from about 28,000 (Royal Botanical Gardens) to 50,000. The majority of plant resources are taken from their natural habitats, and there are neither practical regulations nor tracking systems in place to prevent overharvesting, loss of habitat, or illegal dealing. Medicinal plants are employed for their concentrations of bioactive substances, byproducts of plant secondary metabolism, which have been shown to have positive benefits on human health (Balunas and Kinghorn, 2005).

It was originally the norm for researching plants' potential for medicine. The founder of medicine, Hippocrates (460–377 B.C.), once

remarked, "Let your food be thy medicine and thy medicine be thy food." This concept was in keeping with the significance of food supplements given the nature of their proven bioactive therapeutic and preventative components, raised margin of safety, and desired range of effectiveness. Despite the fact that traditional healers have historically utilized plants for both preventing and treating a variety of ailments, Researchers are currently starting to go beyond the fundamental nutritional benefits of foodstuffs into disease prevention and health encouraging elements since there is growing interest in the health benefits of foods (Bafort et al., 2022).

This research highlights some fundamental concerns with the supply chain of medicinal production in Mohmand valley. Recent studies on the cultivation of medicinal plants and their Supply Chain management. This study is based on an investigation conducted in the Mohmand region regarding the MAPs value chain. In order to boost the marketplaces' competitiveness and eventually generate more, it thus identifies potential barriers to productivity and output as well as possibilities for improvement, and which prospects medicinal plant cultivation for the pharmaceutical industry to fulfil the market demand.

Supply Chain Management of Medicinal Plants.

The demand for medicinal plants as a crucial raw resource is currently growing thanks to significant herbal medicine businesses. The pharmaceutical industry is displaying a greater interest in discovering, developing, and producing the active components of medicinal plants. Traditionally, people gather medicinal plants in the wild. About two thirds of the 50 000 medicinal species currently in use come from wild collection. Despite the perception that something is natural and harmless, it's frequently of poor quality or even dangerous when it's collected spontaneously (Prasad et al., 2018). This represents a severe challenge for consumers, researchers, and medical professionals, and it has led to regulatory demands for high standards of quality, uniformity, and safety for goods developed from medicinal plants. (Rahimi et al., 2012). Additionally, although traditional wild plant collection is still a low-cost practice in many developing nations (Prasad et al., 2018), it has become risky for ecosystems and for the conservation of plant species due to the rise in popularity and quick expansion of the global herbal medicine market.

Economic parameters of medicinal plant's value chain

The international trade in native medicinal plants and plant-based medications has grown significantly in the previous several decades (Hamilton, 2013). International trade in medicinal plants supports millions of people in underdeveloped nations (Mander and Le Breton, 2006). By 2050, these trades are expected to grow significantly due to the significant rise in demand for herbal items (Lange and Mladenova, 1997). A variety of measures or indicators can be utilized to measure the real value, trade, and sustainable cultivation of MAPs for the benefit of farmers and the country.

Pull and push effects may be the primary forces behind the cultivation of medicinal plants. The factors that encourage farmers to grow MAPs rather than conventional crops are commonly referred to as pull effects. These elements include competitive prices, established market routes, dealers' price assurance, and the group of producers' dominances on the cultivation of these commodities (Chandresh et al., 2014).

Domestic value chain of MAP

Williams et al., (2007) believe that a variety of factors influence the market value of individual plant categories, contributing to significant fluctuations in value.

- In general, the quantity of the product being sold and the price per unit have an inverse and disproportionate relationship. When it comes to the sales of the goods, larger amounts sold are worth less than smaller numbers. Plant species that are harvested for their fruits, leaves, and roots are valued more than other parts of the plant, such as bark and bulbs, despite their higher quantity sold.
- The cost of harvesting a plant species varies depending on the harvester's access to resources and the distance between trading markets and the harvesting sites.
- In local markets, prices for purchasing indigenous products are also subject to negotiation between buyers and sellers.

Global value chain of MAP

MAPs' economic indicators and international market values are determined by several types of variables. The simplest formula, "supply and demand," regulates all international trade, including the two types of "high value minor" commodities, such as MAPs (Agcaoili and Rosegrant, 2010). These crops make up a very small portion of a nation's agricultural output, but in the last ten years, their importance has grown significantly as a result of the increased demand for these plants in the worldwide medical sector (Khan et al., 2011).

Developed nations like the USA and Europe are developing healthcare systems that demand the utilization of herbal resources and products. As a result, there has been a noticeable increase in the demand for MAPs internationally in recent years, which has given MAP exporting nations plenty of potential to raise their economic stake in this industry (Vasisht et al., 2016). Local indigenous plants supply over 80% of the world's supply of MAPs (Bernholz, 2004). MAPs trade a number of important products, including phytopharmaceuticals, nutraceuticals, and cosmetics.

The market for spices, herbs, and MAPs has grown significantly in recent years due to the growing interest in the therapeutic qualities of phytochemicals linked to native medicinal plants in the medical field. The industrial use of these plants to make cosmeceuticals, plant-based

pharmaceuticals, teas, extracts, decoctions, herbal remedies, and nutraceuticals has been expanding more quickly than the use of traditional medications and drugs. A nation's economic growth can thus be greatly enhanced by an industrial sector based on MAPs (Gunjan et al., 2015).

MOHMAND VALLEY

The Mohmand District, a region that makes up 10% of all the Newly Merged Districts (NMDs) territory, has a population of approximately 466,984 people and an area of roughly 2296 square kilometers, according to the Pakistan Bureau of Statistics & LG&RD Department, KPK. Mohmand has a hilly landscape overall. The district's agricultural land is just about 9%, and most areas struggle with a shortage of water. Among the well-known industries are minerals and agriculture. In the field of agriculture, vegetables are the main product. However, Mohmand has deposits of marble, chromite, dolomite, manganese, quartz, emerald, nephrite, and gypsum. The Mohmand Economic Zone, also known as Mohmand Marble City, was founded next to Mamud Gat in order to convert the available marble into top-notch goods and to encourage manufacturing in the area.

According to the established hierarchy, the main transit route (known as the Trunk Road) in Mohmand district is the road constructed by the Federal Works Organization (FWO). This road connects Ghalanai to Peshawar and Shabqadar in the south, and to Nawagai, Bajaur, and Taimergara in the north. Private transportation companies, including bus, coach, and coaster services, offer transport services between Ghalanai and other major urban cities, as well as intercity travel. Apart from the mentioned roads, there is only one bridge located near the Chanda Bazar Road that links the northern and southern parts of the city. This bridge is a reinforced concrete structure that spans 85 meters in length. It has two lanes and is wide enough for two trucks to pass each other simultaneously in opposite directions (Aziz et al., (2018).

Highlighting the Mohmand Urban market and economic zone

Ghalanai Bazar and Main Mandi Bazar are the two primary commercial sections that make up the 37 acres that currently make up the Ghalanai commercial sector. The metropolitan center's north side is served by Main Mandi Bazar, while the south side is served by Ghalanai Bazar. Retail and wholesale marketplaces can potentially be found in each of these locations, which make them essential centers for economic activity in the urban region. MAPs are often sourced from Mohmand District and sold to Lahore and Peshawar, where they are sold in the herbal markets of Afghanistan. Mohmand District provides the market with vast amounts of herbal materials, which are then delivered to different market. The focal point of the country's MAP trade is the Lahore herbal market. It provides significant amounts of materials to the Karachi market in addition to meeting the needs of smaller markets in different Punjabi cities and towns. These businesses typically buy supplies from intermediaries, or referred to suppliers (MUNIR, (2024).

MATERIALS AND METHOD

Initially a conceptual framework of the study was developed keeping in view all the domestic and global value chain parameters. On the basis of this conceptual framework, an empirical framework was developed. From the variables of empirical framework, data set was collected from the domestic and global markets.

Selection of MAP crops from Mohmand

Local communities generally collect different MAP plants from the surrounding areas. These plants were sold to local vendors after initial processing/ value addition. The list of these plants is given below;

1. Nannorrhops Ritchieana (Griff.) Aitch. (Maizary).
2. Caralluma Tuberculata N.E (Pamankay).
3. Mentha Spicata L. (Podina).
4. Mentha Longifolia (L.) (Ilanai).
5. Allium Sativum (Garlic).
6. Morchella Esculenta Fr. (Guji).

These MAP were present/grown in different parts of the Mohmand valley.

Table 1.2: Area selected for data collection Mohmad Valley:

MAP Plant	Village	Characteristics
Nannorrhops Ritchieana	Hazara,Taamanzi, Lati Kor, Youskhel,	Shrub to small tree that is an important part of the locals' lives. Its fruits are edible and can be consumed orally for laxative and purgative effects; the seeds are used to create prayer beads (Dehghani et al., (2023).
Caralluma Tuberculata	Shabeg kor, Halimzia, Danishkol, Khadi Khel Kasori	Caralluma is used to treat skin rashes, inflammation, diabetes, cancer, and bites from snakes and scorpions (Abdel-Sattar et al., 2007; Adnan et al., 2014).
Mentha Spicata. (Podina).	Hazara, Taamanzi, Lati Kor, Youskhel, Ambar,	Mint (Mentha spicata) is a common dietary item that is used to treat a variety of illnesses. The herb mint (Mentha spicata) has leafy stems. Additionally, it is used to treat allergic reactions that cause migraines, diarrhoea, cramping in the abdomen, and heartburn (Ullah et al., (2023).

Mentha Longifolia (L.) (Ilanai).	Hazara, Taamanzi, Lati Kor, Youskhel, Ambar,	It is a well-known herb that is grown throughout Pakistan. More potential was shown by the plant in treating conditions like fever, cough, cold, body aches, burning in the stomach, jaundice, and obesity.
Allium Sativum (Garlic).	Halimzia, Danishkol, Khadi Khel Kasori	The main medical benefits of garlic include lowering cholesterol and blood pressure, preventing cancer, and fighting infections. Varade.et al., (2024)
Morchella Esculenta Fr. (Guji)	Halimzia, Danishkol, Khadi Khel Kasori	It has been utilized as food and food-flavoring material in soups and sauces. Polysaccharides found in mushrooms are potent therapeutic substances with anti-tumor and immune-modulating qualities Kapoor.et al., (2024)

CONCEPTUAL FRAMEWORK

Conceptual model of the study comprised of a systematic framework that depicts a guiding outline of empirical inquiry of the study. In this study an analysis of economics of Medicinal Plants and their supply chain mechanism in Mohmand valley, all variables of the study were arranged in a flow model indicating their nature as dependent and independent variables (Fig 1.1.

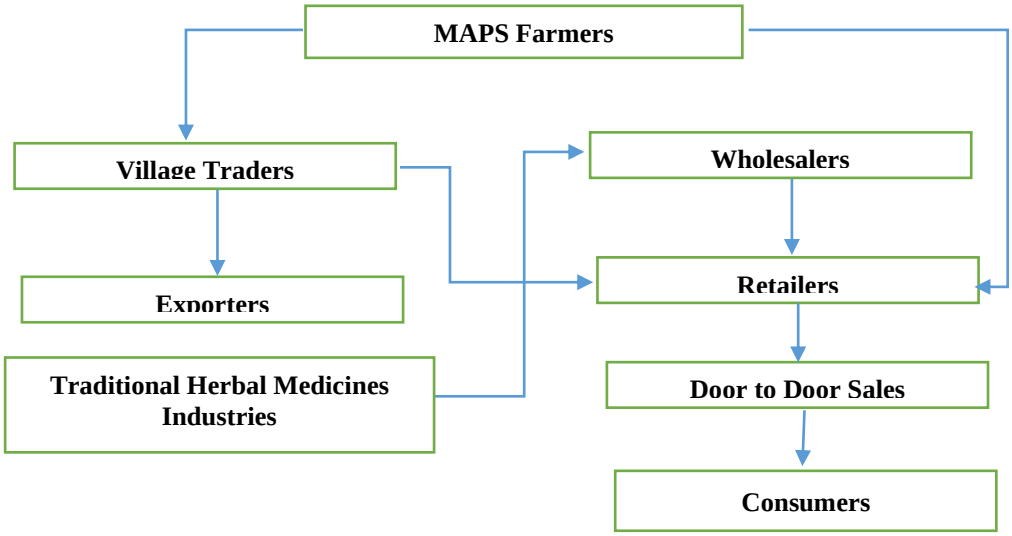

Figure 1.1: Conceptual framework, Supply Chain of Medicinal Plants (Marshall, D.A. 2015).

According to Figure 1.1 Technical literature review was also be conducted on the collection, trading, processing, and national and international marketing of MAPs. This study has also examined the dealers' and suppliers' catalogs and brochures of businesses involved in the trading of MAPs. As a result, the study's regions were generally divided into sources and markets.

EMPIRICAL FRAMEWORK

Empirical framework of the supply chain of medicinal crops of Mohmand District comprised of local production, collection, market surplus and its sale at local collector price, retailer price, wholesaler price and exporter price.

Model Specification:

Total revenue function for MAP depends upon quantity of produce collected by village beopari, its local market price, its price in village market, urban market (Chain stores) and global market. We use the following equation (Khan & Afzal, 2018).

Revenue $=\beta_0+\beta_1$Quantity $+\beta_2$ (local Market Price) $+\beta_3$(Urban Market price) $+\beta_4$(global Market price) $+\varepsilon$

$$TR = \beta_0 + \beta_1 Q + \beta_2 LP + \beta_3 UP + \beta_4 GP + \varepsilon$$

Where, $\beta_0,\beta_1,\beta_2,\beta_3,\beta_4$ are the coefficient and ε are the other factor.

This equation explains the economic analysis of supply chain process of six major medicinal crops which are produced and supplied to the global market through marketing channel of local village or local area market, then Urban or wholesale market and then exported to international market either by sea or air.

RESULTS AND DISCUSSION

The economic analysis of the medicinal crop supply chain in Mehmood Village, KPK, Pakistan, is the primary purpose of the study. Now the result and discussion based involved three ways to fulfill the research objective. The empirical model using simple regression conducted for economic analysis of supply chain. Simple regression is used through SPSS statistical tool for cross sectional analysis of six crops in ten areas of Mohmand village.

REVENUE SUPPLY CHAIN ANALYSIS

Result of each crop showing the level of linearity they have within the variable. The first part of table 1, provides you with output in which independent variables are regressed on revenue scores. In other words, we are using Quantity, collector, local and international market to predict revenue.

Nannorrhops Ritchieana (Griff.) Aitch. (Maizary)

Here are the results of a simple Regression Analysis:

Table a: Showing the statistical results of Nannorrhops Ritchieana (Griff.) Aitch. (Maizary) using Regression Analysis

Variables	Coefficient	Std Error	t	P	VIF
Constant	-128520	118639	-1.08	0.3281	
Collectors	874.953	365.512	2.39	0.0621	2.6
International (price)	30.337	165.526	0.18	0.8631	2.3
National (price)	306.69	244.211	1.26	0.2647	1.1
Quantity (kg)	43.2003	11.7929	3.66	0.0145	3.9

As above table shown that collector probability value is greater than 0.05 so there is positive impact of collector on revenue with 1% increase in collection there is 874.9% increase in revenue. International income price and National price income the probability is higher than 0.05 so there is positive impact on revenue as 1% increase in international price income and National price income there is 30.33% and 306.69% respectively increase in revenue. Now quantity has also positive signifance effect on revenue as T value is 3.66 which is between 2 to 4.

In order to test the research question, a simple regression was conducted, with for the quantity, market price, international price and farmer income as the predictor, and levels of revenue as the dependent variable. Overall, the results showed that the utility of the predictive model was significant, $F = 9.96$, $R^2 = 0.885$, $p < .001$. R-Squared (R^2 or the coefficient of determination), so R^2 is 0.88 it means 88% of the variation in the output can be explained by the input variable which mean it gives confidence as that the model explains 88% of the movement in overall satisfaction. The results showed that all the independent variables were a significant at 95% confident interval.

Caralluma Tuberculata N.E (Pamankay).

Here are the results of a simple Regression Analysis:

Table b: Showing the statistical results of Caralluma tuberculata N.E (Pamankay) using Regression Analysis.

Variables	Coefficient	Std Error	T	P	VIF
Constant	469819	363382	1.29	0.2526	
Collectors/(Rs/kg)	2936.31	406.77	7.22	0.0008	1.3
International (price)	-327.275	418.971	-0.78	0.4701	1.7
National (price)	-753.278	717.971	-1.05	0.3421	1.8
Quantity (kg)	95.9534	18.5543	5.17	0.0036	1.1

Simple regression was conducted, with for the quantity, market price, international price and farmer income as the predictor in a supply chain of Caralluma tuberculate in Mohmand valley, and levels of revenue as the dependent variable. Overall, the results showed that the utility of the predictive model was significant, F = 25.69, R2 = 0.9536, p=.001 so p<0.05, provide the level of Significant. R-Squared (R^2 or the coefficient of determination), so R^2 is 0.9 it means 90% of the variation in the output can be explained by the input variable which mean it gives confidence as that the model explains 90% of the movement in overall satisfaction. The results showed that all the independent variables were a significant at 95% confident interval.

Mentha Spicata L. (Podina)

Here are the results of a simple Regression Analysis:

Table 4.1 c: Showing the statistical results of Mentha spicata L. (Podina) using Regression Analysis.

Variables	Coefficient	Std Error	T	P	VIF
Constant	-494558	574759	-0.86	0.4289	
Collectors (Rs/kg)	2599.35	1293.89	2.01	0.1708	3.8
International (price)	96.5501	1043.57	-0.09	0.9299	3.4
National (price)	331.536	1337.58	0.25	0.8141	7
Quantity (kg)	161.339	27.3142	2.99	0.002	1.3

As above table shown that collector probability value is greater than 0.05 so there is positive impact of collector on revenue with 1% increase in collection there is 2599% increase in revenue. International income price and National price income the probability is higher than 0.05 so there is positive impact on revenue as 1% increase in international price income and National price income there is 96.53% and 331.5 % respectively increase in revenue. Now quantity has also positive significance effect on revenue as T value is 2.99 which is between 2 to 4.

A Simple Regression Analysis was performed, using levels of revenue as the dependent variable and the quantity, market price, international price, and farmer income as predictors in the Mentha spicata supply chain in the Mohmand valley. Overall, the findings demonstrated the significant utility of the predictive model, with a degree of significance of p<0.05, F=19.76, R2 = 0.9405, and p=002). The coefficient of determination, or R-squared, is 0.94, indicating that 94% of the variation in the output can be accounted for by the input variable. This indicates that 94% of the variation in overall satisfaction can be explained by the model,

providing confidence in its ability to predict. All of the independent factors were significant at a 95% confidence interval, according to the results.

Mentha Longifolia (L.) (Ilanai).

Here are the results of a simple Regression Analysis:

Table 4.1 d: Showing the statistical results of Mentha longifolia (L.) (Ilanai) using Regression Analysis

Variables	Coefficient	Std Error	T	P	VIF
Constant	-850597	524978	-1.62	0.1661	
Collectors (Rs/kg)	1880.76	406.762	4.62	0.057	1.1
International (price)	1222.84	771.489	1.59	0.1738	1.7
National (price)	915.741	831.627	-1.1	0.321	2
Quantity (kg)	214.155	33.8572	6.33	0.2015	1.4

As above table shown that collector probability value is equal than 0.05 so there is positive impact of collector on revenue with 1% increase in collection there is 1880.76% increase in revenue. International income price and National price income the probability is higher than 0.05 so there is positive impact on revenue as 1% increase in international price income and National price income there is 1222.84 % and 915.7 % respectively increase in revenue. Now quantity has also positive signifance effect on revenue as 1% increase in Quantity there is 214.15 % increase in revenue.

The Mentha longifolia supply chain in the Mohmand valley was analyzed using a simple Regression Analysis, with revenue levels as the dependent variable and quantity, market price, international price, and farmer income as predictors. With a degree of significance of $p<0.05$, the results showed the prediction model's significant utility overall $F=20.14$, $R2 = 0.9416$, and $p=0028$). With a coefficient of determination, or R-squared, of 0.94, the input variable can explain for 94% of the variation in the output. This suggests that 94% of the variance in total happiness can be accounted for by the model, indicating a high degree of predictability. The results showed that every independent component was significant at a 95% confidence interval.

Allium sativum (Garlic).

Here are the results of a simple Regression Analysis:

Table 4.1 e: Showing the statistical results of Allium sativum (Garlic) using Regression Analysis.

Variables	Coefficient	Std Error	T	P	VIF
Constant	-3831186	830051	-4.62	0.0508	

Collectors (Rs/kg)	636.647	664.61	0.96	0.3821	4.1
International (Price)	630.117	699.662	0.9	0.4091	2.2
National (price)	4062.85	1662.22	2.44	0.0583	4.8
Quantity (kg)	199.845	31.7922	6.29	0.105	1.5

As above table shown that collector probability value is equal than 0.05 so there is positive impact of collector on revenue with 1% increase in collection there is 636.6% increase in revenue. International income price and National price income the probability is higher than 0.05 so there is positive impact on revenue as 1% increase in international price income and National price income there is 630.11 % and 4062.8 % respectively increase in revenue. Now quantity has also positive signifance effect on revenue as 1% increase in Quantity there is 199.84 % increase in revenue.

A simple Regression Analysis was used to examine the Mohmand valley's allium sativum supply chain. The dependent variable was revenue levels, and the predictors were quantity, market price, international price, and farmer income. The results demonstrated the overall considerable utility of the prediction model F =26.14, R2 = 0.9544, and p=0015) at a significance level of $p<0.05$. 95% of the variance in the output can be explained by the input variable, according to an R-squared of 0.95, which measures the coefficient of determination. This implies that the model can explain 95% of the variance in overall pleasure, demonstrating a high level of predictability. Every independent component was significant at a 95% confidence interval, according to the results.

Morchella Esculenta Fr. (Guji).

Here are the results of a simple Regression Analysis:

Table f: Showing the statistical results of Morchella esculenta Fr. (Guji).

Variables	Coefficient	Std Error	T	P	VIF
Constant	33.206	181.099	0.28	0.8617	
Collectors (Rs/kg)	545.04	1.12E-04	4.88	0.046	7.6
International (price)	0.8289	0.18465	0.45	0.6723	1.1
National (price)	0.7573	0.19073	0.92	0.3991	1.7
Quantity (kg)	0.11006	0.02012	2.47	0.0028	6.3

As above table shown that collector probability value is greater than 0.05 so there is positive impact of collector on revenue with 1% increase in collection there is 545% increase in revenue. International income price and

National price income the probability is higher than 0.05 so there is positive impact on revenue as 1% increase in international price income and National price income there is 0.89 % and 0.75 % respectively increase in revenue. Now quantity has also positive signifance effect on revenue as 1% increase in Quantity there is 0.11% increase in revenue.

The Mohmand valley's Morchella esculenta supply chain was examined using a simple Regression Analysis. Quantity, market price, international price, and farmer income were the predictors, and revenue levels were the dependent variable. According to an R-squared of 0.97, which indicates the coefficient of determination, 97% of the variance in the output can be explained by the input variable. The results showed the overall considerable utility of the prediction model F =11.54, R2 = 0.9023, and p=0.0097) at a significance level of $p<0.05$. Thus, a substantial amount of predictability is demonstrated by the model's ability to account for 95% of the variance in overall satisfaction. According to the results, each independent component was significant at a 95% confidence interval.

CONCLUSION AND POLICY RECOMMENDATION

In conclusion, the empirical model results provide valuable insights into the factors influencing the economics of supply chain MAPs in Mohmand, KPK, Pakistan. The findings reveal several key drivers that have a significant impact on the supply chain efficiency of these through local to international market.

Estimates of the price rises associated with the supply chain movement of high value MAPs are provided by the study. While these variances in prices are to be expected, collectors and local merchants' awareness about the demand for the different species is also a contributing factor. Because they typically lack direct knowledge of the final markets for their goods, nomadic gatherers and collectors must depend on local traders to sell their wares throughout the current value chain. Collectors and local dealers need to have a deeper understanding of the markets they are supplying in order to increase their revenue from MAPs. Comprehending the magnitude and seasonality of market prices and demand, along with quality expectations and their influence on suitable pre-harvest and post-harvest management and handling of MAPs species.

On the other hand, the supply chain of MAPs in Mohmand has been observed to be impacted to some extent by the availability of MAPs, training and education, and market excess. While effectiveness yields benefit. In order to improve availability and streamline farmers' access to financing and markets, policymakers should consider these criteria when developing targeted initiatives.

In conclusion, this study makes a substantial contribution to our knowledge of and efforts to improve the Mohmand Valley MAP supply chain. It highlights the enduring significance of these antiquated spices in

the modern day and offers policymakers insightful information to promote economic expansion and supply chain efficiency.

POLICY RECOMMENDATION

- **Sustainable Resource Management:**

  Sustainable resource management of the supply chain has a statistically significant positive impact on the Mohmand, as demonstrated by the empirical models. Modern agricultural technology should be promoted by policymakers in order to improve supply chain performance and production efficiency.

  a. Develop and put into effect rules and policies that address ecological sustainability and biodiversity preservation while harvesting and cultivating MAPs in a sustainable manner.

  b. Educate local people sustainable harvesting methods, such as correct identification, cultivation techniques, and post-harvest handling procedures, through training and technical assistance.

  c. Create community-based monitoring systems to maintain tabs on MAP populations and guarantee that sustainable harvesting methods are being implemented.

- **The network for the Supply Chain:**

  According to the survey, collectors sell almost 90% of MAPs materials unprocessed. The sustainable harvesting techniques, post-harvest processing, and appropriate storage of medicinal plants are areas in which local collectors require expertise. Following are the policy recommendations:

  a. Encourage the formation of cooperatives or producer groups to consolidate MAP harvests, simplify logistics, and negotiate for less expensive prices with consumers.

  b. Make technology and equipment for processing and value addition, like packaging machinery, distillation units, and drying facilities, more accessible.

- **Market Access and Value Addition:**

  These practices frequently disappear from collectors' and farmers' operations, and they are typically carried out with the intention of only satisfying the minimal quality standards required in both the domestic and foreign markets. Following are the policy recommendations:

  a. Perform market analyses to determine possible specialized markets for high-value botanicals as well as domestic and worldwide demand for MAP products.

  b. Provide assistance with developing connections with customers and distributors, participating in trade shows, and advertising MAP items on retail platforms.

c. Promote investment on research and development to investigate value-added prospects, like the synthesis of nutraceuticals, herbal extracts, and essential compounds from MAPs.

- **Beneficial sharing and Community Empowerment:**

Following are the policy recommendations:

a. Ensure absolutely certain that local communities are involved in the decision-making process about the management of MAP resources and benefit-sharing agreements.

b. Implement procedures, including as revenue-sharing plans, community development efforts, and capacity-building programs, for the open and equal transfer of benefits resulting from the exploitation of MAP.

c. Encourage the integration of women and other minorities into the MAP value chain by offering them opportunities for employment and training to increase their involvement and empowerment.

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