**Assessment of Acreage Response of Chickpea to Price and Non-Price Factors in Gujarat, India**

**ABSTRACT**

The study focused on assessing the acreage response of chickpea to price and non-price factors in Gujarat. The analysis aimed to determine how farmers allocate acreage and production in response to price and non-price factors. The study used time series secondary data from 1995-96 to 2022-23 for districts including Junagadh, Rajkot, Jamnagar, and Ahmedabad. The Nerlovian Partial Adjustment Model (1956) was employed to analyze the acreage response. Results showed that lagged price had a positive and significant effect in Rajkot (0.09) and Jamnagar (0.06) districts. Factors such as lagged area, lagged price, price risk, and yield risk played a significant role in chickpea acreage response. Short-run and long-run elasticities were mostly found to be inelastic, with short-run price elasticity positively significant in Rajkot district (1.32). Long-run price elasticities were more elastic in every district compared to short -run elasticity.

**Key words:** Acreage response, Chickpea, Nerlovian Partial Adjustment model, Elasticity.

**INTRODUCTION**

Pulses are a significant segment of Indian agriculture, following cereals and oilseeds. India holds the title of being the largest producer, consumer, and importer of pulses globally. The country leads in the production of chickpeas, pigeon peas, mung beans, urad, and masur. Chickpeas and pigeon peas are particularly crucial in terms of area and production potential in India. Pulses are rich sources of thiamine, niacin, calcium, phosphorus, and iron. They provide a substantial amount of energy (345 kcal), protein (24.5 gm), calcium
(140 mg), phosphorus (3 mg), iron (8 mg), thiamine (0.5 mg), riboflavin (0.3 mg), and niacin (2.0 mg) per 100 grams. Due to their higher protein content compared to cereals, pulses are not only an economical protein source but also a vital supplement for individuals with cereal-or tuber-based diets. Hence, they are often referred to as "Vegetarian people's food" or "Poor man's food." The potential of pulses to contribute to global food security, nutrition, and environmental sustainability has been recognized by the UN, declaring 2016 as the "International Year of Pulses" (<https://www.un.org>). Supply response models, such as the Nerlovian model, offer insights into farmers' decision-making based on price and non-price factors. These models help understand how farmers react to changes in crop prices and how they allocate resources among crops in response to price fluctuations (Ramesha, 1988).

**GUJARAT SCENARIO OF CHICKPEA**

In Gujarat area, production and productivity of the chickpea in Gujarat during 2021-22 is given below in a table 1. The highest area and production were seen in Jamnagar. The major chickpea growing districts of Gujarat were Jamnagar, Amreli, Rajkot, Junagadh and Devbhoomi Dwarka.

**Table 1: Major Districts of Gujarat State in terms of area, production and productivity of chickpea during 2022-23**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **District** | **Area****(‘00’ ha)** | **Production****(‘00’ MT)** | **Productivity (Kg/ha)** |
| 1 | **Jamnagar** | 843.36 | 1694.59 | 2009.34 |
| 2 | **Amreli** | 831.59 | 1632.36 | 1962.94 |
| 3 | **Rajkot** | 745.73 | 1497.10 | 2007.56 |
| 4 | **Junagadh** | 677.95 | 1348.17 | 1988.59 |
| 5 | **Devbhoomi Dwarka** | 599.91 | 976.56 | 1627.85 |

Source: Directorate of Agriculture, Government of Gujarat, Gandhinagar (2022-23c)

**OBJECTIVES**

The main objectives of this study are as follows:

1. To examine the acreage response of chickpea with respect to the price and non-price factors in the study area.
2. To quantify the short and long run elasticities of price and non-price factors.

**METHODOLOGY**

The study area included the top four chickpea-producing districts in Gujarat. Junagadh, Rajkot, Jamnagar, and Ahmedabad districts were picked. The study is entirely dependent on secondary data on the area, production, productivity minimum support price, gross irrigated area and annual rainfall of chickpea crops from 1995–1996 to 2022-23.

Data was collected from the following resources including;

1. Directorate of Agriculture, Government of Gujarat, Gandhinagar
2. Meteorological cell, Department of Agricultural Engineering, Anand Agricultural University, Anand
3. Meteorological cell, Department of Agricultural Engineering, Junagadh Agricultural University, Junagadh
4. Gujarat State Disaster Management Authority ﻿
5. Agri exchange APEDA

**ANALYTICAL FRAMEWORK**

* + - 1. **Acreage response model:**

To estimate the supply response function of pulses under, Nerlovian lag adjustment model adopted. It intends to examine and identify important price and non-price factors which may influence the farmers’ decision-making process regarding area allocation of a crop. Nerlovian lag adjustment model is a combination of two behavioral equations. First equation suggesting a behavioral relationship stating that the desired area under the crop depends on a number of price and non-price factors. second equation is partial acreage adjustment equation indicates the farmers do not adjust their area allocation fully to the change in price and non-price factors. In the present study, the following acreage response model used for pulses based on the Nerlovian framework. (Wani *et al*, 2015).

The area response function specified as follows;

 ……**(7)**

Where,

 = Acreage that farmers prefer to allocate to the study crop with no difficulties of adjustment (ha)

 = One year lagged Minimum Support Price (MSP) of the study crop (Rs.)

 = One lagged yield of the study crop (Rs.)

= Yield risk of study crop measured by standard deviation of three preceding years

 = MSP risk of studied crop measured by standard deviation of three preceding years

 = Weather risk of studied crop measured by standard deviation of RF variable of three preceding year

 = Gross area irrigated Under all Crops in the Year ‘t’

 = Intercept

 = Parameter coefficients (i= 1, 2,…6); and

 = Stochastic error term

**Partial acreage adjustment equation**

 **………..(8)**

Where,

= Acreage under the crop in time ‘t’;

 At-1 = Lagged area of study crop

= Desired area under crop in the year t; and

 Ω = Nerlovian coefficient of adjustment(0<Ω<1)

In equation 8, the coefficient of adjustment will be given by,
Ω = 1- coefficientof lagged area (At-1). since data for variable A\*t are not available, it is not possible toestimate the first equation directly. Instead, a model through which the parameters of equation 7 can be estimated is needed. Such a model is called as the reduced form of equation 7. For studying the area response, both linear and log-linear forms tried in the present study as follows:

**Linear model:**

**… (9)**

Where,

**=** One-year lagged acreage of the study crop and other variables are the same as defined in equation (7).

**Log-linear model:**

**……. (10)**

Where,

 b0=β0Ω;b1= β1Ω; b2=β2Ω; b3=β3Ω;b4=β4Ω;b5=β5Ω;b6= β6Ω;
b7=1- Ω;Vt=VUt

Among the two models, the model with the highest value of adjusted R2 will beused for further analysis. It is to be noted that if the farmers slowly adjust their acreageto the changes in the factors affecting acreage, then Ω takes a value close to zero. If thefarmersquicklyadjusttheiracreagetothechangesinthefactorsaffectingacreage, t hen Ωtakesavalue nearone.

Inthecaseoflinearfunctions,theshort-runpriceelasticitiesofarea(A)andproduction (P)willcomputed asfollows.

**Short-run price elasticity of (A) = Regression coefficient of price**

**Short-run price elasticity of (P) = Regression coefficient of price**

The short-run non-price elasticities of area and production for linear functions are also computed in the same way as shown above, in case of log-linear functions, the regression coefficient of price and non-price variable represented the respective short-run elasticities with the coefficient of adjustment.

**RESULTS AND DISCUSSION**

**Determination of Acreage Response of Chickpea in Gujarat**

A supply response analysis is commonly used to determine the acreage allocation of farmers, production in the current year in response to price and non-price effects of the current as well as the lagged years. However, in this study it was proposed to use combined Nerlovian model, to estimate the area and production response function with a single equation model. From the studies the key nine variable taken in analysed the acreage and production of chickpea growers in Gujarat are as follows.

**Table 2: Expected sign of selected variable under study**

|  |  |  |
| --- | --- | --- |
| **Sr.no.** | **Determinants of supply response** | **Type and effect assumed** |
| 1 | Lagged price of pulses ) | Positive and significant |
| 2 | Lagged yield of pulses ) | Positive and significant |
| 3 | Yield risk ) | Negative and significant |
| 4 | Price risk ) | Negative and significant |
| 5 | Weather risk  | Negative and significant |
| 6 | Rainfall (RF) | Positive and significant |
| 7 | Lagged area under pulses  | Positive and significant |
| 8 | Gross irrigated area  | Positive and significant |
| 9 | Lagged production under pulses  | Positive and significant |

The estimated Acreage response of chickpea for selected chickpea producing districts isgiven in the table 3. The linear specification model was found suitable in all the selected districts *viz.,*Junagadh, Rajkot, Ahmedabad and Jamnagar district. For explaining production response of chickpea crop, the model was chosen based on the higher value of Adjusted .

**Table 3: Factors influencing production response of chickpea crop in Gujarat during 1995-1996 to 2022-23**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables/districts** | **Junagadh****(linear)** | **Rajkot****(linear)** | **Jamnagar****(linear)** | **Ahmedabad****(Linear)** |
| **Coeff. (SE)** | **Coeff. (SE)** | **Coeff. (SE)** | **Coeff. (SE)** |
| **Lagged price of chickpea ()** | 0.047(0.034) | 0.093\*\*(0.030) | 0.066\*(0.023) | 0.004(0.003) |
| **Lagged yield of chickpea )** | -0.079(0.079) | -0.077(0.102) | -0.041(0.131) | -0.008(0.019) |
| **Yield risk ()** | 0.143(0.129) | -0.363(0.223) | -0.418(0.272) | 0.103\*(0.038) |
| **Price risk )** | -0.056(0.136) | -0.163(0.344) | -0.505(0.256) | -0.009(0.023) |
| **Weather risk**  | 0.154\*(0.056) | 0.101(0.344) | 0.254(0.201) | -0.026(0.041) |
| **Gross irrigated area**  | -0.143(0.121) | -0.048(0.295) | -0.108(0.177) | -0.051(0.031) |
| **Lagged area under chickpea**  | 1.139\*\*(0.165) | 1.138\*\*(0.229) | 0.909\*\*(0.266) | 0.725\*(0.266) |
| **Constant** | 38.200(118.39) | 13653.9(6696.2) | 57.525(118.05) | 36.098(22.266) |
| **Adjusted R-square** | 0.87 | 0.84 | 0.74 | 0.76 |
| **Multiple R** | 0.95 | 0.94 | 0.90 | 0.91 |

Note: 1. The value within parentheses area standard error of estimates;

 2. \* and \*\* indicates significance at 5 per cent and 1 per cent levels, respectively; and

 3. The value of multiple R more than the value of correlation coefficient indicating the absence of multicollinearity.

The value of adjusted ranged from 0.74 to 0.87 in all the selected districts. The effect of multicollinearity influencing the gross irrigated variable was also removed by taking the standard deviation of gross irrigated variable. The value of multiple R was found to be higher than all correlation coefficients. Thus, either complete absence or negligible presence of multicollinearity is proved. (from Appendix I to appendix IV).In Junagadh district use rainfall data for weather risk instead of three-year standard deviation of rainfall for removing multicollinearity.

Lagged price of chickpea was found to be positive in selected districts *viz*., Junagadh (0.04), Rajkot (0.09), Jamnagar (0.06) and Ahmedabad (0.004) and out of four markets Rajkot and Jamnagar show positively significant result in lagged price of chickpea. It can be interpreted that every one unit increase in lagged price the acreage allocation under chickpea increases 0.06 units. The lagged yield was found negative in all the selected districts *viz.,*Junagadh (-0.07), Jamnagar (-0.07), Ahmedabad (-0.04) and Rajkot (-0.008) districts.In terms of yield risk found positive effect in Junagadh (0.14) and positive and significant effect in Ahmedabad (0.10) district. yield risk shows negative effect in Rajkot (-0.36) and Jamnagar (-0.41) district. Results of price risk found to be negative in each selected district. Weather risk showed positive impact on Rajkot (0.10) and Jamnagar (0.25) districts and show negative impact on Ahmedabad (-6.91). Positively and significant impact found on Junagadh (0.15) district. Gross irrigated area was found negative in each selected district. Lagged area of chickpea was found to be positively significant in all selected district *viz.,* Junagadh (1.13), Rajkot(1.13), Jamnagar(0.90) and Ahmedabad(0.72) districts.

In Junagadh district, lagged area under chickpea crop was significant and positive, it revealed that farmers of Junagadh district allocate area under cultivation for chickpea based on previous year land allocation. Lagged price and price risk having expected sign but insignificant means their factors were considered while area allocation of chickpea crop.

In Rajkot district, lagged area and lagged price under chickpea crop was significant and positive, it indicated that farmer of Rajkot district allocate area under cultivation for chickpea based on previous year land allocation and price. Yield risk and price risk having expected sign but insignificant means their factors were considered while area allocation of chickpea crop.

In Jamnagar district, lagged price and lagged area under chickpea crop was positive and significant it indicates that farmer of Jamnagar district allocate area under cultivation for chickpea based on these factors. Yield risk and price risk also having expected sign means their factors considered in area allocation of chickpea crop.

In Ahmedabad district, lagged area of chickpea were positive and significant, it indicates that farmer of Jamnagar district allocate area under cultivation for chickpea based on previous year area. Lagged price, Price risk and weather risk having expected sign but insignificant means their factor was considered in area allocation of chickpea.

Shende *et al.* (2011) analysed the acreage response of soyabean and found that lagged area was most responsible factor for increasing production positive same as Junagadh and Rajkot district.

**Estimation of Short- Run and Long Run Elasticities**

The short-run and long-run price elasticities and the non-price elasticities of acreage of chickpea are presented in Table 4. The coefficient of adjustment measures how willing farmers are to modify their acreage in response to the influence of price and non-price factors. It illuminates growers' actions and the thought process behind their price expectations.

The coefficient of adjustment varies from 0.36 (Junagadh) to 0.94 (Jamnagar). The higher the value of adjustment factor indicate that the farmers would take relatively less time in adjustment for their acreage to the price change. The study show that majority of the factors were found to be inelastic in the short-run. In short run, elasticity of price was positive in Junagadh and Ahmedabad district. Rajkot district shows Positively significant effect of price elasticity. Jamnagar district shows negative and significant effect of price elasticity. Yield response showed negative effect in all the selected district except Jamnagar district (2.48). The yield risk showed negative effect on Rajkot and Jamnagar district and positively significant effect in Ahmedabad district. The price risk showed negative in all district except Junagadh (0.18). Weather risk shows negative impact on Ahmedabad district. The gross irrigated area shows negatively effect on all the selected district except Rajkot district (0.13). The long Run elasticity of all the factors were found to be more than short-run elasticity in all districts.

 **Table 4: Estimated coefficient of adjustment and price and non-price elasticity of acreage response function of chickpea in Gujarat**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Elasticities/****Districts** | **Junagadh****(Log Linear)** | **Rajkot****(Log Linear)** | **Jamnagar****(Log Linear)** | **Ahmedabad****(Log Linear)** |
| **Short-run elasticities** |
| **Price** | 1.106 | 1.325\*\* | -0.208\* | 0.353 |
| **Yield** | -1.395 | -0.697 | 2.480 | -1.470 |
| **Yield risk** | 0.583 | -0.487 | -0.490 | 0.375\* |
| **Price risk** | 0.183 | -0.249 | -0.489 | -0.256 |
| **Weather risk** | 1.753\* | 0.663 | 1.150 | -0.781 |
| **Gross area irrigated** | -0.211 | 0.136 | -0.245 | -0.322 |
| **Long-run elasticities** |
| **Price** | 3.006 | 2.144 | -0.219 | 0.378 |
| **Yield** | -3.794 | -1.128 | 2.615 | -1.573 |
| **Yield risk** | 1.587 | -0.788 | -0.517 | 0.402 |
| **Price risk** | 0.499 | -0.403 | -0.515 | -0.274 |
| **Weather risk** | 4.765 | 1.074 | 1.212 | -0.836 |
| **Gross area irrigated** | -0.575 | 0.221 | -0.258 | -0.344 |
| **Coefficient of adjustment** | 0.367 | 0.617 | 0.948 | 0.934 |

 Note: \* and \*\* indicates significance at 5 per cent and 1 per cent levels, respectively

**CONCLUSION**

The acreage response of chickpea was estimated by Nerlovian Partial Adjustment Model. In production response Lagged price of chickpea was found positive and significant in Rajkot district. The regression coefficient of lagged price was found to be positive and significant in Rajkot (0.09) and Jamnagar (0.06) district. Yield risk found to be negative in all the selected district exceptAhmedabad. In case of price risk showed all districts having negative impact on acreage response of chickpea crop. Weather risk showed positive and significant impact on Junagadh (0.15), and negative impact onAhmedabad (-0.02) districts. Study the short-run and long-run price elasticities and the non-price elasticities of acreage response of chickpea using the log specification model across all the selected districts. The coefficient of adjustment varies from 0.52 in Junagadh to 1.23 in Rajkot. The higher the value of adjustment factor indicate that the farmer would take relatively less time in adjusting their production to the price change. The majority of the components were discovered to be inelastic in the study's findings regarding short-run and long run elasticity. In terms of short run elasticity of Rainfall were found to be positive and significant in Junagadh (2.02) and Jamnagar (2.55) districts. Elasticity of weather risk shows positive in Junagadh and Jamnagar districts. At that time long run elasticities of rainfall found to be elastic in every district except Ahmedabad district.

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**APPENDIX**

**APPENDIX – I**

**Zero-order correlation matrix of the variables used in the linear acreage response model for chickpea in Junagadh**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |
|  | 0.5977 | 1 |  |  |  |  |  |  |
|  | 0.9506 | 0.7243 | 1 |  |  |  |  |  |
|  | 0.8221 | 0.5783 | 0.8206 | 1 |  |  |  |  |
|  | 0.1475 | -0.0881 | 0.1084 | -0.0431 | 1 |  |  |  |
|  | 0.1325 | -0.1934 | 0.0158 | 0.0699 | 0.1191 | 1 |  |  |
|  | 0.4333 | 0.4813 | 0.3696 | 0.3488 | -0.0341 | -0.1065 | 1 |  |
|  | -0.0455 | -0.2381 | -0.0794 | -0.4121 | 0.1936 | 0.2204 | -0.1203 | 1 |

**APPENDIX – II**

**Zero-order correlation matrix of the variables used in the linear acreage response model for chickpea in Jamnagar**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |
|  | 0.5082 | 1 |  |  |  |  |  |  |
|  | 0.9506 | 0.5584 | 1 |  |  |  |  |  |
|  | 0.6804 | 0.5328 | 0.5457 | 1 |  |  |  |  |
|  | -0.1876 | -0.3368 | -0.1633 | -0.2278 | 1 |  |  |  |
|  | 0.3985 | -0.1264 | 0.2416 | 0.3493 | -0.1573 | 1 |  |  |
|  | 0.2485 | 0.1352 | 0.0775 | 0.2855 | 0.2361 | 0.29087 | 1 |  |
|  | 0.0207 | -0.1280 | -0.0512 | 0.1140 | -0.0926 | -0.12572 | 0.2131 | 1 |

**APPENDIX – III**

**Zero-order correlation matrix of the variables used in the linear acreage response model for chickpea in Rajkot**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |
|  | 0.5187 | 1 |  |  |  |  |  |  |
|  | 0.9506 | 0.6258 | 1 |  |  |  |  |  |
|  | 0.7000 | 0.4132 | 0.664 | 1 |  |  |  |  |
|  | 0.2612 | -0.2653 | 0.229 | 0.2329 | 1 |  |  |  |
|  | 0.3985 | -0.1723 | 0.242 | 0.5475 | 0.2747 | 1 |  |  |
|  | 0.5328 | 0.0131 | 0.407 | 0.4633 | 0.6569 | 0.5592 | 1 |  |
|  | 0.1488 | 0.1279 | 0.202 | -0.0063 | -0.2746 | -0.2761 | -0.1638 | 1 |

**APPENDIX – IV**

**Zero-order correlation matrix of the variables used in the linear acreage response model for chickpea in Ahmedabad**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  |  |  |  |  |
|  | 0.1026 | 1 |  |  |  |  |  |  |
|  | 0.9506 | 0.2617 | 1 |  |  |  |  |  |
|  | 0.7298 | 0.0068 | 0.6900 | 1 |  |  |  |  |
|  | 0.2600 | 0.7779 | 0.4448 | 0.1445 | 1 |  |  |  |
|  | 0.3985 | -0.3541 | 0.2416 | 0.4396 | -0.2979 | 1 |  |  |
|  | 0.3251 | -0.5887 | 0.1601 | 0.1072 | -0.4874 | 0.3199 | 1 |  |
|  | 0.1488 | -0.0711 | 0.2023 | -0.1061 | 0.3005 | -0.2761 | 0.3004 | 1 |