LouisSaveinDupuisJournalofMultidisciplinaryResearch2024,
3:292-298 Doi.: 10.21839/lsdjmr.2024.v3.194

Research Article

Profit Optimization in Agricultural Crop Production in Belthangady Taluk Using Linear Programming Models

Mr. B Ganesh Nayak

Assistant Professor Dept.Of Mathematics

Sri. Dharmasthala Manjunatheshwara College (Autonomous) Ujire, 574240.

Ph: 9480146495

Dr. R. Ananthi

Head, Department of Mathematics

Periyar Government Arts College, Cuddalor

Abstract

India, being a developing economy, depends greatly on agriculture, which under pins the livelihoods of a large segment of its population. Agriculture serves not only as a food source for millions but also plays a crucial role in economic development, offering jobs and creating income for both farmers and workers. Nonetheless, the industry encounters ongoing issues like inadequate access to quality resources, a lack of skilled work force, in effective markets, and decreasing production levels. To address these challenges, the use of linear programming—an optimization method grounded in science and mathematics—has surfaced as a viable solution. By effectively distributing resources, enhancing crop selections, and maximizing returns within established limits, linear programming enables farmers and decision-makers to make informed choices, promoting sustainable agricultural methods and boosting productivity to satisfy increasing needs.

Keywords: *Agriculture, livelihoods, challenges, optimization, sustainability.*

Introduction

Agricultural planning is a corner stone of socioeconomic development, intricately balancing the forces of nature and economics. In India, agriculture contributes approximately 25% to the Gross Domestic Product (GDP) and supports the livelihoods of nearly 70% of the population. The growing demand for agricultural commodities, driven by rapid population growth, underscores the importance of efficient planning. To meet these increasing needs, higher productivity must be achieved despite shrinking cultivable land due to urbanization and industrialization. As a result, maximizing crop production per unit area through optimal resource utilization is crucial. Effective crop planning involves a careful evaluation of various resources, such as land, water, labour, and capital, along with irrigation methods, soil characteristics, cropping patterns, climatic conditions, and socio-economic factors. These diverse elements make agricultural planning a complex yet essential process.

Agricultural economics, which focuses on scientific methodologies for improving agricultural productivity, has emerged as a significant field of study. One of its primary objectives is to identify optimal crop patterns and maximize profits through the application of optimization techniques. Among these, Linear Programming (LP) stands out as a robust and widely used method due to its ability to efficiently allocate limited resources. LP requires inputs such as crop yield data, labour availability, production costs, and soil characteristics to formulate effective strategies. The application of Operations Research (OR) models in agriculture dates back to the 1950s, with Waugh pioneering the use of LP to determine the least-cost combinations of feed for livestock. These models minimize costs while adhering to constraints, such as nutritional requirements, highlighting the utility of LP in agricultural decision-making.

The concept of LP was introduced by George B. Dantzig in 1947, laying the foundation for its application in various sectors, Croprotations, where the objective was to maximize gross margins while accounting

For constraints like land, labour, machinery, and capital. Since then, L Phase evolved to address a wide array of agricultural challenges, from farm-level planning to regional-scale resource allocation. Zhang and others have documented its extensive applications in fields such as forestry, fishery, and livestock management, demonstrating the method's adaptability and effectiveness in diverse agricultural contexts. Linear Programming has also found widespread use across industries for optimizing production, distribution, marketing, and policy decisions. It remains one of the most studied and impactful optimization techniques, capable of addressing a range of real-world problems. Two primary methods are used to solve LP problems: the graphical method and the simplex method. The simplex algorithm, developed by Dantzig, provides a systematic approach to finding optimal solutions by iterating through feasible solutions while improving the objective value. Challenges such as initial infeasibility are addressed using advanced techniques like the two-phase method or Big-M method, which incorporate artificial variables to stream line problem-solving. These innovations have expanded the applicability of LP, enabling its integration with tools like Geographic Information Systems (GIS) for strategic agricultural planning.

Modern advancements have further enhanced LP's utility. Keith highlighted the relevance of LP in contemporary farm planning, particularly when used alongside integer programming to overcome traditional LP limitations. Felix and Judith demonstrated that LP models outperform conventional planning methods, achieving significant cost reductions Of the regional diet.

Rubber

The growth of rubber farming in Belthangady has consistently risen, yetit continues obevulnerable to changes in climate and market values. Rubber is an adaptable substance, utilized in various items ranging from

including agriculture. Shortly after, Heady proposed using LP to optimize

and profit increases. Ion and Turek applied econometric models to optimize crop structures, resulting in a remarkable 143% profit increase and a 81% reduction in costs. These successes underscore the transformative potential of LP in improving agricultural productivity and profitability.

The simplex method, a core LP tool, was initially developed by Dant zig during his tenure at the Pentagon to address logistical and planning challenges during World War II. Its applications have since extended to dynamic scheduling and planning under uncertainty, show casing its versatility. By enabling the evaluation of optimal choices among various alternatives, the simplex method has become an indispensabletoolinthedevelopmentofmathematicalmodelsforagriculturalplanning.Recognizedas one of the most significant scientific advancements of the mid-20th century, Linear Programming has savedindustries,includingagriculture,substantialresourceswhileenhancingproductivity.Itscontinued integration with modern technologies ensures its enduring relevance in addressing the challenges of sustainable agricultural development and global food security.

Significance of the study

Prior to grasping the importance, it is essential to examine several key crops grown in Belthangady Taluk and their economic and cultural significance.

Paddy

Being an agriculturally dominant area, almost 60% of the workforce in Belthangady relies on farming for their income. Rice is the main crop, widely grown in the irrigated valley sand low-lying regions. Its farming represents the conventional agricultural way of life in the area and constitutes a key component

erasers to the production of tires, tubes, and industrial goods. India ranks as the sixth- largest worldwide producer of natural rubber, with a yearly output of 694,000 tonnes (2017-18) and a capacity of 900,000 tonnes, 75% of which is harvested. Nevertheless, local consumption exceeds production, resulting in imports that make up 40% of the overall demand. In India,

68% of rubber use is associated with the automotive tire industry. Belthangady has demonstrated the ability to adapt to market conditions but is confronted with issues related to climate change and price fluctuations.

Coconut

Even though Belthangady does not yield an excess of coconuts, minor amounts are sent to northern Karnataka. The area imports coconut oil to satisfy local needs, mainly from Cochin and Kozhikode.

The majority of coconuts are sold directly by farmers at weekly markets or via commission agents, with little large-scale exportactivity. None the less, dried coconut (copra) holds a crucial position in the import and export market, backed by major suppliers working in the district.

Areca Nut

Areca nut ranks among Belthangady key economic crops, constituting a major share of Mangalore's exports. Farmers generally sell are can utsvia authorized commission agents. Nuts of export quality are treated with sulfur fumigation and classified into uniform grades. Despite market variations caused by climate change and the COVID-19 pandemic, farmers

Quantities to supplement their income.

A growing number of people in Belthangady are leaving agriculture for urban jobs, motivated by declining earnings in farming. Even with government programs like agricultural loans and subsidies, farmers frequently find it challenging to determine the best crops or crop combinations to enhance profitabilitywhileworkingwithlimitedresources.Thisresearchseekstoinformfarmersabouteffective crop selection and intercropping, encouraging the implementation of methods that reduce risk while improving yields and profitability. By promoting an understanding of balanced farming and efficient resource use, the study aims to provide farmers with practical solutions to tackle contemporary agricultural issues. Ultimately, tackling these challenges could renew interest in agriculture as a sustainable source of income, guaranteeing economic stability and food security for the residents of Belthangady Taluk.

BACKGROUND

Recognizingtheidealcroppatternandmaximizhave gained from a price increase, resulting in heightened cultivation and profit.

Cashew Nut

The cashew nut is another significant commercial crop in the area, prized for its role in generating foreign exchange income. Although local production does not meet factory needs, raw cashew nuts are sourced from Africa, processed in Mangalore, and then re-exported worldwide. Furthermore, approximately 1,200 tonnes of cashew oil are shipped each year to countries including the UK, the USA, and several European countries.

Pepper

Pepper,akeyspicecrop,iswidelygrowninBelthangady,oftenasamixedcropwitharecanut.Farmers plant rooted cuttings around the base of areca palms, and the pepper vines start yielding in their third year. Various government schemes support pepper cultivation, emphasizing its role in regional agriculture.

Vegetables

Vegetablessuchasokra, brinjal,andchiliesarealsogrown,althoughtheir cultivationislimiteddueto theregion'shighrainfall.Despitethesechallenges,farmersmanagetogrowvegetablesinsmalleringfoodcropproductioniscrucialforachievingthehighestprofitin farming. Proper crop selectionandresource utilizationdirectlyaffectthefinancial sustainability of farming practices.

Agricultural planning greatly benefits from the use of optimization techniques, which provide structured and scientific approaches to decision-making. These techniques help farmers allocate resources efficiently and plan cultivation strategies to achieve better results.

1. To maximize profit, it is essential to analyze key factors such as crop yield, labor availability, productioncosts,andsoilconditions.Athoroughunderstandingoftheseelementsensuresinformed decision-making and promotes efficient agricultural practices.

OBJECTIVE OF STUDY

Toimproveresourceallocationacrossagriculturalcentersandenhancetheefficiencyofproduction planning.

Toassessanddetermine themosteffectivelanddistributionforfoodcrops

usingagricultural data.

Tocreatea mathematicalframework forcalculatingagriculturalprofit,takingintoaccount land availability, costs, and profit per acre.

Todeterminetheoptimal landallocationforfoodcrops,consideringagricultural dataandkeyfactors such as labour wages, production expenses, and machinery costs.

Research Methodology

ThisstudyfocusesonBelthangadytalukinD consultationswithlocalfarmersandagriculturalexperts.Thedatacollectedisthenanalysedtogenerate insightful conclusions and offer practical recommendations for improving farming practices.

SamplingMethodUsed

For this study, a convenience sampling method is applied. The research is conducted in Puduvettu village,locatedinBelthangadytaluk,Karnataka.Thesampleincludes25farmerswhocultivatevarious crops suited to the region's soil conditions.

PROBLEM

If a farmer has 5 acre of land to grow two crops Rubber and Arecanut. The profit from crops Rubber andArecanutperacreareestimatedasRs.86,400and Rs.1,75,000respectively.Toobtainbetteryield the expenses per acre is Rs. 43,200 and Rs. 86,400 respectively. If the total amount farmer has Rs. 5,00,000,thenhowmuchlandshouldbeallocatedtoeachcropsoastomaximizethetotalprofitofthe farmer?

Plant	**Expenses**	**Profit**
Rubber	43,200	86,400
Arecanut	1,25,000	1,75,000

Solution:

Let**x**representtheacresoflanddedicatedtoRubberplanting.

CornerPoints:

Tofindtheoptimalsolution,weevaluatethecoordinatesofthecornerpoints formed by the intersection of the constraints. These corner points are: (0,0) (0,4), (1.52,3.48) (5,0)

akshinaKannadadistrict,aimingtoeducatelocalfarmers on utilizing scientific approaches to improve agricultural productivity and the quality of their outputs. Primarydataisgathered throughsurveyswithin thestudyarea, alongside datafromtheDepartmentof Horticulture. Additional primary data is collected via direct observation and personal interviews with farmers.Secondarydataisobtainedfrombothpublishedandunpublishedsources,including

Let**y**representtheacresoflanddedicatedtoArecanutplanting.

Clearly,x≥0 andy≥0 sincetheareaplantedcannot be negative.

ObjectiveFunction(Profit Maximization):

Thegoal istomaximizethe totalprofit, denotedasPPP,which isgiven by:

P=86,400x+175,000y

Where:

- 86,40086,40086,400istheprofitper acrefrom Rubber.
- 175,000175,000175,000isthe profitper acrefrom Arecanut.

Constraints:

Theproblemis subject tothefollowing constraints:

LandConstraint:

Thetotalland usedforplantingboth cropscannot exceed5 acres:

x+y≤5

ExpenseConstraint: Theexpensesarerelatedtotheresourcesused ingrowingbothcrops. Given the coefficients for the expenses, this constraint is expressed as:

0.43x+1.25y≤5

Non Negativity Constraints:

Bothxandymustbegreaterthanor equalto0:

x≥0, y≥0

ObjectiveFunctionEvaluation:

Tofindtheoptimalsolution,evaluatethe profitfunctionPPPateachcorner point:

1.At (0,0):

P=86,400(0)+175,000(0)=0

1. At (0,4): P=86,400(0) +175,000(4)=700,000
2. At(1.52,3.48):P=86,400(1.52)+175,000 (3.48) =131,788.8+609,000=740,788.8
3. At (5,0): P=86,400(5)+175,000(0)=432,000

Cornerpoints	**P= 0.86x+ 1.75y**
(0,0)	0
(0,4)	7
(1.52,3.48)	7.3972
(5,0)	4.3

Themaximumprofitisobtainedatthecorner point **(1.52,3.48),** wherethe profitis **Rs.740,788.8**. This istheoptimalsolutionforlandallocation,whereappr oximately1.52acresarededicatedtoRubberand

3.48acrestoArecanut.

Scope for Further Research

This study is confined to the agricultural challenges faced by farmers in Puduvettu village, located in the Belthangady taluk. The farmers in this region predominantly cultivate Rubber, Coconut, and Arecanut,andtheissuestheyencounterarespecificto different cropprofilesor challenges.

SampleSize:

Theresearchincludesonly25farmersfromt hevillage,whichisarelativelysmall sample size. A larger sample could yield more generalized and robust conclusions.

Duration of the Study:

The study was conducted over a period of just one month, which may not be sufficient to capture seasonal variations in agricultural practices or the long-term effects of certain agricultural decisions.

PotentialBiasinResponses:

Theremaybebiasesintheresponsesprovid edbythefarmersdue topersonalexperiences,perceptions,orexternalpres sures.Whileeffortsweremadetominimize these biases, they still represent a limitation of the study.

thisgeographicalarea.However,thesechallenges arenotuniquetojustthisregion;theyarereflectiveof broaderagriculturalissuesthataffectproduction efficiency, cost of cultivation, and profitability across different areas. Given the distinctive nature of these problems, there is a need for further research to identify and address the diverse obstacles that farmers face in similar agricultural settings.

Future studies can expand the scope to include different regions and a wider range of crops, thereby exploringpotentialsolutionstothevariouschallenge sthatimpactagriculturalproductivity.Thiswould help in formulating more robust and adaptable solutions to the problems associated with crop production,resourcemanagement,andeconomicsu stainabilityinagriculture.Additionally,researchers couldexploretheapplicationofmoderntechnologie s,policychanges,andmarketdynamicstoimprove the efficiency and profitability of farming practices.

LimitationsoftheStudy

Despiteitscontributions,thisstudyhascertai nlimitationsthatshouldbeconsidered:

GeographicalFocus:

The studyislimited tothe agriculturalissuesof farmers inPuduvettu village, Belthangady taluk, and does not extend to other regions or farming communities with

DataAvailabilityandAccuracy:

TheaccurateapplicationoftheLinearProgr ammingProblem (LPP) method in agricultural settings depends heavily on the availability of precise, real-time data from local agriculturists. Without accurate data, the results may be suboptimal or even misleading, which could affect the practical implementation of the model in real-world scenarios.Therefore,foreffectiveapplicationofthe LPPmethod,reliabledatafromavarietyof sources is crucial.

MajorObservationsandRecommendations

Afterconductingthesurvey,severalimporta ntfindingsweremaderegardingtheagriculturalcon ditions in Puduvettu village, Belthangady taluk, highlighting key challenges and providing potential solutions for improving agricultural practices.

Emphasis on Raw Material Resources:

It is essential to prioritize securing reliable sources of raw materials for agricultural production. Having a dependable and transparent supply chain will help mitigate potential disruptions and ensure consistent production.

AddressingLaborShortages:

Whileotheraspectsofproductionarewell-represented,thelabour force in agriculture in Puduvettu village has been underemphasized. Enhancing the skills, availability,andconditionsofthelabourforceisnecessarytosupportmoreeffectiveandefficient farming practices.

TransportationCostsImpactingProduction:

Transportationexpensesplayasignificantrolein the total cost of agricultural production. It is important to include these costs when planning the financial aspects of farming, as they directly affect the overall profitability of agricultural operations.

EscalatingInputCosts:

Therisingpricesofessentialagriculturalinputssuchasseeds,fertilizers, and pesticides represent presence of affordable substitutes in the market can discourage the production of high-quality crops.Policiesthatfosterbettermarketconditions,faircompetition,andsupportforlocalfarmers are crucial to help them thrive in the competitive environment.

EnvironmentalFactorsand Local Issues:

Localenvironmentalconditions suchastemperature, moisture,labourcosts,theft,andgeographicalfactorssignificantlyaffectfarmingincomes.These challenges, combined with inflation, can make it difficult for farmers to maintain profitability. Addressing these issues through improved practices, security, and policy support is essential to help farmers overcome these challenges.

Recommendationsfor Improvement:

Reduce Transportation Expenses:

Explore ways to reduce transportation costs, such as by establishing local processing units or encouraging collective transportation efforts among farmers.

Cost Reduction Strategies for Inputs:

a critical challenge for farmers in the region. Farmers should explore strategies to reduce input costs, such as adopting alternative practices or more efficient resource use, to mitigate the impact of rising prices.

Influence of Global Market Trends:

The international market can influence local agricultural pricing through fluctuations in global commodity prices. Farmers need to be aware of these changes and adjust their strategies to minimize the risks associated with global market volatility.

Maintaining BufferStock for Risk Management:

Holding aportion ofthecropas bufferstock can help farmers manage unpredictable market conditions and provide liquidity when needed. A recommendationforfarmersistoretainatleast25%oftheirproduceasbufferstocktosafeguard against market fluctuations.

CompetitionandAvailabilityofSubstitutes:

Competitionamonglocalfarmers,traders,and the

Promote sustainable agricultural practices, such as organicfarmingandcroprotation,toreducedependencyonexpensiveinputsandincreaselong- term sustainability.

LaborManagementandTraining:

Investinlabourtrainingprograms, ensurefair wages, and provide better working conditions to attract and retain skilled labour in agriculture.

Market Diversification:

Encourage farmers to diversify crops and explore niche markets to reduce the risks associated with fluctuating prices for individual products.

Buffer Stock Practices:

Educate farmers on the benefits of maintaining buffer stock and offer support through training and government-backed programs.

Address Environmental and Local Challenges:

Implement solutions tailored to the local environment, such as improving irrigation

systems, providing better security, and promoting climate-resilient agricultural methods.

Byaddressingtheseobservationsandfollowingtherecommendedstrategies,farmerscanimprovetheir productivity, reduce operational costs, and strengthen their financial stability in the long term.

Conclusion

Agriculture is a backbone of India's economy, supporting the livelihoods of over 80% of the rural population. In Puduvettu village of Belthangady taluk, farmers are encountering severe difficulties, especiallyduringtherainyseason,whichhascaused By focusing on enhancing agricultural practices and providing appropriate guidance, farmers can overcometheobstaclestheyface,leadingtohigherproductivity.Thiswillcontributetobettereconomic conditions and improved living standards in the local community. A renewed focus on agriculture can drive both local development and overall prosperity.

Reference

Andres Weintraub and Carlos Romero,

Operations Research Models and the Management of Agricultural and Forestry Resources: A Review and Comparison. INFORMS, 36(5)(2006):

Felix Majeke and Judith Majeke,

A Farm Resource Allocation Problem: Case Study of Small Scalecommercial Farmers in Zimbabwe. Journal of Sustainable Development in Africa, 12(2)(2010):

Keith Butterworth,

Practical Application of Linear/Integer Programming in Agriculture. Journal ofOperational Research Society, 36(2)(1985): etc

AshrafIqbalFazileandS.

HussanAshraf,TourisminIndianPlanning and Development.Sarup& SonsBook Company, India, 2006,

DES: Directorate of Economics & Statistics,

Digest of Statistics, Planning and Development Department, Government of

manytoturnawayfromagriculture.Factorssuch asthegrowingdemandforlabour,risinginputcosts,highttransportationexpenses,limitedlocaldemand, and the exploitation by intermediaries have made it increasingly challenging for farmers to produce high-quality crops. This situation often forces farmers to sell their produce at distress prices to unauthorized agents, who capitalize on their hardship.

There is a pressing need to reinstate the importance of agriculture and support it as a vital profession. Farmers should be educated about the resources available to them, including effective marketing strategies, soil management, and choosing the right crops for their environment. This knowledge will empower them to improve yields and maximize profits.

Jammu and Kashmir, Srinagar, 2011-2012