

**The LPP model parameters meant for Wheat Production
Decision Making**

*A Project Dissertation submitted in partial fulfilment of the
requirements for the degree of*

MASTER OF SCIENCE IN APPLIED MATHEMATICS

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DECLARATION

We, Renu Meghwal, 2K21/MSCMAT/60 & Sonu, 2K21/MSCMAT/51 Student of M.Sc. Mathematics, hereby declare that the dissertation project we are submitting to the Department of Applied Mathematics, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of a Master of Science degree is original and not copied from any source without proper citation. The dissertation project is titled "The LPP model parameters meant for Wheat Production Decision Making". This work has never before served as the foundation for the award of a degree, associate degree, scholarship, or another comparable title or honour.

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CERTIFICATE

I hereby certify that the Project Dissertation entitled "The LPP model parameters meant for Wheat Production Decision Making" submitted by RENU MEGHWAL, Roll No. 2K21/MSCMAT/60 & SONU, Roll No. 2K21/MSCMAT/51 [Department of Applied of Mathematics], Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of Master of Technology, is a record of project work done by students under my supervision. To the best of my knowledge, this work has not been submitted in part or in whole for any degree or diploma at this University or elsewhere.

Place: Delhi
Date: May, 2023

Prof. L.N. Das
Supervisor

Abstract

This report presents a multi-objective linear programming model. The LPP model is based on the data of Wheat Production in India from 2001-22 . We use concept of LPP Simplex Method using TORA software to solve our LPP Model. We considered wheat price, ethanol price, wages, import and export price to be constant and same all over India throughout the year. The study finds important variables, such as weather patterns, different zones for wheat cropping, export and import prices in different regions that affect decision-making. Change in these variables can change the solution of LPP Model. This multi-objective model can be used as a tool for comparing the profit or production of wheat in India. With the help of post-optimality analysis on this model, we can analyse the parameters like land availability, wages, the effects of climatic variability, soil characteristics, input costs on wheat yields and profitability using a mix of field data, modelling strategies, and statistical analysis can bring change in overall wheat production in that year

Keywords - LPP(Linear Programming Problem), Model , Optimization, Objective Function, Constraints, Decision Variable, Simplex Method, Sensitivity Analysis, Parameters, Zones, Wheat Production, Import , Export, Wages,Multi Objective Model, TORA, Optimal Solution, MOLP.

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We owe a debt of gratitude to us good departmental friends who have supported us in our endeavours and shown us the way forward for our personal and professional development over time. We would want to express our gratitude to our family and friends for always supporting us when we needed it.

we would like to end by thanking God Almighty for seeing to it that no unforeseen problems occurred while We were working.

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Contents

1. Introduction	8
1.1 Linear Programming Model	10
1.1.1 Decision Variables	10
1.1.2 The objective function	10
1.1.3 The constraints	11
1.2 Problem Formulation	12
1.2.1 General Mathematical Model for LPP	12
1.2.2 Simplex Method	13
2 Parameters Description for Modelling LPP that Decides the Wheat Production Decision Variables	17
2.1 Land Area	18
2.2 Production	19
2.3 Wheat import and export consumption	22
2.4 Wages	24
2.5 Energy	25
3 Multi Objective Model	27
3.1 TORA- A online platform for Optimization and Simulation	32
4 Regional variations in the production of wheat in India	35
4.1 Worldwide Wheat Production	36
5 Wheat Production affecting parameters[9]	40
6. CONCLUSION	42

List of Tables

1	C_{ij} Values for year 2001-22	29
2	x_{ij} values for year 2001-22	33

List of Figures

1	Simplex Algorithm [7]	15
2	Wheat Yield[16]	19
3	Wheat Production[14]	21
4	Bar Graph of Stock Vs Years by Python[18]	23
5	Python Code for Bar Graph[18]	24
6	Regional Variation of Production	36
7	World Wheat Production in tonnes	38

1. Introduction

In the real world, there are so many financial models or business models in which there will be several actions. Mostly the financial models are based on mathematical computation like cost, profit or loss. We have to use some applications to analyze these factors. In operational research main goal of our problem solving based on computation of matrices, feasible region of constraint spaces. There will be one or more objective functions, constraints, and decision variables in all mathematical or statistical models objective functions, constraints, and decision variables.[1]

In 1947 World war 2nd, George B Dantzing had developed the LPP solution technique i.e. Simplex Method. Initially, it was solving military logistic problems. Now, this is one of the most popular programming methods being used in airlines, agriculture, business, pollution control, health care system, and many other LPP model. Every LP model has some similar properties. These are important qualitative for decision-makers to learn and understand before using them in any kind of problem. But if we use LPP on large data, it will be difficult to solve it numerically. To avoid the struggle there are so many user-friendly computer software. Software which is used in solving LPP are TORA, MATLAB, QM and LINDO. Here our objective is to analyze the optimality for the wheat production, There are so many studies on individual factors, but we will do the sensitivity analysis for maximum profit and other factors. For sensitivity analysis LPP is a prerequisite. In this dissertation we are emphasizing the application of TORA for solving multi-objective LPP.[10]

In recent time, Optimization has become most important factor in all business sectors and manufacturing companies. In every organization main task is produce more with less resources. Therefore effective decision making is necessary, otherwise they have to face the expensive consequences due to wrong decisions. So it is necessary to think about the strategic points to achieve optimality. Importance of application of operational research. Recently, Optimization has become the decision-making and strategy maker.[3]

In mathematical practices, frequently we have to work on mathematical models to resolve reality. However, the model is a synopsis of reality. There, are so many assumptions and constraints for a real world problem. We have to ignore

some assumptions to discuss a model. There are so many techniques to solve these mathematical models. But generally, if we discuss in the terms of theoretical and practicals, 2 types of techniques exist- the qualitative and quantitative. Qualitative approach includes the nature of the problem in a theoretical manner and the quantitative approach includes mathematical form of the real-world problem to be solved by mathematical concepts. By this we can conclude a solution that will be useful for decision makers. [6]

In operational research, application of linear programming is also a quantitative approach. It is a common approach that deals with the effective distribution of limited resources to well-known activities to achieve the desired aim. Nowadays real-world problems are one of the main goals in every organization. In LP, (linear programming) using sensitivity analysis we decision-makers optimality. After making a model if the model is true and there will be only some valid assumptions. But for some assumptions the model will be sensitive. Conclusions from an analysis are frequently susceptible to model modifications, assumptions being broken, or other input disturbances. To make the appropriate modifications when necessary, one must understand how each piece of data affects the overall outcome. Data analysts must consequently be able to evaluate how sensitive their findings are to different input disturbances. Sensitivity analysis is the term for this.

The purpose of sensitivity analysis is obvious. It enables the analyst to establish testing methods, identify outliers or incorrect data values, discover outliers, optimize resources, cut expenses, and prevent unforeseen issues. It also enables the analyst to examine the consequences on inferences of departures from the assumptions made and the data values. In every analysis of mathematical models, relationship between inputs and outputs should be known due to complexity of that model. We have another name for the sensitivity analysis that is post optimality analysis. By this name we can say this process is for after we have achieved the optimality then by changing some conditions continuously we can see the difference, but optimality should remain constant.[3]

As we know India is an agricultural country. More than half of the population depends on agricultural activities. India has 2nd position in producing cereal like wheat and rice. But after green revolution wheat production reduced. Due to degradation of land resources this happened. Similarly there are many resources and parameters in wheat production like land, wages, energy etc. Here we discuss some important resources for the analysis of wheat production.

1.1 Linear Programming Model

[9] In Linear Programming there are multiple methods to solve linear equations. This methods are based on some model. LP is also model we call it LPP model. The LPP model contain three basic fundamental elements

1.1.1 Decision Variables

-

A decision variable in a linear programming problem (LPP) denotes an unknown quantity or value that must be established in order to optimise the objective function while taking into account a number of restrictions.

Typically, decision variables are represented by symbols like x_1 , x_2 , x_3 , and so on. These variables are frequently used to denote amounts, such as how much of a certain product to make, how many hours to devote to a specific work, or how much of a resource to use.[10]

Finding the values of these choice variables that maximise or minimise the objective function while meeting the constraints is the goal of a linear programming issue.

Decision variables (activities) Evaluation of different ways of acting (alternatives) and selection best to arrive at the optimal value of the objective function is governed by the nature of the objective function and resource availability. For this, certain activities (also called decision variables) are usually labeled x_1 , x_2 , . . . , x_n are conducted. The value of these variables (activities) represents the extent to which each of these is carried out. In the LP model, all decision variables are continuous, controllable and not negative. That is, $x_1 \geq 0$, $x_2 \geq 0$, . . . , $x_n \geq 0$. The constraints are often linear inequalities or equations that restrict the practical range of the decision variables, whereas the objective function is typically a linear function of the decision variables.

Depending on the goal of the challenge, the decision variables can then be utilised to decide how to distribute resources most efficiently, minimise expenses, or maximise earnings.

1.1.2 The objective function

-

The objective function in linear programming problems (LPP) is a mathematical expression that denotes the quantity that has to be optimised, such as profit, revenue, or cost. The decision variables, or the variables that are subject to optimisation, are often combined linearly to form the objective function. The objective function for each LP problem is expressed in the general form as follows: optimization (maximize

or minimize) $Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$, where Z is the measure-of-performance variable, which is a function of x_1, x_2, \dots, x_n . Quantities c_1, c_2, \dots, c_n are parameters that represent the contribution of a unit of the respective variable x_1, x_2, \dots, x_n to the measure-of-performance Z . The optimal value of the given objective function is obtained by the graphical method or simplex method. Constraints are linear inequalities or equations that restrict the practical range of the decision variables, and they can also apply to the objective function. The constraints often indicate restrictions on the decision factors, such as resource limitations. In order to determine the best values for the choice variables that meet the constraints and optimise the objective function, one must first solve the linear programming problem, which is made up of the objective function and the constraints.

1.1.3 The constraints

-
The extent to which the aim may be fulfilled is always subject to specific limitations (or limits), such as: Manpower, machinery, raw materials, space, money, etc. In terms of the decision variables, such restrictions should be stated as linear equality or inequality. From These requirements must be met by the LP model's solution.

A mathematical method for locating and producing the ideal solution for the goal function is called linear programming. A linear function is optimised (maximised or minimised) in relation to certain limitations. These restrictions are also expressed as linear equations. A linear programming problem's viable zone and eventual optimal solution are both strongly influenced by constraints. The ideal solution is located at the corner or vertex of the feasible region that maximises or minimises the objective function, which is typically represented graphically as a bounded polygon or region.

1.2 Problem Formulation

We convert the problem statements into Mathematical expressions by identifying the fundamental elements in the problem. ie. Decision Variables, constraints and the objective function.

Example 0.0.1 Consider a factory producing two types of products X and Y using two Machines A and B. The total available working times on machine A and B are 40 and 45 hrs respectively. Let say each unit of product X needs 2 unit of each machine while each unit of product Y requires 1 unit of machine A and 3 units of machine B. The factory gets a profit of 10 per unit and 15 per unit on product X and Y respectively. Formulate a LPP to Maximize the profit.

Let x and y be the no. of units produced of Product X and Y respectively. then

$$\text{Max } z = 10x + 15y$$

s.t.

$$\begin{aligned} 2x + 1y &\leq 40 \\ 2x + 3y &\leq 45 \\ x, y &\geq 0 \end{aligned}$$

1.2.1 General Mathematical Model for LPP

A general LPP model with n decision variables and m constraints.

Maximize (or Minimize) $z = c_1x_1 + c_2x_2 + c_3x_3 + \dots + c_nx_n$
subject to the linear constraints

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots + a_{1n}x_n &= b_1 \\ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \dots + a_{2n}x_n &= b_2 \\ a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + \dots + a_{3n}x_n &= b_3 \\ &\vdots \\ a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \dots + a_{mn}x_n &= b_m \end{aligned}$$

Numerous optimisation issues with linear objective functions and constraints are represented by the generic form of LPP. Finding decision variable values that fulfil restrictions and maximise the objective function is the goal of the LPP. The optimal solution is located at the corner or vertex of the feasible area that maximises or

minimises the objective function. The feasible region of the LPP is the set of all locations that meet the criteria.[12]

1.2.2 Simplex Method

One well-liked method for solving optimisation problems in linear programming is the simplex strategy. These problems often require a function and several limitations that are stated as inequalities. The answer is typically located at one of the vertices since the inequalities form a polygonal area. The vertices are methodically examined as potential solutions using the simplex method.

Some simple optimisation problems can be resolved by drawing the limits on a graph. However, this method can only be used to solve systems of inequalities involving two variables. In actuality, there might be a staggering amount of extreme points because problems can include thousands of variables and hundreds of equations.[10]

The approach first presupposes that the consumer is acquainted with an extreme point. A test is used to assess whether the problem's most extreme solution is the best one once the problem is specified algebraically. A adjacent extreme point along an edge in the direction where the objective function's value grows the quickest is sought for if the test for optimality is unsuccessful. When travelling along an edge, the target function value occasionally grows without bound. The process is completed by identifying the line along which the goal reaches positive infinity. If not, a new extreme point is achieved with a target function value that is at least equal to the previous one. The process is then carried out again.

Termination occurs when the unbounded situation or the ideal extreme point are found. Although in principle the needed steps can expand exponentially with the number of extreme points, in actuality the approach frequently converges on the optimal solution in a number of steps that is just a minor multiple of the number of extreme points.

Here we have a algorithm or we can say a process to solve it.

1. **Create The Problem** and list both the inequality restrictions and the objective function.
2. **Create equation from inequalities** For each inequality, one slack variable is added to achieve this.
3. **Make the first Simplex Table**Assign the bottom row to the objective function.
4. **The pivot column is identified by the bottom row's most unfavourable item.**
5. **Determine the quotients. A row is designated by the lowest quotient. The pivot element is the object at the point where the row indicated**

in this step and the column identified in step 4 intersect. The far right column is divided by the column that was chosen in step 4 to get the quotients. A quotient with a numerator or denominator of 0, or that is negative, is disregarded.

6. **To make all other items in this column zero, do pivoting.** The Gauss-Jordan approach is used in the same manner as before.
7. **We are done when there are no more negative entries in the bottom row; otherwise, we retrace our steps back to step 4.**
8. **Read your responses aloud.** Utilise the columns containing 1s and 0s to obtain the variables. Zero exists for all other variables. The bottom right corner displays the highest value that you are looking for.

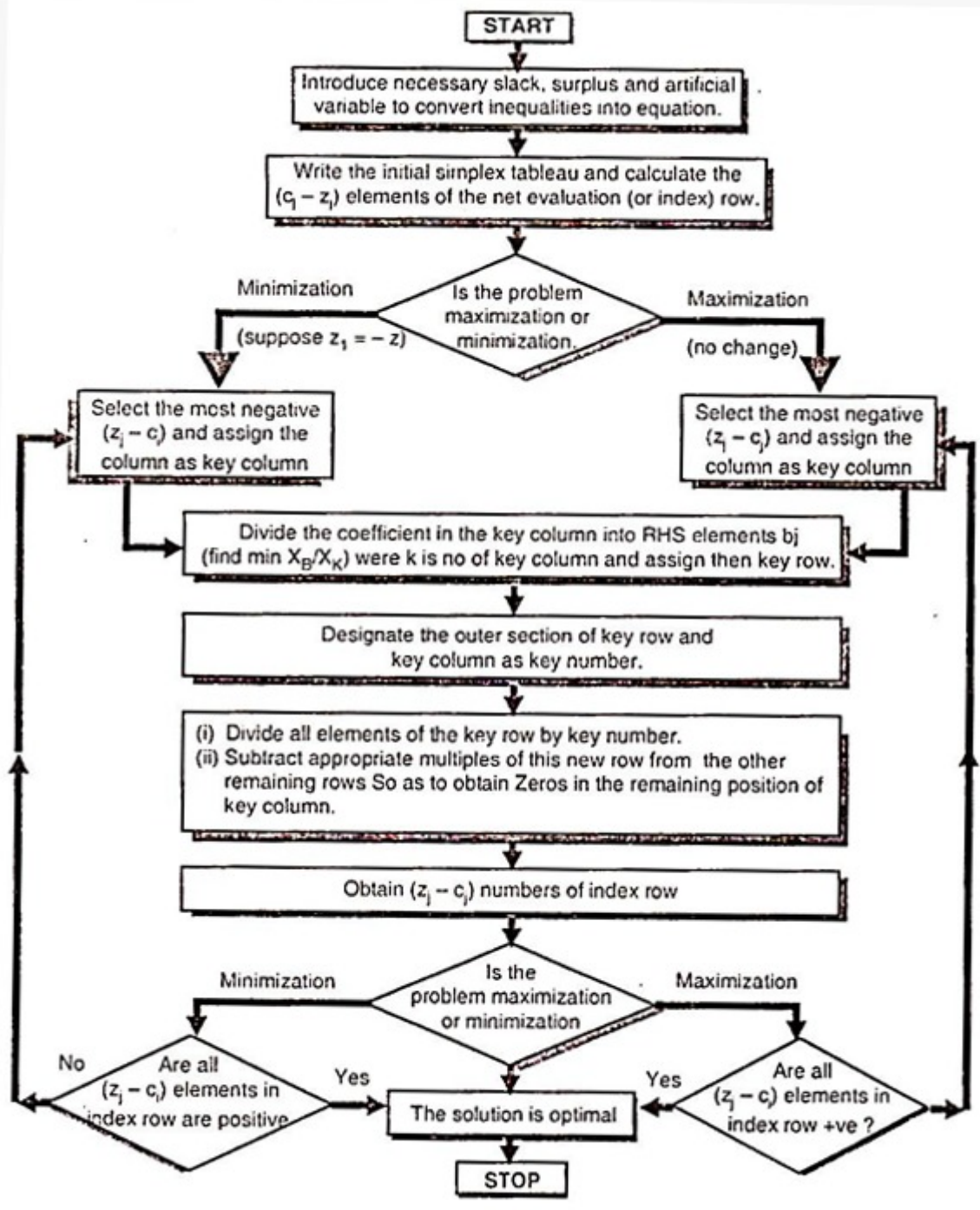


Fig. 4.6. Schematic Diagram of simplex algorithm.

Figure 1: Simplex Algorithm [7]

Now let's take an example based on this algorithm.

Question The Ravi works two jobs on the side, Jobs I and II. He never intends to put in more than 12 hours a week in total. She has concluded that he requires two hours of preparation time for every hour he works at Job I, one hour of preparation time for every hour he works at Job II, and he cannot spend more than 16 hours on preparation. How many hours should he work each week at each job to earn the most money if he earns 40 rupees an hour at Job I and 30 rupees an hour at Job II?

Solution

We will use the above-mentioned method to resolve this issue. By applying this algorithm we obtained the final answer. According to the final answer, Ravi will earn 400 if he works 4 hours at Job I and 8 hours at Job II. He would have used up all of the working time and preparation time because both of the slack variables are 0, which indicates that none will be left.

2 Parameters Description for Modelling LPP that Decides the Wheat Production Decision Variables

For the post optimality of wheat production we have to discuss so many factors or parameters. these parameters will be considered as constraints. Some assumptions are considered in each model. Similarly if we will make a objective function using data of wheat production in particular time.

Due to the abundance of natural resources in our country, it is crucial to fully utilise the biological potential of our main field crops, especially wheat. Given the high yielding types, the abundance of resources, the lush ground, and the diligent farmers, the climate here is ideal for the growth and production of wheat. However, the farmers are unable to produce wheat at its full capacity. Wheat farming comes with a lot of limitations. A basic prerequisite for maintaining any crop is high-quality seed.[11]

As the efficacy of agricultural inputs depends on seed potential, the crop's intended yield is dependent on the availability of high-quality seeds of improved kinds. Approximately 675.1 million tonnes of wheat were produced worldwide in 2011–2012. China, India, the United States, Australia, and other significant wheat-growing nations are listed here. India's position today

Having a harvest of 86.87 million tonnes during the 2011–2012 season, second in terms of wheat output. Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Gujarat, and West Bengal are the states that produce the most wheat. Wheat was grown on 316.8 thousand hectares in West Bengal in 2010–2011, producing 874.4 thousand tonnes at a productivity of 2760 kg per hectare.[14]

2.1 Land Area

Different wheat growing zone -

The country's whole wheat-growing regions have been divided into the following six primary zones.[14]

- **Northern Hill Zone (NHZ)** - Hilly regions of Sikkim, Himachal Pradesh, Uttarakhand, and JK—with the exception of the Tarai region, Jammu, Kathua, and Samba districts—as well as Una and Paonta valley (Total Area 0.8 million ha)
- **North Western Plains Zone (NWPZ)** - Punjab, Haryana, Western UP (excluding Jhansi Div), Rajasthan (except Kota Udaipur Div), Delhi, Una Paonta valley of HP, Jammu, Samba Kathua districts of JK, and Chandigarh are some of the places that fall under this category. (11.5 million hectares in total)
- **North Eastern Plains Zone (NEPZ)** - Eastern UP(28 dist), Bihar, Jharkhand, West Bengal, Assam, Odisha, and other NE states (except Sikkim) (Total Area 10.5 million ha)
- **Central Zone** - MP, Chattisgarh, Kota, Udaipur Division of Rajasthan, and Jhansi Division of Uttar Pradesh. (5.2 million hectares in total)
- **Peninsular Zone** - Maharashtra, Tamil Nadu (except Nilgiris Palani Hills), Karnataka Andhra Pradesh (Total Area 1.6 million ha)
- **Southern Hill Zone(SHZ)** - Nilgiris Palani Hills of Tamil Nadu (Total Area 0.1 million ha)

The kind of soil, crop rotation, and facilities available all have a role in how much agricultural work is needed to prepare the ground for growing wheat crops. More friable soil and deeper ploughing are required for the sowing of wheat. In India, the Rabi season is when wheat is grown. Typically, it is planted in November and harvested in March or April. The total area under wheat cultivation in the country grew by 1.5

million hectares, or 5%, from 29.04 million to 30.54 million hectares. The largest proportion of land area is in Uttar Pradesh (32%) with 9.75 million hectares, followed by Madhya Pradesh (18.75%), Punjab (11.48%), Rajasthan (9.74%), Haryana (8.36%), and Bihar (6.82%). Jharkhand (51%), Madhya Pradesh (27%), and Rajasthan (13%), nonetheless.

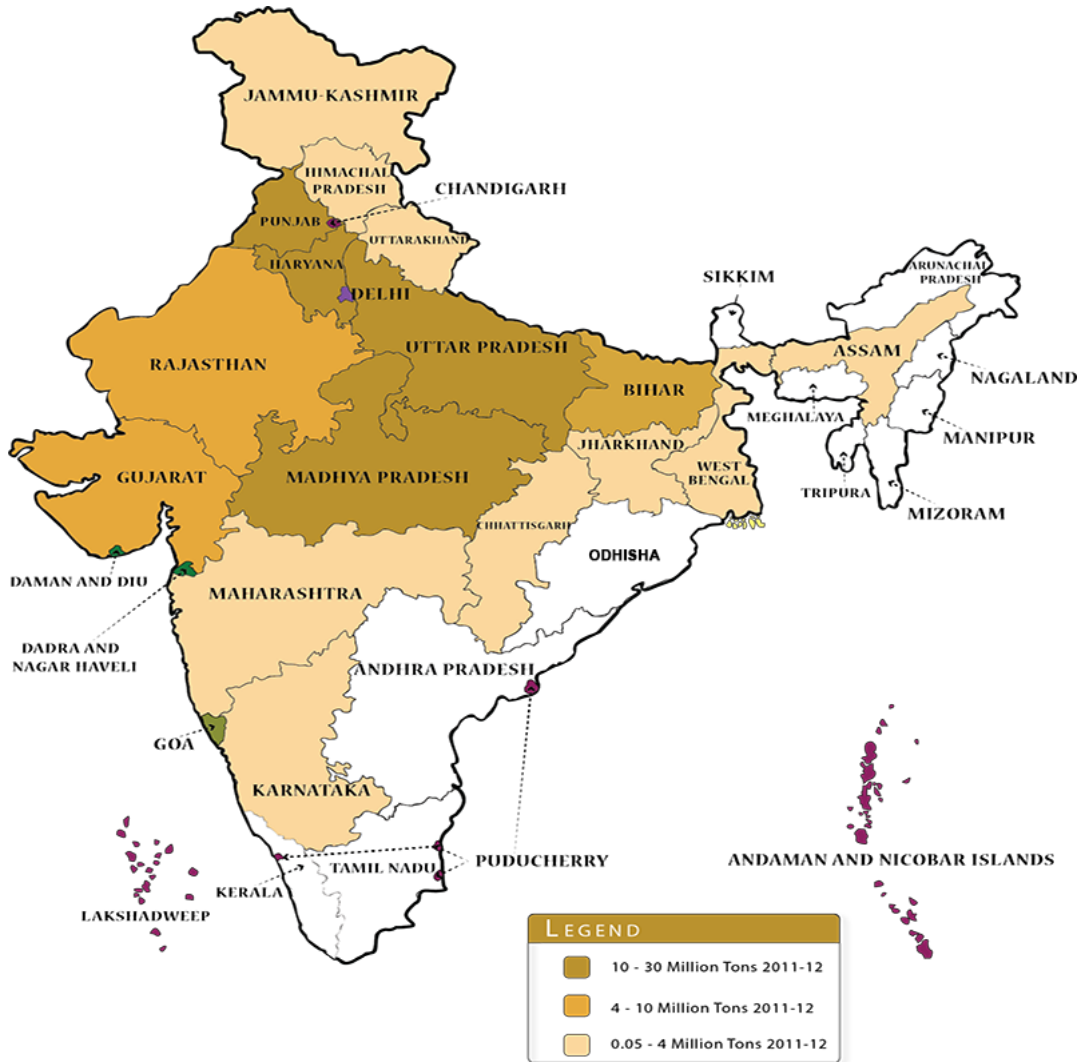


Figure 2: Wheat Yield[16]

2.2 Production

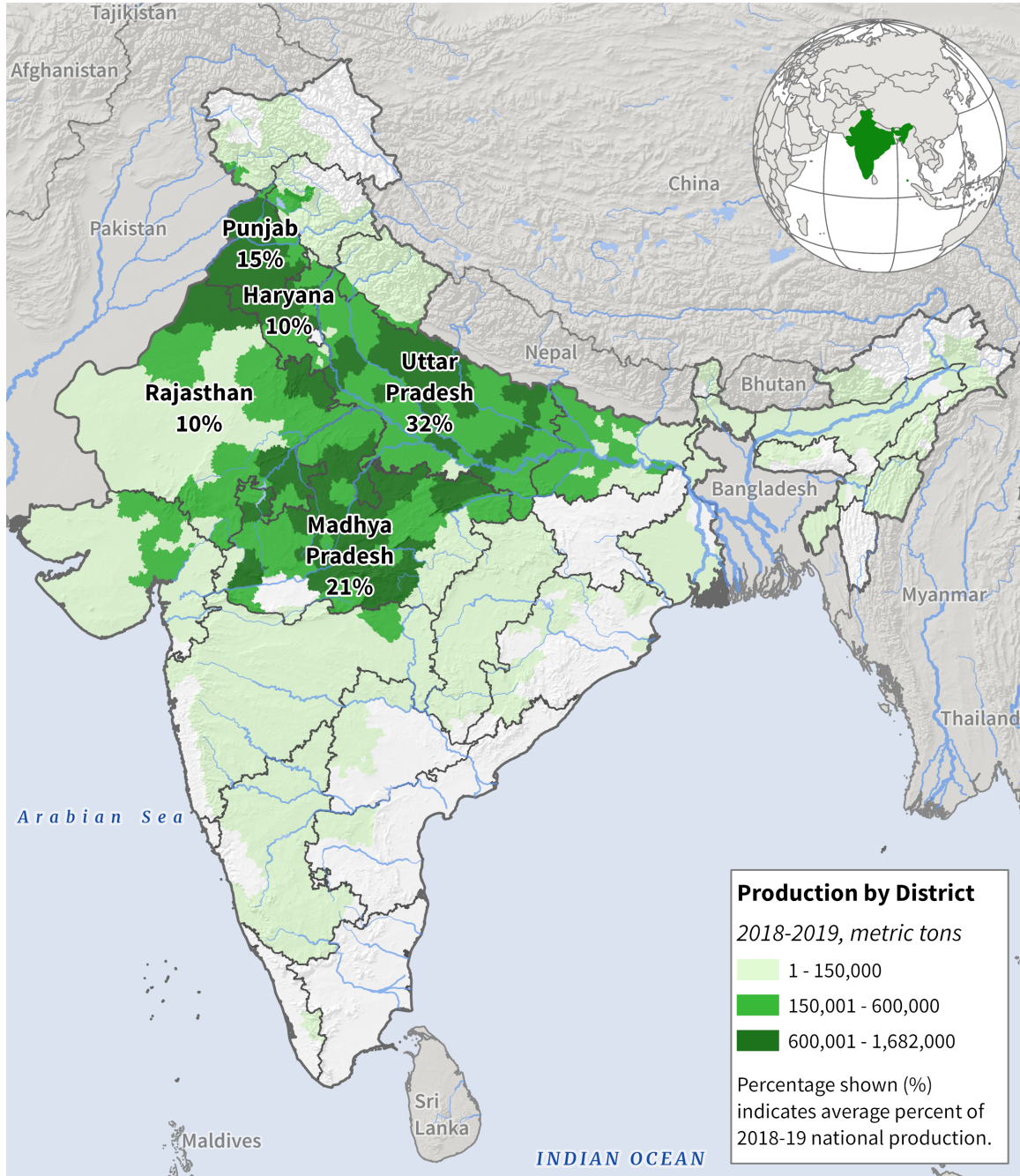
Over 220 million hectares of wheat have been planted worldwide. Both developed and developing nations grow wheat, with developed areas accounting for 53% of the

world's total harvested land and 50% of global production. Compared to 74% in affluent nations, wheat makes up more than 35% of the calories consumed from cereal in developing regions. Worldwide, over 70% of the wheat produced is used for human consumption, 20% is used for livestock, and just 2% to 3% is used for industrial purposes.

Although Uttar Pradesh, Madhya Pradesh, Punjab, Haryana and Rajasthan produce the majority of the country's wheat, almost all states in the country grow wheat. Half of the wheat produced in this country is grown in Uttar Pradesh and Madhya Pradesh. Wheat production also shows a similar upward trend and increased by 7.18 million tons (8.22%) from 2012 to 2013 and increased from 87.39 million tons to 94.57 million tons in 2017. -2018. This increase in production is largely due to regional expansion, followed by a very small increase in productivity, with Uttar Pradesh still leading the country, producing 28 million tonnes, or nearly 30% of the country's total producer. About 85 million tonnes (90%) of wheat is produced in the traditional wheat growing regions of Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Bihar and Rajasthan. Madhya Pradesh and Jharkhand showed the largest increase in volume, with production nearly doubling from 9.45 million to 16.32 million to 220,000 to 380,000. However, Uttar Pradesh lost 1.4 million tonnes over the same period, raising serious concerns.

Punjab and Haryana are historically high wheat producing states with production above the national average [10]. The non-traditional wheat producing states of West Bengal (23%), Himachal Pradesh (19.28%) and Assam (16.39%) had the highest productivity. However, Haryana's output is declining and this is a very serious concern. India's wheat production, yield and area based on five-year figures show that the area under the crop has decreased to 29.58 million hectares. However, wheat production increased significantly from 95.85 million tons to 99.7 million tons. The increase in productivity levels observed in wheat growing areas was primarily responsible for the increase in production.

India: Wheat Production



USDA Foreign Agricultural Service
 U.S. DEPARTMENT OF AGRICULTURE

Source: India Ministry of Agriculture, Directorate of Economics and Statistics, Market Year 2018/19 data by districts

Figure 3: Wheat Production[14]

2.3 Wheat import and export consumption

India is both an importer and exporter of wheat, with the balance between the two varying from year to year based on factors such as domestic demand and international market conditions.[4]

In recent years, India has been a net exporter of wheat, with the country exporting around 10 million tonnes of wheat in the 2020-2021 fiscal year. The main export markets for Indian wheat include neighboring countries such as Bangladesh, Nepal, and Sri Lanka, as well as countries in the Middle East and Africa.

At the same time, India also imports wheat to supplement its domestic supply and meet demand, particularly when local production is lower than expected. In the 2020-2021 fiscal year, India imported around 1.5 million tonnes of wheat. The main sources of imported wheat for India include countries such as Australia, Canada, and the United States. However, India also imports wheat to meet domestic demand when the production falls short, which has happened in the past due to weather-related issues or other factors. In 2021, India imported about 3.5 million metric tons of wheat, mainly from Australia and Ukraine, to fulfill domestic requirements.

The government of India regulates the import and export of wheat through various policies and measures, such as import duties and export subsidies, to balance domestic supply and demand and to protect the interests of farmers and consumers. The import and export of wheat in India can have significant impacts on the sensitivity of the country's agricultural sector and overall economy.

On the one hand, the export of wheat can provide benefits to Indian farmers and the agricultural sector by creating new markets and opportunities for selling their products. This can lead to increased production, higher prices, and greater economic growth in the sector. Additionally, the foreign exchange earnings from exports can help to strengthen India's economy by boosting its reserves and balance of payments.

On the other hand, importing wheat can have a negative impact on domestic farmers and the agricultural sector. When the country imports wheat, it can put downward pressure on prices and reduce the demand for domestically-produced wheat. This can result in lower incomes for farmers and reduced investment in the agricultural sector. Additionally, excessive imports can negatively impact the country's balance of payments and foreign exchange reserves.

Overall, the import and export of wheat in India can have complex and varied effects on the country's economy and agricultural sector, depending on factors such as production levels, global demand and supply, government policies, and market conditions.

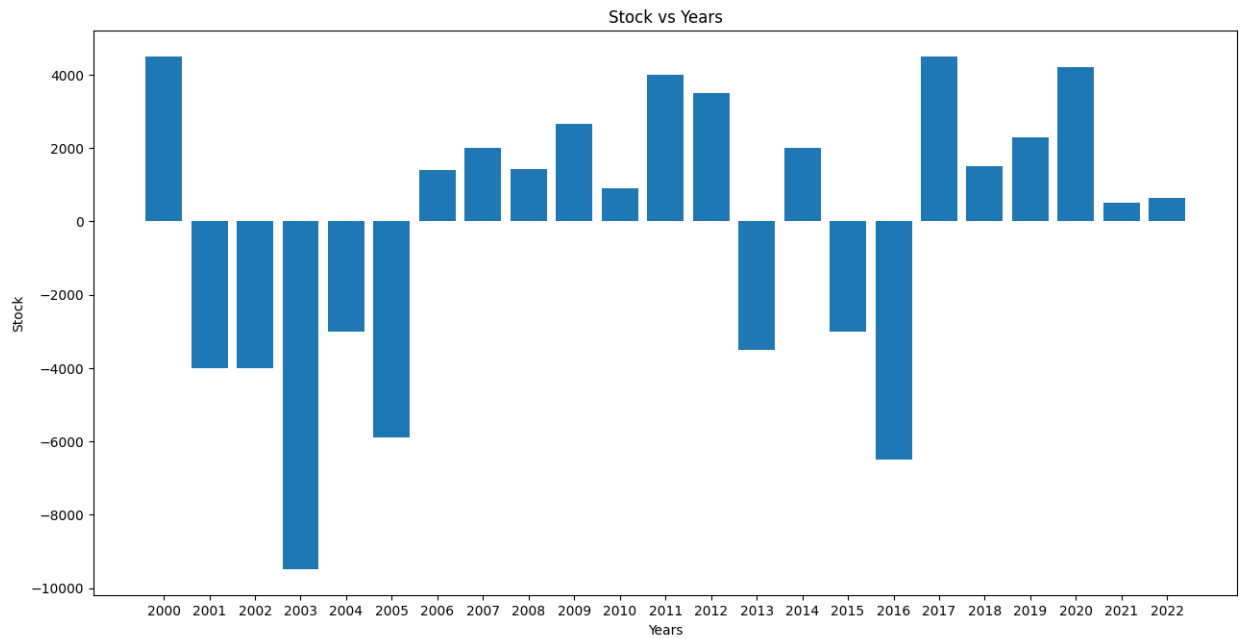


Figure 4: Bar Graph of Stock Vs Years by Python[18]

We have enough data to figure out the Value of wheat stocks per year. Needed data is wheat import, wheat export, total wheat production and total consumption per year. we have figured out the Stock value of total produced wheat by a formula.

We have calculated the stock value shown in above graph by using data of production , consumption, import and export
 $\text{Production} - \text{Export} + \text{Import} - \text{Consumption}$.

After getting values by above formula We have made this bar graph by python so coding of this graph is as following.


```
histogram.py - C:/Users/HP/Documents/histogram.py (3.11.2)
File Edit Format Run Options Window Help
import matplotlib.pyplot as plt

# Sample data
data = {2000:4500, 2001:-4000, 2002:-3999.25, 2003:-9500, 2004:-3000, 2005:-5900, 2006:1400, 2007:2000, 2008:1430, 2009:2670, 2010:900, 2011:4000, 2012:3500, 2013:-3500, 2014:2000, 2015:-3000}

# Create Bar chart
plt.bar(data.keys(),data.values())

# Add labels and title
plt.xlabel('Years')
plt.ylabel('Stock')
plt.title('Stock vs Years')
plt.xticks(list(data.keys()))

# Display histogram
plt.show()
```

Figure 5: Python Code for Bar Graph[18]

2.4 Wages

Wages consists with cultivation labour cost,plantation cost, corp protection cost, harvesting cost and transportation cost.Wages in wheat production in India vary depending on factors such as location, labor market conditions, and skill level of the workers. According to data from 2020, the minimum daily wage for agricultural labor in India ranged from around Rs. 200 to Rs. 450 (2.70to 6.10 USD) in different states, but skilled workers may earn higher wages. However, it's worth noting that wage rates can change over time due to factors such as inflation and government policies.The types of wages paid in wheat production in India can include daily wages, piece-rate wages, or a combination of both. Daily wages are typically paid based on the number of hours worked each day, while piece-rate wages are paid based on the amount of work completed or units produced. In some cases, workers may receive a combination of both daily and piece-rate wages. The specific type of wage paid may depend on factors such as the job duties, the productivity of the workers, and the preferences of the employer. The sensitivity of wheat production to wages depends on various factors, including the labor-intensity of the production process, the availability of alternative inputs such as machinery, and the elasticity of demand for wheat. In general, if wages increase, it could lead to higher production costs, which may reduce profitability and output, especially for small-scale farmers who heavily rely on manual

labor. However, if the demand for wheat is highly elastic, farmers may not be able to pass on the increased production costs to consumers, leading to lower profitability and potentially reduced production. Alternatively, if wheat production is highly mechanized or alternative inputs are readily available, the sensitivity to changes in wages may be lower. As the data is not available for the particular wages, So we can ignore this factor in our model. [14]

2.5 Energy

The primary energy resources used in wheat production in India include diesel or gasoline for tractors and other machinery, electricity for irrigation and other operations, and fertilizers made from fossil fuels. Additionally, some farmers may use animal power for plowing and other tasks. Renewable energy sources such as solar-powered irrigation systems are also being increasingly used in some regions. There are so many uses of energy in wheat production.[15]

- **Hydrocarbon**

Hydrocarbons are used in wheat production in several ways. Fossil fuels such as diesel or gasoline are used to power tractors and other machinery used for tilling, planting, and harvesting crops. Additionally, hydrocarbons are used to manufacture fertilizers and pesticides used in wheat production. Fertilizers are made from natural gas, while pesticides are often made from petroleum-based chemicals. The use of hydrocarbons in agriculture can contribute to greenhouse gas emissions, air and water pollution, and other environmental issues. However, there are efforts to reduce the use of hydrocarbons in wheat production through the adoption of sustainable farming practices, such as organic farming and precision agriculture, and the use of renewable energy sources to power farm equipment.

- **Diesel**

Diesel is commonly used in wheat production for powering farm machinery, such as tractors, cultivators, and combines, which are used for operations such as tilling, planting, harvesting, and transportation of wheat. The amount of diesel used in wheat production depends on various factors such as the size of the farm, the scale of production, and the efficiency of the equipment used.

- **Electricity**

Electricity is used in wheat production for various purposes, such as powering irrigation systems, lighting, and running farm machinery. In some areas

where irrigation is necessary, electricity is used to pump water from groundwater sources or surface water bodies to the fields. Electricity is also used to power lighting systems in greenhouses and indoor farms. Additionally, some farmers use electric tractors and other equipment that are powered by electricity rather than diesel or gasoline

- **Water irrigation**

The sensitivity of wheat production to the energy used for water irrigation depends on various factors, including the availability and cost of energy, the efficiency of irrigation systems, and the availability and cost of alternative sources of irrigation water. In regions where irrigation is necessary for wheat production, the energy required to pump water can account for a significant portion of the total energy used in the production process. An increase in the cost or scarcity of energy used for water irrigation could lead to higher production costs, reduced profitability, and potentially reduced output. However, the adoption of more efficient irrigation systems, such as drip irrigation and precision irrigation, can help reduce the amount of energy needed for water irrigation. Additionally, the use of alternative sources of irrigation water, such as rainwater harvesting and wastewater recycling, can help reduce the dependence on energy-intensive groundwater pumping.[7]

3 Multi Objective Model

In this dissertation, we are emphasizing the application of TORA for solving the multi-objective LPP

$$\text{Max } Z = (Z_1, Z_2, Z_3, \dots, Z_{22})$$

where each objective function is subject to constraints

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{15}x_5 \leq \text{Crop harvested area}$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{25}x_5 \leq \text{Wages}$$

$$a_{31}x_1 + a_{32}x_2 + \dots + a_{35}x_5 \leq \text{Total wheat price}$$

where a_{1j} is the coefficient associated with land utilized to yield wheat in i^{th} year.
 a_{2j} is the coefficient associated with wages to yield wheat in i^{th} year.
 a_{3j} is the coefficient associated with price of wheat in i^{th} year

Now, we have to define what is Z_i , i.e.

$$Z_i = C_{i1}x_{i1} + C_{i2}x_{i2} - C_{i3}x_{i3} - C_{i4}x_{i4} + C_{i5}x_{i5} - C_{i6}x_{i6}$$

where

C_{i1} = per tonne wheat production price in i^{th} year

C_{i2} = average ethanol price per tonne in i^{th} year

C_{i3} = wages to produce one tonne of wheat in i^{th} year

C_{i4} = wages to produce one tonne of ethanol in i^{th} year

C_{i5} = price of export one tonne of wheat in i^{th} year

C_{i6} = price of import one tonne of wheat in i^{th} year

x_{i1} quantity of wheat produced in i^{th} year

x_{i2} quantity of ethanol produced in i^{th} year

x_{i3} quantity of wheat yield in i^{th} year

x_{i4} quantity of ethanol produced in i^{th} year

x_{i5} quantity of wheat export in i^{th} year

x_{i6} quantity of wheat import in i^{th} year

As the data available to us is insufficient for further calculations, so we assumed following data by ourself:

C_{i3} = wages to produce one tonne of wheat in i^{th} year = 40% * Wheat price of i^{th} year

C_{i4} = wages to produce one tonne of ethanol in i^{th} year = 40% * Ethanol price of i^{th} year

C_{i5} = price of export one tonne of wheat in i^{th} year = Wheat price of i^{th} year + 10% * Wheat price of i^{th} year

C_{i6} = price of import one tonne of wheat in i^{th} year is same as Wheat price of i^{th} year

Also the ethanol price for each year is not available so we calculated price of one tonne of ethanol in 2021 and used it for all further calculations i.e.

Price of 1 litre ethanol = Rs 63.45

1 tonne of ethanol = 1266.95 Lt.

Price of 1 tonne of ethanol = 1266.95 * 63.45 = Rs 80387.9775

$$Z_i = C_{i1}x_{i1} + C_{i2}x_{i2} - C_{i3}x_{i3} - C_{i4}x_{i4} + C_{i5}x_{i5} - C_{i6}x_{i6}$$

For simplifications we can write,

$$\begin{aligned} Z_i = & \left(\frac{\text{Wheat Producer Price}}{\text{Total Wheat Production}} \right) x_{i1} + 80387.9775 \left(\frac{\text{Total ethanol Production}}{\text{Total Wheat Production}} \right) x_{i2} \\ & - (40\% * \text{Wheat price of } i^{th} \text{ year}) * x_{i3} - (40\% * \text{Ethanol price of } i^{th} \text{ year}) * x_{i4} \\ & + (\text{Wheat price of } i^{th} \text{ year} + 10\% * \text{Wheat price of } i^{th} \text{ year}) * x_{i5} \\ & - (\text{Wheat price of } i^{th} \text{ year}) * x_{i6} \end{aligned}$$

For each year i from 2001-2022 we have calculated all the cost values and put it in the following table :

Table 1: C_{ij} Values for year 2001-22

YEAR	C_{i1}	C_{i2}	C_{i3}	C_{i4}	C_{i5}	C_{i6}
2001	0.081795	0	2279.72	32155.91	6269.23	5699.3
2002	0.100013	1133.1092	2911.2	32155.9	8005.8	7278
2003	0.100956	1148.6092	2655.54	32155.9	7302.735	6638.85
2004	0.093241	854.9537	2690.936	32155.9	7400.074	6272.34
2005	0.108507	898.6729	2979.184	32155.9	8192.756	7447.96
2006	0.150452	1207.0629	4173.828	32155.9	11478.027	10434.57
2007	0.191062	1270.3889	5793.524	32155.9	15932.191	14483.81
2008	0.163043	1201.6729	5124.14	32155.9	14091.385	12810.35
2009	0.122789	780.1756	4123.984	32155.9	11340.956	10309.96
2010	0.170207	1082.4037	5501.364	32155.9	15128.751	13753.41
2011	0.165955	1289.6832	5766.88	32155.9	15858.92	14417.2
2012	0.177694	1160.9572	6743.68	32155.9	18545.12	16859.2
2013	0.189106	1198.1599	7073.322	32155.9	19451.663	17683.33
2014	0.165432	1273.9796	6342.668	32155.9	17442.337	15856.67
2015	0.161155	1389.3751	5577.92	32155.9	15339.28	13944.8
2016	0.150216	1568.6500	5545.408	32155.9	15429.872	13863.52
2017	0.1516147	1150.1250	5974.228	32155.9	16429.127	14933.57
2018	0.162683	1600.8532	6498.876	32155.9	17871.909	16247.19
2019	0.1504455	8925.137	6234.464	32155.9	17144.776	15586.16
2020	0.1753154	13882.9855	7563.88	32155.9	20800.67	18909.7
2021	0.237028	26248.1160	10390.372	32155.9	27206.3	25975.93
2022	0.222741	36488.8952	9893.2	32155.9	27206.3	24733

Further, we will calculate our objective function for each year using the cost C_{ij} values from the above table. For year 2001 it will be

$$Z_1 = (0.081795)x_{11} + (0)x_{12} - (2279.72)x_{13} - (32155.91)x_{14} + (6269.23)x_{15} - (5699.3)x_{16}$$

sub to constraints

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{15}x_5 \leq 25731$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{15}x_5 \leq 158853169.32$$

$$a_{31}x_1 + a_{32}x_3 + \dots + a_{15}x_5 \leq 397132923.3$$

Since the complete data is not available to form the coefficients of the constraints, so we have represented these coefficients as the unknown constant coefficient a_{ij} while on the right hand side of the constraints we have taken values of area harvested in year 2001, wages for total wheat production in 2001 and Total wheat production price in 2001 for constraint 1,2 and 3 respectively

Similarly forming objective functions and constraints for year 2002,

$$Z_2 = (0.100013)x_{21} + (1133.1092)x_{22} - (2911.2)x_{23} - (32155.91)x_{24} + (8005.8)x_{25} - (7278)x_{26}$$

sub to constraints

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{15}x_5 \leq 26345$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{15}x_5 \leq 211848024$$

$$a_{31}x_1 + a_{32}x_3 + \dots + a_{15}x_5 \leq 529620060$$

On calculating all objective functions for year 2001-22

$$Z_1 = (0.081795)x_{11} + (0)x_{12} - (2279.72)x_{13} - (32155.91)x_{14} + (6269.23)x_{15} - (5699.3)x_{16}$$

$$Z_2 = (0.100013)x_{21} + (1133.1092)x_{22} - (2911.2)x_{23} - (32155.91)x_{24} + (8005.8)x_{25} - (7278)x_{26}$$

$$Z_3 = (0.100956)x_{31} + (1148.6092)x_{32} - (2655.54)x_{33} - (32155.91)x_{34} + (7302)x_{35} - (6638.85)x_{36}$$

$$Z_4 = (0.093241)x_{41} + (854.9537)x_{42} - (2690.936)x_{43} - (32155.9)x_{44} + (7400.074)x_{45} - (6272.34)x_{46}$$

$$Z_5 = (0.108507)x_{51} + (898.6729)x_{52} - (2979.184)x_{53} - (32155.9)x_{54} + (8192.756)x_{55} - (7447.96)x_{56}$$

$$Z_6 = (0.150452)x_{61} + (1207.0629)x_{62} - (4173.828)x_{63} - (32155.9)x_{64} + (11478.027)x_{65} - (10434.57)x_{66}$$

$$Z_7 = (0.191062)x_{71} + (1270.3889)x_{72} - (5793.524)x_{73} - (32155.9)x_{74} + (15932.191)x_{75} - (14483.81)x_{76}$$

$$Z_8 = (0.163043)x_{81} + (1201.6729)x_{82} - (5124.14)x_{83} - (32155.9)x_{84} + (14091.385)x_{85} - (12810.35)x_{86}$$

$$Z_9 = (0.122789)x_{91} + (780.1756)x_{92} - (4123.984)x_{93} - (32155.9)x_{94} + (11340.956)x_{95} - (10309.96)x_{96}$$

$$Z_{10} = (0.170207)x_{10,1} + (1082.4037)x_{10,2} - (5501.364)x_{10,3} - (32155.9)x_{10,4} + (15128.751)x_{10,5} - (13753.41)x_{10,6}$$

$$Z_{11} = (0.165955)x_{11,1} + (1289.6832)x_{11,2} - (5766.88)x_{11,3} - (32155.9)x_{11,4} + (15858.92)x_{11,5} - (14417.2)x_{11,6}$$

$$Z_{12} = (0.177694)x_{12,1} + (1160.9572)x_{12,2} - (6743.68)x_{12,3} - (32155.9)x_{12,4} + (18545.12)x_{12,5} - (16859.2)x_{12,6}$$

$$Z_{13} = (0.189106)x_{13,1} + (1198.1599)x_{13,2} - (7073.322)x_{13,3} - (32155.9)x_{13,4} + (19451.663)x_{13,5} - (17683.33)x_{13,6}$$

$$Z_{14} = (0.165432)x_{14,1} + (1273.9796)x_{14,2} - (6342.668)x_{14,3} - (32155.9)x_{14,4} + (17442.337)x_{14,5} - (15856.67)x_{14,6}$$

$$Z_{15} = (0.161155)x_{15,1} + (1389.3751)x_{15,2} - (5577.92)x_{15,3} - (32155.9)x_{15,4} + (15339.28)x_{15,5} - (13944.8)x_{15,6}$$

$$Z_{16} = (0.150216)x_{16,1} + (1568.6500)x_{16,2} - (5545.408)x_{16,3} - (32155.9)x_{16,4} + (15429.872)x_{16,5} - (13863.52)x_{16,6}$$

$$Z_{17} = (0.1516147)x_{17,1} + (1150.1250)x_{17,2} - (5974.228)x_{17,3} - (32155.9)x_{17,4} + (16429.127)x_{17,5} - (14933.57)x_{17,6}$$

$$Z_{18} = (0.162683)x_{18,1} + (1600.8532)x_{18,2} - (6498.876)x_{18,3} - (32155.9)x_{18,4} + (17871.909)x_{18,5} - (16247.19)x_{18,6}$$

$$Z_{19} = (0.1504455)x_{19,1} + (8925.137)x_{19,2} - (6234.464)x_{19,3} - (32155.9)x_{19,4} + (17144.776)x_{19,5} - (15586.16)x_{19,6}$$

$$Z_{20} = (0.1753154)x_{20,1} + (13882.9855)x_{20,2} - (7563.88)x_{20,3} - (32155.9)x_{20,4} + (20800.67)x_{20,5} - (18909.7)x_{20,6}$$

$$Z_{21} = (0.237028)x_{21,1} + (26248.1160)x_{21,2} - (10390.372)x_{21,3} - (32155.9)x_{21,4} + (27206.3)x_{21,5} - (25975.93)x_{21,6}$$

$$Z_{22} = (0.222741)x_{22,1} + (36488.8952)x_{22,2} - (9893.2)x_{22,3} - (32155.9)x_{22,4} + (27206.3)x_{22,5} - (24733)x_{22,6}$$

3.1 TORA- A online platform for Optimization and Simulation

TORA (TOol for Research in Optimization with Applications) is a software tool for solving various types of optimization problems, including multi-objective linear programming (MOLP) problems. Multiple, frequently competing objectives can be simultaneously optimised using the mathematical technique known as MOLP.[20]

The value of TORA software for MOLP resides in its capacity to successfully and efficiently resolve challenging MOLP issues. Users can enter several objective functions, restrictions, and decision variables into TORA, and the software then offers a variety of solutions that are the best in terms of various trade-offs between the objectives. .

The Pareto-optimal set, which consists of all solutions that cannot be improved in one aim without degrading performance in another, can be discovered with the aid of TORA software. These options can assist decision-makers in finding the optimum compromises between various goals and in formulating well-informed choices that meet a variety of goals.

Moreover, TORA also provides sensitivity analysis, which can help in identifying the impact of changes in the input parameters on the optimal solution. It can also provide graphical representation of the results that help in visualizing the trade-offs between different objectives.

In summary, TORA software is significant for MOLP because it provides an efficient and effective tool for solving complex optimization problems with multiple objectives. It can help decision-makers in identifying the best trade-offs between conflicting objectives and make informed decisions that satisfy multiple objectives.

With the help of TORA, we solve our LPP to minimize our objective functions. The table below shows the calculated decision variables for each LPP

Table 2: x_{ij} values for year 2001-22

x_{ij}	j=1	2	3	4	5	6
i=1	69681	0	69681	0	2649.4	55.15
2	72770	1.31	72770	1.31	3671.13	59
3	65760	1.2	65760	1.2	4092.92	37.36
4	72150	0.98	72150	0.98	2009.93	45.4
5	68640	0.98	68640	0.98	746.17	37
6	69354.49	1.33	69354.49	1.33	46.6	6114.9
7	75806.7	1.53	75806.7	1.53	0.25	1815.1
8	78570.2	1.5	78570.2	1.5	1.12	22.51
9	80679.4	1	80679.4	1	46.51	171.58
10	80803.6	1.39	80803.6	1.39	60.95	185.28
11	86874	1.78	86874	1.78	871.33	1.73
12	94880	1.75	94880	1.75	6800.65	6.08
13	93510	1.78	93510	1.78	6026.8	14.16
14	95850	1.94	95850	1.94	3381.96	32.16
15	86530	1.91	86530	1.91	1121.69	521.43
16	92290	2.3	92290	2.3	486.24	5751.83
17	98510	1.8	98510	1.8	555.18	1653.11
18	99870	2.54	99870	2.54	479.93	2.74
19	103600	14.69	103600	14.69	492.47	1.88
20	107861	23.79	107861	23.79	2534.73	2
21	109590	45.7	109590	45.7	7791.35	5
22	111039.03	64.37	111039.03	64.37	7219.81	5.16

Since we calculated the decision variables using TORA software to solve our linear programming problem, now we can further calculate the values of our objective functions by putting these values of decision variables from table into the above formed equation of objective functions yearwise.

$$Z_1 = -142,552,091.33125$$

$$Z_2 = -182,920,455.369038$$

$$Z_3 = -145,020,405.8904$$

$$Z_4 = -179,586,113.490404$$

$$Z_5 = -198,676,759.6975$$

$$Z_6 = -325,775,915.7541$$

$$Z_7 = -465,506,287.3463$$

$$Z_8 = -402,910,904.2748$$

$$Z_9 = -334,398,195.7899$$

$$Z_{10} = -446,185,589.3632$$

$$Z_{11} = -487,239,046.8036$$

$$Z_{12} = -513,861,373.5511$$

$$Z_{13} = -544,482,875.0797$$

$$Z_{14} = -510,337,732.2345$$

$$Z_{15} = -472,767,557.0012$$

$$Z_{16} = -584,080,180.8406$$

$$Z_{17} = -604,127,786.2857$$

$$Z_{18} = -640,571,360.8018$$

$$Z_{19} = -637,802,158.2987$$

$$Z_{20} = -763,577,200.7524$$

$$Z_{21} = -927,090,473.6602$$

$$Z_{22} = -904,279,715.037$$

Since we have calculated all our objective functions then we can compare cost of wheat production for 2001-22. Clearly from above data, one can easily check in which year profit/loss is max/min by comparing total price of wheat produced in i^{th} year to the cost of production of wheat in that year.

4 Regional variations in the production of wheat in India

At the national level, the area under wheat, production and yield has changed from 2008-2009 to 2012-2013 from 2013-2014 to 2017-2018. At present, the cultivated area of wheat is about 30 million hectares. Comparing the previous two periods, the change in wheat production was stronger, followed by area and yield. The average change in production was about 9%. The country produced an average of 7.3 million tonnes more than the previous period. Major wheat growing states like Punjab, Madhya Pradesh and Rajasthan have seen positive changes in area and yield and production. Surprisingly, Jharkhand recorded a positive change in area, yield and production, while Haryana and Uttar Pradesh, the major traditional wheat growing states, showed a negative change in production due to a negative change in yield. Regional disparities in area and yield had a significant impact on wheat production. Madhya Pradesh saw an increase in average production of 6.87 million tonnes, followed by Rajasthan (1.2 million tonnes). However, production declined in Uttar Pradesh (1.41 million tonnes) and Haryana (0.11 million tonnes).

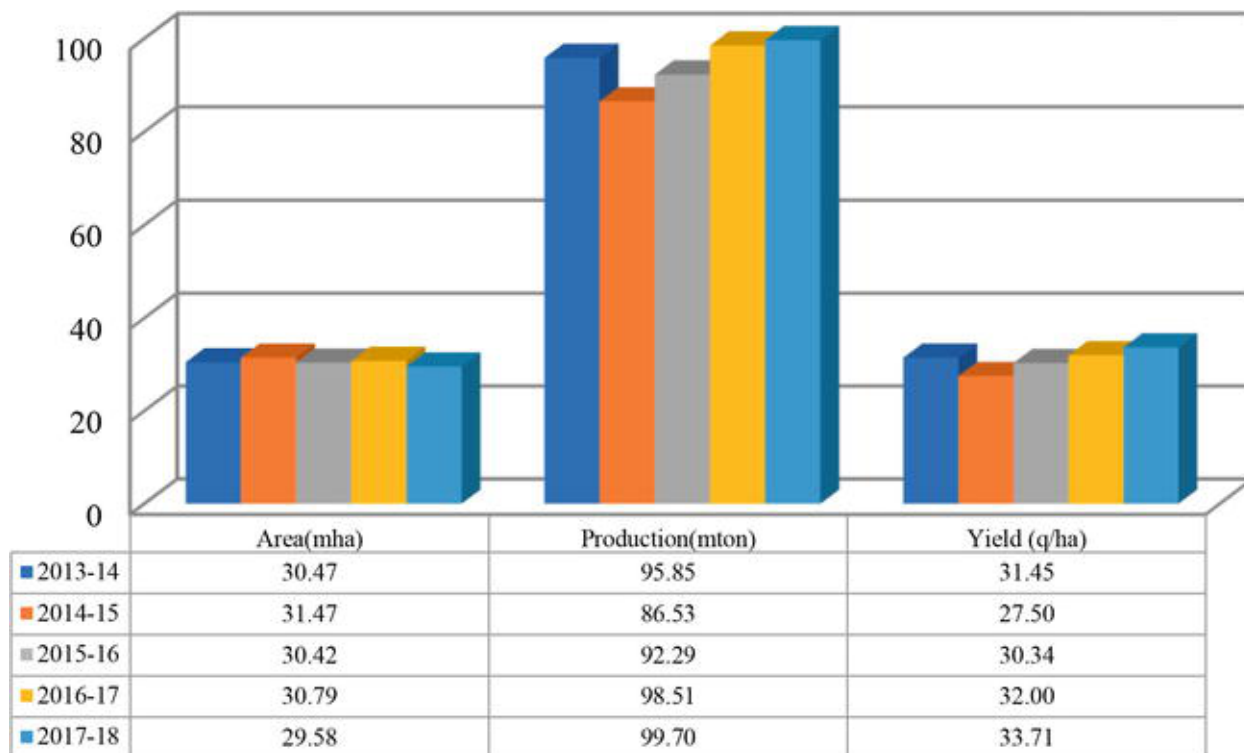


Figure 6: Regional Variation of Production

Comparing acreage and output by state for 2017–18 reveals that Uttar Pradesh, Punjab, Madhya Pradesh, and Haryana were the top producers in the country. The greater productive position of Punjab, Haryana, and Uttar Pradesh has been sustained for many years, nevertheless. Due to the stagnation of wheat acreage and output, these states’ capacity for increasing production was constrained. This shows that the cultivation and production of wheat has virtually reached its limit in these states. In the upcoming years, states like Rajasthan and Madhya Pradesh could investigate expanding wheat production. In order to enhance output, the acreage in these states must raise the yield on farmers’ fields. Around 29 million tonnes are being produced in these states, which needs to be doubled by 2050 with a total production target of 140 million tonnes

4.1 Worldwide Wheat Production

The demand for wheat is expanding along with the global population and is anticipated to do so in the upcoming years. The market for wheat was estimated to be worth 127.7 billion dollar in 2021, and it is anticipated to rise to 169.1 billion dollar by 2027. The increased use of wheat in global cuisines and rising demand

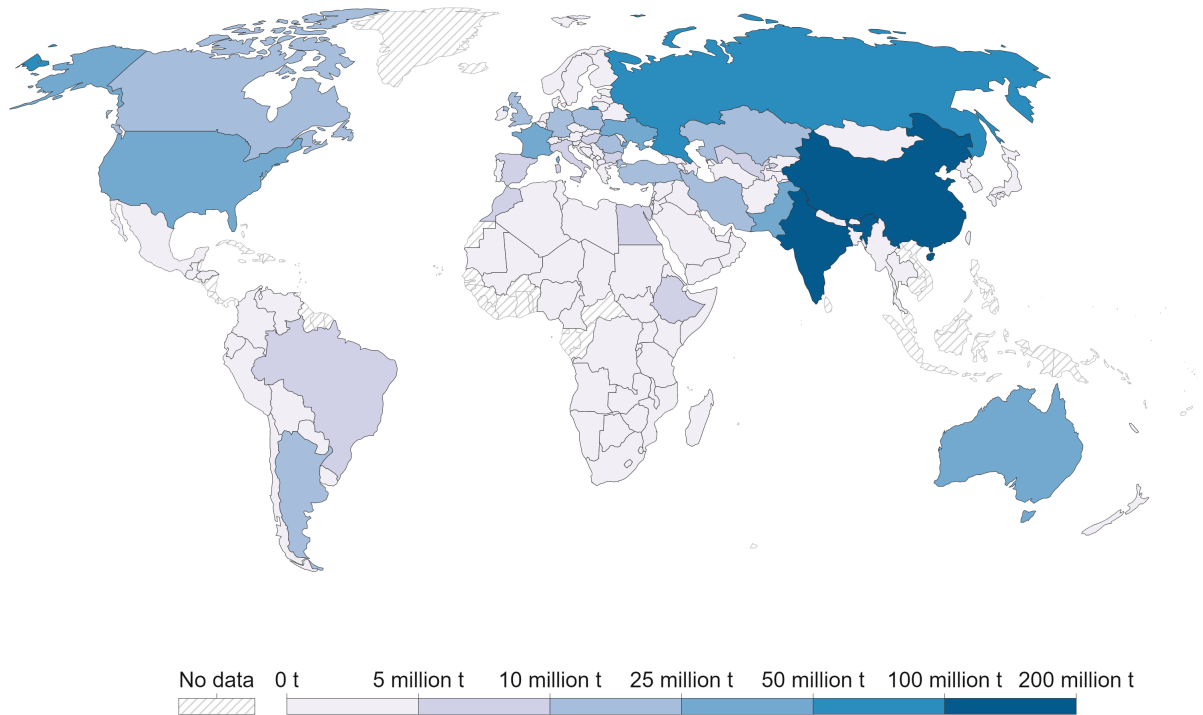
from the processing industries for goods like flour, pasta, noodles, and beverages are anticipated to propel the market in the years to come, despite factors like rising awareness of gluten allergies and sensitivities and unpredictable weather in several regions of the world that could hinder growth during the forecast period.[4]

China, India, Pakistan, and Australia are among the world's top producers of wheat, along with other countries in the Asia Pacific area. The two countries that produce and consume the most wheat globally are China and India. Due to the fact that wheat is a significant staple grain in this area, demand for and consumption of it have increased.

To compile a list of the top wheat-producing countries, we used information from *indexmundi*, which offers projections for each country's annual production of wheat in 2022. The *indexmundi* figures for the annual production of wheat come from the United States Department of Agriculture. Then, we ordered the countries based on their anticipated combined 2022 wheat production.

Wheat production, 2021

Wheat production is measured in tonnes.



Source: Food and Agriculture Organization of the United Nations

OurWorldInData.org/agricultural-production • CC BY

Figure 7: World Wheat Production in tonnes

1. **China** 138 million Metric Tonnes Per Year
2. **European Union** 134.7 million Metric Tonnes Per Year
3. **INDIA** 103 million Metric Tonnes Per Year
4. **Russia** 91 million Metric Tonnes Per Year
5. **United States** 44.9 million Metric Tonnes Per Year
6. **Canada** 35 million Metric Tonnes Per Year
7. **Australia** 33.0 million Metric Tonnes Per Year
8. **Pakistan** 26.4 million Metric Tonnes Per Year
9. **Ukraine** 20.5 million Metric Tonnes Per Year

10. **Argentina** 17.5 million Metric Tonnes Per Year
11. **Turkey** 17.25 million Metric Tonnes Per Year
12. **United Kingdom** 14.6 million Metric Tonnes Per Year
13. **Iran** 13.2 million Metric Tonnes Per Year
14. **Kazakhstan** 13 million Metric Tonnes Per Year
15. **Egypt** 9.8 million Metric Tonnes Per Year
16. **Brazil** 9.2 million Metric Tonnes Per Year
17. **Uzbekistan** 6.6 million Metric Tonnes Per Year
18. **Ethiopia** 5.7 million Metric Tonnes Per Year
19. **Afganistan** 4.5 million Metric Tonnes Per Year
20. **Algeria** 3.7 million Metric Tonnes Per Year

5 Wheat Production affecting parameters[9]

1. Climate: India's wheat-growing regions are primarily located in the north, where the climate is generally suitable for wheat production. However, unseasonal rains or early heat waves can affect the crop. In recent years, climate change has led to more extreme weather events that can impact wheat production.

2. Soil quality: In India's wheat-growing regions, soil quality can vary, therefore farmers must take precautions to make sure the land is healthy and well-drained. Utilising organic materials, such as compost or manure, and using the right tillage techniques can increase soil fertility.

3.Varieties: India produces a number of different wheat types, and farmers must pick the one that is most suited to their particular growing environment. Disease-resistant and high-yielding cultivars are preferred.

4.Fertilizer and nutrient management: The production of wheat in India depends heavily on the usage of fertilisers, particularly nitrogen. To prevent nutrient depletion and environmental damage, farmers must carefully monitor the usage of fertilisers.

5 Water availability:India needs irrigation since its rainfall is frequently insufficient, inconsistent, or unreliable. To promote the use of effective irrigation techniques, the government offers subsidies and other rewards.

6.Land Area One of the main factors affecting wheat output in India is the amount of land that can be used for wheat farming. The potential for enhanced wheat output is larger the more acreage is available for growing wheat.The amount of land that can be used for wheat farming is a key factor in determining the nation's overall wheat production.

7.Import India's local wheat production may fall as a result of wheat imports. This is due to the fact that imports make wheat more affordable and available,

which may cause farmers to reduce their output. The availability of less expensive imported wheat can also result in a drop in the cost of domestic wheat, which might deter farmers even more from raising their output. Furthermore, importing wheat increases the chance of bringing in pests and illnesses that could harm wheat production domestically.

8.Export India may enhance domestic wheat output as a result of its wheat exports. This is due to the fact that exporting wheat increases its profitability for farmers, which may encourage them to expand production. Additionally, raising the price of domestic wheat as a result of exporting wheat may encourage farmers to expand their output. A scarcity in the domestic market, however, might raise costs and reduce availability for domestic customers if there is an excessive export of wheat.

9.Wages The price of wheat might rise if production workers' wages rise, which would raise the cost of production. Increased wheat output prices can also benefit India's economy. It could increase the income of farmers, leading to greater investment in their farms, and potentially increasing productivity. This, in turn, could lead to higher yields and greater food security for the country. The effect of wages for wheat production on India will depend on various factors, such as the balance between supply and demand for wheat, the cost of inputs, and the purchasing power of consumers.

6. CONCLUSION

Wheat production decision making may be optimised using linear programming model. We can maximise the production of wheat while taking into account restrictions like the amount of accessible land, labour, and resources by expressing the issue as a linear programming model. The ideal distribution of these resources is achieved by the linear programming problem solution, which boosts wheat production's efficiency and profitability. By using linear programming techniques, farmers in the wheat business may make better decisions and increase their yearly production.

For the production of wheat, the use of multi-objective models gives a thorough method of decision-making that takes into account several competing objectives at once. A multi-objective model helps farmers to make educated and well-balanced decisions by taking into account numerous criteria including maximising production, minimising expenses, and lowering environmental effect.

We have referred the approximate data[17] from the sites, these are not sufficient to fit to solve the existing LPP model problem therefore we organised the data to fit the problem solution. After introduction to multi objective model we emphasize the solution process by using the TORA software.

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