A Linear Goal Programming Model to Multiple Objectives in Arable Farm Planning

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ABSTRACT

Other than profit maximization or cost minimization, farmers have a variety of other goals that may conflict with each other to achieve. Less attention has been paid to including these other goals in management models. A mix farm was modeled in this study utilizing the Lexicographic linear goal programming approach.Different crops, land allotment at each stage of farm growth, the number of seedlings and their cost, and the farming seasons were all taken into account and put into the model. The activities and requirements for the production of the farm products, such as the costs (purchase cost of the seedlings for each of the produce, Clearing of bush costs, Costs of Cultivating, Costs of Planting, Costs of Weeding, Costs of Harvesting, Costs of Processing, Costs of Transport/Logistics, Revenue generated from Sales, Total Costs and Total Profits, etc.) were included. In order to create objectives and link target goals to them, linear programming models were created for each of the aforementioned criteria.The targets for each of the developed objective goals were expressed based on the developed objective goals, and they were then turned to restrictions by adding deviational variables from the target values. The precise deviational variables included in the goal programming model were determined by examining the goals. These were assigned a pre-emptive priority and their importance was sorted in order.The Goal Programming model was created as a result. The model was then put to the test on a real-world farm situation, and the results showed that a compromise solution was reached.

Keywords: Goal programming, Arable farming, Linear programming, compromised solution.

Date of Submission: 01-01-2023 Date of Acceptance: 11-01-2023

I. Introduction

Concerns about the imminent prospect of food crises have arisen during the past few years in numerous nations, including Nigeria (Attah, 2012). Low yields resulting from inefficient production processes caused by technical and allocative inefficiencies, insufficient agricultural investments, inappropriate and labor-intensive agricultural technology, and poor prioritization of farm objectives have all become symptoms of declining farm productivity.

With a population of over 130 million, Nigeria is the most populous country in Africa. Its domestic economy is dominated by agriculture, which accounts for over 40% of the country's Gross Domestic Product (GDP) and two-thirds of its labor force. According to research, mixed agricultural systems are the foundation of much of Nigeria's agriculture since they provide the majority of the population with food, raw resources, and a means of subsistence.

According to published figures, Nigeria is the most populous nation in Africa, home to more than 130 million people, with an agriculture-dominated domestic economy that accounts for 40% of GDP and 60% of the labor force. Onyagede tribe in the Ohimini local government areas of Nigeria's Benue State a hub for the commerce of yams, cassava (manioc), corn, and other agricultural commodities. Concerns have also been expressed regarding the possibility of a food crisis in Nigeria. The low yield of farm products is a result of labor-intensive agricultural technology, technical and allocational inefficiencies, and poorly prioritized farm goals.

Although the need for food and the vast population are clear, mix farming necessitates the best use of the limited resources available. Mix Farming planning issues are quite complicated (Hazell and Norton, 1986). Along with producing various crops, farmers also have a range of methods from which to pick. The most prevalent multiobjective models were profit, risk, and sustenance (e.g., Brink and McCarl (2021).

In order to increase production and get the maximum yield out of limited resources, farming necessitates numerous decision-making procedures. Farmers have a variety of goals to pursue in addition to profit maximization or cost reduction.

However, numerous reviews have been written on the use of linear programming and goal programming in farming systems, including those by Kelechi Igwe (2013), Godlove Shu (2008), Peter et al (2013), Okpanachi, et al (2022), and many others.

In order to address issues with agricultural land allocation in India, Sharma Dinesh (2016) conducted a survey on fuzzy goal programming. In their study, Ibrahim and Omotesho (2011) identified the ideal company combination for vegetable production under Fadama in north central Nigeria. A LP model was also developed by Kaur et al. (2010) to recommend the ideal cropping strategy for maximizing net returns and assuring significant groundwater savings in Punjab, Pakistan. By utilizing the LP approach, Abdelaziz et al. (2010) in North Darfur State, Sudan, were able to produce the ideal crop pattern. In order to help small-holder farmers in Nigeria's Driver Savannah zone achieve their most crucial aim of feeding their families all year round, Adejobi et al. (2003) created a linear goal programming model for the best crop combinations under constraints of limited resources. For irrigation agriculture, Latinopoulos et al. (2005) developed a goal programming paradigm. Goal programming was used by Vivekandan et al. (2009) to improve the agricultural pattern for various areas. A linear programming model was created to predict the allocation of land to maximize farm productivity. Sofi et al. (2015) used the simplex technique to identify the solution. In their study, Tanko and Baba (2002) investigated how small-scale farmers who depend on arable crops used the resources available to them during the 2009 agricultural season in Niger State, North Central Nigeria. For the objective of selecting the ideal crop mix to maximize income, Phillip et al. (2019) applied linear programming to farm data obtained from 120 smallholder farmers in the 2017-18 cropping season in agricultural zone 4 (AZ4) of Adamawa state, Nigeria. Francis et al. (2021) create prototype farm plans based on the multi-objective production objectives of small-scale arable crop farmers in Nigeria's Kogi State. In the Nigerian Kwara State LGAs of Moro and Irepodun, Adewumi (2018) determined the best production schedules for farmers who grow cassava as a crop.Igwe and Onvenweaku (2013) used the linear programming technique on farms to maximize the gross margin from different combinations of arable crops and chosen animal companies. The ideal production strategy for farmers in Nigeria's Niger State growing maize-based crops was discussed in et al. (2019). Because the objectives were incommensurable, Orumie et al. (2022) used the Lexicographic linear goal programming approach to model a fish farm. A model for managing nutrients in rice production was utilized by Ghosh et al. Senegalese Subsistence Farms were the subject of a Goal Programming via Multidimensional Scaling application by Barnett, Douglas, et al. in 1982.

Additionally, a number of studies have been applied to natural resource planning (Romero, 1986), design of cattle rations (Rehman and Romero, 1984, 1987), and issues with sugar beet fertilizer combination (Minguez, 1988).

Due of the incomparability of the objectives, a farm will be modelled un this study utilizing the Lexicographic linear goal programming approach. All of the mixed farming strategies for various crops will be taken into consideration in the study. Production of farm products, realizing a specific rate of return on investment, effective resource allocation, accumulating financial income, spending on labor, yields, risks, operating profit, machine utilization, and using all available land for cultivation are the multi-objective goals that must be incorporated into the models that will be developed.

II. Methodology

Schniederjans and Kwaks (1982a) referred to the most commonly applied type of goal programming as "preemptive weighted priority goal programming". A generalized model for this type of programming is as follows:

minimize:
$$\mathbf{Z} = \sum_{i}^{m} w_{i} p_{i} (d_{i}^{-} + d_{i}^{+}) (1)$$

such that

$$\sum_{j}^{n} a_{ij} x_{ij} + d_{i}^{-} - d_{i}^{+} = b_{i} \qquad (i = 1, 2, ..., m),$$

$$x_{ij}, d_{i}^{-}, d_{i}^{+} \ge 0, w_{i} > 0 (3)$$

$$(i = 1, 2, ..., m) : \quad j = 1, 2, 3..., n) (4)$$
(2)

The farmer aims to avoid underutilizing labor and resources, reduce costs, increase sales income, and maximize profit.

The following provides information on the variables and objective functions that represent the different performance criteria:

2.1. Parameters and Variable Notations with Objective Functions

$$\begin{split} &i= The type \ of \ crop \ i \ (i=1, \ , n \) \\ &pi= The \ unit \ profit \ from \ ith \ produce \\ &P= Total \ profit \ (Target \ Profit) \\ &l= The \ type \ of \ labour \ (l \ =1, \ , n \) \end{split}$$

L = Total available labour

- L_k = The labour capacity required for ith produce
- f = The type of fertilizer (f = 1, , F)
- F = Total amount of accessible fertilizer, herbiside, pesticide, germicide
- D = Land capacity

 $t_i = \text{ cost of transportation of produce i to market}$

- T= total cost of transportation
- P_i= profit per produce
- P= Total profit
- $q_i = processing \ cost \ for \ ith \ product$
- Q = total processing cost
 - The model takes the following standards into account:

Cost of farming from planting to harvest, Required seedlings (resource usage), Seed cost type and crop type income from sales realized profit employment of labor, Shipping and receiving

Therefore, reduce production costs and resource usage are crucial criterion. maximize your use of labor, your use of land, your sales income, and your profit.

The above are stated as follows:

2.2 Multi-Objectives In A Farm Formulation

Farmers frequently do have many goals that are geared at meeting their diverse interests. Farmers, nevertheless, will undoubtedly desire to advance, endure, and enjoy security within their operational environment.

As a result, we take into account a variety of (different) farming goals while utilizing the farm's current infrastructure. The management intends to prevent underutilizing labor and resources, reduce costs, increase sales revenue, and maximize profit.

The following provides information on the variables and objective functions that represent the different performance criteria:

Minimize Production cost

$$\sum_{i}^{n} c_{i} x_{i} = C \qquad . \qquad . \tag{5}$$

Maximize Revenue

$$\sum_{i}^{n} R_{i} x_{i} = S \tag{6}$$

Resource Utilization (Fertilizer and pesticide).

$$\sum_{i}^{n} a_{i} x_{i} = A \tag{7}$$

 $\sum_{i=1}^{n} d_i x_i = D$

Labour Utilization/weeding/clearing of bush

$$\int l_i x_i = L \tag{9}$$

(8)

Maximize Profit

$$\sum_{i}^{n} p_{i} x_{i} = P \tag{10}$$

2.3 Model Formulation (Gp Model) For The Above Equations

2.3.1 Maximum Land Utilization

This is done to ensure that the crops don't utilize above the designated capacity limit (LAND). The objective of reducing the under- and overuse of the Land can be summed up as:

Min $d_1^+ + d_1^-$

$$\sum_{k}^{n} d_{k} x_{k} + d_{1}^{-} - d_{1}^{+} = D$$
(11)

DOI: 10.35629/4767-11010111

where

- D is available capacity of Lands (goal)
- $\begin{array}{c} d_1^- \\ d_1^+ \end{array}$ is underutilization of Lands
- is overutilization of Lands

 $Min(d_2^+)$

2.3.2 Minimize purchase Cost/ Resource Utilization (cost of seedling/cost of seedling)

s.t

$$\sum_{k}^{n} a_{k} x_{k} + d_{2}^{-} + d_{2}^{+} = A$$
(12)

where.

 $d_2^$ is under expenses on purchase / fertilizer

 d_2^+ is over expenses on purchase / fertilizer

2.3.3 Minimize Cost of Preparation/labour cost

Mathematically, the goal constraints of preparation costs:

$$\sum_{i}^{n} l_{i} x + d_{v}^{-} - d_{v}^{+} = L : v=3, 4, \dots s$$

The goal of minimizing the preparation cost for the ith crop type is represented as

$$\min d_{\nu}^{+}$$
s. t
$$\sum_{i}^{n} l_{i}x + d_{\nu}^{-} - d_{\nu}^{+} = L$$
(13)

where

 d_{ν}^{-} is underspending during farming preparation goal d_{ν}^{+} is overspending during farming preparation goal

2.3.4Minimize Cost of Processing

. Mathematically, the goal constraints of precessing costs:

$$\sum_{i}^{n} q_{i}x + d_{s+1}^{-} - d_{s+1}^{+} = Q$$

The goal of minimizing the production cost for the ith produce type is represented as . ..

Min
$$d_{s+1}^{+}$$

s. t
$$\sum_{i}^{n} q_{i}x + d_{s+1}^{-} - d_{s+1}^{+} = Q$$

where

 d_{s+1}^- is underspending during processing goal d_{s+1}^+ is overspending during processing goal

2.3.5 Minimize Transportation goal

. The goal of minimizing the production cost for the ith type is represented as

$$\sum_{i=1}^{n} t_{i}x + d_{s+2}^{-} - d_{s+2}^{+} = T$$

And the deviational variable to include becomes

$$\min d_{s+2}^+$$

s. t
$$\sum_{i=1}^{n} t_i x + d_{s+2}^- - d_{s+2}^+ = T$$

where d_{s+2}^{-} is underspending on transportation d_{s+2}^+ is overspending on transportation

(14)

(15)

2.3.6 Maximize Sales Revenue

Thus the goal is to minimize underachievement of the target, and it is represented thus:

Max d_{s+3}^+

s.t

$$\sum_{i}^{n} S_{i} x_{i} - d_{s+3}^{-} + d_{s+3}^{+} = S$$
(16)

where

 d_{s+3}^- is underachievement of the sales revenue goal

 d_{s+3}^+ is over achievement of the sales revenue goal.

2.3.7 Minimize total cost

. The goal of minimizing the production cost for the ith fish type is represented as Min d_{s+4}^+

s. t

$$\sum_{i}^{n} C_{i} x + d_{s+4}^{-} - d_{s+4}^{+} = C$$
(17)

where

 d_{s+4}^{-} is underspending during farming goal d_{s+4}^{+} is overspending during farming goal

2.3.8 Maximize Profit

 \sum_{h}^{n}

This goal can be represented as $Min d_{s+5}^{-}$

s. t

$$p_i x_k + d_{s+5}^+ - d_{s+5}^- = P \tag{18}$$

where

 d_{s+5}^+ is overachievement on the profit target d_{s+5}^- is underachievement on the profit target

Equation (11) to (18) represent the Farmers goal.

2.4 Goal Priority Structure

A good priority structure reflects management choices in a hierarchical representation of the target priorities. Problem with rigid constraint should be designed as a goal in a way that it is being minimized and given high priority in the achievement function.

However, depending on the preferences that the management listed, a goal prioritization structure must be created and which are described below:

 P_1 guarantees that the expenditures associated with clearing brush, cultivating land, planting, weeding, and harvesting are kept to a minimum.

P₂make sure to limit the underutilization of resources and land.

P₃ ensures that sales target is met

P4ensure that the purchase cost target is fulfilled and that total cost overruns are kept to a minimum.

 P_5 make sure that the entire profit, processing expenses, transportation costs, and logistics costs are not breached. As a result, the farm model's lexicographic goal is to minimize departures from various management-imposed objectives.

Thus;Min.

$$Z = P_1(d_v^+), P_2(d_1^+ + d_1^-), P_3(d_{s+3}^-), P_4(d_2^+, d_{s+4}^+), P_5(d_{s+1}^+, d_{s+2}^+, d_{s+4}^-)$$

S.t

Eqn (11) to (18) holds. hcAll variable are non-negative

III. Application Of The Formulated Model To A Farm/Data Collection

The study was carried out in a specific PLOT of farmland owned by the Onyagede tribe in the Ohimini local government areas of Nigeria's Benue State. The state's topography and climate make it ideal for growing a variety of arable crops, such as cassava, yam, maize, and sorghum, as well as millet, vegetables, rice, citrus fruits, palm produce, vegetables, and animals, earning Benue State the title of "Food Basket of the Nation.".

Their primary occupations outside of the Civil Service are farming and trading.

The information in the table below was taken from a farmer's prior farm records in 2021 at a specific farm in the state of Ohimini Benue. The mixed farming system problem, which involves eight different crops—cassava, yam, maize corn, cowpea, pigeon peas, Guinea corn, groundnut, and vegetables—is taken into account in the modeling.

The requirements, land distribution throughout each stage of farm growth, number of seedlings and associated costs, and criteria throughout farming eras are outlined in the table below (costs)

The farm produce is produced according to the activities and requirements listed in rows one through twelve, while the produce itself is listed in columns according to those requirements. For instance, the sort of agricultural food grown is shown in table 1's row 1. The amount of land allotted to each type of farm produce is shown in Row 2. The buying price of the seedlings for each of the produce is shown in Row 3. The rows corresponding to serial numbers three through twelve on the same table show the costs associated with clearing of brush, cultivating, planting, weeding (in four phases), harvesting, processing, transport/logistics, sales income earned, total costs, and total profits. The last column of the same table lists the availability of the aforementioned prerequisites.

Sales revenue is generated by converting the produce to monetary value by converting processed cassava floor from basins, tubers of yams, wheelbarrows of corn, and so on.

Total costs is obtaind by summing every other costs, whereas total profit is total sales minus total costs.

S/N	Farm Produce Activities	Groundnut	Cassava	Yam	Maize	Guinea Corn	Pigeon pea	Millet	Sorghum	Sign Of Const	Target Value
1	Land	1	1	1	0.5	0.5	1	0.5	0.5	=	6 plots
2	Purchase cost	1000	3,000	35,000	500	1000	1000	500	500	<=	42,500
3	Clearing of bush	2500	2500	2500	1250	1250	2500	1250	1250	<=	15,000
4	Cultivating	5833	5831	5500	3000	3000	5833	3000	3000	<=	35,000
5	Planting	1800	1800	2400	1000	1000	2000	1000	1000	<=	12000
6	Weeding 1-3 stages	6000	5000	5000	3500	3500	6000	3500	3500	<=	36,000
7	Harvesting	2500	3500	5500	1500	1500	3500	1500	1500	<=	21000
8	Processing		25,000							<=	25,000
9	Transport/ logistics	8000	8000	7000	2000					<=	25,000
10	Sales revenue	45,000	24basin 120,000	100 tubers @1,600 =160,000	5wheel @5000 25,000	17,000	31,000	21500	18000	>=	437,500
11	Total cost= $2+\ldots+9$	27,633	54,631	62,900	10000	9000	20,833	10750	10750	<=	210530
12	Total Profit = 10-11	20,367	68,369	99,100	12,500	8000	10167	10250	7250	>=	226,970

Table1: Activities in the farm

3.2 Formulation Of The Objectives

Let x_i be farm produce type such that $i=1, 2, 3, \ldots, 8$, where ;

- x₁ is Grandnut
- x₂ is Cassava
- x₃ is yam
- x₄ is maize
- x_5 is guinea corn
- x₆ is pigeon pea
- x₇ is millet
- x₈ is sorghum

Then, from the table 2 above, the goal target for each of the objectives becomes

 $\begin{array}{l} x_1 + x_2 + x_3 + 0.5x_4 + 0.5x_5 + x_6 + 0.5x_7 + & 0.5x_8 < = 6(\text{Land goal (plots)}) \\ 1000x_1 + 3000x_2 + 35000x_3 + 500x_4 + 1000x_5 + 1000x_6 + 500x_7 + 500x_8 < = 42,500 \\ (\text{purchase cost (N)}) \\ 2500x_1 + 2500x_2 + 2500x_3 + 1250x_4 + 1250x_5 + 2500x_6 + 1250x_7 + 1250x_8 < = 15000 \\ (\text{clearing const} \quad (\mathbb{N})5833x_1 + 5831x_2 + 5500x_3 + 3000x_4 + 3000x_5 + 5833x_6 + 3000x_7 + 3000x_8 < = 35000 \\ \end{array}$

(cultivating cost constraints (\mathbb{N})) $1800x_1 + 1800x_2 + 2400x_3 + 1000x_4 + 1000x_5 + 2000x_6 + 1000x_7 + 1000x_8 <= 12000$ (planting cost constraints (\mathbb{N})) $6000x_1 + 5000x_2 + 5000x_3 + 3500x_4 + 3500x_5 + 6000x_6 + 3500x_7 + 3500x_8 < = 36,000$ (weeding cost constraints (\mathbb{N})) $2500x_1 + 3500x_2 + 5500x_3 + 1500x_4 + 1500x_5 + 3500x_6 + 1500x_7 + 1500x_8 <= 21,000$ (Harvesting cost constraints (\mathbb{N})) $25000x_1 \le 25000$ (processing cost goa constraints 1 (N)) $8000x_1 + 8000x_2 + 7000x_3 + 2000x_6 + <=$ 25000 (transport/ logistics cost goal constraints (\mathbb{N}) $45,000x_1 + 120,000x_2 + 160,000x_3 + 25,000x_4 + 17,000x_5 + 31,000x_6 + 21,500x_7 + 18000x_8 = 100,000x_1 + 100,000x_2 + + 100,000x_2$ >437500 (sales revenue goalconstraints (\mathbb{N})) $24,663x_1 + 51,631x_2 + 60,900x_3 + 12,500x_4 + 9000x_5 + 20833x_6 + 10,750x_7 + 10,750x_8 < = 201030$ (total costs goal constraints (\mathbb{N})) $20367x_1 + 68,369x_2 + 99,100x_3 + 12,500x_4 + 8,000x_5 + 10,167x_6 + 10250x_7 + 7250x_8 = >236,003$ (total bprofit goal constraints (\mathbb{N})) $x_1, x_2, x_3, x_4, x_5, d_i^-, d_i^+ >= 0$

From the above model, the goal for each of the objective according to the management of the farm is represented in table 2 below

		Target	Constraints	Deviational var to	Priority level
			Signs	min	
1	Land goal	6plots	=	$d_1^- + d_1^+$	P_2
2	Purchase cost goal	#42,500	<=	d_2^+	P_4
3	Clearing of bush goal	#15,000	<=	d_3^+	P_1
4	Cultivating goal	#35,000	<=	d_4^+	P_1
5	Planting goal	#12,000	<=	d_5^+	P_1
6	Weeding1-3 goal	#36,000	<=	d_6^+	P_1
7	Harvesting goal	#21,000	<=	d_7^+	P_1
8	Processing goal	#25,000	<=	d_8^+	P_5
9	Transport/logistics goal	#25,000	<=	d_9^+	P_5
10	Sales revenue goal	#437,500	>=	d_{10}^{-}	P_3
11	Total cost goal	#201,030	<=	d_{11}^+	P_4
12	Total Profit goal	#236,003	>=	d_{12}^{-}	P_5

Table 2Summary of the goal targets for each of the objectives with priorities

From the table we have that : Min.

 $Z = P_1(d_3^+, d_4^+, d_5^+, d_6^+, d_7^+), P_2(d_1^+ + d_1^-), P_3(d_{10}^-), P_4(d_2^+, d_{11}^+), P_5(d_8^+, d_9^+, d_{12}^-)$

S.t $x_1 + x_2 + x_3 + 0.5x_4 + 0.5x_5 + x_6 + 0.5x_7 + 0.5x$ $0.5x_8 + d_1^- - d_1^+ = 6$ $1000x_1 + 3000x_2 + 35000x_3 + 500x_4 + 1000x_5 + 1000x_6 + 500x_7 + 500x_8 + d_2^- - d_2^+$ =42,500=15000 $2500x_1 + 2500x_2 + 2500x_3 + 1250x_4 + 125x_5 + 2500x_6 + 1250x_7 + 1250x_8 + d_3^- - d_3^+$ $5833x_1 + 5831x_2 + 5500x_3 + 3000x_4 + 3000x_5 + 5833x_6 + 3000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_5 + 5833x_6 + 3000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_6 + 3000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_8 + 3000x_8 + d_4^- - d_4^+ = 35000x_8 + 3000x_8 + d_4^- - d_4^+ = 35000x_8 + d_4^- - d_4^- + d_4^- - d_4^+ = 35000x_8 + d_4^- - d_4^- + d_4^- + d_4^- - d_4^- + d_4^- +$ $1800x_1 + 1800x_2 + 2400x_3 + 1000x_4 + 1000x_5 + 2000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_5 + 1000x_5 + 1000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_5 + 1000x_5 + 1000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_5 + 1000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_5 + 1000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000x_8 + d_5^- - d_5^+ = 120000x_8 + d_5^- - d_5^- = 12000x_8 + d_5^- - d_5^- = 12000x_8 + d_5^- = 12000x_8$ $6000x_1 + 5000x_2 + 5000x_3 + 3500x_4 + 3500x_5 + 6000x_6 + 3500x_7 + 3500x_8 + d_6^- - d_6^+ = 36,000$ $2500x_1 + 3500x_2 + 5500x_3 + 1500x_4 + 1500x_5 + 3500x_6 + 1500x_7 + 1500x_8 + d_7^- - d_7^+$ =21,000 $d_8^- - d_8^+ = 25000$ $25000x_1$ $8000x_1 + 8000x_2 + 7000x_3 + 2000x_6$ $+ d_9^- - d_9^+ = 25000$ $45,000x_1 + 120,000x_2 + 160,000x_3 + 25,000x_4 + 17,000x_5 + 31,000x_6 + 21,500x_7 + 18000x_8 + 21,000x_8 + 21,$ $d_{10}^- - d_{10}^+ = 437500$ $24,663x_1 + 51,631x_2 + 60,900x_3 + 12,500x_4 + 9000x_5 + 20833x_6 + 10,750x_7 + 10,750x_8x_8 + d_{11}^+ - d_{11}^+ + 10,750x_8x_8 + d_{11}^+ + 10,750x_8 + d_{11}^+ + 10,750x_8 + d_{11}^+ + 10,750x_$ $d_{11}^- = 201030$ $20367x_1 + 68,369x_2 + 99,100x_3 + 12,500x_4 + 8,000x_5 + 10,167x_6 + 10250x_7 + 7250x_8 + d_{12} - 2000x_{12} + 10,100x_{12} + 10,100x_{12$ $d_{12}^+=236,003$ $x_1, x_2, x_3, x_4, x_5, d_i^-, d_i^+ >= 0$

IV. Data Analysis/Results Output

The TORA 2007 software is used to examine the goal programming model in the order of highest priority to lowest priority, as illustrated below. Thus,

Min.

$$Z = P_1(d_3^+, d_4^+, d_5^+, d_6^+, d_7^+)$$

S.t $0.5x_8 + d_1^- - d_1^+ = 6$ $x_1 + x_2 + x_3 + 0.5x_4 + 0.5x_5 + x_6 + 0.5x_7 + 0.5x$ $1000x_1 + 3000x_2 + 35000x_3 + 500x_4 + 1000x_5 + 1000x_6 + 500x_7 + 500x_8 + d_2^- - d_2^+ = 42,500$ $2500x_1 + 2500x_2 + 2500x_3 + 1250x_4 + 125x_5 + 2500x_6 + 1250x_7 + 1250x_8 + d_3^- - d_3^+ = 15000x_1 + 1250x_1 + 1250x_2 + 1250x_1 + 1250x_2 + 1250x_2 + 1250x_1 + 1250x_2 + 1250x_2$ $5833x_1 + 5831x_2 + 5500x_3 + 3000x_4 + 3000x_5 + 5833x_6 + 3000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_4 + 3000x_5 + 5833x_6 + 3000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_7 + 3000x_8 + d_4^- - d_4^+ = 35000x_8 + d_4^- - d_4^- + 3000x_8 + d_4^- - d_4^+ = 35000x_8 + d_4^- - d_4^- + 3000x_8 + d_6^- + 3000x_8 + d_6^- + 3000x_8 + d_8^- + 300x_8 + d_8^- + 300$ $1800x_1 + 1800x_2 + 2400x_3 + 1000x_4 + 1000x_5 + 2000x_6 + 1000x_7 + 1000x_8 + d_5^- - d_5^+ = 120000$ $6000x_1 + 5000x_2 + 5000x_3 + 3500x_4 + 3500x_5 + 6000x_6 + 3500x_7 + 3500x_8 + d_6^- - d_6^+ = 36,000$ $2500x_1 + 3500x_2 + 5500x_3 + 1500x_4 + 1500x_5 + 3500x_6 + 1500x_7 + 1500x_8 + d_7^- - d_7^+ = 21,000$ $25000x_1$ $d_8^- - d_8^+ = 25000$ + $8000x_1 + 8000x_2 + 7000x_3 + 2000x_6$ $+ d_9^- - d_9^+ = 25000$ $45,000x_1 + 120,000x_2 + 160,000x_3 + 25,000x_4 + 17,000x_5 + 31,000x_6 + 21,500x_7 + 1800 + 100,000x_5 + 100,000x_6 + 21,000x_7 + 100,000x_7 + 10$ $d_{10}^- - d_{10}^+ = 437500$ $24,663x_1 + 51,631x_2 + 60,900x_3 + 12,500x_4 + 9000x_5 + 20833x_6 + 10,750x_7 + 10,750x_8x_8 + d_{11}^+ - d_{11}^+ + 10,750x_8x_8 + d_{11}^+ + 10,750x_8 + d_{11}^+ + 10,750x_8 + d_{11}^+ + 10,750x_$ $d_{11}^- = 201030$ $20367x_1 + 68,369x_2 + 99,100x_3 + 12,500x_4 + 8,000x_5 + 10,167x_6 + 10250x_7 + 7250x_8 + d_{12}^- - d_{12}^- + 10,167x_6 + 10,17x_6 + 10,17$ $d_{12}^+ = 236,003$ $x_1, x_2, x_3, x_4, x_5, d_i^-, d_i^+ >= 0$

							LINEAR P	ROGRAMMIN	lG g Grid:							
Problem Title	e: FARM	I GOAL PR	OGRAMMI	NG PROB	∟EM			>>0	lick Maximiz	e(Minimize)-c	ell to change	it to Minimiz	e(Maximize)			
Nbr. of Varia	ibles: 32							221	ell of target o	column(row).	then invoke i	oumn(row), c oull-down Edi	tGrid menu			
No. of Const	raints 12							>>F	or INSERT m	ode, a single(double) click	of target rov	//column will			
							p	lace new rov	v/column afte	er(before) tar	get row/colu	nn.				
						INPL										
	×1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
Var. Name	Groundnut	cassava	yam	maize	guineacorn	pigeonpea	millet	sorghum	d1-	d1+	d2-	d2+	d3-	d3+	d4-	
Minimize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1
Constr 1	1.00	1.00	1.00	0.50	0.50	1.00	0.50	0.50	1.00	-1.00	0.00	0.00	0.00	0.00	0.00	0
Constr 2	1000.00	3000.00	3500.00	500.00	1000.00	1000.00	500.00	500.00	0.00	0.00	1.00	-1.00	0.00	0.00	0.00	0
Constr 3	2500.00	2500.00	2500.00	1250.00	1250.00	2500.00	1250.00	1250.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.00	C
Constr 4	5833.00	3831.00	5500.00	3000.00	3000.00	5833.00	3000.00	3000.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-1
Constr 5	1800.00	1800.00	2400.00	1000.00	1000.00	2000.00	1000.00	1000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 6	6000.00	5000.00	5000.00	3500.00	3500.00	6000.00	3500.00	3500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 7	2500.00	3500.00	5500.00	1500.00	1500.00	3500.00	1500.00	1500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 8	2500.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 9	8000.00	8000.00	7000.00	2000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 10	45000.00	120000.00	160000.00	25000.00	17000.00	31000.00	21500.00	18000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 11	24633.00	51631.00	60900.00	12500.00	9000.00	20833.00	10750.00	10750.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Constr 12	20367.00	68369.00	99100.00	12500.00	8000.00	10167.00	10250.00	7250.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Lower Bound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	:6
Upper Bound	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	minity	
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Figure 1. Input data for the goal programming model

Problem Title:	FARM 0	GOAL PROG	RAMMIN	G PROBLEI	vi			Editing G	rid: « Maximize()	Minimize)-cell	to change it	to Minimize(Maximize)			
Nhr. of Variables	32							>>To D	ELETE, IN SE	RT, COPY, or I	PASTE a colu	mn(row), cli	ck heading			
	. JE							cell >>For I	of target col NSERT mod	lumn(row), the e. a single(do	en invoke pu uble) click of	II-down EditG target row/c	irid menu column will			
No. of Constraints	s: IZ							plac	e new row/o	column after(l	before) targe	t row/colum	n.			
	x16	x17	x18	x19	x20	INPUT	GRID - LINE	AR PROGRA	MMING x24	x25	x26	x27	x28	x29	x30	x31
Var. Name	d4+	d5-	d5+	d6-	d6+	d7-	d7+	d8-	d8+	d9-	d9+	d10-	d10+	d11-	d11+	d1
Minimize	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 4	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 5	0.00	0.00	-1.00	1.00	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 7	0.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Constr 9 Constr 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.00	-1.00	0.00	0.00	0.
Constr 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-1.00	0.
Constr 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.
Lower Bound	0.00	0.00 infinity	0.00 infinity	0.00 infinity	0.00	0.00	0.00 infinity	0.00 infinity	0.00	0.00	0.00 infinity	0.00 infinity	0.00 infinity	0.00 infinity	0.00 infinity	0. infin
Unrestr'd (y/n)?	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n	
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							_			_						
)O 計 🤞	n 0	C = Figure	2. C	ontinua	ation	of Inpu	ut data	for th	e goal	l progr	ammi	ng mo	c sunny / del	∖@' ⊜ <i>∥</i>	ỗ ⊄») ENG	6:54 PN
O 団 単 🧕	• 0	€ ■ Figure	2. C	ontinua	ation	of Inpı	ut data	for th	e goal	l progr	ammi	ng mo	c sunny / del	× @ ™ <i>(</i> (듣 句») ENG 	6:54 PN
○ ○ 肖 🥌		Figure	2. C	ontinua	ation	of Inpı	it data	for the	e goal	l progr	ammi	e 30% ng mo	c sunny ∕ del	\ @ ₩ ■ //	〔 (↓ v) ENG	6:54 PM
O I → ●	FARM C	Figure	2. C	ontinua	ation (of Inpu	ut data	for the	e goal	progr	ammi	e 30%	C Sunny <	ヽ (; *= <i>M</i>	ද (1)) ENG 	6:54 PN - C
Grid	FARM C	Figure	2. C	ontinua G PROBLE	ation (of Inpu	ut data	GRAMMING Editing G >>Clict >>To D	e goal	progr	ammi to change it	e 30%	C Sunny ~ del Maximize) ck heading	\ @ \ <i>M</i>	ද (1)0) ENG 	6:54 PN - C
Grid Problem Title: Nbr. of Variables:	FARM C	Figure	2. Co	ontinua G PROBLEM	ation (of Inpu	It data	GRAMMING Editing G >>Cict >>To D cell >>For	e goal	I progr Minimize)-cell RT, COPY, or f umn(row), th e. a single(do	to change it ASTE a colu en invoke pu uble) click of	to Minimize(mn(row), clia I-down EditG	C Sunny C Sunny del Maximize) ck heading rid menu column will	\ (i) \(in) \(h) \(h) \(h) \(h) \(h) \(h) \(h) \(h	੍ਰ (\$)) ENG 	6:54 PM
O ⊟ł 🍏 Grid Problem Title: Nbr. of Variables: No. of Constraints	FARM C : 32 :: 12	Figure	2. Co	ontinua G PROBLEM	ation (of Inpu	it data	GRAMMING Editing G >>Click >>To D cell >>For I plac	e goal rid: (Maximize(L LLTE, INSE of target col NSERT model e new row/or	Minimize)-cell RT, COPY, or I lumn(row), thi e, a single(do column after(I	to change it ASTE a colu en invoke pu uble) click of pefore) targe	to Minimize(mn(row), clie i-l-own EditG target row/c t row/column	C Sunny C Sunny del Maximize) x heading irid menu will h.	\ (j) \(\mathbf{m}\) <i>(m)</i>	∉ ⊄》)ENG 	6:54 PM
O ☐	FARM () 32 5: 12	Figure	2. Co	ontinua G PROBLEI	ation (of Inpu	ut data	for the Corrections of the Corrections of the Source of the So	e goal rid: Maximize(LETE, INSE of target col NSERT mode e new row/o	Minimize)-cell RT, COPY, or I umm(row), th e, a single(do column after(t	to change it ASTE a colu an invoke pul uble) click of pefore) targe	to Minimize(mg mo	C Sunny del Maximize) ck heading rid menu column will 1.		፪ 석3) ENG	6:54 PN
O Ħ	FARM C : 32 :: 12	Figure	ERAMMIN	G PROBLEM	ation (LINEAR PR(for the SGRAMMING Editing G ->>Click ->>To D cell ->>To D cell ->>To D cell ->>To D cell ->>To D cell ->>To D cell ->>To D ->>To D ->>>To D ->>To D ->> To D ->>To D ->> ->>To D ->> ->>To D ->>To D ->> ->>To D ->> -	rid: (Maximized ELETE, INSE of target col NSERT modde e new row/co MMING	Minimize) cell RT, COPY, or I umn(row), the e, a single(do column after(t	ammi: to change it PASTE a colu an invoke pu luble citick of before) targe	to Minimized Ing mod	C Sunny ~ del Maximize) rid menu column will 1.	\ 0 ₩ //	(ф)) ENG 	6:54 PM
O ☐	FARM C : 32 :: 12	GOAL PROG	2. C	G PROBLER	ation (M x24 d8*	of Inpu	LINEAR PR(For the SGRAMMING Editing G >>Click >>To D cell >>For plac AR PROGRA	e goal rid: Maximize(f LETE, INSE of target co NSERT mode SERT	Minimize) cell RT, COPY, or I umnfrow), the e, a single(do column after(t	ammii to change it PASTE a colu sh invoke pu buble) click of before) targe x30 d11+	to Minimized mg mO to Minimized I-down Edific target row/c trow/column x31 d12-	C Sunny del del Maximize) rid menu column will h. x32 d12+	∑ ĝ 🗐 ∕⁄	震 (\$)) ENG ■ R.H.S.	6:54 PM
Grid Grid Problem Title: Nbr. of Variables: No. of Constraints Var. Name Minimize	FARM C : 32 s: 12	COAL PROG		G PROBLER	x24 48+ 0.00 	of Inpu Inpu x25 0.00	It data	SGRAMMING Editing G >>To D cell >>For 1 plac	rid: Maximize(I LETE, INSE of target co NSERT mode SERT mode MING x28 d10+ 0.00 x27	Minimize) cell Rif, COPY, or I umn(row), the e, a single(do column after(t) x29 d11. 0.00	ammi to change it PASTE a colu en invoke pul ubley citick of before) targe x30 d11+ 0.00	to Minimized mng moo to Minimized mn(row), clic L-down Edito target row(column target row(column target row(column target row(column target row(column)	C Sunny × del Maximize) sk heading rid menu sk unn will h.	∑ ĝ 🗐 ∕/	震 (13) ENG 	6:54 PN
Grid Grid Problem Title: Nbr. of Variables: No. of Constraints Var. Name Minimize Constr 1 Constr 2	FARM C : 32 : 12 : 12 : 100 0.00	Coll prog		C PROBLET	x24 dB+ 0.00 0.00	of Inpu INPUT x25 0.00 0.00	LINEAR PRO	for the	e goal rid: Maximize(t LETE, INSE of target col NSERT mode e new row/or MMING x28 d10+ 0.00 0.00	Minimize)-cell RT, COPY, or I umn(row), the e, a single(do column after(f x29 d112 0.00 0.00	ammi PASTE a colu en invoke pu bible citick of before) targe x30 d11+ 0.00 0.00	to Minimize(mm(row), clic I-down EdifG target row(column target r	C Sunny × del Maximize) ck heading rid menu column will h.	∑ ĝ 🐜 <i>k</i>	 ■ RH.S. = 6. 4250. 	6:54 PN
O H M	FARM C : 32 : 12 : 12 : 20 : 400 0.00 0.00	2 Figure 50AL PROG 50AL	2. C	C PROBLEI 8 PROBLEI 8 PROBLEI 8 PROBLEI 8 PROBLEI 9 PROBLEI	x24 0.00 0.00 0.00	of Inpu NPUT x25 49- 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	1t data	for the DGRAMMING Editing 6 >>Clev >>To D cell >>For plac AR PROGRAM x27 d10- 0.00 0.00 0.00	e goal rid: Maximize(LETF, INS ELTF, INS SERT mode e new row/or MING x28 d10+ 0.00 0.00 0.00	Minimize)-cell RT, COPY, or I umn(row), the e, a single(do column after(t) x29 d11- 0.00 0.00 0.00 0.00	to change it ASTE a colu nirvoke pul uble) click of before) targe x30 d11+ 0.00 0.00 0.00 0.00	to Minimize(mn(row), clid ladown EdilG target row/c trow/column x31 d12- 0.00 0.00 0.00	C Sunny × del Maximize) ck heading rid menu column will h. x32 d12+ 0.00 0.00 0.00 0.00	× ĝ ⊯ ∥	 ₹ (1)) ENG ■ R.H.S. ■ 42500. ■ 42500. ■ 15000. 	6:54 PN
Constr 2 Constr 3 Constr 4	FARM C : 32 : 12 :: 12 :: 12 :: 12	221 3 3 3 3 4 3 4 4 5 5 5 6 6 1 1 1 1 1 1 1 1	2. C	C PROBLER 8 PROBLER 0.00 0.00 0.00 0.00	x24 d8+ 0.00 0.00 0.00 0.00	of Inpu ************************************	LINEAR PRO GRID - LINE x26 d9+ 0.00 0.00 0.00 0.00 0.00	SGRAMMING Editing G S>Clock >>To D cell >>For II Second x27 d10 0.00 0.00 0.00 0.00 0.00 0.00 0.00	e goal	Minimize)-cell RT, COPY, or J RT, COPY, or J RT, COPY, or J L Minimized and the second column after(t 229 d11- 0.00 0.00 0.00 0.00	to change it ASTE a colu ninvoke pub uble) click of before) targe x30 d11+ 0.00 0.00 0.00 0.00	30*/ 10 3	C Sunny × (del del Maximize) ck heading rid menu column will h. x32 1 d12+ 0.00 0.00 0.00 0.00	∑ ĝ (m) <i>(k</i>)	 RHS RHS RHS 6. 42500. 15000. 35000. 	6:54 PN
Grid Problem Title: Nbr. of Variables: No. of Constraints Var. Name Minimize Constr 1 Constr 2 Constr 5 Constr 6 Constr 5 Constr 6 Constr 7 Constr 6 Const	FARM C : 32 : 12 x20 d6+ 1.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	Coal prog	x22 a7+ 1.00 0.00 0.00 0.00 0.00 0.00 0.00	C PROBLET	x24 det 0.00 0.00 0.00 0.00 0.00	of Inpu 	1t data LINEAR PR(GRID - LINE x26 0.00 0.00 0.00 0.00 0.00 0.00 0.00	for the SGRAMMING Editing 6 S>Tot 0 Cell S>Fot 0 Cell S>Fot 0 Cell Sof 0	e goal	x29 d11- 0.000 0.000 0.000 0.000	ammi: by change if ASTE a colu en invoke publie) citick of before) targe x30 d11+ 0.00 0.00 0.00 0.00 0.00 0.00	30% 10 Minimize(mm(row), citi 1down EditG target row/column 412- 0.00 0.00 0.00 0.00 0.00 0.00 0.00	C Sunny × del dkaximize) ck heading rid menu olumn will t. x32 1 412+ 0.00 0.00 0.00 0.00 0.00 0.00	∑ ĝ 🐜 <i>d</i>	 ₹ (1)) ENG ₹ (1)) ENG ₹ (1)) ₹ (1	6:54 PN
O H M	FARM 0 : 32 :: 12 :: 12 : 12	x21 0.00 0	x22 d74 1.00 0.00 0.00 0.00 0.00 0.00	C PROBLET	x24 d8+ 0.00 0.	of Inpu x25 49. 0.00	LINEAR PRO GRID - LINE x26 d9+ 0.00 0	for the SGRAMMING Editing 6 >>Tot cell >>Tot plac AR PROGRAM \$27 410 0.00 0.00 0.00 0.00 0.00 0.00 0.00	e goal	Minimize)-cell RT, COPY, or I urnn(row), the e, a singlet(ob column atter(t x29 d111- 0.00 0.00 0.00 0.00 0.00 0.00 0.00	ammi: to change it ASTE a colu an invoke publicy cick of helfore) targe x30 d11+ 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	*30***********************************	C Sunny × del del Maximize) tc heading rid menu td td menu td td td td td td td td td td td td td	∑ ĝ	 ₹ (3)) ENG ■ R.H.S. ■ R.H.S. ■ A2500. = 15000. = 15000. = 15000. = 36000. = 32000. = 32000. 	6:54 PN - C
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A Linear Goal Programming Model To Multiple Objectives In Arable Farm Planning

Figure 4: Result output data for the goal programming priorities

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x15: d4-	2006.28	0.00	0.00	
x16: d4+	0.00	1.00	0.00	
x17: d5-	0.00	0.00	0.00	
x18: d5+	0.00	1.00	0.00	
x19: d6-	0.00	0.00	0.00	
x20: d6+	0.00	1.00	0.00	
x21: d7-	0.00	0.00	0.00	
x22: d7+	0.00	1.00	0.00	
x23: d8-	22495.91	0.00	0.00	
x24: d8+	0.00	0.00	0.00	
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x27: d10-	0.00	0.00	0.00	
x28: d10+	0.00	0.00	0.00	
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Figure 5 : Continuation of result output data for the goal programming priorities

V. Result Summary

The result output of this investigations are represented in figures 4 and 5. The result output in figure 4 and 5 were obtained by solving the MOGP developed using TORA 2007 software. Figure 5 and 4 show that the first priority goal has been fully attained by minimizing all the deviational variables to zero. Thus the deviational variable $(d_2^-, d_4^- \text{ and } d_8^-)$ (= 31475.92, 2006.28, and 22495.91 respectively). This implies that the purchase cost, cultivating costs and processing costs can be reduced from N42,500, N15,000 and N25,000 to N31475.92, N2006.28, and N22495.91 respectively This means that the processing fee for cassava floor reduced from the initial cost by N2504.09. Also, the total purchase costs for all the produced can be minimized from the initial costs to N11,024.08.

VI. Conclusions

The outcome indicates that the ideal answer has been found, and the model created is suitable for farms with many aim functions because it lowers all investment expenditures and raises sales, which boosts profit. Additionally, it is believed that the interpretation above will direct management's choices about business expansion.

However, other farmers with multiple resource usage, such as the use of machinery and equipment, and various crop varieties, can apply the created model in their farm management to meet market demand.

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