Case Report
Volume 10:12, 2022

Journal of Phylogenetics & Evolutionary Biology

ISSN: 2329-9002

Open Access

Decision Making Under Uncertainty in Production of Crop Case Study: Maize Crop Production at Adet Werda

Aregawi Yemane[1]*, Alehegn Melesse[1], Ephrem Gidey[2] and Amare Matebu[2]

[1]Department of Industrial Engineering, Bahir Dar University, Bahir Dar, Ethiopia
[2]Department of Industrial Engineering, Addis Ababa Science and Technology University, Addis Ababa, Ethiopia

Abstract

In the decision making under uncertainty individual decision makers must choose one of a set number of decision alternatives with ample or given information about their outcomes, but most of the times, have not enough knowledge or data about the probabilities of the given state of nature. This paper focuses on the maxi max, maxi min, mini max, regret and realism criteria. The different approaches were analyzed and compared in a case study of variety of maize production volume at Addet Woreda. The main problems that have faced in Adet Wereda the research center do not use alternative production strategies to produce maize variety products. Due to this problem the center may loss the production volume and quality of the product. To solve this problem, different decision making under uncertainty tools were used to optimize the production volume gain per year. The aim of this paper is to introduce decision making under uncertainty to optimize the course of action from the given alternatives on variety of maize production volume at Adet Wereda research center.

Keywords: Optimization • Uncertainty • Decision making • Hurwitz

Introduction

The success or failure that an individual or organization experiences, depends to a large extent on the ability of making appropriate decisions. Making of a decision requires an enumeration of feasible and viable alternatives (courses of action or introduction to decision analysis feasible and viable alternatives (courses of action or strategies), the projection of consequences associated with different alternatives, and a measure of effectiveness (or an objective) by which the most preferred alternative is identified. The field of decision analysis provides a framework for making important decisions. Decision analysis allows us to select a decision from a set of possible decision alternatives when uncertainties regarding the future exist. The goal is to optimize the resulting payoff in terms of a decision criterion. Decision analysis provides an analytical and systematic approach to the study of decision making.

Making decisions at both personal and organizational level can be made with some difficulty. In this case decision maker should understand the path for each action through preparation of systematic methods of analyzing the various situations. This research concerned with decisions under uncertainty, the decision maker should:

- Gather necessary information to design course of actions
- List all events that may occur
- Take assumptions
- Describe consequences resulting from the various courses of action
- Determine the probability of an uncertain event occurring

In Ethiopia, maize grows from moisture stress areas to high rainfall areas and from low lands to the high lands. It is largely produced in western, central, southern, and eastern parts of the country. In 2012/2013 cropping season 2013044.93 hectares of land was covered with maize with an estimated production.

In our country maize is produced mainly for food, especially in major maize producing regions particularly for low income groups, it is also used as staple food. Maize is consumed as "injera", porridge, bread and "nefro". It is also consumed roasted or boiled as vegetables at green stage. In addition to above, it is used to prepare local alcoholic drinks known as "tela" and "arekie or caticala". The leaf and stalk are used for animal feed and also used as industrial raw material for oil and glucose production.

In order to analyses this situations commonly used decisions making models under uncertainty were used. These are:

- Maxi max or Mini min IEM-20-8776;
- Maxi min or Mini max IEM-20-8776;
- Equally likely
- Criterion of realism
- Criterion of regret

Statement of the problem

Agricultural sector in Ethiopia is the backbone of the country's development. Amhara region agriculture research institute is one of the research centers to conduct researches to increase the production variety and volume in different area.

Among those areas, Adet Wereda is one of the research centers. The researchers have selected for the purpose conducting this paper. In that area different crop products are cultivated. The researchers have selected maize variety for this paper.

The main problems that have faced in that area are: In Adet Wereda the research center does not use alternative production strategies to produce maize variety products. Due to this problem the center may loss the production volume of that area. To solve this problem, different decision making under uncertainty tools were used to optimize the production volume gain per year.

***Address for Correspondence:** Aregawi Yemane, Department of Industrial Engineering, Bahir Dar University, Bahir Dar, Ethiopia; Tel: +251-914803572; E-mail: aregawi.meresa@mu.edu.et*

Received: 31 March, 2020, Manuscript No: jpgeb-20-8776; **Editor assigned:** 03 April, 2020, PreQC No: P-8776; **Reviewed:** 17 April, 2020, QC No: Q-8776; **Revised:** 19 December, 2022, Manuscript No: R-8776; **Published:** 26 December, 2022, DOI: 10.37421/2329-9002.2022.10.254

Research questions

- What are the major decision alternatives in decision making under uncertainty in variety maize production in Adet Wereda?
- What optimization models commonly used decisions making under uncertainty for the variety maize production volume on different rainfall range?

Objective of the study

This paper has two objectives general objective and specific objective.

General objective: To optimize the course of action from the given alternatives on variety of maize production volume at Adet Wereda research center.

Specific objective: To evaluate the variety of maize production volume using decision making under uncertainty tools.

- To prioritize the variety of maize production volume for the given situation.
- To decide the best strategy depending on the situation.

Case Presentation

To conduct this paper the researchers follow different methodologies to collect necessary information and data.

Primary data collection

Discussion was made with ARARI director and Adet Wereda research center of crop production managers to collect information about the different types of crop products and the environmental situations (Table 1).

Secondary data collection

Annual planed and actual production volume reports of maize variety per hectare under different environmental condition. After collecting the data then selecting the necessary tool to analysis the data is a critical thing. Decision analysis employs a diversity of tools to estimate all important information to support the decision making process. A model is developed to characterize analysis, and originated a suggested course of action. Decision making under uncertainty, as under risk, involves the (random) states of nature. Specifically, the payoff matrix of a decision problem with m alternative actions and n states of nature can be represented as: The element ai represents action I and the element Sj represents state of nature j. The payoff or outcome associated with action ai and state Sj is P (aj, Sj).The difference between making a decision under risk and under uncertainty is that in the case of uncertainty, the probability distribution associated with the states Sj, j=1, 2, ... , n, is either unknown or cannot be determined. This lack of information has led to the development of the following criteria for analyzing the decision problem: In order to analyses this situations commonly used decisions making models under uncertainty were used. These are: maxi max or minimin, maximin or minimax, equally likely and criterion of realism criterion of regrets and compared in the case study of production volume of maize variety. The analyses were made on annual production volume of average of eight years for each type of maize variety and evaluate each alternative then to decide the best strategy depending on the situation.

Table 1. The payoff matrix of a decision.

Alternative actions whose payoffs depend on					
State	of s1	s2	s3	....	sn nature
Course of actions					
a1	P (a1, s1)	P (a1, s2)	P (a1, s3)	....	P (a1, sn)
a2	P (a2, s1)	P (a2, s2)	P (a2, s3)	....	P (a1, sn)
a3	P (a3, s3)	P (a3, s2)	P (a3, s3)	....	P (a1, sn)
.	.	.	.	.	.
am	P (am, s1)	P (am, s2)	P (am, s3)	....	P (am, sn)

Basic assumptions

The following assumptions should be considered to analysis the data.

- All maize type planting date, crop density, fertilizer amount and timing, weed and pest control strategies to be similar
- Seed rate to be constant 25 kg. per hectare
- Constant sales price for each maize variety.

Weather is one of the key components that control agricultural production. In some cases, it has been stated that as much as 80% of the variability of agricultural production is due to the variability in weather conditions, especially for rain fed production systems [1]. Climate variability is one of the main sources of uncertainty and risk in many agricultural systems around the world [2].

Indeed, agriculture has been described as the most weather- dependent of human activities and most production decisions directly or indirectly involve a consideration of this factor. Because farmers usually do not know what climate to expect in the following growing season, they have evolved conservative cropping strategies that not only may fail to capitalize fully on beneficial conditions but also frequently buffer poorly against negative effects [3].The complex pattern illustrates the dynamic, iterative nature of decisions, which are subject to continuous revisions in response to updated information and. Making a decision implies that there are alternative choices to be considered, and in such case the researchers want not only to identify as many of the alternatives as possible but also to choose the one to be best fits to the researcher goals, objectives, desires, etc [4]. Scientific interest in using crop models at regional and global scales for large-scale assessment of agricultural systems has drawn attention to generic, simplified crop models [5]. The element ai represents action I and the element Sj represents state of nature j. The payoff or outcome associated with action ai and state Sjis P(aj, Sj).The difference between making a decision under risk and under uncertainty is that in the case of uncertainty, the probability distribution associated with the states Sj, j = 1, 2, ... , n, is either unknown or cannot be determined [6]. This lack of information has led to the development of the following criteria for analyzing the decision problem:

Laplace (equally likely decision) criterion: The Laplace criterion is based on the principle of insufficient reason.

Maximax or minimin: This is optimistic type of decision making method in this model the most maximum is selected among the maximums of production strategies [7].

Maximin minimax: This is a pessimistic approach. It suggests that the decision maker examines only the minimum payoffs of alternatives and chooses the alternative whose outcome is the least bad.

Criterion of realism (Hurwitz): It is one of criterions used to select the minimum and the maximum payoff to each given action. Instead of assuming total optimism or pessimism, Hurwitz incorporates a measure of both by assigning a certain percentage weight to optimism and the balance to pessimism. Using α and $1-\alpha$ as weights; α represents the index of pessimism and the alternative with the highest average selected. The index α reflects the decision maker's attitude towards risk taking.

H (Ai)=α (row maximum)+(1-α) (row minimum)-for positive-flow payoffs (profits, revenues).

H (Ai)=α (row minimum)+(1-α) (row maximum)-for negative-flow payoffs (costs, losses).

Criterion of regret (savage criterion): Minimax criterion examines the regret, opportunity cost or loss resulting when a particular situation occurs and the payoff of the selected alternative is smaller than the payoff that could have been attained with that particular situation. The regret corresponding to a particular payoff Xij is defined as Rij = Xj(max) – Xij; where Xj (max) is the maximum payoff attainable under the situation Sj.

This definition of regret allows the decision maker to transform the payoff matrix into a regret matrix [8].

Data collection and analysis data collection

Using data collection methods mentioned above, the following data were collected.

The variety of maize and its correspondence rain fall with its production volume for eight years average (Table 2).

Data analysis

This table shows the variety of maize and its correspondence rain fall with its production volume.

Laplace criterion or criterion of rationality: This also known as equal probabilities criterion or criterion of rationality; since the probability of states of nature is not known it is assumed that all states of nature occur with equal probability, i.e. assign an equal probability [9]. This method is summarizing as:

- Determine expected value for each alternative; if n denotes the number of events and p'
- 's' denote the payoffs, then expected value is given by
- 1/n(p1+p2+p3+…+pn)
- Choose the alternative that yields the maximum value of p. Sine n=6, then (E.V) BH546 50+40)=55.83 (E.V) PAC781 45+42)=53.67 (E.V) BH547 (E.V) galaxy 40+38)=52.5 (E.V) CPS.6 90+85)=62.17 (E.V) CPS.10 40+30)=52.5

Maxi max criterion or criterion of optimism: This criterion provides the decision maker with optimistic criterion. This method is summarizing as follow. Locate the maximum payoff values corresponding to each alternative (Table 3).

- Locate the minimum payoff values
- Corresponding to each alternative (or course of action or strategy), then Thus the maxi max payoff is 90 Select an alternative with maximum corresponding to the alternative payoff value [10].

Maxi min criterion or criterion of pessimism: This criterion provides the decision maker with pessimistic criterion. The working method is summarizing as follow (Table 4).

Thus, the Maxi min payoff is 42 corresponding to the alternative PAC781 and BH547.

Hurwitz criterion or criterion of realism: Also called weighted average criterion, it is a compromise between the maxi max (optimistic) and mini max(pessimism) decision maker to take in to account both maximum and minimum for each alternative and assign them weights according to his degree of optimism or pessimism [11]. This method is summarizing as follow:

- Choose an appropriate, α so that (1-)
- α) represents degree of pessimism
- Determine the maximum as well as the of each alternative and obtain :
- H=α*maximum+ (1- α)*minimum, for each alternative.
- Choose the alternative that yields the maximum value of H.
- We have to estimate the value of α is equal to 0.7 because when the manager of the institute told us averagely the ratio of their plan and their actual output is 100:70 respectively. So that we can conclude α value is equal to 0.7.

H (BH546) =0.7*70+.3*40=61

H (PAC781) =0.7*66+0.3*42=58.8 H (BH547) =0.7*78+0.3*42=67.2

H (galaxy) =0.7*70+0.3*40=61 H (CPS.6) =0.7*90+0.3*25=70.5

H (CPS.10) =0.7*68+0.3*40=59.6

Thus according Hurwitz criterion, the research center will choose alternative CPS.6.

Mini max criterion or minimum regret criterion: This criterion is also known as opportunity loss decision criterion or mini max regret criterion. This method is summarizing as follow:

Determine the amount of regret corresponding to each alternative for each state of nature. The regret for j^{th} event corresponding to i^{th} alternative is given by: i^{th} regret = (maximum payoff-i^{th} payoff) for j^{th} event.

- Determine the maximum regret amount for each alternative.
- Choose the alternative which corresponds to the minimum of the maximum regrets (Table 5).

The research center minimizes its regret to 35 by selecting BH547 (Table 6).

Table 2. Variety of maize and its correspondence rain fall with its production volume for eight years average.

	Annual rain fall in mm³					
Variety of Maize	<=500	500-600	600-800	800-1000	1000-1200	>=1200
BH546	55	70	65	55	50	40
PAC781	50	62	66	57	45	42
BH547	42	70	78	71	55	51
Galaxy	50	70	64	53	40	38
CPS.6	25	38	60	75	90	85
CPS.10	68	72	56	49	40	30

Table 3. Maxi min criterion or criterion of optimism.

Variety (in quintal)	State of natures (rain fall in mm³)						Maximum row
	<=500	500-600	600-800	800-1000	1000-1200	>=1200	
BH546	55	70	65	55	50	40	70
PAC781	50	62	66	57	45	42	66
BH547	42	70	78	71	55	51	78
Galaxy	50	70	64	53	40	38	70
CPS.6	25	38	60	75	90	85	90
CPS.10	68	72	56	49	40	30	68
Max	-	-	-	-	-	-	90

Table 4. Maxi min criterion or criterion of pessimism.

Variety (in quintal)	State of natures (rain fall in mm3)						Minimum row
	<=500	500-600	600-800	800-1000	1000-1200	1200	
BH546	55	70	65	55	50	40	40
PAC 781	50	62	66	57	45	42	42
BH547	42	70	78	71	55	51	42
Galaxy	50	70	64	53	40	38	40
CPS.6	25	38	60	75	90	85	25
CPS.10	68	72	56	49	40	30	40
Max	-	-	-	-	-	-	42

Table 5. Mini max criterion or minimum regret criterion.

Variety (in quintal)	State of natures (rain fall in mm3)						Maximum row
	<=500	500-600	600-800	800-1000	1000-1200	1200	
BH546	13	2	13	20	40	45	45
PAC 781	18	10	12	18	45	43	45
BH547	26	2	0	4	35	34	35
Galaxy	18	2	14	22	50	47	50
CPS.6	43	34	18	0	0	0	43
CPS.10	0	0	22	26	50	50	50
Minimum	-	-	-	-	-	-	35

Table 6. Summarized results of alternative decision making models.

Decision models	Analysis Selected alternatives	Aggregate value (Quintal per hectare)
Laplace criterion	CPS.6	62.17
Maxi max criterion	CPS.6	90
Maxi min criterion	PAC781, BH547	42,42 respectively
Hurwicz criterion	CPS.6	70.5
Regret criterion	BH547	35

To select the best strategy for maize variety production in Adet Wereda research center the aggregate value obtained in each maize variety production strategies is considered.

BH546=0

PAC781=42

BH547=42+35=77

Galaxy=0

CPS.6=62.17+90+70.5=222.67

CPS.10=0

From the above aggregate values the most profitable production of maize variety is CPS.6.

Therefore, this type of maize must be selected for the Adet Wereda research center to increase the production volume [12-15].

Conclusion

Decisions under uncertainty, the decision makers have to select one of stated alternative course of action with the extended information about their profitability, outcomes, and costs, earn financial results. This paper describes decision making process under uncertainty of rain fall variation with annul production volume of variety of maize in Adet Wereda. The decision making models under uncertainty are Laplace criterion, maxi max criterion, maxi min criterion, Hurwicz criterion and regret criterion were used and compared in the case study of production volume of maize variety. The analyses were made on annual production volume of average of eight years for each type of maize variety and evaluate each alternative. The alternative five (PCS.6) is recommended to cultivate in that area, where the research center should produce the PCS.6 type of maize to get maximum production volume annually.

References

1. Oram, Peter A. "Sensitivity of agricultural production to climatic change, an update." *Intern Sym Clim Variab Food Sec Deve Coun* 5 (1987).
2. Bert, Federico E., Emilio H. Satorre, Fernando Ruiz Toranzo and Guillermo P. Podestá. "Climatic information and decision-making in maize crop production systems of the Argentinean Pampas." *Agric Syst* 88 (2006): 180-204.
3. Podesta, Guillermo, David Letson, Carlos Messina and Fred Royce, et al. "Use of ENSO-related climate information in agricultural decision making in Argentina: A pilot experience." *Agric Syst* 74 (2002): 371-392.
4. Wen, Meilin and Kakuzo Iwamura. "Fuzzy facility location-allocation problem under the Hurwicz criterion." *Eur J Oper Res* 184 (2008): 627-635.
5. Harris, R. "Introduction to decision making, Virtual Salt." (1998).
6. Lopes, Ana Paula. "Decision making under uncertainty in viticulture: A case study of port wine." *Hyperion Econom J* 1 (2013): 3-12.
7. Dzotsi, K. A., B. Basso and J. W. Jones. "Parameter and uncertainty estimation for maize, peanut and cotton using the SALUS crop model." *Agric Syst* 135 (2015): 31-47.
8. Hoogenboom, Gerrit. "Contribution of agrometeorology to the simulation of crop production and its applications." *Agric For Meteorol* 103 (2000): 137-157.
9. Green, Michael and E. K. Weatherhead. "Coping with climate change uncertainty for adaptation planning: An improved criterion for decision making under uncertainty using UKCP09." *Clim Risk Manag* 1 (2014): 63-75.
10. Abraha, Amare Mesfin. "Analysis of Factors Affecting Proper Utilization of Water through Irrigation C ooperatives at Kolla Tembien Wereda, C entral Tigray, Ethiopia." PhD diss, Mekelle University (2008).
11. Niguse, Hagos. "Challenges and Prospects of Utilizing Irrigation Technologies: Survey of Ganta-Afeshum Woreda, Eastern Zone, Tigray, Ethiopia." (2014).
12. Kemal, Seifu, Endrias Geta and Berhanu Nega. "Determinants of Small Scale Irrigation Utilization by Smallholder Farmers: The C ase of Misrak Azernet Berbere Woreda, Southern Ethiopia."
13. Mahmud, Jemal. "Analysis of the Role of Cooperatives in Agricultural Input Output Marketing in Eastern Zone, Tigray Region." (2008).
14. Woldemariam, Alema. "Analysis of the role of cooperatives in agricultural input and output marketing in southern Zone of Tigray, Ethiopia." PhD diss., Mekelle University (2008).
15. Tedros, Tsehaye. "Contribution of Small Holders' Irrigation to Households Income and Food Security: A Case Study of Gum-selasa and Shilena Irrigation Schemes, Hintalowejerat, South-Estern Zone of Tigray, Ethiopia." PhD diss. (2014).

How to cite this article: Yemane, Aregawi, Alehegn Melesse, Ephrem Gidey and Amare Matebu. "Decision Making Under Uncertainty in Production of Crop Case Study: Maize Crop Production at Adet Werda." *J Phylogenetics Evol Biol* 10 (2022): 254.