

## Chapter 7

### COMPARATIVE ANALYSIS OF MCDM TOOLS-FOR SELECTION OF OPTIMAL CROP COMBINATION

The chapter overviews the traditional and novel MCDM techniques to select an optimal crop combination based on the defined set of criteria in decision space. Ten different MCDM techniques were compared to determine an optimal crop combination. 24 alternatives and 8 criteria are defined in decision space for the evaluation.

#### 7.1 Introduction

Approximately 43% of the total available land is under cultivation in a country. For decades, basic food crops were cultivated to feed the country. Modifications in the farm operational activities to meet the needs of the growing population is needed to be adopted by the growers to increase and improve the crop yield. Thus, for current farm practice quality crop, high production is what is needed to get an optimized farm return. To fulfil all these purposes the most crucial and significant parameter is the selection of crop or a crop combination based on the physical, environmental and market conditions of a region.

Furthermore, large number of interrelated parameters pose a challenge to sustainable growth of a sector. Dependency of around 70% of the population (FAO, 2020) on agriculture for their livelihood and the challenges faced by the sector due to varying parameters motivates researchers, statisticians, mathematicians and environmentalists to evaluate the correlation among the factors and provide an optimized results to generate more revenue. However, researchers argue that to evaluate the decisions on crop combination single criterion cannot be considered rather more criterion is needed to estimate the appropriate crop combination for a particular region as there are multifarious parameters that impact the sector. Thus, (Goodridge, 2017; Gowda & Jayaramaiah, 1998; Joerin et al., 2001; Quaddus & Siddique, 2001; Qureshi et al., 2018; Ullah & Mansourian, 2016) employ MCDM techniques.

To evaluate the results of multi-objective systems, hybrid MCDM techniques such as Fuzzy-AHP, GIS, Fuzzy-TOPSIS had been developed. MCDM techniques most often used in engineering however, there are only few researchers that apply hybrid MCDM techniques in agriculture sector to determine the optimality of decision variables.

Some of the most popular MCDM techniques reviewed in literature were listed in Table 7.1. Though there are many other techniques available in literature but these are some which is most often applied by researchers to obtain the optimality of decision-making issues. The decision maker has to evaluate the most appropriate MCDM technique that best defines the problem solution. Hence, for making decision by adopting MCDM technique there are numerous methods to assign weights to the attributes such as: Direct Ranking, Delphi method, Point Allocation, Ratio Method, Entropy Method, Standard Deviation method and so on. We apply Standard Deviation method to assign weights to an attribute.

**Table 7.1:** MCDM Techniques

Techniques		Literature
AHP	Analytic Hierarchy Process	(Montazar & Gaffari, 2012) apply AHP to determine the optimal crop pattern
ANP	Analytic Network Process	(Seyedmohammadi et al., 2019) to evaluate the land suitability to maximize the crop yield.
ELECTRE	Elimination and Choice Translating Reality	(Sadeghiravesh et al., 2014) to identify the optimal alternative by considering the system's complexity.
GP	Goal Programming	For optimal allocation of land and water resources by selecting an optimal crop pattern (Vivekanandan et al., 2009) employed GP.
MACBETH	Measuring Attractiveness by a Categorical Based Evaluation Technique	-
MAUT	Multi-Attribute Utility Theory	(Belton & Stewart, 2002) use MCDM technique for optimal land use allocation.
MAVT	Multi-Attribute Value Theory	(Dooley, 2005) apply MAVT to evaluate 3 alternatives under consideration.
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation	(Agha et al., 2012) use AHP and PROMTHERE approach to rank the crop son

		the basis of the criteria selected in a decision space.
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution	A TOPSIS method is applied (Indahingwati et al., 2018) to determine the for-fertilizer selection
WSM	Weighted Sum Model	(Kolios et al., 2016) a comparative analysis had been carried out under stochastic conditions.

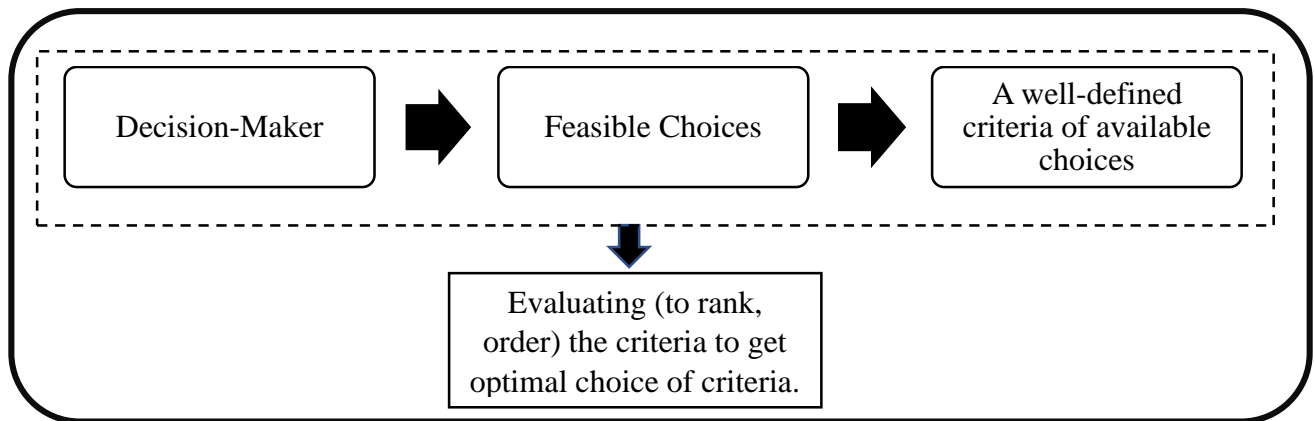
## 7.2 Illustration of MCDM Techniques

To develop decision-making tool to support the farmer in selecting the optimal crop combination 12 criteria and 8 alternatives were discussed in Chapter 6. The results obtained were compared with Fuzzy-TOPSIS evaluated by (Qureshi et al., 2018). The crops that were cultivated in Rabi season in Rajasthan were considered. The first step to evaluate the alternatives on the basis of the defined criterion in the decision space is to develop a decision matrix.

In chapter-3 we evaluate the optimal crop combination by using Multi Objective Linear Programming approach and analyse the effect of one crop over the other by using operations research tools and statistical analysis. In this chapter we will discuss different MCDM techniques to determine an optimal crop combination and compare the results.

Optimization models using Linear Programming (LP) technique had been extensively used to determine the crop pattern (Ahmad et al., 2018; Filippi et al., 2017c). Dynamic Programming is popularly used for the allocation of irrigation water (A. Singh, 2012). Dynamic model adds a non-linearity to the model. Because of the system complexity the use of Non-Linear Programming in agriculture is limited (Georgiou & Papamichail, 2008b; Giménez et al., 2016; A. Singh, 2014). From the literature it can be concluded that all the optimization model developed is limited with the set of constraints such as crop production, cost factor, land availability and many more that defines the solution feasibility. MCDM helps to evaluate the criteria that is difficult to represent in the form of mathematical equation.

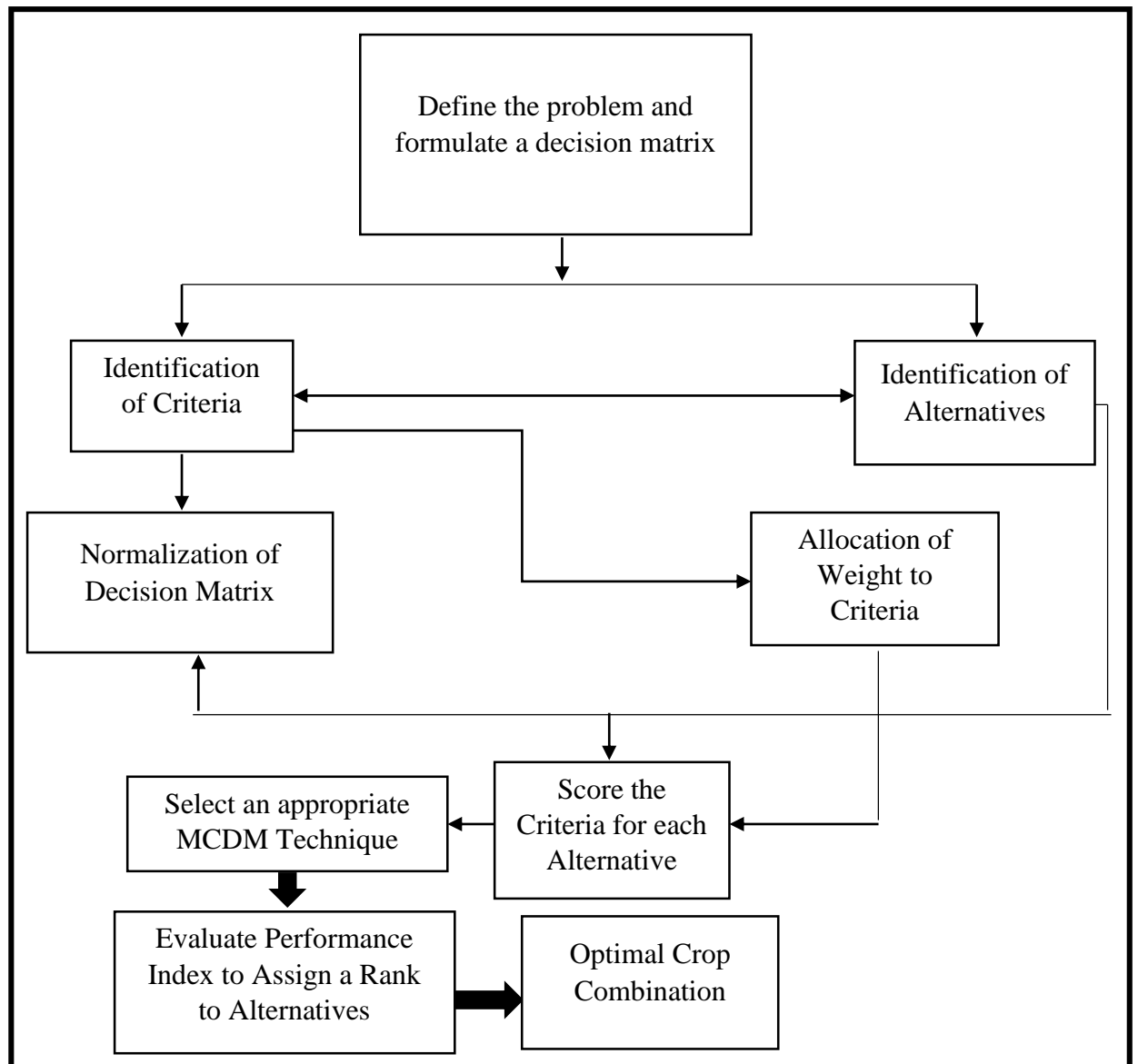
From the literature reviewed two types of decision-making situations are identified: first one deals with single objective and another one deals with considering several decision alternatives simultaneously. Most of researchers argued that in reality the situations are much more complex and thus, there is a need to consider more than one objective under consideration (Mousavi et al., 2013; Raju et al., 2001).



**Fig. 7.1:** Traditional Paradigm Decision-Making

Thus, to achieve an optimality of the solution, decision-making model plays a significant role. Therefore, a need to develop a mathematical model to select an optimal crop pattern emerges. A mathematical model is developed for Rajasthan scenario. The state being owned with arid topographical features, with erratic rainfall pattern supports diversified variety of cultivation particularly in Rabi season.

To determine a feasibility region and to evaluate all the possible alternatives that can be adopted by the farmers ten different MCDM techniques were employed. MCDM technique can evaluate both dimensional and non-dimensional criteria. In this chapter we discussed the different crop combination preference, and then a comparative analysis of different tools is carried out.



**Fig. 7.2:** The Systematic MCDM Process

Multi-Objective Optimization by Ratio Analysis (MOORA), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Grey Relational Analysis (GRA), Evaluation based on Distance from Average Solution (EDAS), Weighted Sum Model (WSM), Weighted Product Model (WPM), Weighted Aggregated Sum Product Assessment (WASPA), Complex Proportional Assessment (COPRAS), Preference Selection Index (PSI), Additive Ratio Assessment (ARAS), were compared to determine the optimal crop combination. The results of the MCDM techniques are illustrated in following sections. Standard deviation method is applied to assign a weight to an attribute.

### 7.3 Standard Deviation Method

The weights associated with each criterion were evaluated by standard deviation method. Standardization is carried out to transform the different units into a same common measurable unit in order to improve the optimal results by comparing the weights.

$$x'_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad 1 \leq j \leq n \quad (7.1)$$

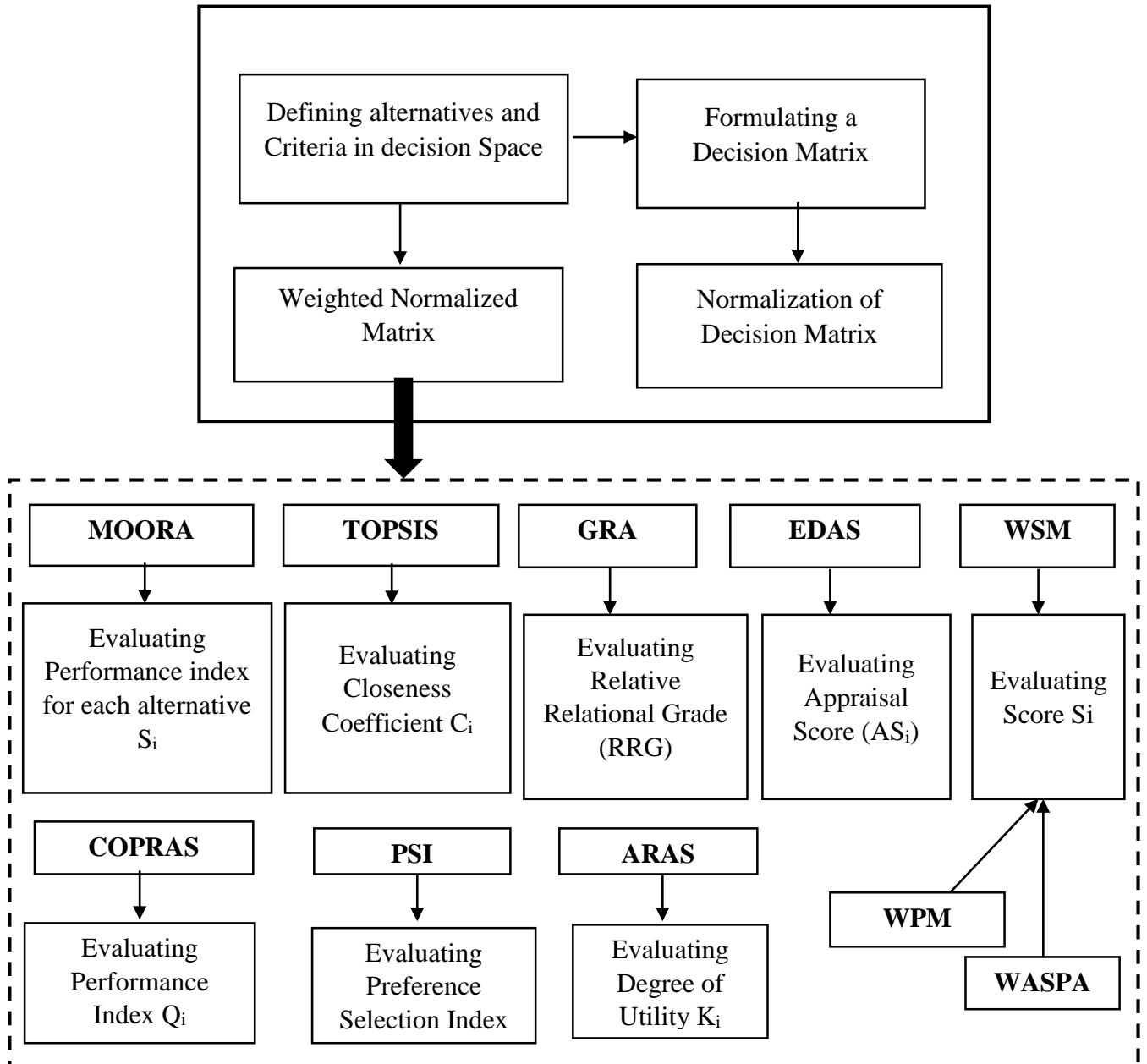
$N$  is the matrix after normalization  $\max x_{ij}$  and  $\min x_{ij}$  is the maximum and minimum value of the decision criteria of evaluation  $j$ . The values of all the criteria after normalization must lie between 0 and 1. The standard deviation of each value is calculated as follows:

$$SDV_j = \frac{\sqrt{(x_{ij} - x''_{ij})^2}}{\sqrt{m}} \quad (7.2)$$

$m$  is the number of alternatives available in a system and  $x''_{ij}$  denotes mean value of the normalised criterion. After we get normalised matrix, next is to evaluate the weight.

$$W_j = \frac{SDV_j}{\sum_{j=1}^n SDV_j} \quad (7.3)$$

Once the weights are assigned to the criterion the alternatives are ranked by using different MCDM techniques such as WSM, WPM, GRA, TOPSIS, MOORA and so on. Table 7.1 indicates the weights assigned to different attributes in decision space.



**Fig. 7.3:** MCDM Techniques Applied for Analysis

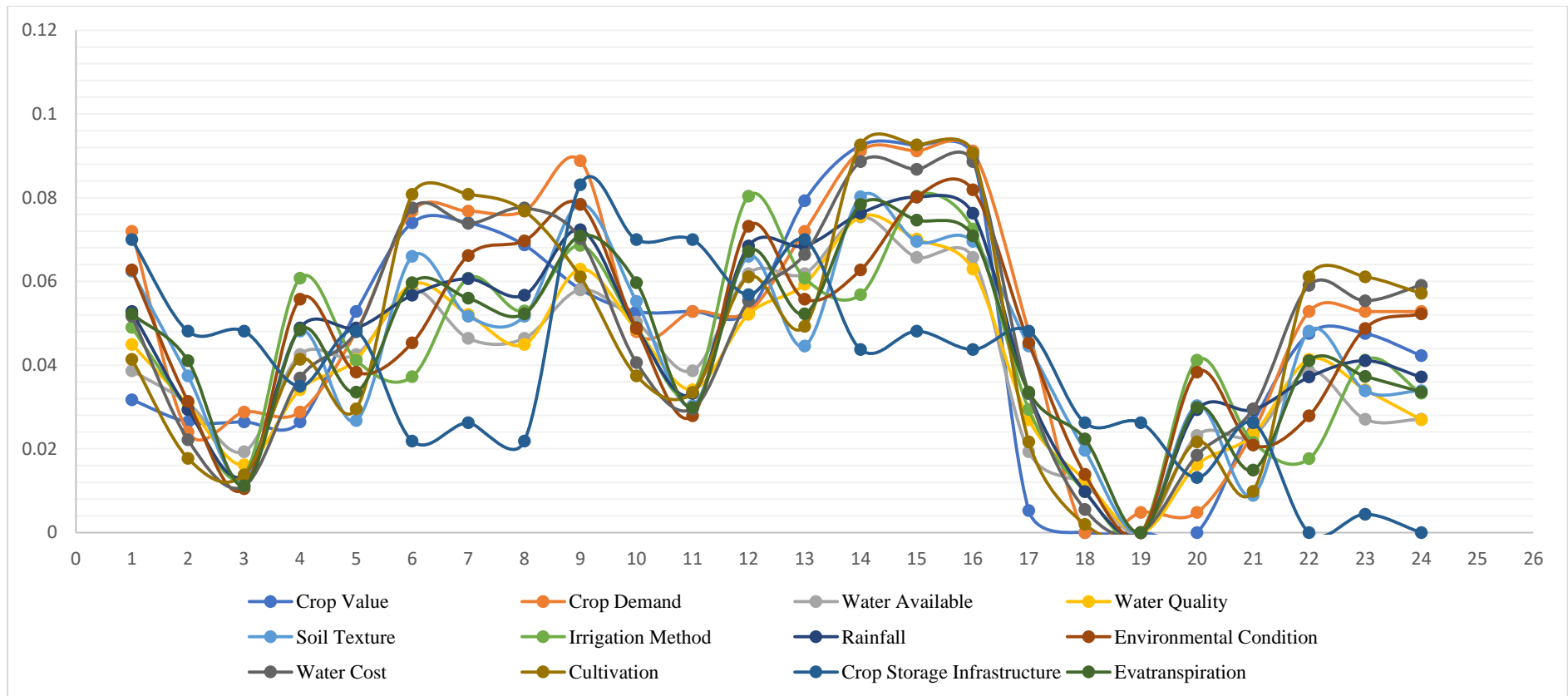
**Table 7.2:** Mean Evaluation Values (design/decision matrix)

Alternatives	Crop Value	Crop Demand	Water Available	Water Quality	Soil Texture	Irrigation Method	Rainfall	Environmental Condition	Water Cost	Cultivation	Crop Storage Infrastructure	Evatranspiration
C1	5	8.2	5.4	5.8	7.4	5.4	5.8	7.4	5.8	4.6	8.6	5.8
C2	4.6	4.2	4.6	4.2	4.6	3.4	3.4	3.8	2.6	2.2	6.6	4.6
C3	4.6	4.6	3.4	2.6	1.8	1.8	1.8	1.4	1.4	1.8	6.6	1.4
C4	4.6	4.6	5.8	4.6	5.8	6.6	5.4	6.6	4.2	4.6	5.4	5.4
C5	6.6	6.2	5.8	5.4	3.4	4.6	5.4	4.6	5.4	3.4	6.6	3.8
C6	8.2	8.6	7.4	7.4	7.8	4.2	6.2	5.4	8.6	8.6	4.2	6.6
C7	8.2	8.6	6.2	6.6	6.2	6.6	6.6	7.8	8.2	8.6	4.6	6.2
C8	7.8	8.6	6.2	5.8	6.2	5.8	6.2	8.2	8.6	8.2	4.2	5.8
C9	7	9.6	7.4	7.8	9.2	7.4	7.8	9.2	7.8	6.6	9.8	7.8
C10	6.6	6.2	6.6	6.2	6.6	5.4	5.4	5.8	4.6	4.2	8.6	6.6
C11	6.6	6.6	5.4	4.6	3.8	3.8	3.8	3.4	3.4	3.8	8.6	3.4
C12	6.6	6.6	7.8	6.6	7.8	8.6	7.4	8.6	6.2	6.6	7.4	7.4
C13	8.6	8.2	7.8	7.4	5.4	6.6	7.4	6.6	7.4	5.4	8.6	5.8
C14	9.6	9.8	9.2	9.2	9.4	6.2	8.2	7.4	9.8	9.8	6.2	8.6
C15	9.6	9.8	8.2	8.6	8.2	8.6	8.6	9.4	9.6	9.8	6.6	8.2
C16	9.4	9.8	8.2	7.8	8.2	7.8	8.2	9.6	9.8	9.6	6.2	7.8
C17	3	6.2	3.4	3.8	5.4	3.4	3.8	5.4	3.8	2.6	6.6	3.8
C18	2.6	2.2	2.6	2.2	2.6	1.4	1.4	1.8	0.8	0.6	4.6	2.6
C19	2.6	2.6	1.4	0.8	0.4	0.4	0.4	0.2	0.2	0.4	4.6	0.2
C20	2.6	2.6	3.8	2.6	3.8	4.6	3.4	4.6	2.2	2.6	3.4	3.4
C21	4.6	4.2	3.8	3.4	1.4	2.6	3.4	2.6	3.4	1.4	4.6	1.8
C22	6.2	6.6	5.4	5.4	5.8	2.2	4.2	3.4	6.6	6.6	2.2	4.6
C23	6.2	6.6	4.2	4.6	4.2	4.6	4.6	5.8	6.2	6.6	2.6	4.2
C24	5.8	6.6	4.2	3.8	4.2	3.8	4.2	6.2	6.6	6.2	2.2	3.8
	B	B	B	B	B	B	B	B	NB	NB	NB	NB

B\*: Beneficiary-Criteria; NB\*: Non-Beneficiary-Criteria

**Table 7.3:** Weighted Normalised Mean Values of the Attributes

Alternatives	Crop Value	Crop Demand	Water Available	Water Quality	Soil Texture	Irrigation Method	Rainfall	Environmental Condition	Water Cost	Cultivation	Crop Storage Infrastructure	Evatranspiration
C1	0.031706	0.071998	0.038664	0.044948	0.062401	0.049017	0.052801	0.062729	0.051697	0.04139	0.069967	0.052255
C2	0.026422	0.023999	0.030931	0.030565	0.03744	0.02941	0.029334	0.031365	0.022156	0.017739	0.048102	0.041057
C3	0.026422	0.028799	0.019332	0.016181	0.01248	0.013725	0.013689	0.010455	0.011078	0.013797	0.048102	0.011197
C4	0.026422	0.028799	0.04253	0.034161	0.048138	0.060781	0.04889	0.055759	0.036926	0.04139	0.034983	0.048522
C5	0.052843	0.047999	0.04253	0.041352	0.026743	0.041174	0.04889	0.038334	0.048004	0.029564	0.048102	0.033592
C6	0.073981	0.076798	0.057995	0.059332	0.065966	0.037253	0.056713	0.045304	0.077545	0.080809	0.021865	0.05972
C7	0.073981	0.076798	0.046396	0.05214	0.051703	0.060781	0.060624	0.066214	0.073852	0.080809	0.026237	0.055987
C8	0.068697	0.076798	0.046396	0.044948	0.051703	0.052939	0.056713	0.069699	0.077545	0.076867	0.021865	0.052255
C9	0.058128	0.088798	0.057995	0.062928	0.078446	0.068624	0.072358	0.078411	0.07016	0.061099	0.083085	0.070917
C10	0.052843	0.047999	0.050263	0.048544	0.055269	0.049017	0.04889	0.048789	0.040619	0.037448	0.069967	0.05972
C11	0.052843	0.052799	0.038664	0.034161	0.030309	0.033332	0.033245	0.02788	0.029541	0.033506	0.069967	0.02986
C12	0.052843	0.052799	0.061862	0.05214	0.065966	0.080388	0.068446	0.073184	0.055389	0.061099	0.056848	0.067185
C13	0.079265	0.071998	0.061862	0.059332	0.044572	0.060781	0.068446	0.055759	0.066467	0.049274	0.069967	0.052255
C14	0.092476	0.091198	0.075394	0.075513	0.080229	0.05686	0.076269	0.062729	0.088623	0.092634	0.043729	0.078382
C15	0.092476	0.091198	0.065728	0.070119	0.069532	0.080388	0.08018	0.080154	0.086777	0.092634	0.048102	0.07465
C16	0.089834	0.091198	0.065728	0.062928	0.069532	0.072546	0.076269	0.081896	0.088623	0.090663	0.043729	0.070917
C17	0.005284	0.047999	0.019332	0.026969	0.044572	0.02941	0.033245	0.045304	0.033234	0.02168	0.048102	0.033592
C18	0	0	0.011599	0.012586	0.019612	0.009803	0.009778	0.01394	0.005539	0.001971	0.026237	0.022395
C19	0	0.0048	0	0	0	0	0	0	0	0	0.026237	0
C20	0	0.0048	0.023198	0.016181	0.030309	0.041174	0.029334	0.038334	0.018463	0.02168	0.013119	0.02986
C21	0.026422	0.023999	0.023198	0.023373	0.008914	0.021568	0.029334	0.02091	0.029541	0.009855	0.026237	0.01493
C22	0.047559	0.052799	0.038664	0.041352	0.048138	0.017646	0.037157	0.02788	0.059082	0.061099	0	0.041057
C23	0.047559	0.052799	0.027064	0.034161	0.033875	0.041174	0.041068	0.048789	0.055389	0.061099	0.004373	0.037325
C24	0.042275	0.052799	0.027064	0.026969	0.033875	0.033332	0.037157	0.052274	0.059082	0.057157	0	0.033592
	B	B	B	B	B	B	B	B	NB	NB	NB	NB



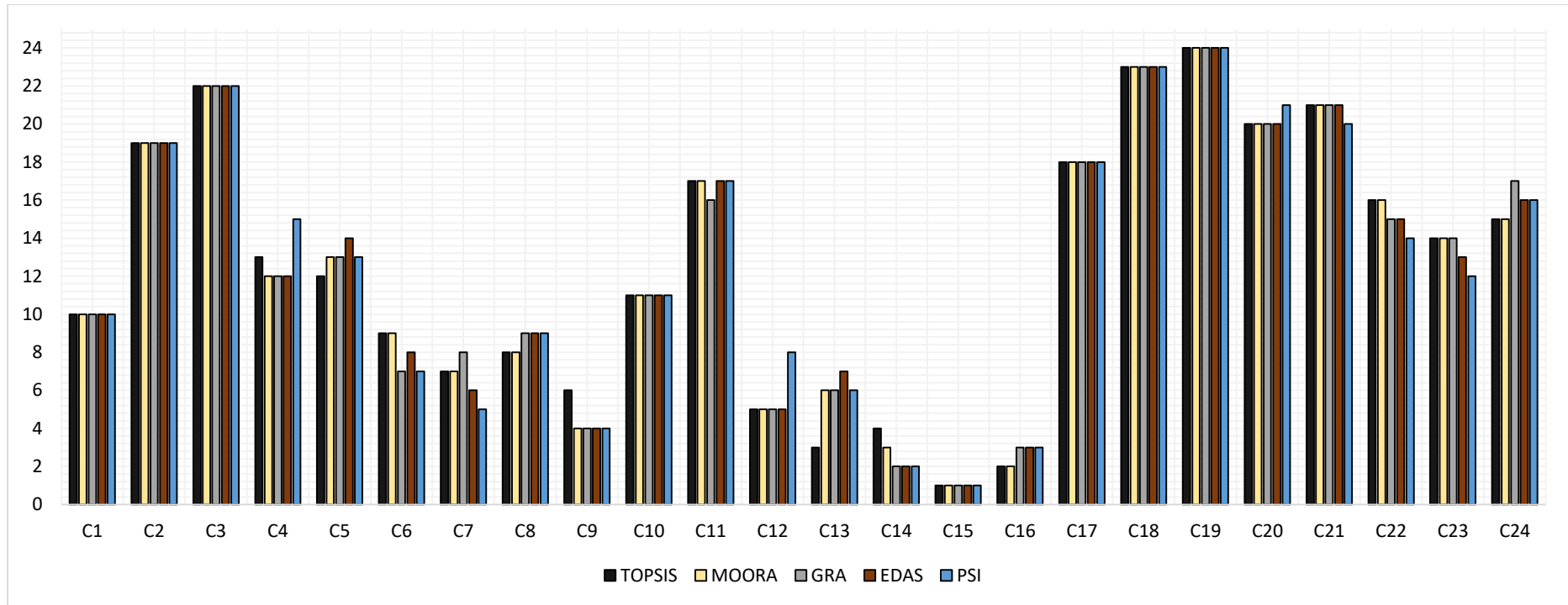
**Fig. 7.4:** Weighted Normalise Value of the Attributes

Fig. 7.4 represents the weighted normalized values assign to an attribute. Preferences were allotted to criteria on the basis of weights assigned. The main purpose of assigning weights is to avoid the misuse of MCDM techniques by allocating cardinal values to each attribute. If weights were not assigned to the attributes then all the attributes were treated same which is not true in case of real scenario. Thus, the first step in MCDM techniques is assigning weights to criteria. The decision matrix contains both beneficiary as well as non-beneficiary variables.

**Table 7.4: TOPSIS, MOORA, GRA, EDAS and PSI Results and Rank**

Alternatives	TOPSIS		MOORA		GRA		EDAS		PSI	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
C1	0.535302	10	0.198957	10	0.592037	10	0.615429	10	0.61855	10
C2	0.460917	19	0.110413	19	0.448478	19	0.332277	19	0.349409	19
C3	0.430895	22	0.056909	22	0.396539	22	0.182167	22	0.228107	22
C4	0.520677	13	0.183658	12	0.517708	12	0.490408	12	0.484286	15
C5	0.524081	12	0.180604	13	0.503903	13	0.454986	14	0.495884	13
C6	0.554769	9	0.233405	9	0.659642	7	0.726852	8	0.726403	7
C7	0.57132	7	0.251752	7	0.659508	8	0.741896	6	0.741857	5
C8	0.56314	8	0.239362	8	0.639033	9	0.706501	9	0.714921	9
C9	0.578319	6	0.280427	4	0.799011	4	0.89101	4	0.838894	4
C10	0.533168	11	0.193862	11	0.575142	11	0.586362	11	0.590774	11
C11	0.488722	17	0.140359	17	0.494817	16	0.418993	17	0.469473	17
C12	0.580539	5	0.267108	5	0.693976	5	0.773533	5	0.725652	8
C13	0.584568	3	0.264054	6	0.6705	6	0.736483	7	0.73725	6
C14	0.581832	4	0.3073	3	0.894713	2	0.973647	2	0.919778	2

C15	0.593104	1	0.327613	1	0.902956	1	1	1	0.939751	1
C16	0.590757	2	0.315998	2	0.861823	3	0.96385	3	0.915175	3
C17	0.465468	18	0.115508	18	0.458964	18	0.355494	18	0.377184	18
C18	0.416252	23	0.021175	23	0.369411	23	0.106944	23	0.115549	23
C19	0.408584	24	-0.02144	24	0.341751	24	0	24	0.03188	24
C20	0.456181	20	0.100209	20	0.413796	20	0.248083	20	0.24292	21
C21	0.455901	21	0.097155	21	0.404606	21	0.220012	21	0.254518	20
C22	0.492432	16	0.149955	16	0.49847	15	0.446824	15	0.485037	14
C23	0.509674	14	0.168303	14	0.499581	14	0.458919	13	0.500491	12
C24	0.498845	15	0.155913	15	0.487622	17	0.43205	16	0.473555	16



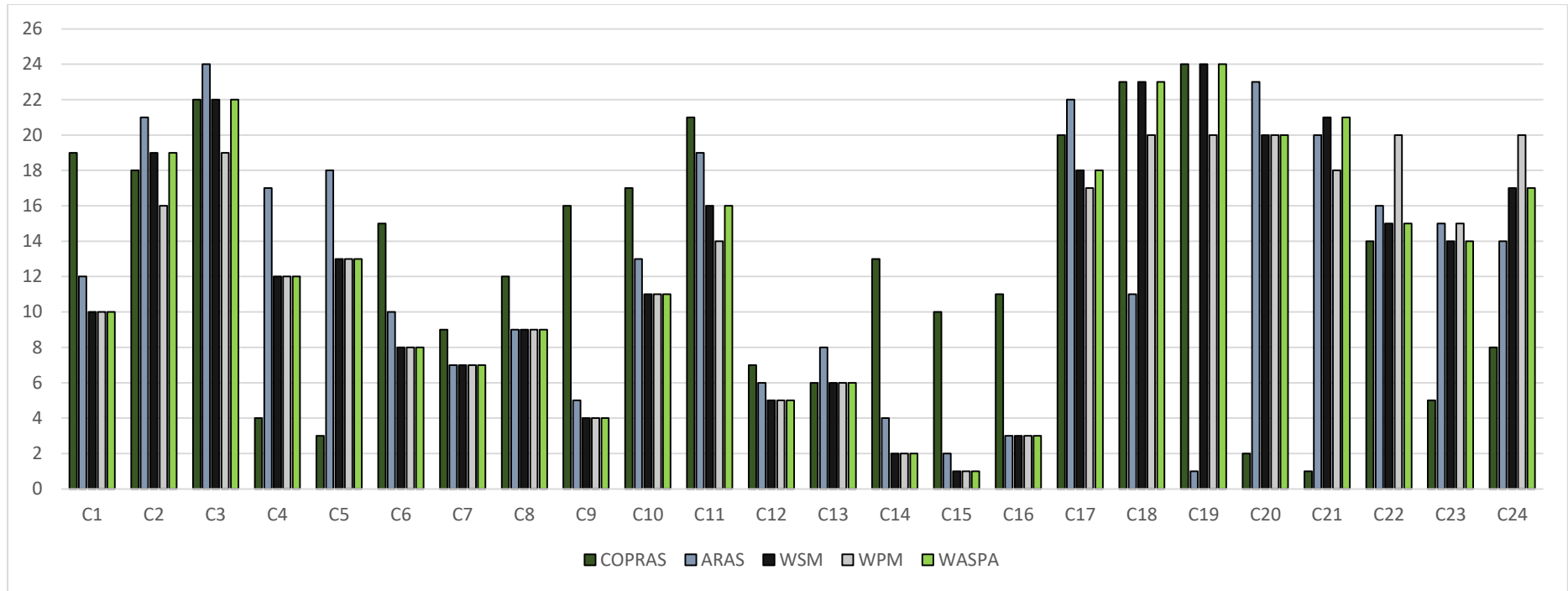
**Fig. 7.5:** Comparative Analysis of MCDM Techniques

MOORA, TOPSIS and GRA (Fig. 7.5) provides approximately the same results for the combination of crop preferred. Hence, it can be concluded that these are the most appropriate techniques for the criteria and the alternatives under consideration. However, it is difficult to judge the appropriate model for the analysis as it completely depends on the decision matrix or the criteria chosen by the decision-makers for evaluation.

**Table 7.5: COPRAS, ARAS, WSM, WPM and WASPA results and rank**

Alternatives	COPRAS		ARAS		WSM		WPM		WASPA	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
C1	0.808143	19	0.281038	12	0.629573	10	3.14418E-16	10	0.314786	10
C2	0.813257	18	0.228946	21	0.36852	19	4.71397E-19	16	0.18426	19
C3	0.785186	22	0.219381	24	0.225257	22	4.8036E-22	19	0.112629	22
C4	0.907354	4	0.264657	17	0.507302	12	2.28765E-17	12	0.253651	12
C5	0.908012	3	0.255265	18	0.49913	13	2.11115E-17	13	0.249565	13
C6	0.822444	15	0.308148	10	0.713281	8	1.01002E-15	8	0.35664	8
C7	0.858546	9	0.315651	7	0.725524	7	1.52E-15	7	0.362762	7
C8	0.854076	12	0.308893	9	0.696424	9	8.10664E-16	9	0.348212	9
C9	0.819642	16	0.342344	5	0.85095	4	1.45324E-14	4	0.425475	4
C10	0.81348	17	0.276116	13	0.609368	11	2.54184E-16	11	0.304684	11
C11	0.799034	21	0.235558	19	0.466106	16	7.13537E-18	14	0.233053	16
C12	0.876757	7	0.324237	6	0.74815	5	3.08985E-15	5	0.374075	5
C13	0.876869	6	0.31353	8	0.739978	6	2.59329E-15	6	0.369989	6
C14	0.829287	13	0.360903	4	0.914037	2	2.94874E-14	2	0.457019	2

C15	0.857575	10	0.371276	2	0.931939	1	4.03031E-14	1	0.465969	1
C16	0.854917	11	0.362902	3	0.903863	3	2.66027E-14	3	0.451932	3
C17	0.804858	20	0.228311	22	0.388724	18	3.03977E-19	17	0.194362	18
C18	0.728586	23	0.28462	11	0.13346	23	0	20	0.06673	23
C19	0.467265	24	0.661231	1	0.031037	24	0	20	0.015519	24
C20	0.995887	2	0.227774	23	0.266453	20	0	20	0.133227	20
C21	1	1	0.231648	20	0.258281	21	4.62377E-21	18	0.129141	21
C22	0.826641	14	0.266581	16	0.472433	15	0	20	0.236216	15
C23	0.880785	5	0.268457	15	0.484676	14	3.58381E-18	15	0.242338	14
C24	0.875207	8	0.268619	14	0.455576	17	0	20	0.227788	17



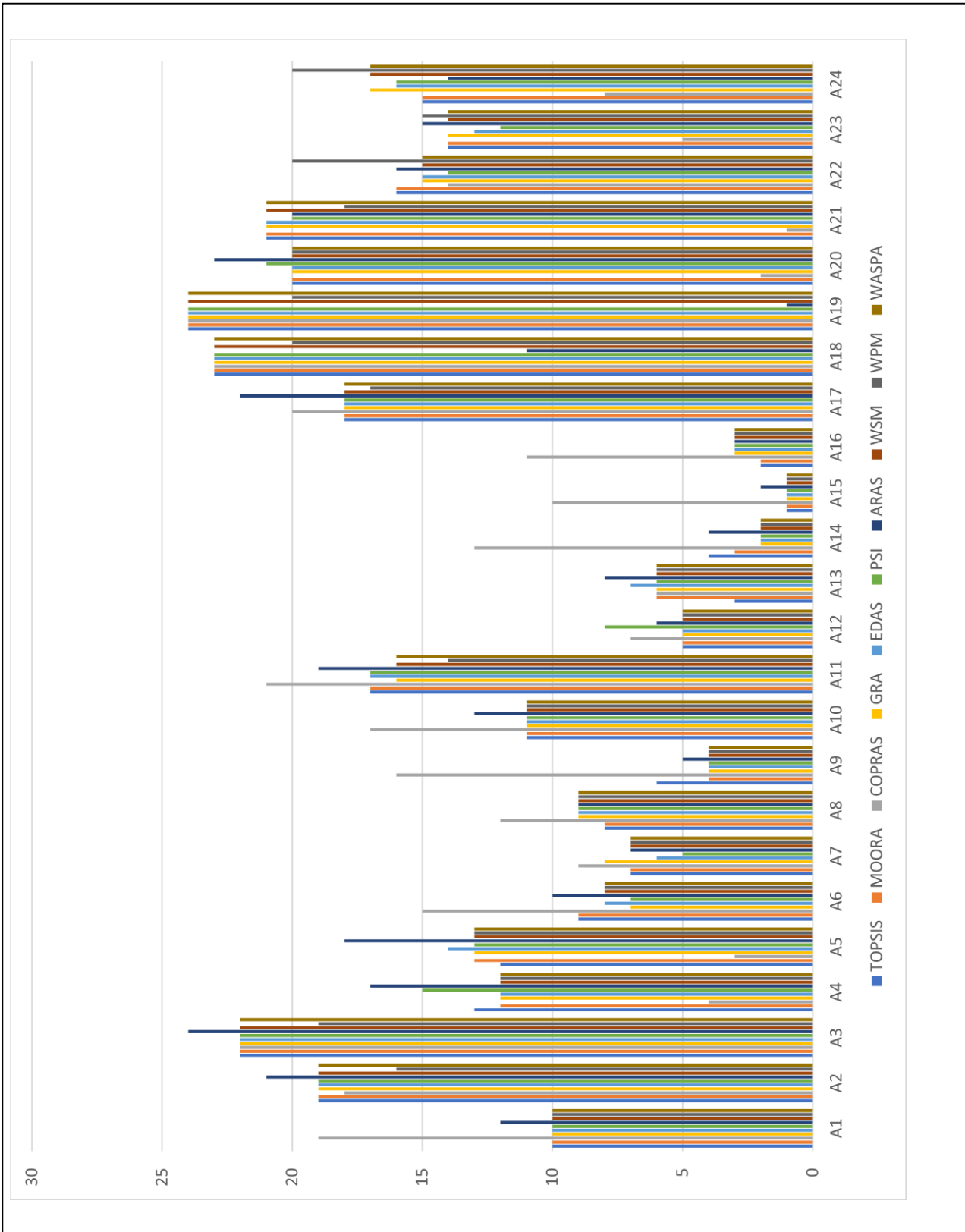
**Fig. 7.6:** Comparative Analysis of MCDM Techniques

COPRAS and ARAS shows (Fig. 7.6) a wide variation in the selection of crop combinations as compared to the other MCDM techniques. For the combinations C1, C4, C5, C6, C7, C8, C9, C10, C14, C15, C16, C20, C21, C23, and C24 the difference in the crop preference is observed. These variations in COPRAS are due to the high score measures. However, the other techniques show approximately the same results or the crop preferences/ranking. The results indicate that the crop combination C15 based on the defined criteria in decision space is the preferred crop combination. For MCDM model we employed a set of eight crops that were cultivated in Rabi season in Rajasthan. However, for Multi-Objective Linear Programming approach a set of four crops were considered. This is so because rest of the crops considered for evaluating MCDM techniques were cultivated in region though, in small quantity will not provide significant contribution in obtaining a feasible region.

Comparative analysis of techniques (Table 7.6) indicates that MOORA, TOPSIS, GRA, EDAS, PSI, WPM, WSM, WASPA were considering C15 as a best optimal crop combination.

**Table 7.6:** Comparison of MCDM Technique

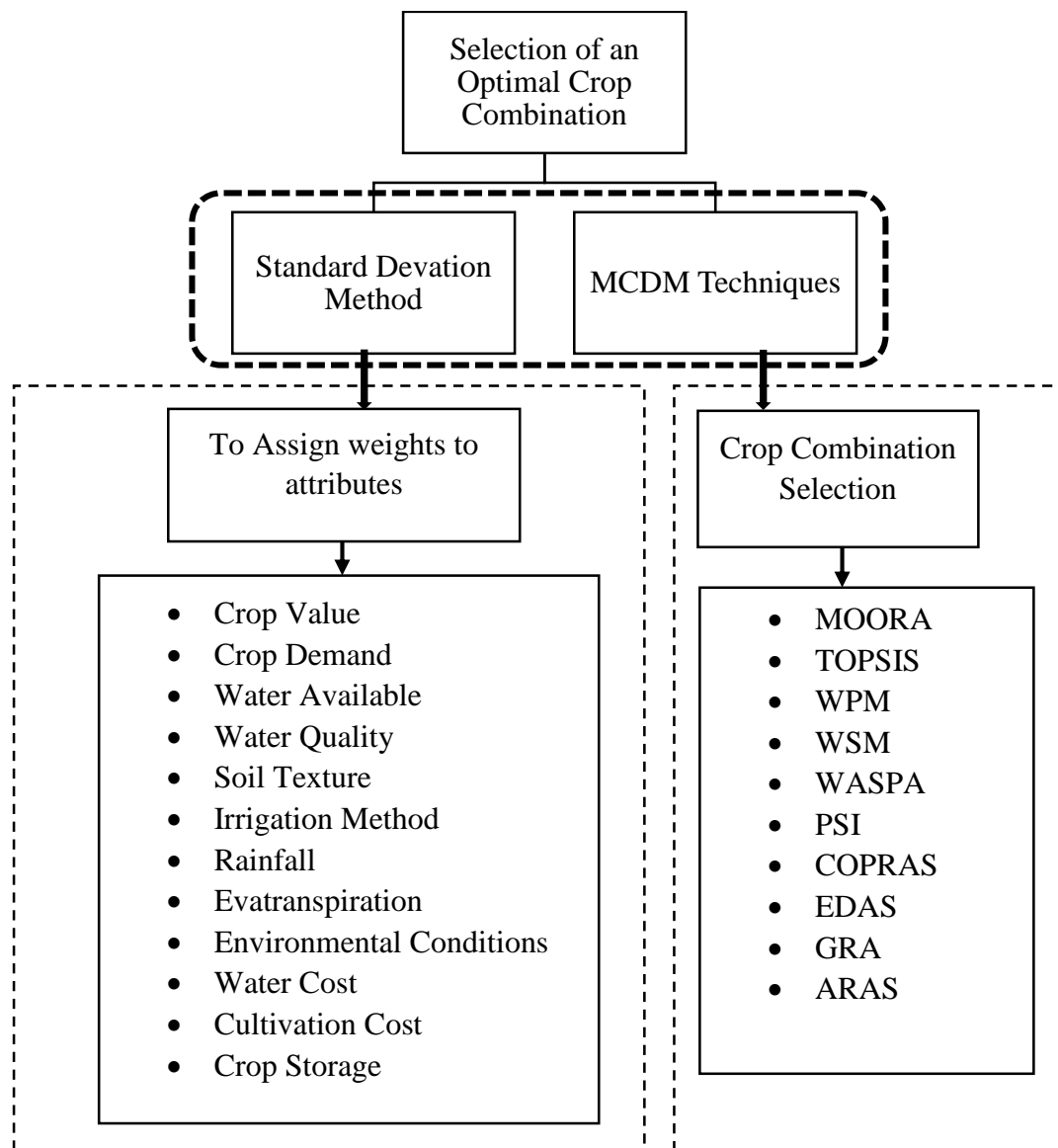
Alternatives	TOPSIS	MOORA	COPRAS	GRA	EDAS	PSI	ARAS	WSM	WPM	WASPA
C1	10	10	19	10	10	10	12	10	10	10
C2	19	19	18	19	19	19	21	19	16	19
C3	22	22	22	22	22	22	24	22	19	22
C4	13	12	4	12	12	15	17	12	12	12
C5	12	13	3	13	14	13	18	13	13	13
C6	9	9	15	7	8	7	10	8	8	8
C7	7	7	9	8	6	5	7	7	7	7
C8	8	8	12	9	9	9	9	9	9	9
C9	6	4	16	4	4	4	5	4	4	4
C10	11	11	17	11	11	11	13	11	11	11
C11	17	17	21	16	17	17	19	16	14	16
C12	5	5	7	5	5	8	6	5	5	5
C13	3	6	6	6	7	6	8	6	6	6
C14	4	3	13	2	2	2	4	2	2	2
C15	1	1	10	1	1	1	2	1	1	1
C16	2	2	11	3	3	3	3	3	3	3
C17	18	18	20	18	18	18	22	18	17	18
C18	23	23	23	23	23	23	11	23	20	23
C19	24	24	24	24	24	24	1	24	20	24
C20	20	20	2	20	20	21	23	20	20	20
C21	21	21	1	21	21	20	20	21	18	21
C22	16	16	14	15	15	14	16	15	20	15
C23	14	14	5	14	13	12	15	14	15	14
C24	15	15	8	17	16	16	14	17	20	17



**Fig. 7.7:** Comparison of MCDM techniques

## 7.4 Conclusion

The results of the mathematical techniques indicate that the MCDM techniques adopted provides approximately the same crop combination as practiced by the growers to optimize the farm revenue. However, the crop preference by applying Multi Objective Linear Programming approach is quite different from that of MCDM technique. Cost coefficient in case of MOLP model and the weights assigned to the attributes in decision space in MCDM formulation causes a variation in results. In MOLP the crop cultivated as minor crop did not contribute significantly in optimality. The MCDM techniques often misled decision makers resulting in inappropriate selection of MCDM techniques.



**Fig. 7.8:** MCDM Technique for Optimal Crop Combination Selection

The authors do not suggest the preference of one MCDM over the other, but one MCDM technique will provide a robust outcome than other (Haddad & Sanders, 2018). This is so because of the requirement vector, that defines an upper and lower bound to a defined set of constraints and provide with a range of allowable increase or decrease of activity coefficient. However, in MCDM techniques there is no such restrictions or bounds imposed by MCDM tools on decision alternatives and criteria.

The MOLP results (Chapter 3) illustrates that in rabi season the crop set (mustard-wheat-barley) is preferred crop combination under a defined set of constraints on other hand, MCDM techniques show that C15 (wheat-mustard) is the preferred crop combination. The variation in results is due to the variation in the defined set of parameters in decision space.