A Linguistic MCDM Framework for Sustainable Agriculture Design

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Abstract

In the direction of being sustainable, agriculture must satisfy the necessities of present and future generations while guaranteeing expediency, ecological health, and social and economic equity. Therefore, concerning only the environmental or the economic aspect of the agricultural development is not enough to satisfy the issues stated above. The social, economic, and environmental aspects of the agricultural transition are crucial. One cannot be separated from others. So, planning and evaluating the current situation in agriculture is essential for reaching a well-designed strategy for sustainable agriculture (SA). The inclusion of stakeholders, collaborative working of governments, municipalities, and practitioners are complete resolutions to create shared knowledge and awareness. Starting from this point of view, this paper suggests group decision-making (GDM) based design framework SA. For this purpose, the Axiomatic Design (AD) technique is provided. To create a flexible environment for decision-makers (DMs) and simplify the computations, the AD technique is integrated with a 2-tuple linguistic model. The 2-tuple model facilitates the interpretation of the assessments by providing linguistic outputs. A case study is presented to test the applicability of the suggested methodology, and the results and analysis are provided followingly.

Keywords: Sustainable agriculture, sustainable design, MCDM, Axiomatic Design, 2-Tuple linguistic model

I. INTRODUCTION

In 2015, United Nations generated an agenda covering seventeen different goals as the 2030 Sustainable Development Goals (SDGs). Zero hunger (goal 1), clean water (goal 6), sustainable cities and communities (goal 11), responsible consumption and production (goal 12), and climate action (goal 13) are the crucial ones that are highly related to the agriculture industry [16]. Consequently, the revision of existing agricultural systems is one of the essential targets to reach sustainable development. Agriculture stands at an important place for humanity by providing food for a living. Nevertheless, to be able to meet the increasing demand with accelerated population growth, to overcome the loss of biodiversity and food loss and waste, a novel agricultural approach is needed [40].

The sustainable Agriculture (SA) notion is on the agenda since the 1970s [4]. In these years, still the importance of recycling, having less waste, and improving productivity were assigned as the significant issues about SA. Today the expectations from SA remain the same as before. Currently, novel digital technologies started to involve in the traditional agricultural systems. We are facing a new era with more automized, controllable, and transparent food production. However, the rising hunger and malnutrition, and overexploitation of natural resources continue. Accordingly, to achieve a durable and robust plan for SA, a design methodology in which all the stakeholders can be integrated may be a quality solution [5, 32, 36]. Considering the stakeholder's expectations, an action/solution prioritization may be handy for practitioners, governments, or municipalities. From this point of view, this paper suggests a linguistic design framework for SA. The SA design procedure is approached as multi-criteria decision-making (MCDM) process, and the design parameters are based on the stakeholders' expectations from SA.

As an MCDM technique, the Axiomatic Design (AD) approach is suggested regarding its benefits, such as reducing design iterations and random searches for solutions [20]. In favor of fortifying the AD technique's use of linguistic variables, the AD is extended with the 2-tuple linguistic model [24]. The 2-tuple linguistic model enables the creation of computations with linguistic variables, and it provides interpretability of the results via linguistic variables closer to human thinking. A group decision-making (GDM) approach is also followed in this recommended framework to mimic the stakeholder integration. Aggregation of multiple evaluations is handled with the 2-tuple model's operators [22]. To the best of our knowledge, the main contributions of this work can be summarized as follows:

- Integrating AD technique to SA design subject for the first time,
- Integrating the 2-tuple linguistic model and AD model for the first time in the SA design problem.

The remaining parts of the paper are as follows: Section II presents the theoretical background of the methodology by explaining the SA notion and its expectations. Section III provides the methodological background by giving the preliminaries about suggested techniques.

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Section IV provides the case study to test the applicability of the suggested framework. The following section gives the results and analysis of the case study. Finally, Section VI gives the concluding remarques.

II. THEORETICAL BACKGROUND

A. Sustainable Agriculture

In the direction of being sustainable, agriculture must satisfy the necessities of present and future generations while guaranteeing profitability, environmental health, and social and economic equity [17]. Therefore, concerning only the environmental or the economic aspect of the agricultural development is not enough to satisfy the issues stated above. The social, economic, and environmental aspects of the agricultural transition are crucial. One cannot be separated from others. In the literature, the transition/transformation to the SA is commonly associated with the social movements created by the stakeholders [3, 32, 36].

The need for a practice change and redesigning the farming systems are the critical enablers for SA. Recently, the integration of innovative technologies into the traditional farming environment speeded up this transition for farmers [10, 12, 29]. However, technological availability is not the same for every region in the world. So, planning and evaluating the current situation in agriculture is essential for reaching a well-designed strategy for SA.

The inclusion of stakeholders, collaborative working of governments, municipalities, and practitioners are the key enablers for social transition. Food and Agriculture Organization of the United Nations (FAO) emphasizes five main principles for food and agriculture sustainability [40]:

- Adding value to food systems by augmenting production and employment,
- Conserve and intensify natural resources,
- Support inclusive economic growth,
- Reinforce resistance of communities and ecosystems,
- Governance adaptation.

Concerning these main principles, this paper generates the main expectations of stakeholders from academic and industrial literature.

Furthermore, the powerful solutions/actions based on the five main principles of FAO are generated from the literature as well. The details of the expectations and the actions will be given in Section II.C. The following section will present the background of the SA and the MCDM applications in the literature.

B. Sustainable Agriculture and MCDM

As aforementioned, the primary success factor for SA is the evaluation of economic, social, and environmental components together. MCDM approach is a possible way to investigate the interactions and system components behaviors [26]. From groundwater zone determination to the land suitability assessment MCDM approaches proposed various techniques to analyze and investigate complex models with multiple criteria and alternatives. The design tools such as AD and the Quality Function Deployment are also common techniques used in alternative selection problems. However, in this paper, the AD technique is utilized thanks to its design nature. It aims to prioritize the most suitable actions/solutions that can cover all the expectations.

When the "sustainable agriculture" and "multi-criteria decision-making" words are search on the Scopus database together, eleven different works were obtained. Their focused area and applied techniques are listed in Table 1.

Table 1. MCDM based SA studies

Year and Reference	The objective of the study	Technique	Linguistic Technique	Case Study
2020 [28]	Land suitability analysis	AHP and WCL	No	Yes
2020 [2]	Land suitability assessment	AHP	No	Yes
2019 [41]	Suitability mapping for rice cultivation	AHP	No	Yes
2019 [13]	Assessment of sustainable sugarcane farms	VIKOR, TOPSIS, VTOPES	No	Yes
2019 [42]	Agricultural supply chain risk management	SWARA and FMEA	No	Yes
2019 [15]	Agriculture supply chains	TOPSIS	Yes	Illustrative Example
2018 [30]	Crop selection pattern	TOPSIS	Yes	Yes
2017 [11]	Land suitability evaluation for wheat cultivation	AHP	No	Yes
2016 [23]	Representation of groundwater potential	AHP	No	Yes
2014[25]	Selecting peach ideotypes	ELECTRE-Tri and DRSA	No	Yes
2005 [26]	Economic and environmental analysis of farming practices	MODAM	No	Yes

As Table 1 states, the most common technique for SA studies is the AHP approach suggested by Saaty [31]. When the "sustainable agriculture design" is searched on the Scopus database, two different works are obtained, one is focused on the design and analysis of the hydraulic structures for SA [34], and the other is concentrated on risk analysis and design of activities concerning the risk factor [37].

When the whole related literature is analyzed, we can deduct that the MCDM tools are potent solutions to handle complex decision problems in the SA area. Moreover, we found that there is a lack of a roadmap for policymakers and stakeholders. Consequently, this paper aims to fulfill this gap and propose a design methodology for policymakers and farmers. The model is based on linguistic variables and the AD technique. The following section will give the details of obtained expectations, solutions/actions, and the decision-making model.

C. Sustainable Agriculture Expectations

The expectations of all stakeholders for SA activities are derived from the academic and industrial literature. Moreover, the industrial experts who also helped assess the case study validated the listed expectations and the potential solutions.

Figure 1 here presents the suggested decision model with the expectations [1, 10, 17, 26, 29, 36], and followingly Table 2 gives the identified actions/solutions [6, 17, 26, 39] for the SA approach.

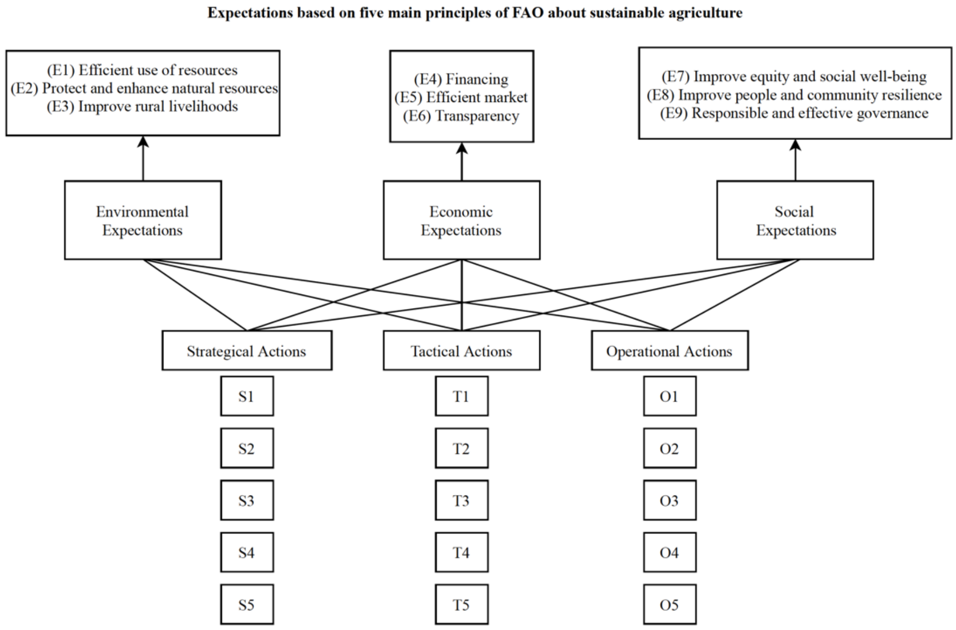

Figure 1. Suggested decision-making model for action prioritization

Table 2. Actions to prioritize for SA

Stakeholder dialogue	Strategical	**S1**
Co-constructed knowledge with awareness rising	Strategical	**S2**
Creating inclusive platforms	Strategical	**S3**
Regulations and standards based on climate-change mitigation and adaptation	Strategical	**S4**
Enhance gender equity	Strategical	**S5**
Developing decentralized capacity	Tactical	**T1**
Develop financial incentive packages to support private investment and enable equitable distribution of benefits	Tactical	**T2**
Decentralize decision-making	Tactical	**T3**
Apply mediation and other conflict resolution mechanisms in resource governance	Tactical	**T4**
Generalize risk assessment/management and communication	Tactical	**T5**
Encouraging flexibility in production systems	Operational	**O1**
Promote small/medium enterprises	Operational	**O2**
Improve rural nutrition: production of more and affordable nutritious and diverse foods, including fruits & vegetables	Operational	**O3**
Increase/protect farmers' access to resources, such as pasture, water, credit	Operational	**O4**
Increase rural job opportunities e.g., in small and medium enterprises sustainability and related activities	Operational	**O5**

The listed actions in Table 2 are divided into three leading groups as strategical, tactical, and operational. In favor of designing strategies for SA, knowing the possible effects of the actions at the managerial level also may guide the practitioners to create a better transition plan.

III. METHODOLOGICAL BACKGROUND

This section will provide the methodological background with preliminary information about the 2-Tuple linguistic model and the AD technique. First, the main benefits and properties of the 2-Tuple model and AD are given, and later the principal methodology for GDM aggregation is presented.

A. 2-Tuple Linguistic Model

Herrera and Martinez first represent this model in 2000 [24]. The 2-tuple linguistic model and its extensions have been applied to various topics, mainly decision-making and decision analysis problems [24, 27, 35]. Basic definitions are as follows [24]:

The 2-Tuple fuzzy linguistic representation model represents the linguistic information using a 2-Tuple *(S, α)* here; *S* is a linguistic label, and *α* is a numerical value representing the value of the symbolic translation. The function is defined as:

$$\Delta_s : [0, g] \to \bar{S}$$
$$\Delta_s(\beta) = (S_i, \alpha), \text{with} \begin{cases} i = round(\beta) \\ \alpha = \beta - i \end{cases} \qquad (1)$$

The linguistic term set *S* could be converted into 2-Tuple form by adding zero value as in the following relation:

$$S_i \in S \Rightarrow (S_i, 0) \qquad (2)$$

For further details, the readers can refer to [24]. The main benefits of a 2-tuple linguistic model have augmented the accuracy and interpretability of the results, the possibility of dealing with variables closer to human beings' cognitive processes, and increased accuracy of computations. Regarding these benefits to create a flexible environment for the decision-makers (DMs) and better analysis and knowledge about the SA area, the suggested 2-Tuple methodology is integrated with the AD technique.

B. Axiomatic Design

AD is a technique first introduced by Suh [38]. For the selection problem, a linguistic-based AD is proposed; it is used with 2-Tuple linguistic information to overcome the multi-granularity arising from multiple experts. The AD technique uses two axioms: the first one is the independence axiom, which sets out that function requirements (FRs) must be independent, and the second one is the information axiom, which sets out that the design with the minimum information content is better than all the other designs that satisfy the FRs [38].

AD is based on the information content (I), which is represented by the probability function for fulfilling an FR. In 2-tuple AD, fuzzy membership functions for linguistic variables are used instead of probability functions. Figure 1 represents the System Range (SR) and Design Range (DR) for fuzzy membership functions.

I_i is calculated as the following relation for Fuzzy AD [7]:

$$I_i \begin{cases} \infty & , no\ intersection \\ log_2\left(\dfrac{area\ of\ SR}{common\ ares}\right) & , otherwise \end{cases} \tag{3}$$

Then the weighted total information content (I) is calculated with:

$$I = \sum_{i=1}^{n} w_i \times I_i \tag{4}$$

where n is the number of criteria, w_i is the weight of criteria and I_i is the non-weighted information content calculated with Eq. (3).

Finally, the prioritization of alternatives is obtained by ranking the options with increasing order. The alternative with the minimum information content is the most appropriate one for the solution.

C. Aggregation Technique for GDM

This paper proposed a linguistic SA design framework with a GDM approach. The main benefit of the GDM approach is to create an unbiased, objective decision-making environment where the final solution is beneficial to each DM. The GDM approach is based on the aggregation of different opinions from multiple DMs [9]. GDM is a commonly adopted method preferred over a single DM due to its superiority in avoiding partiality and bias [8, 21].

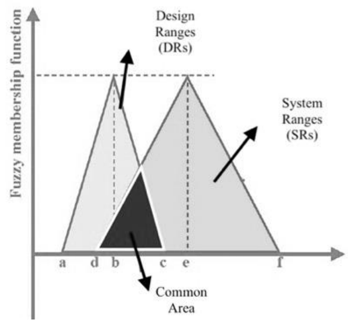

Figure 1. System ranges, design ranges, and common area in fuzzy membership functions [7]

Regarding all the benefits mentioned above, the 2-tuple linguistic model's *Linguistic Hierarchies (LH)* approach is selected as an aggregation technique for this GDM methodology. The methodology is based on the experts' knowledge; however, the experience level and knowledge may differ concerning the interest of DMs. So, providing different granulated linguistic evaluations set to each DM may be a powerful solution to balance the knowledge difference rising from different backgrounds.

LH [24] approach unifies the multigranular linguistic input under the one unified linguistic set. A transformation equation exists to normalize label sets with different granularity. The following equation gives the relations:

$$TF_{t'}^{t}(S_i^{n(t)}, a^{n(t)}) = \Delta\left(\frac{\Delta^{-1}(S_i^{n(t)}, a^{n(t)}) \cdot (n(t') - 1)}{n(t) - 1}\right) \tag{5}$$

where *TF* is the transformation function for *LH*, and the transformation is from t^{th} level to t'^{th} level.

Furthermore, for aggregating normalized linguistic variables *Weighted Aggregation Operator (WAO)* of 2-Tuple model is recommended as well. The following equation gives the formulation:

$$\vec{x} = \left(\frac{\sum_{i=1}^{n} \Delta^{-1}(e_i, \alpha_i) \times \Delta^{-1}(w_i, \alpha_i)}{\sum_{i=1}^{n} \Delta^{-1}(w_i, \alpha_i)}\right) = \Delta\left(\frac{\sum_{i=1}^{n} \beta_i \times w_i}{\sum_{i=0}^{n} w_i}\right) \tag{6}$$

where, (e_i, α_i) is the assessments provided by each expert; (w_i, α_i) stands for the weights of experts and n represents the number of experts and β_i is the β values for ith criterion's importance.

The detailed steps of the suggested methodology will be given in the next section.

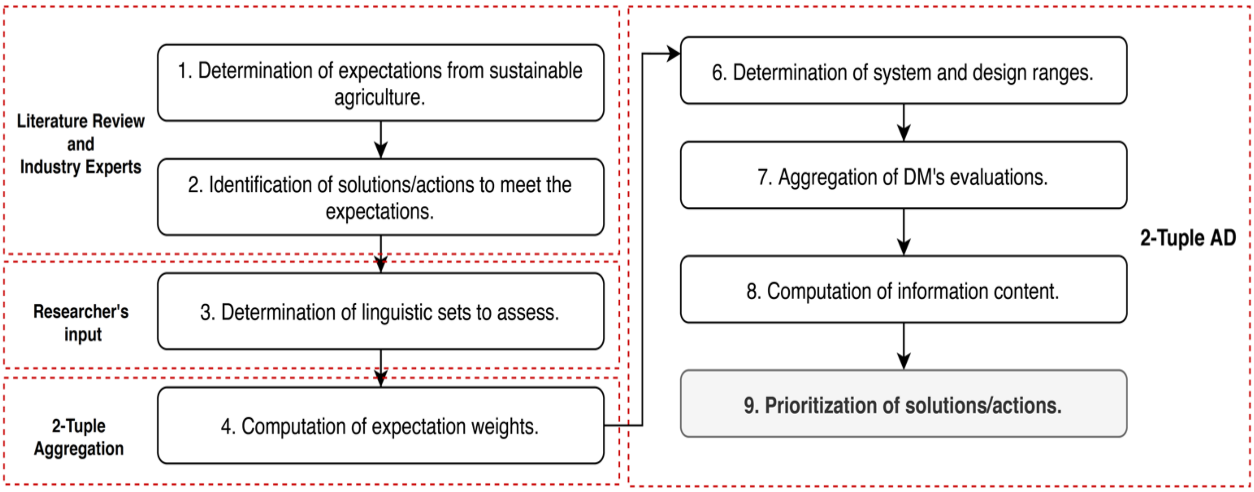

Figure 2. Detailed steps of the suggested framework.

D. Suggested Framework

The preliminaries provided in the previous section forms the methodological basis of the SA design framework. Here Figure 2 presents the flow of the recommended framework. Followingly, in the case study, the indicated steps will be followed in order to test the applicability of the design model.

IV. CASE STUDY

The case study is designed to test the applicability of the suggested framework. When the framework is formed, the first step was creating a decision-making group and validating the framework to them.

The decision-making group comprises three competent experts in sustainable agriculture, sustainable design and agriculture, and sustainable supply chain and its design. The DMs working on sustainable agriculture and design are assessed by using nine scaled linguistic sets. Due to the volatile background of DMs, two different linguistic sets are provided. The third DM works on sustainable supply chains, and their design used five scaled linguistic sets. The details of linguistic sets are as follows:

The second level five scaled (Very Low(VL)- Low (L)- Medium (M)-High(H)-Perfect (P)) and the third level nine scaled (Very low (VL)-Low(L)-Medium Low (ML)- Almost Medium (AM)- Medium (M)-Medium High (MH)- High (H)- Very High (VH)- Perfect (P)) hierarchy of letters [18].

The Delphi [23] method is followed for the separate meetings with each DM. Their judgments are collected separately and aggregated by using the 2-tuple model's LH approach.

As stated in Figure 2, the first three steps of the framework are completed as explained above. Then for the following steps, the weights of the expectations are obtained first by normalizing assessment under nine scaled sets then unifying them using Eq. (6). Table 3 gives the individual assessments of DMs and the aggregated importance of expectations.

The exact process is conducted for the assessment of relations between expectations and actions. Due to the page restriction, only the aggregated decision matrix for AD is given in Table 4.

Table 3. Expectation weights

	Five scaled set	Nine scaled set		Unified under nine scaled
	DM1	DM2	DM3	Aggregated
E1	P	VH	P	(P,-0.39)
E2	P	P	P	(P,0)
E3	H	H	VH	(H,0.39)
E4	M	AH	H	(AH,0.17)
E5	M	H	VH	(VH,-0.04)
E6	H	VH	VH	(VH,-0.22)
E7	H	VH	H	(H,0.39)
E8	M	AH	AH	(AH,-0.22)
E9	P	P	P	(P,0)

Table 4. The aggregated assessment matrix for 2-tuple AD.

	DRs	S1	S2	S3	S4	S5	T1	T2	T3	T4	T5	O1	O2	O3	O4	O5
E1	LAM	(L,0)	(H,0)	(P,0)	(VH,0.22)	(VL,0)	(M,0)	(VL,0)	(L,0)	(H,0)	(H,0)	(H,0)	(M,-0.39)	(M,0)	(P,0)	(L,0)
E2	LAM	(AM,0.22)	(AM,0.22)	(AH,0.22)	(P,0)	(L,-0.43)	(H,-0.43)	(VL,0)	(L,0)	(L,0)	(H,0)	(H,0)	(M,-0.39)	(H,0)	(P,0)	(M,-0.43)
E3	LMH	(AH,0.22)	(H,0)	(L,0.43)	(P,0)	(AM,-0.22)	(M,0)	(AM,-0.22)	(M,-0.39)	(H,0)	(M,-0.39)	(L,0)	(AH,0.22)	(H,-0.43)	(VH,-0.22)	(H,0)
E4	LAM	(AH,-0.22)	(M,0)	(VH,-0.22)	(H,0)	(L,0)	(AH,-0.22)	(P,0)	(M,0)	(M,0)	(H,0)	(M,0)	(P,0)	(AM,-0.22)	(AM,0.22)	(H,0)
E5	LAM	(M,-0.43)	(AM,0.22)	(H,0)	(H,0)	(M,0)	(M,0)	(VH,-0.17)	(M,0)	(L,0)	(L,0)	(M,0)	(H,0)	(L,0)	(AM,0.22)	(M,0)
E6	LAM	(VH,-0.22)	(AM,0.22)	(VH,-0.22)	(P,0)	(AM,-0.22)	(AH,-0.22)	(H,0)	(VH,-0.22)	(AH,-0.22)	(H,0)	(L,0)	(AM,0.22)	(AM,0.22)	(M,0)	(M,0)
E7	LMH	(H,0)	(H,0.39)	(H,0)	(M,0)	(P,0)	(VH,-0.22)	(L,0)	(M,-0.39)	(M,0)	(M,0)	(L,0)	(AH,0.22)	(M,0)	(H,0)	(P,-0.39)
E8	LAM	(P,0)	(P,-0.39)	(VH,-0.22)	(AH,-0.22)	(P,0)	(H,0)	(AM,-0.22)	(M,0)	(M,0)	(L,0)	(L,0)	(H,0)	(H,0.39)	(P,0)	(P,-0.39)
E9	LMH	(AH,-0.22)	(P,-0.39)	(VH,-0.22)	(L,0)	(AM,-0.22)	(M,0)	(H,-0.43)	(H,0)	(P,0)	(H,0)	(M,0)	(M,0)	(H,-0.43)	(H,-0.43)	(H,0.39)

For the design ranges (DRs) in the AD technique, a nine-scaled assessment set is suggested to DMs, and their compromise assessment is obtained as a consensus. The suggested assessment set is as follows: *At least very low (LVL)- at least low (LL) - at least medium low (LML) - at least almost medium (LAM) - at least medium (LM) - at least medium high (LMH) - at least high (LH) - at least very high (LVH) at least perfect (LP).*

According to the design ranges and the aggregated DMs assessment, as in Figure 1, the intersection area of both assessments is calculated to obtain each action's information content. The information content is obtained with Eq.(3). Then, the expectation importance will be multiplied to obtain the final ranking as in Eq (4).

The results and their analysis will be given in the next section.

V. RESULTS AND ANALYSIS

After applying the steps stated in Figure 2, the final relation matrix where the weighted information values are stated is given in Table 5.

The ∞ refers to no intersection between the system and design ranges. That means the solutions do not meet the expectations. Therefore, the AD provided a pre-elimination to reach the most efficient solutions for SA. The elimination of less effective actions narrows down the design process, and it only suggests and ranks the most efficient actions. The information content is calculated by taking the intersection of each system range with the assigned design ranges. The design ranges and the intersection of a system range are presented as an example in Figure 3.

Moreover, all the operational solutions are eliminated. The operational solutions contain the solutions for operational, short-term actions. We can assume that the short-term actions are not as powerful as tactical and strategical solutions for SA.

As the existing literature confirms that the tactical and strategical transition is the critical enabler for SA [17, 18], our suggested methodology validated the same result by eliminating short-term actions as a solution.

Table 5. Ultimate relation matrix with information contents

	S1	S2	S3	S4	S5	T1	T2	T3	T4	T5	O1	O2	O3	O4	O5
E1	∞	0.03	0.00	0.00	∞	0.18	∞	∞	0.03	0.03	0.03	∞	0.18	0.00	∞
E2	0.08	0.08	0.01	0.00	∞	0.61	∞	∞	∞	0.04	0.04	∞	0.04	0.00	∞
E3	0.03	0.09	0.47	0.00	∞	1.00	∞	∞	0.09	∞	∞	0.03	∞	0.23	0.09
E4	0.29	0.15	0.05	0.03	∞	0.29	0.00	0.15	0.15	0.03	0.15	0.00	∞	0.07	0.03
E5	∞	0.05	0.02	0.02	0.11	0.11	0.02	0.11	∞	∞	0.11	0.02	∞	0.05	0.11
E6	0.06	0.08	0.06	0.00	∞	0.36	0.04	0.06	0.36	0.04	∞	0.08	0.08	0.19	0.19
E7	0.08	0.00	0.08	0.81	0.00	0.19	∞	∞	0.81	0.81	∞	0.02	0.81	0.08	0.99
E8	0.00	0.08	0.04	0.27	0.00	0.03	∞	0.14	0.14	∞	∞	0.03	0.00	0.00	0.08
E9	∞	1.30	0.24	∞	∞	1.07	∞	0.10	0.00	0.10	1.07	1.07	∞	∞	0.00
Sum:		**1.88**	**0.97**	**1.13**		**3.84**									

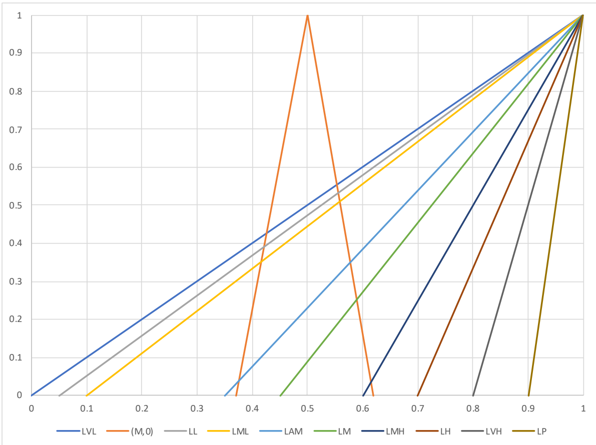

Figure 3. The intersection of design ranges and system range

Table 6. Ranking of the feasible solutions

S#	Solution	Rank
S2	Co-constructed knowledge with awareness rising	3
S3	Creating inclusive platforms	1
S4	Regulations and standards based on climate-change mitigation and adaptation	2
T1	Developing decentralized capacity	4

Furthermore, among appropriate solutions, the majority are the strategical solutions that can transform the mentality of the conventional agricultural systems. The ranking of the feasible solutions concerning their weighted information values is given in Table 6.

Creating inclusive platforms is selected as the most potent solution for SA design. As stated in the literature, inclusive platforms are significant enablers for long-term capacity building, knowledge sharing, and consensus-based decision making [14, 17, 19, 33]. Therefore, for building shared knowledge and joint actions for SA design, these platforms are the primary facilitator for technological innovations as well.

VI. CONCLUSIONS

The accelerated population growth and the consumption of natural resources to feed the increasing population are two significant challenges that agriculture faces today. Plus, the severe effects of climate change related to the extending natural sources cause vulnerabilities at various stages of the agricultural value chain.

As a result, SA is recommended by various policymakers and nongovernmental organizations. The SA approach suggested, yet the need for an appropriate roadmap or a “to do” list for practitioners was a gap in the literature. Therefore, this paper suggested a linguistic design framework for SA design.

The framework is built with the integration of the 2-tuple linguistic model with the AD technique. The 2-tuple linguistic model provided interpretability of the assessments closer to human thinking, and also it enables to make computations with multi-granular data. The multi-granular data eliminated the knowledge and background differences of DMs. They felt comfortable while evaluating the relations between the expectations and the solutions. As a result, a ranking of four solutions is obtained. The majority of the results were strategic solutions. The methodology also validated the existing literature by emphasizing the importance of strategic approaches for a successful SA design.

The SA expectations were generated from the academic and the industrial literature as a significant input to the framework. Also, they are validated by the experts. However, future studies can improve the number of expectations, and real field research can be applied to reach real stakeholders.

As a limitation, the number of DMs can be stated. In this paper, the recommended methodology is tested with three DMs; however, the framework can work with DMs up to more high numbers. Also, a sensitivity analysis can be performed to investigate the solution rankings by changing the design ranges.

Furthermore, for future studies, the same methodology can be followed for other industries as well. The same methodology can serve as valuable guidance for strategy and solution detection for various sectors by improving the expectations according to the industries.

VII. ACKNOWLEDGMENTS

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