IJFANS International Journal of Food and Nutritional Sciences

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Determination of Adoption of Climate-Smart Agriculture (CSA) Technologies in Rice Production in Using TOPSIS Method

Gayatri Parasa

Department of Computer Science & Engineering, Koneru Lakshmaiah Education Foundation

gayathriparasa20@gmail.com

M. Arulselvi

Department of Computer Science & Engineering, Annamalai University, Tamilnadu.

marulcse.au@gmail.com

Abstract.

With the goal of achieving sustainable agriculture and guaranteeing food security in the face of climate change, climate-smart agriculture is a method to creating agricultural strategies to modernize agricultural systems utilizing digital tools. This article provides a thorough assessment of the literature on robots, the Internet of Things, and remote sensing as "smart agricultural technologies" for Cyprus's climate-smart agriculture. An overview of climate-smart agriculture is presented at the beginning of the study to highlight its significance in enhancing agricultural production methods to solve the interrelated issues of food security and climate. A thorough analysis of the published literature in the fields of robotics, the Iot., plus remote sensing is conducted, with a focus just on work done in Cyprus with relation to agriculture. This article explores many facets of the Cypriot agricultural sector's climate-smart agricultural research position, identifies shortcomings, and offers new directions. In the TOPSIS technique, order selection is determined by comparing the best solutions. One of the most prevalent non - linear and non-judgement call (MCDM) techniques today was that one. In order to cope with data that has only true values, the TOPSIS technique was principally developed. These estimates are typically viewed as gaps since it might even be difficult to create meaningful measures of alternative with relation to local requirements in so many cases. Although these improvements are based on diverse heuristic methods for determining adaptive and maladaptive optimum solution, the TOPSIS method has indeed been extended for periods within few research. These ideal solutions are provided by measured demands or intervals that can be achieved in the choice problem. Within that

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

paper, we offer a novel straightforward approach for interval stretching of both the Topsis, free from the artificial preconceptions and limitations of earlier approaches.so this is in opposition to the fundamentals of the conventional TOPSIS method. the alternatives are Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. the Evaluation parameter are Percent of Households Aware of the CSA Technology and Practice, Percent of Households Aware and Using the CSA Technology and Practice, Pearson Correlation Coefficient. Improved crop varieties is got first rank and Irrigation technologies is got lowest rank.

Keywords: Climate-Smart Agriculture, Sustainable Development Goals (SDGs), MCDM.

1. INTRODUCTION

For the majority of international organizations tackling climate change, agriculture, and development, CSA has evolved into a core idea. Additionally, it is believed that CSA is a crucial tool for accomplishing your "Sustainable Development Goals (SDGs)". Most importantly, CSA supports the majority of rural African farm owners who are most at risk from severe weather and climatic conditions. The majority of developing nations are looking into different approaches to develop affordable and trustworthy weather monitoring and forecasting systems, as well as strategies for combining such devices with advanced devices like biomarkers, Internet - of - things sensor, and agricultural robots. to improve the management of crops, livestock, and food security. For instance, smart agriculture, which falls under the categories of smart farming, smart agriculture, and CSA, has made a substantial contribution to agribusiness in Ghana, Kenya, Nigeria, and South Africa by ensuring increased agricultural productivity and lowering agricultural losses. The notion of CSA was very well stated in the letter and is highly valued by numerous organizations all over the world, but there is still room for more research on this topic, especially in Africa. The literature has compared reported on a number of CSA research issues, including the integration element of the three key pillars of CSA. Research on CSA is described as being very young, with its advances still in the policy status of structural elucidation, in a recent systematic review by Chandra et al. Africa must comprehend the most recent advancements and activities taking place in the CSA research field in order to successfully deploy CSA. In

ISSN PRINT 2319 1775 Online 2320 7876
Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019**

order to comprehend the topical trends, breakthroughs, in this paper, we unveil a novel direct approach towards period lengthening of TOPSIS that's also free from the needless expectations and limitations of earlier techniques. the present review intends to map and analyses CSA research papers in Africa using scientific methods. Therefore, by examining the development of CSA research themes and methods as well as the future direction of CSA in support of climate-related policy decision-making, this study makes a significant scientific contribution. The TOPSIS approach has received considerable criticism despite being simple to use and widely adopted; as a result, other iterations of the method have been created. The rank reversal issue, which applies to both the AHP and TOPSIS approaches, is one of the complaints. When a qualification or possibility is added or removed, the ranking of the alternatives is said to have undergone a rank reversal. Oprikovic and Tzeng were the first to criticize TOPSIS' platform called, which is another significant complaint. Finding a compromise solution that is both close to and far from the NIS is the goal of the TOPSIS technique. The rankings indicator uses two distances with in computation and does not take into account their respective weights or relevance. The association between criteria is a further complaint against or drawback of TOPSIS. Results are impacted by overlapping information because the TOPSIS technique uses Distance metric, which ignores relatedness.

2. CLIMATE-SMART AGRICULTURE

We looked at how well farmers in Lushoto were aware of and using different CSA technologies overall, in addition to the mentioned CSA technologies they were exposed to it during the learning trip. More than 200 distinct CSA practices, either with themselves or in various combinations, were reportedly used by farmers. The majority of farmer-reported CSA practices are in line with the FAO criterion of CSA. The numerous CSA techniques used to produce crops and livestock, implement alternative operating income innovations, conserve waterways, or save energy. Most of the farmers who participated in the poll were knowledgeable about various CSA methods. In addition to Liamungo90 bean variations, composting, mineral fertilizers, early planting, break livestock feeding, agroforestry, and regionally tolerant crop types, more than multiple of households were aware of upgraded or cross resistant crop varieties. Or more 50percent of respondents of the households had expertise of agricultural production, minimal tillage, raking, cover crops, traditional and modern environmental sensing, non-burning, rooftops and edge gardening, and better feed.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Biogas, marengo pit, chamoes, & strip farming CSA techniques were four technologies and practices that members in FotF were introduced to during educational tour, but only a small number of households were aware of these. Results show a strong link between knowledge about it using of CSA technology. Composting, cut-and-carry, the use of mineral fertilizers, permaculture, and early crop sowing were some of the CSA neologisms to ranchers that improved crop types. GHG emissions are decreased through upgraded cooking stoves and biogas for more efficient energy use. In Lesotho, the utilization of animal waste in biogas industrial machinery for anaerobic digestion may offer answers for the energy needs of cooking and lighting, as well as a byproduct of agricultural fertilizer. The development of CSA technology business models, the identification of suitable consumer categories, and market entry should all be supported by steps. Other activities, such as CSA technology brokering, are necessary to uncover new campaign objective and market opportunities for technology providers in order to develop business models of various CSA technologies. Additionally, a prospective labelling programmed and an impact analysis of CSA technology innovations would enable the unambiguous articulation of the economic and climatic implications of the technologies, offering proof and assurance to the ultimate adopters and end users.

3. MATERIALS AND METHOD

Researchers have utilized this TOPSIS method, a very well MCDM methodology, extensively for a variety of reasons. In other terms, TOPSIS is a method for assigning preference to the best answer while putting orders. An approach to order preference that was explicit and resembled an ideal answer was put out by Hwang and Yoon in 1981. The beneficiary characteristics are maximized and the cost characteristics are minimized in this ideal solution, also known as a positive global optimum. An anti-optimal or counter-ideal answer maximizes cost criteria and characteristics while minimizing benefit criteria and qualities. "The order preference by similarity to optimal solution (TOPSIS)" technique, developed by Hwang and Yoon, is one of the widely used techniques for traditional MCDM. The "positive ideal solution (PIS)" and negative ideal alternative (NIS) concepts serve as the foundation for this technique (NIS). PIS is a strategy that maximize benefit criteria while minimizing distribution cost, in opposed to NIS, which maximizes cost criterion and reduces benefit criteria. The fundamental tenet of TOPSIS seems to be that the chosen alternative

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

should be closest to the PIS and farthest from the NIS. Although the formula for TOPSIS is straightforward and logical, the effects that weighting are twofold in conventional TOPSIS, and the produced Euclidean distances just aren't weighted. Rather than the term weighting matrix required by TOPSIS for the aggregation procedure, weighted Euclidean distances are used in the current paper. When all possibilities have same values for a property, that attribute does not function very well. Additionally, the property can be deleted if all entries are identical. In general, a lower IE of a characteristic denotes a higher DAD and a higher weight, and vice versa. TOPSIS and DAD are connected. For instance, if an attribute's values are constant across all alternatives, then that attribute is the best option for each one and remains true to the deleterious ideal situation. As a result, DAD is partially related to either the EM and TOPSIS approaches. The multiple qualities frequently differ in terms of dimensions & order of magnitude for many non - linear and non judgement call issues. Attributes are always normalized when employing the entropy-based TOPSIS technique. Studies show that DAD is impacted by normalization. In contrast to mean normalization, min-max normalization (MMN) modifies DAD. Since the DAD is a factor in both the EM and TOPSIS methods, normalization could have an impact on the TOPSIS method's outcome if it modifies the DAD. Therefore, a thorough analysis of normalization's impacts is required. The effects of some commonly employed normalizing techniques in the perturbation theory TOPSIS method are examined with one-event and associated data in this study, which uses IE as an indication to quantify DAD. On the basis of this, the use of various normalization methods in the Optimization technique and the synergy among EM and TOPSIS technique are examined.

4. RESULT AND DISCUSSION

TABLE 1. Climate Smart Agriculture Technologies Using TOPSIS

	Percent of	**Percent of**	**Pearson**

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

	Households Aware of the CSA Technology and Practice	Households Aware and Using the CSA Technology and Practice	Correlation Coefficient
Improved crop varieties	97.5	95.1	0.69
Chemical fertilizers	76.4	81.5	0.83
Agroforestry	65.2	85.2	1
Early planting	80.3	64.2	0.66
Minimal tillage	77.6	70.7	0.97
Irrigation technologies	46.7	16.1	0.53
Organic pestcontrol	78.3	35.8	0.95
Strip cropping	67.9	56.8	0.88
Biogas, biodigester	64.9	45.8	0.24
Matengo pits	85.2	73.09	0.59

Shows the table 1. the alternatives are Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. the Evaluation parameter are Percent of Households Aware of the CSA Technology and Practice, Percent of Households Aware and Using the CSA Technology and Practice, Pearson Correlation Coefficient.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

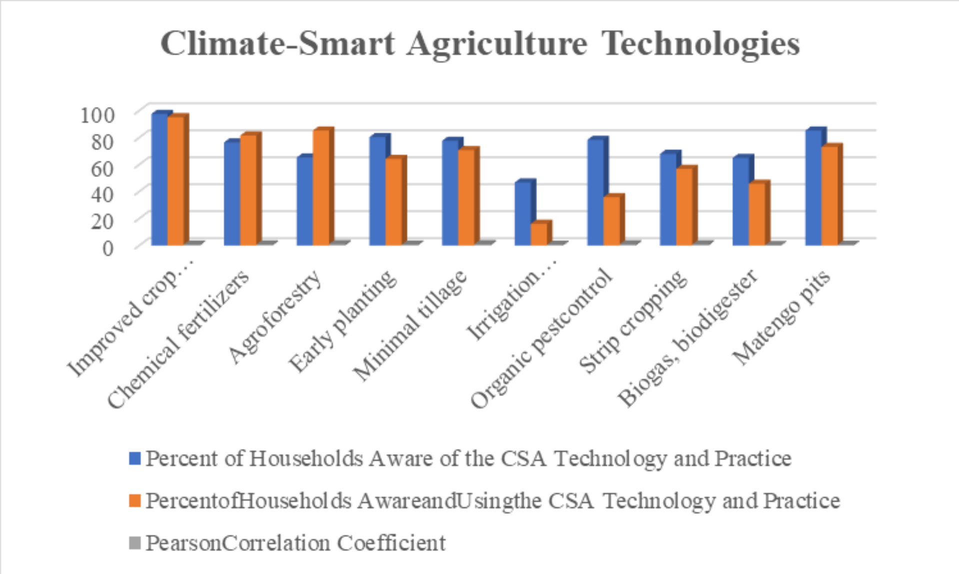

FIGURE 1. Climate Smart Agriculture Technologies Using TOPSIS

Shows the figure 1. the alternatives are Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. the Evaluation parameter are Percent of Households Aware of the CSA Technology and Practice, Percent of Households Aware and Using the CSA Technology and Practice, Pearson Correlation Coefficient.

TABLE 2. Square root value

	Percent of Households Aware of the CSA Technology and Practice	Percent of Households Aware and Using the CSA Technology and Practice	Pearson Correlation Coefficient
Improved crop varieties	9506.25	9044.01	0.4761
Chemical fertilizers	5836.96	6642.25	0.6889
Agroforestry	4251.04	7259.04	1
Early planting	6448.09	4121.64	0.4356

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Minimal tillage	6021.76	4998.49	0.9409
Irrigation technologies	2180.89	259.21	0.2809
Organic Pest control	6130.89	1281.64	0.9025
Strip cropping	4610.41	3226.24	0.7744
Biogas, biodigester	4212.01	2097.64	0.0576
Maten goes pits	7259.04	5342.148	0.3481

Shows the table 2 various square root value for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. Square root value is obtained by using the formula (1).

TABLE 3. Normalized Data

	Normalized Data		
Improved crop varieties	0.410341	0.463381	40.12312
Chemical fertilizers	0.321539	0.363101	31.44006
Agroforestry	0.274402	0.309871	26.83105
Early planting	0.337952	0.381636	33.04499
Minimal tillage	0.326589	0.368804	31.93389
Irrigation technologies	0.196543	0.221948	19.21794
Organic pestcontrol	0.329535	0.372131	32.22195
Strip	0.285765	0.322704	27.94215

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

cropping			
Biogas, biodigester	0.273139	0.308446	26.70759
Matengo pits	0.358574	0.404924	35.06143

Shows the table 3 various Normalized Data for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. Normalized value is obtained by using the formula (1). Table 4 shows Weightages used for the analysis. We take same weights for all the parameters for the analysis.

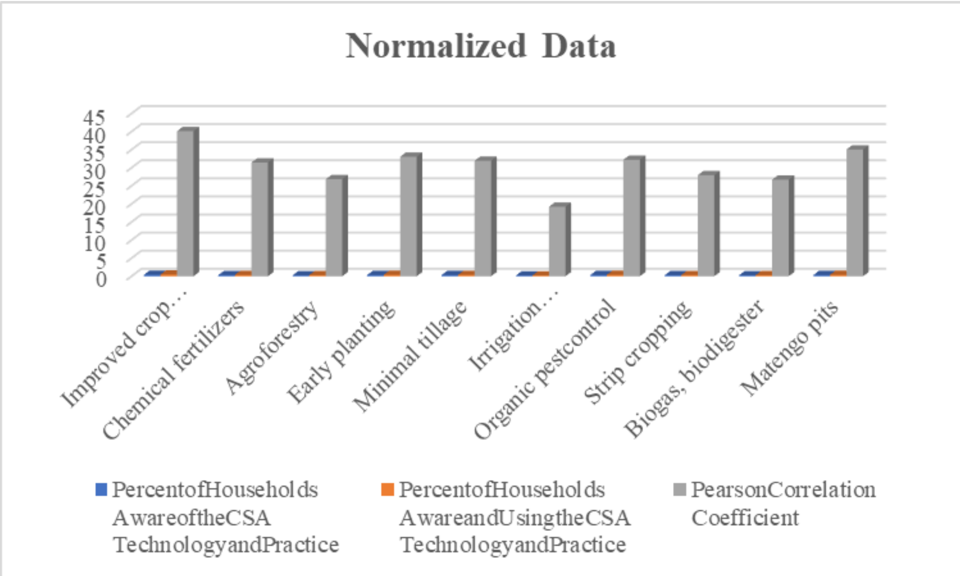

FIGURE 2. Normalized Data

Shows the figure 2 various Normalized Data for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. Normalized value is obtained by using the formula (1). Table 4 shows Weightages used for the analysis. We take same weights for all the parameters for the analysis.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

TABLE 4. Weight

	Weight		
Improved crop varieties	0.25	0.25	0.25
Chemical fertilizers	0.25	0.25	0.25
Agroforestry	0.25	0.25	0.25
Early planting	0.25	0.25	0.25
Minimal tillage	0.25	0.25	0.25
Irrigation technologies	0.25	0.25	0.25
Organic Pest control	0.25	0.25	0.25
Strip cropping	0.25	0.25	0.25
Biogas, biodigester	0.25	0.25	0.25
Maten go pits	0.25	0.25	0.25

Shows the figure 4. Climate Smart Agriculture Technologies weight are same 0.25.

TABLE 5. Weighted normalized decision matrix

	Weighted normalized decision matrix		
Improved crop varieties	0.102585	0.115845	10.03078
Chemical fertilizers	0.080385	0.090775	7.860016
Agroforestry	0.068601	0.077468	6.707762
Early planting	0.084488	0.095409	8.261247
Minimal tillage	0.081647	0.092201	7.983471
Irrigation technologies	0.049136	0.055487	4.804486

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Organic pestcontrol	0.082384	0.093033	8.055487
Strip cropping	0.071441	0.080676	6.985538
Biogas, biodigester	0.068285	0.077111	6.676898
Matengo pits	0.089644	0.101231	8.765358

Table 5 shows weighted normalized decision matrix for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. To figure out the weighted normalized decision matrix, we used the formula (2).

TABLE 6. Positive Matrix

	Positive Matrix		
Improved crop varieties	0.102585	0.115845	10.03078
Chemical fertilizers	0.102585	0.115845	10.03078
Agroforestry	0.102585	0.115845	10.03078
Early planting	0.102585	0.115845	10.03078
Minimal tillage	0.102585	0.115845	10.03078
Irrigation technologies	0.102585	0.115845	10.03078
Organic Pest control	0.102585	0.115845	10.03078
Strip cropping	0.102585	0.115845	10.03078
Biogas, biodigester	0.102585	0.115845	10.03078
Maten go pits	0.102585	0.115845	10.03078

Table 6 shows Positive Matrix for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control,

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Strip cropping, Biogas & biodigester, Maten go pits. In various Positive Matrix in Maximum value.

TABLE 7. Negative matrix

	Negative matrix		
Improved crop varieties	0.049136	0.055487	4.804486
Chemical fertilizers	0.049136	0.055487	4.804486
Agroforestry	0.049136	0.055487	4.804486
Early planting	0.049136	0.055487	4.804486
Minimal tillage	0.049136	0.055487	4.804486
Irrigation technologies	0.049136	0.055487	4.804486
Organic Pest control	0.049136	0.055487	4.804486
Strip cropping	0.049136	0.055487	4.804486
Biogas, biodigester	0.049136	0.055487	4.804486
Maten go pits	0.049136	0.055487	4.804486

Table 6 shows Negative Matrix for Improved crop varieties, Chemical fertilizers, Agroforestry, Early planting, Minimal tillage, Irrigation technologies, Organic Pest control, Strip cropping, Biogas & biodigester, Maten go pits. In various Positive Matrix in Maximum value.

TABLE 8. Si Positive, Si Negative, Ci and Rank

	Si Positive	**Si Negative**	**Ci**	**Rank**
Improved crop varieties	0	5.226915	1	1
Chemical fertilizers	2.171022	3.055893	0.584646	6

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Agroforestry	3.323412	1.903503	0.364173	8
Early planting	1.769743	3.457172	0.661417	3
Minimal tillage	2.047551	3.179364	0.608268	5
Irrigation technologies	5.226915	0	0	10
Organic pestcontrol	1.975527	3.251388	0.622047	4
Strip cropping	3.045604	2.181311	0.417323	7
Biogas, biodigester	3.35428	1.872635	0.358268	9
Matengo pits	1.265572	3.961343	0.757874	2

shows the table 8 Si positive, Si negative, CCi Closeness coefficient and Final Result of ranking Si positive, Irrigation technologies is having is Higher Value and Improved crop varieties is having Lower value. In Si Negative, Improved crop varieties is having is Higher Value Irrigation technologies is having Lower value. Ci is calculated using the formula (5). In Ci, Improved crop varieties is having is Higher Value and Irrigation technologies is having Lower value. Improved crop varieties is got first rank and Irrigation technologies is got lowest rank.

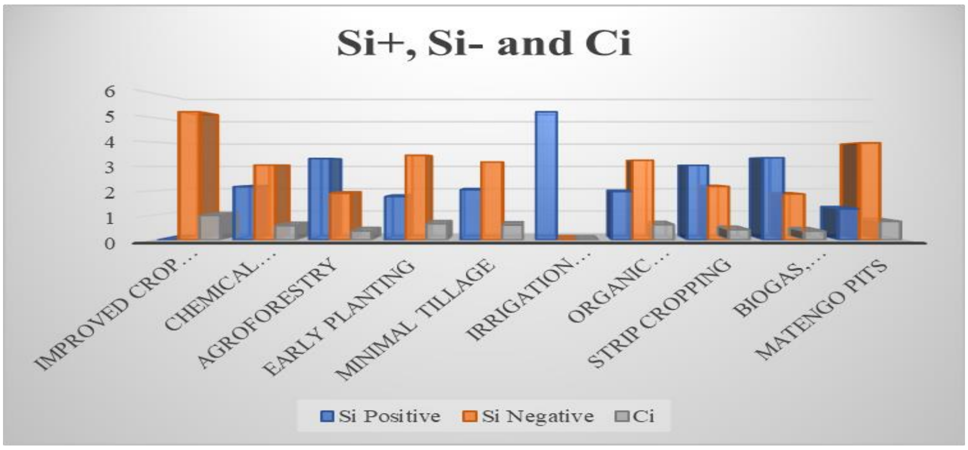

FIGURE 3. Si positive, Si Negative and Ci

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Figure 3 shows the Si positive, Si negative, CCi Closeness coefficient and Final Result Si positive, Irrigation technologies is having is Higher Value and Improved crop varieties is having Lower value. In Si Negative, Improved crop varieties is having is Higher Value Irrigation technologies is having Lower value. Ci is calculated using the formula (5). In Ci, Improved crop varieties is having is Higher Value and Irrigation technologies is having Lower value.

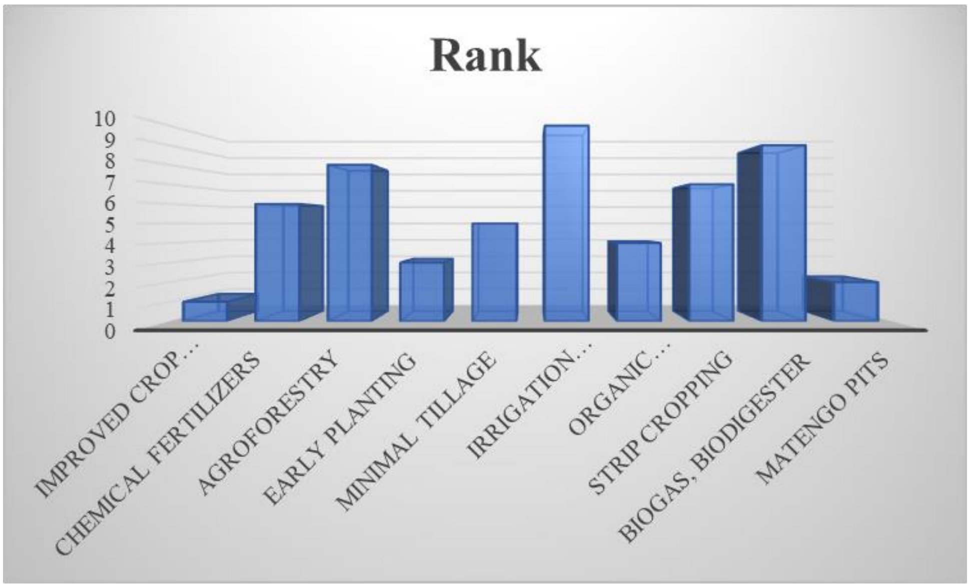

FIGURE 4. Final result for Ranking

Shows the figure 4. climate-smart agriculture (CSA) technologies using TOPSIS method final result. Improved crop varieties are got first rank and Irrigation technologies is got lowest rank

5. CONCLUSION

In order to talk about the necessity for "climate-smart agriculture (CSA)" in West Africa, prominent agricultural advancements that offer CSA guidelines in the region, organizational system is a system to help scale CSA, and to enhance understanding of CSA concepts and some challenges to scaling up in West Africa, this paper will draw on the body of available literature. According to the examined academic research, CSA appears to be a viable strategy for tackling the problems associated with food security, climate change adaptation, and mitigation. Numerous "CSA technologies", agroforestry (farmer-managed natural rejuvenation, rotational trees), technologies for water and soil conservation (joy, crescent, conservation agriculture), and climate information systems are very valuable and promising

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019**

options for coping with climate change and reducing risk. region. Additionally, it was discovered that increasing capacity was aided by the construction of West Africa's CSA, national scientific policy debate platforms on CSA, institutionalized bodies at community, national, and regional levels, and multistakeholder innovation platforms. Development and promotion of CSA innovations and technologies in the area. CSA yet confronts a lot of difficulties. An easy design analysis computation requiring little quantitative input makes up the combined TOPSIS-CSA application. In this study, multivariate linear regression analysis with the TOPSIS method and CSA are combined to find significant factors by adapting a polynomial to empirical observations. The cost, time, and number of arithmetic operations for applying the TOPSIS model were significantly lowered by the econometric discourse. Comparing TOPSIS meta-model deployments to other MADM techniques like AHP, DEA, ELECTRE, SAW, and GRA, they are highly straightforward and simple to use. Improved crop varieties is got first rank and Irrigation technologies is got lowest rank

REFERENCE

[1]. Partey, Samuel T., Robert B. Zougmoré, Mathieu Ouédraogo, and Bruce M. Campbell. "Developing climate-smart agriculture to face climate variability in West Africa: Challenges and lessons learnt." Journal of cleaner Production 187 (2018): 285-295.

[2]. Tran, Nhat Lam Duyen, Roberto F. Rañola Jr, Bjoern Ole Sander, Wassmann Reiner, Dinh Tien Nguyen, and Nguyen Khanh Ngoc Nong. "Determinants of adoption of climate-smart agriculture technologies in rice production in Vietnam." International journal of climate change strategies and management 12, no. 2 (2016): 238-256.

[3]. Taylor, Marcus. "Climate-smart agriculture: what is it good for?." The Journal of Peasant Studies 45, no. 1 (2018): 89-107.

[4]. Chandra, Alvin, Karen E. McNamara, and Paul Dargusch. "Climate-smart agriculture: perspectives and framings." Climate Policy 18, no. 4 (2018): 526-541.

[5]. Lipper, Leslie, Philip Thornton, Bruce M. Campbell, Tobias Baedeker, Ademola Braimoh, Martin Bwalya, Patrick Caron et al. "Climate-smart agriculture for food security." Nature climate change 4, no. 12 (2014): 1068-1072.

[6]. Venkatramanan, V., and Shachi Shah. "Climate smart agriculture technologies for environmental management: the intersection of sustainability, resilience, wellbeing

ISSN PRINT 2319 1775 Online 2320 7876
Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019
and development." Sustainable green technologies for environmental management (2019): 29-51.

[7]. Mwongera, Caroline, Kelvin M. Shikuku, Jennifer Twyman, Peter Läderach, Edidah Ampaire, Piet Van Asten, Steve Twomlow, and Leigh A. Winowiecki. "Climate smart agriculture rapid appraisal (CSA-RA): A tool for prioritizing context-specific climate smart agriculture technologies." Agricultural systems 151 (2017): 192-203.

[8]. Long, Thomas B., Vincent Blok, and Ingrid Coninx. "Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy." Journal of cleaner production 112 (2016): 9-21.

[9]. Kurgat, Barnabas K., Christine Lamanna, Anthony Kimaro, Nictor Namoi, Lucas Manda, and Todd S. Rosenstock. "Adoption of climate-smart agriculture technologies in Tanzania." Frontiers in sustainable food systems 4 (2015): 55.

[10]. Nyasimi, Mary, Philip Kimeli, George Sayula, Maren Radeny, James Kinyangi, and Catherine Mungai. "Adoption and dissemination pathways for climate-smart agriculture technologies and practices for climate-resilient livelihoods in Lushoto, Northeast Tanzania." Climate 5, no. 3 (2017): 63.

[11]. Barasa, Paul M., Christina M. Botai, Joel O. Botai, and Tafadzwanashe Mabhaudhi. "A review of climate-smart agriculture research and applications in Africa." Agronomy 11, no. 6 (2014): 1255.

[12]. Adamides, George. "A review of climate-smart agriculture applications in Cyprus." Atmosphere 11, no. 9 (2016): 898.

[13]. Mutenje, Munyaradzi Junia, Cathy Rozel Farnworth, Clare Stirling, Christian Thierfelder, Walter Mupangwa, and Isaiah Nyagumbo. "A cost-benefit analysis of climate-smart agriculture options in Southern Africa: Balancing gender and technology." Ecological Economics 163 (2019): 126-137.

[14]. Wang, Zheng-Xin, and Yan-Yu Wang. "Evaluation of the provincial competitiveness of the Chinese high-tech industry using an improved TOPSIS method." Expert Systems with Applications 41, no. 6 (2014): 2824-2831.

[15]. Chen, Pengyu. "Effects of normalization on the entropy-based TOPSIS method." Expert Systems with Applications 136 (2019): 33-41.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019**

[16]. Tsaur, Ruey-Chyn. "Decision risk analysis for an interval TOPSIS method." Applied Mathematics and Computation 218, no. 8 (2011): 4295-4304.

[17]. Vafaei, Nazanin, Rita A. Ribeiro, and Luis M. Camarinha-Matos. "Data normalisation techniques in decision making: case study with TOPSIS method." International journal of information and decision sciences 10, no. 1 (2018): 19-38.

[18]. Huang, Jingwen. "Combining entropy weight and TOPSIS method for information system selection." In 2008 ieee conference on cybernetics and intelligent systems, pp. 1281-1284. IEEE, 2008.

[19]. Monjezi, Masoud, Hadi Dehghani, T. Narain Singh, Ahmed Reza Sayadi, and Ahamad Gholinejad. "Application of TOPSIS method for selecting the most appropriate blast design." Arabian journal of geosciences 5, no. 1 (2012): 95.

[20]. Li, Xiangxin, Kongsen Wang, Liwen Liu, Jing Xin, Hongrui Yang, and Chengyao Gao. "Application of the entropy weight and TOPSIS method in safety evaluation of coal mines." Procedia engineering 26 (2011): 2085-2091.

[21]. Çelikbilek, Yakup, and Fatih Tüysüz. "An in-depth review of theory of the TOPSIS method: An experimental analysis." Journal of Management Analytics 7, no. 2 (2012): 281-300.

[22]. İç, Yusuf Tansel. "An experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies." Robotics and Computer-Integrated Manufacturing 28, no. 2 (2012): 245-256.

[23]. Sarkar, Asis. "A TOPSIS method to evaluate the technologies." International Journal of Quality & Reliability Management 31, no. 1 (2013): 2-13.

[24]. de Farias Aires, Renan Felinto, and Luciano Ferreira. "A new approach to avoid rank reversal cases in the TOPSIS method." Computers & Industrial Engineering 132 (2019): 84-97.

[25]. Byun, H. S., and K. H. Lee. "A decision support system for the selection of a rapid prototyping process using the modified TOPSIS method." The International Journal of Advanced Manufacturing Technology 26 (2005): 1338-1347.

[26]. Rahim, Robbi, S. Supiyandi, A. P. U. Siahaan, Tri Listyorini, Andy Prasetyo Utomo, Wiwit Agus Triyanto, Yudie Irawan et al. "TOPSIS method application for decision support system in internal control for selecting best employees." In Journal of Physics: Conference Series, vol. 1028, p. 012052. IOP Publishing, 2018.