IJOEAR

International Journal of Environmental & Agriculture Research

www.ijoear.com

ISSN
2454-1850

Volume-5, Issue-11, November 2019

Preface

We would like to present, with great pleasure, the inaugural volume-5, Issue-11, November 2019, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas

Environmental Research:

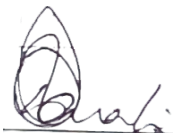
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

Mukesh Arora
(Editor-in Chief)



Dr. Bhagawan Bharali
(Managing Editor)

Fields of Interests

Agricultural Sciences	
Soil Science	Plant Science
Animal Science	Agricultural Economics
Agricultural Chemistry	Basic biology concepts
Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
Crop Production	
Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
Sugar crops: sugarcane. sugar beets, sorghum	Potatoes varieties and production.
Livestock Production	
Animal husbandry	Ranch
Camel	Yak
Pigs	Sheep
Goats	Poultry
Bees	Dogs
Exotic species	Chicken Growth
Aquaculture	
Fish farm	Shrimp farm
Freshwater prawn farm	Integrated Multi-Trophic Aquaculture
Milk Production (Dairy)	
Dairy goat	Dairy cow
Dairy Sheep	Water Buffalo
Moose milk	Dairy product
Forest Products and Forest management	
Forestry/Silviculture	Agroforestry
Silvopasture	Christmas tree cultivation
Maple syrup	Forestry Growth
Mechanical	
General Farm Machinery	Tillage equipment
Harvesting equipment	Processing equipment
Hay & Silage/Forage equipment	Milking equipment
Hand tools & activities	Stock handling & control equipment
Agricultural buildings	Storage

Agricultural Input Products	
Crop Protection Chemicals	Feed supplements
Chemical based (inorganic) fertilizers	Organic fertilizers
Environmental Science	
Environmental science and regulation	Ecotoxicology
Environmental health issues	Atmosphere and climate
Terrestric ecosystems	Aquatic ecosystems
Energy and environment	Marine research
Biodiversity	Pharmaceuticals in the environment
Genetically modified organisms	Biotechnology
Risk assessment	Environment society
Theoretical production ecology	horticulture
Breeding	plant fertilization

Board Members

Goswami Tridib Kumar

Presently working as a Professor in IIT Kharagpur from year 2007, He Received PhD degree from IIT Kharagpur in the year of 1987.

Dr. Mahendra Singh Pal

Presently working as Professor in the dept. of Agronomy in G. B. Pant University o Agriculture & Technology, Pantnagar-263145 (Uttarakhand).

Jiban Shrestha

Scientist (Plant Breeding & Genetics)

Presently working as Scientist (Plant Breeding and Genetics) at National Maize Research Programme (NMRP), Rampur, Chitwan under Nepal Agricultural Research Council (NARC), Singhdarbar Plaza, Kathmandu, Nepal.

Dr. V K Joshi

Professor V.K.Joshi is M.Sc., Ph.D. (Microbiology) from Punjab Agricultural University, Ludhiana and Guru Nanak Dev University, Amritsar, respectively with more than 35 years experience in Fruit Fermentation Technology, Indigenous fermented foods, patulin ,biocolour ,Quality Control and Waste Utilization. Presently, heading the dept. of Food Science and Technology in University of Horticulture and Forestry, Nauni-Solan (HP), India.

Mr. Aklilu Bajigo Madalcho

Working at Jigjiga University, Ethiopia, as lecturer and researcher at the College of Dry land Agriculture, department of Natural Resources Management.

Dr. Vijay A. Patil

Working as Assistant Research Scientist in Main Rice Research Centre, Navsari Agricultural University, Navsari. Gujarat- 396 450 (India).

Dr. S. K. Jain

Presently working as Officer Incharge of All India Coordinated Sorghum Improvement Project, S. D. Agricultural University, Deesa, Gujarat.

Dr. Salvinder Singh

Presently working as Associate Professor in the Department of Agricultural Biotechnology in Assam Agricultural University, Jorhat, Assam.

Dr. Salvinder received MacKnight Foundation Fellowship for pre-doc training at WSU, USA – January 2000- March 2002 and DBT overseas Associateship for Post-Doc at WSU, USA – April, 2012 to October, 2012.

Mr. Anil Kumar

Working as Junior Research Officer/Asstt. Prof. in the dept. of Food Science & Technology in Agriculture & Technology, Pantnagar.

Muhammad Farooq

Mphil (Food Technology) Gold Medalist

PhD Scholar, Food Science and Biological Engineering, Jiangsu University in China

Production Manager Zeal Food & Beverages Industry Aladand Road, Amandara Batkhela Malakand Agency KP. He developed the skills for Preparation of different fruit pulp preserve Orange, Peach, Guava, Strawberry, and orange squash, orange marmalade.

Dr. Deshmukh Amol Jagannath

Presently working as Assistant Professor in Dept. of Plant Pathology, College of Agriculture polytechnic, NAU, Waghai.

Table of Contents

S.No	Title	Page No.
1	**Impact of Solid Waste Management Practices on Environmental Protection Case of Kicukiro District** **Authors:** Mukeshimana Mionne, Abias Maniragaba, Francois Xavier Nshimiyimana **DOI:** https://dx.doi.org/10.5281/zenodo.3558827 **Digital Identification Number:** IJOEAR-NOV-2019-2	**01-07**
2	**Paper Removed**	
3	**Optimization of antibiotic activity of composites of ethanolic extracts of flower of Mangifera indica, Gongronema latifolium leaves and Citrus sinensis peel using the mixture experimental design of the response surface methodology** **Authors:** Ta'awu, K. G., Ekanem, M. C., Udofia, P. G. **DOI:** https://dx.doi.org/10.5281/zenodo.3558833 **Digital Identification Number:** IJOEAR-NOV-2019-6	**17-22**
4	**Trends and Pattern of Crop Diversification in Kheri District, Uttar Pradesh, India** **Authors:** Moin Khan, Dr. Ateeque Ahmad **DOI:** https://dx.doi.org/10.5281/zenodo.3558835 **Digital Identification Number:** IJOEAR-NOV-2019-7	**23-32**

Impact of Solid Waste Management Practices on Environmental Protection Case of Kicukiro District

Mukeshimana Mionne[1*], Abias Maniragaba[2], Francois Xavier Nshimiyimana[3]

University of Lay Adventists of Kigali (UNILAK), P.O. Box 6392 Kigali-Rwanda

Abstract— *This Solid waste management practices are essential component of environmental infrastructure in human settlements; its poor management can lead to health problem and environmental destruction in general, this study was conducted in Kicukiro district. The data were collected on the sample of 97 households and some authorities through questionnaires, and interview and were analyzed using SPSS Version 20 (statistical tools) and this helped in generating tables and performing descriptive statistics like percentages, frequency, and mean.*

The results obtained revealed that that in terms of waste segregation is explained excluding solid wastes from liquid wastes considering the mean of 2.73 which was interpreted as high mean. Those results influenced the grand mean to become 2.04 which is interpreted as low mean. This means that waste segregation practices is not efficiently done in households located in Kicukiro. It was revealed that transportation of wastes is characterized by the short time of loading wastes considering the mean of 2.91 which is interpreted as high mean. The findings revealed that the environmental protection in Kicukiro District is characterized by the following: little harmful materials (plastic packages) in the soils considering the mean of 3.18. This showed that there is link between solid waste management practices and environmental protection in Kicukiro District. For proper practices of waste management which is positive but only for waste transportation to have a significant relationship with environmental protection considering the correlation coefficient of 0.259 and the p-value or Sig.(2-tailed) of 0.010 which is below the p-alpha of 0.05. It is recommended that Kicukiro District has to launch a sustained, education and communication campaign informing residents on the importance of managing waste properly and its importance to their health, the environment and cleanliness of the city or use another waste reduction strategy in order to encourage recyclable production of goods to allow access to recyclable products.

Keywords— Solid Waste Management, environmental protection.

I. INTRODUCTION

Solid waste management practices are essential component of environmental infrastructure in human settlements. These practices encompass all activities undertaken from the point of waste generation up to the final disposal. In most of African urban areas, solid waste management is ultimately a responsibility of Municipal Councils while most cases of rural areas the wastes are handled and disposed at the household level (Frank, 2006). and Rwanda is not an exceptional (ADB, 2012).

Accordingly, Kigali town's waste contains still 70 percent of organic, biodegradable waste and in rural areas the portion of waste reach more than 95 percent. Waste sorting, composting and recycling activities have been at the very beginning and until 2015 and yet Rwanda has started to invest in environmentally safe landfills. The operating dumpsite receives about 400 tons per day of solid, not sorted waste or 140,000 tons per year (MININFRA, 2013).

Management of solid waste is a global problem and is faced by all developing countries. The rapid pace of increase in population, economic growth, urbanization and industrialization is coupled with accelerated solid waste generation.

The management of solid waste stands as the most visible environment problem facing the districts in Rwanda and is attaining a worrisome dimension with urbanization increment rate. Despite the rapid growth of its population, districts have never had any clear Master plan to re-organize the planning and settlement since colonial era. This has put pressure on the infrastructure which has resulted in many complex problems regarding settlement notably waste management, where the solid waste problem is visible in most parts of the districts' urban centers; on the roads, within the neighborhoods and around residential buildings and in different places of the urban areas. Failure to address waste management related issues is expected to lead to numerous social and environmental contaminations (Nshimiyimana, 2015).

The Government of Rwanda has made waste management one of the priority areas in achieving vision 2020. During the Economic Development for Poverty Reduction Strategy (EDPRS) I period (2008-2012), the sector aimed at improving the environmental health and hygiene conditions of the population by promoting safer methods of waste disposal from community and health facilities. EDPRS II (2013-2018) stipulates that because of the rapid urbanization which will occur in Rwanda in the next five years, with 35% of the population envisaged to live in urban areas by 2020, it is likely to have huge economic and environmental impacts, through increased pressure on urban infrastructure, such as transport and solid and liquid waste (SLW) management systems. Regarding that this study aims at inspect the impact of current waste management practices on environmental protection in Rwanda by taking the case of Kicukiro District.

II. MATERIALS AND METHODS

2.1 Population of the study

The target population of this study was composed by households and private people involved in collecting wastes in Kicukiro District, precisely Kicukiro district where 3219 are the households and the managing director of Ubumwe Cleaning Company as well as the officer in charge of environment participated.

This study was conducted in Kicukiro District which is located in Kigali city. Kicukiro district is one of the three districts of Kigali City. Kicukiro District is located Latitude :-$2^0$0'14.08"and Longitude: $30^0$8'49.05" urban area have 318,564 total population (C2012) ,12 sectors, Area :167 km^2,Density:1900/km^2(4,900/sq.mi) and urbanization (C2012) Rural:38,623,Urban :279, 941. Kicukiro district is part of Kigali City where people emigrate from different areas for different reasons including socio-economic needs, like formal and informal jobs, business and life style. The choice of this district it has been performed well regarding waste management do by Ubumwe Cleaning Company.

2.2 Sample size

William (2004) noted that sampling is a devise or a way that is used in selecting of the members is able to question, or who are a fair presentation of all the members in a union. However the formula of Taro Yamane was used to calculate the sample size

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Source: Yamane,1967

Where N= Total population, n=Sample size, and e= Error margin

Applying the above formula, the sample employed for this study was calculated from the total 3219 households from Kicukiro district. The sample was calculated as follows

$$n = \frac{3219}{1+3219(0.1)^2} = 97 \quad (2)$$

III. RESULTS AND DISCUSSIONS

Table 1 show the main forms or types of wastes that are mostly exist in households. Majority of households revealed that the most wastes included garbage wastes with the percentage of 81.4%. This is due to that most of the wastes in the households are related to food residues and most of them are biodegradable.

TABLE 1
FORMS OF WASTES IN SURVEYED HOUSEHOLDS

		Frequency	Percent
Valid	Plastic wastes	9	9.3
	Garbage wastes	79	81.4
	Paper wastes	6	6.2
	Iron waste	3	3.1
	Total	97	100.0

Source: Primary data, 2018

3.1 Status of solid waste management practices in Kicukiro district

3.1.1 Status of waste segregation in Kicukiro

TABLE 2
PERCEPTIONS OF RESPONDENTS ON STATUS OF WASTE SEGREGATION IN KICUKIRO

	N	Mean	Std. Deviation
In households, wastes are segregated for facilitating collection process	97	1.81	.833
Households have different bins for each kind of wastes	97	2.13	1.027
Solid waste are excluded for liquid wastes	97	2.73	.930
Biodegradable and non-biodegradable are put into different bins	97	1.49	.503
Waste segregation	97	2.0438	.38190

Source: Primary data, 2018

Note: Categories of means: 1.00-1.85= Strongly Disagree (SD); 1.86-2.71=Disagree (D); 2.72-3.57=Agree (A); 3.58-4=Strongly Agree (SA) (Field, 2005)

In households it was revealed that waste segregation is explained excluding solid wastes from liquid wastes considering the mean of 2.73 which is interpreted as high mean but was revealed that households that were surveyed don't have different bins for each kind of waste considering the mean of 2.13 which is interpreted as low mean, not segregating waste for facilitating the collection process with the mean of 1.81 which is interpreted as very low mean.

Also households fail to put biodegradable and non-biodegradable wastes in different bins considering the mean of 1.49 which is interpreted as very low mean. Those results influenced the grand mean to become 2.04 which is interpreted as low mean. This means that waste segregation practices is not efficiently done in households located in Kicukiro.

3.1.2 Status of waste collection in Kicukiro

The second indicator of waste management practice that was considered in this study was waste collection. This concerns all activities for collecting wastes from households to landfill and the intention of this was to know if wastes are collected efficiently or not.

TABLE 3
PERCEPTIONS OF RESPONDENTS ON STATUS OF WASTE COLLECTION IN KICUKIRO

	N	Mean	Std. Deviation
There is a clear policy for waste collection	97	2.92	.986
Waste are collected in all households with affordable charge	97	2.76	1.248
Waste are collected by trained people	97	2.06	1.029
Collection of waste is done periodically	97	2.85	.833
Household help in easing the process of waste collection	97	2.68	1.036
Waste collection	97	2.6536	.49709

Source: Primary data, 2018

Note: Categories of means: 1.00-1.85= Strongly Disagree (SD); 1.86-2.71=Disagree (D); 2.72-3.57=Agree (A); 3.58-4=Strongly Agree (SA) (Field, 2005)

According to the above table 3, the effectiveness of waste collection is based on the following: clear policy for waste collection considering the mean of 2.92 which is interpreted as high mean, collection of waste in all households with affordable charges considering the mean of 2.76 which is interpreted as high mean, and collection of waste is done periodically considering the mean of 2.85 which is interpreted as high mean. But respondents found the following to be critical: collection of wastes by trained people considering the mean of 2.06 which is interpreted as low mean; where this means that wastes are not collected with people with trainings in wastes management, and households fail to easy the process of waste collection considering the mean of 2.65 which is interpreted as low mean. In the end the grand mean shows that waste collection is not practiced effectively efficiently since it is 2.65 which is interpreted as low mean.

3.1.3 Status of waste transportation in Kicukiro

Transporting wastes was not an easy task and requires special equipment. The intention of this was to know if transportation

of waste management fulfills all requirements in Kicukiro District.

Table 4 below shows the perceptions of respondents on how wastes are transported in Kicukiro District.

TABLE 4
PERCEPTIONS OF RESPONDENTS ON STATUS OF WASTE TRANSPORTATION IN KICUKIRO

	N	Mean	Std. Deviation
Loading time of wastes is not long	97	2.91	.925
Modern packing mechanisms followed for waste transportation	97	2.30	.854
Vehicles were covered during transportation	97	2.10	.653
Transportation of wastes is contracted to private agencies	97	2.75	.524
The money for waste transport are affordable	97	3.04	.735
People who collect waste are protected enough	97	2.42	.643
Waste transportation	97	2.5876	.26581

Source: Primary data, 2018

Note: Categories of means: 1.00-1.85= Strongly Disagree (SD); 1.86-2.71=Disagree (D); 2.72-3.57=Agree (A); 3.58-4=Strongly Agree (SA) (Field, 2005)

Table 4 showed the perceptions of respondents of respondents on waste transportation in Kicukiro District. It was revealed transportation of wastes is characterized by the short time of loading wastes considering the mean of 2.91 which is interpreted as high mean, transportation of wastes is contracted to private agencies considering the mean of 2.75 which is interpreted as high mean, and the money for waste collection is affordable considering the mean of 3.04 which is interpreted as high mean. But the following were found to be critical considering their means; that are following modern packing for waste transportation considering the mean of 2.30 which is interpreted as low mean, well covering the cars that transport wastes considering the mean of 2.10 which is interpreted as low mean, and people who collect waste are not protected considering the mean of 2.58 which is interpreted as low mean. Concluding to this transportation is not done in adequate manners considering the grand mean of 2.58 which is interpreted as low mean.

TABLE 5
PERCEPTIONS OF RESPONDENTS ON STATUS OF WASTE DISPOSAL IN KICUKIRO

	N	Mean	Std. Deviation
Landfill for waste are far away of the household	97	3.62	.620
There are adequate materials that are used for waste disposal	97	3.30	.543
There is effective mechanism of reducing the smell of wastes from landfill	97	2.31	.727
Biodegradable and non-biodegradable wastes are disposed differently	97	3.38	.620
Waste disposal	97	3.1521	.33571

Source: Primary data, 2018

Note. Categories of means: 1.00-1.85= Strongly Disagree (SD); 1.86-2.71=Disagree (D); 2.72-3.57=Agree (A); 3.58-4=Strongly Agree (SA) (Field, 2005)

According to the above table 5 the effectiveness of waste disposal is explained by the following: landfill for waste are far away for the households considering the mean of 3.62 which is interpreted as high mean, there are adequate materials that are used for waste disposal considering the mean of 3.30 which is interpreted as high mean, and biodegradable and non-wastes are disposed differently in landfills considering the mean of 3.38 which is interpreted as high mean. Finally, it was revealed that it was revealed that there is no effective mechanism for reducing smell of wastes from landfill considering the mean of 2.31 which is interpreted as low mean. And in conclusion it was revealed that wastes in general are disposed effectively considering the mean of 3.15 which is interpreted as high mean.

3.2 Solid waste management practices and environmental protection in Kicukiro District

The second specific objective of this study was to assess the relationship between waste management practices and environmental protection. This was achieved by correlating the results of the independent variable and the dependent variable meaning results of waste management practices and environmental protection. The correlation helps to show the relationship between variables where its positive value explains the positive relationship. And the significance relationship should be tested where the significance level of 0.05 was used in this study where the p-value less than the significance level indicates

the significance of the relationship.

TABLE 6
CORRELATIONS BETWEEN WASTE MANAGEMENT PRACTICES AND ENVIRONMENTAL PROTECTION

		Environmental protection
Waste segregation	Pearson Correlation	.035
	Sig. (2-tailed)	.733
	N	97
Waste collection	Pearson Correlation	.101
	Sig. (2-tailed)	.323
	N	97
Waste transportation	Pearson Correlation	.259*
	Sig. (2-tailed)	.010
	N	97
Waste disposal	Pearson Correlation	.098
	Sig. (2-tailed)	.338
	N	97
*. Correlation is significant at the 0.05 level (2-tailed).		

Note: $r_s = 1$: perfect correlation, $0.9 \leq r_s < 1$: strong correlation(very high),$0.7 \leq r_s < 0.9$:high correlation, $0.5 \leq r_s < 0.7$:moderate correlation, $r_s < 0.5$:weak(low) correlation, $r_s = 0$: absence of correlation.

Table 6 showed the correlation between waste management practices and environmental protection. To all practices of waste management practices the relationship is positive but only for waste transportation to have a significant relationship with environmental protection considering the correlation coefficient of 0.259 and the p-value or Sig. (2-tailed) of 0.010 which is below the p-alpha of 0.05.

IV. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

4.1 Summary of findings

This study focus was to examine the impact of solid waste management practices on environmental protection conducted in Kicukiro district in order to evaluate solid waste management practices in terms of waste segregation, collection, transportation, and disposal in Kicukiro District.

In term of waste segregation, the results of solid wastes from liquid wastes considering the mean of 2.73 which is interpreted as high mean but households that were surveyed don't have different bins for each kind of waste considering the mean of 2.13 which is interpreted as low mean. Segregating waste for facilitating the collection process with the mean of 1.81 which is interpreted as very low mean,. Those results influenced the grand mean to become 2.04 which means that waste segregation practices is not efficiently done in households located in Kicukiro.

Concerning waste collection, it was found that the effectiveness of waste collection is based on the following: clear policy for waste collection considering the mean of 2.92 which is interpreted as high mean, collection of waste in all households with affordable charges considering the mean of 2.76 which is interpreted as high mean, and collection of waste is done periodically considering the mean of 2.85 which is interpreted as high mean.

In the end the grand mean shows that waste collection is not practiced effectively efficiently since it is 2.65 which are interpreted as low mean.

It was revealed transportation of wastes is characterized by the short time of loading wastes considering the mean of 2.91 which is interpreted as high mean, transportation of wastes is contracted to private agencies considering the mean of 2.75 which is interpreted as high mean, and the money for waste collection is affordable considering the mean of 3.04 which is interpreted as high mean. Concluding to this transportation is not done in adequate manners considering the grand mean of 2.58 which is interpreted as low mean. The effectiveness of waste disposal was revealed that wastes in general are disposed effectively considering the mean of 3.15 which is interpreted as high mean.

In general all practices of waste management practices the relationship is positive but only for waste transportation to have a significant relationship with environmental protection considering the correlation coefficient of 0.259 and the p-value or Sig.(2-tailed) of 0.010 which is below the p-alpha of 0.05. This indicates that waste transportation us key factors to environmental protection but more are need to be done for improving the whole system of waste management practices.

4.2 Conclusion

The focus of the study was to investigate the impacts of solid waste management practices on environmental protection. It was found that with the increasing in the global population and the rising demand for food and other essentials, there has been a rise of the amount of waste being generated daily by each household. To all practices of waste management practices the relationship is positive but only for waste transportation to have a significant relationship with environmental protection considering the correlation coefficient of 0.259 and the p-value or Sig.(2-tailed) of 0.010 which is below the p-alpha of 0.05.. The sustainability of our environment, an adequate sort from household level is a requirement for a good management of solid waste. This is only successful after education of the people and their involvement in waste handling and separate waste like degradable and non-degradable waste.

After the sort, some fractions must be transformed in marketable things such as: compost and biological digestion can also yield biogas that can be used as the source of energy. Other material like metal and plastic bags can be recycling of other materials. Landfill site must be the last option for treating ultimate solid waste and this must be done under environmental condition.

4.3 Recommendations

Governments have a range of policy options to encourage waste management practices that will reduce greenhouse gas emissions. Practical approaches that could be applied in most cities include:

- Public education to inform people about their options to reduce waste generation and increase recycling and composting.
- Pricing mechanisms, such as product charges can stimulate consumer behavior to reduce waste generation and increase recycling. A product charge is a cost assessment added to the price of a product and is tied to the cost of the desired waste management system. Consumers would pay for the waste management service when they buy the product. The fees collected would be directed to municipalities relative to the waste generated.
- Another pricing mechanism well suited to urban areas is user charges tied to quantity of waste disposed. Consumers who separate recyclables pay a lower fee for waste disposal. This pricing policy can work well in locations where waste collection is from individual households so that waste quantities for disposal can be readily monitored. However, it may not be practical in many areas in developing countries, particularly in those where there are communal collection points associated with multi-unit households (such as apartment user charges tied to quantity or volume).
- Preferential procurement policies and pricing to stimulate demand for products made with recycled post-consumer waste. Use of compost in public parks and other property owned by cities

REFERENCES

[1] Achankang, E. (2003). Globalisation, Urbanisation and Municipal Solid Waste Management in Africa. African Studies Association of Australasia and the Pacific Conference Proceedings – Africa on a Global Stage. University of Adelaide.

[2] Alamgir, M. C. McDonald, K. E. Roehl, and A. Ahsan (2005). Integrated Management and Safe

[3] Armah, N.A. (1993). Waste Management. The Future of Our Cities. Proceedings of the Ghana Academy of Arts and Sciences. Volume XXVIII. Pp 78-83. Accra. GAAS.

[4] Attahi, K. (1999). Abidjan, Cote d'Ivoire. Onibokun, A. G. (Ed). Managing the Monster. Urban Waste and Governance in Africa. Pp. 11- 48. Ottawa, IDRC.

[5] Cointreau, S. (2001). Declaration of Principles for Sustainable and Integrated Solid Waste Management. Accessed at: http://web.worldbank.org. 17/06/10.

[6] Cooper, J. (1999). Solid Waste Management in Copenhagen. Atkinson, A. et al., 1999. The Challenges of Environmental Management in Urban Areas. Aldershot and Vermont, Ashgate

[7] CPCB. (2013). Status report on municipal solid waste management. Retrieved from http://www.cpcb.nic.in/divisionsofheadoffice/pcp/MSW_Report.pdfhttp:// pratham.org/images/paper_on_ragpickers.pdf

[8] Cronbach, L. J. (1951) "My current thoughts on coefficient alpha and successor procedures" Educational and Psychological Measurement 64(3) 391-418. DOI.Centers for Disease and Control. (2009). Solid Waste. Retrieved July 16,from http://www.cdc.gov/nceh/ehs/NALBOH/NALBOH-4.pdf

[9] Davies, A. R. (2008). The Geographies of Garbage Governance: Interventions, Interactions and Outcomes. London, Ashgate

[10] Devas, N. (1999).Who Runs Cities? The Relationship Between Urban Governance, Service Delivery and Poverty. Urban Governance, Poverty and Partnerships. Theme Paper 4. Birmingham. The School of Public Policy. University of Birmingham.Disposal of Municipal Solid Waste in Least Developed Asian Countries: A Feasibility

[11] Dernbach H, Henning KD. Purification steps for landfill gas utilization in cogeneration modules. Resour Conserv 1987;14:273– 82.

[12] EPA. (2002) Domestic Waste Management Ghana Environmental Protection .Agency Newsletter, 47, (5) 5.Accra, Ghana EPA.

[13] Gall et al (1996: Business Research Methods (8th ed.) Ohio: South-Western college publishing.

[14] Gbekor, A. (2003). Domestic Waste Management. Ghana Environmental Protection Agency (EPA) Newsletter Vol. 47 No. 5. Accra, Ghana EPA.

Optimization of antibiotic activity of composites of ethanolic extracts of flower of *Mangifera indica, Gongronema latifolium* leaves and *Citrus sinensis* peel using the mixture experimental design of the response surface methodology

Ta'awu, K. G.[1], Ekanem, M. C.[2], Udofia, P. G.[3]

[1]Department of Food Science and Technology, Federal Polytechnic, Mubi, Adamawa State
[2,3]Department of Food Technology, Akwa Ibom State Polytechnic, Ikot Osurua

Abstract— *The generation of pathogenic microorgannisms is overwhelming the potency, safety and cost of synthetic antibiotics. The study south insight for the use of plant materials to fight microbes and optimized antibiotic activity of pure, binary and ternary blends of ethanol extracts of flower of Mangifera india, Gongronema latifolium leaves, Citrus sinensis peel on Streptococcus aureus using the Simplex Lattice {3,3} mixture experimental design of the response surface methodology (RSM). Fourteen (14) blends of the plants' parts were produced and tested on the S. aureus. Inhibition zones inhibited by the extract blends ranged between 11-19 mm. Blends C and BC exhibited the highest value of 19 mm. Other blends equally exhibited some inhibition effects on the growth of the test microorganism, however, decreasing in values as their proportions in the blends carried. ANOVA on the data revealed that the model of the experiment was significant ($p<0.05$; $R^2=0.8350$), the pure; A, B, C, and the ternary blends, ABC, were significant in the model ($p<0.05$). Although other blends were n ot statistically significant ($p>0.05$), the graphic and the equation indicated their positive contributions to the model. The model showed overall mean inhibition zone of 14.11 mm compared to 22.5 mm observed in Levofloxacin on the test organism. The study showed that ethanolic extracts of the plants' parts could provide the basis for engineering and synthesis of potent antibiotics.*

Keywords— Synthetic antibiotics, shynergism, Simplex Lattice design, antibiotics activity, zone of inhibition.

I. INTRODUCTION

Microbial infectious diseases are leading causes of morbidity and mortality in the developing world. It is estimated that about 60% of the earth's biomass comprises of microbes. The genetic, metabolic and physiological diversity of microbes makes the war against them difficult, hence it continued negative effect on health the world over (Radulovic *et al.,* 2013).Synthetic antibiotics are the major antimicrobial drugs used to control and treat health problems in man and farm birds and animals (Cech *et al.,* 2013). Most antibiotics are expensive, generate multi-drug resistant pathogens and parasites, they are toxic to man and the environment. In order to circumvent the negative effect of synthetic antibiotics, herbal medicine is gaining some recognition and prevalence of use (Welz *et al*., 2018). Herbal medicines are eco-friendly and bio-friendly because the plant sources are nutritious and edible. They contain phyto chemicals; vitamins and nutrients which are needed separately in foods for good health. Besides, they have served as foods and health tonics for generations today without reported adverse health effect (Welz et al., 2013).

Antimicrobial activities of many plants have been widely studied as possible alternatives to the synthetic counterparts. For instance, (Rasulovic *et al*., 2013) have reported activities of extracts of parts of *Moringa oleifera* against some pathogenic microorganisms. *Mangiferaindia, Gongronema latifolium* and, *Citrus sinensis* peel are underutilized wastes of edible plants (Ugochukwu and Babady, 2002). *Citrus sinensis* peels are rich in Vitamin C, fibre, and many nutrients, including phenolics and flavonoids which are also good antioxidant agents. *M. indica* contains alkaloids, they are used as a basic medicinal agent for their analgesic, antispasmodic and bactericidal effects. According to Chinedu and Friday (2015), *Gongronema latifolium* leaves contain alkaloids, glycosides, tannin, saponin, and flavonoids all of which are antioxidants and antimicrobial. *Staphylococcus aureus* is a leading cause of food poisoning (Ogston *et al.,* 1984).It is a gram-positive, catalase positive cocci belonging to the staphylococcaceae family. *S. aureeus* is approximately 0.5-7.5μm diameter, non-motile, non-spore forming,

facultative anaerobes. *S. aureus* is part of human flora and are primarily found in the nostrils and other body cavities, often implicated in a variety of food borne diseases (Vameen *et al.*, 2009).

Mixture experimental design of the response surface methodology optimizes the blending of individual components to obtain superior activity over single effect. The design chosen in this work is due to it accuracy, simplicity, robustness, predictability, and reproducibility (Bondari, 1999).

The aim of the study was to determine the antimicrobial potency of composites ethanol extract of flower of *Mangifera India, Gongronema latifolium leaves* and, *Citrus sinensis* peel on *Staphylococcus aureus* using the mixture experimental design of the Response Surface Methodology (RSM).

II. MATERIALS AND METHOD

2.1 Procurement of plant material and microbial cultures

Flowers of *Mangifera Indica* tree was collected from a local farm in IkotOsurua, *Gongronema latifolium* leaves and *Citrus sinensis* were obtained from a local market in IkotEkpene Local Government Area. The plants were identified and authenticated by the Botany unit of the Department of Science Technology, Akwa Ibom State Polytechnic, IkotOsurua, IkotEkpene, Akwa Ibom State as the plant parts.

2.2 Test microorganism

Test microorganism was collected and handled according to the method of Cheesbrough (2003). Pure culture of *Staphylococcus aureus* was obtained from the General Hospital, IkotEkpene Local Government Area, Nigeria. The sample was aseptically transferred to and maintained on nutrient agar, and subcultured regularly and preserved on solid media at 4^{o}C for further analysis and certainty.

2.3 Inoculaum preparation

3-4 loopful of isolated colonies was inoculated into 5 ml of suitable broth, incubated at about 37^{o}C. The actively growing bacterial suspensions were adjusted with suitable broth to obtain turbidity visually comparable to that of 0.5 McFarland standard equivalents to approximately $1x10^{8}$cfu/ml.

2.4 Sterilization

The plant materials were surfaced sterilized separately soaks in 1% mercuric chloride ($HgCl_2$) for 5 minutes and rinsing them in 4 to 5 times with distilled water before oven dried at 40^{o}C. The piece was then grounded with a manual grinder separately into powder form.

2.5 Ethanolic extraction of plant parts

1.5 Kg of powdered plant parts were separately extracted with 2 L 95% ethanol by maceration at room temperature for 12 days. The extracts were filtered using Whatman No.42filter paper; the extract was concentrated to dryness with rotary evaporator at reduced pressure. The concentrated extract was weighed and stored in an airtight glass container and kept in a refrigerator.

2.6 Preparation of blends of ethanol extract of the plant parts

The blends of ethanolic extracts of plants' parts were prepared according to the method of Bondari, (1999), in Table 1. The augmented Simplex Lattice mixture experimental design implied1, 0.5, 1/3, 2/3 or referred to as {q, m}Simplex Lattice Design, where q represents the number of factors involved with m+1 equally spaced proportions from0 to 1 for each component. All possible mixtures for {q=3, m=2} and {q=3, m=3} (Table 2). Graded proportions of the ethanolic extracts of the plant parts were mixed together to obtain blends of the extracts as follows; pure A, B, C, binary, AB, AC, BC, and the tenary and A, B, C blends. Antibiotics activity of each blend was tested on *Staphylococcus aureus* comparing the values with Levofloxacin, as a standard antibiotic.

TABLE 1
THREE-COMPONENT (A, B, AND C) SIMPLEX LATTICE
DESIGN FOR 0, 1/3, 2/3, AND 1 DESIGNATED AS {3, 3} DESIGN SITUATIONS

Component	Unit	Lower Proportion	Upper Proportion
A	-	0	1
B	-	0	1
C	-	0	1

$$A + B + C = 1 \text{ or } 100\% \quad (1)$$

2.7 Theory of mixture experimental design

According to Bondari, (1999), statistical modeling in a mixture experiment models the blending surface such that predictions of the response for any mixture component, singly or in combination, can be made empirically. Testing of the model adequacy is also an important part of the statistical procedure. The component proportions in a mixture experiment vary together like in factorial experiments because they are constrained to sum to a constant (1 or 100% for standard designs).

2.8 The Agar disc diffusion technique

The agar disc diffusion was carried out according to the method adopted by. Sterile filter paper disc 6.0 mm in diameter were impregnated with blends of flower of *Mangifera indica leaves, Gongronema latifolium leaves* and *Citrus sinesis* peel (Table 2). The blend impregnated filter papers were carefully placed aseptically on the surface of the nutrient agar that was pre-inoculated with the test organisms using sterile forceps in each plate. The plates were left undisturbed for 15 minutes after which there were incubated at 37^{o}C for 24 hours.

2.9 Measurement of zones of inhibitions

Inhibitions zones of each blend were measured according to the method of Heatley *et al.,* (2009). The diameters of the zones of inhibition of growth of the test microorganism (the paper disc) were measured using the millimeter rule.

2.10 Data analysis

Experimental design, analysis of variance and optimization analyses on the data obtained from inhibition zones of microbial colonies were carried out using the Design*Expert Ver. 11. (Stat-Ease, Inc. 2021 East Hennepin Ave, Suite 480, Minneapolis, MN 55413).

III. RESULTS AND DISCUSSION

3.1 Result

Table 2 shows response of *S. aureus* in terms of inhibition zone, to the blends of ethanolic extracts of flower of *Magnifera indica leaves, Gongronema latifolium* leaves and *Citrus sinensis* peel compared with Levofloxacin. According to the table, inhibition zones of the pure the blends of extracts of A, B, C on the test organisms ranged from 13.00 to 19.50 mm. Pure blend of *C. sinensis* showed the highest inhibition zone of 19.50 mm, followed by A, 13.0 mm, and C, 12.0 mm. The binary blends, AB, AC, BC exhibited inhibition zones of 13.0, 15.0, 19.0 mm respectively on the test organism. Also, the binary blend, AC exhibited the highest inhibition zone of 19.0 mm on the test organism, followed by AB and AC at 15.0 and 13.0 mm respectively. The centroid blends; A0.333 / B0.333 / C0.333; A0.667 / B0.166 / C0.166; A0.166 / B0.667 / C0.166; A0.166 / B0.166 / C0.667; A0.666 / B0.166 / C0.166 exhibited some growth inhibition on *S. aureus*but not comparable with the pure blends of the extracts. The results shared some comparison with the Levofloxacin, which showed a mean inhibition zones of 22.5 mm in all the trials. Synergism was observed in binary blends AB, BC. The phenomenon could be promoted by molecular interactions of chemical compounds in the plants, part extracts. The observation was in agreement with that reported by Lawal *et al.,* (2013) on ethanol extract of orange peel on *S. aureus*. The model of the design was significant ($p=0.0172$, $R^2= 0.8350$) and mean inhibition zone of 14.11 mm. Figure 1 shows that *C. sinensis* exhibited the highest potency of antibiotic activity against the test microorgnsism, from the figure also, the potency of *C. sinensis* reduced as its proportion in the blends reduced. The contour plot, (figure 2) further explained the variability of antibiotic activity of each plant part extract as the proportion varied. Equation 2 supports the practical significance of the model, showing the contribution of each

blend to the model. The growth inhibition activity of blends of the extract showed promising potential in the utilization of the plants to combat activities of pathogenic microorganisms.

TABLE 2
PROPORTIONS OF BLENDS OF EXTRACTS OF *MANGIFERA INDICA* (A), *GONGRONEMA LATIFOLIUM* (B), AND *CITRUS SINENSIS PEEL* (C) RESPONSES ON *STAPHYLOCOCCUS AUREUS*

	Composites			Coordinates	IZ (mm)	IZL (mm)
Runs	A	B	C			
11	1	0	0	1.00, 0.00, 0.00	13.0	22.5
9	0.167	0.167	0.667	0.16, .167, .667	11.5	22.5
13	0.00	0.00	1.00	0.00, 0.00, 1.00	19.5	22.5
10	0.333	0.333	0.333	0.333, 0.333, 0.333	12.0	22.5
7	0.667	0.167	0.167	0.667, 0.167, 0.167	13.0	22.5
2	0.50	0.50	0.00	0..50, 0.50, 0.00	13.0	22.5
5	0.00	0.50	0.50	0.00, 0.50, 0.50	19.0	22.5
12	0.00	1.00	0.00	0.00, 1.00, 0.00	13.0	22.5
6	1.00	0.00	0.00	1.00, 0.00, 0.00	13.5	22.5
1	0.50	0.50	0.00	0.50, 0.50, 0.00	11.5	22.5
8	0.167	0.667	0.167	0.167, 0.667, 0.167	12.5	22.5
4	0.00	1.00	0.00	0.00, 1.00, 0.00	12.0	22.5
3	0.50	0.00	0.50	0.50, 0.00, 0.50	15.0	22.5
14	0.50	0.50	0.00	0.50, 0.50, 0.00	13.5	22.5

IZ (mm) = inhibition zone in millimeters, IZL (mm) = inhibition zone of Levofloxacin in millimeters, coordinates are points on the edges of experimental space, Run = randomized experimental runs.

The activities of the test substances could be similar if the concentration of the plant extracts blends were assured, the plant blends would be expected to be more potent because they contain many more chemical compounds than the single component of the standard.

Inhibition zone =

13.28*flower of *M. indica* + 12.07**G. latifolium* leaves + 18.72**C. sinensis peel* + 2.71**M. indica* leaves**G. latifolium* - 5.96**M. indica* leaves**C. sinensis* peel + 10.74**G. latifolium* leaves**C. sinensis* peel -123.38**M. indica* leaves**G. latifolium* leaves**C. sinensis* peel (2)

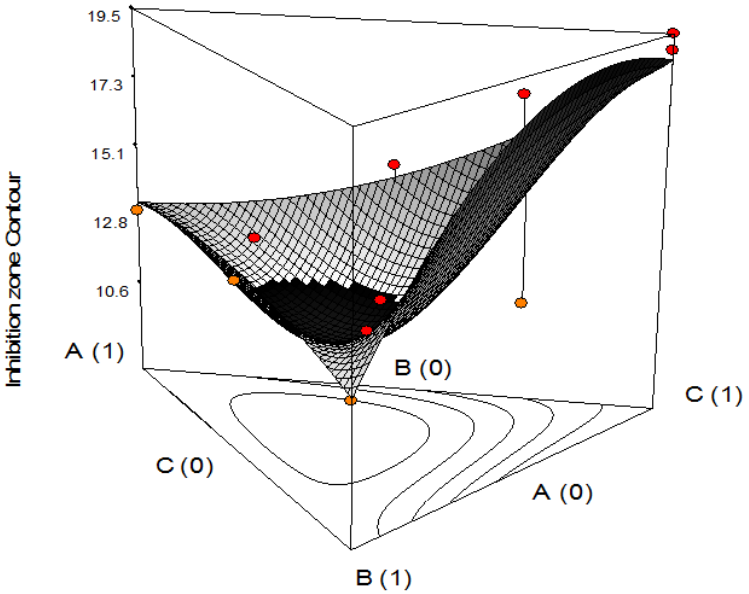


FIGURE 1: Response surface plot of inhibition zones (mm) against concentration of composites plant materials

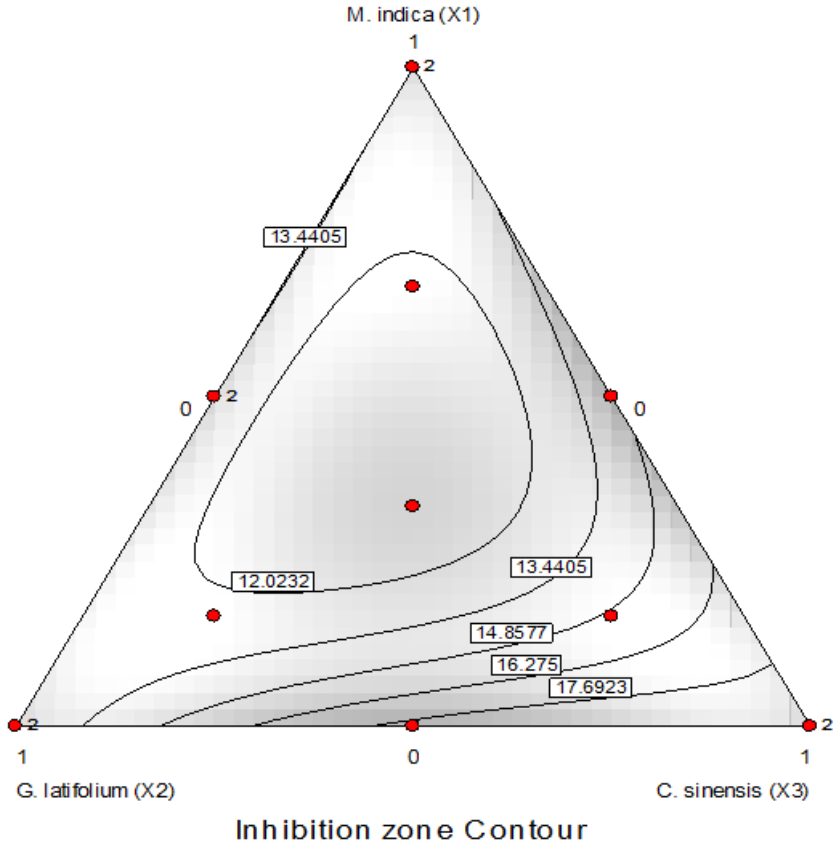


FIGURE 2: Contour plot of inhibition zones of ethanol extracts of flower *Mangifera indica, Gongronema latifolium* leaves and *Citrus sinensis* peel blends on *Staphylococcus aureus*

Growth inhibition action of blends of ethanolic extracts of flower of *Mangifera indica*, *Gongronema latifolium* and *Citrus sinensis* peel on *Staphylococcus aureus* showed good potential of antibiotic activity of the plants and good comparability of the blends with that of the Levofloxacin antibiotic. The lower inhibition zone exhibited by the blend could be attributed to lack of standardization of the concentration to meet the specificity of the test organism. Levofloxacin is a pure substance and organism specific plant extracts are broad spectrum against a wide range of microorganism.

IV. CONCLUSION

The constituent of the plants extracts could be a source of lead compounds for the development of potent broad spectrum antibiotics. The study revealed synergy and antagonism of activity as the proportion of the ethanolic extracts of plants plant varied, this could guide the combination of the component extract for optimal activity. More work should be done on the microbial activity of other parts of the plants in addition to effect of solvents and extraction time.

REFERENCES

[1] Bondari, K. (1999). Interaction in entomolong: multiple comparisons and statistical interactions in entomological experimentation. *Journal of Entomological Science.* **34:** 57-71.

[2] Cech, N. B., Junio, H. A., Ackermann, L. W., Kavanaugh, J. S. and Horswill, A. R.. (2013) Quorum quenching and antimicrobial activity of Goldenseal (*Hydrastiscanadensis*) against Methicillin-Resistant Staphylococcus aureus (MRSA). Planta Medica, 78(14):1556-1561.

[3] Cheesbrough, M.(2003). Medical laboratory Manual on tropical health technology.(low priced). England: Orington Cambridgeshire. Pp.20-23.

[4] Chinedu, I. and Friday, O. U. (2015). Phytochemical Analysis of *Gongronema latifolium* Benth Leaf Using Gas Chromatographic Flame Ionization Detector. International Journal of Chemical and Biomolecular Science, 1(2): 60-68.

[5] Heatley,N. G., Florey,H.W., Chain,E. ,Jennings,. A and Sanders, A.G. and Abraham E. P. (2009). Method for measuring the sensitivity of micro-organisms to antibiotics. Oxford University Press London **10** (1): 200-204

[6] Lawal, D. I., Bala, J. A., Aliyu, S. Y. and Huguma, M. A. (2013). Phytochemical Screening and In Vitro Antibacterial Studies of the Ethanolic Extract of *Citrus sinensis* (Linn.) Peel against Some Clinical Bacterial Isolates. *International Journal of Innovation and Applied Studies*. 2 (2): 138-145.

[7] Ogston, A.On Abscesses. Rev Infect Dis. 1984; 6:122–128. [PubMed: 6369479]

[8] Radulović, N. S. 1., Blagojević, P. D., Stojanović-Radić, Z. Z., Stojanović, N. M.. (2013). Antimicrobial plant metabolites: structural diversity and mechanism of action. Curr Med Chem. 2013; 20(7):932-52.

[9] Ugochukwu, N. H and Babady, N. E., (2002).Antioxidant effects of *Gongronema latifolium*in hepatocytes insulin dependent diabetes Filoterapia, 73 (7-8), 612 -618.

[10] Vameem,M.A., Nadim,H., Akhtar,N. Iram,Jared, I. and Hameed,A.(2009). Antibiotics Susceptibility profile of Methicillin-Resistant *Staphylococcus* isolated from nasal sample of hospitalized patient. *Journal of Clinical microbiology*. **25**(5): 225-334.

[11] Welz, A. N., Agnes E. and Klaus M. (2018).Why people use herbal medicine: insights from a focus-group study in Germany. BMC Complementary and Alternative Medicine. 18:92. https://doi.org/10.1186/s12906-018-2160-6.

Trends and Pattern of Crop Diversification in Kheri District, Uttar Pradesh, India

Moin Khan[1], Dr. Ateeque Ahmad[2]

Department of Geography, Aligarh Muslim University, Aligarh-202002

Abstract— *Crop diversification in India is visualized as the shift from traditionally cultivated less remunerative crops to more remunerative crops. The process of crop diversification is a result of government efforts, market conditions, and farmers' decisions according to the physical conditions of a particular area. The study has been carried out considering Lakhimpur Kheri district as the study area. The crop diversification was estimated by applying three techniques given by Gibbs and Martin, Bhatiya and Singh. Two agricultural years 2006-07 and 2016-17 are taken for the study. The study focused on the spatial comparison in which the block is the minimum unit area for the analysis. The maps for the spatial distribution of crop diversity are generated in the Arc GIS 10.2.2. A change in the crop diversification in a decade has also been examined. There was great similarity in the results by applying all the techniques, but there was some exception in some cases. The results show that, in 2006-07, the diversification was high in the northern and southern blocks like Nighasan, Dhaurehra, Isanagar, Mitauli, and Pasgawan while the blocks lying in the western and central region registered the low intensity of diversification. While, in 2016-17, southern blocks registered high crop diversification and the diversification was low in the central region in almost all the techniques applied.*

Keywords— Crop diversification, Agriculture, Kheri District, Indian Agriculture.

I. INTRODUCTION

Crop diversification, fundamentally, refers to the inclusion of a wider choice in the production of a variety of crops in a given area in order to accelerate the agricultural efficiency and to reduce risk (Papademetriou and Dent, 2001). Regional studies dealing with agricultural geography of a specific area in India illustrate the agricultural distribution in terms of their locale. Regional studies dealing with all of India have been so few and are so out of date that they are partly forgotten. Engelbrecht, in 1914, examined the distributional patterns of different crops with statistical analysis. Thus, it is the need of the hour to analyze the crop patterns of India from a regional perspective by focusing on the areal concentration and diversification of crops (Bhatiya, 1965; Radhakrishnan, 1930; Engelbrecht, 1914). Presently, Indian agriculture is passing through significant resource allocation. Two drastic phenomena that are occurring are crop diversification and agricultural-land conversion for industrialization. The policies of the government also shifting from the basic cereals to the production of so-called high value non-food commercial crops, mainly vegetables, fruits and flowers (Chakrabarti and Kundu, 2009). The period of 1970-71 to 2006-07 was a very crucial period in Indian agricultural history. The decade of the 1960s and 1970s witnessed the successful operation of the Green Revolution in a few selected areas of the economy followed by a significant change in the 1980s. The further decade of the 1990s affected by globalization led to the diversification of crops at the local level (Ghosh, 2011). The diversification of crops is very essential to generate agronomic, ecological, and risk management benefits. Cropping diversity helps to deal with the reduction in pest and disease pressures and increase nutrient cycling. These processes can decrease input requirements, enhance productivity, and reduce environmental threats from high fertilizer and pesticide applications. A shortcoming of crop diversification is potentially enhanced production risk associated with mastering the technology and biology of new crops (Smith and Young, 2003). However, agricultural diversification is seen as a possible solution for rural poverty, as distinct from the objective of strengthening the national economy (Courtenay, 1984).

II. LITERATURE REVIEW

Mandal and Dutta (1993) assessed the role of irrigation in the crop diversification in special reference to rice-based systems in Bangladesh. It has been found that the irrigation in the non-rice crops is more profitable than Boro rice. Thus, the 'vital input' for such a non-rice crop is irrigation. Although the irrigation practices were introduced in order to enhance rice production, therefore it is not appropriate for non-rice crops in the rice-based system. Zohir (1993) presumes crop

diversification to imply a greater relative emphasis on non-cereal production. In the context of agricultural scenario in Bangladesh, a farmer may cultivate all crops except rice and wheat; and an increase in their relative share in cultivated land may be characterized by enhanced crop diversification. Singh and Sidhu (2004) pointed out a very interesting fact about the agricultural pattern of Punjab. The diversified cropping pattern of Punjab drastically changed into a wheat-rice specialization over the past few decades. The diversity of crops tends to decline with time, which is a serious concern for the overuse of natural resources, ecological problems, aquifer crisis, and growing income risk. Blank (1990) suggested a new single index model (SIM) application procedure which makes ease for the user to examine the risk/return trade-off among crop portfolios. A new performance estimate is derived from the SIM to aid in ranking crop portfolios based on that trade-off. Mandal (2010) examined the cropping patterns risk management in the flood plains of Assam. The crop-growing sector in Assam is faced with higher risk and uncertainty due to frequent floods every year causing great damage to crops, livestock, and property. In such conditions, the farmers are forced to adjust the cropping pattern and cropping season to some extent.

III. OBJECTIVES

The objectives of this study are as follows:

- To examine the crop diversification in different blocks of Kheri district.
- To make a comparison of crop diversification in 10 years by using different techniques.

IV. METHODOLOGY

In the present study different techniques as to be adopted to examine the crop diversification of different areas at different times. Three main techniques have been used to make a comparison of crop diversification in different blocks to acquire more accuracy in the results. The first technique is used given by Gibbs and Martin, The second technique is applied proposed by Bhatia and the last technique is implemented is given by Singh. the detail description of these techniques has been put the following:

4.1 Gibbs and Martin's Method for Demarcating Crop Diversification Regions

$$\text{Index of Crop Diversification} = 1 - \frac{\sum X^2}{(\sum X^2)}$$

Where X is the percentage of total cropped area under an individual crop. In this technique 0 represents no diversification or monoculture and 1 represents the highest possible diversification.

4.2 Bhatia's Method for Demarcating Crop Diversification Regions

$$\text{Index of Crop Diversification} = \frac{Total\ \ Cropped\ \ Area\ \ Under\ \ x\ Crops}{Number\ \ of\ \ 'n'\ Crops}$$

Where 'x' stands for those crops which individually occupy 10 percent or more of the total cropped area. The high index value represents low diversification and low index value demonstrates the high diversification.

4.3 Singh's Method for Demarcating Crop Diversification Regions

$$\text{Index of Crop Diversification} = \frac{Percentage\ \ of\ total\ \ harvested\ \ area\ \ under\ \ 'n'\ crops}{Number\ \ of\ \ 'n'crops}$$

Where 'n' crops are those which individually occupy 5 percent or more of the total harvested area. Similar to Bhatiya's technique, the high index value represents low diversification and vice versa.

V. STUDY AREA

Lakhimpur Kheri District of Uttar Pradesh state has been taken as the study area for this study. Kheri is the largest district in Uttar Pradesh, lying along the Indo-Nepal Border. It is located in the Terai belt of Indo Gangetic Plain; moreover, the district has been placed in Eastern Uttar Pradesh, regionally. Kheri district has its headquarters in the city of Lakhimpur. Kheri district is roughly triangular in shape, pointing its apex towards the north; it is a part of Lucknow division. Kheri district

sprawls between the parallels of 27°41' and 28°42'N latitudes and 80°2' and 81°19E latitudes. Kheri District has an area of 7680 km², ranking first in size in the state.

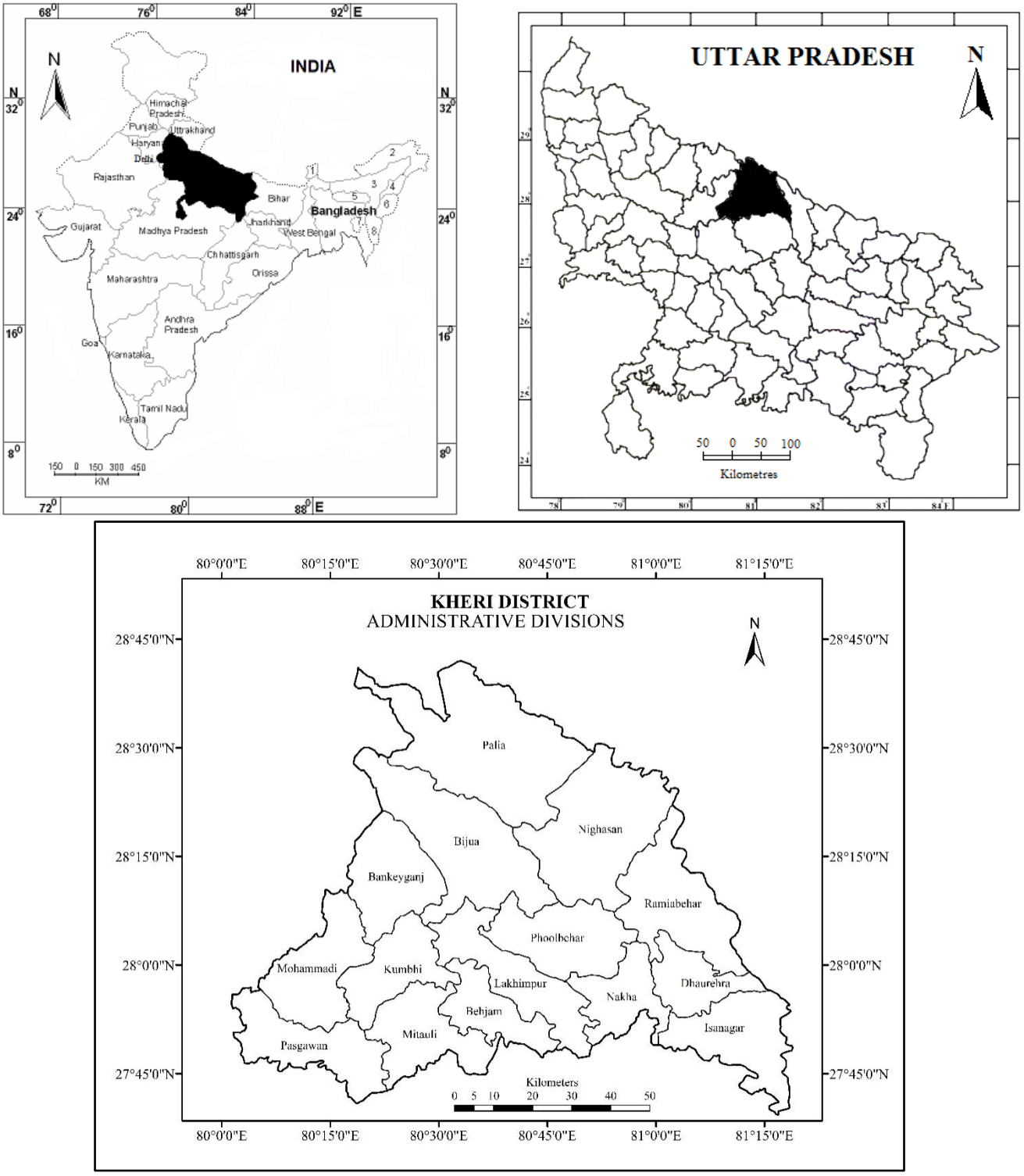


FIGURE 1: Study Area (Kheri District, Uttar Pradesh, India)

VI. RESULT AND DISCUSSION

The cropping pattern of Kheri district has been scaled by various techniques to examine the diversification of cropping pattern. The methods of Gibbs & Martin, Bhatia and Singh have been applied to blockwise data of Kheri district. The results acquired from these techniques are choroplethed in the maps and analyzed as follow:

6.1 Crop Diversification (2006-07)

The calculation made by the Gibbs and Martin's formula, the crop diversification in the district was estimated as 0.74 in 2006-07. The index varies from 0.69 in Palia block to 0.76 in Dhaurehra block recording highest diversification in the cropping pattern. The whole district has been divided into three categories by chroplething on the map.

TABLE 1
CROP DIVERSIFICATION INDEX, KHERI DISTRICT, UTTAR PRADESH 2006-07

Blocks	Gibbs & Martin	Bhatiya	Singh
Palia	0.69	29.13	23.56
Nighasan	0.75	27.96	19.24
Ramiyabehar	0.75	28.92	23.03
Kumbhi	0.74	28.92	23.82
Bijua	0.72	30.57	30.57
Bankeyganj	0.71	30.91	30.91
Mohammadi	0.72	29.72	29.72
Mitauli	0.75	28.38	19.46
Pasgawan	0.74	28.45	23.51
Behjam	0.73	29.85	29.85
Lakhimpur	0.73	29.29	29.29
Phoolbehar	0.72	30.37	30.37
Nakha	0.73	29.29	23.31
Dhaurehra	0.76	22.81	19.35
Isanagar	0.75	26.59	16.51
Kheri District	**0.74**	**28.93**	**23.26**

Source: computed by author from District Statistical magazine, Kheri District-2006-07

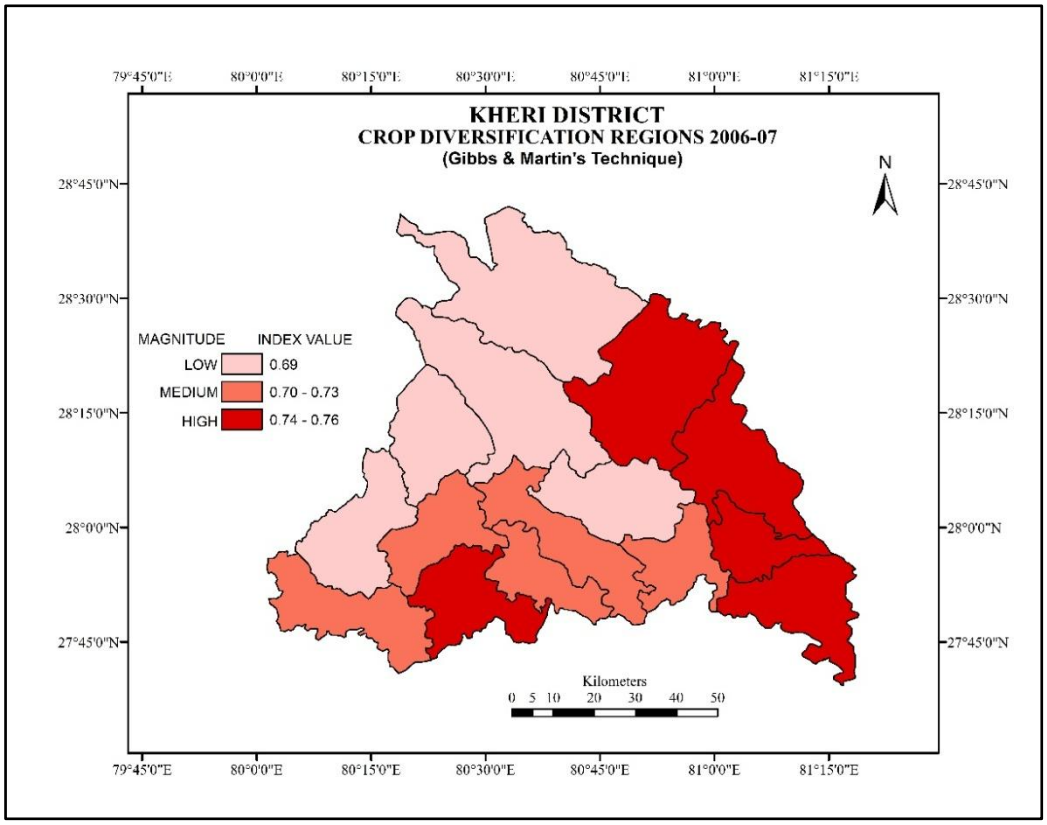


FIGURE 2: Crop Diversification Index after Gibbs & Martin

6.1.1 Area of high crop diversification

The blocks of Nighasan, Ramiabehar, Dhaurehra, and Isanagar lying in the Tarai region along the border of Nepal were indexed in the high diversification in the cropping pattern according to the Gibbs and Martin's technique (Fig 2). Besides these, Mitauli block in the southern boundary of the district also registered high diversification of the crops. All these blocks have good availability of river water throughout the year, flat floodplain rejuvenated every year by the rivers, and an adequate amount of rainfall, which supports the maximum number of crops in the district. But in the case of Mitauli, the maximum crops are grown by farmers to cope with the risk of monsoon failure.

The application of Bhatiya's technique (fig 3) finds out that high crop diversification prevails in Nighasan, Dhaurehra, Isanagar, Mitauli and Pasgavan block where index varies from 22.71 to 28.54. According to Singh's technique (fig 4), the high crop diversification lies in Nighasan, Dhauerehra, Nakha and Mitauli Blocks. Thus, it is clear from the results shown in the map that the area of high diversification is quite similar in all the indexes

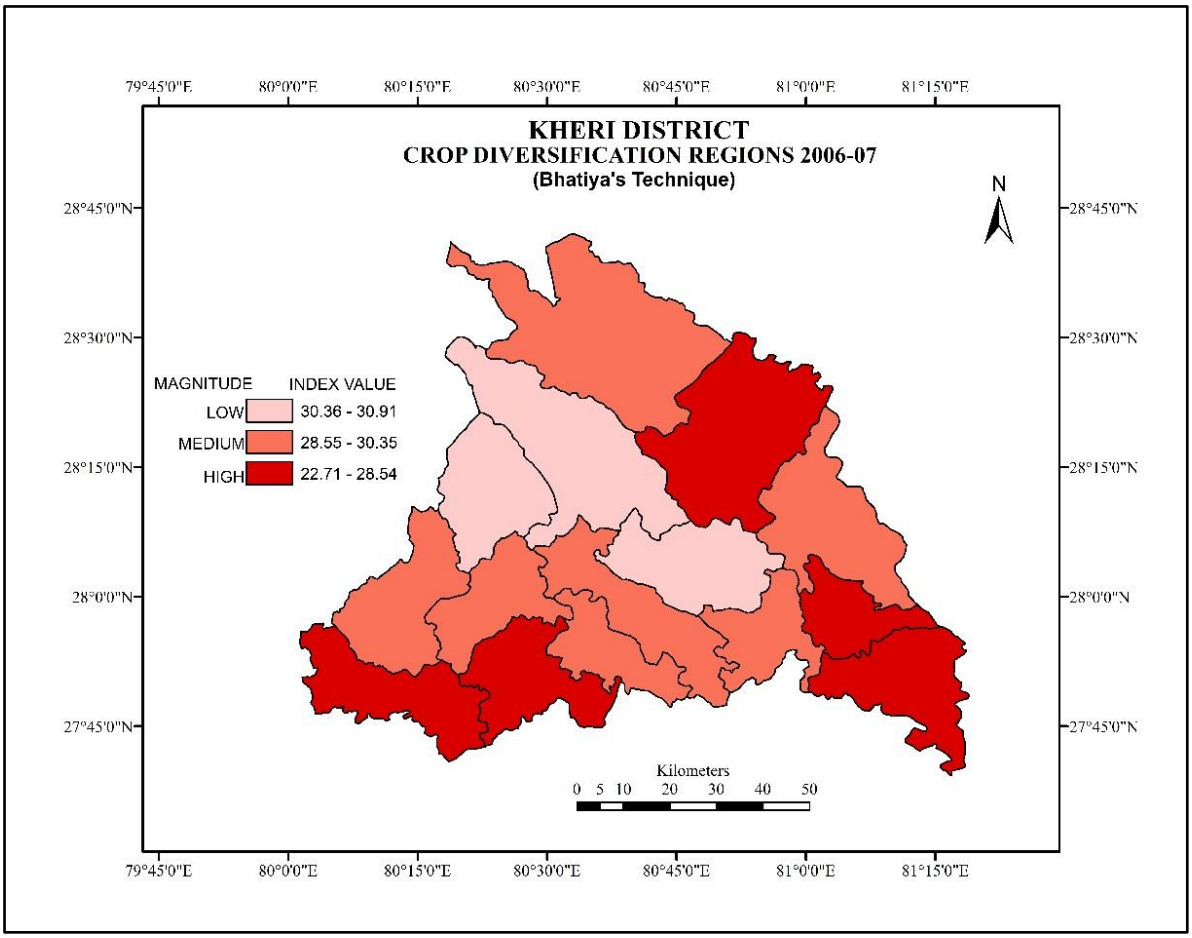


FIGURE 3: Crop Diversification Index after Bhatiya

6.1.2 Area of Moderate Crop Diversification

According to Gibbs and Martin's technique, the moderate crop diversification indexed between 0.70 and 0.73 has been registered in the blocks of Pasgawan, Kumbhi, Behjam, Lakhimpur and Nakha. In these blocks, the farmers cultivate only those crops which respond well in the prevailing physical conditions of these areas. The rain fed crops are generally cultivated in the monsoon season i.e. groundnut, urad, sesamum, barley, and vegetables. In Bhatiya's index, the moderate diversification of crops lies between the index value of 28.55 and 30.35. Applying this technique, seven blocks were reported to have moderate diversification of crops. These blocks comprised Palia, Ramiabehar, Nakha, Lakhimpur, Bhehjam, Mitauli and Mohammadi. While the results by applying Singh's techniques are slightly different. In this index, the moderate diversification is registered between the index values of 19.47-23.82. Hence, six blocks were registered with moderate crop diversification. These blocks consisted of Palia, Ramiabehar, Isanagar, Phoolbehar, Kumbhi, and Pasgawan.

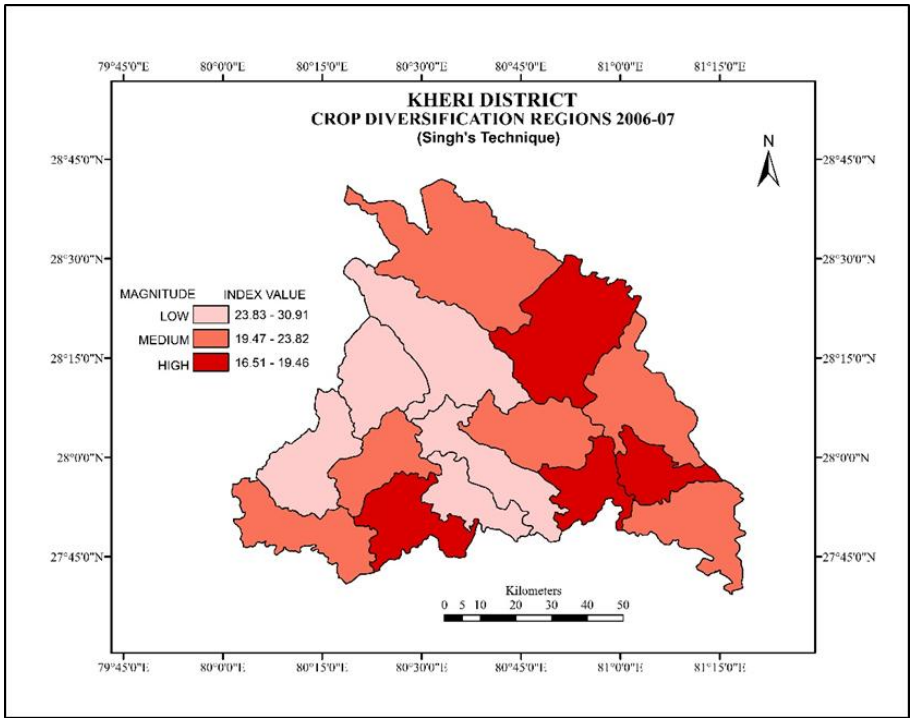


FIGURE 4: Crop Diversification Index after Singh

6.1.3 Area of Low Diversification

According to Gibbs and Martin's technique, the low crop diversification was recorded in the index up to 0.69. There were five blocks in the district which were experiencing the low crop diversification. These blocks were Palia, Bankeyganj, Phoolbehar, Bijua and Mohammadi. While in Bhatiya's index of diversification, the low diversification of crop was scaled between 30.36 and 30.91. Only three blocks fell into this category namely Bijua, Phoolbehar and Bankeyganj. With the application of Singh's technique, the low diversification of crop is scaled between the index values of 23.83-30.9. The low crop diversification, in this index, was found in five blocks. These blocks consisted of Bijua, Lakhimpur, Behjam, Bankeyganj and Mohammadi. Thus from the above analysis, it has been pointed out that the low diversification of crop was dominant in Bijua and Bankeyganj by applying all the techniques.

TABLE 2
CROP DIVERSIFICATION INDEX, KHERI DISTRICT, UTTAR PRADESH 2016-17

Blocks	Gibbs and Martin's Index	Bhatiya's Index	Singh's Index
Palia	0.69	23.75	23.75
Nighasan	0.66	30.81	30.81
Ramiyabehar	0.66	30.18	30.18
Kumbhi	0.67	29.73	23.89
Bijua	0.69	30.55	30.55
Bankeyganj	0.71	31.17	31.17
Mohammadi	0.69	30.09	30.09
Mitauli	0.72	29.03	23.41
Pasgawan	0.72	29.24	23.53
Behjam	0.73	29.51	23.41
Lakhimpur	0.73	29.76	29.76
Phoolbehar	0.72	30.56	30.56
Nakha	0.72	29.06	23.28
Dhaurehra	0.72	28.40	22.66
Isanagar	0.65	27.80	24.19
Kheri District	**0.72**	**29.70**	**23.59**

Source: computed by the author from District Statistical magazine, Kheri District, 2016-17

6.2 Crop Diversification (2016-17)

A comparison of crop diversification has been made of a decade. The data of 2016-17, after10 years from 2006-07 has been analyzed to examine crop diversification in different blocks of Kheri district. Three techniques are adopted to scale the level of diversification in the district i.e. Gibbs and Martin's technique, Bhatiya's technique, and Singh's technique. All the blocks are stratified in three categories-high, medium and low following the indices are given by these scholars.

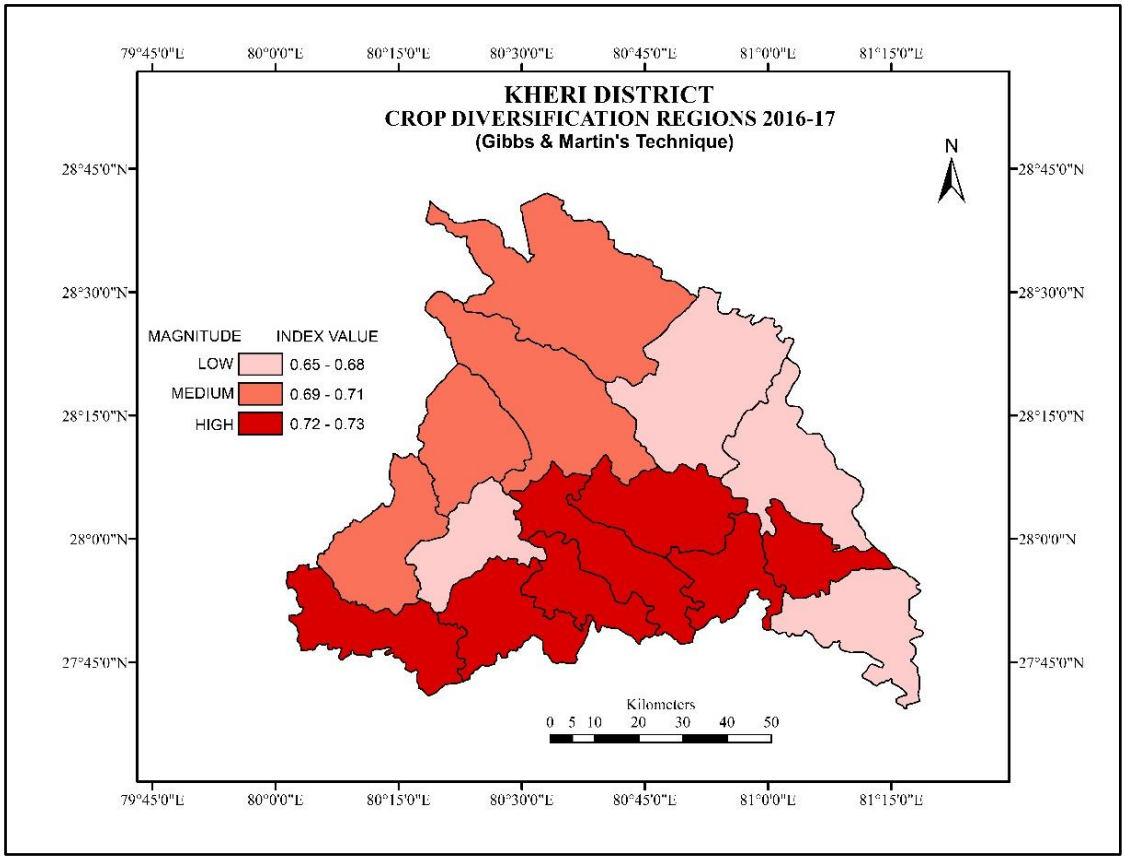


FIGURE 5 Crop Diversification Index after Gibbs & Martin

6.2.1 Areas of High Diversification

Gibbs and Martin's index (Fig 5) categorized the high diversification of the crops between the index value of 0.72 and 0.73. On this basis of this technique, seven blocks are identified as the highly diversified area in terms of crop cultivation. Pasgawan, Mitauli, Behjam, Lakhimpur, Phoolbehar, Nakha, and Dhaurehra blocks were reported high crop diversification. In Bhatiya's technique (Fig 6), the high diversification was scaled between 23.75 and 27.83 in the index. Only two blocks were identified to have high crop diversification i.e. Palia and Isanagar. While considering Singh's technique (fig 7) of crop diversification, the index of high diversification ranged from 22.66 to 24.19. As a result, eight blocks fell in this category of high diversification. These blocks were identified as Palia, Dhaurehra, Isanagar, Nakha, Behjam, Kumbhi, Mitauli and Pasgawan.

6.2.2 Areas of Moderate Diversification

The areas of moderate diversification have been scaled by Gibbs and Martin's technique between the value between 0.69 and 0.71 values in the index. Based on this technique, four blocks are recognized as the blocks of moderate diversification in the district. These blocks consisted of Palia, Bijua, Bankeyganj, and Mohammadi. On the other hand, Bhatiya's technique ranged between 27.84 and 30.01 to depict the moderate diversification of the crops. Interestingly, all the southern crops are fallen in this category. These blocks are Dhaurehra, Nakha, Lakhimpur, Behjam, Kumbhi, Mitauli and Pasgawan. While applying Singh's technique, the index of moderate crop diversification scaled between 24.20 and 30.18. Only three blocks are laying in this category i.e. Ramiabehar, Lakhimpur and Mohammadi.

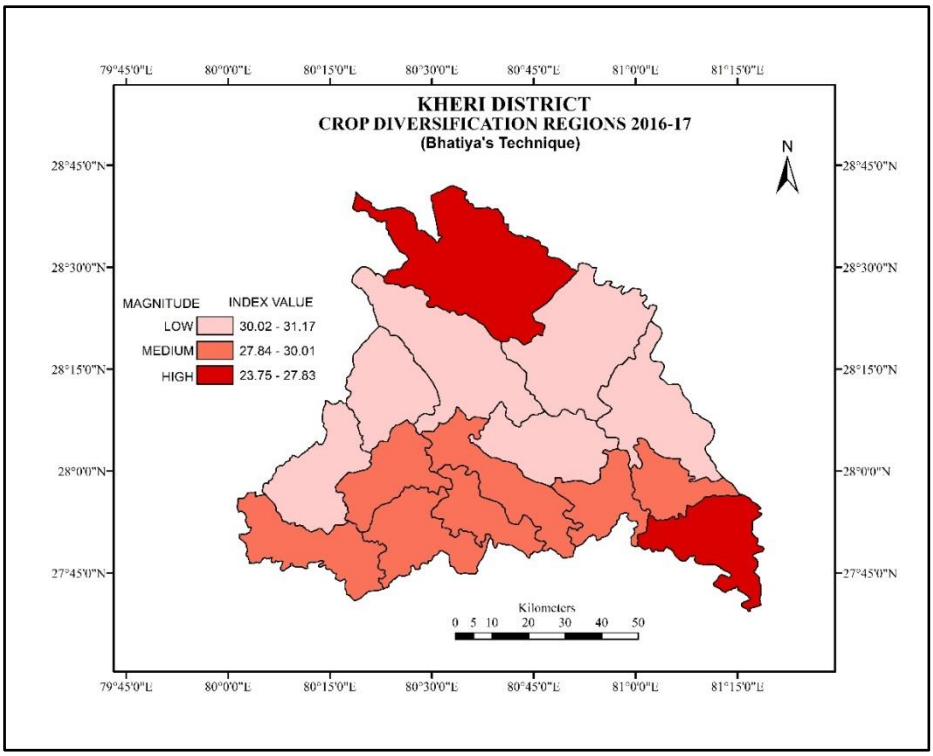


FIGURE 6: Crop Diversification Index after Bhatiya

6.2.3 Areas of Low Diversification

According to Gibbs and Martin's technique, the low diversification of crops has been demonstrated in the choropleth map between 0.65 and 0.68. The total number of blocks in this category was four i.e. Nighasan, Ramiabehar, Isanagar and Kumbi. While applying Bhatiya's technique the diversification of crop is low between 30.02 and 31.17 in the index. A total of six blocks fell in these categories which are Mohammadi, Bankeyganj, Bijua, Phoolbehar, Nighasan, and Ramiabehar. While applying Singh's technique the low diversification of crops has been ranged between the value of 30.19 and 31.17 in the index. Low crop diversification was identified in for blocks according to this technique these blocks are Bankeyganj, Bijua, Phoolbehar, and Nighsan.

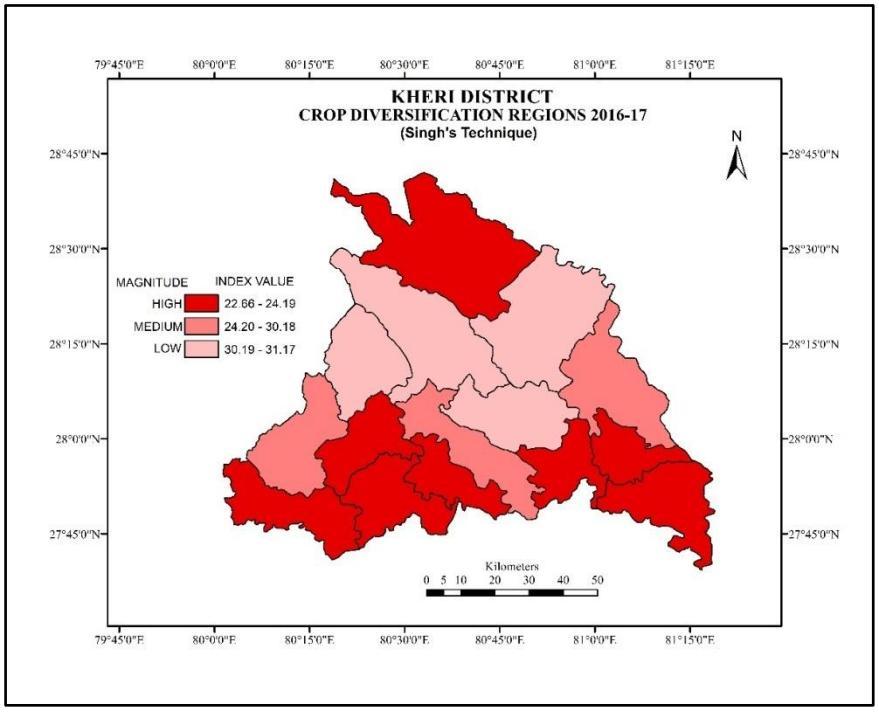


FIGURE 7: Crop Diversification Index after Singh

TABLE 3
CHANGES IN THE CROP DIVERSIFICATION IN KHERI DISTRICT BETWEEN 2006-07 AND 2016-17

Blocks	Gibbs and Martin's Index		Bhatiya's Index		Singh's Index	
	2006-07	2016-17	2006-07	2016-17	2006-07	2016-17
Palia	0.69	0.69	29.13	23.75	23.56	23.75
Nighasan	0.75	0.66	27.96	30.81	19.24	30.81
Ramiyabehar	0.75	0.66	28.92	30.18	23.03	30.18
Kumbhi	0.74	0.67	28.92	29.73	23.82	23.89
Bijua	0.72	0.69	30.57	30.55	30.57	30.55
Bankeyganj	0.71	0.71	30.91	31.17	30.91	31.17
Mohammadi	0.72	0.69	29.72	30.09	29.72	30.09
Mitauli	0.75	0.72	28.38	29.03	19.46	23.41
Pasgawan	0.74	0.72	28.45	29.24	23.51	23.53
Behjam	0.73	0.73	29.85	29.51	29.85	23.41
Lakhimpur	0.73	0.73	29.29	29.76	29.29	29.76
Phoolbehar	0.72	0.72	30.37	30.56	30.37	30.56
Nakha	0.73	0.72	29.29	29.06	23.31	23.28
Dhaurehra	0.76	0.72	22.81	28.40	19.35	22.66
Isanagar	0.75	0.65	26.59	27.80	16.51	24.19
Kheri District	**0.74**	**0.72**	**28.93**	**29.70**	**23.26**	**23.59**

Source: Computed by the author, 2019

Table 3 shows the change in crop diversity during the period of 10 years. This comparative analysis helps to understand the pattern of crop diversification in two different years. Considering Gibbs and Martin's technique, in the year 2006-07, Dhaurehra block registered the highest diversification of crops with an index value of 0.76, while, Palia was the least in crop diversity with an index value of 0.69. Applying the same technique, in the year 2016-17, Lakhimpur and Behjam recorded the highest crop diversification, however, Isanagar was the at the bottom. In Bhatiya's technique, in the year 2006-07, Dhaurehra was at the top in terms of crop diversity with an index value of 26.59 and Bankeyganj block was at the lowest in crop diversity having the index value of 30.91. Using the same technique, in the year 2016-17, Palia registered the highest crop diversity with an index value of 23.75, on the other hand, Bankeyganj was at the bottom line with an index value of 31.17. Similarly in Singh's index of crop diversification, in 2006-07, Isanagar experienced the highest crop diversity with an index value of 16.51 and Bankeyganj block was leading in crop specialization with an index value of 30.91. While in the year 2016-17, the crop diversification, using Singh's technique, Dhaurehra registered the highest crop diversity with an index value of 22.66, and Bankeyganj block was at the bottom in terms of crop diversification scaling 31.17 index values.

VII. CONCLUSION

The findings of the study show that the intensity of crop diversification in all the blocks quite lies in the same range. In some cases, the differences are found, which is due to the differences in the formulas of various techniques. The blocks lying in the high crop diversity may be slipped to moderate in the other technique's application but it did not fell in the category of low diversification and vice versa. Thus, all the techniques depict the resembling picture of diversification in the 15 blocks of the Kheri district. The results suggested that, in 2006-07, the diversification was recorded high in the northern and southern blocks like Nighasan, Dhaurehra, Isanagar, Mitauli, and Pasgawan while the blocks lying in the western and central region registered the low intensity of diversification. While, in 2016-17, southern blocks registered high crop diversification and the diversification was low in the central region in almost all the techniques applied.

REFERENCES

[1] B.K. Ghosh, Determinants of the Changes in Cropping Pattern in India: 1970-71 to 2006-07, The Bangladesh Development Studies, Vol. 34, No. 2 (June 2011), pp. 109-120

[2] E.G. Smith, and D.L. Young, Cropping Diversity along the U.S.-Canada Border, Review of Agricultural Economics, Vol. 25, No. 1 (Spring - Summer, 2003), pp. 154-167

[3] Engelbrech, Agricultural Regions of Asia, Part IV: India," Econ. Geog., Vol. 9, 1933, pp. 109-136

[4] J. Singh, and R.S. Sidhu, Factors in Declining Crop Diversification: Case Study of Punjab, Economic and Political Weekly, Vol. 3, 9No. 52 (Dec. 25-31, 2004), pp. 5607-5610

[5] K.S. Ahmad, Geographical factors in the production and distribution of wheat in the Panjab, and distribution of wheat in the Panjab," Calcutta Geogra. Rev., Vol. 4, 1942, pp. 124-146

[6] M. K. Papademetriou, and F.J. Dent, Crop Diversification in The Asia-Pacific Region, Food And Agriculture Organization of The United Nations Regional Office for Asia And The Pacific Bangkok, Thailand, April 2001, RAP Publication: 2001/03

[7] M.A.S. Mandal, and S.C.Dutta, Irrigation for Crop Diversification in Rice-based Systems in Bangladesh, The Bangladesh Development Studies, Vol. 21, No. 3, Crop Diversification in Bangladesh (September 1993), pp. 91-100

[8] P.P.Courtenay, The Diversification of Malaysian Agriculture, 1950-80: Objectives and Achievements, Journal of Southeast Asian Studies, Vol. 15, No. 1 (Mar., 1984), pp. 166-181

[9] R. Mandal, Cropping Patterns and Risk Management in the Flood Plains of Assam, Economic and Political Weekly, Vol. 45, No. 33 (August 14-20, 2010), pp. 78-81

[10] S. Chakrabarti, and A. Kundu, Rural Non-Farm Economy: A Note on the Impact of Crop-Diversification and Land Conversion in India, Economic and Political Weekly, Vol. 44, No. 12 (Mar. 21 - 27, 2009), pp. 69-75

[11] S. Zohir, Problems and Prospects of Crop Diversification in Bangladesh, The Bangladesh Development Studies, Vol. 21, No. 3, Crop Diversification in Bangladesh (September 1993), pp. 73-90

[12] S.C. Blank, Returns to Limited Crop Diversification, Western Journal of Agricultural Economics, Vol. 15, No. 2 (December 1990), pp.204-212.

[13] S.S.Bhatiya, Patterns of Crop Concentration and Diversification in India, Economic Geography, Vol. 41, No. 1 (Jan., 1965), pp. 39-56.

AD Publications
Sector-3, MP Nagar, Rajasthan, India
www.adpublications.org, www.ijoear.com, info@ijoear.com